

Modelling Early Food Production in the Mid-Holocene of the Eastern Sahara. A Sustainable Rural Livelihood Approach

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Declaration:

I, Andie Byrnes, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

The thesis employs an approach adapted from the Sustainable Rural Livelihoods (SRL) model, which was pioneered in development economics. The model provides both descriptive and explanatory components. The purpose of the research is to determine whether the SRL approach can improve the handling of archaeological data and its interpretation. It has been tested in four case studies focusing on early food production in marginal areas of the mid-Holocene eastern Sahara. It assesses how livelihoods were practiced in terms of risk and sustainability. A strength of the SRL approach is that it incorporates the belief that all aspects of a livelihood should be allocated equal value, including economic, ecological, human wellbeing and social assets. In particular it provides the opportunity to evaluate a qualitative model to improve an understanding of the variables that might have influenced livelihood strategies in prehistory. Ethnographic data has been employed to inform an understanding of the risks and opportunities confronting populations living in arid and semi-arid environments. In the penultimate chapter the thesis compares the findings from the four case studies to test the value of the SRL model for drawing inferences about risk, opportunity and sustainability in arid and semi-arid environments. Whilst the research is not problem-orientated it does identify gaps in current research with a view to recommending new research priorities.

Impact Statement

The Sustainable Rural Livelihood approach is derived from problem-orientated development economics but this thesis assesses it in terms of its value to academic archaeology. Within archaeology the research has two possible applications: 1) in the design of field archaeology projects that seek to prioritise data collection and 2) in the field of data analysis and interpretation after excavations have taken place. To test the value of the latter, I plan to publish the SRL approach online, together with all four case studies, to engage in discussion with researchers who have expertise in these areas, to measure the value of the approach and to refine it. The same methodology could be applied usefully to ethnographic research, following an analysis of its potential role in ethnographic theoretical approaches. Looking beyond academic applications, it would be interesting to apply the model to studies of small communities impacted by heritage tourism, where it could be used not merely to assess impacts but to devise solutions to some of the more pressing problems being experienced. I am currently using the model as a methodology for assessing information about the socio-economic context of long distance maritime trade in the 19th Century. This is a minor part of a bigger project but should measure the value of the SRL approach in historical periods. This project will be published online when the project is complete and an assessment of the value of the SRL approach will be published as an appendix at that time. Although I have not yet investigated the possibilities of the SRL approach as a collaborative tool, I would hope that it will be possible to work with others to investigate other potential uses for the SRL model.

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Illustrative Material

The four Case Studies that support this thesis are contained on the CD-ROM enclosed. They can also be found online at www.polstudy.wordpress.com, which can also be accessed using the following QR code:



1 - Introduction

1.1 Introduction to the research questions

Nomadic and semi-nomadic pastoralists during the mid-Holocene in the eastern Sahara experienced variable environmental conditions in marginal areas and employed a number of livelihood management strategies to handle risk and uncertainty as climatic conditions began to deteriorate. This research employs a qualitative approach pioneered in development economics to look at the conditions under which early food production emerged in marginal dryland areas of the mid-Holocene eastern Sahara. The objectives are to assess the livelihoods that were practiced under these conditions and determine how these livelihood practices can be assessed and compared in terms of risk, opportunity and sustainability. The thesis is not designed to answer problem orientated questions encountered in the prehistory of the eastern Sahara, but instead concentrates on a methodology for data analysis using eastern Saharan regions as case studies.

Four geographical areas are used as case studies (figure 1.1), each in a different type of dryland environment, each of which focuses on the investigation and evaluation of livelihood management in early food producing economies in Egypt. Much of the excellent research conducted into these areas is currently represented by data scattered throughout assorted publications and websites and is rarely assembled into synopses for each region. These four areas are discussed using the Sustainable Rural Livelihood approach developed for use in development economics (Carney 1998; DFID 1999; Farrington *et al* 1999; Hamilton-Peach and Townsley 2007; Sayer and Campbell 2004, p.215-221) in order to explore the relationships of different livelihood assets, influential variables and potential livelihood outcomes. A particular interest is how different livelihood approaches handled risk, opportunity and sustainability in dryland environments.



Figure 1.1 - The regions where the four case studies are based (Source: Google Earth)

The mid-Holocene presented both opportunities for groups and challenges to groups exploiting dryland livelihoods, and were characterized by seasonal uncertainty and longer term climatic fluctuation, which influenced the types of livelihood strategies that could be supported and the types of social complexity that emerged. Accordingly, the research questions have been formulated as follows:

Can a model derived from development economics describe and characterize mid-Holocene livelihoods in the eastern Sahara and elsewhere, in terms of risk, opportunity and sustainability allowing them to be directly compared and contrasted? Specifically:

- Can the chosen Sustainable Rural Livelihood (SRL) approach help to provide an understanding of dryland livelihoods in the east Sahara in the mid-Holocene, in order to improve the ability of archaeologists to handle vulnerabilities (risk and uncertainty) and opportunities in order to achieve sustainability?
- Can the SRL model help to standardize the collection and presentation of data
- Can ethnographic material help to interpret prehistoric socio-economic data captured in the SRL model, maximizing the value of the archaeological data?
- Can the SRL model help to improve the ability of archaeologists to compare and contrast the use of landscape?
- Can the model suggest new problem-orientated data collection priorities?

The Sustainable Rural Livelihood (SRL) approach provides both a descriptive matrix and an explanatory component which includes variables that can act on any given situation. Four case studies are described using the Sustainable Rural Livelihood framework developed for use in development economics. These are used to explore the relationships of different livelihood assets, influential variables and outputs. In its Guidance Sheets, the Department for International Development (DFID) has described the Sustainable Livelihood approach as follows (DFID 1999, p.1):

The sustainable livelihoods framework presents the main factors that affect people's livelihoods, and typical relationships between these. It can be used in both planning new development activities and assessing the contribution to livelihood sustainability made by existing activities. In particular, the framework:

- provides a checklist of important issues and sketches out the way these link to each other;
- draws attention to core influences and processes; and
- emphasizes the multiple interactions between the various factors which affect livelihoods.

The framework is centred on people Its aim is to help stakeholders with different perspectives to engage in structured and coherent debate about the many factors that affect livelihoods, their relative importance and the way in which they interact.

This is conceptualized as a diagram that shows how different components and influences can be visualized, explored and analyzed. It has been modified here to reflect that it is being used to deal with prehistoric contexts before the development of modern organizations, formal institutions and government bodies (figure 1.2). This diagram is shown at full size in Chapter 2 (figure 2.12), where it is discussed in detail. The framework is intended to assist analysis for the purpose of managing complex data, not to constrain it: "The livelihoods framework is not intended to depict reality in any specific setting. It is, rather, intended as an analytical structure for coming to grips with the complexity of livelihoods" (Farrington *et al* 1999, p.3):

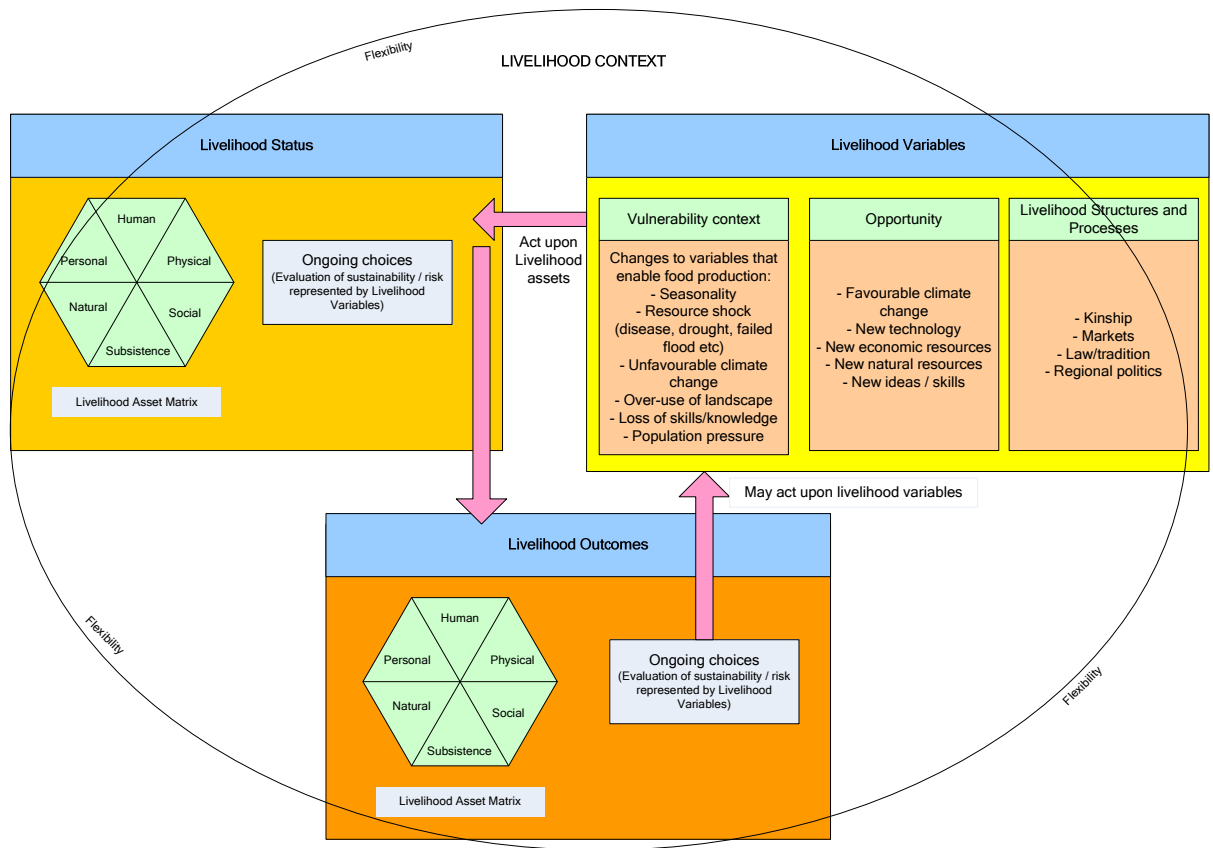


Figure 1.2 - The Sustainable Rural Livelihood Model

1.2 Hypotheses

The research questions listed above have been formulated as six hypotheses. Joel Mokyr warns about making the hypotheses too inflexible to be tested reasonably, but not so flexible that they cannot be tested either usefully or at all (Mokyr 1983, p.1).

A - New approaches to modelling in archaeology, derived from approaches in development economics and created explicitly to analyze livelihood sustainability, can improve data capture and analysis in archaeology.

By applying techniques that look at the entire profile of a given community within a clearly defined framework, it should be possible to capture and characterize the full range and depth of its status and its potential for sustainability. As development economics needs to include data from both economic and social components of human life in order to assist and achieve sustainability, its focus is on achieving depth of understanding in all segments of a

community's life (DFID 1999). It is hoped that this approach will assist archaeologists to obtain maximum information from even minimal data.

It is expected that descriptive and analytical methods used in development economics can be used to help understand process in the past, and that these approaches, by focusing explicitly on sustainable livelihoods, provides an appropriate lens through which to view, understand and characterize the early food producing activities of prehistoric groups. The Sustainable Rural Livelihood approach, which includes both economic and social parameters as assets involved in livelihood management, should help to present a balanced view of all the factors which that influence behaviour.

B - The Sustainable Rural Livelihood (SRL) model provides a new way of bridging between ethnographic and archaeological data in a way that enables archaeologists to maximize the value of sometimes sparse data in marginal dryland environments.

The SRL model is a practical tool for gathering data, can also be used as a way of demonstrating the value of ethnographic data for informing archaeologists about processes in dryland environments by assembling ethnographic data in the SRL model prior to its use for archaeological data, thereby building an understanding of how ethnographic and archaeological data might correspond to one another.

C - The SRL Model improves comparative studies between contemporary sites by presenting data within the same formal framework of analysis.

The SRL model is a formal framework for capturing and describing data and identifying influences that might result in changes to sustainability (Carney 1998; DFID 1999; Morton and Meadows 2000). By capturing data within the clearly defined categories, it is possible to compare different sites or areas across all categories or within a specific set of categories. This enables different levels of complexity to be picked out and focused upon.

D - Variables involved in decision making and risk handling that may lead to changes in the archaeological record can be suggested by completing the SRL Model

Although Eastern Saharan data is not, in general, sufficiently robust to establish a direct relationship between possible influences on human activity and actual outcomes, the data can suggest why the archaeologically visible outcomes occurred. Decisions made under conditions of risk and uncertainty, and requirements for sustainability will be tested using data from the mid-Holocene eastern Sahara.

E - The SRL Model will help to clarify priorities for data collection

By insisting that all aspects of a community's life are important to its sustainability, new approaches in development economics help to create complete pictures of a community's status. In archaeology, similar gaps can be highlighted and, where possible, new strategies developed for looking at gaps in knowledge and how to address them can be identified.

F - The SRL Model can help to answer specific key questions about livelihood management systems

At the end of each case study the same eight key questions are asked of the data, and these are used to measure how successful the completion of the model was in the extraction of data from the published material. These questions are about livelihood management techniques, risk handling and sustainability.

Potential Problems

- It was identified at an early stage that the archaeological data might be too impoverished to fulfil the requirements of the SRL model, thereby presenting a risk to exploring hypotheses A – D. It was a concern that extrapolation from the data would make it either difficult or impossible to populate the SRL model in part (with an emphasis on data in any one category at the expense of any other) or in total (with insufficient data under any category). As one of the purposes of this approach is to provide a balanced way of presenting and using data to understand both economically rational and irrational variables influencing behaviour, failure to adequately complete the model in at least one of the case studies would represent a failure of the modelling approach used.
- With respect to E, although it was expected that research gaps would be identified, it was equally possible that they would not be.

1.3 Methodology

1.3.1 Process

In order to pull all the threads of the thesis together, which includes data drawn from archaeological research, ethnography, development economics, economic anthropology and quantitative analysis techniques, the following methodology has been used to assemble and present the required components. Only published material is used. The steps describe how the research has been assembled, shown as a schematic in figure 1.3:

- Selection of four regions with which to conduct the case studies
- Identification of and description of the modelling and theoretical systems that are to be used for descriptive and explanatory purposes (chapter 2)
- Familiarization with ethnographic material and development economic research into sustainable dryland economies (chapter 2; appendices C, D, E, F and H)
- Situation of the modelling techniques employed in the thesis within an archaeological theoretical framework (chapter 3)
- Familiarization with eastern Saharan archaeology
- Establishment of the climatic and environmental background to the mid-Holocene (chapter 4)
- Research into risk and uncertainty in dryland environments (chapters 4 and 5)
- Formulation of key questions for applying the SRL model to issues of risk, opportunity and sustainability (chapter 7, section 7.1.6).
- Creation of a template for data collection for the case studies (chapter 7)
- Application of the SRL Model to the data to the four areas (chapters 6, 7 and 8; case studies), supplemented by additional techniques as required (described in chapter 2).
- Comparative analysis of the four case study areas (chapter 9)
- Measurement of all findings against the hypotheses and presentation of final conclusions (chapter 10)

Methodology					
	Initial Research	Core Research	Implementation	Comparison	Conclusions
	<div>Research into the possibility of using economic modelling in archaeology</div> <div>Selection of case study areas and initial assessment of the quality of the data</div>	<div>Risk and uncertainty in ethnographic research</div> <div>Situate model in an archaeological theoretical context</div> <div>Research climatic context</div> <div>Familiarization with qualitative techniques</div> <div>Familiarization with the archaeology of the eastern Sahara</div>	<div>Application of SRL model in four eastern Saharan case studies</div>	<div>Comparative analysis of all four case studies</div>	<div>Final conclusions</div>

Figure 1.3 - Schematic showing the main stages in the completion of the thesis

1.3.2 Data Quality, Collection and Inference

1.3.2.2 Data Quality and Limitations

The SRL approach depends upon the availability of data for all asset components within the matrix. As stated in section 1.2 on page 20, a successful test of the case studies depends on sufficient data to be available in at least one of the case studies. In this section of the quality and limitations of the data are assessed.

In all of the case studies the quality of the archaeological data is very variable and often fragmentary due to natural and human processes (Butzer 1982, p.177-181; Kuper 2002; Schild and Wendorf 2012). In hyper-arid areas, due to the friability of sand and the impacts of wind erosion on lighter particles of sand and organic remains many occupation sites are heavily deflated and may be completely unstratified, surviving as palimpsests of mainly inorganic materials on a single modern surface (Garcea 1993). Organic remains rarely survive this process, leading to a depletion of zoological and botanical information, and much of the remaining objects may be heavily abraded (Fanning and Holdaway 2001; Shirai 2005a). It should be noted that even where stratigraphic information is available from sites, some of these are from a small number of small sample trenches cut through much larger sites, and therefore provide a potentially biased sample, presenting only part of the complete story (Hodder 1999, p.52-3; Lucas 2001, p.60-61; Lucas 2012, p.63-66; Trigger 1996, p.402). Even

in the case of the Badarian sites, the lack of stratigraphy and the failure to establish a typological sequence means that it too must be treated as a palimpsest. This is discussed further in Chapter 6, "Introduction to the Case Studies." Modern techniques have been applied to most of the areas, but in the cases of both Gilf Kebir and the Badarian excavations the quality of the excavation techniques from the 1920s to 1950s (Bagnold *et al* 1939; Brunton and Caton-Thompson 1928; Brunton 1937, 1948; Rhotert 1952), was inferior to those of today, as discussed below.

Rock art data is included in the Gilf Kebir case study, because modern excavations and analysis have provided convincing indications of different phases of rock art themes correlating with palaeozoological data and dated archaeological remains (Kuper 2013; Honoré 2017; Zboray 2009, 2013). However, rock art in Dakhleh Oasis is not included as a dataset due to problems correlating rock art and archaeological phases. Although it is considered to be broadly "Neolithic," (Polkowski *et al* 2013) this includes early and late Bashendi A, Bashendi B and Sheikh Muftah periods, which is not sufficiently specific to be of use as a dataset for the Bashendi B.

In the cases of the Gilf Kebir, Nabta Playa and Dakhleh Oasis, modern field work have ensured that data is captured using modern surveys, excavations and sampling techniques. Publication has, however, been variable.

At Nabta, because the site is in the desert it did not suffer from agricultural or other forms of development, but sites and artefacts have suffered deflation, erosion and abrasion. Poor preservation has favoured inorganic remains, particularly lithics (e.g. figure 6.4) and deflation at the site led to the preferential survival of the bones from medium-sized and larger animals and poor preservation of plant remains. Gautier (2001) notes that sampling of archaeozoological remains at both Nabta has been problematic because a) sample sizes have differed due to alternative sampling strategies and b) samples sent away for analysis were often selected by non-specialists and c) field identifications that were made by specialists were carried out without comparative data that would have been available under lab conditions (Gautier 2001, p.610). Storage inadequacies and failure of remote specialists to return samples aggravated the situation. Looting from the site has been a problem. This was magnified after the publication of a book that interpreted the site in terms of star maps dating to 16,500-17,500BC (Brophy 2002) and generated a lot of unwanted interest in Nabta from New Age enthusiasts (Schild and Wendorf 2012; Wendorf and Schild 2015). Souvenir hunters visit the site and do it considerable harm by denuding the site of artefacts, moving stone slabs from one site to another and rearranging both objects and sites, particularly the stones of the stone circle (Schild and Wendorf 2012, p.429). The stone circle and other key components have therefore been moved to the Nubia Museum in Aswan, where they are a permanent outdoor installation (Wendorf and Schild 2015). Regarding publication, two volumes were produced. The first volume (Wendorf, Schild *et al* 2001) described fieldwork in detail, but information was not standardized from one paper to the next so much of the information about

technologies (e.g. core types and numbers, debitage and artefact types) are not directly comparable from one site to the next. In addition, it prioritized the Early Neolithic rather than the Late Neolithic. In the second volume (Nelson *et al* 2002) the ceramics are discussed, but there are inconsistencies in the tabulation of the data presented in the text, discussed further in Chapter 8, the Nabta Playa case study.

Most of the sites are in areas that are now desert around the edges of the modern oasis. Some are undoubtedly under cultivated land, as is the case in the Nile valley. Because they are essentially desert sites, they are often in highly deflated condition, but as well as the usual inorganic remains, some organic remains have been found including bones, pollen and macrofossils and radiocarbon dates are available from numerous sites (McDonald 2016, p.182).

Some of the results of the strands of research by the **Dakhleh Oasis Project** have been presented at a four-yearly conference and are published as interim reports in the Dakhleh Oasis Papers monographs and in papers scattered through various journals and edited volumes, detailed in Chapter 6. A volume dedicated to the ceramics of Dakhleh in 2018, was produced in 2018 (Warfe 2018). No equivalent exists for the lithic technology, and no detailed data has been published on core and debitage types, so there are some significant differences in the availability of the data between this and the other case studies. So far there is no single overview of the prehistory of Dakhleh. The research by Woods (2016) into religion and ritual in the prehistory of the Western Desert includes Dakhleh but is exclusive to undated rock art and is not incorporated into the case study. There have been no reports of tourist activity that has afflicted the Gilf Kebir and Nabta.

In the Gilf Kebir tourism has been a problem (Kuper 2002). Although it is in one of the most remote areas of Egypt, Wadi Sura I in the Gilf Kebir (Almasy 1939; Kelly 2002), became enshrined in the 1996 film “The English Patient” as The Cave of Swimmers. Just before the 2011 revolution in Egypt over 2000 visitors a year took trips to the site and, in the process, collected artefacts as souvenirs from the desert surface, damaging the prehistoric surfaces in four-wheel drives and inflicting damage on the rock art by touching, wetting and tracing it (Honoré 2017, p.7; Kuper 2007a, p.24; Kuper 2002b, p.118-21). Nabta Playa is a short drive from the main road leading to the major tourist destination at Abu Simbel, and has suffered a similar fate, with the added indignity of being targeted by New Age enthusiasts who have routinely rearranged objects and monuments (Schild and Wendorf 2012). Some of the most important monuments have now been located to the Nubian museum in Aswan to protect them (Schild and Wendorf 2015). The main publication of the Gilf Kebir (Linstädter 2005a), largely written in German, prioritizes the Gilf B rather than the Gilf C. There has been no central publication of the Dakhleh Oasis information, so the data is scattered through various publications and re-uses the same core images. Very little information is available in tabulated form about the technologies employed, meaning that very little extrapolation is possible from the data presented. In addition, the earlier Masara periods are privileged in the publications.

On a positive note, in each case sufficient archaeological material survives to enable experimental assessments to be made of the livelihood strategy of each group under consideration, and in each area there is sufficient climatic and environmental data to attempt to reconstruct natural contexts in which livelihoods were practiced.

The **Badarian excavations** ran over three seasons, 1922-3, 1923-4, and 1924-5 (Brunton 1929; Brunton 1929b; Brunton 1937; Brunton 1948; Brunton and Caton-Thompson 1928). Excavation standards were advanced for the period, but the publications were by no means as detailed as modern reports. At Badari, Mostagedda and Matmar, Brunton excavated both cemeteries and settlements, but focused attention on the cemetery sites (Brunton and Caton-Thompson 1928; Brunton 1937 and 1948). He cleared whole sites rather than sampling them, meaning that there was little left to explore later. Caton-Thompson describes how in the 1923-24 season he had 300 workmen “methodologically working the screes northwards to Badari” (Caton-Thompson and Whittle 1975, p.90). He made no plans of sections and no stratigraphic features were noted. Only a few of the burials were published as plans. Much of the organic material excavated was so fragile that it could not be preserved, and Brunton commented at Mostagedda, when talking about the difficulties of excavating matting, that the team’s “botanical knowledge was insufficient to describe it accurately in the field” (1937, p.47). Similarly, no experts on site were available to analyze the human remains. The excavations at Mostagedda in two seasons in 1927/28 to 1928/29 and Matmar in another two season in 1929/30 and 1930/31 were both published many years after the excavations were carried out in 1937 and 1948 respectively and far more briefly than the Badari excavations. The collection strategy at settlement sites favoured only the most diagnostic pieces of stone tool technology and ceramics, to the detriment of debitage (Caton-Thompson and Whittle 1975, p.90; Holmes 1989a, 1989b; Friedman 1994, p.304-7). Tomb robbing was extensive at the cemetery sites (Brunton 1929, p.458). Sites were also disturbed by later re-use, particularly in the Old Kingdom and Roman periods. In all his publications Brunton indicates where sites were disturbed and undisturbed (Brunton 1937, 1948; Brunton and Caton-Thompson 1928). Caton-Thompson, looking for a stratified settlement site, confined her activities to Hemamiyeh North Spur (Brunton and Caton-Thompson 1928, chapter V). She divided the site into strips 35ft long by 10ft wide, which were then divided into 5-foot squares, and each artefact was located to the nearest foot and precise depth, and she undertook sieving at the site. The excavation established that the Badarian predated the Naqada I period, but the fixed 6-inch levels did not correspond to the actual stratigraphy of a sloping site with varying levels of stratigraphic thickness, meaning that it has proved to be impossible to tie the different parts of the site together in a stratigraphic sequence. The only secure internal distinction observed is a natural formation that Caton-Thompson calls breccia, found 6 and a half feet below the surface, which seals largely undisturbed deposits below and has deposits that overlie it. Other Badarian levels over the top lie between 6ft and 4ft 6 inches and above that, to a level of 3ft 6 inches, was a Badarian / Naqada I transition layer. Caton-Thompson never had the chance to give a full account of the excavation, on the one hand due to restrictions imposed by publication

costs which prevented her from discussing the sections and inventory in detail and publishing a separate publication on flint implements; and on the other by the destruction of all her field notes, unpublished sections and photographs during the London Blitz in 1940 (Caton-Thompson and Whittle 1975, p.89). The review of Badarian lithics in museums by Diane Holmes (1989a) demonstrates highly selective object collection practices, focusing on distinctive artefacts at the expense of less distinctive flakes and debitage, meaning that modern analysis of the lithic assemblage is confined to only a biased sample of the full lithic dataset preserved in museum collections. The excavated material from the Brunton and Caton-Thompson excavations was divided between twenty eight different museum collections, a practice consistent with the conventions of the day. The largest single accessible collection is in the Petrie Museum of Egyptian Archaeology at UCL, London. Publication of the Badarian (Brunton and Caton-Thompson 1928; Brunton 1937, 1948) was impressive in its day, but complete records of all sites were not published, and modern analysis focusing on museum collections has been important but has not been drawn together in a modern interpretative synthesis.

Poor quality data is unavoidable in the eastern Sahara. Variability in the quality of the data obviously presents potential problems for any approach attempting to assess all aspects of a livelihood. Palimpsests (defined in Appendix A) and items in museum collections that are only loosely provenanced can provide a particular challenge for archaeologists. Approaches to such problematic datasets clearly require the development of consistent methodologies that produce archaeological interpretations that are generally considered to be archaeologically viable. This is a matter continues to be discussed but has not yet been resolved (e.g. Allen 1991; Bailey 2007, 2008; Bradley, P. 1998b; Daubney 2015; Foley 1981a, 1981b; Fanning and Holdaway 2001; Gordon 2006; Hey 1999; Historic England 2012; Holmes 1989; Lisk *et al* 1998; Lucas 2005; Schofield 1995; Snashall 2002; Vallverdú *et al* 2005; Vaquero 2008; Vaquero and Pastó 2001; Witmore 2009). Approaches to palimpsests and museum collections would develop from the development of standardized methodologies for collection and analysis in the future. A standardized approach to palimpsests, at least in the eastern Sahara, might help to maximize the value of such data, and discussion at conference level about how this might be handled could improve the analytical potential of palimpsests and the value of the output of such archaeological endeavours.

Even the simplest of the models contemplated for analysis of the four areas selected require information in a number of social, ecological and economic dimensions. However, the SRL model itself helps to tackle the issue of poor quality data by making it a requirement that surviving material is queried in different ways depending upon the problem it is being asked to address. By requiring the completion of the model down to the everyday details of livelihoods, the information available from the surviving material remains can be used to propose a range of possibilities. For example, bifacial lithic tools may answer a range of questions about economic activities, industrial production, trade and social relationships and symbolic expression. However, where the data cannot be used to complete the model in certain areas,

this is made explicit, and in the hands of a fieldwork project could be used to suggest future directions for field research.

One of the approaches taken here has been to take often reductive statements about what data represents in social terms and explore a range of other possibilities for the same data. An example from this thesis is taking the suggestion by Gillian Woods that much of the Late Neolithic ceremonial centre at Nabta can be explained by reference to shamanism, and proposing other solutions that fit the data. This produces a series of alternative outcomes rather than a definitive explanation that merit either 1) further analysis of the raw data with a view to narrowing down a plausible interpretation, 2) more excavation where possible or 3) an admission that the data cannot provide sufficient confidence in any one answer, but instead requires a more holistic approach.

In all of the case studies, where published archaeological material has not been not sufficient to extrapolate in a direct and empirical way, ethnographic research has been used to supplement archaeological data to approach questions about livelihood risks and opportunities. Whilst ethnographic information cannot substitute for archaeological data, it can help with the task of extrapolating from the archaeological remains to the livelihoods they represented. Chapter 5, "The Vulnerability Context," describes modern livelihood strategies practiced under conditions of risk and uncertainty, and this body of research has been used to suggest potential livelihood strategies that would have been available to pastoralists in the environmental conditions prevalent during the mid Holocene in the eastern Sahara. The use of ethnographic data in the thesis is discussed in this chapter in 1.5.2.

1.3.2.3 Data Collection

All of the data used within the thesis has been assembled from academic publications. Although I have visited each of the areas included in the thesis in order to understand topographical, geological and geomorphological features, together with the conditions under which artefacts have been deposited and from which they have been retrieved, I have not carried out any field work in order to supplement datasets. The objective throughout has been to use data in existing publications to see what can be extracted and extrapolated from it using the modelling techniques described in chapter 2 supplemented by knowledge derived from ethnographic data, described in chapters 3 and 5.

1.3.2.4 Publication

It has recently been pointed out (Berggren and Hodder 2003; Hurcombe 2014, p.152; Lucas 2001, p.105; Redford 2008, p.23; Weeks 2008, p.21; Whittle 2003, p.82-3) that excavation reports continue to emphasize the division of excavated remains into chronological and analytical divisions of materials assembled by separate specialists, rather than providing an integrated understanding of sites as living societies. The standard approach of the excavation report allows data to be divided into clearly delineated segments that can be reconsidered by future analysts. However, the dangers are that some object types are prioritized over others

(Lucas 2001, p.79); that specialist reports are often not incorporated seamlessly into the final consolidated report but find themselves relegated to appendices that list and tabulate features (Connah 2010, p.137); that new digital methods of recording are associated with “further systematization of work in large-scale projects and further codification may take the excavations further from the process of interpretation (Berggren and Hodder 2003, p.57); and that a filtering process on what is or is not deemed of value to include includes a bias in what is made available (Buccatelli 1998). As Hurcombe (2014, p.152) states: “although artefacts are studied by archaeologists in categories that are defined by materials . . . that is not how they existed in life This whole material culture was bound with people’s ideas, identities and beliefs.” Although, As Gosden points out (2010, p.110) archaeology may find it difficult at times to match Geertz’s “thick description” (Geertz 1973), it does have the opportunity to build on its data to provide narratives that are richer than those sometimes produced in archaeological monographs. It was hoped that the Sustainable Rural Livelihood approach would help to tackle the fragmented way in which past societies are often reported in excavation monographs, where specialist reports divide up the remains of past societies in a way that is convenient to archaeologists but often fails to represent life as it was lived. An example that comes to mind because I worked at the site is the first full report on the Middle Palaeolithic Pontnewydd Cave in North Wales (Green 1984), which consists of a series of technical reports unconnected by any form of interpretation. Another is the much-needed analysis of ceramics from Dakhleh Oasis (Warfe 2018), which is confined to a technical analysis and makes no attempt to place ceramics into the wider context of livelihoods in the oasis. This type of report is, however, the essential foundation for interpretative work (Redford 2008, p.23; Weeks 2008, p.21). These and other archaeological publication issues are discussed at length by Jones *et al*/2003. The SRL matrix also divides and subdivides societies and livelihoods (DFID 1999) but does so in a way that promotes discussion of those livelihoods within a framework that is equipped to incorporate data as a unit of analysis and interpretation. Particularly, it positions assembled data in the context of a number of dynamic variables that may act upon that data to transform it. The SRL Approach is a reflexive approach that is potentially subject to later modification as new data is secured.

1.3.2.5 Qualitative Approaches

Qualitative approaches explicitly acknowledge the dynamic character of society and recognize that interpretation is not a replication of data but an interpretation of that data, for which multiple narratives may be created. It has a transparency that allows research to be communicated to non-specialists and allows the researcher to examine how meanings are formed within cultures (Corbin and Strauss 2008). The merits of qualitative and quantitative approaches are discussed in Chapter 3 “Situating the SRL model within archaeological theoretical approaches”, section 3.5, but here it should be noted that in order for qualitative approaches to result in explanations that carry a level of confidence, detailed description is needed, to establish a strong foundation for the explanatory approaches (Corbin and Strauss 2008, p.15). The case studies therefore include a large descriptive component.

1.4 The Sustainable Rural Livelihood Model

The Sustainable Rural Livelihood (SRL) model is discussed in detail in Chapter 2. It derives from applied theoretical approaches but sits squarely between theoretical and methodological approaches. The thesis takes data from published reports, removes it from the categories in which it is usually framed in analytical divisions imposed by field and post-excavation specialists. Instead, the data is placed into a descriptive, interpretative and explanatory framework designed to reflect the livelihoods and livelihood options that are suggested by the excavated remains. The SRL approach (Carney 1999; DFID 1999; Hamilton-Peach and Townsley 2004, 2007) therefore places data presentation into an explicitly interpretative framework that lends itself to explanatory approaches and to comparative studies between different sites and areas. The SRL approach is supported, when required, by other techniques for further understanding livelihoods and their specific characteristics. The SRL approach demands a highly formal approach to data collection (DFID 1999) but provides individual researchers with flexibility about how that data is explored. In development economics it is used to create social and economic profiles in order to suggest solutions for securing sustainability in the future (Morton and Meadows 2000). In archaeology it would be most likely to form the basis of a comprehensive exploration of an excavated site, series of sites or an entire landscape.

The use of a modelling approach based explicitly on development economics, which is, as far as I know, new to archaeology is intended to represent a new way of handling existing data with a view to extracting a more complete understanding of livelihoods. This is consistent with geologist Chamberlain's approach of the late 1800s (Chamberlain 1890), also discussed Trigger (1995, p.456). Chamberlain focused on improving methods in areas where knowledge exists but much remains to be known. He describes the Euclidian approach of studying of a problem by close imitation of previous thinkers with an approach that he describes as "creative study" (Chamberlain 1890 p.754). He argues that "it is not necessary that the subject-material should be new; but the process of thought and its results must be individual and independent, not the mere following of previous lines of thought ending in predetermined results" (1890 p.754).

A possible objection to the use of the SRL model is that it is designed to represent societies in the present rather than in the past and that simply lifting it and that applying it to prehistoric contexts might not be straight forward. When I tested the model against a modern ethnographic society (Appendix H) there were no problems. However, this was not the case when I began to look at the asset matrix and the variables that might act upon it during the case studies.

The asset matrix that defines the Livelihood Status is very dependent upon the archaeological material available for each of the components (natural, subsistence, social, human, physical and personal). Where the gaps were substantial, this was dealt with by making these gaps explicit and not attempting to extrapolate from limited data. Where archaeological material was found to be sufficient, interpretations of the data were attempted, and in some cases the limitations and potential of the model were tested by pushing the data to its limits for the purposes by proposing a number of different possible interpretations for the same data. Of all the asset components, the “personal” category was the most difficult to fulfil, due to its somewhat nebulous character in non-complex societies, but archaeological measures for handling it in prehistoric contexts are proposed in Appendix G.

The variables that acted upon these assets in the Livelihood Variables described in the original SRL model (figure 2.9) were more clearly inappropriate. To test the SRL model in prehistoric contexts, it had to be modified. Whilst the Vulnerability Context required no changes, the Livelihood Structures and Processes were focused on national government, laws, policies and private sector intervention, and there was no explicit section for the role of opportunity. Livelihood Structures and Processes were therefore modified to encompass variables that would have acted on communities in prehistory (figure 2.12). A separate category to capture the importance of opportunity was added.

The output of the model and supporting models is subjective. It was hoped that data in publications would be available for the application of statistical measures, but although this proved not to be the case, even had this been possible such findings would still have been fitted in to a subjective framework, where interpretation and explanation are based on variable archaeological material that does not lend itself to purely empirical approaches. There is further discussion of some of the merits of qualitative versus quantitative approaches, including computer simulation modelling, in Chapter 3 (section 3.4), but here I wish to emphasize that this approach shares many of the benefits of ethnographic approaches to modern communities, in that it can answer open questions and incorporate multiple interpretations of data in order to arrive at possible, but not definitive versions of a perceived situation.

1.5 Ethnographic Analogy

1.5.1 Understanding ethnographic approaches

Ethnographic data is defined here as information recorded by modern and historical observers who have spent time researching ethnographic groups operating livelihoods that may be partially analogous to those in prehistory. Ethnographic analogies have been used in two

principal guises: direct analogy and more holistic and indirect approaches (Orme 1981; Trigger 1996). Direct approaches, often referred to as ethnoarchaeology, examine material patterning and uses these to create analogies for archaeological contexts (Lucas 2001, p.180). However, as Wylie says (1985, p.63) the influence on archaeology of ethnographic analogy "has long been an object of uneasy mistrust among archaeologists" and concerns have been frequently expressed about the archaeological use of ethnographic data (e.g. Agorsah 1990; Ascher 1961; Bernbeck 2008; Clarke 1978, chapter 9; David and Kramer 2001; Hodder 1982c, 1990; Orme 1981; Rosen 2008; Shaw 1989a; Wylie 1985; Wengrow 2001, p.91-104; Wobst 1978, 2006).

In the 1970s and early 1980s the debates of the "New Archaeology" put ethnographic analogy at centre stage. Binford (1981) suggested that if behaviours in the present produced similar deposits to material remains left in the ground in the past they could be used as bridges to an understanding of past human behaviours. His aim was to clarify the technical end of archaeology, looking at manufacturing, use and deposition. In this it was functional and its wider emphasis was on looking for adaptive practices within ecological frameworks. It was only later that the scope of ethnographic analogy was expanded to look at socially-derived aspects of human life. Shanks and Tilley (1987), amongst others, were concerned that "behavioural correlates" between archaeological and ethnographic materials and practices were both deterministic and of dubious value. Lane (2006) observes that research using ethnographic data to assist with explanations of depositional data has been better received than symbolic and structural studies, and that all methods have been used more in Europe than in Africa (the latter point also made by Agorsah 1990). More holistic approaches looked for an improved understanding of archaeological theories of material culture (Hodder 1982c, p.212). These approaches developed an understanding of objects as they operate within society and act upon it, rather than taking the narrower view of objects as things produced by society (Gosden 2010, p.114).

One of the most damaging criticisms is that ethnographic samples normalize important variation, leading to system-wide general explanations that take out granularity and paint misleadingly homogenous pictures that are simplistic and reductionist (Borić 2005; Cordell and Plogg 1979; Hodder 1982c; Jochim 1991; Wobst 1978). Leach (1973), a structural anthropologist, was particularly eloquent in his rejection of archaeology's search for universal laws of behaviour, on the basis of his observations of extreme variability of behaviours in his own field, and he argued forcefully against direct analogy between modern and prehistoric groups. Responding to processual archaeology's use of ethnographic data in generalizing theories of human existence, Ian Hodder's research with ethnographic groups in sub-Saharan Africa emphasised the heterogeneous character of the groups he studied and, at the same time, presented a serious challenge to the idea that material remains always reflected cultural ideas because sometimes they were sometimes used in processes of concealment and transformation (Hodder 1982c). Agorsah is similarly damning: "It is becoming quite clear that mere accumulation of ethnographic data and the provision of half-baked generalization with

the usual cautionary note 'more needs to be done on the subject' are in effect obstructing the development of the type of researching ethnoarchaeology that would contribute viable theoretical formulations" (Agorsah 1990, p.190). David and Kramer remind archaeologists that human behaviour cannot be determined by social norms because individual people do not always conform to social rules, and may be transformed by processes that cannot be captured by ethnographic generalization (David and Kramer 2006, p.35).

Questions of temporal scale frequently arise as a major dilemma facing archaeologists who wish to make use of ethnographic data. Although people living in the past and living in the present may have lived their lives at similar temporal resolution, the datasets used by the researchers in the different fields offer a different type of temporal resolution (Jochim 1991, p.315; Lucas 2010). In the early 1950s Clark (1951) observed that archaeological and ethnographic records represent different temporal scales and phenomena and are therefore mismatched, a point made by other writers including Binford (1986) and Bailey (1981). Rates of change may be similar but it is our ability to observe them that differs. As Binford puts it: "the observations by ethnographers and historical figures, whilst perhaps documenting something of the internal dynamics of cultural systems, cannot be expected to be necessarily germane to an understanding of a much slower and larger-scale process of change and modification" (1986, p.27). Wobst is concerned that when ethnographic data is applied to palimpsests, it is marrying different scales of living because ethnographic data represents daily living whereas palimpsests represent much longer periods of time, sometimes several distinct episodes and sometimes centuries of living (Wobst 2006). A similar point is made by Rosen (2008, p.115) who says that an understanding of pastoralists from short-term ethnographic data has inhibited an understanding of pastoralists in the *longue durée*. Leach (1973b) warned that too many archaeologists are tempted to use ethnography as "fossilized survivals" (p.761). Phillipson worries that scholars without a background in Africa have a view of African history that is "still all too often expressed in terms of a timeless, almost mythical, *status quo* which ignores the major economic and social changes that have taken place in many parts of Africa during recent decades (1989, p.1). David and Kramer refer to this sense of timelessness as "the ethnographic present" and question its ability to cast light on processes that make up the material recorded over any time spans except those that are very short (2006, p.50). Lucas (2010, p.34) suggests that "rather than inferring dynamic events from static things, archaeology can explore the latent forces that bind things into material assemblages or collectives," a distinction between latent and manifest agency. Rosen (2008) looks further at the idea of fossilization, again highlighting the problem of using ethnographic records as snapshots in time, which are then applied to the *longue durée* but also points out that ethnographic analogy discourages archaeologists from seeing variations in pastoral schemes that are beyond familiar analogies, the latter point also made by Wobst (1978) and Hurcombe (2014, p.5-6) who suggest that there may have been many practices in prehistory that are simply no longer carried out today. This can be illustrated by the production and use of Clayton Rings at the end of the mid-Holocene in Egypt and Nubia, items that are no longer

made today and for which no convincing function has so far been suggested (Riemer 2004b; Kuper 2007c, p.25).

Another concern is that there are no examples of incipient pastoralism in modern contexts, where pastoralists practice independent herding without recourse to agricultural produce (McCorriston *et al* 2012, p.46), although there are examples of incipient cultivation. Each example of pastoralist activity is well developed, having evolved usually over centuries. Even in examples where many pastoralists are now adopting cultivars for the first time, most groups have been familiar with cultivators for a long time and in many cases have been dependent on exchange with cultivators for a supply of grain. This means that early experiments combining hunting, herding, fishing and foraging are not represented in the modern ethnographic record and analogies are therefore not available. A related concern is that most ethnographic groups have been heavily influenced by colonial activities and today are influenced by pressure put on them by modern economic conditions, both of which make direct and rational analogy impossible. This point has been made by a large number of writers (e.g. Grove 1978; Kinahan 2004, p.157; Rosen 2008, p.117; Silberbauer 1981; Stahl 1993; Wengrow 2006, p. 10; Wobst 1978).

Geographical correlation is another issue. Linguistic studies have been used to suggest that some of today's Saharan groups may be the direct descendants of prehistoric African populations (e.g. Cavalli-Sforza *et al* 1994, p.172-3), and there have been some suggestions (Clark 1952, p.3; Smith A.B. 1984, 2005a, p.43) that this gives them particular relevance in terms of understanding the use of specific topography and landscapes shared by both past and present groups. Such inferences are highly questionable given the time gap between prehistoric and modern groups and the many influences that have impacted them in the intervening time.

Specific approaches have been suggested to mitigate the problems. For example, Ucko (1969, p.262) recommends that archaeologists avoid direct analogy but instead use ethnographic data to improve understanding of livelihoods before attempting to interpret it in prehistory. Wengrow believes that the strength of anthropological research for answering archaeological questions depends to a great extent on the similarity between the questions "that each has asked of their respective material, and upon the quality of the answers they have provided" (Wengrow 2001, p.92). Yellen (1997, p.12) argues that general analogies should be stated in the form of hypotheses which may then be tested, an approach supported by Wobst (1978) and David and Kramer (2006, p.48). Agorsah (1990, p.195-6) also emphasises the importance of using a clearly defined procedure for the use of ethnographic data in archaeology: "Ethnoarchaeology in Africa should embark upon a more systematic definition of the interface between modes drawn from human behaviour and those drawn from prehistoric societies," p.203.

Hofman looks forward to an archaeological world where "as we learn to read the archaeological record more effectively, we should be able to learn about a past, or pasts,

which are not limited by our own knowledge of the present" (1994, p.342). However, it is difficult to envisage an archaeology of prehistoric subsistence and society without analogy, and many archaeological writers, however conflicted about the problems of using ethnographic data, find its benefits to be worth discussing with a view to establishing workable methodologies (Atherton 1983; David and Kramer 2006; Orme 1981; Wobst 1978; Wylie 1985; Yellen 1997). In spite of the difficulties, the skilled analyses of modern groups and their problems offers the potential of assisting with the task of connecting some of the archaeological dots (e.g. Hodder 1982b; Trigger 1995; Veth 2005; Wendrich and Barnard 2008).

1.5.2. How ethnographic data is used in this thesis

Data capture of a modern ethnographic society, such as that of the Hadendowa that formed my first test case study (summarized in Appendix H) showed not only what could be captured in the SRL asset matrix, but what sort of information would be needed from archaeological contexts to achieve a similar level of resolution. This again focused attention on the potential problem of data quality, as highlighted in Chapter 1, section 1.2, and Chapter 1, section 1.3.2.1. It was immediately obvious that given the poor survival of organic remains in the archaeological datasets, certain aspects of food production and trade in foods and craft items made of organic materials would be difficult to capture. Similarly, religious beliefs that can be observed in person during ethnographic interviews are lost in the archaeological record.

To address this, and mindful of the concerns about ethnographic analogy raised above, my general objective was not to draw highly specific ethnographic analogies to explain individual assemblages of archaeological data but to aim for a much broader heuristic evaluation of the range of possibilities and responses that might take place. This is a holistic and inductive approach that does not make exact analogies between past and present but uses ethnographic data as a tool with which to assess the relationship between livelihoods and the opportunities and constraints that may act upon them. As far as possible, I have limited myself to groups that share the same types of environmental constraints to those in the past. Information derived from the present is used as a guide, not a precise analogue, to the possibilities for human action under certain conditions where similar constraints and opportunities may have existed. It has not been used to understand particular artefacts or artefact distribution or to project precise situations into the past in a deterministic fashion. More specifically, ethnographic data has been used to help complete the SRL model in three ways.

First, in order to suggest explanations for some of the outcomes visible in the archaeological record ethnographic data is used to understand the most likely responses to dryland environments with a view to better understanding prehistoric societies, particularly with respect to their handling of risk and uncertainty. Peter Ucko's recommendation that archaeologists use ethnographic data to "widen the horizons of the interpreter" (1969, p.262) informed how

ethnographic data was used in this thesis. The outcome of this research is captured in detail in Chapter 5 where modern techniques for handling risk and uncertainty are listed and described to use as a tool for extrapolating from archaeological data to suggestions for livelihood strategies. This informed much of the work in the case studies and in Chapter 9, "Comparative Findings."

Second, ethnographic data has assisted with the completion of the asset matrix in suggesting where analogues were not going to be available. Anthropologists have the ability to observe and interview their subjects, whereas in archaeology analogues and proxies for certain behaviours need to be found in the archaeological record and methods for interpreting it. This led to the development of the "Potential Archeological Indicators" listed in Appendix G that might be used for completing the SRL model. It also led to additional research into concepts like land tenure, boundaries, power and religion, concepts that are fundamental to the livelihoods of modern subsistence communities but which are very difficult to identify archaeologically.

Third, the knowledge used to complete the evaluations in the Livelihood Variables and Key Questions in the case studies and in Chapter 9, "Comparative Findings and Future Research" was largely based on the research into comparable ethnographic communities, some of which is captured in Chapter 5, "The Vulnerability Context: Risk and Uncertainty in Dryland Environments," Appendix C "Milk and Lactose Intolerance," Appendix D "Opportunity and Resistance to Change," Appendix F "Comparative Values of Livestock," and Appendix H "Test Case Study: The Hadendowa of Beja".

Fourth, research into the specifics of livelihoods of specific groups like the Hadendowa, the Ma'aza, the Himba, the Hadendowa, the Tonga, the Dinka, the Wodaabe and the Barabaig, to name only some of the ethnographic populations mentioned in the text, whilst providing an understanding of many of the activities carried out and decisions made, were also useful warnings against coming to firm conclusions about livelihood patterns based on material remains alone. This meant that although ethnographic information informed this research, it was not used to extrapolate directly from material remains to simple explanations. Rather, it offered a basis from which to discuss a number of possible explanations.

Finally, it was also clear that the inclusion of government, N.G.O and global markets as impacts on local communities would need to be replaced in the SRL model with external impacts relevant to subsistence economies.

1.6 The Case Studies

1.6.1 Introduction to the Case Studies

As already discussed, settlement structures in the eastern Sahara are rare, although not completely absent. Similarly, funerary remains are by no means common. By far the greatest source of information is from heavily deflated palimpsests. Where possible a mixture of types of sites has therefore been used in this thesis to represent different types of deposition that are found in the eastern Sahara. All of the areas under discussion are dryland environments, each with a different type of water supply. The four areas modelled are 1) the Ru'at el-Baqar phase of Nabta Playa (5400-4500 cal. BC), 2) Dakhleh Oasis (Bashendi B 5300-4000 cal. BC), 3) Gilf Kebir (Gilf C 4500-3500 cal. BC), and 4) Badari (4400-3800 cal. BC). Each is described briefly in the Literature Review, section 1.6 and in detail in Chapter 6, the introduction to the Case Studies, as well as in the case studies themselves.

The unit size being modelled is that of a “group,” which is defined as a set of households. The term is deliberately flexible to reflect the potentially fluid nature of group membership (Crumley 1995, p.4; Gatto 2009, p.127; Schareika 2003, p.2; Wengrow and Graeber 2015). The sites were selected not on the basis of precise contemporaneity but on the basis of similarity of the food production preferences at each place. As the objective is to compare similar livelihoods, this emphasis seems both viable and sensible.

The Nabta, Gilf Kebir and Dakhleh areas are all desert locations with access to water on a seasonal basis. The Badarian sites, with access to river water on a year-round basis and floodwater on a seasonal basis (Brunton and Caton-Thompson 1928; Brunton 1929a, 1937, 1948) have been added to provide a different type of hydrological perspective to the other three areas. Other areas were considered, including the Faiyum, Farafra and Djara, all of which have been well recorded and are currently part of major fieldwork projects. However, all three are part of a northern Egyptian technological and economic tradition (Riemer *et al* 2013) whereas the Badarian is associated with a cultural output that, like Nabta and the Gilf Kebir shares elements the the Sudanese Nile, whilst Dakhleh sits at the interface between north and south, which makes them directly comparable when discussing concepts like social and economic interactions and technological traditions. More importantly, the Badarian provides a useful contrast to the more explicitly dryland sites above, and was chosen to provide an example of how the SRL model can be used to compare and contrast areas with different environmental backgrounds and economic foundations and with richer cultural output. Literature Reviews in section 1.6 provide an overview of each of the areas used in the case studies.

Table 1.1 shows a chronological framework of the main archaeological units mentioned in the text.

Kyr Cal. BC	Faiyum	Nabta	Gilf Kebir	Dakhleh	Khartoum Neolithic	Abkan	Badarian
3.0			Gilf D				
3.5					Late		
4.0		B. Ansam	Gilf C		Middle		Badarian
4.5	Faiyum Neolithic	R. Baqar		Bashendi B	Early	Abkan	
5.0							
5.5			Gilf B				
6.0				Bashendi A			
6.5	Qarunian						
7.0		R. Ghanam					

Table 1.1 - Chronology of the main archaeological units mentioned in the text

1.6.2 Comparative criteria

Comparative research has its own methodologies (Bollig 2006; Dennell 1977; Salzman 1971; Schweizer 1998). As Bollig emphasizes, “Only comparative research designs lead to valid explanations beyond the single case. Furthermore, comparative research leads to a broader understanding of options and limitations within a specific type of society” (Bollig 2006, p.16). Salzman (1971) emphasizes the need for a methodology for comparative studies, in which questions are clearly expressed, the focus of the comparison is explained and the variables to be compared are defined. To begin with, the areas themselves need to be comparable. Each case study offers opportunities for exploring localized responses to different conditions, which are compared in Chapter 9. The headings in the SRL template, described in Chapter 7, form the basis of the comparison and a set of “key questions” has been developed for comparative purposes, described in Chapter 7. All four case studies have been, and continue to be subject to professional archaeological and geological research, and all of the sites under discussion continue to offer potential information about how groups organized themselves and how their social organization evolved in terms of increasing economic flexibility, improved efficiencies and social complexity. The main feature that all areas share is the challenge of dryland living, dealing with one or more limitations in resources, such as water, land and the availability of both wild and domesticated animal and plant species. Although the main objectives of this research are to improve data gathering and presentation, the value of the SRL model is demonstrated by asking questions about comparing risk handling in four of the areas discussed. This is discussed further in chapter 9 “Comparative Findings.”

1.6.3 Radiocarbon dates

Plenty of dates are available for all of the case studies except the Badarian, which was largely excavated before the use of radiocarbon dating (Brunton and Caton Thompson 1928; Brunton 1937; Brunton 1948; Caton-Thompson and Whittle 1975). All dates available are tabulated in the case studies. Uncalibrated dates were calibrated using quickcal2007 ver1.5 (Cologne Radiocarbon Calibration and Paleoclimate Research Package (University of Cologne) <http://www.calpal-online.de/index.html>). A particularly important survey of radiocarbon dates from 150 sites that was correlated with human activities and climatic processes during the Holocene of the eastern Sahara was published in 2006 (Kuper and Kröpelin 2006) demonstrating a north-south arc of abandonment beginning at c.5300BC. This has enabled comparison between different archaeological phenomena across wide geographical areas (Kuper and Kröpelin 2006; Kuper and Riemer 2013). In terms of the case studies, all dates have used the conventional rather than the accelerator method.

Problems with radiocarbon dating as a technique, some of which were encountered in the case studies, are discussed in detail by Whittle (1988, p.12-35). At Nabta Playa, where thirty four dates were obtained for the Ru'at el Baqar, four were rejected as anomalous, strongly conflicting with other determinations for the same feature (Schild and Wendorf 2001c, p.54-55, Tables 3.1 and 3.2). Of the thirty four dates nineteen had a standard deviation of over ± 70 (Schild and Wendorf 2001c, p.54, Table 3.1), which Whittle suggests may be a realistic minimum estimate of counting error (Whittle 1988, p.19). Although there are sufficient radiocarbon dates to fix many features and sites of the Ru'at el Baqar securely within the Nabta sequence, some are by no means as secure, such as a date for the stone circle E-92-9 that was obtained from a nearby hearth (hearth 9) thought to be contemporary (Schild and Wendorf 2001c, p.54 Table 3.1). The availability of organic remains on which to run Carbon 14 tests at Nabta has been uneven, but all but one dates were obtained on charcoal (Schild and Wendorf 2001c, p.54, Table 3.1). In the case of the Badarian only twelve dates have been obtained before Dee *et al* (2013) used organic samples in museum collections to add another eight, making a total of 20 dates. These were combined by Dee *et al* (2013) to obtain two new date ranges for the Badarian at 68% and 95% confidence. For the Gilf C of the Gilf Kebir, only 10 dates are available, only three of which have a standard deviation of ± 70 or less (Linstädter and Kröpelin 2004, p.760; Von Czersiewicz 2005), and other criteria, mainly lithics and ceramics, are used to place the sites with confidence within localized sequences. In the case of the Bashendi B of Dakhleh Oasis twenty three dates are available, of which nine have a standard deviation of ± 70 or less (McDonald 2001, p.27). Some Dakhleh dates were obtained on ostrich eggshell, and these have been adjusted for isotopic fractionation (McDonald 2001, p.27).

In this thesis, the role of radiocarbon dating is minimal, mainly due to the palimpsest nature of the data. The comparisons in the case studies are concerned with comparing groups that have chosen pastoralism as a livelihood strategy than ensuring that they correspond

chronologically. Beyond ensuring that the sites belong to the mid-Holocene or early late Holocene, radiocarbon dates have not been used in the discussions in the case studies.

1.7 Literature Reviews

1.7.1 Development Economics

The broad purpose of development economics is to address poverty, deprivation and lack of social and economic opportunities in underdeveloped and repressive countries, with a view to ensuring livelihood sustainability and creating social and economic opportunities (e.g. Carney 1998; Chambers and Conway 1988; Cliggett 2005; Dalal-Clayton *et al* 2003; Dasgupta 1997; Leach and Mearns 1996; Sayer and Campbell 2004; Sen 1999; Streeten *et al* 1981). A number of standard texts have been introduced for researchers and practitioners (Dalal-Clayton *et al* 2003; DFID 1999; DFID 2000a; Sayer and Campbell 2004; Streeten *et al* 1981; Sumner and Tribe 2008), and these are supplemented by an enormous output of literature on the subject. The Sustainable Livelihoods approach was first introduced as an idea by the Brundtland Commission on Environment and Development (United Nations 1987) as a device to link economic, social and ecological considerations in a cohesive structure in order to tackle both poverty and ecological damage. The concept was expanded during the 1992 United Nations Conference on Environment and Development (United Nations 1992) and has been further elaborated since then. The SRL model itself was discussed in detail by Carney (1998) and Sayer and Campbell (2004), modified by Hamilton-Peach and Townsley (2007), and has been adopted by The International Fund for Agricultural Development (IFAD) and The Department for International development (DFID), which has produced guidelines for practitioners, including Oxfam (DFID 1999, 2000; Neefjes 2000).

Many of the useful texts from an archaeological perspective are those that look at specific problems and solutions with reference to specific areas under conditions of both environmental and economic stress, without losing sight of social, religious and other driving influences (e.g. Behnke *et al* 1993; Belal *et al* 2009; Bollig 2006; Cliggett 2005; Ellis *et al* 1993; Dixon *et al* 2001; Homewood 2005; Johnson and Anderson 1988; Manger *et al* 1996; Morse *et al* 2009; Mortimore 1998; Vlasich 2005). All share an interest in understanding how humans operate under conditions of risk and uncertainty, and all look for ways in which to describe, evaluate, understand and learn from the relationship between the visible outcome and the livelihood that produced it.

1.7.2 Ethnographic data

Ethnographic field studies have described economies and societies that appear to be analogous in some ways to those of much earlier periods (e.g. Abati 1998; Bates 1973; Bollig

2006; Deng 1972; Evans-Pritchard 1940; Hobbs 1989; Klima 1970; Manger *et al* 1996; Newman 1970; Schareika 2003; Vlasich 2005). A lot of understanding of how different subsistence economies have worked comes from the study of appropriate ethnographic accounts and analysis of contemporary groups. Familiarization with ethnographic methods was incorporated into this workstream in order to improve an understanding of the value and limitations of ethnographic accounts and methodologies (e.g. Agorsah 1990; Eriksen 2001; Geertz 1988; Hann and Hart 2011; David and Kramer 2001; Garrow and Yarrow 2012; Gosden 1999; Hodder 1982a, 1982c, 1990; Orme 1981; Shankland 2012; Trigger 1995; Ucko 1969; Veth 2005; Wengrow 2001, p. 91-104; Wylie 1985; Wolcott 2008; Veth *et al* 2005).

1.7.3 The climatic and environmental setting

Climate and the environment have been the subjects of increasing research in the Sahara over the last few decades. The specific conditions of the mid-Holocene are discussed in Chapter 4. For the purposes of this thesis, the most relevant works are those which look at the relationship between climate, environment and archaeology. These include work to discover general trends in climate and their impact on human activities (e.g. Darius and Nussbaum 2007; deMenocal 2005a; deMenocal *et al* 2000a; Hassan 2000, 2002c, 2006; Kuper 2002, 2006a, 2006b; Kuper and Kröpelin 1995, 2006; Wendorf, Karlén *et al* 2007) and research into the climate of specific regions (e.g. Barich 1993, 2002; Bolten and Bubenzer 2007; Brookes, 1989a; Brooks 2005a, 2006b; Brooks *et al* 2005; Butzer 1976 Hahn 1993; Hassan 1984a, 1986a; Haynes 2001; Haynes *et al* 1989; Neumann 1989a, 1989b, 1993; Peters and Pöllath 2003). At the same time there have been some important research projects looking at archaeobotanical and archaeofaunal remains to assist with reconstruction of the environmental conditions in particular places at particular times (e.g. Gautier 1987, 1989, 2001; Goodman and Hobbs 1988; Hassan 2000; Hassan *et al* 2001; Linstädter and Kröpelin 2004; Kindermann *et al* 2006; Kröpelin 1987; McDonald 2001; Neumann 1987, 1989; Peters 1987, 1988; Schild and Wendorf 2002).

Because climate and environmental conditions can have such a profound impact on human life, there is always the temptation to assume that it is the main driver for human livelihood strategies and changes that can be observed in human behaviour. There are, however, numerous warnings against seeing climate as determinative of human actions (e.g. Brooks 2006a, 2006b; Cremaschi and Di Lernia 1999; deMenocal 2001; Diamond 2006; Dimbleby 1967, p.17; Fagan 2004; Hahn 1993; Hassan 1986a, Hassan 1997c; Hassan 2000, p.62; Kuniholm 1990 p.645, 646, 647; Leach and Mearns 1996; Minnis 1996; Plog and Hantman 1990; Robertshaw 1988; Yokell 2004). These issues are discussed in Chapter 4 “Climate and Environment History of the Eastern Sahara.”

1.7.4 Archaeological research into early food production livelihoods in the eastern Sahara

A number of explanations have been given for the arrival and adoption of domesticated animals and plants during the mid-Holocene in the eastern Sahara, (e.g. Barker 2006, chapters 1 and 10; Butzer 1976; Caneva 1991, 1992; Close 2002b; Gautier 1987; Goring-Morris 1993; Hassan 1984; Shirai 2010; Smith, A.B. 1980, 1984, 1996, 2005b; Wendorf and Hassan 1980; Wendorf, Schild and Close 1984, 1989; Vermeersch 2002; Wendorf and Schild 1994; Wenke 1984; Wenke and Casini 1989; Wenke *et al* 1988; Wetterstrom 1993). The earliest evidence of domesticated sheep and goat comes from the Eastern Desert in the mid-Holocene, which has been the focus of attention by Belgian teams since the 1980s in the Eastern Desert (Moeyersons *et al* 1998, 2002; Vermeersch 2002, 2008; Vermeersch *et al* 1994, 1996a, 1996b, 2002, 2005). Sheep and goat have no wild ancestors in Egypt and are thought to have been introduced from the Near East where they were domesticated much earlier (Garrard 1998), via northern Negev and Sinai, the Mediterranean or south-western Sinai (Close 2002b; Tassie 2014, p.139-150), coinciding with increasing aridity in the Near East (Close 2002b; Garrard 1998). From there they spread west into the rest of Egypt (Barich and Lucarini 2002; Barich and Hassan 2000; Churcher 1999; Churcher *et al* 2008; Gautier 2001; McDonald 2002; Riemer 2007), and south into Nubia (Arkell 1953; Tigani el-Mahi 1988).

Whether cattle were domesticated locally or introduced from the Near East at this time is still under discussion (usefully summed up by MacDonald 2000; but see also Bradley and Loftus 2000; Marshall and Hildebrand 2002; Morris 1994; Wendorf and Schild 1994). It is suggested that domesticated cattle appear during Wendorf and Schild's Ru'at el-Ghanam Middle Neolithic levels at Nabta Playa, particularly at E-75-8, where they date to 6,100 – 5600 BC. An even earlier date for cattle domestication at Nabta Playa (Gautier 1984; Wendorf, Close and Schild 1989; Wendorf and Schild 1980; Wendorf and Schild 1994) has been rejected by many writers (e.g. Brass 2007; Grigson 1991, 2000; Wengrow 2006; Smith, A.B. 1992b). Cattle remains have been identified at a number of other sites throughout Egypt and Nubia associated with pastoral and hunting economies including the Khartoum Neolithic (Arkell 1953; Sadig 2010; Tigani el-Mahi 1988), the Faiyum Neolithic (Holdaway and Wendrich 2017; Shirai 2010), and the Gilf Kebir during phases C and possibly D (Cziesla 1996; Gehlen *et al* 2002; Wendorf and Schild 1980).

The oldest ceramics in the Old World have been found in Niger, Tagalal, and Adrar Bous spreading eastward reaching Libya (Le Quellec 2006; Kuper and Kröpelin 2006). In the Mid-Holocene a new form of undecorated ceramics was introduced, and the impression-decorated pottery of the Sudan tradition was found as far north as the Egyptian oases and the Great Sand Sea (Gehlen *et al* 2002). New bifacial technologies also appear in the mid-Holocene of the Western Desert and may indicate connections throughout the area (Holdaway *et al* 2010; Kindermann 2002, 2003, 2004; Lenssen-Erz and Linstädter 2010; Lucarini 2012, 2014a; McDonald 2002b; Riemer 2003, 2010; Riemer and Kindermann 2008; Shirai 2010).

Wild grasses were intensively exploited by occupants of the Western Desert at Nabta Playa area, Eastpans, Dakhleh and Farafra as well as further south in the Sudan (Barakat 2002; Barakat and Fahmi 1999, 2002; Barich and Lucarini 2002; Barich and Hassan 2000; Bettinger 2006; Harlan 1989; Hassan *et al* 2001; Lucarini 2006, 2014b; McDonald 2008; Out *et al* 2016; Wasylikowa 2001; Wasylikowa and Dahlberg 1999).

All these innovations will have been accompanied by social mechanisms that not only bound groups together and provided a framework within which livelihood activities were pursued, but would also have formed the basis of relationships with other groups (Dalal-Clayton *et al* 2003, p.91-2; Dasgupta 1997, p.9; Kindermann 2002; Quan 1998; Riemer 2010; Riemer *et al* 2013; Riemer and Kindermann 2010).

1.7.5 Archaeological research into areas covered in the thesis

In this section, sites included in the thesis are highlighted in bold when mentioned for the first time. All areas are associated with the use of domesticated livestock in dryland areas. The adoption of domesticated livestock, sometimes with the associated changes of lifestyle that would have been imposed, represented a significant decision, a change in economic behaviour, social organization and overall livelihood structure (Barker 2006, p.38; Hassan 1981; Marshall and Hildebrand 2002) even when combined with hunting, gathering and fishing economies.

Although prehistoric sites had been found in the early 20th Century (e.g. Bagnold *et al* 1939; Brunton and Caton-Thompson 1928; Brunton 1929a, 1929b, 1937, 1948; Caton-Thompson and Gardner 1934; Caton-Thompson 1952; Petrie 1920; Quibell 1900), modern research in the Egyptian and Nubian Deserts began in earnest as a result of the UNESCO-sponsored rescue mission to salvage Nubian archaeology, which would soon be flooded by Lake Nasser in the 1960s (Wendorf and Schild 1980, p.xv). The discovery of remarkable sites at **Nabta Playa** by the Combined Prehistoric Expedition resulted from long-term and ongoing investigations into the area. The Ru'at el-Baqar phase of Nabta Playa contains a series of occupations that continued in the Nabta area from the early through the mid-Holocene. Occupied during a humid inter-phase (Schild and Wendorf 2002), the Ru'at el Baqar occupation was based on the seasonal presence of a playa lake, a temporary rain-fed area of water that dried towards the end of the season. The occupants of the playa during the Ru'at el Baqar were herders, hunters and plant collectors (Applegate *et al* 2001; Close 2001, p.384; Gautier 2001, p.624-5). There have been many papers published in academic journals about Nabta in general (e.g. Close 1992; Schild and Wendorf 2002; Wendorf *et al* 1992; Wendorf and Schild 1980, 1984, 1998; 2002) with the main body of work consisting of two volumes covering the settlements and the ceramics respectively (Wendorf, Schild *et al* 2001; Nelson *et al* 2002). These publications cover occupation evidence, lithics, botanical and faunal remains, radiocarbon dates and environmental analysis, together with what has been interpreted as a ceremonial centre (Applegate *et al* 2001; Applegate and Zedeño 2001; Bobrowski *et al* 2006; Close, A.E.

2001; Gautier 2001; Irish 2001; Królik and Fiedorkzuk 2001; Mohamed 2001; Nelson 2001a; Schild and Wendorf 2004; Wasylikowa 2001; Wendorf and Królik 2001; Wendorf and Malville 2001. Apart from one site, E-75-8 (Close 2001; Nelson 2001a), the Ru'at el Baqar occupation sites are characterized by palimpsests (Królik and Fiedorczuk 2001; Wendorf and Schild 2001b) and are discussed, a refinement of the chronological sequence of humid and arid phases was published in 2002 (Schild and Wendorf 2002). A comprehensive sequence of radiocarbon dates was published (Schild and Wendorf 2001c, p.54-55). Evidence of domestic and economic activities is ephemeral, mainly in the form of occupation debris surrounding hearths.

The **Badarian** sites, named after the type site of el-Badari by excavators Brunton and Caton-Thompson (1928), are clustered around a 35km stretch of the Nile from Qau el-Kebir in the south to Matmar in the north, on the edges of the low desert. Sites consist mainly of cemeteries, with large numbers of mainly single interment burials, which have produced numerous grave goods, whilst occupation sites are few and sparse (Brunton and Caton-Thompson 1928; Brunton 1937, 1948; Holmes and Friedman 1989, 1994). The material retrieved during these excavations suggests subsistence based on herding, hunting and fishing with some indications of incipient agricultural activity (Brunton and Caton-Thompson 1928; Brunton 1929a, 1937; 1948), although the degree of investment in agriculture has been questioned (Wengrow *et al* 2014). The Badarian is hemmed in by the drylands of the Eastern Desert on one side and the Nile on the other. It provides a useful comparison for the more obviously dryland sites discussed in the other case studies. The main stratigraphic sequence of the Badarian sites was clarified by Gertrude Caton-Thompson at Hemamiyeh (Brunton and Caton-Thompson 1928). Further attempts to refine the Badarian sequence on the basis of pottery analysis (Brunton 1929 and Petrie 1939) were flawed and have been reassessed, a matter not helped by a shortage of radiocarbon dates (Dee *et al* 2013; Caton-Thompson and Whittle 1975; Friedman 1994; Math 2007; Newell 2012). Holmes surveyed and later excavated in the region using modern techniques (Holmes 1992a, 1993; 1994; 1996; Holmes and Friedman 1989, 1994). The Badarian has been the subject of several interpretative synopses in book chapters and papers, looking at both cemetery and, where available, settlement data (Castillos 2000; Flores 2003, p.5-6, 67-68, 81-82, 101-102, 115, 141; Hassan 1988; Hoffman 1979; Holmes 1989a and 1989b; Horn 2010, 2014, 2015, 2017a, 2017b; Math 2007; Midant-Reynes 1992; Stevenson 2009a; Tassie 2014, p.246-269; Wengrow *et al* 2014; Wetterstrom 1993, p.214-220; Yokell 2004; Zakrzewski 2003, 2006, 2007) and academic dissertations (Anderson 1989, 1992; Math 2017; Newell 2012). Contacts with other areas have been quite extensively discussed (Gatto 2009; Hassan 1986c; Holmes 1992; Hendrickx and Vermeersch 2000; Kuper 1996; McDonald 1996; Midant-Reynes 1992; Riemer and Kindermann 2008; Tutundzic 1989).

The **Gilf Kebir** (meaning great plateau) is a dissected plateau, carved into a northern and southern section, in the far southwest of Egypt, near the Libyan and Sudanese borders. It consists of two plateaus connected by a small land bridge, covering an area of c.90,000km²

(Linstädter 2007, p.20). The Gilf rises 300m from the surrounding desert, and all three available environments were used: the wadis, the plateau and the surrounding plains (Linstädter 2005g, p.355-358; Schön 1996b, p.125-128; Wendorf and Schild 1998, p.109). Exploration of the area was undertaken in the period between the First and Second World Wars by military staff based at Wadi Halfa on the Sudanese side of the Egyptian border, and their associates (Almasy 1939; Bagnold 1931, 1935; Bagnold *et al* 1939; Clayton 1933a, 1933b). In the 1930s they identified archaeological remains and mapped the area. An archaeological expedition sponsored by Robert Mond in 1937-8 included the archaeologist Oliver Myers, who identified a number of archaeological sites and collected lithics from the sites he excavated (Bagnold *et al* 1939; McHugh 1975). More recently, under the auspices of the University of Cologne, fieldwork has taken place to clarify both the archaeological and environmental facies, resulting in a good understanding of the geology and the various phases of archaeology (Cziesla 1996; Gautier 1982; Gehlen *et al* 2002; Kröpelin 1993a, 1993b, 2005; Kuper 2002; Kuper *et al* 2009a, 2009b, 2010, 2011a, 2011b; Lenssen-Erz and Linstädter 2010; Linstädter 2003, 2005a, 2005b, 2007; Linstädter and Kröpelin 2004; Neumann 1987; Schön 1989; Van Neer and Uerpmann 1989). The climatic evidence investigated in Wadi Bakht has provided a better understanding of the water resources available in the Gilf Kebir at that time than in most other eastern Saharan areas (Peters 1988; Linstädter and Kröpelin 2004). During Gilf C two of the eastern wadis were blocked by sand dunes and during seasonal rainfall formed lakes in the dry valleys, now represented by deep sediments, and waters gathered in the areas surrounding the plateau, where they ran off from the plateau via wadis and steep cliffs (Linstädter 2003a, p.136; Linstädter 2005g, Linstädter and Kröpelin 2004). The Gilf C occupants who took advantage of these rainfall events were herders of sheep, goat and possibly cattle, and hunted to supplement their diet (Gautier 1980, p.319, 341; Gehlen *et al* 2002; Wendorf and Schild 1980). Occupation sites are usually palimpsests of varying sizes (e.g. Linstädter 2005g; Schön 1996a, 1996b; von Czerniewicz 2005). A small number of Gilf C rock art sites are present, distributed mainly along the western edge of the Gilf Kebir (Honoré 2015; Kuper 2013; Zboray 2009; Zboray 2013).

Dakhleh Oasis is one of several oases in the Western Desert. Water was provided both by springs that were fed by the Nubian Aquifer and from rainfall regimes that may have been bimodal due to the collision of southern monsoonal and northern temperate rainfall regimes (Butzer 1999; Haynes 1987, 2001; Close 1992; Hassan *et al* 2001; Ibrahim and Ibrahim 2003, p.45-47; Kindermann *et al* 2006; Magaritz and Goodfriend 1985; McDonald 2016; Neumann 1989a, 1989b, 1993; Sampsell 2003, p.147-148; Shirai 2010). Dakhleh has received considerable attention from the Royal Ontario Museum and the University of Monash, and numerous publications on the subject of the archaeology have been published in journals and in the Oasis Papers produced by the Dakhleh Oasis Project (Hope 2002; McDonald 1991a, 1991b, 1996, 1999, 2001, 2002a, 2002b, 2008, 2009, 2013, 2016; Thompson 2008). It has also been incorporated into landscape-focused studies of the Western Desert (e.g. Riemer 2003; Shirai 2010). Domesticated goats and ceramics appear at the end of Bashendi A

(c.6500-5400 Cal BC) but only became an important part of the economy in Bashendi B, where cattle and goat are represented together with wild species (Churcher *et al* 2008) (5300-4000 Cal BC). The Bashendi B occupation is represented by ephemeral occupation remains mainly as palimpsests, artefacts, few botanical and zoological remains, and only little evidence for symbolic activities (McDonald 1999; McDonald 2008 p.100, Table 1). Ceramics were the subject of a PhD study, the results of which have now been published (Warfe 2018). There is rock art in the southeast of the oasis but the dating is uncertain (Classen *et al* 2009, p.63; James 2012; Kuciewicz *et al* 2014; Krzyzaniak 1990; Polkowski 2015a, 2015b; Polkowski *et al* 2013; Winkler 1938) and has been excluded from this case study.

1.8 Structure of the thesis

1.8.1 Volume 1: Thesis

Chapter 1 Introduction.

Chapter 2 “Modelling Early Food Production: A Sustainable Rural Livelihood Approach” describes the SRL approach in detail, and discusses how ethnographic is used within the thesis.

Chapter 3 “Situating the SRL model within archaeological theoretical approaches” describes how the SRL approach relates to existing archaeological approaches.

Chapter 4, “Climate and environment history in the eastern Sahara,” provides a framework for understanding the environmental context within which the case studies are set.

Chapter 5, “The Vulnerability Context: Risk and Uncertainty in Dryland Environments” captures my research into development and ethnographic research into how vulnerability in drylands is managed using different livelihood strategies.

Chapter 6, “Case Studies” introduces the four case studies, including the objectives of the case study, a history of excavation and analysis, and a discussion of internal chronology.

Chapter 7, “Application of the SRL Model to the Case Studies,” introduces the practical task of applying the SRL model to archaeological data.

Chapter 8, “Case Study 1, Nabta Playa in the Ru’at El Baqar” provides an abridged version of one of the case studies

Chapter 9, “Comparative Findings,” addresses what has been learned about risk, opportunity and sustainability in the eastern Sahara during the mid-Holocene as represented by the four case studies.

Chapter 10, “Final Conclusions,” address the hypotheses described in the introduction and assess what has been learned about the use of the SRL approach and the degree of success with which the approach can be combined with archaeological, environmental and ethnographic data to obtain insight into the prehistoric livelihoods.

The Bibliography follows the Conclusion.

The Appendices are added to the end of Volume 1:

- Appendix A, Glossary
- Appendix B, Data Collection Forms: Evaluation and Criteria
- Appendix C, Milk and Lactose Intolerance
- Appendix D, Resistance to Change Amongst the Puebloan Indians
- Appendix E, Human Nutritional Requirements, Sources and Results of Deficiencies
- Appendix F, Comparative Values of Cattle, Sheep and Goat
- Appendix G, Potential Archaeological Indicators of SRL components

1.8.2 Volume 2. The Case Studies (CD-ROM)

The case studies are separated into a separate volume on a CD-ROM due to the high word count of each one, including the full version of the Nabta Playa case study, which appears in abridged form in Chapter 6. The case studies are also available on the web at www.polstudy.wordpress.com or by scanning the website’s QR code:



1.9 Terminology

A Glossary is included in Appendix A. However, a select number that refer specifically to the livelihoods discussed in the case studies require further comment and these are mentioned below.

1.9.1 Food Production

The term “food production” is used in preference to the term “Neolithic” which is particularly unhelpful for the description of many of the contexts under discussion, again due to the assumptions that are associated with the term (e.g. Smith 1984, p.87; Garcea 1993, p.18-19). Food production refers to any livelihood strategy that includes the adoption and maintenance of domesticated species. It can include large and small scale management of livestock and/or management of cereals, pulses or legumes, and may or may not be accompanied by temporary/permanent settlement structures. Food production (herding and cultivation) may be supplemented by hunting, the gathering of wild plants and fishing. Levels of food production differ depending on the capability of the land, the levels of humidity available and the group’s existing knowledge, skills and demography. Different types and scales of food production will be discussed in the text.

1.9.2 Livelihood

The term "livelihood" is used throughout the thesis. Livelihoods are captured in the SRL model in the Asset Matrix and express the ways in which people combine and use their assets to achieve their goals (Chambers and Conway 1991). It refers to how people, as households and groups, conduct, express and reinforce their social systems, organizational structures, ideals and beliefs through economic and social activities and through material culture. Sustainable livelihoods are those that "can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long term" (Chambers and Conway 1991).

1.9.3 Risk and uncertainty

Various different definitions of risk and uncertainty exist, and can be used inconsistently (Behnke *et al* 1993; Bollig 2006, p.7-16; Cashdan 1990). I use Knight’s classic distinction between the two, in which risk exists within a framework of life experience and can be quantified and assessed using *a priori* reasoning, whereas uncertainty extends beyond knowledge and experience and requires people to make decisions without sufficient information to make a confident estimate of an outcome (Knight 1921, I.I.26). The concepts of risk and uncertainty are discussed fully in Chapter 5, “Risk and Uncertainty in Dryland Environments.”

1.9.4 Drylands

The FAO (Food and Agriculture Organization of the United Nations) defines a dryland as a region with a growing period of between 1 to 179 days, which includes arid, semi-arid and dry sub-humid environments (FAO 2000, p.19). Further, “dryland areas are ‘fragile’ in that they

are extremely vulnerable to land degradation resulting from over-grazing and other forms of inappropriate land use" (FAO 2000, p.17). This definition has been adopted in this thesis.

1.10 Conclusions

The purpose of the thesis is not to solve specific archaeological problems such as, for example, how domestication occurred in the eastern Sahara. The intention is to use the SRL approach to explore concepts such as risk, opportunity and sustainability in marginal environments. To test the viability of the SRL approach for answering specific questions of the archaeological data, a set of key questions are asked, and additional techniques are used to maximize the value of the SRL approach, discussed in Chapter 2.

Dryland environments present both challenges and opportunities for archaeologists interested in how groups use areas where basic resources required for survival may be limited. Archaeological survey, excavation and publication over the last few decades has improved knowledge of the data emerging from the areas of the eastern Sahara, which are now desert, enabling researchers to use the data to formulate hypotheses and learn more about how livelihoods operated. As different areas are explored it should be possible to explore links between them and to understand the extent of the relationship between the dryland occupants of the eastern Sahara and the emerging farming communities along the Nile. As part of this process, understanding how individual dryland livelihoods functioned and can be characterized and how they responded to variable conditions, including vulnerability and opportunity, will help to build a coherent picture of the eastern Sahara in the early and mid-Holocene. This research hopes to contribute to that process.

2 - Modelling Early Food Production: A Sustainable Rural Livelihood Approach

2.1 Modelling dryland livelihoods

Development economics is the branch of economics concerned with supporting indigenous populations, described by Professor Adedayo (2012, p.12) as “a multidimensional phenomenon involving a broad set of economic, social, environmental, institutional and political factors.” Development economists work to improve conditions for marginalized groups to enable them to survive as functioning communities and economies under changing circumstances. Development economics, and the branch of economic anthropology related to it (Ensminger 2002; Hann and Hart 2011; Wilke and Cliggett 2007), have been innovating rapidly in the last few decades, and one of their key tasks now is to understand the livelihood mechanisms of societies which operate, often very successfully, under marginal or adverse conditions at subsistence level or just above so that solutions can be proposed (rather than imposed) to compliment and build on existing skills and traditions (Behnke and Scoones 1993; Carney 1998; Dalal-Clayton *et al* 2003; Jallow 1990; Hamilton-Peach and Townsley 2007; Leach and Mearns 1996; Masood and Shaffer 1996; Mortimore 1989). One of the tools central to development is encapsulated by the Human Development Index, based on the idea that there are three essential outcomes for human development: long and healthy life; the ability to acquire knowledge with which to participate in community life; to have access to resources to enable a reasonable standard of living and improve people’s inclusion in decision making processes and their personal independence (UNDP 2015). Once the information has been assembled and the organization of a given livelihood understood, the best measures for sustainable development can be assessed (Binns 1992, p.157). Data capture is therefore an important part of the activities of development economics, as it is of archaeologists and anthropologists. The importance of capturing all the variables that act on a society and its ability to adapt or change is what makes many development economics perspectives so useful.

Fine-grained studies into how modern communities are composed, interact with each other and how they make decisions have been important aspects of these approaches (Chambers 2008; Chambers and Conway 1992; Perrier 1995; Sumner and Tribe 2008). For example, within these studies social factors and unpredictable environmental resources have been factored in where they had formerly been disregarded (e.g. Behnke and Scoones 1993; Scoones 1995b; Dasgupta 1997, p.4-5). Approaches have been developed that looked closely at how societies work in practice and what sort of variables must be taken into account

in order to improve economic and social sustainability. It became clear that numerous aspects of a livelihood need to be considered in order to assess how decisions are made and what leads to sustainability as all unified economic systems are associated with mechanisms to protect group identity and social organization. This usually incorporates ideas like religion, justice, ideology, leadership, individual identity and long-standing tradition (e.g. Abraham 2006; Eyhorn 2006; Jallow 1990; Manger *et al* 1996; Masood and Shaffer 2006; Dasgupta 1997; Cliggett 2005; Sen 1999) together with individuals' perception of risks and their own inclinations (Eyhorn 2006, p.44-45; Sayer and Campbell 2004, p.102), factors that modern development economists now take into account when any change to an economic system is proposed. They also involve the idea of communal identities, based around internal information flows, leadership and the formalization of external relationships (Manger *et al* 1996; Hobbs 1989; Sen 1999).

The same problems faced by development economists are exponentially more difficult for archaeologists who strive to understand all the variables that may influence societies at points in time and space, especially where new opportunities and constraints come into being. Archaeologists face a different challenge from development economists and anthropologists, because they are working with datasets that cannot be verbally interrogated or empirically observed in all their living detail. This is particularly the case for research into pastoralists whose mobile lifestyles leave somewhat ephemeral remains (e.g. Barnard and Wendrich 2008; Bernbeck 2003; Cribb 1991; Honeychurch and Makarewicz 2016, p.349-50; Leary 2014). In archaeology, where the quantity, quality and type of data is often a limiting factor, one of the main challenges has been to find ways of portraying the various integrated aspects of a livelihood without being excessively biased towards one aspect of the data (e.g. ecological or economic) to the detriment of all other (e.g. social and cultural). This has been most obviously captured in the conflict between processual and post-processual approaches discussed by a number of authors (e.g. Dark 2013; Johnson 2010; Trigger 1996), but is also the result of the way in which archaeological post-excavation work is organized and published (Hurcombe 2014, p.152; Lucas 2001, p.105; Redford 2008, p.23; Weeks 2008). As Trigger explains (1995, p.450) there is "growing support for the position that while important aspects of human behaviour can be understood as rational adaptations to ecological, demographic and technological factors, all cultural change takes place within a context of beliefs and practises that guide human behaviour." This view has been shared by other archaeologists, anthropologists and economists who attempt to blend both economic and social perspectives (e.g. Barich 1988; Dewey 1966; Harvey 2000; Kent and Vierich 2008; Moss 1992; Sen 1999). As already highlighted above, a similar problem has existed in development economics, where emphasis on certain aspects of livelihoods at the expense of others has led to failed attempts to improve the sustainability of high-risk groups (e.g. Binns 1992; Manger *et al* 1996; Sen 1999; Masood and Shaffer 2006; Dasgupta 1997; Ellis *et al* 1993; Cliggett 2005). To address this problem, new qualitative ways of capturing and modelling data about communities living in

stressful environments have been applied to development economics and adopted in this thesis.

The challenge for development economists was to devise a way of modelling that would capture sufficient data whilst not oversimplifying the livelihood that it is supposed to represent. The primary potential value of descriptive modelling is that it can be used to break down often complex data into digestible chunks, enabling the overall pattern of competing influences to be analyzed, understood and compared. As Sayer and Campbell put it, "simple indicator sets are desirable, but it would be foolish to expect simplicity when dealing with complex systems" (2004, p.218). The prime explanatory variable that influences an outcome or set of outcomes may be different on a case by case basis, and models will need to include the possibility that a number of variables and a number of outcomes are possible in any situation (Dasgupta 1997), a point also recognized by archaeologists (e.g. Bettinger 1993). The economist Partha Dasgupta, suggests that "[T]he art of good modelling is to generate a lot of understanding from focusing on a very small number of causal factors" (Dasgupta 1997, p.9). He believes that modelling can be used "to make predictions of what the data that haven't yet been collected from the contemporary world will reveal" (p.10). This suggests that there is the potential for a carefully chosen modelling technique to handle an incomplete data set, a thought that has obvious appeal in archaeology.

Different models are designed for different tasks. Some models set out to represent the complexities of production systems but are not intended to be tools for gathering and analyzing data. They may be convoluted and multi-layered, with numerous linkages demonstrating how different elements are connected (see figures 2.1 and 2.2) and are useful for representing complexity within communities. Other models, like the Sustainable Rural Livelihood model, are designed to be flexible tools that incorporate idea that a community may lie anywhere on a continuum of relatively simple to more complex economic and social arrangements.

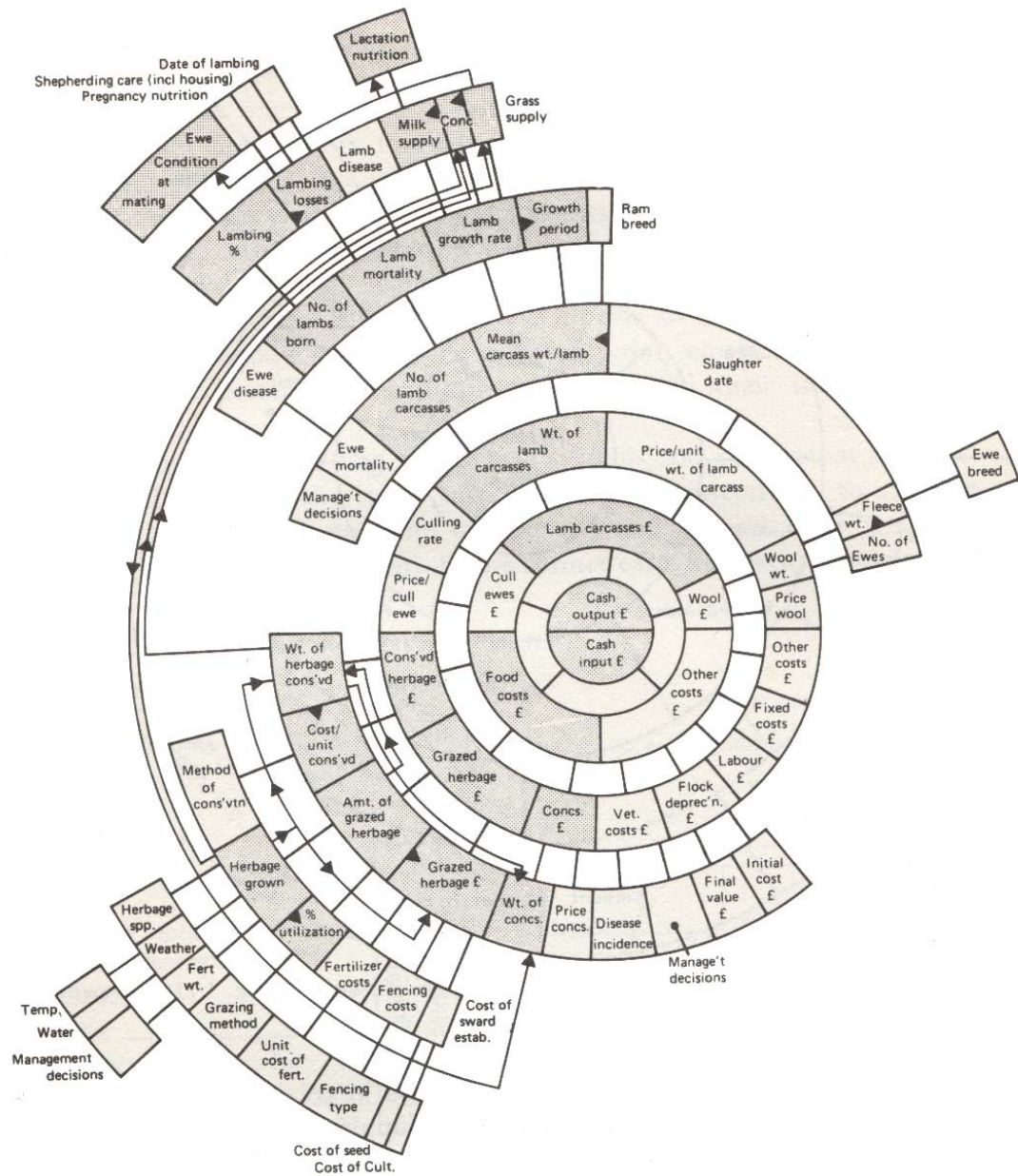


Figure 2.1 - Components in sheep production (Spedding 1975, figure 2.16, p.32)

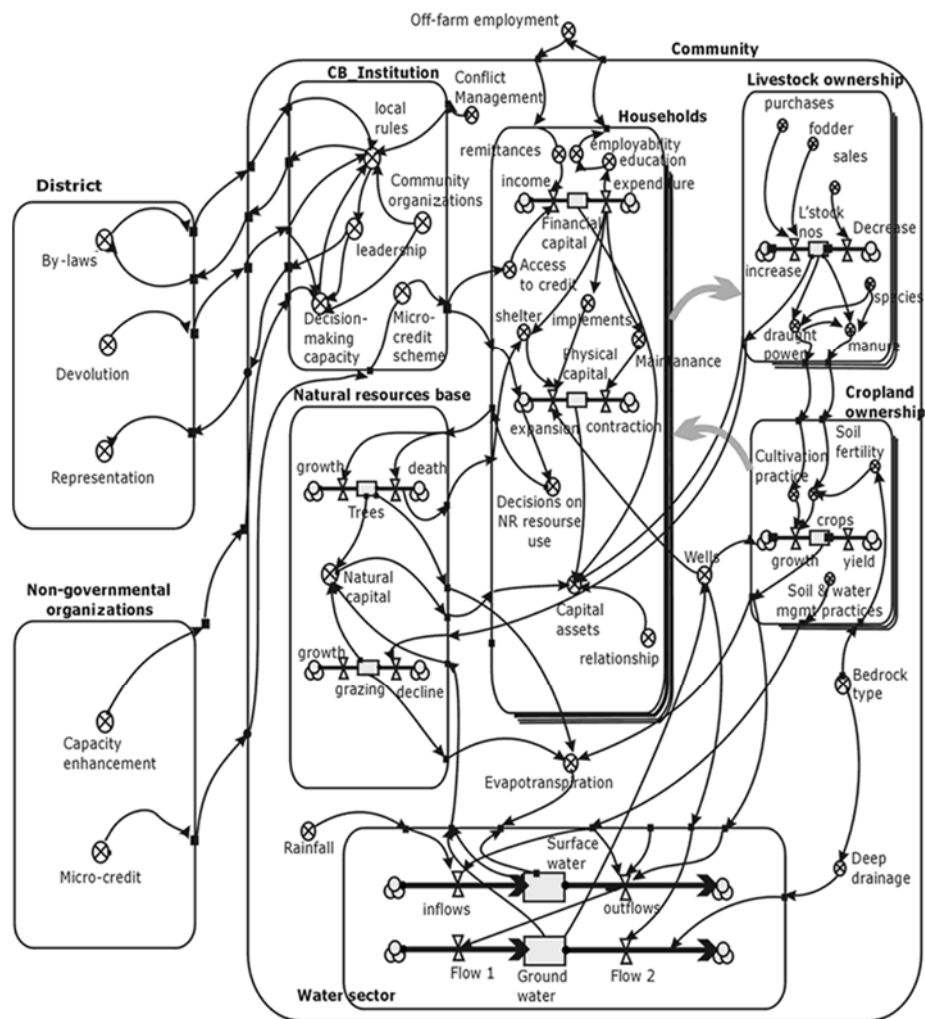


Figure 2.2 - Conceptual box-and-arrow model of integrated resources

(Sayer and Campbell 2004, p.115)

In this thesis there is an explicit acceptance that it is valid to examine the activities of modern pastoralists and hunters in order to understand the repertoire of alternatives that would have been available in the past and is discussed in section 2.8. Ethnographic data was used as a starting point to find a modelling technique that was appropriate for assessing archaeological data. Only by understanding the potential patterns of behaviour that may be detectable in the past could a suitable model be identified. At the most basic level, potential communities may be characterized as a series of ongoing choices about economic activities, social organization and quality of life. On a day to day basis, strategy and choice may be influenced by a number of factors all set within an inherited social and cultural context (Cashdan 1990; Jallow 1990; Tainter and Tainter 1996; Carney 1998; Moritz *et al* 2011; Mortimore 1998; Sen 1999; Sayer and Campbell 2004). The next task was to identify an appropriate model.

A number of relevant models for resolving developing world problems have been created by development economists. One of the earliest and most influential models was that of Arthur Lewis, whose core ideas were that traditional economic models could not be applied to subsistence (agricultural) economies and that there is very little capital endowment in these sectors. He contrasted this with the capital driven urban sector (Lewis 1954). Since then many other models and solutions to economic difficulty in developing countries have been proposed, some of which were considered for this thesis, but were rejected. These include Duncan's influential POET model (Duncan 1961, 1964); Ilbery's Point Score Analysis system (Ilbery 1975, 1977); the Integrated National Resource Management (INRM) approach (e.g. Attah-Krah 2006, Campbell *et al* 2001, Douthwaite *et al* 2004); the SEIC model (Tabara and Pahl-Wost 2007); the Rural Livelihood System (RLS) model (Baumgartner and Högger 2004); and the Millennium Ecosystem Assessment conceptual framework (MEA Board 2003; MEA 2005). Most of these models emerge from the basic idea that sustainability can only be achieved when a number of important components are fully integrated and fully functional, as expressed in a simple Venn diagram (figure 2.3):

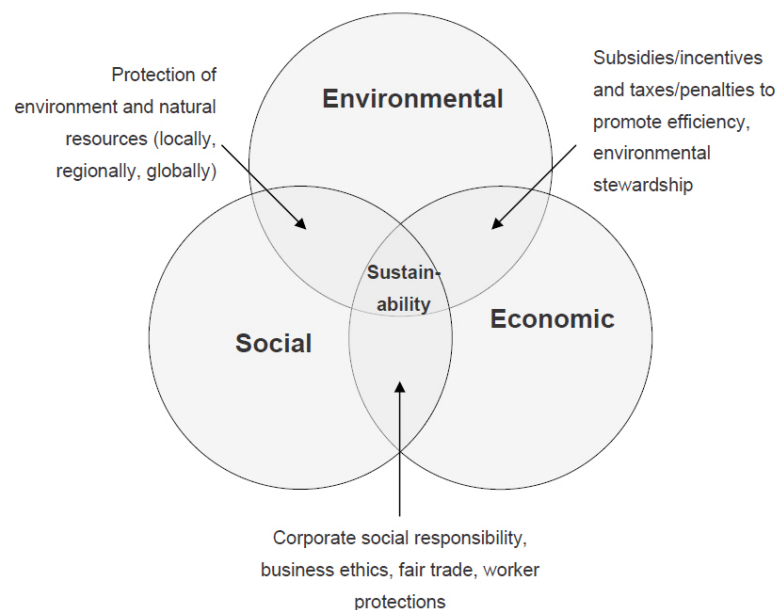


Figure 2.3 – Venn diagram of components necessary for a sustainable livelihood (Rosen and Kishawy 2012, p.156)

Duncan's influential POET model (Duncan 1961, 1964) was a useful start but was too simple for the purposes of this thesis, being deterministic in its assumption that only these four components play a part in defining a livelihood system: population, environment, technology and organization (figure 2.4). Population includes demographic variables like size, age, and fertility rates. Environment comprises all the natural resources available in an economy. Technology is the means by which environment and population are mediated and ties the user

of the technology into tasks relating to manufacturing and raw material acquisition. Organization refers to any organizational structure within society, be it political, economic, religious, cultural or any of another number of formal or informal arrangements. Its importance lay in recognizing that environmental factors were not the only pre-condition for sustainability, that components must be interactive and involve feedback systems, and that these interactions are multi-directional. However, terming it an ecological complex (Duncan 1961) indicates that Duncan still incorporated the idea that ecological factors dominate, with a flow from non-material ecological matters to dependent social and economic structures. It was very influential and is certainly the basis of other future attempts to model livelihoods, but it now seems very reductionist and fails to capture the complexity of interactions between the different elements in society, the economy and the ecological setting and ignores the role played by culture in mediating between aspects of complex systems.

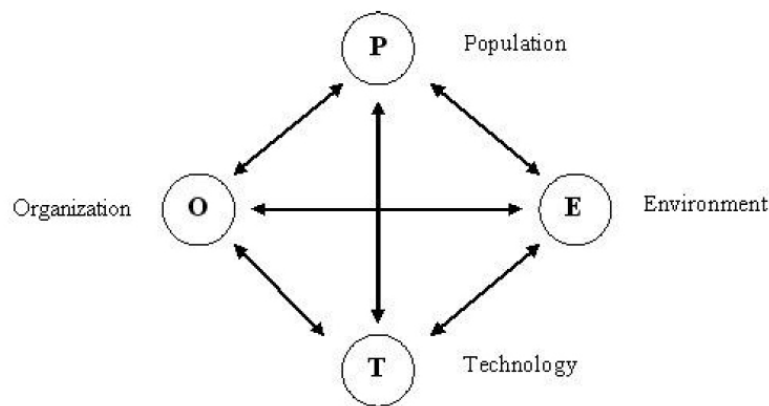


Figure 2.4 – The POET model

Tabara and Pahl-Wostl (2007) built on Duncan's model. They identify four key modelling components: structure, energy and resources, information and knowledge, and social-ecological change within a context of sustainability learning: "the co-adaptive systemic capacity of agents to anticipate and deal with the unintended, undesired and irreversible negative effects of development" (2007). The emphasis is on increasing the capacity of individual agents to be increasingly effective in a social-ecological system. They provide the theoretical SEIC model "to help highlight the key components that should be taken into account when assessing the effects on sustainability of processes for social learning in the management of social-ecological systems" (2007). This integrative model is shown in figure 2.5. The authors argue that sustainability occurs when the socio-environmental system (C) is favourably changed within manageable thresholds by creating adaptive changes in government (S), and efficiently managing flows of Information (I) to reduce the pressure on natural resources and the use of energy (E).

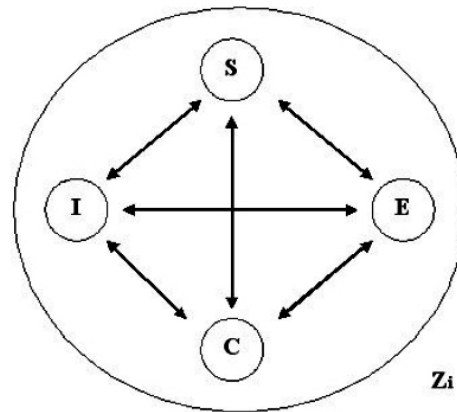


Figure 2.5 – The SEIC model (Tabara and Pahl-Wostl 2007, figure 2). S = structure and ruling institutions; E = energy and resources; I = information and knowledge; C = social-environmental change and Z_i is the size of the sociological ecological system i .

The SEIC approach is an improvement on the POET model but is still unsuitable for archaeological research. One of the problems was that it is a tool for promoting social learning, emphasizing the role of individual agents in a way that would be unusable with most of the data being used in this thesis; another is that it is less on understanding the current situation and more to do with managing and delivering sustainable change. It is highly self-conscious and interventionist, using social learning as a device to improve sustainability. Finally, the four SEIC components lack the detail and complexity required for a descriptive and explanatory approach.

I also looked at the Point Score Analysis system developed by Ilbery (1975, 1977) as a means of shedding more light on the way in which people made decisions in pastoral regimes and where cultivation is present. Ilbery's approach incorporates both economic and "socio-personal circumstances" as components of decision making, including a wide number of variables (Ilbery 1977, p.66), placing a heavy emphasis on the agency and preferences of decision makers. In 1984 he created a typology of hop farmers based on 32 variables that are organized by attributes based on family occupation and farm and farmer characteristics (e.g. size of farm, and the age and education of the farmer). He found that personal preferences and the perception of others, rather than purely income-orientated factors, played an important role in decision making. However, although I was prepared to adapt it due to its design for use with archaeological data, none of the data available was rich enough to apply Ilbery's methodology, although it has potential for discussing decision making in historical agriculture where sufficient documentation is available.

The Integrated Natural Resource Management (INRM) model, modified and employed by different writers in different ecological situations (e.g. Attah-Krah 2006, Campbell *et al* 2001, Douthwaite *et al* 2004) has potential for understanding natural and agricultural resource management flows. INRM "involves the integrated analysis and management of the

components of production, in such a way that one is able to achieve the products required by man for survival, while maintaining environmental balance and sustainability” (Attah-Krah 2006, p.8). Campbell *et al* (2001) provide a slightly broader definition of INRM as “a conscious process of incorporating the multiple aspects of natural resource use (be they bio-physical, socio-political or economic) into a system of sustainable management to meet the production goals of farmers and other direct users (food security, profitability, risk aversion) as well as the goals of the wider community (poverty alleviation, welfare of future generations, environmental conservation)”. However, although (INRM aims to place people at its core, and solving human problems is its essential task, it is explicitly economic and ecological in its outlook, leaving little room for social drivers, as shown in figure 2.6. It was also developed for agricultural production, reflecting the fact that the term was first coined in 1996 by the Consultative Group on International Agricultural Research (CGIAR) system, a coalition of 15 international research centres (Douthwaite *et al* 2004, p.323) and is always geared towards that type of economic activity. Although most approaches agree that it is necessary to understand the system under analysis it, and that “modelling is a practical approach to deal with variables that change more slowly than the length of a project” (Douthwaite *et al* 2004, p.324) there is also no agreed-upon shared model in INRM. Finally, it depends on a very high granularity of economic and ecological data that is often missing from prehistoric contexts.

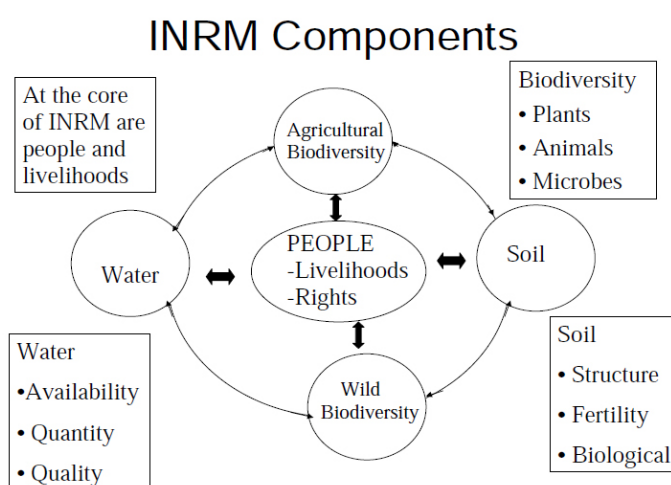


Figure 2.6 - Components and interactions in INRM
(Source: Attah-Krah 2006, figure 1, p.10)

The Rural Livelihood System "mandala" (RLS) has a number of areas of similarity to the Sustainable Rural Livelihood (SRL) model but differs in a number of significant areas (figure 2.7). It is more inductive, emphasising the metaphoric and symbolic, giving much greater emphasis to emotional dimensions and inner realities (Eyhorn 2006; Ludi 2009; Baumgartner and Högger 2004). As well as economic and ecological factors, the RLS puts considerable emphasis on how these dimensions and realities contribute to decision making: “This inner

reality can never be fully explored by outsiders, but it 'shines through' many perceptible phenomena like a person's enthusiasm, artistic creativity, sociability or trance" (Högger 2004, p.38). A number of examples are given in Baumgartner and Högger (2004), showing how effective a tool it can be, but for the purposes of this thesis there is no way of accessing many of these areas of emotional and personal decisions in livelihood management.

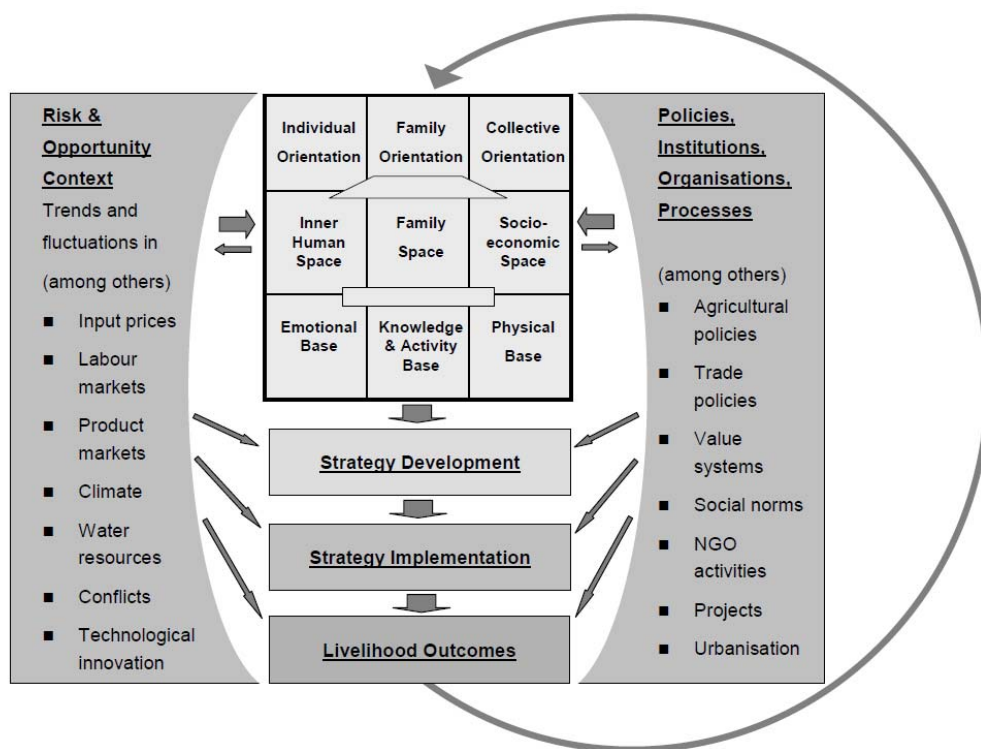


Figure 2.7 - The RLS Mandala

The Millennium Ecosystem Assessment (MEA) model (MEA 2005; Millennium Ecosystem Assessment Board 2001) was also considered. The MEA was initiated in 2001 by the United Nations (UN), with the objective of making scientific assessments of the consequences of ecosystem change and the action needed to ensure conservation and sustainability of those ecosystems, with special reference to their contribution to human well-being and improved decision making (MEA 2005). It operates under the assumption that human activity is undermining the capability of ecosystems to meet human demands for food and clean water: "The human species, while buffered against environmental immediacies by culture and technology, is ultimately fully dependent on the flow of ecosystem services (MEA Board 2003, p.1). It is designed to operate at the regional level and is intentionally focused on scientific as well as cultural intervention to resolve ecosystem problems (see figure 2.8). Although it recognizes four types of productive capital (manufactured, human, social and natural) (MEA Board 2003, p.29) its emphasis is on initiating ecosystem change rather than capturing existing livelihoods. Lenssen-Erz and Linstädter (2010) have used elements from the

Millennium Ecosystem Assessment (MEA) model (MEA 2005) to develop a methodological approach to assessing change in the prehistoric past.

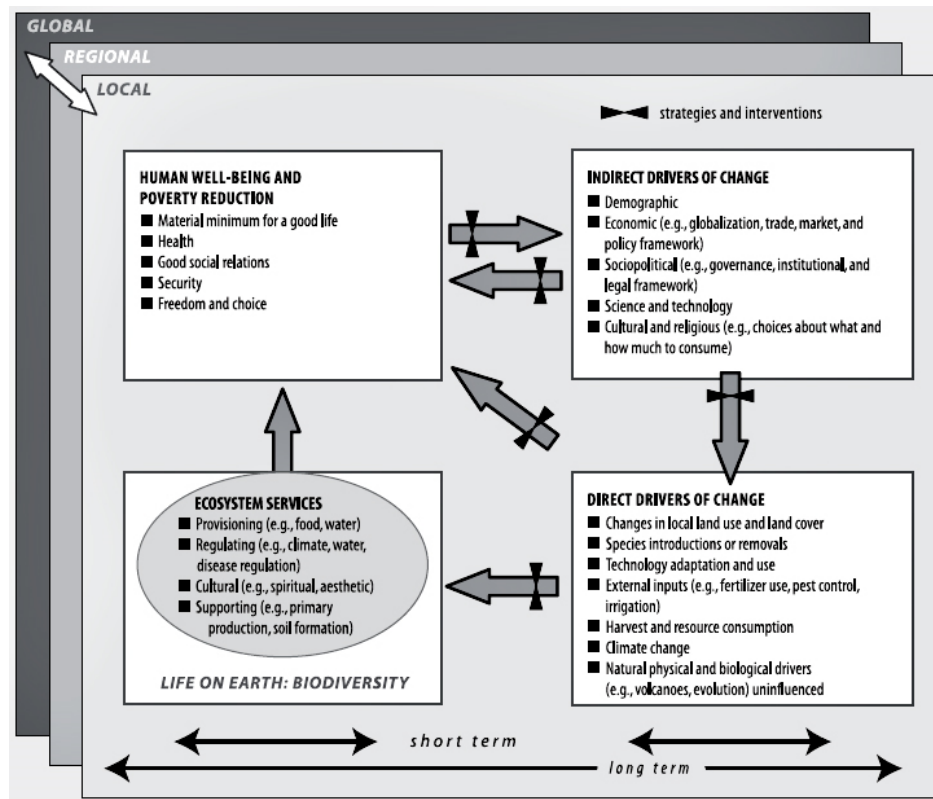


Figure 2.8 – MEA ecosystems conceptual framework
(Source: MEA Board 2003, Box 2, p.9)

The SRL model is far more helpful at a community or group level, capturing data to understand how communities operate within a relatively narrow catchment at any given time. The MEA concentrates on capturing change between conditions. The two would probably work well together, but the SRL model is explicitly asset-driven and includes an assessment of long term sustainability as a requirement for the completion of the model, into which are incorporated potential opportunities and vulnerabilities.

The Sustainable Rural Livelihoods (SRL) model was developed in the early 1990s by a number of writers (Ashley and Carney 1999; Carney 1998, 1999; Chambers and Conway 1992) under the auspices of the United Nations Development Programme (UNDP) and the Department For International Development (DFID). It was designed to serve as a tool to assist analysts with some of the difficulties experienced by development economists who were trying to understand how to influence decisions of those operating subsistence economies for the purpose of improving their livelihood prospects (Campbell 2001; Chambers and Conway 1992; Dalal-Clayton *et al* 2003; Dixon *et al* 2001; Frankenberger *et al* 2000; Homewood 2005).

An early model, based on Carney (1998) was incorporated into DFID Guidelines (DFID 1999, figure 1, p.1), shown below (figure 2.9), demonstrating its intention to characterize different economic systems not in terms of modern measurements of poverty and wealth, but in terms of vulnerability, opportunity, marginality and comparative advantage. Sayer and Campbell used the same elements illustrated in the DFID version but emphasized the dynamic linkages between them (Sayer and Campbell 2001) shown below in figure 2.10. A more recent version added the “Personal” category to the Asset Matrix (Hamilton-Peach and Townsley 2007), shown in figure 2.11, below and described briefly in table 2.1 and in more detail in Chapter 7, section 7.3.8. The Sustainable Rural Livelihood Approach was considered to be the most promising of the various options.

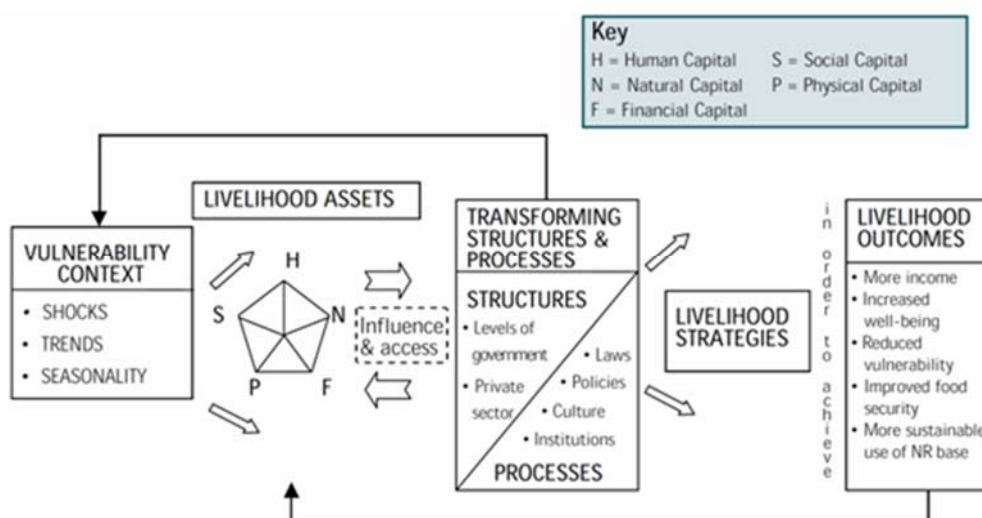


Figure 2.9 - The Sustainable Livelihood model in the DFID Guidelines (DFID 1999, figure 1, p.1)

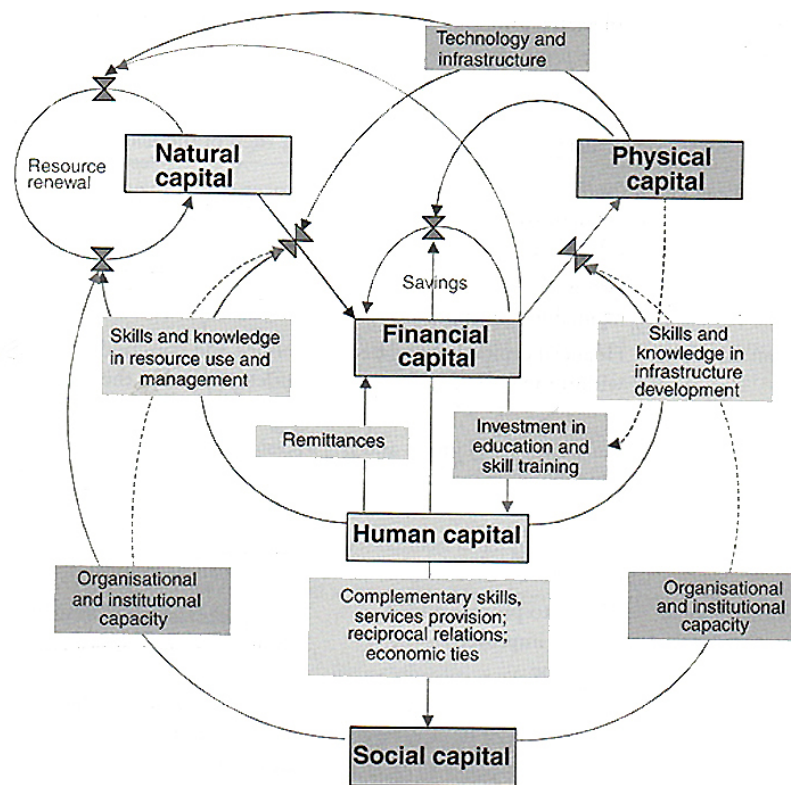


Figure 2.10 - The dynamic nature of assets in a modern development economics scenario (Sayer and Campbell 2001, figure 10, p.218)

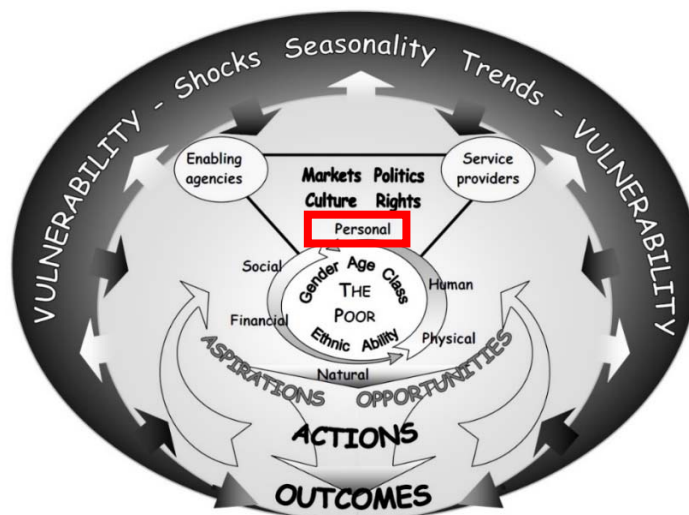


Figure 2.11 – The Personal asset added to the Asset Matrix in 2007 (Source: Hamilton-Peach and Townsley 2007)

The SRL model has a number of benefits that render it more suitable than those described above. Although it certainly divides livelihoods into components it is much less reductionist and deterministic than models like Duncan's POET model (Duncan 1961) and the INRM model (Campbell *et al* 2001). Even Tabara and Pahl-Wostl's SEIC model, which built on Duncan's approach, builds in a deterministic view of how sustainability can be achieved, which minimizes its use for the investigation of a broad range of possible livelihoods and outcomes. The separation of assets and variables in the SRL approach, by contrast, is non-deterministic, allowing any number of variables to act on a broad range of assets. Ilbery's Point Score Analysis has potential for scenarios where there is high resolution of data that allows the quantification of variables, a feature shared with the INRM model, but for this particular study, where activities cannot be quantified with any confidence, the SRL approach is far more flexible. Closely related to the SRL model is the Rural Livelihood System (RLS), but this was rejected in favour of the SRL approach because the RLS relies very heavily on metaphoric, symbolic, emotional aspects of living and inner realities. These are much easier to approach in anthropological interviews and observations than archaeological research, and therefore not as easy to apply to archaeological contexts, although they dovetail with archaeological interests in phenomenology and agency. The Millennium Ecosystem Assessment (MEA) model is ecologically driven, designed to prevent ecosystem problems. Although it has potential for use at the landscape level in archaeology, it is not easily scaleable.

As the emphasis in this thesis is on livelihood strategies, the evidence-based Sustainable Rural Livelihood model, which incorporates social and cultural components and concepts of personal well-being along with economic and environmental data, is considered to be the most appropriate tool for the type of data and the questions being asked of it in this thesis, balancing deductive and inductive approaches and combining both descriptive and explanatory components. It has been designed to observe trends over time and in space and to look at opportunities, shocks and stresses and the impacts that these may have (DFID 1999; Morse *et al* 2009). Whilst putting any complex system in a diagram carries the risk of appearing to freeze something dynamic and endlessly shifting, it is still helpful to have a working model with which to capture the relationship between different components of livelihood management, and which explicitly incorporates the idea that change is integral to society.

The SRL model shares with other approaches the benefit of separating assets that can be defined in the archaeological record from variables that may have acted upon them, but it is much less determinative in what these variables are, and assigns equal value to each of the assets upon which they may act. This leaves far greater flexibility for testing hypotheses about social and economic activity and change, providing the potential to gain insights into archaeological questions about the prehistoric past.

Finally, the asset matrix places a requirement upon the researcher to present the available archaeological material in a formal and coherently structured form. This is invaluable for assessing the quantity and quality of the data available, for assessing archaeological material in terms of livelihood information, and for using asset summaries from different sites for comparative purposes. Although archaeological reports are organized to reflect excavation strategies and post-excavations specializations, it was hoped that the data required to assess the livelihoods that these excavations represented would be available in the published reports.

2.2 The Sustainable Rural Livelihood Model

2.2.1 The Integrated Model

The SRL approach was first promoted by the United Nations Development Programme in 1990. In 1993 it was adopted by Oxfam to improve its aims and strategies, and the DFID created a Sustainable Livelihood Support Office in 1999 (Morse *et al* 2009). Small (2007, p.27) describes the SRL approach as a “paradigm shift in international development thinking.” As it is designed as a tool to first record and then assist with the assessment of data, it is proposed that it has a potentially similar value in archaeology. It takes into account that all people demand a minimal set of requirements for survival but that after basic survival is secured, other aspects of life are also essential for well-being. It examines all aspects of lives, divided for analytical purposes into six categories that make up the SRL matrix. Where it becomes more than merely a graphical representation or a static snapshot of a society is in the exploratory and explanatory power of the variables that act, all the time, on the matrix and the ways in which real people manage the relationship between their lives and the variables that act upon those lives. The role of these fundamentally human goals can be a factor in how communities assess internal dynamism and external change or adopt new approaches in their livelihoods. This means that to be truly sustainable, rather than just surviving societies, however simple, should be understood in terms of those social and personal conditions and aspirations as well as purely economic and environmental ones. Today the SRL approach creeps into all sorts of studies, even when not explicitly referenced (see for example Dixon *et al* 2001. p.15, figure 1.5; FAO 2000).

There are a number of advantages of the Sustainable Rural Livelihood (SRL) approach from an archaeological perspective as follows. It can model complicated aspects of socioeconomic systems and the linkages between them transparently (see figure 2.8). It incorporates the ideas that whilst sustainability may be essential for survival, other less economically-driven factors which also influence human responses to alternative options are given equal weighting. It builds in the idea of multiple variables potentially operating on assets. It allots equal importance to subsistence and social assets. It encourages users to think about

how different aspects of the matrix will result, under certain conditions, in different outcomes (see, for example, the radar diagram in figure 2.15). It can help to assess how successful (i.e. sustainable) a livelihood strategy can be under the given conditions and gives a specific definition of sustainability, against which livelihoods can be measured. It provides an all-inclusive approach to livelihoods. The graphic representation of the model in figure 2.8 makes the approach unambiguous. Although not designed specifically for comparative studies in either space or over time, I suggest that it is entirely suitable for those purpose, demonstrated in Chapter 9. It is compatible with the use of ethnographic data. The model does not underestimate the complexity of small scale production systems, and it is substantive, as exemplified by the case studies.

The standard manual on the subject of the SRL framework, *Pastoralism and Sustainable Livelihoods: An Emerging Agenda* (DFID 2000a) explains the SRL model as follows

It views people as operating in a context of vulnerability. Within this context, they have access to certain assets or poverty reducing factors. These gain their meaning and value through the prevailing social, institutional and organizational environment. This environment also influences their livelihood strategies - ways of combining and using assets - that are open to people in pursuit of beneficial livelihood outcomes that meet their own livelihood objectives (DFID 2000a p.14).

Carney 1998, who was instrumental in the development of the SRL model, helpfully defines a livelihood, making it clear that it is not merely task-orientated (p.4):

A livelihood comprises the capabilities, assets (including both material and social resources) of activities required for a means of living.

Looking specifically at the idea of sustainability, the concept is derived from the knowledge that communities need to respond to short and long term vulnerability. As a working concept, sustainability has much in common with Resilience Theory, which has been discussed by various disciplines, notably psychology, and has also been adopted by some branches of development economics (Gichuhi 2015). Both look at ways of ensuring the SRL model incorporates the idea that sustainability may be influenced by other factors embedded in social frameworks and ideas of desirability and choice, which are equally important to human well-being and social security. Chambers and Conway (1992, p.7) elaborate as follows:

A livelihood comprises the capabilities, assets . . . and activities required for a means of living; a livelihood is sustainable which can cope with and recover from stress and shocks; maintain or enhance its capabilities and assets and provide sustainable livelihood opportunities for the next generation; and which contribute net benefits to other livelihoods and the local and global level in the short and long-terms.

An important point is that the SRL model is orientated towards people and how they live their lives rather than just the resources they use or the governments that manage the economies within which they exist (Carney 2003, p.13; Farrington 1999, p.4; DFID 2000a, p.3). Whilst it

may seem that the SRL approach is driven by assets rather than people, at its heart is the desire and the practical need to find out what motivates people, what their priorities may be and how to help them restructure whilst retaining the ideologies and social institutions that they value (Carney 1998), incorporating ideas of both economic and social risk (FAO 2001b; Moritz *et al* 2011). The relationship between the Asset Matrix and the livelihood variables expresses some of this complexity.

The SRL model (figure 2.12) conceptualizes assets in the form of the Livelihood Asset Matrix, six criteria or livelihood characteristics, which sit within a context of vulnerability and opportunity. The Asset Matrix hexagon is the data capture vessel. At the centre of the hexagon, the point represents zero access to assets, and the radiating lines indicate differing to maximum access to assets. There is particular emphasis on the importance of variables that may influence the various components of a livelihood, captured in the Livelihood Variables tables, and how these may transform livelihoods. These variables are often outside the control of the people who are most effected by them. Although they are often negative, including drought, disease, climate change, the collapse of social networks and other shocks and longer term trends, they may be positive too, including opportunities offered by new products, services and technologies. The Livelihood Status matrix is framed within the context of flexibility. Flexibility represents the ability and willingness to make short-term strategic choices and take up economic, cultural and environmental opportunities when available, and to employ cultural devices to sustain a sense of community and individual identity, and to use these techniques to incorporate and modulate change.

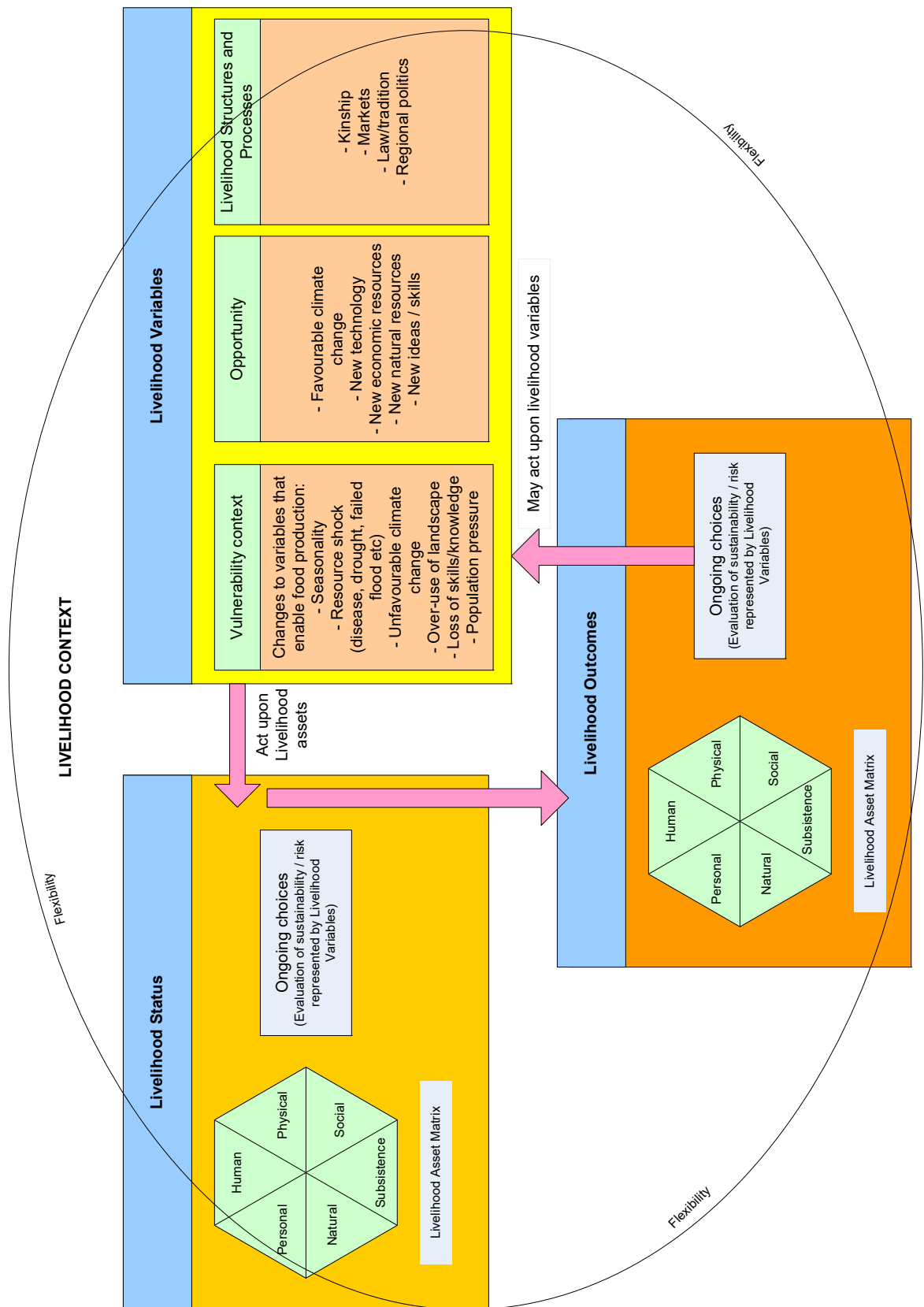


Figure 2.12 - The SRL Model, modified for use in archaeology

2.2.3 The Components of the Livelihood Asset Matrix

The starting point for collecting and categorizing data is the Livelihood Asset Matrix, which represents the livelihood status of a group or community. The Livelihood Asset matrix provides a series of headings which make up the main assets and inputs which go into making up a community. The DFID Sustainable Livelihood Guidance Sheet emphasises that the benefit of the matrix is that it brings to life important inter-relationships between the various assets (DFID *n.d.*), reflecting the mix of assets available to people and how these influence their livelihood strategies.

The model analyses the influences of a number of variables on a core matrix of assets, which are as follows (figure 2.13):

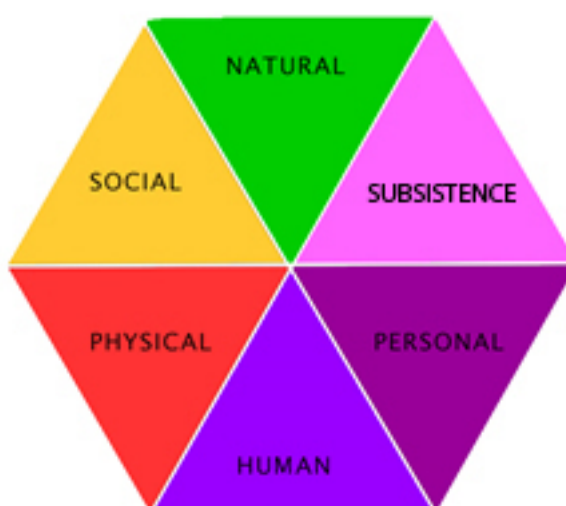


Figure 2.13 - The livelihood asset matrix

The above livelihood asset matrix can be expanded to show how these components are described and what the research demands may be, shown in figure 2.14 below. These are discussed further below, and. In Chapter 7 it is suggested how archaeological measures might be applied for each component and these are captured in Appendix G.

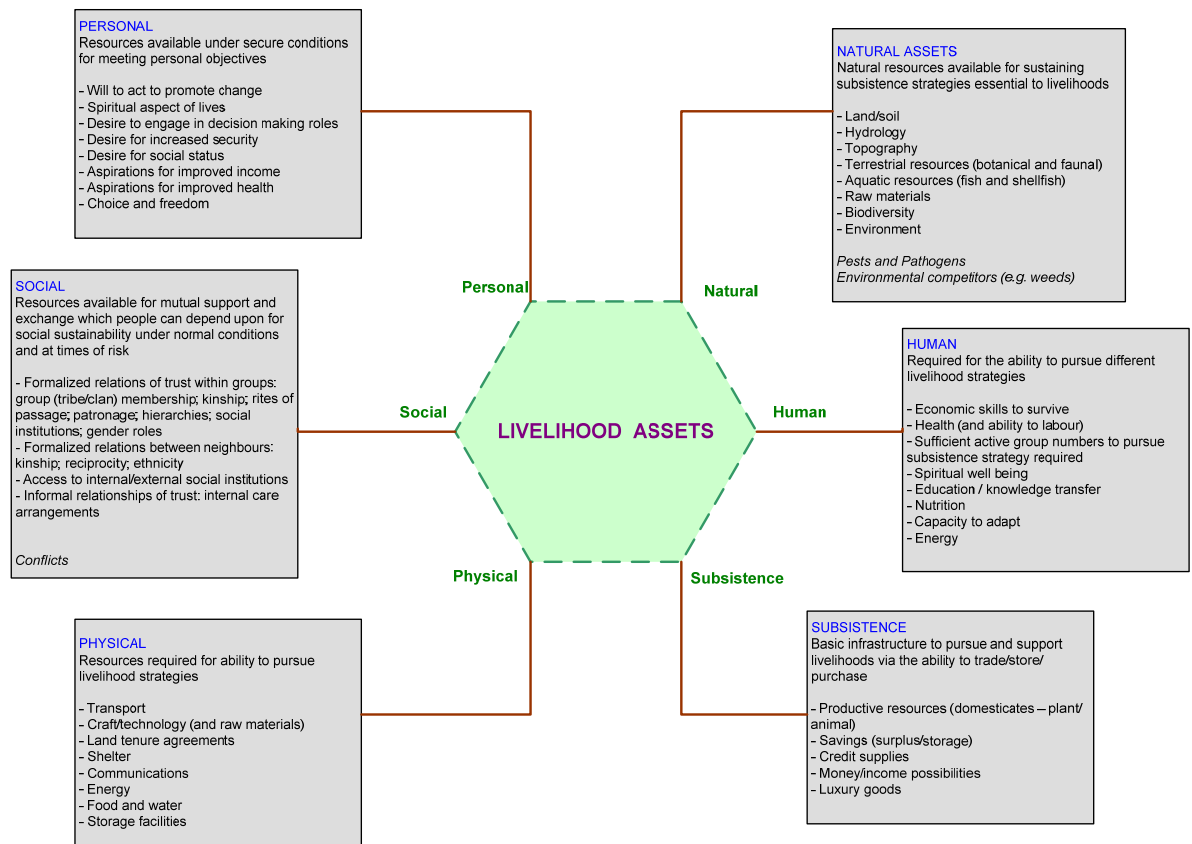


Figure 2.14 - Variables in the asset matrix, based on the DFID Guidelines (DFID 1999)

The assets can be summarized as follows. These are developed in Table 2.1, where the criteria for recognizing the asset components archaeologically and characterizing them are also shown.

- Natural (environmental and biological resources, maintenance of biodiversity)
- Subsistence (ability to acquire/produce food, store, save and trade)
- Human (ability to support physical well-being and provision of good health)
- Social (resources for mutual support, group identity, maintenance of traditions and group spiritual fulfilment)
- Personal (ability to achieve individual satisfaction within a community)
- Physical (Infrastructure required for pursuit of livelihood choices, including technology, shelter, transport)

It should be noted that some components may appear in more than one asset class. For example, livestock is not only a subsistence asset but is also a human asset and may also be a financial and social asset (DFID 2000a, p.7, 16-17; Evans-Pritchard 1940). Similarly, when

resources are limited, assets may be under-represented in one area if they have been invested significantly in another. An obvious example is the depletion of natural assets after over-grazing or over-hunting. Archaeological indicators of the components in the asset matrix are shown in more detail in Chapter 7.

The assets are broken down into a series of components shown in Table 2.1, below, which are described in detail in Chapter 7. This consists of three columns: Assets, Characterization and Sustainability. **Assets** are the sections of the hexagon. **Characterization** refers to how these are perceived and evaluated. **Sustainability** is the determination of whether what is observed can be sustained in the longer term. Sustainability may be economic or social, and is usually both as they reinforce each other. The SRL matrix frames livelihoods within functional and pragmatic categories that avoids the vague and often disputed concatenations like “socio-economy” and “socio-culture” and does not allow for often dichotomous simplifications of livelihoods. The data in table 2.1, below, is based on Carney 1998, Corloni and Crowley 2005 module 5, the DFID Guidelines 1999, Morse *et al* 2009.

Asset Component	Characterization	Sustainability
Natural Resources for sustaining subsistence strategies essential to livelihoods. Natural assets both constrain and enable the range of choices that can be made.	Whilst the greatest possible mix of natural assets in a predictable environment will be most likely to provide the ideal situation for economic development, even the most marginal areas can support livelihoods if water is available. Variability of climate, seasonality, and ecological conditions are important in risk management. Understanding the natural conditions under which people lived is essential to contextualizing the livelihoods.	Maintenance of the natural conditions that support life are achieved by risk management strategies to ensure that resources are not over-exploited.
Subsistence The way in which a community manages its resources and infrastructure for meeting subsistence objectives, external obligations and the health needs of humans and livestock.	The ability to consume, store, exchange, trade or otherwise convert one type of resource into another, more desirable one. It is a measure of social and economic flexibility and the ability to ensure long term security.	Indications of economic and social stability and flexibility.
Human Human resources for the ability to sustain given livelihood strategies	A combination of nutrients and energy from the livelihood on an ongoing basis, together with	Indications of good nutrients and energy supply from the diet on

Asset Component	Characterization	Sustainability
	mechanisms for ensuring the transmission of subsistence and cultural knowledge.	an ongoing and consistent basis. Absence of disease and congenital conditions. Optimal gender and age mix. Social networking activities to ensure maintenance of gene pool, trade relations and reciprocal obligations.
Physical The infrastructure and physical resources required for the ability to pursue livelihood strategies	To enable people to pursue their lifestyles they need basic physical infrastructure, which is dependent upon local or imported materials and the use to which they are put. The degree of physical infrastructure varies depending on how mobile communities need to be.	The ability to source energy and raw materials, to produce industrial and craft products, to source and construct appropriate shelter along a continuum of sedentary or mobile livelihood strategies.
Social Inter- and Intra-group resources for mutual support and sustainability of the group's population and traditions.	The portfolio of mechanisms used to organize and support groups, both internally within groups and via social networks. This includes social organization, ideology, religion, identity, cultural output and indications of inter-regional connections.	Whether or not social systems are successful is largely a value judgement so here the measurement is confined to how well the systems identified support the sustainability of the community as a whole.
Personal Individual requirements for ongoing well-being and quality of life for an individual within a community.	Personal satisfaction is probably best seen as the successful operation of all other aspects of the matrix, working to provide the optimal conditions for individual rights to be considered and goals to be met. Decline of personal value can be seen in terms of failure of any of those elements, resulting in the need to go short (of food, security) or in non-causal loss (disease, illness, epidemic) or in enforced change due to forces outside control (natural disasters). The Personal element can be both individual (the person) and collective (a livelihood that acts in the interests of individuals who feed into it).	The sustainability of personal well-being depends largely on the sustainability of all the other components of the asset matrix.

Table 2.1 - Characterization of assets and measures of sustainability

Access to assets may change constantly. Figure 2.15 demonstrates the dynamic and interactive nature of assets and their relationship to one another in one example. In the

original diagram all assets are shown having maximum potential but the strength of assets is always relative to other assets. The relationship between assets can be expressed using the asset matrix, by altering the hexagram (or in earlier versions the pentagram).

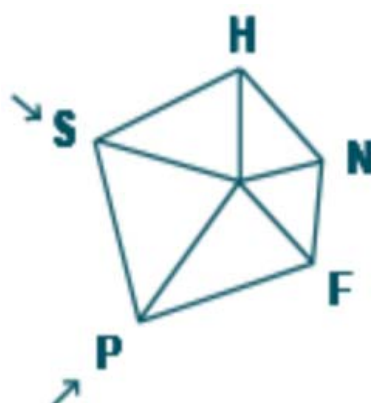


Figure 2.15 – DFID pentagon for a specific urban context. In this example the livelihood seems unsustainable as it shows poor human, financial (subsistence) and natural assets together with declining access to physical and social assets (DFID 1999, section 2.1)

Asset Category Strengths and Weaknesses

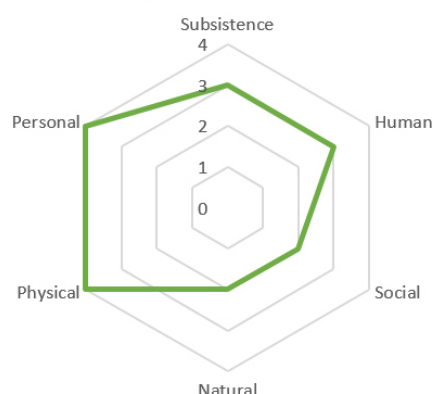


Figure 2.16 – Radar diagram from Chapter 9 and Appendix H showing the radar diagram from the Hadendowa test case study, demonstrating that whilst relatively sustainable in some areas, the cutting of trees for fuel and charcoal for urban centres has undermined natural resources, and that social structures are being impacted by the loss of young men and families to the same urban areas

Radar diagrams can be used to show how assets are stronger in some parts than others. Obviously, a major question is how to assess each component, to define measurables. Whatever weighting systems are adopted by the practitioner, the numbers are derived qualitatively, not quantitatively. The numbers are being used to deliver a graphical representation of a subjective system of values. My approach, based on Nelson *et al* (2016) is discussed in detail below in section 2.4.

2.2.4 The Livelihood Variables

After the livelihood asset matrix has been completed, the model goes on to show how these different assets can be modified by vulnerabilities and opportunities, which cause different livelihood strategies to be followed and different actions to be taken. Vulnerability “refers to contingencies and stress, and difficulty in coping with them” (Manoli *et al* 2014). Community assets are therefore seen in the wider context of external impacts, the decisions that need to be taken in the face of those impacts, and the resulting livelihood outcomes that result from these complex variables. These are listed in figure 2.17 under the following headings: Vulnerability Context, Opportunity and External Processes. Variables are not always easy to assess. As archaeologist Robert Bettinger emphasises, “it requires hard choices about the variability that is important and the variability that is not” (Bettinger 1993, p.44).

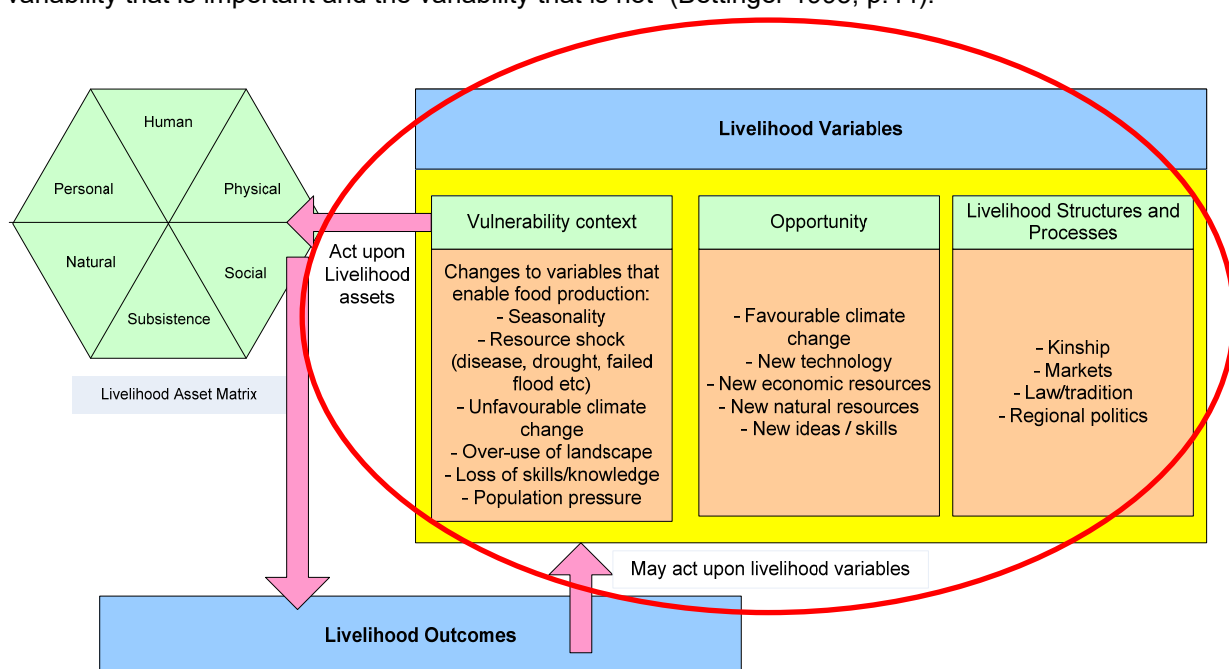


Figure 2.17 - Livelihood variables within the SRL model

The situation of risk or security within which groups exist and within which inputs are made and outputs emerge is described as a set of livelihood variables. This includes **opportunities** and **vulnerabilities**, and the **structures and processes** that act upon the way in which livelihoods are managed. Of these, the variable most usually concentrated upon is vulnerability, the shocks and stresses that are faced by any given livelihood (Morse *et al* 2009, p.5).

The work of both development economists and anthropologists makes it very clear that particularly in areas of environmental unpredictability the concepts of vulnerability and opportunity are central to livelihood maintenance and that the process of managing livelihood systems in these contexts is particularly challenging (Behnke *et al* 1993; Carney 1998;

Mortimore 1998; Sayer and Campbell 2004; Sumner and Tribe 2008). Development economists have spent a considerable amount of time defining what constitute the main vulnerabilities and the opportunities which may become available with those contexts of strategic planning (Behnke *et al* 1993; Carney 1998; Sayer and Campbell 2004; Sumner and Tribe 2008). The development and anthropological literature provides numerous examples of groups who live successfully in Sahelian and other disequilibrium environments. Examples of such groups who have lived successfully in desert environments are the Beja of Sudan (Manger *et al* 1996), the Ma'aza of Egypt (Hobbs 1989), the Sandawe of Tanzania (Newman 1970), the Herero of western Botswana (Vivelo 1977), the Barabaig of East Africa (Kilma 1970); the Himba of Namibia (Abati 1998; Bollig 2006), the Wodaabe of southeastern Niger and the Puebloans of southwest North America (Vlasich 2005).

2.2.4.1 Vulnerability Context

The vulnerability context describes the variables that challenge a community's ability to maintain food production and social structures. The previous section described the assets which make up a livelihood system. These livelihood assets are acted upon by a number of variables which can be understood as vulnerabilities and opportunities. As the primary concern of all groups is basic survival and the minimisation of anticipatory risk (Lavigne-Delville 1997, p.149) understanding vulnerability contexts is fundamental to understanding how groups operate under varying conditions of uncertainty. Stiglitz has suggested that in the past economists have failed to understand the degree to which people are risk averse, and the impact that this has on their response to adverse events, the shocks that can destabilize economies and social structures, and sometimes threaten life (Stiglitz 2014, p.14).

Vulnerabilities and opportunities are dependent upon different environments and on the implementation of novel ideas about livelihood management. They help to determine the available options for a community. Changes to the variables that enable food production which may lead to the implementation of short or long term measures include resource shock (drought, flash flood/storm, disease, altered seasonality), cultural causes (political dispute, human movement, population growth, war, over-use of biomass, spiritual/religious crisis, loss of skills/knowledge), industrial failure (loss of raw materials, loss of skills/knowledge) (Boserup 1965, 1981; Dei 1990; DFID 1999, 2000a; Farrington 1994; Fodchuck 1990; Holland 1990; Morse *et al* 2009; Moritz *et al* 2011; Robinson 2004).

Within the vulnerability context people have access to certain assets or risk-minimizing techniques, which they can combine to achieve beneficial outcomes even under difficult livelihood circumstances. As Alger (2000, p.347) points out "The concept of vulnerability offers us an analytical framework for unravelling the stereotypes and generalizations that so often blur our vision of real life." Whilst it is possible to suggest specific types of vulnerability as actors on a given situation, these do not take place either in isolation from one another or from the social context upon which they are acting, including social structure, kinship networks,

political entitlements, economic activities and the ways in which ecological constraints are handled.

Vulnerability may also be seen in terms of the erosion of human capabilities and choices which may victimize all members of society but may single out certain community members, like the impoverished, the old, the disabled, children and women (UNDP 2014, p.1), an aspect of life captured in the Personal asset category. The UNDP emphasises that human capabilities are built up and maintained over a lifetime and are the result of life histories and by the interplay of the community with environment and society as a whole. However, even with a lifetime of experiences built on previous histories, short term shocks may have effects that are more than transitory on the future lives of individuals (UNDP 2014, p.3). If vulnerability is defined as “an exposure to a marked decrease in a standard of living” (Stiglitz 2014, p.14) then, again, short term shocks may be exacerbated at the level of an individual who has a less than advantageous position in a community. Nelson *et al* (2016) identify eight variables as enabling/constraining factors, and by weighting them for each of their case studies, are able to generate a “vulnerability load,” a useful concept that is used in my own case studies and discussed below in 2.4.

Vulnerability, risk and uncertainty are discussed in depth in Chapter 5.

2.2.4.2 Opportunities

Opportunities are ideas, technological innovations or imports, new production possibilities (including new animal and plant types, favourable climatic change, production surplus or any other innovation, adaptation or adoption) that may be leveraged by an individual, household or group in order to improve livelihoods. As Ingold says (1981, p.126) every innovation “whether of local origin or introduced from outside, represents just one of a potentially infinite range of possible solutions to a given problem.” Some of the solutions to vulnerability will depend on new opportunities but opportunity may also represent improvements and refinements to an already successful lifestyle. I have discussed more about opportunity and innovation in Chapter 5. Appendix D describes the resistance of Puebloan Indians of southwest North America when confronted with the potential of both newly introduced and ongoing opportunities. Opportunity has been explored further in each of the case studies.

2.2.4.3 Livelihood Structures and Processes

Livelihood structures and processes include a variety of institutions at local and regional level. These are the social and political structures. In development economics this includes state and governmental influences and the impact of international politics, conflicts and markets (Carney 1998; DFID 1999). These are not applicable to prehistoric contexts, although they would be more appropriate for historical cultures that demonstrated a greater level of

complexity. In prehistoric contexts, structures and processes that might impact livelihood variability could include social, contractual and kinship networks, local markets and trade arrangements, territoriality including agreements about land tenure and common-land, local political, leadership or organizational difficulties, and religious or spiritual institutions.

2.2.5 Livelihood Outcomes

The outcomes of the SRL model describe what happens when livelihood variables act on an existing livelihood status (figure 2.18).

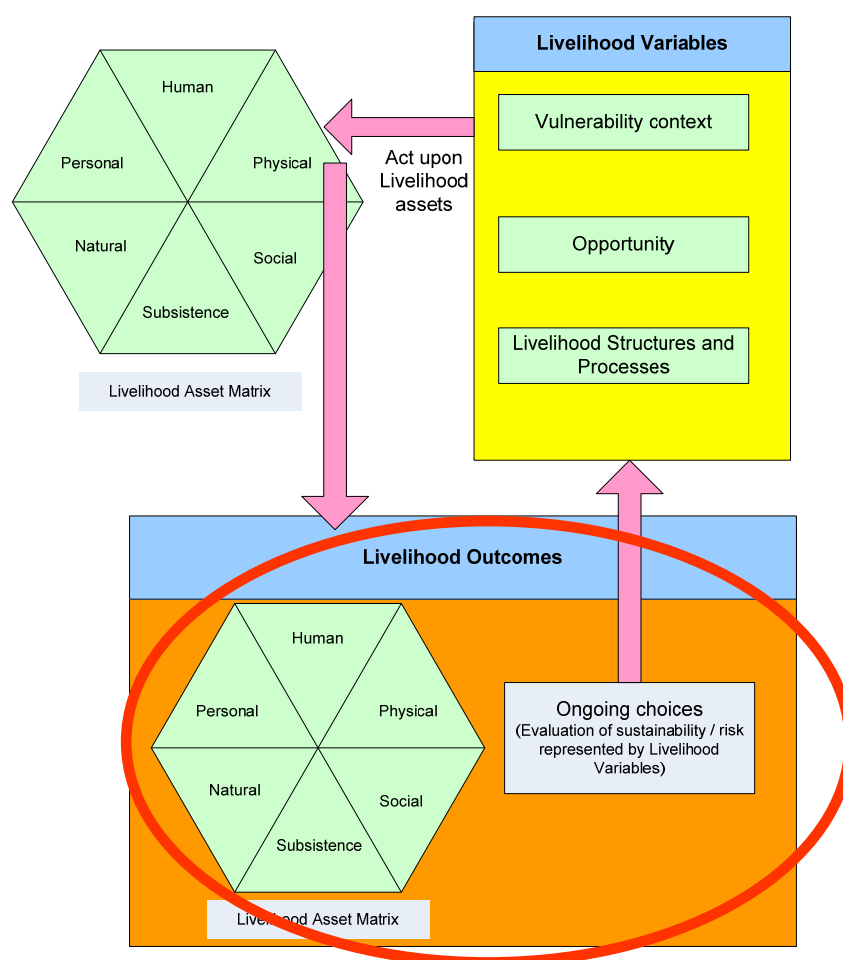


Figure 2.18 - The livelihood Outcomes section of the diagram

This part of the model looks at the influences external to those dealt with by existing risk management strategies. These may lead to observable change in livelihood situations. Positive outcomes, for example, would be increased production and food security, sustainable natural resource management strategies, lower vulnerability, improved health and life expectation, and overall improved well-being. Negative outcomes are often environmental. Research into modern groups indicates that small-scale societies are not merely passive

environmental participants but may set about modifying their environments to suit their needs, sometimes resulting in over-exploitation of the environment, particularly around sources of water in arid locations (e.g. Adriansen 1999, 2008; Binns 1992; Hunn 1993; Rodríguez-Estrella 2012). The degree to which societies are able to respond to changing conditions will depend partly upon the composition of the subsistence economy adopted by a group, the internal social organization, the links with kin and other groups, and the way in which the environment is stable or the degree to which it changes.

2.3 Supporting Models

In some instances it has been possible to work backwards from archaeological data to suggest how certain outcomes may have been influenced. A number of tools to accomplish this are described below.

A graphic tool derived from the SMART (Simple Multi-Attribute Rating Technique) approach is used in “Case Study 2: The Badarian” to represent some of the variables that are involved in managing livelihoods in dryland environments (Goodwin and Wright 2004). The SMART technique is very useful for highlighting important aspects of problems and the various aspects that will need to be taken into account for resolving them, and its main objective is to create a better understanding of the problem (Goodwin and Wright 2004, p.33-34). The full implementation of the SMART approach is a series of steps to assist with decision making, but its main focus is on the identification of attributes that are relevant to a problem for which decisions need to be made. An important process in this multi-stage process is to develop a value-tree, which breaks the problem down into a main overall objective and multiple sub-objectives, to which attributes are assigned and the possible alternative outcomes linked. This part of the technique is used by itself to highlight the relationships between different variables, as in the example below (figure 2.19), which looks at the variables involved in deciding on a crop to plant, discussed in Case Study 2, the Badarian, and in Chapter 9, Comparative Findings.

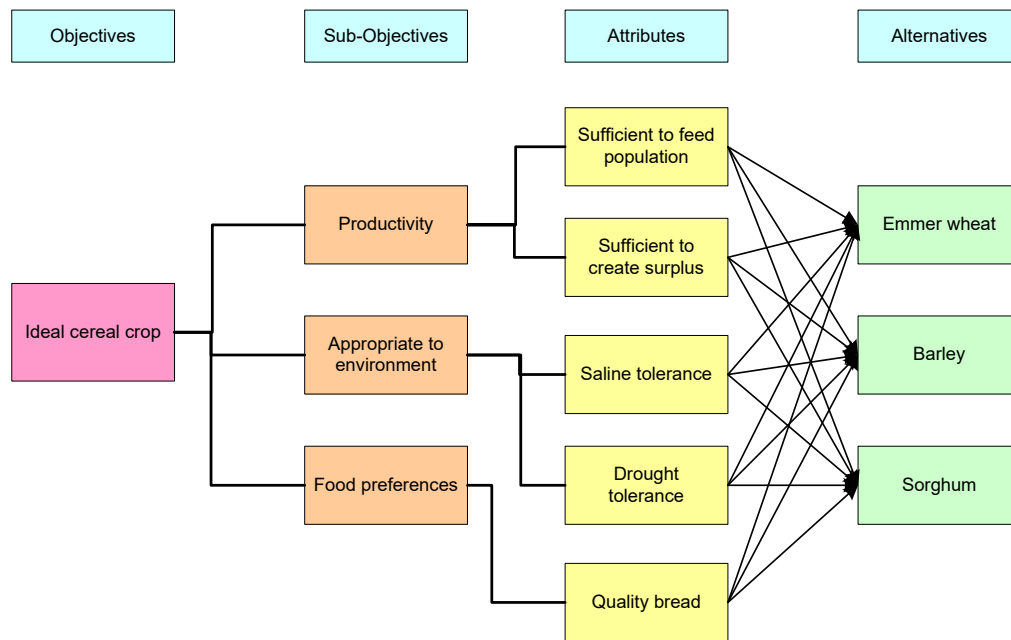


Figure 2.19 – Components in a decision to grow a particular crop

Some specific questions are further approached using a Quality Function Deployment model (Slack *et al* 2000) in Chapter 9. It is a more complex version of the “utility function” concept that relates goods to a perceived value of these goods, a perception which can change when conditions change (Kohler and Van West 1996; Rima 1972). Quality Function Deployment (QFD) was developed at Mitsubishi’s Kobe shipyard in Japan and has been used extensively by manufacturers of industrial machinery and developers of interactive products (Slack *et al* 2000). In industry it attempts to capture what the customer needs and how it might be achieved. It is a very useful way of graphically representing and calculating the importance of different benefits and risks with any given combination of functional choices, allowing subjective scores to be applied to different aspects of human requirements, and showing how they can be achieved. I have used this frequently in the past to translate stakeholder requirements into specific software specifications, but I have adapted it here (figure 2.19) to assess how key human requirements could be met in a given context, how they were actually met, and the absolute importance of each environmental component is, or could be, valued relative to the others. This is particularly useful when a specific component is puzzling. It should be remembered that outcomes will vary depending on the questions asked, and perceived value is a subjective approach and may be evaluated differently by other researchers, so it is useful for working through ideas rather than presenting a definitive answer.

	Importance	Cattle	Sheep	Pig	Goat			
Heat tolerance	9	■	○	◇	●	5	●	Highly useful
Drought tolerance	9	■	○	◇	●	4	○	
Poor quality food tolerance	8	■	○	●	●	3	■	Middle
High quality milk provision	7	■	●	◆	■	2	◇	
High quality meat value	7	●	■	○	■	1	◆	Low usefulness
Efficient energy reserves	8	●	■	■	◇			
Supply of hides	3	●	■	○	■			
Supply of wool	2	◆	●	◆	◇			
Ability of herd to recover	7	◇	■	●	■			
Numbers of individuals in litter	5	◇	◇	●	◇			
Early breeding age	5	◇	■	●	■			
Long lifespan	6	●	■	○	■			
Traction	5	●	◆	◆	◇			
Trampling (threshing)	3	◇	●	○	●			
Social value *	9	●	◇	◆	◇			
Capital value *	9	●	◇	◆	◇			
Absolute importance		391	323	278	324			
Relative importance		1 st	3 rd	4 th	2 nd			

Figure 2.20 - Relative values of cattle, sheep, pig and goat in dryland subsistence economies

In the above diagram (figure 2.20) a simple rating system of subjective values derived from ethnographic data is used to allocate key attributes of each animal, and to see how each animal rates overall. This is discussed in Chapter 9.

In all of the case studies, a system developed by Nelson *et al* (2016) is used to gauge vulnerability in access to food and to give a top-level assessment of the food resource situation in all of the case studies. Nelson *et al* describe vulnerability load and list eight variables that contribute to it. Vulnerability load is the “the extent to which each variable contributed to the likelihood that people might experience impacts from climate challenges” (Nelson *et al* 2016, p.300). The variables are divided into population-resource conditions and social conditions, highlighting that both natural and human variables impact livelihood conditions and the choices that can be made. The variables are ranked using a simple qualitative scale to measure its contribution to overall vulnerability. The variables contributing to vulnerability load are shown in the following table (table 2.2) (Nelson *et al* 2016, p.300):

Vulnerability variables		Evidence for vulnerability	Value for variable for resilient food system
Population-resource conditions			
V1	Availability of food	Insufficient calories or nutrients	Balance of available resources and population reduces risk of shortfall
V2	Diversity of available, accessible food	Inadequate range of resources responsive to varied conditions	Diverse portfolio reduces risk, increases options
V3	Health of food resources	Depleted or degraded resources, habitats	Healthy habitats, contribute to managing risk and change
Social conditions			
V4	Connections	Limited connections with others experiencing different conditions	Social networks expand access to food and land
V5	Storage	Insufficient, inaccessible storage	Stored foods reduce risk in times of shortage
V6	Mobility	Inability to move away from challenging food conditions	Movement to alternative places, landscapes and social groups offers potential for addressing resource shortfall through access to food/land
V7	Equal access	Unequal control and distribution of land, water and food resources	Equal access avoids challenges to coping and adaptive capacity in disaster risk management
V8	Barriers to resource areas	Physical barriers limiting access to key resource areas	Lack of barriers enhances capability of people to provision themselves with food

Table 2.2 – Vulnerability variables (Nelson et al 2016)

The qualitative ranking scheme is as follows for measuring each variable, based on contribution to vulnerability (2016, p.300):

1. No contribution
2. Minor contribution
3. More substantial contribution
4. Substantial contribution

A score of 1 for variable 1 (availability of food) would indicate that food supply did not

contribute to vulnerability and would not therefore be a problem for the community. A score of 4, however, would indicate high vulnerability. A total of all variables (a possible maximum of 32) gives an estimate of how vulnerable the entire community was. By dividing vulnerability into resource and social conditions, the importance of natural versus human influences can be made explicit. In table 2.3 the outcome is divided into two rows: "Data," which reflects what the actual data indicates, and "Extrapolated," which uses the combined knowledge derived from the case study and ethnographic studies to suggest more realistic scores. Question marks represent insufficient data. The variables for each case study, using best judgement on the data captured in the assets in the following format (table 2.3):

	Population-resource conditions			Social-resource conditions					Total /32
	V1	V2	V3	V4	V5	V6	V7	V8	
Data									
Extrapolation									

Table 2.3 - Population-resource and social-resource conditions

Finally, the risk management strategies discussed in Chapter 5 are compiled into a table and measured qualitatively for both insight into individual risk management strategies and for comparative purposes (table 2.3). I have used a simple yes/no/? rating on whether there is evidence for a practice, but I have also indicated how much confidence there is in the data and the judgement, using a simple High (H), Medium (M) and Low (L) scale. The example below (table 2.4) is copied from the Gifl Kebir case study.

	Evidence for strategy present ✓ / ✕	Quality of data available	Confidence that strategy practiced
Food procurement Diversification	✓	M	H
Food procurement Specialization	✕	M	L
Storage	✕	M	L
Mobility	✓	H	H
Habitat management	✓	M	H
Social networks	✓	H	H
Communication of knowledge	✓	M	H
Exchange of information	?	L	M
Leadership / roles	?	L	M

Division of labour	?	L	H
Technology specialization	x	H	L
Ideology and religion	✓	H	H
Opportunity and innovation	✓	M	H
Conflict	x	L	M
Trade/exchange	✓	M	H
Stint/hunger foods	x	L	M
Migration out of the area	✓	H	H
Remaining to experience impoverished conditions/death	x	H	H

Table 2.4 - The Evidence for risk management strategies in the Gilf Kebir

Where quality of data is low to medium but the corresponding confidence is medium to high, this is because ethnographic data suggests that even though it may not be prominent archaeologically, it is a livelihood management activity that was very likely to have been practiced. The data may be equivocal, but the experience of modern groups suggests that there is a high probability that certain activities would have taken place in conjunction with others shown in the table.

2.4 Initial Testing of the SRL Framework

A major workstream was to explore the full extent to which the SRL model could capture relevant data. This took two forms. First, the framework was used to gather as much pertinent ethnographic data about dryland livelihoods under each of the Asset Matrix and Vulnerability Context sections as possible, in order to develop an understanding of dryland livelihoods and to see how this knowledge could be represented within the framework. Secondly, a specific case study was worked through at a basic level, using data published about the Hadendowa nomadic pastoralists of the northeast Eastern Desert in northeast Sudan, a summary of which is contained in Appendix H. These proved to my satisfaction that the SRL approach was viable and, most importantly, a powerful and useful tool. Much of the data in the first test study was incorporated into chapter 5 as well as in the case four studies. My initial test of the model against archaeological data in a test case study for the Gilf Kebir in both the Gilf B and C phases argued that it had potential where data is sparse.

2.5 Conclusions

It is proposed that the Sustainable Rural Livelihood approach is an appropriate qualitative device for describing, discussing and assisting in the explanation of archaeological data. It

was designed by development economists during a re-evaluation of their attempts to understand and improve the sustainability of livelihoods in developing countries by providing balanced insights into sustainable livelihood management. As its focus is the extraction and presentation of data and the exploration of variables that have explanatory value, it is proposed that it has considerable potential for archaeological investigation.

Use of the model for prehistoric contexts implies that a way of compartmentalizing components of societies today is equally appropriate to societies in the past. The model as it stood was certainly not appropriate to prehistoric situations, making reference, for example, to NGOs and global markets. It has therefore been modified to reflect a different, reduced set of variables. As a working tool it has proved itself to be useful and successful in development economics, and although it is an artifice, like all models of human behaviour, it is also a tool for representing reality. The SRL model is not designed to stifle the people it describes; it is designed to provide the tools with which to identify and understand multiple aspects of their livelihoods. The decision to use it for assessing archaeological data was based on its emphasis on data collection, its equal weighting of all components that make up a livelihood and its explanatory aspects.

The next task was to ensure the SRL model that satisfies theoretical approaches to archaeology. Chapter 3 therefore focuses on how the SRL model relates to existing theoretical approaches in archaeology, and how it differs from them.

3 - Situating the SRL model within archaeological theoretical approaches

3.1 Introduction

For several decades archaeological theory has debated what sort of versions of the past can be recovered. Most books on archaeological theory present archaeology as a mosaic of ideas derived from more established and more information-rich areas of endeavour (Bintliff and Pearce 2011; Dark 2013; Hill 1970, p.12; Hodder 2001; Johnson 2010; Lucas 2001; Ridges 2006, p.146; Trigger 1996; Willey 1974c). Ridges is concerned that that "the diversity of perspectives now applied in archaeology potentially presents a problem for interpretation" (Ridges 2006, p.146). My own approach to organizing and interpreting archaeological data is derived from an approach used in development economics, but it is not entirely unlike earlier models that were developed for use in archaeology. The Sustainable Rural Livelihood approach explicitly includes all aspects of human activity. The SRL model has much in common with the ecological and economic analysis of the systems-focused archaeologies that emerged as a result of or in tandem with the New Archaeology. However, it also emphasises social influences and the importance of personal utility, so it overlaps considerably with many of the goals of post-processual archaeology. The SRL approach was explained in Chapter 2, but here I situate it within the context of related archaeological theoretical approaches to see how it complements them, and in which ways it differs.

3.2 Archaeological approaches to modelling past communities

The first approaches to modelling in archaeology co-incided with the development of Processualism, a new causal and explanatory approach to understanding the people behind the archaeological remains (Patrik 1985) and it is at this time that models of human behaviour were first developed.

Gumerman distinguishes between mechanistic models on the one hand and dynamic and systemic conceptual models on the other. Mechanistic models represented culture and environment as an integrated whole, but placed the environment as the dominant and conditioning component driving culture and ideology, and were often expressed graphically in

a linear fashion (figure 3.1) (Gumerman 1988b, p.7-9). This type of model was joined by and largely replaced by models that were focused on inter-relatedness of cultural and ecological concepts, and importantly emphasized that ecological and human relationships were intimately connected (figure 3.2) (Gumerman 1988b, p.13-14). In most models the dichotomy between natural and cultural systems is firmly retained but the processes that act upon these twin aspects are given more balanced influence on the overall system (e.g. Anderson 1973; Euler *et al* 1979; Flannery 1968; Rappaport 1979).

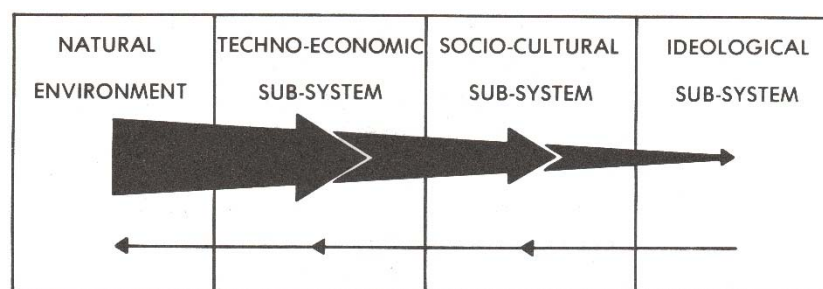


Figure 3.1 - Gumerman's mechanistic model of cultural-environmental relationships
(Source: Gumerman 1988b, p.8, figure 1.1)

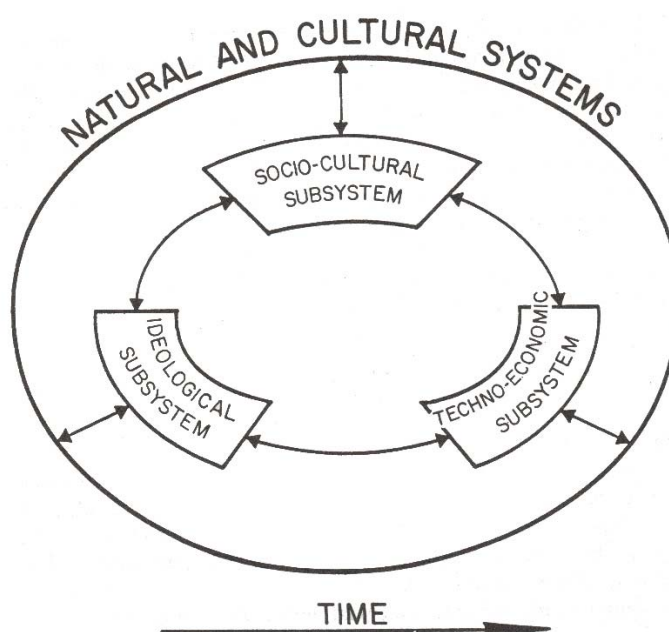


Figure 3.2 - Gumerman's dynamic model of cultural-environmental relationships showing a more integrated approach
(Source: Gumerman 1988b, p.14 figure 1.2)

Processual archaeologists derived many ideas from outside the discipline, one of which was systems thinking, a set of approaches with which the SRL approach has an overlap. In archaeology early systems-based ideas looked at the way in which different components and

variables act upon each other to produce balanced economic systems, which exist within an ecological system that constrains and acts upon economic activities. Systems thinking differs from systems theory, the former looking at livelihoods as a series of interacting parts, the latter an explicitly mathematical way of modelling such systems.

Grahame Clark's approach is a good example of functional systems approaches, with basic components of social organization linked together in ways that indicated causal relationships should aspects of one or more than one component change, influencing the functionality of the system as a whole (J.G.D. Clark 1939; 1953). He expressed this in the form of a systems model as shown in figure 3.3 (J.G.D. Clark 1957, p.175). The importance of this diagrams is that it clearly linked economic, domestic, ecological and cultural aspects, indicating that they are all important in influencing outcomes. Whilst he was not avoiding aspirations and values, and indeed describes a three-way relationship between biome, culture and habitat, he saw them as driven by economic factors, which coloured his explanations of how livelihoods may be understood.

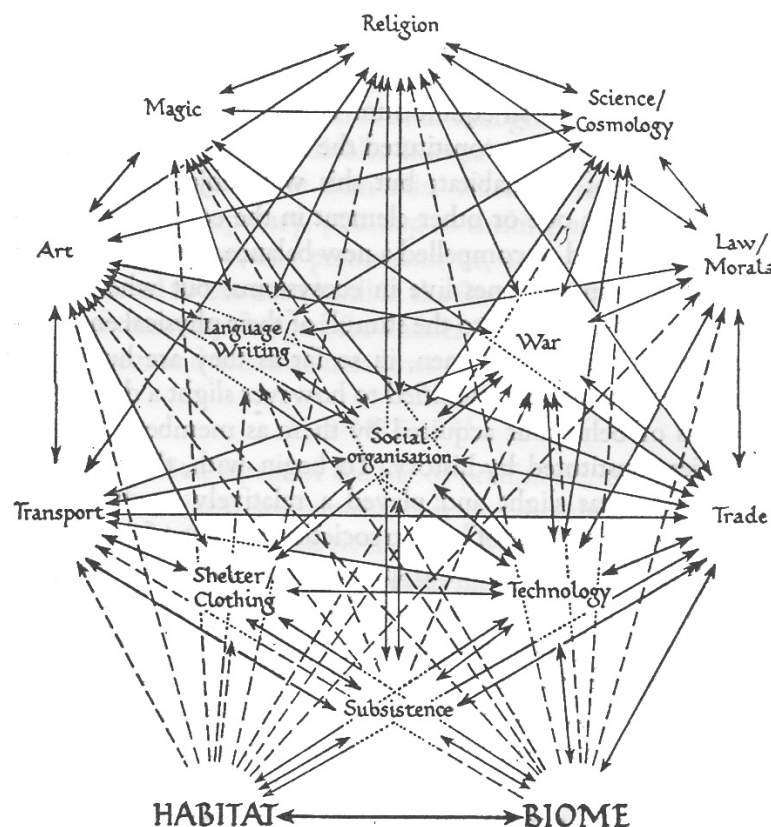


Figure 3.3 - J.G.D. Clark's system diagram 1957

It differs from the SRL model in several ways. First, it situates habitat and biome as the two major organizing influences and is heavily dependent on the impacts of internal changes without explicitly incorporating the potentially influential variables from outside that closed

model. It is therefore essentially limited to internal systems of behaviour. Another difference is that the categories are highly selective. Instead of nesting ideas within livelihood categories, as the SRL model does, Clark has selected labels that may or may not be sufficient for describing the functional organization of any given group or society. Finally, Clark's systems model is less of a working tool than a conceptual representation of the internal workings of a community and does not allow for the development of a qualitative understanding of a specific community or the many variables that might operate on it from outside.

David Clarke proposed a type of systems theory based analysis (Clarke 1968, 1972, 1973, 1978). He was interested in both cultural and economic concepts expressed within classes and he wanted to place far greater emphasis on explicitly theoretical approaches than his predecessors, seeking to systematize archaeological theory (Clarke 1968). However, this particular vision of a model of the past (figure 3.4) was not significantly different conceptually from Grahame Clark's, although David Clarke's incorporated ongoing time as an element, explicitly indicating that the system may and probably will change. Clarke was criticized for not supporting his work with ethnographic research, meaning that it remained abstract and untested (Torrence and van der Leeuw 1989, p.2).

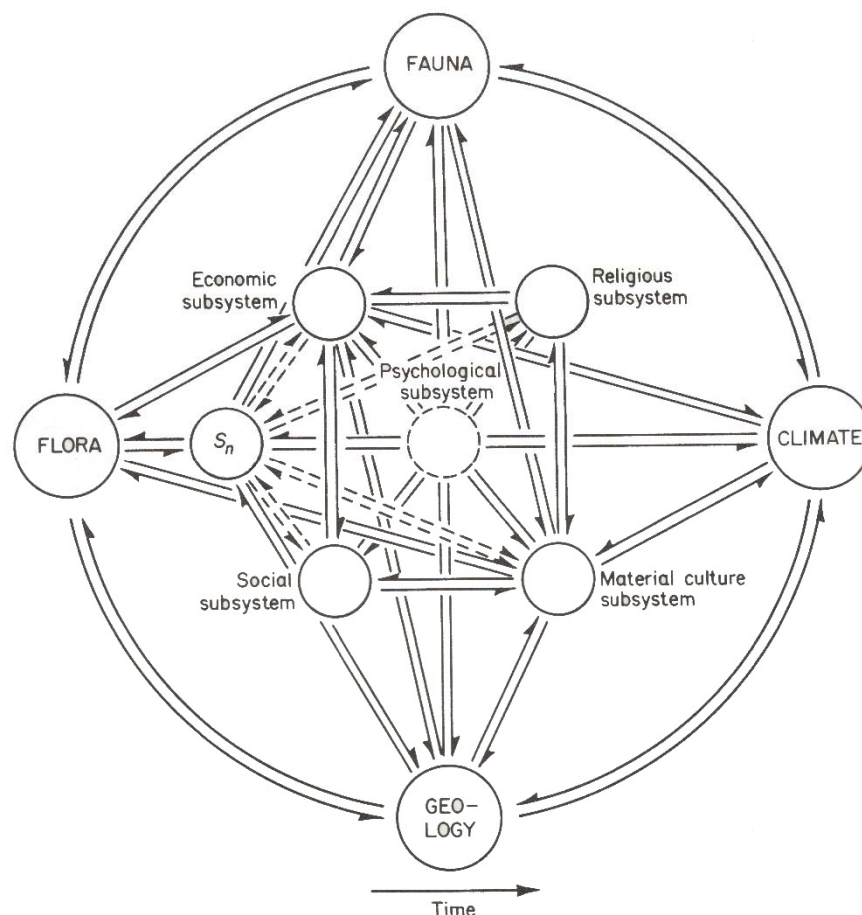


Figure 3.4 - David Clarke's systemic model (Source: Clarke 1978, p.134)

An experiment using systems theory was conducted by Kent Flannery in the US. The main difference between Flannery and previous attempts to use broadly system-based structures was that his approach was quantitative rather than qualitative (Flannery 1965, 1967, 1968, 1972, 1973; Flannery and Marcus 1993). The strength of his approach lay in its ability to describe interactions within a system, but it was less successful for explaining the cultures and transformations that it described. For one thing, it was very rarely possible to assign quantitative values to all the variables for which values were required, a problem that Flannery himself acknowledged in his 1968 paper about the use of systems theory in Mesoamerica. A second problem was that mathematical approaches have been too rigid in their requirements for every sub-system to relate to others in clearly defined ways, which is impractical when the relationships between subsystems may vary considerably (Dark 2002, p.173). A third weakness was that his explanations were based on the assumption that change was a matter of shifts between steady states and transitional periods, which oversimplifies how societies change and how these changes may occur.

Superficially, the parallels between the above systems and the SRL model seem clear - there is a division of a social group into units of analysis that emphasises linkages and alterations between those linkages and a belief that there might be multiple variables at work. The SRL approach shares many of these interests, but it differs in a number of significant ways – 1) it incorporates the belief that human groups are influenced not only economic and environmental factors, as Clark also believed, by social considerations and insists on a full survey within all the categories of the matrix; 2) it is situated within a dynamic context; 3) it emphasises multiple levels of human engagement with livelihoods; 4) it is a tool, not merely a graphic representation; 5) explanatory variables are made explicit within the SRL so that the relationship between vulnerability, opportunity, assets and outcomes is clearly demonstrated; 6) it not only sees the social unit as a correct and proper unit for analysis, but also incorporates ideas of social expression, differentiation and agency as important influences on livelihood management; and 7) whereas systems and structural approaches focus on steady states to the detriment of explanations of change (Bailey 1983, p.170; Holdaway and Wandsnider 2006, p.185), the SRL model is situated within a context of dynamism, of ongoing influences.

Moving on from these systems orientated approaches, a basket of related ideas collectively referred to as “post processualism” offered an alternative perspective to processualism, emphasising how societies organized themselves, the active role played by cultural and ideological components in human life, the way that material culture embodies ideas and is used to transform societies and how people may have experienced their own lives and the contexts within which they lived those lives (Barrett 1994; Hodder 1982a, 1985; Johnson 2010; Lucas 2001; Patterson 1990; Trigger 1996). The roles of individual groups, people, animals and events are given much greater emphasis (e.g. Barrett 1994, p.1-3; Dobres and Robb 2000; Gardner 2004; Honeychurch and Makarewicz 2016, p.350-351; Oma 2010; Orton 2010; Sykes 2014) and many of these ideas explored the areas of inference that Hawkes thought were

difficult to infer by archaeology (Hawkes 1954, p.161-3), reaching beyond the purely economic and functional aspects of life researched by earlier archaeology approaches (Glassie 1975; Hodder 1982; Levi-Strauss 1963; Patrik 1985; Preucel 2010). The emphasis was on the ways in which people were contributors to complex internal and external relationships, knowledge ideals, beliefs and consciousness (Barrett 1994). These approaches are very consistent with the thinking behind the design of the SRL model.

The SRL approach, in looking at both material and more ephemeral assets and needs, makes room for both processual and post processual approaches, including agency and phenomenology, within the Social, Human and Personal asset categories.

3.3 Issues of scale

One of the benefits of the SRL approach is that it can incorporate multiple scales. Zimmerman and Artz (2006, p.129) define scale as a representational model of something that exists as an implicit understanding, a construct that we impose in order to approach the reality that the term "scale" contains. N. Smith (2000) defines three types of scale: cartographic (at the level of the map), methodological (research-selected), geographical, and conceptual (the experiential overlay that people place on areas). Scales may also be temporal and social. As Lock and Molyneaux point out (2006, p.xii), it is the challenge of the archaeologist "to understand the dynamics of scale that entered into production and to account for these in interpretation" and as Gosden and Kirsanow warn (2006, p.27) "each set of archaeological evidence contains nested within it a number of different forms of duration and means of measurement." This section discusses temporal, geographical and social scales.

3.3.1 Temporal scales

One of the basic tensions in archaeology is the contrast between the archaeological record, which is made up of short-term events, and interpretations that generally emphasise the medium and long term (Lucas 2001, p.135). Different processes and events will have different impacts at different temporal scales. For example, in the annual round of nomadic pastoral mobility time can be measured in days and weeks. The annual round of mobility operates within certain seasonal parameters and influences the degree to which land is exposed to grazing, how long that land takes to recover and the health and viability of the grazing herds. Time at this scale is of essential importance to a community whose decisions are based around animal welfare and the need to make decisions within the course of a year (Savory 1999; Voisin 1988; Weber and Horst 2011). Lucas (2005, p.217) draws a distinction between chronological time and real time. He sees chronological time as a construct deriving from the modern western sense of life lived on a continuum from past to present, simple to progressive

and complex. Real time, by contrast, emphasizes human existence as a flow of life, a series of short-term durations tied together by longer term narratives, which results in various different types of temporality. This seems very cogent when looking at the various livelihoods operating in the eastern Sahara during the mid-Holocene, which were clearly non-linear and highly variable in chronological terms. Time can therefore be measured archaeologically in terms of millions of years down to that of a single lifetime or event (Lock and Molyneaux 2006; Gosden and Kirsanow 2006; Hodder 2000) and there is great difficulty bridging between the “histories of the long-term” and “the momentary and idiosyncratic event” (Barrett 1994, p.2).

Because some of the subsistence strategies rely on mobility, some groups may exist across scales, for example moving over landscapes, pausing at base-camps for perhaps several weeks and using temporary campsites for a day or two to extract raw materials. Temporal scales are an unavoidable issue in this thesis, precisely because of the ephemeral nature of the data and the way in which much of it is in the form of palimpsests. However, long term change is an accumulation of short-term changes over time, and the emphasis of the SRL approach on high levels of detail can only assist with understanding social and economic behaviours, the role and development of culture, and the processes of transition and transformation, even where palimpsests dominate.

3.3.2 Geographical and dimensional scales

Topics like materials acquisition, nomadic herding and long-distance trade/exchange are discussed at the landscape level, but questions of local exploitation, habitation, tool manufacturing sites and individual artefact production are at a far more local level. Openshaw (1983, p.3) states that the analytical units chosen by many studies “are arbitrary, modifiable and subject to the whims and fancies of whoever is doing, or did, the aggregating.” A similar point is made by Burgur, emphasising the importance of defining and refining survey parameters (Burgur 2002).

Geography incorporates in its definition the idea of human usage and integration with the landscape and environment in which lives are lived. Although landscapes are the basic nuts and bolts of economic life, particularly in mobile societies, they are also the means by which people define themselves and their place in life, incorporating their surroundings with meaning and understanding and this has been incorporated into many studies, including ideas of culturally and socially embedded meaning (Attenborough 2002, p.186-7; Pollard 1999), taskscapes (Ingold 1993), dwelling (Ingold 2000; McFayden 2008; Thomas 2002, 2008), and some of the more ambitious approaches to phenomenology in archaeology (e.g. Bender *et al* 1997; Tilley 1994, 2004). Definitions often include a concept of space being bound, geographically or politically, and therefore contained in some way that allows it to be isolated and discussed as a coherent entity, what Kössler terms saddling oneself with “the dialectic of the border” (Kössler 2003, p.8).

The term "landscape" is clearly an artefact imposed on geography and environment and therefore implies a certain perspective not only about its physical characteristics but how it is related to and socially constructed from knowledge that has been inherited and accumulated over long periods of time: "landscape can be an object, an experience or a representation and these different meanings frequently merge into one another" (Thomas 2000, p.166) (Bender 1992; Leary 2014, p.4; Mortimore and Adams, 1999 p.7; Sillar 2007). Jordan emphasises that the landscape can be seen as a form of material culture, a dialogue not merely between humans and nature but divine beings as well, with individuals locating themselves "within the social, material and symbolic spaces, thereby constructing their own senses of gender and identity" (Jordan 2007, p.117). Similarly Tilley (1994) sees locales as recognized parts of a landscape connected through "paths," all of which are associated with memories, ideas of power, territoriality and group narratives. Mobile groups in particular may cover enormous distances in their seasonal round, and as part of their familiarity over generations they will come to experience and identify with different topographies, landscape features and favoured settlement, hunting and herding locations, imbuing them with memories and meanings, intellectually and conceptually constructed, part of a larger world-view (Barrett 1991, p.8, 1999, p.259; Bender 1993b; Bender *et al* 1997; Ingold 1993; Knapp and Ashmore 1999, p.1; C. Smith 1999; Thomas 2000, p.171). Nested within a landscape and a locality, various smaller interlinked pockets of existence are lived out, experiences influenced by mediation of perceptions of the landscape within which they operate and to which they respond, sometimes via the use of devices like ceremonies and rituals, rock art, naming practices and oral traditions (Holl and Dueppen 1999; A.B. Smith 2005b, p.138-9; Tilley 1994, p.18). As Snead and Preucel put it, these are acts that domesticate the landscape and situate people within its natural cycle in ways that tie the landscape into social action (1999 p.172-3). Barry Cunliffe refers to this as "a network of personal places (2000, p.111).

Finally, there is the scale at which all these units are sampled - the survey or excavation, its spatial reach and its vertical depth. These samples are sometimes calculated with care, but are often determined by expedience or limiting factors like time, financial budgets or topography. Archaeological analysis extrapolates the data obtained in these sampling activities into proposals about the units as a whole, building interpretations about individual sites into visions for entire zones and landscapes (Burgur 2002; Hey 2006, p.113; Wobst 2006, p.25). Sometimes a large site may be represented by trial trenches and even where large-scale excavations are possible they take place over numerous seasons and the understanding of the site may change from year to year depending on what emerges from the next piece of ground opened. Sampling in archaeology (Clarke 1973, p.17; Lucas 2001, p.60-61; Lucas 2012, p.63-66; Trigger 1996, p.402), and in all qualitative research, is essential (Punch 2005) but does mean that the sampling strategy and methodology employed in surveys needs to be understood by those using the resulting survey data, and that future sampling activities may change the picture (Burgur 2002).

The benefit of the SRL model being a qualitative and descriptive device, is that different levels of scale can be brought into play when the data is available. For example, when mobility is discussed, both the landscape and the immediate locality dimensions are relevant, as groups move from one locality to another through the landscape. At the same time the relationship between settlement sites and outlying material gathering and manufacturing camps can be discussed.

3.3.3 Social Scales and scales of knowledge

The social scales that one can perceive will be dependent on the geographical scale that is being observed, and the two are interlaced, with landscapes producing the most generalized understanding of how people operate, and individual events or items giving a more intimate view of how something was achieved. Bell (1992) usefully describes three levels of analysis, holistic (top-level social organization), individualistic (thoughts of individuals) and empathetic (inner experience). Ian Hodder (2000) also describes three levels of analysis - system (large-scale), macro (structure) and micro (event). He points out that large-scale analyses see all variation as "noise", and that the result can be an excessively homogenous view on something that could be much more complex, failing to observe the "contradictions and conflicts" that are "lived through and resolved" (Hodder 2000, p.26). Gardner also explores the relationship between macro, meso and micro levels but sits them within global and local scales (Gardner 2007).

The palimpsest data used in this thesis can disguise social complexity and variability. Where no variability is identified, legitimate questions can be asked about whether this is an artefact of poor data quality or whether it is an indication of social and economic stability (Wobst 2000). Where stratigraphic data is present, longer term activities and changes in those activities can also be discussed. The SRL model allows this sort of marriage between different scales of analysis.

3.4 Qualitative Research

3.4.1 Introduction to qualitative research

It was emphasised in the introduction that the SRL model is a qualitative research tool. Whilst quantitative approaches are frequently used in both archaeology and the social sciences for validating observed patterns and their significance, "often it was impossible to get to grips with behavioural questions convincingly" (Jowlett 1977, p.163). Jackson *et al* (2007, p.22) distinguish between method (how data is collected) and methodology (the best approach for addressing a given problem). This is particularly relevant in this research, where the quality of data has determined the choice of methodology. Quantitative researchers handle their assessments primarily through statistical approaches, which require reliable and consistent

statistical data Jackson *et al* (2007, p.23). Qualitative approaches, by contrast, are more focused on assessing experiences and accepting open-ended scenarios. For qualitative researchers a conceptual framework is usually a representation of the concepts and variables that are assumed to relate to each other, "a representation, either graphically or in narrative form, of the main concepts or variables and their presumed relationship with each other" (Punch 2005, p.53). There tend to be common themes to most qualitative research, including that it is actor-aware, holistic, descriptive, explanatory, narrative and naturalistic, often placing studies in their natural environments (Denzin and Lincoln 1994, p.141; Punch 2005). Data, usually from multiple sources, is often unstructured at the point of collection and requires the imposition of structure. Case studies are a fundamental feature of qualitative research, aiming "to understand the case in-depth, and in its natural setting recognizing its complexity and its context" (Punch 2005).

Quantitative techniques have very high potential for addressing questions of significance where material differences are noted between sites and between areas, for example between tool types. Even where the function of tool types is unknown, significant differences between them would suggest choices based either on preference or on economic role, both of which would be worth exploring. Similarly, where certain activities can be quantified, such as labour input, productive output, market information and population size, these variables could assist with questions of economic activity, risk and sustainability. Causal relationships could also be assessed in temporal studies. Datasets, however, need to be better than those in the areas under discussion here.

A potential danger with qualitative research projects is that "they appear natural, straightforward, even 'obvious,' and thus easy to accomplish" (Walcott 2009, p.3). As Walcott goes on to say: "Were it not for the complexity of conceptualizing a qualitative study, conducting the research, analysing it and writing it up, perhaps they would be" (Walcott 2009, p.3). Those employing qualitative approaches must accept that data collection and analysis using qualitative techniques is not an entirely objective process and that researchers bring their work particular paradigms, knowledge and biases into their work (Corbin and Strauss 2008, p.32).

The quality of the description in qualitative research needs to be high because it is not as immediately transparent and testable as quantitative research and it feeds directly into any explanation. Getting the *what* right is therefore essential for establishing confidence in the *why*. Explanations, looking at why a described situation exists, search for causes, reasons and accountability (Corbin and Strauss 2008, p.15) and are dependent upon the preceding description for their integrity. The SRL approach therefore combines an emphasis on the collection of robust data to support the explanatory component.

Qualitative methods are therefore more appropriate to the data addressed here and the questions being asked of it.

It was emphasised in the introduction that the SRL model is a qualitative research tool. Jackson *et al* (2007, p.22) distinguish between method (how data is collected) and methodology (the best approach for addressing a given problem). This is particularly relevant in this research, where the quality of data and its publication have determined the choice of methodology, essentially a choice between quantitative and qualitative approaches. Whilst quantitative approaches are frequently used in both archaeology and the social sciences for validating observed patterns and their significance, it is sometimes “impossible to get to grips with behavioural questions convincingly” (Jowlett 1977, p.163). The two approaches are generally presented as an either/or scenario, and this is partly because of how archaeologists decide to practice archaeology. Trigger remarked that “it is generally understood that past behavior and beliefs are not ‘discovered’ or ‘reconstructed’ by archaeologists but, rather, ‘constructed,’ ‘inferred,’ or ‘conjectured’ with varying degrees of probability” (Trigger 1996, p.508). In this statement the two concepts that recur frequently in discussions of qualitative versus quantitative approaches are conjecture and probability. Quantitative techniques attempt to move away from intuitive conjecture and move towards more replicable approaches where variables are given numerical values which are considered to have a high probability of being valid. Qualitative techniques, however, lean towards more flexible discursive and narrative approaches focused on assessing experiences, complex behaviours and accepting open-ended scenarios.

3.4.2 Quantitative techniques in archaeology

Quantitative techniques in archaeology range from simple statistical approaches to complex computational modelling simulations that have only become viable since computing capacity improved and object-orientated programming languages appeared from the mid-1990s onwards (Kohler and van der Leeuw 2007, p.5-6). Quantitative researchers handle their assessments primarily through statistical techniques, which require reliable and consistent statistical data (Jackson *et al* 2007, p.23). At a very simple level, as Larson points out, as soon as data is assembled “you should begin looking at it, checking for errors, checking for unexpected distributions and patterns, and adjusting your research accordingly” (Larson 2017, p.412). In post excavation work, where suitable data is available statistics are a potentially powerful tool for addressing questions of significance where material differences are noted within and between sites, for example between tool types and assemblage composition. Even where the function of tool types is unknown, significant differences between them would suggest choices based either on preference, economic function or social role.

Early attempts to apply more ambitious quantitative approaches aimed to shift archaeology from intuitive towards more objective approaches, what Aldenfelder called “The Quantitative Idiom” (1978, p.14), which included classification, systems theory, predictive modelling, spatial analysis and game theoretical approaches (e.g. Ammerman 1992; Anderson *et al* 1988;

Axelrod 1984; Gould 1969; Isbell and Schreiber 1978; papers in Sabloff 1981; Salmon 1978). These ideas developed in various directions but have ultimately lead primarily to computer simulation modelling. Today computing power is used to model everything from landscape and topography in Geographical Information Systems (GIS) to complex agent-based modelling (ABM) simulations and dynamical systems models. ABM simulations model socioeconomic or socionatural situations based on combinations of techniques where numerical values can be assigned to landscape features, such as water availability and soil fertility, and economic activities such as labour input, productive output, market information and population size. Quantifying such variables can assist with a range of questions including the sustainability of subsistence activity, the impacts of risk and uncertainty and socioeconomic change. ABM, a toolkit of approaches, all have agents (individuals or households) as the primary drivers of all action within the model, enacting micro-behaviours that contribute to the larger view visible at the macro level, and are often referred to as “bottom-up” (Chávez-Juárez 2017, p.717, p.725; Epstein and Axtell 1996; Wilkinson *et al* 2013). Dynamical systems models use mathematical models “to determine the change through time or one or more quantifiable properties of a system” and must be expressed mathematically (Lake 2014).

Although quantitative modelling seeks to achieve a more rigorous output than inferential approaches, it is not always as empirical as might be expected. Kintigh’s remark that intuitive approaches to archaeology “face problems of objectivity or replicability” that make it “difficult to assess the significance or reliability of these analyses” (1987, p.132) might imply an objectivity, validity and reliability of quantitative modelling that has not yet been achieved even now, due to the nature of the data, something that Kintigh himself foresaw: “We must realize that because the archaeological record is formed by people interacting in complex ways with each other, their environment and their cultural heritage (to say nothing of post-depositional processes), many archaeological problems are just inherently difficult” (Kintigh 1987, p.133) . Although GIS models, for example, are based almost entirely on empirical data, agent-based modelling (ABM), in which there is a growing interest, incorporates the inferential findings of fieldwork aided by understanding derived from modern ethnographic research to develop a framework for establishing a model. The following statement by Cleuziou, where he is identifying agents and their social structure for a model of Early Bronze Age Ja’alan in Oman, is an example: “The various extensions surrounding the courtyard *all appear* as single units with some autonomy. From such a pattern, *we can assume* a grouping of nuclear family units into larger residential compounds. *Considering the importance of kinship*, each compound *likely corresponds* to an extended family. Some form of economic and domestic cooperation *must have existed* inside these compounds” (Cleuziou 2012, p.220, my italics). In addition, model designers incorporate a number of assumptions, calculations and choices that need to be made transparent in the documentation. In the Village Ecodynamics Project (VEP) modelling approaches are dependent upon estimates, assessments, algorithms and existing archaeological interpretation of site features, simplification of data, assumptions and judgements: “We do not try to represent the full complexity of the study area or its culture

history in our simulations. Instead we use the models to predict settlement and other patterns through time and across space *given rather simple assumptions*, representing the processes *we deem most critical*" (Kohler *et al* 2012, my italics). Cleuziou's model of Ja'alan, for example, includes the following statement: "We start from *the assumption* that wealth was almost equitably distributed by 3000 BC. Clearly *this is not fully true* for our real society but *seems an acceptable* working hypothesis" (Cleuziou 2007, p.224, my italics).

Depending on the complexity of a model and its purposes, a model may or may not include or exclude such behavioural variables as fallibility in decision making, non-optimal behaviour, heterogeneity of characteristics and behaviours, wishful thinking, over-confidence, incorrect assumptions, variable access to information and socially- or religiously-driven priorities (Barnett *et al* 2010, p.471; Chávez-Juárez 2017; Elster 1989; Thaler 2000, p.133-5). Thaler refers to this as quasi-rational behaviour (2000, p.135). Quantitative models are also, like qualitative models, based on samples, or as Van Pool and Leonard put it, "imperfect and limited data" (2011, p.2). G.A. Clark when even further, warning of "coarse 'grain,' weak integrity, incomplete data matrices, high probability of sampling error" and expresses concern about the ability to evaluate the credibility of mathematical approximations of human systems. Fortunately there are exceptions, where projects like the MASS and VEP initiatives have access to higher than usual resolution data.

Finally, there is a danger in computer simulations, which has been identified by Wilkinson *et al* (2013, p.2), based on their work in the late 1990s "of using input data derived from field work and then using field results to compare with the output from the modelling: this process led to a tendency for the input to influence the output in a self-fulfilling manner." Keeping data sources separate has been the solution in this particular project.

Quantitative modelling clearly has enormous potential but it is clearly important to understand both the quality of the original data and the sort of decisions, assumptions and behavioural variables that are incorporated into computational model designs before the value of their output can be assessed.

3.4.3 Qualitative techniques in archaeology

For qualitative researchers a conceptual framework is usually a representation of the concepts and variables that are assumed to relate to each other, "a representation, either graphically or in narrative form, of the main concepts or variables and their presumed relationship with each other" (Punch 2005, p.53). There tend to be common themes to most qualitative research, including that it is actor-aware, holistic, descriptive, explanatory, narrative and naturalistic, often placing studies in their natural environments (Denzin and Lincoln 1994, p.141; Punch 2005), all of which describe qualitative approaches in archaeology. Data, usually from multiple sources, is often unstructured at the point of collection and requires the imposition of structure. Case studies are a fundamental feature of qualitative research, aiming "to understand the

case in-depth, and in its natural setting recognizing its complexity and its context" (Punch 2005). A potential danger with qualitative research projects is that "they appear natural, straightforward, even 'obvious,' and thus easy to accomplish" (Walcott 2009, p.3). As Walcott goes on to say: "Were it not for the complexity of conceptualizing a qualitative study, conducting the research, analysing it and writing it up, perhaps they would be" (Walcott 2009, p.3). Those employing qualitative approaches must accept that data collection and analysis using qualitative techniques is not an entirely objective process and that researchers bring their work particular paradigms, knowledge and biases into their work (Corbin and Strauss 2008, p.32). In archaeology, as with quantitative approaches, the level of site sampling needs to be taken into account, in order to insure that inferences based on a partial excavation of a site are understood in terms of their limitations and the likelihood that narratives based on partial excavations will have to be rewritten in the future. This is as true for ambitious qualitative conceptual modelling as it is for straight forward excavation reports that include an element of interpretation.

The quality of the description in qualitative research needs to be high because it is not as immediately transparent, quantifiable or testable as quantitative research and it feeds directly into any explanation. Getting the *what* right is therefore essential for establishing confidence in the *why*. Lucas (2001, p.12) states that archaeology should not be merely descriptive but explanatory at three separate levels of observation, description and interpretation, each emerging from the other. I would add explanation to his list. Interpretation and explanation are different problems and are separated out in this approach. For example, one can describe a set of contemporary hearths associated with animal bones and a much smaller volume of hunted remains found with a toolkit associated with pastoralism and interpret this as a nomadic pastoral community supplementing its diet with wild species. But it doesn't explain why. Explanation asks the question why this particular economic activity was practiced, and to find an explanation one needs to look at all the possible variables that lead to that livelihood choice. Explanations, which look at why a described situation exists, search for causes, reasons and accountability (Corbin and Strauss 2008, p.15) and are dependent upon the preceding description for their integrity.

3.4.4 Combining approaches

In spite of the apparent dichotomy of the two methods, there are certain synergies between them, and recent work has considered how to bring them even closer together. All models are attempts to organize data for descriptive and explanatory purposes, providing a linkage between the raw data and an understanding of what that data represents, and as such a model "is not a universal scientific truth but fits some portion of the real world reasonably well, in certain respects and for some specific purpose" (Kohler and van der Leeuw 2007, p.3). Aldenfelder (1981, p.16) points to a methodological relationship between the conceptual

modelling of the sort demonstrated in the SRL model and computer simulation models. Conceptual modelling may be an end in itself but is also a requirement in computer simulation modelling as a precursor to the computer model, and which both “points the way to new goals which are used to direct further research” and reveals the workings of the system to be simulated (Aldenfelder 1981, p.20-21).

Both earlier and recent authors discussing quantitative modelling approaches have highlighted the gap between quantitative methods and theoretical approaches in archaeology (e.g. Van Pool and Leonard 2011; Voorips 1987, p.61): “The use of quantitative methods is essential to current archaeology, but nothing can replace a rigorous theoretical and analytical framework” (Van Pool and Leonard 2011, p.316). This has been answered in a number of ways. For example, a number of recent studies have looked at the gap between GIS and phenomenological approaches represented by, for example, Bender *et al* 1997; Tilley 1994, 2004; Johnson 2007; Thomas 2004, p.198-201). Llobera, for example, looks for different bridging components between theory and methodology in his research using both GIS and interpretative landscape studies (2012). He asks whether GIS approaches have a role beyond large scale processes, whether they can contribute to discussion about the “agential capacity of landscapes and people,” and if they can be used “as a heuristic within an interpretative framework” (Llobera 2012, p.496-497). In this paper Llobera looks specifically at “visualscapes” (p.501) where the descriptive advantages of GIS are joined with theoretical phenomenological approaches to human experiences and activities to produce narratives. In this approach, GIS is used to tackle specific field problems and enrich narratives by incorporating missing data, simulating features in the landscape and helping to establish viewsheds and other patterns of visibility, and to understand altered landscapes (Llobera 2012, p.503-505). In the same volume, addressing the same issue, Gillings suggests that GIS experts should develop their own theoretical frameworks (Gillings 2012). Voss and Allen (2010) combine qualitative and quantitative approaches to improve the analysis of ceramics, combining statistical measurements with intuitive approaches to improve interpretation, whilst Van Derwarker and Peres (2010) discuss how to combine qualitative and quantitative approaches to integrate zooarchaeological and paleoethnobotanical studies, each with their own very unique characteristics. In the future, I would hope that quantitative modelling techniques may be able to assist with the task of unravelling palimpsests of the types represented in the case studies, which would be an important contribution to qualitative research in drylands archaeology.

3.4.5 Quality of Data

All approaches depend upon the availability of reasonable datasets. If this is in the form of published material, the approach taken may depend upon the way in which the data is presented. Jones (2002, p.39-40) describes the process by which excavation work is

transformed during post-excavation activities in a linear but fragmented process from physical remains to an abstract format “that now only have meaning because of their representation in plans, sections, or as a set of figures and measurements on paper” in a way that “would be unrecognizable to those who inhabited the site” (Jones 2002, p.41-42). There is no general standard for archaeological publication, and even within individual projects the data supplied may be different, so that using publications to acquire consistent and reliable data for even the most basic calculations of statistical significance may be difficult. As Kansa and Kansa discuss (2014) the practical limits of conventional publication in print have prevented detailed data becoming generally available. It is perhaps unsurprising, therefore, that most computer modelling projects, such as the Modeling Ancient Settlement Systems in Mesopotamia (MASS) project (Wilkinson *et al* 2013) and the Village Ecodynamics Project (VEP) in Mesa Verde, southwest Colorado in the U.S. (Kohler *et al* 2007; Kohler *et al* 2012; Kohler and Varien 2012) are carried out within the parameters of larger projects that have control over handling, measurement and access to the raw data. Improvements in the organization, accessibility and standardization of presentation of data in both print and far more powerful, flexible and less expensive digital media should become a priority for the future both in the eastern Saharan archaeology and elsewhere.

The potential value of using quantitative techniques, even with the concerns described above, is considerable. Datasets in the areas under discussion in the case studies, however, lack the required stratigraphic integrity, preservation and granularity required for moving beyond conceptual modelling. Qualitative methods are therefore more appropriate to the data addressed here and the questions being asked of it. Qualitative conceptual modelling techniques derived from development economics were selected for this thesis in order to describe and attempt explanation of both economically and socially-derived activities in the early and mid-Holocene, where decisions may incorporate both the compulsion to conform to traditional ideas and methods as well as the impacts of poor decisions and unintended outcomes (Barnett *et al* 2010, p.471; Baumol 1961; Elster 1989; Dasgupta 1997; Gladwin 1989; Thaler 2000, p.133-5).

3.5 Conclusion

Within this complex network of different archaeological ideologies and approaches, my use of the SRL model may well be guilty of trying to achieve the best of all worlds. However, although there is an inevitable focus on building an overview of a functioning system, the detail with which each component is explored is anything but broad-brush, and the model can function at different scales. Although part of the job with any exploration of dryland livelihoods

is to investigate how environmental constraints influence behaviour, there is always room for discussing variation within archaeological assemblages. To understand how groups functioned within a framework of environmental constraint and opportunity, not just economically but culturally, is one of the objectives of the SRL approach. Patrik was close to the mark when she suggested that the “physical mode” of processual archaeology and the “textual model” of post-processual archaeology operate at different levels of the archaeological record, with one relating directly to physical remains and the original use of the artefacts in their social contexts (1985, p.55). It seems to me that both are necessary for a comprehensive understanding of any livelihood as it derives from archaeological remains.

Although the SRL model superficially resembles systems approaches from processual archaeology it is conceptually very different. Linkages between the assets are not measured in terms of responses of one to another as in traditional systems thinking. Instead, the respective strengths of each, judged qualitatively, are used to form an overall understanding of any livelihood situations at one time, and these can be built up into sequences to assist with identification of and explanation of change. Because it incorporates ideas of cultural reflexivity, heuristics and agency into its remit, the SRL approach is also compatible with post-processual experiments.

4 - Climate and environment history in the eastern Sahara

4.1 Introduction

In this chapter climate change during the early and middle Holocene is described with an emphasis on mid-Holocene hydrology. This is followed by a discussion of the relationship between climate and human behaviour.

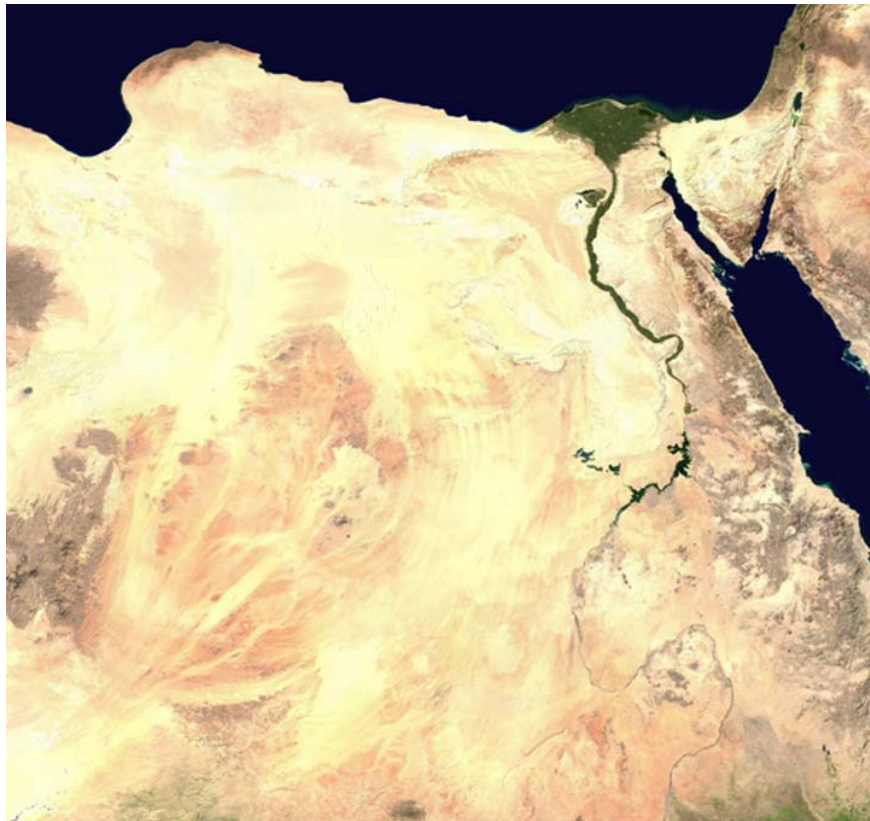


Figure 4.1 - The Eastern Sahara today (Source: NASA)

Today the eastern Sahara, incorporating Egypt, northern Sudan, eastern Libya and north-eastern Chad, is arid desert punctuated by small depressions and highland zones that support some vegetation and fauna (figure 4.1). The impact of climate on a locality depends upon many variables including geology, topography, source of water, water table level; soil types, vegetation types and coverage, solar insolation, proximity to the sea, pressure systems, wind

regimes and global weather systems (D.G. Anderson *et al* 2007; Brooks 2006a, 2006b; Gasse 2002; Lamb 1995; Zerboni 2013). There is therefore the potential for localized and varied human responses to shifting environmental conditions. Broad regional approaches have been supported by localized studies that focus on variations within the general climatic trends. Many of the localized research projects have been set up by multi-disciplinary archaeological teams and have achieved a more granular understanding of the impacts of climate change and variability in the mid-Holocene (e.g. Kuper and Kröpelin 2006; Linstädter and Kröpelin 2004; Schild and Wendorf 2002). In spite of some of the obvious difficulties of defining how and when climate changed and what impact this had on the environment, the archaeology of the eastern Sahara cannot be understood without exploring the climate that influenced the formation of environmental contexts within which different behaviours took place (Plog and Hartman 1990; Hassan 2002a). Changes to environmental conditions, both favourable and unfavourable to human activities, might lead to significant economic and social responses which may be reflected, for example, in subsistence choices, technology, settlement patterns, social organization and cultural output. Whilst climatic conditions do not, by themselves, determine all the choices made by human communities they do create a framework of opportunities and constraints. This is discussed further in section 4.5. In turn, human intervention in the environment may also change the balance between opportunity and constraint.

4.2 Introduction to the Post-Glacial Eastern Sahara

The Holocene represents an interglacial period, commencing at around 14,000 years ago when the continental ice sheets in the northern hemisphere began to retreat (Grove 1995). The monsoonal Inter-Tropical Convergence Zone moved northwards bringing increased rainfall with it and plants colonized the newly available land (Bettinger 2006; Grove 1995; Kuper and Kröpelin 2006, p.803). During the Sahara's climatic optimum between c.8500 and 6500bp (c.7558 – 5452BC) the Sahara and Sahelian boundary is thought to have been as much as c.500km to the north of its present line, (Lioubimsteva 2004, p.505; Nicoll 2001). Within this framework of ameliorating climatic conditions during the early and mid-Holocene there were periods of aridity that interrupted the more humid conditions of the early and mid-Holocene (Butzer 1982; Cremaschi 2002; Cremaschi and di Lernia 1999; Hassan 1986, p.65, 2002b; Linstädter and Kröpelin 2004; Schild and Wendorf 2002). Geomorphological, climatic and occupation data suggest that this variation took place, both geographically and temporally and that the regional differences were marked (Bubenzer and Riemer 2007; Hassan 2000c; Kuper and Kröpelin 2006; Linstädter and Kröpelin 2004; p.63; Peters and Pöllath 2003). Some climate shifts were very abrupt, taking place in less than a decade (deMenocal 2001, p.668; Hassan 2002b; Kuper and Kröpelin 2006, p.803; Schild and Wendorf 2002). Almost

complete aridification of the desert took place by the beginning of the Late Holocene beginning at c.5300BC (Kuper and Riemer 2013).

Kuper and Kröpelin attribute this change in climatic conditions to the extension of the monsoonal ITCZ to the north, providing semi-humid climates in the south of the Sahara and semi-arid conditions in its centre (Kuper and Kröpelin 2006, p.803).

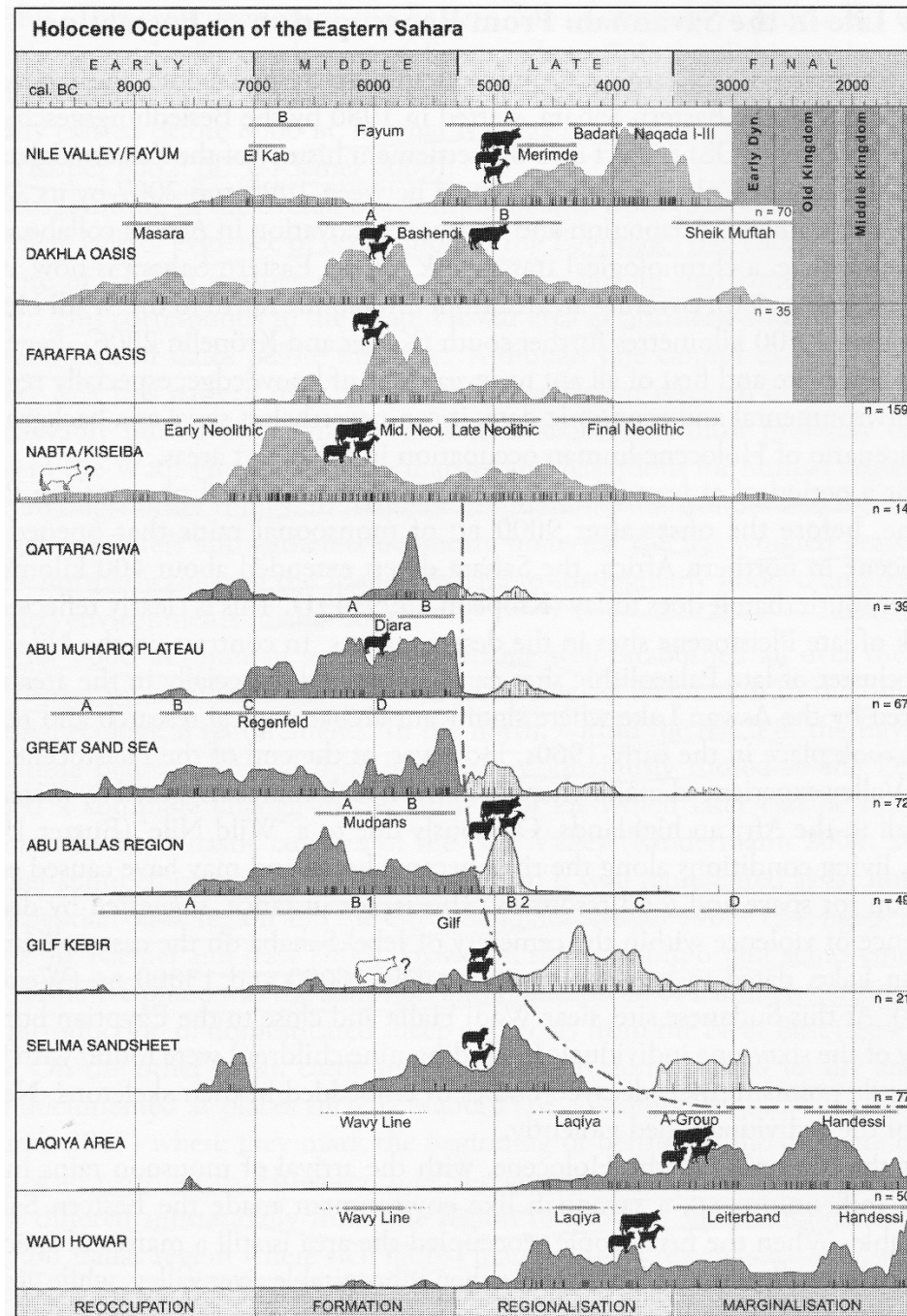


Figure 4.2 - Calibrated Radiocarbon dates showing the occupational history of key areas on a north to south trajectory, with human abandonment of the desert areas coinciding with the beginning of aridification in the eastern Sahara. (Source: Kuper and Riemer 2013, p.35, figure 1.5)

The above diagram (figure 4.2) by Kuper and Riemer (2013, p.35) shows the amount of temporal as well as regional variation in occupation in the eastern Sahara indicated by calibrated radiocarbon dates, showing different geographical peaks and troughs and the degree to which areas in the south were habitable much longer than others before final drying of the Sahara, as the ITCZ retreated at the end of the mid-Holocene:

The changes taking place during the early Holocene had an important impact on human activities in the eastern Sahara, reflected in the intensification of wild grass exploitation, the development of pottery, the digging of wells, examples of sedentism and the domestication of cattle (Barakat and Fahmy 1999; Close 1995; Gatto 2011; Kobusiewicz 2003; Linseele 2010; Richerson *et al* 2001; Wendorf and Schild 2002). The fluctuating conditions may have driven people to gather around limited and seasonal water sources in the Western Desert, which may have led to new concepts of territoriality and social stress (Gatto and Zerboni 2015; Pachur and Hoelzmann 1991; Hoelzmann *et al* 2001; Shirai 2006).

4.3 The Middle Holocene c.7000 – 3500 BC

The Middle Holocene, referred to by Hassan as a “transitional interval” (1986b, p.64) is associated with the partial retreat south of the Inter-Tropical Convergence Zone, which led to increasing aridity with fewer humid phases in parts of northern Africa and Egypt. Cooling on a global basis has been recorded in many regions (Thompson *et al* 2006). Mid-Holocene conditions were generally drier than those of the early Holocene’s most humid phase, lake levels fell, playas were smaller and of shorter duration, biomass was reduced and there was a marked differentiation between conditions in the northern temperate areas and those to the south where the effects of the ITCZ were still felt (Haynes *et al* 1989; Nicoll 2004). Bahariya, the northernmost oasis in the eastern Western Desert had been occupied during the early Holocene but was abandoned during the mid-Holocene (Svoboda 2006). However conditions in the Western Desert were still wetter than today. The environment was very variable spatially, largely determined by topography (Zerboni 2013; Darius 2013). Mediterranean rainfall regimes now extended further south, reaching the Gifl Kebir in the far south of Egypt (Kröpelin 2005), and resulting in bimodal rainfall regimes in Dakhleh oasis (Haynes 1987, 2001; Kindermann *et al* 2006; Magaritz and Goodfriend 1985; McDonald 2016; Neumann 1989a, 1989b, 1993). In spite of the lower levels of annual rainfall, it was apparently distributed, at least in some areas, in a rather more accommodating way: instead of rare heavy summer rainfalls and dry winters, rainfall was more frequent throughout the year, enabling areas to be occupied more consistently throughout the year (Bubenzer and Riemer 2007; Linseele *et al* 2010; Linstädter 2005g, p.367; Linstädter and Kröpelin 2004, p.774). Radiocarbon age determinations suggest declining water availability and corresponding

human activity in the Egyptian eastern Sahara, with a gradient of decreasing moisture from south to north (Kuper and Kröpelin 2006; Kuper and Riemer 2007; Nicoll 2004, p.563).

Neumann's research compared charcoal remains of plants with those that survive in modern environments. Using this data she characterized the Western Desert as semi-arid, with desert type vegetation, probably consisting of dwarf shrubs, tuft grasses and small trees like acacia and tamarix, with variations depending on topography and geomorphology (Neumann 1989a, 1989b). Based on floral assemblages Nicoll (2004, p.565) suggests that conditions are comparable to those found at Ennedi, Darfur and other places within the modern Sahelian-Sudanian vegetation zone, and is surprisingly resilient. This is partly because of the way in which the groups who occupy the Sahara have devised strategies of dealing with risk and uncertainty, via technology, mobility, social networks and other inherently flexible and risk-handling strategies (Halstead and O'Shea 1989; Jallow 1990; Seely 2006), but it is also because wild plant communities are surprisingly resilient to hostile conditions. Increasing aridity does not necessarily cause reduced vegetation (as long as it is not associated with extreme and irreversible drought conditions). Release of carbon dioxide into the atmosphere in times of higher aridity increases rates of photosynthesis and, by reducing the size of stomatal openings, reduces water loss in plants. This makes desert vegetation more efficient in terms of water management and can reduce the impact of climatic stress (Bettinger 2001, p.145-9; Lioubimsteva 2004, p.521). A study of the western Kansas prairie over a thirty year period demonstrated that inter-annual variability actually promoted the co-existence of three common grass species, supporting an ecological theoretical concept called the Storage Effect Theory (Adler *et al* 2006, p.12793). Often plant community responses to climate are non-linear because key species in any environment have different physiological tolerances to water scarcity and/or osmotic stress, nutrient loss and the impacts of erosion, which can be effected by spatial patterning of the vegetation (Kröpelin *et al* 2008, p.768). Finally, impoverishment of vegetation always lags behind climate change (Brooks *et al* 2005).

A paper by Van Neer and Uerpmann (1989) is the main source of information for the palaeofauna for Western Desert as a whole, but as with the palaeovegetation, localized studies provide insights into the areas where archaeological sites are located (Churcher *et al* 2008; Gautier 1980, 2001; McDonald 1991b, 2001; Peters 1987, 1988; Peters and Pöllath 2003). The archaeological record is dominated by small ungulates that can take their water from leaves, roots, tubers and stems, desert-adapted foxes, hares, ostrich, scimitar-horned oryx and giraffe. Dakhleh is the exception to the rule in terms of faunal profile in south Egypt, and this is probably due to year-round rainfall provided by both summer and winter rains and the availability of perennial springs, as described above. The specific conditions in mid-Holocene Dakhleh, Nabta Playa and Gilf Kebir the Middle Egyptian Nile are all discussed in detail within the case studies.

Although the overall picture provided by the above overview of the mid-Holocene may seem bleak, modern groups using the Sahara have proved that it is perfectly possible to sustain fully

functional livelihoods even in apparently hostile conditions (Halstead and O'Shea 1989; Hobbs 1989; Mainguet 2010; Manger *et al* 1996; Mortimore 1998; Seely 2006). The Sahara began to be abandoned after 5000-5300 Cal BC, Nicoll's "exodus event" (Nicoll 2001; Riemer and Kuper 2013), during which period desiccation advanced considerably (Butzer 1999, p.198). The process of aridification did not occur at an even rate throughout the Sahara and some areas could be occupied for longer than others (Gatto and Zerboni 2015; Gehlen *et al* 2002; Kröpelin 2005; Phillipps *et al* 2012; Riemer 2011). The final deterioration of conditions at c.3500BC is visible at several sites in the Sahara, marked by desiccation and desertification (Kuper 2006a, p.413; Kuper and Kröpelin 2006; Neumann 1989a, 1989b; Nicoll 2004; Wendorf and Schild 1976; Zerboni 2013). As the monsoonal belt moved south, people followed in its wake (Kröpelin 1993b; Kuper 2002). When formerly occupied areas in the eastern Sahara were no longer available for settlement, a number of writers believe that conditions forced groups to migrate elsewhere towards more favourable conditions like the river Nile, the Western Desert oases, and Wadi al-Ajal in the Fezzan, (Cremaschi 1999; Hassan 2006; Garcea 1993; Kuper and Kröpelin 2006; Kuper and Riemer 2013).

4.4 Hydrology in the Eastern Sahara

A universally agreed upon range for rainfall volumes in the mid-Holocene Sahara remains elusive (e.g. Butzer 1958; Hassan 1986b; Haynes 2001; Linstädter and Kröpelin 2004; McHugh 1974a; Neumann 1987, 1989a; Peters 1988; Said 1993; Van Neer and Uerpmann 1989). From their work at the Gilf Kebir, Linstädter and Kröpelin suggest a maximum annual rainfall of between 100 and 150mm annually in the early and mid-Holocene, which also agrees with Neumann (1987) and Peters (1988), and this seems to be a reasonable figure given all the available data. Whatever the exact figure, average rainfall is a poor measure of the availability of water in desert environments where high variability means that average figures are of little use (Rosen 2017, p.73). Bearing this in mind, the picture of the mid-Holocene is one of occasional rainfall filling ephemeral lakes in the Sahara, with savannah and Sahel type conditions (Nicoll 2004, p.565). Even with not more than 50mm of rain per year, and particularly if conditions were cooler, some standing water would have been present during and after rainfall (Close 1992, p.160). However, as Rushdi Said points out: "this new frontier was not a generous environment" (1993, p. 181).

In the most eastern part of the Western Desert the Nile flows south to north from eastern and central Africa. The Blue and White Niles join to form the main Nile near Khartoum, Sudan. Nile conditions are determined by rainfall in Ethiopia and Equatorial Africa (Hassan 2007, p.105). Flood waters reach the Egyptian Nile by July and flood waters peak by mid-August, remaining static for around 3 weeks. They may rise again briefly in early October, after which they recede

during November, reaching the lowest levels between April to the end of May (Hassan 2007, p.101-2). During high floods game and waterfowl will congregate along the floodplains. Between October and March the high floods recede very rapidly, making fish easy to catch. Plants re-inhabit the fertile floodplains, and swamps and marshes become filled with water birds (Kees 1961, p.93). If permeable soils absorb waters deeply enough to resist evapotranspiration they will support fast-maturing crops and allow them to germinate and develop, even in hot climates where evaporation rates are particularly high (Doolittle 2001). Variations in flood levels impose a level of uncertainty into floodplain subsistence, which continued even after the introduction of artificial irrigation technologies. As well as water the Nile brings silt from the volcanic areas to the south. The silt contains nitrogen (vital for replenishing land), iron, manganese, zinc and copper (Kish 1993). Accumulation of silt is not uniform and varies through time (Hassan 1997e, p.59-60). The gradient of the Nile's river bed is c. 1:10,000 to 1:15,000 and this delivers the flow of floodwater over levées into the floodplain (Hassan 1997e p.61).

One of the features that differentiates the eastern Sahara from some other world deserts is the underlying Nubian Aquifer, a vital subterranean reservoir for modern Libya, Egypt, Nubia and Chad (Ibrahim and Ibrahim 2003, p.45-47; Sampsell 2003, p.147-148), consisting of porous and non-porous layers of rock that sandwich water that reaches the surface due to the curvature of the rock and depressions in the overlying surface. It was replenished with waters during the early Holocene from highland areas all over north east Africa. The Nubian Aquifer comes to the surface at the oasis depressions of Siwa, Bahariya, Farafra, Dakhleh (figure 4.3) and Kharga as well as a number of other minor oases in the form of natural springs and in the form of groundwater that can be reached by sinking wells (Ibrahim and Ibrahim 2003, p.45-47). The presence of fossil springs demonstrates that water was readily available in these areas throughout the Holocene. Because the oases are depressions, lying well below the level of the current desert surface, they are much closer to the aquifer than the surrounding areas, providing much greener and more habitable zones some of which still house substantial populations today.



*Figure 4.3 – Water from the Nubian Aquifer at Dakhleh Oasis
(Source: Dakhleh Oasis Project <https://bit.ly/2KgyUQT>)*

Apart from the Nile and the oases, the main forms of water resource in the desert areas were the seasonal playa lakes which formed in depressions in the desert floor from short but heavy precipitation events (figure 4.4). Nabta Playa is the best known example (Wendorf, Schild and Associates 2001). In the highland area of the Gilf Kebir plateau three dune-blocked wadis also permitted the creation of temporary lakes, which were an important resource for both animal and human populations (Linstädter and Kröpelin 2004). Rainfall covering the desert floor would feed the arid-adapted shrubs and cause a burst of temporary life just as it does today in some areas like the Gilf Kebir plateau, and as it does in modern semi-arid deserts elsewhere. In marginal areas the fact that climate was unpredictable, causing annual variations in seasonal weather, would probably have been the main influence on human activity. Simple environmental decay would have led to more obvious patterns of human abandonment and migration. The fact that this did not happen in a smooth linear way argues that environmental conditions could be coped with if risk management strategies were flexible enough. This is discussed further in chapter 5 and within the case studies.



Figure 4.4 – Savannah rainfall event
(Source: Soraya Romero, DesertUSA <https://bit.ly/2rCMaY8>)

As well as the lowland plains of the Sahara there are highland zones where humidity sustained resources even when the lowlands were uninhabitable. Even as recently as the 1920s Tebu and other nomads used Gilf Kebir and Jebel Uweinat for seasonal herding (Hassenein Bey 1925/2006, p.206; Kelly 2002, p.85). By the late 1990s, the Teda in the Tibesti highlands numbered c.25,000 with a subsistence based on herds of donkey and camel and date palms (Olson 1996, p.550). Although the volcanic highlands attract rainfall there is insufficient precipitation to support cattle (Olson 1996, p.550). Similarly, the Hadendowa of the

eastern Sudan use lowland areas for summer pasture but in winter they move into the Red Sea Hills where the highlands attract moisture (Manger *et al* 1996).

4.5 Climate change and human behaviour

The fluctuating climate of the Saharan Holocene, with its arid and semi-arid phases means that throughout the early and mid-Holocene there were phases of arid and more humid conditions, but the overall trend was one of aridification. Climate change has often been used to account for states of and changes in economic and cultural behaviour. One of the earliest writers to propose that climate change might go so far as to determine cultural change was Ellsworth Huntington in the early 1900s. By the mid 1930s Julian Steward was proposing that environmental approaches be adopted in archaeology (Steward 1937). Another early writer to emphasise the importance of survival as a source of environmental adaptation was Meggars (1954). An early exponent of ecological approaches was Grahame Clark who argued that ecological constraints acted upon society because ecological conditions determined survival and survival was a human population's primary motivation. His approach used economic ideas to link environment and behaviour (Clark 1939, 1954). These approaches spawned a series of specialized research fields such as site catchment analysis (e.g. Vita-Finzi and Higgs 1970).

Following the heavy emphasis put on climate and environment by processual archaeology, the dangers of over-emphasising the impact of climate on human decision making have been discussed by a number of writers (e.g. Brooks 2006; Cremaschi and Di Lernia 1999; deMenocal 2001; Dimbleby 1967, p.17; Fagan 2004; Hahn 1993; Hassan 1997b; Hassan 1986b; Hassan 2000c, p.62; Kuniholm 1990 p.645, 646, 647; Minnis 1996; Plog and Hartmann 1990; Robertshaw 1988; Shirai 2004, p.135). The dependency of processual archaeology on functional aspects often involved practitioners invoking climatic and environmental explanations to account for function and behaviour. As Silberbauer says, succinctly "As the environment sets out the problem and also supplies the means of dealing with it, it is a seductive logical trap to conclude that the environment also determines behaviour" (1981, p. xii). However, as Atherton says (1983, p.97), there is more than one way to use an environment. Silberbauer describes a tripartite system in which the behaviour of a human population is influenced by socio-cultural systems in relation to their habitat, which they employ, allowing a wide range of choices for solving problems: "None of the component systems will be determinate in the narrow sense" (1981, p.xii).

A useful warning against climatic determinism is provided by Peter Kuniholm:

'Climate' is often used by historians to explain phenomena for which they cannot otherwise account. Accordingly, much of what has been written about climatic effects and climatic change must be read with extreme scepticism. Even though a

disturbance may be obvious in the archaeological record, and it may be synchronous with a climatic event, a cause and effect relationship should be demonstrated before one can say with any degree of confidence that the evidence is secure. (Kuniholm 1990, p.645).

Hahn makes the point that explanations that consider settlement patterns and subsistence strategies cannot be reduced to ecological determinism, but must take into account technology and social and ideological factors as well (Hahn 1993, p.226). Ogilvie (2005) emphasizes that climate change in southeast Arizona in the U.S. may have been a contributing factor to the adoption of agriculture *permitting* but not *causing* it, an important distinction. Finally, Hassan (1986b, p.67; Hassan 2002d, p.4) points out that climatic shifts were in the order of 200, 500 and 900 years, the shortest of which works out as 10 human generations, and it is well beyond the ability of humans to predict climate change, a point also made by Dean (1988), Powell (1988) and geographer Robinson (2004, p.20-22). Even five generations is “well beyond the scope of human prediction, futuristic anticipation, or even concern” (Hassan 1986a p.67).

Population dynamics expert Lori Hunter warns against generalizing about the relationship between population and the environment, cautioning that such generalizations are “difficult because of the many types of demographic factors, multiple facets of the environment, and various mediating influences acting on the relationship” (Hunter 2001, p.47). Some writers have moved completely away from climate as potential explanatory factor. For example, Cremaschi and Di Lernia’s study of the Tadrat Acacus in Libya, a highland zone of the highland Tadrat Acacus in Libya, conclude that

[n]o ineluctable coincidence exists between climatic changes and cultural dynamics: environmental change does not directly determine any human adaptations; instead, cultural responses varied depending on specific external and internal cultural factors, with different times and modalities of realization. Probably, only the onset of dramatic arid conditions produced effective changes in human occupation” (Cremaschi and Di Lernia 1999, p.232).

As well as the dangers inherent in determinism, others lie in possibilism. “Possibilism” is an ungainly but useful term derived from the field of cultural geography, which covers the idea that a middle ground is appropriate. It is initially seductive. For example, in deMenocal’s view (2001), possibilism represents a compromise, suggesting that the natural environment *influences* the range of available (possible) human choices, without determining them. However, Silberbauer outlines the main objection: “Possibilism merely lists the range of things that could be done or that could happen, but says nothing of how or why, and seldom covers the full range of why not; it explains very little about why some possibilities are exploited and others are not”, (Silberbauer 1981, p.xiii). As Silberbauer goes on to remark (p.xiii), both deterministic and possibilistic models fail to incorporate any type of feedback mechanism seeing a humans as solely responsive to their habitat instead of acting upon it in ways that modify it and lead in turn to changes in how humans perceive their surroundings. This point is

substantially reinforced by Kat Anderson's study of the ways in which historic sedentary Californian hunter-gatherers tended to and modified their wild environments for both subsistence and craft purposes (Anderson 2005). Once both deterministic and possibilistic approaches have been rejected as over-simplistic, other models need to be sought that offer ways of understanding and explaining in ways that accept the complex relationship of natural and social environments.

Whatever relationship humans have with their environment, when climatic downturn occurs in situations where other problems already exist, the impact of climate will be exacerbated. Brooks (2006a) explicitly looks at the physical environment not in determinist or reductionist terms, but as the setting within which social changes occur. Brooks *et al* (2005) have emphasized that disputes about environmental determinism have "bedevilled" archaeology in other areas, but suggest that in the Sahara archaeologists "have by and large appreciated the central role of environmental change, without falling into the trap of neglecting other important factors in the development of human societies" (2005, p.258). Hassan (1986b, p.73) warns that "it would be unproductive and brash to use this [climate change] as an excuse to attribute every cultural change to a change in environment or climate, and to be satisfied with the 'temporal coincidence' of a climatic change and a cultural transformation as a manifest proof for causal vectors". Ness argues that no absolutely direct relationship exists between climate and population because technology and social organization always serve to bridge the two, a fact that results in different levels of complexity (Ness 1994).

In spite of all the very sound warnings about overemphasizing the degree to which climate influences human activity, it must be included as one of several possible explanatory solutions for socioeconomic change. As Fagan also points out, "To ignore climate is to neglect one of the dynamic backdrops of the human experience" (2004 p.xiv). In northeast Africa in particular, an area with very limited rainfall, "any small changes in precipitation are bound to affect vegetation and so human responses" (A.B. Smith 2005b, p.71). Barich makes the same point when she says that "in desert situations the impact of the environment must have been decisive in directing a group's decision," although she also points to other causal processes including demography and ideology (Barich 1988, p.3). Lucas (2001, p.136) suggests that some post-processual approaches have gone too far in the direction towards explanations that reject any influence of the environment upon human behaviour in favour of social explanations. It has been convincingly argued that climate change can have a devastating effect on a number of complex societies (Diamond 2005; deMenocal 2001; Linden 2006). Hunter (2001, p.56) emphasizes that climate changes feed into both ecological and human social systems. Some authors have suggested that climatic deterioration resulted, in some cases, in increasing levels of social organization that led to complex societies (Brooks 2005, 2006; MacDonald 1998; Mares 2002, p.2-3). Brooks *et al* (2005, p.258) go so far as to consider the Sahara as "a laboratory of human response to environmental change" which can tell us about how humans adapted to climate change. Kuper and Kröpelin agree (2006, p.803), remarking that the absence of full time human life in most areas of the Western Desert

of Egypt for 1000s of years has provided an excellent opportunity for looking at the relationship between past environments and people. They go on to argue when extreme climate changes occur, humans respond in positive ways by modifying their livelihood strategies up until the point where full desertification occurs.

4.6 Conclusions

Overall, the mid-Holocene eastern Sahara was not a land of luxuriant vegetation and stable conditions. As Hassan puts it (Hassan 1986a, p.67) the early and mid-Holocene “was hardly the land of milk and honey It was a harsh environment with a meagre, unreliable and shifting resource base”. It was also subject to considerable variability over time and some areas could not be occupied during times of climatic stress. Variability was both global and highly localized, so within each of the areas under discussion, it is necessary to form as clear a view as possible of rainfall and biomass, the conditions under which human groups lived. Climate and environment are seen as the context within which groups live, the opportunities they can take advantage of and the constraints within which they operate. Within these contextual variables there may be many different possibilities for economic variability, technological output, social organization and cultural expression. Throughout this thesis a recurring theme is that whilst economic drivers are essential for survival, these cannot be examined in isolation, and where possible, the influence of climate must be seen in terms of strategic responses, preferences and social networks. Climate and environment are discussed in detail for each of the areas within the case studies. The consideration of environment, its impact and the place of human actors in such situations leads to a consideration of risk and vulnerability in the next chapter.

5 - The Vulnerability Context: Risk and Uncertainty in Dryland Environments

5.1 Introduction

The SRL model contains an entire section dedicated to the impact of conditions of vulnerability, which means that embedded into this thesis is the idea that people living under conditions of risk make decisions on an ongoing basis that influence livelihood outcomes. Dryland environments are inherently subject to environmental and other variables that impose conditions of risk and sometimes uncertainty on the communities that make their livelihoods in these marginal areas. Research into risk and uncertainty focuses on learning about the behaviours and outcomes likely under certain conditions and the degree of variability under which they operate. Although it is difficult, archaeologically, to see how such decisions are made, it is possible to see what options might have been available by reviewing the sort of choices available to modern ethnographic groups. This research assists with archaeological interpretation by suggesting a range of possible options open to pastoral communities. This chapter focuses on risk in ethnographic research so that the case studies can draw upon this information to suggest what type of decisions were made.

Although it has been traditional to suggest that physiological survival is the primary concern of any community (Lavigne-Delville 1997; Streeten 1981), survival is based not merely on procuring food but on knowledge sharing, community support, household organization, local and regional identity, social conventions, religious ideas and personal ideologies, all of which support the sustainability of societies (Cliggett 2005; Evans-Pritchard 1940; Gleave 1992c; Hobbs 1989; IFAD Rural poverty Portal 2007; Morgan 1992, p.46; Mortimore 1998, p.36; Sen 1999). In hazardous environments, cultural, religious and social practises are geared to taking many hazards in their stride (Jallow 1990, p.191-2). At the same time “people inevitably make decisions on the basis of subjective probabilities, biased information derived from anecdotal evidence, and prejudicial positions based on their values and worldviews” (Hassan 2008, p.41). An understanding of a wide range of livelihood options that could be implemented for sustainability is therefore required (Liwenga 2003). The stronger a household’s assets, the better the opportunities are for access to food and the maintenance of current livelihoods (Sen 1983; Swift 1989).

5.2 Subsistence and production in dryland environments

5.2.1 Pastoral-Foraging livelihoods



Figure 5.1 - Pastoralism in the Libya Sahara. Source: Stephen Dueppen, <https://blogs.uoregon.edu/dueppen/african-pastoralism/>

Pastoralism in some form or other is present throughout most countries in the Middle East and many African countries, particularly in north Africa (Dixon *et al* 2001). Today there are nearly 200 million pastoralists worldwide (IFAD 2009, p.1) and of these 20 million are nomadic or semi-nomadic animal herders in the north and east Africa (Abraham 2006, p.18) (figure 5.1). Pastoral livelihoods are always combined with other food production and acquisition techniques like hunting, plant collection, horticulture, agriculture, and, often essentially, trading with those who have chosen other livelihood strategies, either regularly or during times of food stress (Atherton 1983, p.83; Cliggett 2005; Grillo 2014; Hobbs 1989; Jallow 1990, p.195; Manger *et al* 1996, p.124-130). Today, hunter-foragers, pastoralists, horticulturalists and agriculturalists may be relatively self-supporting, but all usually have relationships with neighbours and more distant kinship groups (Klima 1970, p.83; Manger *et al* 1996) and trading partners for goods (Cliggett 2005, p.81-3; Viveló 1977, p.97-107), marriage partners (Abati 1998, p.150-153; Hobbs 1989, p. 9-11; Klima 1970, p.64-7; Stenning 1957, p.100-137) and social support (Cliggett 2005, chapters 5 and 7; Minnis 1985, p.22; Viveló 1977, p.97-107).

During the mid-Holocene herding of domesticated cattle, sheep and goat became a defining livelihood strategy. The use of domesticates was combined with hunting game and collecting wild plants to provide a flexible approach to the eastern Sahara (Kuper and Riemer 2013;

Marshall and Hildebrand 2002). As the thesis mainly concerns pastoralists who supplemented their lifestyles with hunting and foraging the discussion of risk and uncertainty presented here concerns pastoral livelihoods. Pastoralism has been variously seen as a purely economic phenomenon (Khazanov 1994), as an instrument of a new form of human interaction and exchange (Wengrow 2006, p.21) and as a term without useful value (Marx 2006). The International Food And Development agency (IFAD) defines pastoralists as "people who derive more than 50% of their incomes from livestock and livestock products" and are able to maintain equilibrium between pastures, livestock and people (IFAD 2009, p.1), which Koochecki and Gliessman refer to as "The triangle of sustainability" (2005, p.1). Pastoralists are defined here as groups who own domesticated animals as a significant part of their subsistence strategy, raise their livestock on uncultivated pasture, and may include an element of mobility in their livelihood strategy to meet the need of sourcing new pasture. The primary characteristic of pastoralism is the herding of animals that convert the natural vegetation of arid and semi-arid zones into animal protein (Sidahmed 2000), which can in turn be converted into meat, blood, fat and dairy products for human consumption. Although milk production diminishes during the dry season, and as animals become weaker, less blood can be extracted but remains an important component of dry season nutrients (Dahl and Hjort 1976; Dyson-Hudson and Dyson-Hudson 1980). Similarly, to produce milk, livestock needs to be well watered. It is difficult to see the value of herding without dairy production given that today more calories are derived from milk than any other source in pastoral societies (FAO 2001a). The benefits of milk and blood must have been well known by the time sheep and goat arrived in Egypt and the Sudan. See Appendix C for a discussion of lactose intolerance in African prehistory. Domesticated animals can also be used for ancillary products including dung (as fuel or fertilizer), workable materials (hide, wood, hair, bone, resins, gums), traction and transport (Behnke *et al* 1993, p.7; Close 1996, p.550; DFID 2000a; IFAD Rural Poverty Portal 2007; Sherratt 1981). Herds are also a means of acquiring wealth and social status (Brooks 2006a, p.33; Evans-Pritchard 1940). Livestock and their products can be sold, rented, loaned and exchanged, used to establish new family units, given to friends and relatives, hidden from raiders in a way that fields of crops cannot be prior to harvesting, and can be split up amongst different areas to minimize risk (Bates 1971 p.143-5; Bollig 2009, p.285-290; Brooks 2006a, p.33; Cliggett 2005; Evans-Pritchard 1940; Harir 1996, p.89-90; Layton 2002).

Where herds are small and where natural resources are limited, herding may be supplemented by hunting and foraging, which may be an important component of the diet, particularly where herds represent storage against future needs or are used for blood and dairy (Bollig and Osterle 2013; Casimir and Bollig 1994; Jacobs 1975; Mortimore 1998, p.87). Where available, protein may also be derived from fishing (Deng 1972; Townsley 1998, p.143; Watson and van Binsbergen 2008, p.14). Plants are also a fundamental part of the diet and acquisition of plant resources for both human and animal dietary needs as well as for craft activities is essential. These activities need to be factored into the annual food acquisition

schedule (Anderson 2005; Hurcombe 2014; Marshall and Hildebrand 2002, p.112). Social attitudes to plant acquisition (and production) may vary between groups but its vital role is never in dispute (Dunne *et al* 2016; Grillo 2014; Harlan 1989; Hurcombe 2014; Mercuri *et al* 2018; Seely 2006, p.32; Yokell 2004, p.41). Knowledge of plant species is important from the point of view of which to include for nutritional and medicinal value, which to avoid and where to find certain species (Minnis 1996, p.62; Seely 2006, p.32). Plants may include grasses, root vegetables, legumes, fruits and tree pods, all of which can be processed and combined in different ways to create meals and medicines. Wild plant foods may be tended and curated to improve productivity (Atherton 1983; Anderson 2005) or protected by local law (e.g. Manger *et al* 1996, p.100).

Herds exist within the natural context of seasonality (figure 5.2), which will influence breeding, herd size and organization, productive strategies and the need to move on a seasonal basis (Bollig 2006, p.210-211; Campbell *et al* 2006; Dalal-Clayton *et al* 2003; Mortimore 1998); but economic, cultural and ideological factors will also influence how herds and pastures are managed (Evans-Pritchard 1940; Jallow 1990, p.195; Mortimore 1998, p.36; Yokell 2004, p.42), a complex of factors that will influence strategies of control of reproduction, mobility and resource usage, including land tenure agreements and other forms of access to land and water (Bardhan and Ray 2008; Binns 1992; Dasgupta 1997; DFID 2000a; IFAD Rural Poverty Portal 2007; Ostrom 2008).



Figure 5.2 - Wet and dry season pastures used by the Wodaabe of southeastern Niger. (Source: Schareika 2003, p.20, 38)

Pastoral communities may organize themselves based on the scale of the household, community or kinship group (Bollig *et al* 2013; Cliggett 2005; Evans-Pritchard 1940; Honeychurch 2013; Manoli *et al* 2014). Different management strategies may be particularly important where cattle, goat and sheep are all kept, because sheep and goat are often herded together but cattle are usually, although not always, herded separately due to different requirements and tolerances (Anderson *et al* 2012; Dahl and Hjort 1976, p.250; Dyson-Hudson and Dyson-Hudson 1980; Niamir 1991, p.2-3; Voth 2014). Some of these can be difficult to identify archaeologically (Barich 1998; Cribb 1991; Gifford-Gonzalez 1998). These ways of organizing may change over time, particularly in response to economic and social

stress, with workforces and management structures altering as circumstances change in the shorter or longer term (Manger *et al* 1996 chapters 6 and 7; Manoli *et al* 2014; Wengrow and Graeber 2015).

Important decisions concern the need to move herds, for example when to mobilize, where herds are grazed, how many animals are slaughtered and at what age, how many are removed for loans and reciprocal arrangements and how many are sold in exchange for other products (Dalal-Clayton *et al* 2003; Manger *et al* 1996; Mortimore 1998; Schareika 2003; Sen 1999, p.165-9). Stenning (1957, p.206-207) defines seven terms applied by the Fulani to different types of movement at different times of year, indicating how flexible and strategic mobile production can be. Mobile pastoralism may be sedentary (including ranching), fully nomadic (when mobility is high and may be irregular in its patterns) or transhumant (when movement is regular and relatively fixed in terms of locations visited). Movement tends to be dictated by the needs of the cattle or other livestock. The Himba of Namibia, for example, experience considerable resource heterogeneity and use five values for assessing an area: the position in the landscape in relation to key resources, location with a view to accessing dry-season water, and the quality of pasture for fodder and the accessibility to a location for cattle (Schnegg and Welle 2007). In drylands the most common are nomadic or semi-nomadic livelihoods (IFAD 2009; Moss 1992, p.69).

As well as the divisions of labour and social responsibilities mentioned above, concepts of ownership may be complex, including ownership of animals and rights to lands used to graze herds and the landscapes through which the herds are moved (Bontkes 1991; McCann 1998; Dasgupta 1997, p.9; Holland 1990, p.223; IFAD Rural Poverty Portal 2007; Harir 1996, chapter 3; Quan 1998, p.167; Weber and Horst 2011). Secure access to common resources, of which water is of key importance, will not guarantee sustainability, but lack of secure access will represent a major and possibly insurmountable risk to any group. Grazing land is required, but land ownership is not always a condition of use and access can sometimes be negotiated, unless conditions of stress cause friction over land usage (Bardhan and Ray 2008; Dasgupta and Heal 1979; DFID 2000a; Manger *et al* 1996; Ostrom 2008; Tiffen 1996). In his description of societies and ecology in northeast Ethiopia, McCann (1988, p.284) describes the concept of land as “a multi-layered set of claims over transfer, direct access, and exchange of land rights over income from its products negotiated between producing and elite classes.”

Pastoral activities may appear to be primarily ecological and economic but may be guided by many factors that are embedded in culture (Evans-Pritchard 1940; Dahl and Hjort 1976; Deng 1972; Dyson-Hudson and Dyson-Hudson 1980; Hodder 1990; Oma 2010; Orton 2010; Honeychurch and Makarewicz 2016, p.350-352), which in archaeology may be suggested by the incorporation of animal symbolism into human life and funerary practices (Brunton and Caton-Thompson 1928; Flores 2003; Gatto 2011; von Czerniewicz *et al* 2004; Weber and Horst 2011, p.1-2; Wengrow 2001; Zboray 2003). This is explored further in the case studies.

5.2.2 Agro-pastoral livelihoods (Dryland mixed farming)

Agro-pastoralists in North Africa can survive in drylands with annual rainfall of 150-300mm (Dixon 2001, p.89-90) but like pastoralists are subject to environmental variability and have their own mechanisms for spreading risk via subsistence strategies and social networks (Layton 2002, p.70). In marginal areas mixed agriculture, combining herding and cultivation, tends to resemble modern smallholder agriculture and horticulture (Hobbs 1989; Harir 1996). Mixed farming concentrates a community's cultivation and livestock production activities in a given area for at least part of the year because cultivation requires some degree of sedentism. Cultivation maximizes the production value of a given area of land and may generate surpluses for storage as insurance against hard times but may be impacted by environmental downturn and only takes place where sufficient water is available to support the growth of plants (Dalal-Clayton 2003, p.48; Davie 2002; Gerrard 2000; Mortimore 1998). The scale of operations can vary enormously. Cultivation may take the form of large field systems or small scale horticultural plots. The output will be influenced by, for example, climate, soil quality, available energy in the form of labour, and technology. Even tiny horticultural plots may be possible at the right season for the right crops in arid environments (Hobbs 1989; Manger *et al* 1996; Rautman 1996).

Cultivation and herding are not incompatible when there is sufficient land to accommodate both cultivation and livestock. Agricultural production often increases the range of fodder available to animals when compared to natural resources alone, with crop residues and agricultural weeds adding to the mix (Scoones 1995b). In dryland environments crop growing can be hazardous and the presence of livestock can be of critical importance when crops fail. Strategies to protect crops from herds may involve localized solutions such as confining herds to the village environs, penning, or more long-distance solutions such as transhumance or fully nomadic lifestyles (Hall *et al* 2001). Herds can also graze on agricultural fields where the unwanted remnant stubble of a harvest are left behind, particularly useful when parts of cereals and legumes are indigestible for humans (McCown *et al* 1979; Onwuka *et al* 1997), converting unusable plant matter into sustenance for livestock. Conflicts may occur when there is not sufficient land to support both cultivation and herds (Hussein 1998; Okeke 2014; Vlasich 2005). When cultivation consumes land used for pasture, or when herds begin to feed on crops when there is insufficient pasture, an alternative grazing solution must be found (Vlasich 2005). In the 1970s, Sandawe subsistence was based on domesticated crops supplemented by livestock production but hunting and gathering were still important (Newman 1970, p.27). Where crops are a major part of a subsistence strategy, and depending on the size of the population and the rate at which it expands, social inequality may be the result of differential access to labour and land in agro-pastoral and fully agricultural societies (Layton 2002, p.74).

5.3 The Nature of Risk and Uncertainty

5.3.1 Defining Risk and Uncertainty

Various different definitions of risk and uncertainty exist, and are used inconsistently (Bollig 2006, p.7-16). I am using Knight's classic 1921 distinction in which risk is a situation where the outcome of a given situation is unknown but an informed decision can be made based on knowledge and information. Uncertainty refers to a situation where much or all of the information needed in order to make a decision is absent (Knight 1921). Risk and uncertainty require that decisions be made, and these involve the application of probability. Probability is the data used to decide whether a decision is more or less likely to succeed than any other action also under consideration, and is a way of measuring risk (Bennett 1998). Uncertainty is a situation in which an unexpected occurrence or series of occurrences, like successive droughts, combine with lack of information to produce a situation that lies outside accumulated experience. Even in modern situations probabilities cannot be measured with any accuracy in situations of uncertainty, where insufficient information is available to assign probabilities with confidence (Cancian 1980; Segal 1994). This is the difference between making informed and uninformed decisions. Decisions made under conditions of risk are based on considerable experience as well as ideological and religious belief whereas those under conditions of uncertainty are often made without confidence outside the usual framework of knowledge and experience. The dynamic character of societies enables them to cope with environmental and social change up until the point where experience and knowledge can no longer provide solutions to problems. This is the tipping point between risk and uncertainty.

5.3.2 Risk

At the heart of risk management is knowledge, which is inherited and transmitted for the benefit of all (Al Tabini *et al* 2012; Anderson 2005; Berkes 2012; Berkes *et al* 2003; Dika Godana 2016; Müller *et al* 2007; Schareika 2003, 2014). Knowledge encompasses not merely economic activity and skills, but the concepts and meanings that contribute to social identity. Inherited knowledge informs individuals that certain options exist, and informs their ability to select between the options available (Berkes *et al* 2000; Brouwers 1993, p.30; Liwenga 2003, p.28; Schareika 2003, 2014). Knowledge is not always distributed evenly between all members of a society due to social conventions and specialized tasks (Liwenga 2003, p.28). Up to date information, as distinct from inherited knowledge, is also of essential value in applying knowledge and experience to current situations (Harir 1996, p.95; Schareika 2014, p.2, 4). Simon (1957) points out that where complete knowledge is unavailable, a decision will usually be based on experience rather than information. Knowledge itself evolves as circumstances alter.

An important objective of risk-management strategies is to achieve the sustainability of a preferred livelihood whilst maintaining cultural identity. In this sense sustainability is a negative feedback loop, a “return to an equilibrium state after a temporary disturbance” (Mortimore 1998, p.17) and is a usual condition of livelihoods that operate under conditions of risk. These are the conditions under which the most fortunate dryland inhabitants make their livings today maintaining a flexible approach to livelihood management in order to incorporate inherent instability. The Department For International Development (DFID 2000a) regards dryland inhabitants as living within a context of vulnerability, with “access to certain assets or poverty reducing factors” which acquire meaning “through the prevailing social, institutional and organizational environment” (DFID 2000a, p.14). Jallow points out that traditional African societies have been extremely effective in the past in terms of sustainability: “contrary to the general view reflected in the literature, traditional African societies have long been able only to maintain a reasonable level of ecological balance through their land use practises, but were able to adjust to and live with natural hazards” (Jallow 1990, p.191-2).

Drought is the most common of the vulnerabilities that threaten dryland communities and rangelands, which may result in famine (Behnke and Scoones 1993; Dalal Clayton *et al* 2003; Mortimore 1989; Mortimore 1998; Seely 2006). Where drought is restricted to one season, it can usually be managed by existing drought management techniques (Johnson and Anderson 1988; Mortimore and Adams 1999) but repeated drought is more difficult to survive and usually results in a high rate of mortality due to famine and disease, as a range of modern famines have demonstrated (Laity 2008; Mortimore and Adams 1999; Sen 1983, 1999). Some livestock may be lost due to starvation, leaving them at their weakest when rainfall produces new pasture, which they may be unable to digest due to inadequate rumen function (Yami 2008, p.117). Animal disease is also common. For example, water carries with it a number of inherent dangers, particularly when it is of poor quality, or when associated with particular animal species. Diseases may be viral, bacterial or parasitic (Moss 1992, p.58). Potential diseases include botulism, cholera, diarrheal diseases, schistosomiasis, leptospirosis, foot and mouth disease, brucellosis, rabies, anthrax, rinderpest, tsetse-related trypanosomiasis, parasitic anaplasmosis and malaria (Bollig 2006, p.124; Catley 2002; Dieckmann 2013, p.273; FAO 2001c; Schrimpf and Feil 2012, p.22). Minor periods of drought are difficult to recognize archaeologically, but more severe cases may be represented by climatic data, geophysical indicators and by changes in the archaeological record, such as reduced settlement density and abandonment, both of which happened at the end of the mid-Holocene.

In recent years it has become clear that perception of risk, including psychological, sociological and anthropological factors, is a major influence on risk handling (Kuper. A and Kuper 1985; Scoones 1996, p.162; Supras Consult 2006, p.2), often referred to as “social risk.” The Supras Consult report refers to this as the “socio-metric paradigm, which views perceptions of risk and their degree of acceptability as part of a culturally and societal determined moral order.” (p.3). Social and economic strategies impact not only subsistence

strategies but the cultural context within which they exist. This means that any predictions about rational actions may be falsified by apparently illogical but realistic behaviours (Carney 1998; DFID 2000, p.14; Holland 1990). Vulnerability may be caused by social, political and economic factors as well as natural factors, because of how lives of people are structured (Blaikie *et al* 1994, p.3). Participation in any level of communal project, whether it is contributing knowledge to a decision about where to find water (Schareika 2014), how to adapt to a new area due to forced migration (Cliggett 2005) or what the losses might be in constructing a ceremonial monument (Richards 2004; 2013) may involve risk to the individual and their status in a community depending on the outcome, or risk to an entire belief system (the latter referred to by Richards, 2013 p.12-13, as “symbolic risk”). Social and symbolic risk are explored in the case studies.

Decision-making is inherent to risk management. Boholm *et al* and their research into decision making in prehistory. Based on Langley *et al* (1995), Boholm *et al* (2013) describe three common errors in understanding how decisions are made: 1) reification, “a tendency to treat a decision as an object rather than a social construct” (Boholm *et al* 2013, p.100), 2) dehumanization, which implies that all decisions are rational without reference to experience, memory or social process, all influences that can alter how decision are perceived and what decisions are made; and 3) isolation, the assumption that decisions are divorced from other decisions and the process that provide the dynamic context in which decisions are made. Decisions may also be heavily influenced by what others in the neighbouring area are doing and perception of the risks that they are taking (Boholm *et al* 2013, p.100-105). Finally, they comment that decisions “have a dubious ontology since it is not always clear from the facts at hand if there is a decision or not” and that even if it is determined that a decision has been made, it may remain unclear what the decision entails and how it came into being. Archaeologically, this obviously presents challenges. It is perhaps easier to detect individual inputs on the micro level than when longer term changes are being discussed. Where significant changes are observed decisions were involved, and it is possible to look from the decisions to the decision makers and speculate on who made the decision (a single leader, a decision-making body, a family) and suggest their intentions.

5.3.3 Uncertainty

When an unprecedented or unexpected disaster occurs, such as a drought that continues for many seasons, experience may not be sufficient to inform decisions about coping, and the scenario can tip towards uncertainty. Uncertainty threatens everything deemed by individuals, households and the community as a whole to be valuable, including economic and social stability, religion and ideology. Changes in circumstance, however they are derived, undermine the value of knowledge about the environment and the best decisions to be made under conditions of everyday risk, increasing vulnerability (Jandreau and Berkes 2016). Even social networks, which in many kinship groups are very robust, may break down, leaving

traditional forms of insurance and support unavailable (Bardhan and Ray 2008; Cliggett 2005; Dalal-Clayton *et al* 2003; Ostrom 2008; Tiffen 1996).



*Figure 5.3 - View of a degrading landscape in Niger (Source: Patrice Savadogo
<http://drylandsystems.cgiar.org/regions/west-african-sahel-and-dry-savannas>)*

When the situation becomes extreme and norms are no longer sustainable, disequilibrium requires emergency action and difficult decisions have to be made (Behnke and Scoones 1993). This means serious changes to fundamental aspects of life, including changed economic activity, loss of homes and territory, new social organization, the loss of religious faith or even the loss of life itself (Cliggett 2005; Dalal-Clayton *et al* 2003, p.48; Mortimore and Adams 1999, p.2; Silberbauer 1981; Toulmin 1992, p.236). Many of the decisions made at these times, disrupting not only subsistence but cultural foundations, are far from straight forward. Unlike conditions of risk, complete disequilibrium may be the difference between life and death, and during the usually traumatic process of survival societies may be redefined: "These events can lead to the social disintegration so often recorded, especially when combined with epidemics, as such events often are. Catastrophic shortages can set conditions for radical social/cultural transformations" (Minnis 1996, p. 70).

As already discussed above, droughts are one of the most common challenges facing pastoral groups. Where droughts are occasional and do not last for multiple seasons, they can be managed. However, where droughts are ongoing, famines may result in 1000s or millions of deaths concentrated in regions, wherever in the world they occur (Laity 2008; Nicholson 2001; Sen 1983). Famines are inherently associated with collapse of economic and social mechanisms, population movements and disease caused by debilitation of human immune systems, breakdown of sanitary arrangements, and the presence of decaying corpses (animal and human) (Mortimore 1989; Mortimore and Adams 1999; Macintosh 2011; Moss 1992, p.58; Pankhurst and Johnson 1988; Sen 1999).

Finally it should be noted that some opportunities, like new technology, may also represent uncertainty if unaccompanied by the incorporation of the knowledge required to implement and support it safely in the short-term and over the long-term. Where a new technology or a new innovation has been invested in but is unaccompanied by knowledge about how to incorporate, implement or sustain it, this puts the investment of acquisition and labour at risk. Under such circumstances there is little means of making up for that lack of knowledge, and that represents the onset of uncertainty (Cancian 1980; Dalal-Clayton *et al* 2003; Vierra 2005a; Vlasich 2005).

5.4 Coping with Risk

Groups operating in marginal environments have built up an enormous amount of data to assist them with decision making, using *a priori* knowledge to assess the value of various outcomes. This means that decisions have a high probability of being suitably informed responses. This has led to three major inter-related livelihood strategies (Seely 2006) and combinations of them (Atherton 1983):

- Hunting and gathering (and fishing)
- Domestic livestock herding (and fishing)
- Irrigated and rain-fed horticulture and agriculture

Below is a long list of alternative strategies that might have been available to decision makers. The reality is that a) not all possibilities will be available to all people, b) only a certain number will be available at any one time, and as matters deteriorate those options will contract, c) not all people will be aware of all possible solutions and d) even where numerous possibilities are known, some will be preferred for reasons beyond the strictly economical, including traditions, values, preferences and social risk. Optimization may well depend upon ideas embedded in tradition, social values, taboos and religious concepts as well as practical considerations and knowledge and access to information (Behnke *et al* 1993; Cliggett 2005; Morgan 1992; Mortimore 1998; Schareika 2003, 2014).

5.4.1 Diversification

Diversification is “the classic hedge against risk of all kinds” (Mortimore 1998, p.87). Longer term coping strategies depend very much on willingness to adapt, take up new opportunities and innovate. One solution is diversification (Cliggett 2005; Cronk 2004; Galaty 1991; Galvin 2009; Manger *et al* 1996; Robinson 2004; Schnegg and Bolten 2007). Mortimore and Adams observe that “It is by now a rather banal observation that income diversification is a means of spreading risk” (1999, p.121). Most pastoral groups supplement their livelihoods with at least one other livelihood strategy (Bollig and Osterle 2013; Casimir and Bollig 1994; Jacobs 1975).

A number of groups maintain a diversified range of stock so that no single breed dominates and benefits of each can be depended upon at different times (Ndege 2006; Salzman 2004). Those groups that have a traditionally narrow range of livestock may diversify in response to reduced biomass in abnormal seasons as a temporary means of reducing stress (DFID 2000a), balancing the relative benefits of species to ensure sustainability. Under optimal conditions, a cow, for example, can only reproduce after it has reached 2 years of age under optimal conditions, requires regular access to water and good quality pasture to become fertile and will rarely produce more than one calf annually (Dahl and Hjort 1976). Ovicaprids can reproduce after only a few months, are far more tolerant of drought conditions and will produce offspring twice a year and are likely to give birth to more than one offspring at a time (Dahl and Hjort 1976; Linseele 2010). Although they need water more frequently ovicaprids require less water and will make do with rough browsing (sheep) and scrub (goats) (Yokell 2004) and will survive where large stock can't in the face of disease and drought (Salzman 2004, p.7). Goat are also well adapted to highland zones, meaning that they can be herded vertically as well as horizontally. Cattle, although they require more investment in terms of management and care, provide much more milk and lactate for longer (Dahl and Hjort 1976). Sheep and goat are more disposable, due to the ability to restore herd sizes, and therefore more likely to be used as a source of meat. Cattle, on the other hand, which have 3½ to 4½ times more calorific value than goat and sheep respectively (Russell 1988), are far more likely to carry much greater social value and be endowed with far more important symbolic roles than the more replaceable sheep and goat (Evans-Pritchard 1940; Lienhardt 1961; Linseele 2010; Ryan 2002; Wengrow 2001).

Plant foods are also used to diversify food acquisition and the intake of nutrition. They are either collected in the wild, wild species may be curated (Anderson 2005) or domesticated species are cultivated on a small-scale or larger scale basis. Some mainly pastoral groups also grow crops in order to supplement their diet, either on a horticultural or partially agricultural basis (e.g. Hobbs 1989; Manger *et al* 1996). Agro-pastoralists may diversify not only by varying their livestock, but by using a number of different crops, which may require different environments and the dispersing of fields (Layton 2002, p.70). This requires quite complex arrangements to ensure that both herds and crops are given the care that they require. The Hadendowa of the northeastern Sudanese Beja, for example, live with minimal rainfall and sparse vegetation but balance herding and horticultural activities by practicing transhumance (Manger *et al* 1996).

A common response to shortages of preferred foods is to resort to hunger foods that are not generally consumed. These famine foods may include wild species of grasses, wild animals, insects, raiding of termite nests for stored grain, leaves, roots, fruit, berries, roots, flowers, pods, seed oil and even tree bark all of which may put pressure on biomass (Bollig 2006, p.198; Cliggett 2005; Harlan 1989, p.71; Minnis 1996; Mortimore 1998; Winterhalder 1981). Following initial strategies, like selling or consuming reserves of livestock, the most common fall-back is to employ famine foods in greater quantities as food stress deepens (Cliggett 2005;

Winterhalder 1981). The more diverse the resources, the greater the opportunity for spreading risk (Mortimore and Adams 1999; Newman 1970, p.34, Schimpf and Feil 2012, p.24). Hunger foods employed during the Sahel drought of 1972-1974 in northern Kano included 10 species used in 631 villages, mainly leaves from trees and forbs, 37 additional species in some villages, and 21 others mentioned in accounts about Northern Nigerian livelihood management (Mortimore and Adams 1999, p.76-7).

5.4.2 Specialization

Specialization is an opposing strategy to diversification, and is rare in dryland environments where risks are high and specialization limits choices (McCabe 2004; Salzman 1971).

Specialization in pastoral economies usually focuses on the degree to which a community places most of its emphasis on pastoral activities rather than supplemental and diversified activities. Large herds of cattle, for example, may be maintained for both status reasons and to improve the chances of some members of the herd surviving during severe droughts (Dahl and Hjort 1976; Deshler 1965, p.167; Evans-Pritchard 1940). Deshler (1965) says that the loss of cattle during a dry season due partly due to starvation but also to ailments associated with malnutrition can reach 10-15% of herds. Those animals that do die of starvation can be eaten and their carcasses used in other ways, whilst surviving animals will be used to regenerate herds following drought. This strategy, however, carries a risk of the herds over-exploiting limited resources (Hassan 1986a; Sidahmed 2000). Where pastoralists are referred to as specialists, it is often because instead of engaging in alternative forms of production themselves, they engage in trade for their source of other products (Grillo 2014; Linseele 2013, p.149). Schareika describes the Wodaabe of southeastern Niger as specialists because their economy is confined to cattle with a few sheep (Schareika 2003, p.9) and they sell livestock to buy grain (p.10).

5.4.3 Storage and herd management

The failure to produce sufficient food to store, or the failure to store surplus efficiently, may lead to famine in hunger seasons and drought years (Cliggett 2005; Mortimore 1989).

Although consumption is the main requirement in any economic system, a secondary objective is delayed-returned or conservation strategies where the production of surplus for sale and storage may support sustainability (Cliggett 2005; Binns 1992, p.156; Seabright 2004, p.71). Savings for pastoralists are partially in the form of domesticated animals (WFP 2009, p.59). Livestock are efficient converters of low cellulose and other plant foods, including agricultural waste, and are particularly valuable for acquiring and storing energy from plants in low production environments (Berkes *et al* 2000, p.1256). They represent storage in the guise of meat, bloody, fat, and dairy products. Consumption of dairy products and blood are ways of utilizing the storage potential of an animal without killing it, thereby perpetuating its value on an ongoing basis (Sherratt 1981; Dahl and Hjort 1976). The slaughter of animals interrupts the flow of other products like milk, blood and fat. The by-products of livestock (dairy, meat,

leather, the entire animal) can be exchanged for other products (IFAD Rural Poverty Portal 2007).

Physical storage facilities are an important form of risk management to make food last into hunger seasons or to exchange for other goods (Cliggett 2005; Hurcombe 2014; Minc and Smith 1989; Orme 1981; Selemani *et al* 2013). Most plant foods can be stored for later use. Fish and meats can be dried, cured, smoked, preserved in salt or fluids and ground into powders, and otherwise conserved for future consumption. Grain can be stored in baskets and pits and on raised platforms but may be vulnerable to the costs of perishability, rodent infestation, insect damage, birds, opportunistic theft and organized raids (Anderson 2005; Chambers and Conway 1991; Cliggett 2005; Diehl 2011; Stahl 2009, p.331-2). Grillo (2014) cites the Samburu of north central Kenya who use pottery particularly during the dry season and during droughts as a means of preserving liquids, transporting vessels in baskets on donkeys (Grillo 2014, p.117-119). Baskets and animal skins can also be used to transport stored goods and fluids (Silberbauer 1981, p.226-7). In the Gilf Kebir rock art site 09/101 a painted cow with a bag hanging down its side is shown, a possible indication that cattle were used as pack animals (Kuper *et al* 2009a, p.19). In the Chufu-Meri area a grinder from site 02/17 "showed rope marks and abrasions on it which indicate that it was obviously tied for transport" (Riemer 2006, p.518).

Finally, there is social storage, which is the use of prestige items "as tokens of value which can be exchanged for food in times of need" (Rowley-Conwy and Zvelebil 1989, p.50), and be used to win favour and seal ties and create relationships of obligation (Evans-Pritchard 1940; Minc and Smith 1989, p.50; Schrimpf and Feil 2012, p.22). Herds may be social assets that are redistributed on a reciprocal basis, together with labour, food and other essentials (IFAD 2009).

5.4.4 Mobility

Mobility is an important option for a pastoral community, but is not necessarily a defining characteristic (Frachetti 2008a, p.368; Jochim 1991, p.308). Marshall and Hildebrand (2002) define mobility as the ability to respond to unpredictable water and pasture by moving. Minnis refers to it as "a set of strategies that increases the spatial resource base" and goes on to observe that "the geographical scale of mobility is determined as much by the social landscape as by the natural environment" (Minnis 1996, p.60). Legge refers to mobility as "highly informed and flexible exploitation of the environment" (1989, p.83), whilst Salzman, amongst others, confirms that mobility is purposeful and informed, often regular and repeated, and not random (Salzman 2004, p.29; Orme 1981, p.260). In areas of marginal natural productivity and biodiversity, confining livestock to one place usually limits the potential productivity of a herd by relying on what become limited resources. Mobility depends on knowledge of seasons, geography and ecology and the management of livestock and herd size (Lenssen-Erz and Linstädter 2010; Perrier 1995, p.52). The cost of moving a herd can be

much less than keeping it one place, permitting practical and sustainable use of available and water throughout the year (Behnke and Scoones 1993; Schareika 2003).

Hurcombe emphasizes that herds are not the only driver for mobility, as the need to acquire plant materials for craft production also imposes demands upon communities that influence the need for mobility and form it takes (Hurcombe 2014, p.64, 111, 164). As pastoral communities often depend on their connections with family in other communities, and the exchange of information that these provide, a certain amount of mobility is also required to maintain information flows between communities (Veth 2005). Sheller and Urry (2006, p.210) emphasize that routes and points between nodes are also of primary importance in the task of moving herds from one place to another. Naimir (1991, p.4) suggests a number of variables influencing the patterns of movement chosen in addition to water and forage: location of salt licks, soil conditions, dew, heat and shade, avoidance of pests and diseased areas, proximity to markets, labour availability, cultural gatherings, territorial boundaries and social relations (particularly alliances and enmities). As well as regular movements to cope with predictable seasonality, less predictable factors also demand mobility, including seasonal failures of rainfall and floods, population density, endemic human and animal disease and pests, overgrazing and desertification and even territorial conflicts (Baron 1981; Salzman 2004, p.29).

There are various sorts of mobility, from complete mobility in a circulatory pattern of temporary occupation to various types of partial mobility where a group moves between base camps and has wider temporary camps that it exploits from those base camps, and permanent bases from which herders part for part of the year to pasture their herds (Binns 1992; Gould 1992; Rosen 2008; Wendrich and Barnard 2008) (figure 5.4). Linseele distinguishes between nomadic pastoralists, who have an irregular pattern of movement, and transhumant pastoralists, who move between fixed points (2013, p.148) but there are many other variants within the overall concept of mobility. Some types of mobility may be little more than foraging or resource acquisition trips taking only weeks or days. Bernbeck refers to such mobile lifestyles as “multi-sited” (2008, p.66). Amongst the Toubou of Tibesti, for example, the Teda are fully nomadic, whilst the Daza are semi-nomadic, dispersing with cattle to pastures in dry seasons and returning to villages in the summer rainy season (Beltrami 1997). At times of difficulty when the range over which a group moves may be expanded in order to locate new pastures (Manger *et al* 1996; Stenning 1957; Veth 2005). Over time, some groups experience migratory drift, which is the displacement of traditional areas in favour of new ones (Stenning 1957, p.206), a form of long-term destocking that does not, however, prevent return to a favoured area after a period of absence.

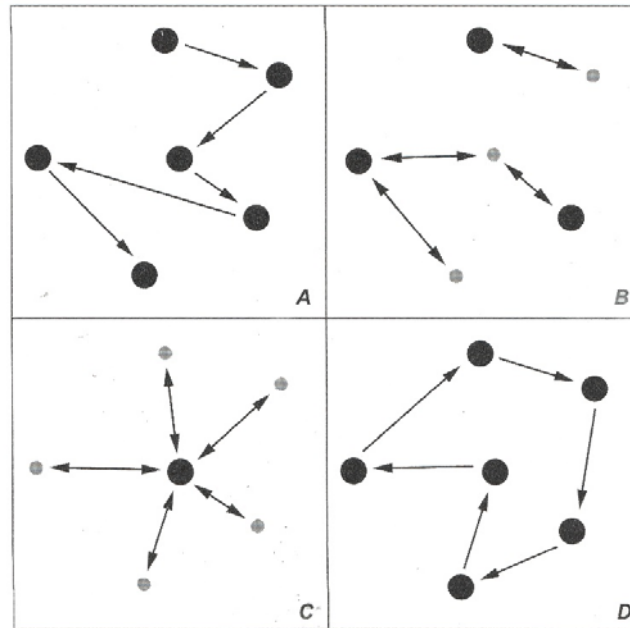


Figure 5.4 - Schematic representation of mobility patterns.
 Black dots indicate the main group; grey dots indicate segments of the group.
 (Source: Wendrich and Barnard 2008, p.5, figure 1.2)

Movements may be constrained by social as well as environmental issues that are caused by changing allegiances, conflicts and reciprocal agreements (Fernández-Giménez 2002; Legge 1989). Land may be regarded as a communal resource by hunter-gatherers and some pastoralists or may be imbued with concepts of ownership or tenure (Binns 1992; Dasgupta 1997, p.6; Manger *et al* 1996, p. 152; Viveló 1977, p.15). Amongst the Hadendowa land is inherited or fought for and is imbued with concepts of honour and heritage and access to land is given by membership of a group by descent or marriage (Manger *et al* 1996). Amongst some groups mobility may be organized on a clan or tribal basis (Holland 1990, p.223).

5.4.5 Habitat management

Pastoralists will often set aside grazing areas to fall back on during dry periods or droughts, usually as part of a transhumant seasonal round, sometimes leaving their own lands to enable favoured pastures to regenerate (Al Tabini *et al* 2012, p.5; Little and Leslie 1999, p.117-120; Schareika 2003). This prevents certain areas from being over-grazed during seasons when pasture is widely available and serves as a form of store for when conditions become more difficult (Schareika 2003, p.50; Schnegg and Welle 2007). During the rainy season territories will generally have good accessibility and good forage, but reserves for drought, which may be used as a last resort, may be more difficult to access and are only viable in the short term (Schnegg and Welle 2007; Ziess 2007). As rainfall alters both temporally and geographically, the location of pastures may have to be reconsidered every year, and may be shifted several times during that year if needed during a dry season (Ziess 2007).

Both Anderson (2005) and Hurcombe (2014) have emphasized the role of management of the natural environment in the activities of ethnographic communities for both subsistence and craft (particularly basket-making) purposes. Most modern groups have mechanisms for managing plant resources for craft sustainably (Hurcombe 2014; Manger *et al* 1996; Wendrich 2007). Improving the conditions of useful plants and curating them requires commitment but reduces the risk of not having supplies when required (Anderson 2005; Hurcombe 2014, p.111).

More formal control of habitat takes the form of tenure agreements, which are invariably very complicated and are constantly subject to renegotiation (Fernández-Giménez 2002; Tiffen 1996). Land tenure is the method by which rights to land and other land-based resources are determined, and helps to prevent over-exploitation of resources (Hobbs 1989, p.74-5; McCann 1988; Dasgupta 1997; IFAD Rural Poverty Portal 2007; Quan 1998). These become particularly difficult during times of resource stress (Elhadary 2010; Scoones 1995b).

Fire is often used amongst pastoral groups to create a suitable habitat for preferred herbaceous species and prevent a shift to shrub dominance; to maintain species that are both highly nutritious and palatable and eliminate undesirable fire-sensitive ones; to control parasites; to produce charcoal; and to open up the landscape to permit freer movement of livestock and eliminate cover for predators (Butz 2009, p.443, 446). Grasses and perennial forbs withstand fire well and are able to regenerate (Woodward 2008, p.18). However, there are also risks that fire can also lead to the erosion of topsoil (Mistry 2000, p.234; Shorrocks 2007, p.38), damage to seedling regeneration (Kelkay 2011; Mistry 2000, p.232) and the conversion of good quality pasture to bushland (MacKenzie 1967, p.21; Woodward 2008, p.17).

5.4.6 Social networks

Social assets describe the resources available for mutual support and exchange, which people can depend upon for social sustainability in both normal conditions and under conditions of risk, thereby pooling and spreading risk (Bollig 2006; Dahl and Hjort 1976; Evans-Pritchard 1940; Gifford-Gonzalez 2005; Mortimore and Adams 1999; Moritz *et al* 2011; M.C. Nelson 1996, p.287; Sen 1983, p.29; Sen 1999, p.9). Minnis suggests that social relations are the best coping strategies, in spite of the high costs incurred in terms of obligations and loss of independence, because they become costly only after other approaches and strategies have failed (Minnis 1996, p.68-9). These social relationships may take different forms, from productive assistance such as lending individual animals (Legge 1989), to more abstract but crucial assistance like providing information about good pasturage (Galaty 1991).

Social networks exist at different scales and may benefit individuals within households and groups, whilst more complex arrangements may benefit entire communities (Mortimore and Adams 1999, p.19; Raynaut 1997b). These links can be profound and lasting, linking individuals and communities (Dalal-Clayton *et al* 2003, p.91-2; IFAD Rural Poverty Portal

2007b; Johnson and Anderson 1988, p.7). Kinship networks are the most common form of social network amongst pastoralists, and there are multiple forms of categorization and organization of kin (Barnard 1992, p.264-281; Cliggett 2005; Dasgupta and Heal 1979; Pelto and Pelto 1979, p.172; Raynaut 1997c). Under conditions of stress, where resources are limited, group support may be available. Livestock may operate as a social cement with loans and gifts of livestock connecting family members, communities and institutions and providing bride dowries, sharing the risks of drought and disease (IFAD Rural Poverty Portal 2007b; Harir 1996, p.89-90). Other forms of reciprocal obligation and social contract and include animal loans of different types, sharing of labour and labour contract and redistribution of food in times of hardship (Harir 1996, p.89-90; Jallow 1990, p.195; Legge 1989).

Social networks are not themselves invulnerable. Boone observes that increasing dependence on domesticates has tended to promote differential access to resources, and that when shortfalls occur those with less access to resources are most vulnerable, whilst the higher ranking members of a community have a much better chance of survival (Sen 1983; Boone 2002). Cliggett (2005) has demonstrated that the elderly of the Gwembe Tonga are by no means able to rely on family assistance, even when starving, if they can offer nothing of value in return. At the same time, family members crucial for loans and other claims may die or move away (Chambers and Conway 1991; Harir 1996, p.89-90). Finally, at times of acute difficulty where no-one is in a position of strength, networks of support may break down completely (Bardhan and Ray 2008; Bollig 2009, p.285-290; Dalal-Clayton *et al* 2003; Ostrom 2008; Tiffen 1996).

5.4.7 Communication of knowledge and information

Two of the greatest mitigators of risk are the transmission of knowledge (from generation to generation) and information (about current matters of economic and social importance in real time). Both provide a way of managing risk in real time.

Inherited knowledge about the environment, about where to locate raw materials and the techniques used to manufacture tools from those materials are part of the fabric of internal social arrangements, at both household and community level (Morgan 1992, p.46; Mortimore 1998, p.36; Schareika 2014). It can take place as part of the daily routine of living, with children learning knowledge that has been transmitted through generations from the current generation of older group members as the seasons unfold (Minnis 1996; Seeley 2006, p.32). The greater the participation in an activity, the more knowledge will be acquired over time, in terms of concepts, meanings, skills and routines (Brouwers 1993, p.30; Liwenga 2003, p.28). Knowledge may not be distributed evenly between all members of a group, and there is particular differentiation between the types of knowledge considered appropriate for men and women (Liwenga 2003, p.30).

Information exchange is more complicated, because it requires effort to obtain (Baron 1981, p.73; Harir 1996, p.95). Although all social interactions represent opportunities to exchange

geographical knowledge, different types of information carry different transaction costs. For example, information about upcoming weather can be gleaned from the stars, a calendrical approach that measures the probability of different weather events arriving at certain times of year, or inspecting the vegetation, an analogous method that considers the biomass as a good indicator of seasonal change, be it early or late (Niamir 1991, p.4; Schareika 2003, p.38). Other information will be more costly to acquire, such as where rains have fallen and where pastures are therefore to be found – this may rely on scouts (McCabe *et al* 1999, p.114) or kinship links over long distances or reciprocal arrangements with other communities (Manger *et al* 1996) and is vital for decisions about when and where to move and which routes to take (Al Tabini *et al* 2012; Eisola *et al* 2006; Galaty 2001; Müller *et al* 2007; Schareika 2003, 2014). Another type of information is that required in trade: where and when markets are to take place, who is to attend, what is to be traded, what relative value traded items will have and whether people and their products can be trusted (Cligget 2005, p.81-83; Bollig 2009; Johnson 1999).

5.4.8 Leadership and community fluidity

Pastoralism does not necessarily require leadership and in pastoral communities both inequality and equality are represented (Rosen 2017, p.38). In pastoral societies status or role may be based on perceived wisdom, experience, craft skills, negotiating skills, healing or spiritual mediation, or other valued characteristics (Klima 1970; Manger *et al* 1996; Niamir 1991; Olupona 2014, p.40; Schareika 2014, p.4; Smith, A.B. 1996, p.30) as well as by lineage (Deng 1972, p.111; Viveló 1977, p.120) and divine right (Viveló 1977, chapter 3), or may become necessary when control over limited resources is required (Viveló 1977, p.15). Often pooling of ideas is the dominant form of decision making unit, and elders are respected and given key positions due to their seniority, experience and knowledge, as well as their skill at drawing together different ideas to form strategies (Schareika 2014; Spencer 1998, p.249). Leadership, if it does manifest itself in one person, may be temporary and subject to negotiation and flexibility (Wengrow and Graeber 2015). Crumley argues that power may be constructed via various different fields of action in a heterarchy, all of which are compatible but with different internal arrangements (Crumley 1995, p.4), meaning that different sources of power may come into play at different times.

Although many clans are patriarchal, matrilineal arrangements are not uncommon, and provide women with an influential role in group management and decision making (Beidelman 1967; Cliggett 2005; Hodgson 2000). Even in exclusively patriarchal organizations, women are always important contributors to household security and may also have input to decisions regarding household and group management, a role that may vary under differing subsistence strategies and altering economic conditions, and along the entire continuum between domestic, economic and symbolic spheres (Toulmin 1992; Bianco 2000). The elderly and children also have important roles to play, again varying in significance depending on economic conditions and social organization (Cliggett 2005; Toulmin 1992). During times of

stress, women, children and the elderly may have much more important roles in the pastoral community, particularly when communities are divided in order to put the interests of herds first (Binns 1992; Liwenga 2003; Manger *et al* 1996).

5.4.9 Technology

Technology is an integral part of any livelihood, however simple or complex. Ness describes how technology bridges between population and the environment to lessen the stress on the latter, resulting in different levels of complexity and reducing the role of environmental determinism in explanatory discussions of dryland communities (Ness 1994). The ability to adapt technology to prevalent conditions is a powerful one (Nelson 1996; Shirai 2010; Torrence 1989b).

Nelson sees technology as a reflection of prioritisation during conditions of stress, because time needs to be spent in food acquisition not tool manufacturing, meaning that tool choices are significant, representing certain choices for risk management (Nelson 1996, p.109). As technological failure is more costly under conditions of risk, tools and facilities will be optimised for effective livelihood management (Nelson 1996, p.124). Decisions about tool technology amongst pastoralists, particularly those that move around, must incorporate the issue of portability (Close 1996; Nelson 1996, p.121-123). This is a particular issue where no pack animals are available. Pottery and grindstones, for example, may be very difficult to transport (Close 1996, p.550). However, mobile people do employ both (Grillo 2004; Eerkens 2008). Whilst discussions of technology are often confined to objects (stone, wood and bone tools, basketry and pottery), other activities may also be classified as technological adaptations, including habitation constructions, storage pits, grindstones and wells (Rosen 2008, p.123-126).

All technologies are based on resource availability or the ability to trade for materials, including stone for tools, clay for pottery, and certain plant species for basketry and cordage. This requires scheduling to ensure that parts of the community are in the right place at the right time of year for the resources to be exploited or for trade to take place (Brown 1989; Hurcombe 2014; Marshall and Hildebrand 2002, p.112). These activities have to be co-ordinated with other scheduling activities like moving herds to find pasture and gathering wild plants when they are ready for harvesting. Scheduling is a very important part of risk management, particularly in unpredictable environments subject to stochastic rainfall events.

As well as purely functional roles in risk management technologies of all sorts are the product of tradition, ideas, cultural values and personal engagement with the material (Hodder 1990; Ingold 2013; Sørensen 1989), and this may be particularly the case with decorated pottery and very fine flaked stone tools (Barkai 2011, p.6; Edmonds 1995, p.42; Gero 1989, p.92; Wobst 2000, p.47). These are indirect benefits to livelihood sustainability, helping groups to define themselves, to build relationships and to engender a sense of security.

5.4.10 Ideology, religion and tradition

Ideology often plays a prominent role in pastoral livelihood management (e.g. Bollig 2006; Manger *et al* 1996; Cliggett 2005; Deng 1972; Evans-Pritchard 1940; Hobbs 1989; Lienhardt 1961; Rosen 2008). Ideology, which includes spiritual and religious systems and the ritual expression of those beliefs, is often used to reinforce social stability (Cliggett 2005; Jochim 1991, p.315) but may itself alter where change is unavoidable (Cliggett 2005; Deng 1972, p.156-160; Vivello 1977, p.126). Salzman suggests that ideology can account for why people make choices that do not always make economic sense, such as decisions not to use certain resources (Salzman 2002), in which specialized knowledge about natural resources and landscape use may be incorporated into ideas of identity (e.g. Oestigaard 2009, p.14) and be translated into myth, symbol and ritual (e.g. Lienhardt 1961, p.147). Ancestors are often important to groups who depend on their heritage to support their future (Bollig 2006, p.19, 353; Manger *et al* 1996; Mortimore and Adams 1999). Sometimes specialists are employed to intercede with the supernatural (Bollig 2006; Cliggett 2005).

The idea of tradition is one of mutability, the use of accumulated experience to adapt and change, whilst building on existing wisdom and values (Spencer 1998, p.249). Hunn describes traditions as “the product of generations of intelligent reflection tested in the rigorous laboratory of survival (Hunn 1993, p.13). Shared social values and guidelines, like rules of behaviour, and concepts of right, wrong and justice may be responsible when strong traditions are adhered to.

5.4.11 Opportunity, invention and innovation

Many types of risk management strategy, like diversification of resource base and the use of new technologies may be entirely dependent on brand new options becoming available and communicated (Dixon *et al* 2001, p.13). The introduction of Near Eastern sheep and goat into northern Africa in prehistory and the decision of groups to adopt them, followed later by the introduction of domesticated wheat and barley are examples of opportunities that were taken up. In marginal environments the adoption of an innovation, even when it may look positive, represents a considerable risk not merely to economic security but to social organization and cultural norms (Mokyr 1990, p.157-8; Vlasich 2005). As Doolittle points out (2001, p.451) the mere presence or availability of a resource does not guarantee acceptance: “When it comes to explanatory value . . . diffusion is short on power. Just because things can diffuse does not mean that they will. One is forced to ask why people adopt an innovation.”

Opportunities may be regarded with caution because as well as bringing something potentially positive, they frequently represent risks (Abrahams 1996; Eyhorn 2006; Sørensen 1989; Stiglitz 2014, p.14; Vlasich 2005). Perhaps unsurprisingly the only changes that will ever be acceptable to groups being challenged with environmental deterioration or unsustainable livelihoods are those compatible with existing environmental conditions, social mechanisms and traditions (Masood and Schaffer 2006; Morgan 1992; Ness 1994; Sørensen 1989;

Streeten *et al* 1981; Ortiz 2005; Terrell and Hart 2008; Torrence and van der Leeuw 1989). Groups will fight to preserve their traditions in the face of the need to change livelihood strategies, if apparent improvements in productivity may undermine traditional processes (DFID 2000a; Koenig 2006; Vlasich 2005).

Opportunities are often taken up slowly, on an experimental basis and in a way that does not radically redesign their existing strategies if those strategies were functional (Dennell 1983, p.175-6) and are only considered to be innovations if accepted by the group (Torrence and van der Leeuw 1989, p.11). The costs of taking up an innovation that fails may be high so must be carefully weighed (Mellor 2008, p.214-226). The risk of taking up a novel idea is judged on the basis of past experiences (van der Leeuw 1989, p.316) but also, when available, on the experiments of others. There may be a period during which some members of a community, early adopters, choose to take a risk by incorporating a novel way of doing things, whereas others will wait to see how that risk pays off (Bargatzky 1989; Layton 1989). Moky (1990, p.158) suggests that heads of extended families will be more cautious than heads of nuclear families because of the greater number of people depending upon their decisions. Where opportunities were taken up and change did occur, corresponding changes in cultural output and ideological conceptualization could also be expected (Hesse 1982; Smith, A.B. 2005, p.201). Opportunity is discussed further in Appendix D.

5.4.12 Raiding and theft

Raiding is the organized and illicit procurement of livestock by one tribe from another, and is widely although not universally practiced in pastoral economies (Clare *et al* 2008; Manger *et al* 1996; Minnis 1996; Stahl 2009, p.331-2). It is endemic today in the Sahel and East Africa (Schilling *et al* 2012). It can occur in times of wellbeing or hardship, but becomes far more common during times of need. After conducting interviews with the Turkana and Pokot in Kenya, Schilling *et al* (2012) conclude that the two main motives for raiding herds are hunger and drought on the one hand (the Turkana) and the expansion of wealth and the payment of dowry on the other (the Pokot). Amongst the Teda of Tibesti, theft is not condemned and organized raids took place even after they were brought under French and Italian control in 1918 (Beltrami 1997). The result for the victims may be loss of access to critical resources like water and pasture, loss of vital livestock, the breakdown of social structure, social networks, trade and exchange possibilities, social cohesion and economic stability, as well as damage to the status of individuals and the reduction of marriage possibilities, enforced migration and even lack of life (Frankenberger *et al* 2001; Schilling *et al* 2012). A more unexpected and indirect but still devastating outcome may be the spread of the disease from stolen livestock to new populations (Schilling *et al* 2012).

5.4.13 Trade and Exchange

Trade and exchange transfer goods and services between communities to the probable benefit of all. There are several examples today of symbiotic relationships existing between

hunters and agriculturalists, where the hunters provide meat in exchange for desirable goods, some necessities and some luxury items (Grillo 2014; Hobbs 1989; Nicolaisen 1989; Newman 1970). The contexts within which these exchanges and negotiations take place are far from simple, because as well as providing the opportunity to sell and buy, they also provide the opportunity to meet people, exchange information and reinforce relationships (Cligget 2005, p.81-83; Bollig 2009; Johnson 1999). Trade and exchange involve relationships of trust, price-setting and the acquisition of reliable information to enable good decisions to be made, not least about trustworthiness and the fluctuating value of goods (Bollig 2009; MacMillan 2002). Whilst information flows within communities vary fluidly, communication is less fluid between them (Seabright 1999, p.199). There are transaction costs involved in the acquisition of information, and the greater the distances between people and the difficulties of establishing contact, the higher the costs of the process (Harir 1996). As Agbe-Davies and Bauer emphasize, trade is a social activity “a concept that focuses not just on the movement of goods but also on the social context and consequences of the exchange” (2010, p.13). It is a process that connects people, not merely in short term transactions but long term relationships.

5.4.14 Stint

Stint is the practice of self-denial. At times of food shortage lower quality foods are consumed and current consumption is reduced, causing a dependence on energy stored in the body (Chambers and Conway 1991). Obviously this is an unsustainable solution that is only viable in the short term, but may be a way of eking out resources during times of shortage. During periods of stint hunger foods are the main form of intake, with preferred foods being unavailable or being left to recover (Cliggett 2005). Knowledge of hunger foods is often communicated from one generation to the next as vital knowledge for survival in times of maximum food stress (Minnis 1996; Seely 2006).

5.4.15 Labour

Because technology is usually limited, labour is one of the single most important assets of a household and a community, determining the number of animals that can be herded or the amount of land that can be managed under cultivation (Gleave 1992b). Although the balance is changing in modern times, labour, rather than land, can be the single most limiting factor in the ability of people to expand their productivity, and within any dryland community demand for labour exists in a series of peaks and troughs (Binns 1992, p.166). The Wodaabe cite labour as one of the five principal factors ensuring herd fertility and health, for tasks like searching for pasture, driving animals to graze, removing parasites, searching for lost animals, providing medical care, tethering calves, milking cows, making ropes, work with newborns, and maintenance of any related equipment (Schareika 2003, p.10). The demand for labour fluctuates on a seasonal basis with higher levels of activity required during wet seasons when higher levels of mobility are required, new camps must be established, herds must be

protected from predators and animals are at their most productive. Young animals may need to be tended. Dairy animals need to be milked, milk needs to be transformed into dairy products, and storage devices and other relevant equipment need to be manufactured. Demands on labour are at their lowest during dry seasons, particularly towards the end of the dry season.

5.5 Coping with Uncertainty

This is a much shorter section than the one on coping with risk, due to of the nature of the problem itself. Whereas there are tried and tested methods for dealing with risk, uncertainty takes place when those methods are exhausted. The strategies commonly employed under risk management conditions are often undermined and may disintegrate under conditions of uncertainty. It becomes necessary to change when difficult conditions cease to be manageable or become long term. Taking drought as an example, as it is the most frequently experienced danger to dryland livelihoods (Mortimore 1989), Manger identifies a three-phase economic response to drought summarized in (1996 p.138-9), most of which are repeated by Cliggett's analysis of drought handling amongst the Tonga of the Gwembe (2005):

Stage	Examples
Phase 1	<ul style="list-style-type: none"> • Male animals and unproductive females sold <ul style="list-style-type: none"> ◦ Buy food ◦ Reduce fodder requirement • Look for ways to diversity income <ul style="list-style-type: none"> ◦ Use of unfavoured wild plants • Migration begins, with some family and most possessions left behind
Phase 2	<ul style="list-style-type: none"> • Female animals sold, putting herd in jeopardy • Increased mobility • Essential tools and possessions sold • Money and goods borrowed from outside kin • Increasing dependence on charity
Phase 3	<ul style="list-style-type: none"> • Mass migration to towns / other areas <ul style="list-style-type: none"> ◦ Nothing left behind <ul style="list-style-type: none"> ▪ Considerable death risk to some though not all population (human and animal)

Table 5.1 - Three-phase economic response to drought, summarized in Manger et al 1996 p.138-9

Schrimp and Feil describe the same sort of process in more generalized terms, defining three stages of coping that begin with non-erosive approaches to failed coping strategies (2012, p.10) shown in Table 5.2:

Stage	Examples
Non-erosive coping	<ul style="list-style-type: none"> • Insurance (leveraging social mechanisms) • Risk-minimizing • Loss management • Diversification • Intensified food production • Arid/saline tolerant species • Non-preferred wild foods
Erosive coping	<ul style="list-style-type: none"> • Disposal of productive assets • Partial migration • Labour sales
Failed coping	<ul style="list-style-type: none"> • Charity • Total migration • Sale of children • Destitution

*Table 5.2 – Three stages of coping seen in terms of environmental and livelihood impact
(Source: Schrimpf and Feil 2012, p.10)*

An example of the severe impact that drought may have on water sources is shown in figure 5.5, where the lake that supplied water for humans and herds has dried up:



*Figure 5.5 - Sahelian drought 2012 in Chad showing dry lake bed. Source: Al Jazeera
<https://www.aljazeera.com/indepth/inpictures/2012/06/2012624213039862469.html>*

These solutions are by no means exhaustive and other mechanisms may be employed in different areas to manage uncertainty. Amongst the Tonga of the Gwembe, in good times

there was co-operation and sharing was common between towns and rural areas. Repeated and prolonged droughts changed that, and co-operative ventures broke down in the face of household and individual needs (Cliggett 2005). The position of the elderly became very vulnerable. Although disabled, unmarried or widowed elderly offer many benefits to society (with roles in rituals, cultural knowledge transmission and loyalty to the community) they are also costly (unable to produce children, low strength, ill health, no spouses to support them). Community and family interests usually dominate over individual ones, and as a result older individuals are sometimes sacrificed (Bardhan and Ray 2008; Cliggett 2005; Dalal-Clayton *et al* 2003; Ostrom 2008; Tiffen 1996).

A common response is to use assets to stave off starvation. Assets can be sold or exchanged for other products, but this can lead to a positive feedback situation in which selling one's only way of sustaining a livelihood only results in short term alleviation and pushes the family, group or community further towards disaster. Under these extreme conditions people may be forced to migrate, or die of disease and starvation. Following the great Sahel drought of West Africa in 1969-1974 crops failed across the entire region, and livestock holdings were decimated. The natural habitats changed, with annual grasses replacing perennials and sand dunes covering areas which were formerly vegetated. Up to six million people were threatened with starvation. The responses included abandonment of settlements, massive migration and death (Mortimore and Adams 1999, p.2).

A last resort, before starvation, is often permanent migration (Cliggett 2005; Gould 1992; Raynaut 1997a, p.111-2; Silberbauer 1981; Winkels and Adger 2002), what Gould refers to (1992, p.285) as "permanent relocation." In the Turkana area of Kenya multi-year droughts caused the temporary migration of 20% of the population (J.E. Ellis 1995). Migration today is often into urban areas (Manger 1996a p.133-4; Cliggett 2005) but may also be from naturally richer areas to more impoverished ones when population pressure means that the land can no longer sustain everyone who is making demands on it (Cliggett 2005; Raynaut 1997a; Toulmin 1992, p.236). This can cause both environmental and social stress in the new dryland areas now being occupied (Spencer 1998a, p.157-8). In her research into the Tonga of the Gwembe in Zambia, Cliggett describes some of the stresses involved for those migrating, including the need to cope with different languages or dialects, separation from kinship groups, loss of ancestry specific locations, loss of ritual connections with specific land, different ecological conditions and conflict over access to resources (Cliggett 2005).

Migrating populations can be difficult for those people in the areas upon which the new populations descend. Where migration shift takes place, groups may stray into lands where they don't have family or social ties, and this may cause conflict (Silberbauer 1981; Spencer 1998; Stenning 1957; Winkels and Adger 2002, p.6). Sometimes, where droughts impact a large area, the usual patterns of mobility are insufficient to serve the needs of either humans or livestock, which may tip the situation into one of uncertainty. Although they bring with them whatever wealth they may have, labour, marriage partners, knowledge, skills, and culture and

may integrate well with the assistance of social networks (Winkels and Adger 2010, p.10) they may also put pressure on the host territory.

5.6 Conclusions

Risk is factored into all dryland livelihoods, and uncertainty is the outcome of situations where tried and tested risk strategies cannot be employed. Sustainability is a measure of the success of the combination of strategies and resources, both traditional and new, to ensure survival of both lives and traditional values. It is easy enough to list possible options for people living under conditions of risk, but the important thing is to understand the contexts within which these options are selected. Questions that might be asked of livelihoods in marginal environments include: Is the chosen livelihood an effective way of managing sustainability? How are subsistence strategies managed? How have communities combined different forms of subsistence to minimize risk? What sort of social mechanisms are suggested by the data? These situations are well documented in the literature of ethnographic research and development economics. Identifying them in archaeological contexts is a matter of looking at all the available data with a view to identifying the common themes of risk management in dryland economies: for example, evidence for mobility, diversification, exchange and storage (e.g. Barker and Gilbertson 2000; Barnard and Wendrich 2008; Cribb 1991; Kuper and Riemer 2013; Halstead and O'Shea 1989). Uncertainty is far more difficult to identify archaeologically but may be visible in suggestions of permanent abandonment or signs of immigration.

6 - Introduction to the Case Studies

6.1 Introduction

This chapter provides an introduction to the four case studies. Specifically it looks at 1) the methodology, 2) the key questions that will be asked of each case study and 3) the current state of research and publication for each of the areas explored in the case studies. The four case studies are Nabta Playa in the Ru'at el-Baqar (Late Neolithic), the Qau el-Kebir to Matmar region in the Badarian, Dakhleh Oasis in the Bashendi B, and the Gilf Kebir plateau in the Gilf C (figure 6.1). The case studies test the SRL approach as an archaeological tool, using published data to explore livelihood practices in marginal environments. The areas selected are all in the Eastern Sahara in modern Egypt. All sites date to the mid-Holocene, the period during which the desert began to dry up at around 5300 BC as the ITCZ shifted south, a process completed at around 4900 BC (Kuper and Riemer 2013, p.46). Although all areas had access to water, and all livelihoods combined herding with some hunting and plant collection the topographies, water sources and localized environmental conditions differed. The objective of the case studies is to see how, archaeologically, these differences result in appropriate risk management strategies.



Figure 6.1 - The four areas discussed in the case studies (Source: Google Earth)

In exploring the marginal environments of the eastern Sahara, often with problematic datasets, I have chosen to push the data as far as I can, to find reasonable explanations. These would benefit from further analysis and, where possible, testing. In the case of the Badarian, this means using publications from the early 20th Century and employing both disturbed and undisturbed contexts, extrapolating from often limited archaeological remains in a way that a less experimental approach would probably avoid. In the cases of Nabta Playa, Dakhleh and Gilf Kebir, the data consisted almost entirely of palimpsests, and again the data has been pushed its limits in order to explore the value of the SRL model for capturing, describing and discussing data. This demonstrates the range of possibilities represented by the data and offers the opportunity to create new hypotheses on which to base future research (Scarborough 2009, p.197). The SRL approach evinces both the sort of questions that can be asked, and how a richly informed perspective on a particular archaeological context can be produced.

In the next chapter the methodology for completing the case studies is discussed. In this chapter the four case studies are introduced.

6.2 Case Study Backgrounds

6.2.1 Case Study 1 - Nabta Playa

6.2.1.1 Introduction to the Ru'at el-Baqar Late Neolithic at Nabta Playa

Nabta Playa lies in the southeast of the Western Desert 30km north of the Sudanese border, approximately 100km west of the Nile Valley, which equates to a one to three day walk, (Wendorf and Schild 1998, p.98) in what is now hyper-arid desert. The term “playa” refers to the presence of seasonally water-filled lakes and pools in basins, which attracted various forms of animal and human life. Schild and Wendorf suggest that rainfall was brief, resulting in “shallow pools of water” that could have sustained people and animals for as long as it remained (Schild and Wendorf 2001, p.45). Because it was first identified in modern times it benefited from the application of modern excavation techniques and the recognition of the importance of multi-disciplinary approaches, involving archaeological, geological, geomorphological, faunal, botanical and other specialized skillsets being employed to extract as much data as possible from the material. The main sites are shown in figure 6.2.

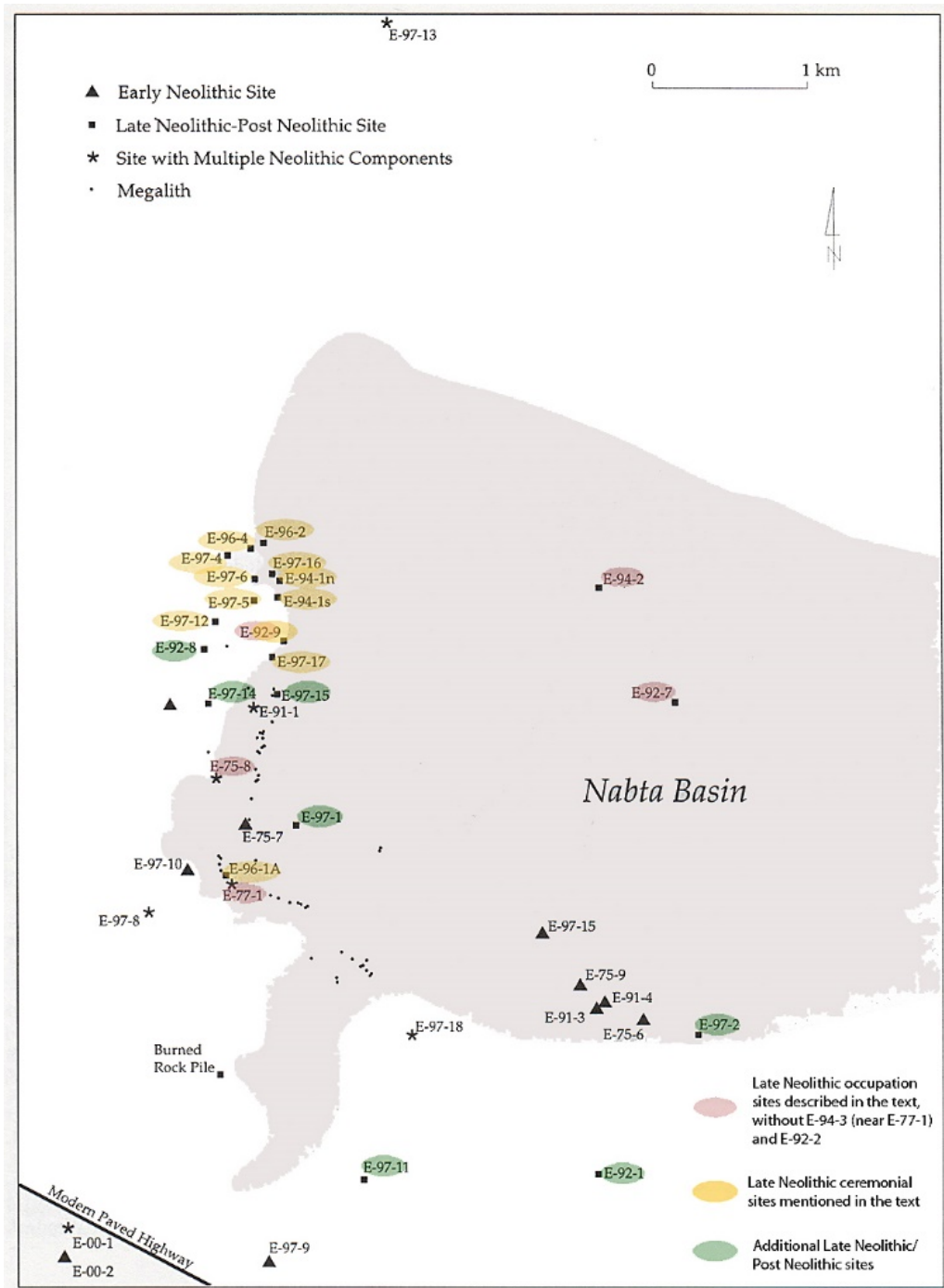


Figure 6.2 - Map of sites at Nabta Playa, annotated with a colour-coded key, added to show sites mentioned in the text
(Source: Wendorf and Schild 2001a, fig 1.2, p.5)

The earliest occupation dates to the early Holocene, during which hunter-foraging communities using distinctive Epipalaeolithic tool-kits moved into the area to take advantage of improved conditions and the presence of small game. During the mid-Holocene climate became increasingly arid as the ITCZ began to move south (Riemer and Kuper 2013; Kuper and Kröpelin 2006), but the desert areas were still capable of supporting life, with the introduction of domesticated animals assisting with this process of adaptation to what were

probably increasingly stochastic climatic conditions. At Nabta the periods corresponding to the mid-Holocene are the Ru'at El-Ghorab or Middle Neolithic followed by the 100-year Post-Middle Neolithic Arid Phase. The basin was reoccupied during the Ru'at el-Baqar or Late Neolithic (5400 – 4650 Cal BC), abandoned again in the 50 year Post-Late Neolithic Arid Phase and reoccupied once more during the Bunat el-Ansam or Final Neolithic (Schild and Wendorf 2002).



Figure 6.3 – Nabta Playa components during the Ru'at el Baqar. Clockwise from top left, the shaped stone from Complex Structure A (Source: Wendorf and Schild 2002, plate 36); black-topped ware (source: Nelson and Khalifa 2010, p.148, figure 4), Articulated cattle skeleton from tumulus E-94-1N (source: Schild and Wendorf 2015, p.367, figure 24) and the stone circle at E-92-9 (source: Schild and Wendorf 2015, p.367, figure 24)

The Ru'at el-Baqar consists primarily of palimpsests, but stratified data has been found at the multi period site E-75-8. The period is defined mainly by inorganic remains, some of which are captured in figure 6.3 and are discussed in the case study. The ceremonial centre, consisting of a number of different features, also belongs partially to this period (Schild and Wendorf 2001b, p.44). The so-called megalithic components were not recognized until 1992, having been mistaken for bedrock (Wendorf and Schild 2001, p.9) and are divided across two periods with the tumuli and stone circle concentrated in the Valley of Sacrifices belonging to the Ru'at el-Baqar period (meaning "Cattle Herders"), menhir alignments and the so-called "complex structures" apparently straddling both Ru'at el-Baqar and Bunat el-Ansam (meaning "Megalith Builder") periods (Schild and Wendorf 2004, p.11-14). Although some sites are placed within the Ru'at el-Baqar and some in the Bunat el-Ansam, Wendorf and Schild accept that the

dating is not secure “and it cannot be determined conclusively whether or not the various units were built together or at different times” (2001a, p.9). However, on the basis of their excavations the CPE have divided the sites up between the two units, placing the stone circle, the tumuli, megalithic alignment A1 and Complex Structure E-96-1A in the Ru’at el-Baqar, and that scheme has been followed here. The publications used most frequently in this paper are Wendorf, Schild and Associates 2001 and subsequent papers. This is because publications prior to Wendorf, Schild and Associates 2001 do not distinguish clearly between the Ru’at el-Baqar and the subsequent Bunat el-Ansam, if at all. Some of the distinguishing features of the Ru’at el-Baqar are shown in figure 6.3.

6.2.1.2 History of excavation and analysis

Nabta Playa was found in 1973 by members of the Combined Prehistoric Expedition (CPE) who paused on the way to the Nubian Nile Valley. They recognized prehistoric lithics strewn on the desert floor, which led to the discovery of Nabta Playa, “a huge paleolake basin with hundreds of Stone Age camps, tumuli, groups of megalithic structures and alignments of stelae” (Schild and Wendorf 2004, p.11). Survey and excavation took place over a number of seasons: 1974-5 and 1977 (Wendorf and Schild 1980), 1990-2, 1994 and 1996 (Wendorf, Schild and Associates 2001) and 2001 (Wendorf *et al* 2005; Schild and Wendorf 2012).

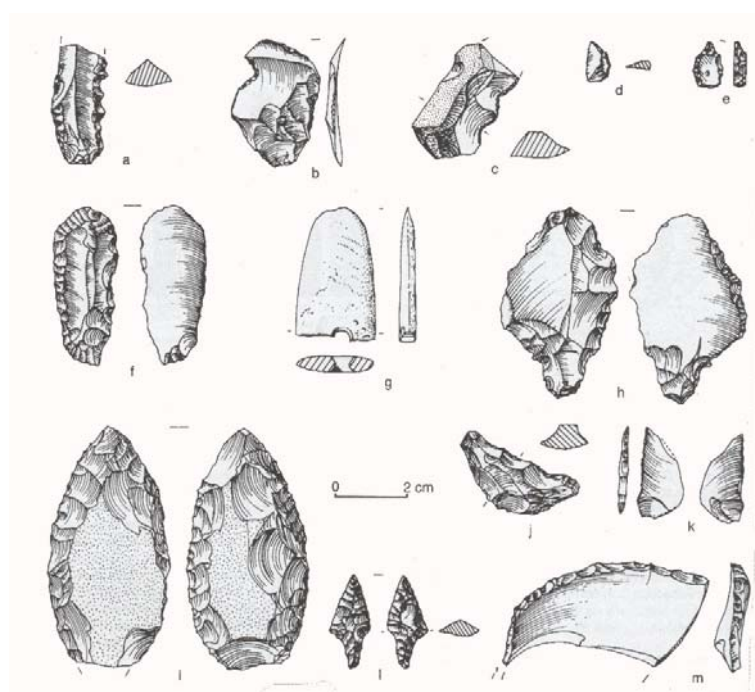


Figure 6.4 - Ru'at el Baqar lithics from E-75-8 (Source: Nelson 2001, p.396)

The excavations have been published as papers in both journals and books, and in two volumes dedicated to the site. Both of these two volumes (Wendorf, Schild and Associates 2001; Nelson *et al* 2002), together entitled *Holocene Settlement of the Egyptian Sahara*, consist of as a series of short excavation reports at different sites at different periods. Much

greater emphasis is placed on the earlier Neolithic phases. The Ru'at el-Baqar and Bunat el-Ansam are still sometimes dealt with as a single unit, and the detail for the Ru'at el-Baqar is often difficult to isolate. Volume 2, dedicated to the pottery, presents a number of specific problems, including some minor inconsistencies, and an approach to the data that is only loosely structured. The first issue is that the detailed categorization of the pottery took place after the publication of Volume 1. The writers of the first volume did not have access to the analysis provided by the second, meaning that the terminology adopted in volume 1 is not used in volume 2, which makes it challenging to integrate the ceramic data in the two volumes. Additionally, the second volume focuses heavily on early Neolithic pottery, and Ru'at el-Baqar pottery is not discussed in as much depth. Again, the Ru'at el-Baqar and Bunat el-Ansam are sometimes dealt with as single units, which leads to some confusion within the volume. Finally, whilst the categories of pottery defined for the biggest of the Ru'at el-Baqar sites, E-75-8, were originally defined by Gatto and were described in Volume 1 without citation, presumably meaning the categories were unpublished (Nelson 2001, p.539), Nelson categorizes the ceramics in a different way in Volume 2, without further reference to Gatto's scheme, meaning that it is difficult to integrate the two schemes.

6.2.1.3 Chronology

The Nabta Playa occupations consist of a mixture of both stratified and heavily deflated sites. The stratified sites have enabled a broad chronology to be developed, consisting of three early phases, a poorly represented middle phase, and both the Ru'at el-Baqar and Bunat el-Ansam Final Neolithic phases, each divided by periods of aridification when Nabta was abandoned. Each has been characterized in geological and stratigraphic terms (Schild and Wendorf 2002).

An emphasis has been placed on obtaining radiocarbon dates (Wendorf and Schild 2001c) and these are listed in the case study. More unconventional dates have been acquired from the stone circle and megalithic alignments based on estimates of the astronomy of the period, placing it within the Late Neolithic (Schild and Wendorf 2004, p.12). However, the dates for the ceremonial centre are by no means secure, only some of those are only indirectly associated with the sites concerned (Wengrow 2006, p.57). A map of the sites is shown in figure 6.5.

6.2.2 Case Study 2 – Badari (Qau el Kebir to Matmar)

6.2.2.1 Introduction to the Badarian

The Badarian extends over a 35km stretch of land parallel to the Nile, from just south of Asyut in the north to Qau el-Kebir (also known as El Etmanieh) in the south, the core areas being Badari, Mostagedda and Matmar. Although Brunton's records and maps do not tally precisely, it consists of several clusters of sites, which add up to some 46 settlement sites in total, with around 42 cemeteries containing, between them, over 500 excavated graves (Brunton and

Caton-Thompson 1928; Brunton 1937, 1948). The most recent dates available put the Badarian at between 4400 and 3800BC (Wengrow *et al* 2014).

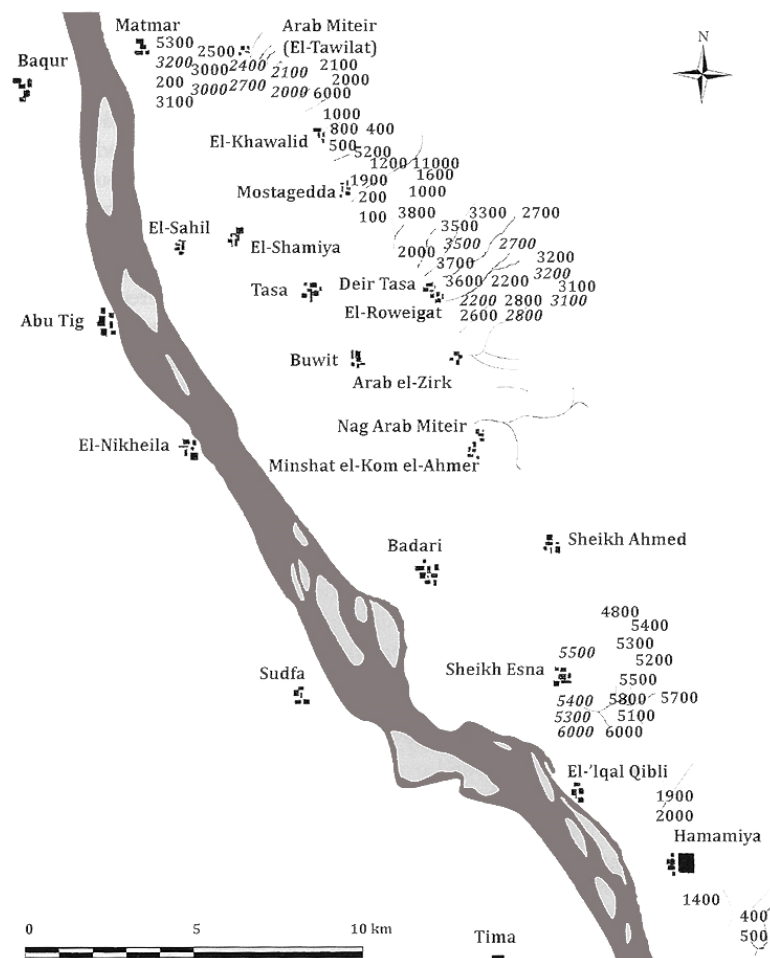


Figure 6.5 - Map of the Badarian sites (Source: Tassie 2014, p.249)

Occupation evidence is much more fugitive than funerary remains, and this may be a) because the Nile has changed its course, thereby destroying prehistoric data, b) because more recent villages have been built over the top of the prehistoric sites, c) because settlements were so transient that they are not there to be found or d) because settlement sites were on the opposite side of the Nile. Occupations consist of scattered remains of ash, debris, and occasional hearths and storage features (Brunton and Caton-Thompson 1928). By contrast, the cemeteries are very content-rich with grave goods consisting of ceramics, both fine and coarse, a generalized flake and blade industry with a small bifacial component (Holmes 1989), items of jewellery and ornamentation, small sculptures and cosmetic items (Brunton 1929, 1937, 1948; Brunton and Caton Thompson 1928; Friedman 1994; Holmes 1989a, Holmes 1989b). The economy is much debated and will be discussed in the case study. A sample of some of the objects found in Badarian sites are shown in figure 6.6 and 6.7.

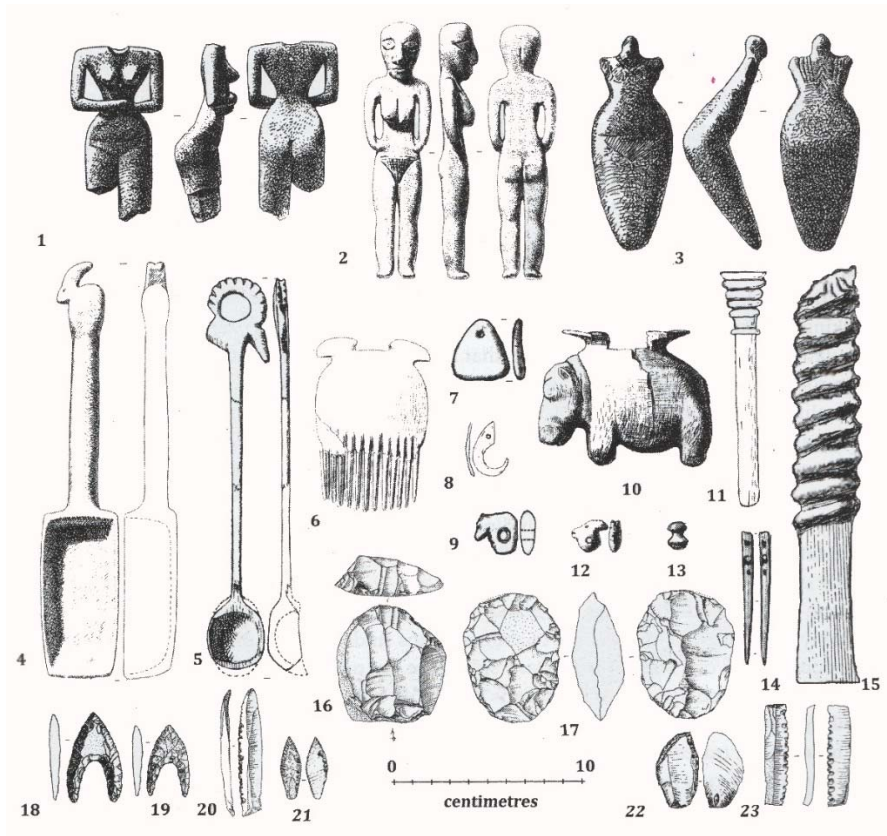


Figure 6.6 - A range of artefacts from Badarian graves (Source: Tassie 2014, p.257, figure 77)

6.2.2.2 History of excavation and analysis

The excavations ran over three seasons, 1922-3, 1923-4, and 1924-5 (Brunton 1929; Brunton 1929b; Brunton 1937; Brunton 1948; Brunton and Caton-Thompson 1928). Excavation standards were advanced for the period, but the publications were by no means as detailed as modern reports, as already discussed in Chapter 1.



Figure 6.7 - Examples of ceramics from the Badari region
(Source: Petrie Museum of Egyptian Archaeology)

More recently, fieldwork by Holmes and Friedman was carried out in a two week survey between February and March 1989, during which they excavated two test pits at Hemamiyeh, incorporating a sequence from the Badarian to Naqada II (Holmes and Friedman 1989, 1994). As well as re-examining Brunton's and Caton-Thompson's excavations in the same area, they found a previously unrecorded site, where they excavated one test pit, which they named BD-1. In 1992 a second season carried out surveys at other sites, during which the Badarian Site 3400 was test excavated (Holmes 1993), with a test pit, 2m x 4m, producing 342 sherds and 2112 lithic artefacts.

Several sites outside the core area of the Badarian concentration of settlements and cemeteries have been judged by some writers to be Badarian. Of all of them, Maghar Dendera 2 is the most important. On a narrow part of the floodplain, with considerable amounts of Badarian type pottery, it seems to be a Badarian outlier used for herding and some hunting, with a large fishing component (Hendrickx *et al* 2001; Vermeersch and Hendrickx 2002). Consisting of hearths, storage pits, emplacements for vessels and some postholes (albeit with no evidence of walls) the lithic assemblage differed from other Badarian sites suggesting to the excavators that it was a specialized seasonal occupation. Gabra found Badarian remains to the south of Deir Tasa (1930) including a settlement site 5000m sq. As with the occupation sites excavated by Brunton, the site was very shallow and of variable depths and there were pits interpreted as granaries and hearths.

Examples in the Qena bend may be other outliers of the Badarian (Darnell, D. 2002). Hays considered sites at El Khattara to be Badarian, even though they are over 100km to the south (Hays 1984, p.72) but Hassan and Matson place them in the early Naqada (Hassan and Matson 1989, p.314). An example from Hierakonpolis (Hoffman 1979; Holmes 1988, p.82) is

slightly later, as are examples at Armant where Mond and Myers assigned 30% of the pottery at the lowest level of the Armant Bucheum 1000 to the Tasian/Badarian (Mond and Myers 1937, p.169-11).

Elsewhere, Murray and Derry (1923) located a recently plundered grave around 5 miles inland due west of the Ras Samadi headland on the Red Sea coast on a small tributary on the Wadi Samadi. It was surrounded by a ring of large stones and had a roughly circular outline with a depth of 3 feet. Resch (1964) suggested that it was consistent with the Badarian. Debono (1951a, 1951b) found evidence for the occupation of a site at Laqeita oasis near Wadi Hammamat, the main route between Upper Egypt and the Red Sea today with pottery dated by Debono to the Badarian and Naqada I periods. At El Gouna near Hurghada on the Red Sea coast Vermeersch, Van Peer *et al* (2005) located a hearth at the foot of a limestone hill that have affinities to the archaeology of the Badari region. Finally, excavations at the Wadi Atulla revealed a severely plundered site that may have been connected to the Badarian (Friedman and Hobbs 2002).

There have been numerous pieces of academic research based completely or partially on the work of Brunton and Caton-Thompson, many of them looking at specific aspects of the Badarian, like the lithic industry (Holmes 1989); pottery (Friedman 1994); differentiation between the Tasian and the Badarian (Friedman and Hobbs 2002; Tassie 2014; Horn 2017a, 2017b); social structure (Anderson 1989, 1992), symbolic expression (Horn 2010; Wengrow *et al* 2014); seriation (Newell 2010), and the question of whether turquoise and copper from Sinai are present (Andelkovic 1995; Brunton 1929, p.463; Finkenstaedt 1983; Horn 2015; Tutundcizk 1989). It has also been summarized and discussed in a number of books about early Egypt (Baumgartel 1955; Hayes 1964; Hoffman 1979; Midant-Reynes 1992/2000; Romer 2012; Tassie 2014; Wengrow 2006).

Although there have been calls for further excavations to be carried out before destruction by expansion of modern settlements, encroachment by modern agriculture and the extension of cemeteries (Hoffman 1979; Holmes 1988; Holmes 1992; Holmes and Friedman 1989; Holmes and Friedman 1994), this was not acted upon and it is probable that all opportunities for using modern techniques to clarify the Tasian and Badarian along the Nile are now permanently lost (Holmes 1993, p.21), although it would be worth considering options for surveying the wadis, low deserts for sites and the western bank of the Nile as additional resources.

6.2.2.3 Chronology of the Badarian

The internal chronology of the Badarian is opaque. Caton-Thompson's excavation of the stratified settlement site Hemamiyeh established that the Badarian predated the Naqada I period. Brunton assigned sequence dates to the Badarian based on stylistic features (Brunton and Caton-Thompson 1928, p.26), following Petrie's seriation system. However, the proposed internal chronology, developed before algorithmic seriation techniques were available, has been challenged (Friedman 1994; Horn 2017a; Math 2007; Newell 2012, p). Friedman concluded that there is not sufficient evidence from the ceramics to distinguish between sub-

phases in the Badarian (Friedman 1999, p.9). The practical consequence of this is that the Badarian is often treated as a palimpsest, because there is no confidence in any proposals of internal chronology.

The duration of the Badarian period has been assessed using scientific dating techniques. A series of thermoluminescence dates were taken from sherds found at Hemamiyeh (Caton-Thompson and Whittle 1975). Hoffman considered them to be “internally consistent”, suggesting that the Badarian had a lengthy duration and, together with radiocarbon dates, suggest a span of 5500-3800BC for the Badarian (Hoffman 1979, p.142). This is now considered to be too early. The only secure internal distinction observed is defined by a natural formation that Caton-Thompson calls breccia, which seals largely undisturbed deposits below and has deposits that overlie it. Accelerator dates from a midden at Badarian settlement Area 3400 near Deir Tasa provided dates that were c.200 years older, suggesting that the earliest levels at Hemamiyeh do not represent the earliest Badarian phase (Friedman 1994, p.348). Dee *et al* (2013) have provided a range of dates for the Badarian from 4407-4308 – 3800-3667BC (68%) or 4489-4266 – 3896-3616BC (95%).

Brunton divided the area occupied by Badarian sites into an earlier Tasian and a later Badarian phase (1937, p.32). Brunton acknowledged the difficulties of separating the two burial classes, referring to it as “a very difficult question,” acknowledging that it is “possible that in many cases the description as Tasian is not warranted” (1937, p.5). He referred to the available knowledge of the Tasian as “very elementary” (1937, p.8). However, he decided to distinguish between the two even when only slight Tasian affinities were present. The Tasian was defined by a small number of artefact types that Brunton considered to be diagnostic (Brunton 1937, p.25-32). Kaiser accepted the existence of a Tasian but saw it as the outcome of northern traditions, evolving into the Naqada I period, pushing any Badarian populations out of the area (Kaiser 1985). More recently, surveys and excavations by Friedman and Hobbs in the Eastern Desert (Friedman and Hobbs 2002) and by Deborah and John Darnell in the Western Desert (Darnell, D. 2002; Darnell, D. 2008; Darnell, J.C. 2002; Darnell and Darnell 1998) come close to supporting Brunton's original proposals, positioning the Tasian as a desert tradition found in multiple environments in a number of different areas, perhaps originating from the Sudan (Darnell and Darnell 1998, p.80). On the other hand, other writers dismiss the Tasian as a chronological or cultural unit (e.g. Baumgartel 1955, p.20-21; Holmes 1989, p.14; Holmes 1993, p.24). Most recently and convincingly, Maarten Horn has argued in two papers that there are no grounds for separating the Tasian and Badarian. In one paper Horn argues that in the Qau to Matmar region the Tasian cannot be distinguished from the Badarian on the basis of objects, personal ornamentation or grave arrangements, and the inferences that can be drawn from them in terms of identity and technology (Horn 2017a). In the other paper (Horn 2017b) Horn analyses the practice of burial-superimposition, which he concludes is an intentional funerary practice and that Brunton's two phases actually represent a single archaeological unit. As Wengrow *et al* observe, this is consistent with practices shared along the Sudanese Nile in the fifth millennium BC (Wengrow *et al* 2014). Darnell and

Darnell (1998) believe that the Tasian sites in the region of Wadi el-Hôl in the Qena bend were not chronologically distinct from the Badarian but “rather a nomadic people with whom Badarian and Amratian cultures interacted” (1998, p.80), which seems like a plausible solution to the dilemma.

Finally, Newell’s seriation of the Badarian material based on pottery and palettes, both common in graves defines two phases, with open ceramics earlier and closed forms later in the sequence, and a change from round-based to flat-based designs (2012). He admits, however, that this has limitations and suggests that his conclusions might be challenged by future research. The big difference between Brunton and Newell is that Newell proposes a different order of interment of bodies within the individual cemeteries. At this time neither scheme is secure, and it is hoped that Horn’s research will be able to tackle some of these problems.

6.2.3 Case Study 3 – Gilf Kebir

6.2.3.1 Introduction to the Gilf C period at the Gilf Kebir

The Gilf Kebir Holocene occupation consists of four phases, which extend from the early Holocene to the very end of the mid-Holocene (Gehlen *et al* 2002). Gilf C (4300-3300BC) was preceded by the Epipalaeolithic Gilf B (6500-4300BC). Pottery was introduced into the Gilf B at the end of the period (Gilf B2) but the Gilf C is the first Gilf Kebir phase to feature domesticated cattle, goat and sheep (Linstädter 2005g, p.361-363). The data takes the form of palimpsests of pottery and stone tools. There are no stratified contexts dating to Gilf C. Rock art makes up another dataset, and this has been tied convincingly into the archaeological record and analysis by Zboray (2003a, 2003b, 2009) and the ACACIA Group from the University of Cologne (Kuper *et al* 2011-1; Kuper 2013). Extreme aridity and lack of modern agriculture or settlement has preserved sites, but high levels of aeolian activity and erosion mean that very few faunal and fewer botanical remains have been found, and it has been difficult in all but a few cases to relate these with confidence to any of the four periods (Peters 1988). Tourism has become a problem in recent years as visitors to the area have taken home artefacts as souvenirs or moved them away from their find places into attractive arrangements (Bagnold 1982 p.vii; Förster *et al* 2010; Kuper 2002, p.1; Linstädter 2003a).

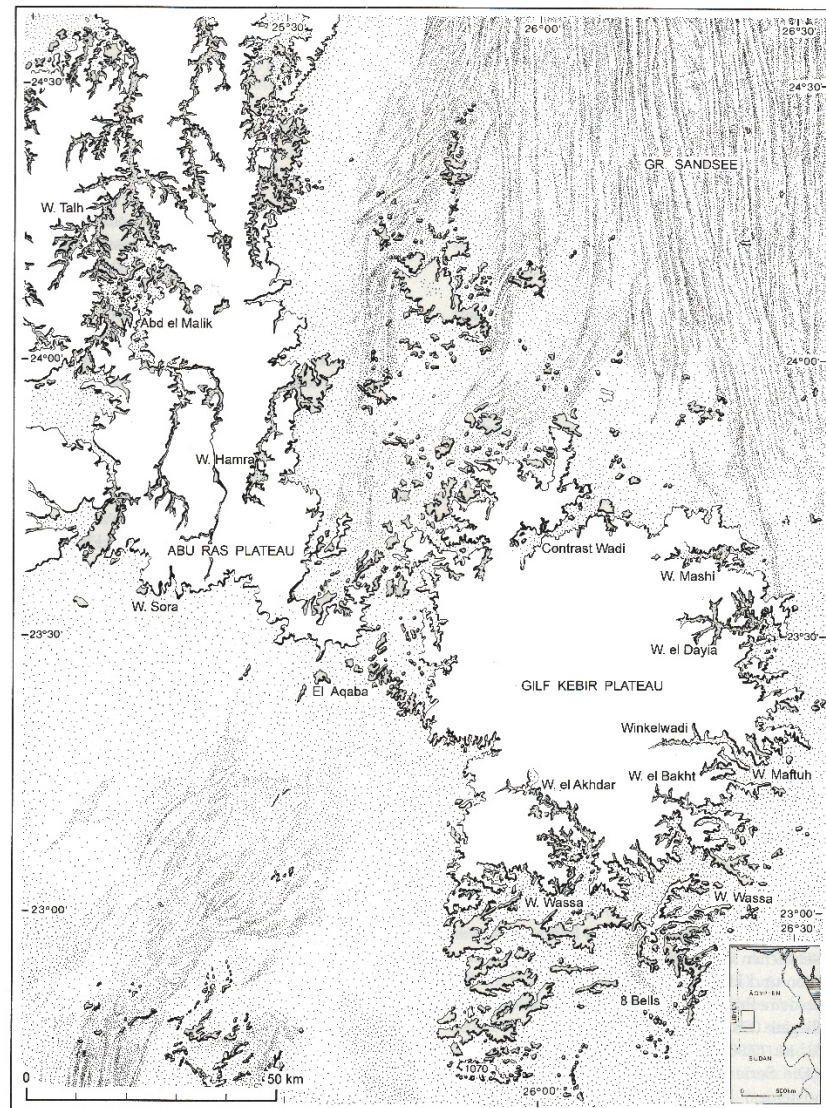


Figure 6.8 - Map of the Gifl Kebir showing the main wadis where the sites mentioned in the text are located (Source: Schön 1996, p.20)

Gifl C sites are confined mainly to the southern Kemal el-Din or Gifl Kebir plateau, but there are some on the northern Abu Ras plateau as well (Kuper *et al* 2009a Linstädter 2003a; Linstädter and Kröpelin 2004; Schön 1996b). Most of the Gifl C rock art is found on the western flank of the Abu Ras plateau in the vicinity of Wadi Sura (Honoré 2017; Zboray 2009). The main concentration of occupation is divided between the dry run-off valleys of the Wadi el-Akhdar and Wadi el-Bakht, which benefited from the formation of seasonal lakes behind dune barriers, and other smaller and less permanent camps on the plateau. By the end of this period archaeological remains are restricted to Wadi el-Bakht, the dune barrier at Wadi el-Akhdar having been breached, abruptly draining the seasonal lake behind it (Kröpelin 1989). The vast majority of sites are palimpsests, some of them multi-period. Apart from rock art there are no indications of ceremonial activities.

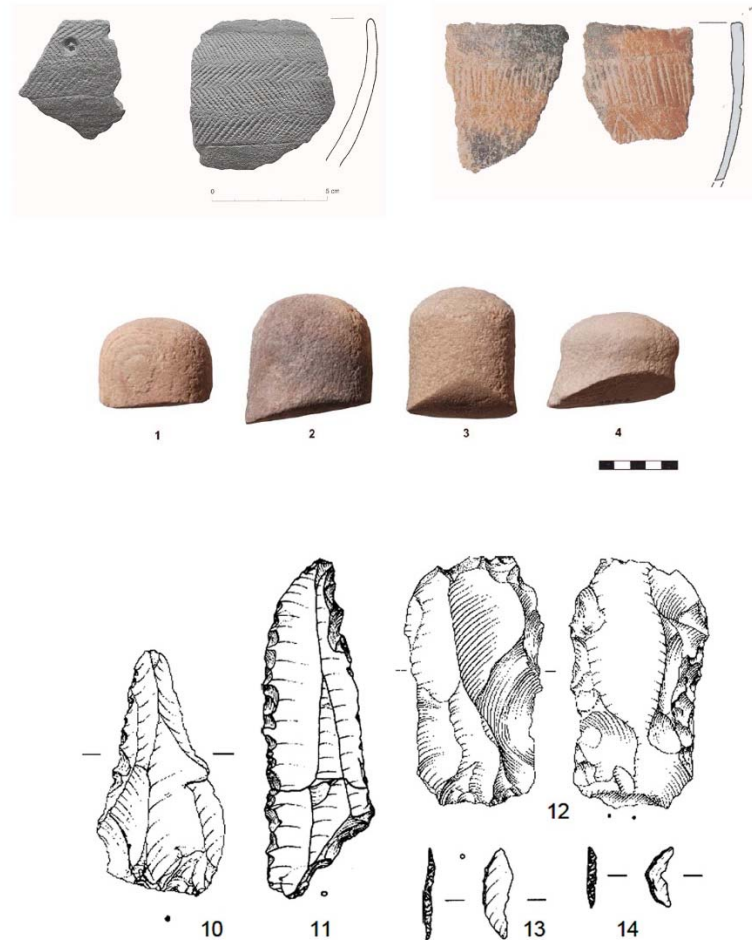


Figure 6.9 - Gilf C artefacts Top: Ceramics (source: left Classen and Pastoors 2005, p.275, figure 6; right Kuper, Leisen et al 2009a, p.18, figure 18); Second row: Gilf-type grinders (source: Kuper et al 2010, p.22, figure 24); Bottom row: Lithics (Source: Gehlen et al 2002, p.106, figure 13)

Over the last few years it has become increasingly clear that the Gilf Kebir should not be considered in isolation, but as part of a broader pattern that includes the Jebel Uweinat massif 120km to the south, some 10 days away, and the much smaller massifs Jebel Arkenu, 20km to the northwest of Jebel Uweinat and Jebel Kissu, 25km to the southeast (Darius 2013; Darius and Nussbaum 2007; Honoré 2017; Menardi Noquera *et al* 2005; Zboray 2013).

Although the rock art has received a lot of attention, with Zboray alone having organized multiple expeditions over the last 15 years (Zboray 2003a, 2003b, 2009, 2010; 2013), archaeological investigation is very much in its infancy and is confined mainly to surveys, some of them using Google Earth following recent restrictions on travel to the area (Peroschi *et al* 2014). Very little excavation has taken place, meaning that it is difficult to compare Jebel Uweinat directly to the Gilf C.

6.2.3.2 History of excavation and analysis

Although the earliest confirmed discovery of the Gilf Kebir was by Prince Kamal el Din and John Ball in 1925, who visited again in 1926 (Kelly 2002), most of the first serious survey work carried out at the Gilf Kebir in the inter-war years. In the 1930s the Zerzura Club was formed, an informal gathering of mainly military personnel stationed in Wadi Halfa on the Nile, at the Sudanese side of the border with Egypt. They began a search for the fabled site of Zerzura oasis (Beadnall 1931) and undertook expeditions by car, aeroplane and on foot, which were forerunners of a number of formal expeditions. Chief amongst these activities, from an archaeological point of view, were Egypt Desert Survey surveyor Patrick Clayton whose detailed maps of the Gilf Kebir in the 1930s and 1940s remain the most detailed to date (Clayton 1933a, 1933b); Ralph Bagnold, who identified archaeological remains (Bagnold 1931, 1933, 1935; Bagnold *et al* 1933; Bagnold and Harding King 1931); William Kennedy Shaw, who discovered rock art in the Gilf Kebir between 1934 and 1935 (Kennedy Shaw 1936); and explorer and Laszlo Almaszy who discovered the Cave of Swimmers, now known as Wadi Sura I (Almaszy 1939). Some initial work was also carried out on the geology and the environment of the Gilf Kebir (e.g. Cox *et al* 1933; Kennedy Shaw *et al* 1936). Many of these accounts of the exploration of the Gilf Kebir were published by the Royal Geographical Society, which contributed financial resources.

The first formal archaeological work took place when Ralph Bagnold and Robert Mond led three expeditions to the Gilf Kebir (Bagnold *et al* 1939). In the mid-1970s the lithics collected by Meyer during the Bagnold-Mond expedition were analyzed by McHugh (1975), who also recorded 697 potsherds. The last expedition before the war took place in 1938, and was sponsored by the Egypt Exploration Society. Funded by Robert Mond it is known as the Mond Expedition, and key members were Ralph Bagnold, rock art specialist Hans Winkler and archaeologist Oliver Myers. The archaeological material was not examined until McHugh made it the subject of his doctoral research (McHugh 1971). Leo Frobenius led two expeditions (Rhotert 1952) but the artefacts from these expeditions were destroyed in the Second World War.

The Combined Prehistoric Expedition carried out surveys and excavations in the area in the 1970s and published their preliminary findings (Wendorf and Schild 1980) but did not return. The Geological Survey of Egypt and NASA visited and carried out surveys (El-Baz and Maxwell 1982). Since 1980 extensive investigation has been carried out by the University of Cologne, first by the BOS (Besiedlungsgeschichte der Ost-Sahara) project between 1980 and 1992 and then by the subsequent ACACIA (Arid Climate, Adaptation and Cultural Innovation in Africa) project from 1995 onwards (Gehlen *et al* 2002; Linstädter 2005a; Linstädter and Kröpelin 2004; Schön 1996a, 1996b). A four-phase chronology (Gehlen *et al* 2002) combined the data from the Wadi el-Bakht and Wadi el-Akhdar (Csziela 1996; Gautier 1980; Kröpelin 1987, 1989; Linstädter 1998; 1999; McHugh 1975; Schön 1996a, 1996b, 1989) and this has

been confirmed by more recent excavations (Linstädter 2005). Work at both Wadi el-Bakht and Wadi el-Akhdar have been published in two edited volumes (Schön 1996a, 1996b; Linstädter 2005), consisting of collections of excavation reports and multi-disciplinary analysis of sites of all periods, together with extensive plans, maps and illustrations, the main themes of which are summarized in the final chapters of each. The work at Wadi el-Bakht alone produced 138 sites, of which 18 were excavated and many others systematically surveyed (Linstädter 2005g, p.355). The emphasis of fieldwork has been on Gilf B sites, which are larger and more numerous and are associated with some remarkable rock art scenes. A second strand of work carried out by the University of Cologne is the Wadi Sura-Projekt, and has focused on the rock art of the northeastern Gilf and its associated archaeology in and around the Wadi Sura rock shelters, again mainly Gilf B, published mainly online in a series of interim reports covering their work between 2009 and 2011 (<http://wadisura.phil-fak.uni-koeln.de>).



Figure 6.10 – Cattle paintings in the Gilf Kebir. Clockwise from top left: Wadi Sura I (photograph Andie Byrnes); WG25 (Source: Zboray 2013, p.19) Wadi Sura I (photograph Andie Byrnes); AM51, Wadi Abd El Melik, (Source: Zboray 2010, p. 242, figure 2)

Both rock art styles and archaeological excavation in the immediate vicinity of Wadi Sura II have helped to tie in the rock art with the four occupation phases, most belonging to Gilf B and Gilf C (Honoré 2015, 2017; Kuper *et al* 2011-1; Kuper 2013; Zboray 2003a, 2003b, 2009, 2010, 2013). The main distinguishing factors dividing Gilf B and Gilf C rock art are the change of subject matter, and the different styles of execution. Gilf B scenes focused on

hunting and scenes of socializing accompanied by headless mythical creatures, whereas Gilf C scenes are focused almost exclusively on livestock, mainly cattle, as shown in figure 6.7.

Most of the climatic data for the area is based on the excavation and analysis of the section of breached dune playa sediment, site 82/13, which provides “the thickest and most detailed sedimentary archive of Egypt’s entire Western Desert” (Linstädter and Kröpelin 2004, p.756). Extensive Gilf C settlement remains have been found in the wadis of the eastern edge of the southern plateau and the northern edges of the northern plateau. Whereas the northern plateau sites are largely Gilf B pottery-users who made use of temporary playa lakes at the foot of the cliffs, the southern plateau sites, with temporary lakes formed behind barrier dunes in dry wadis, date to both Gilf B and the later pastoralist Gilf C. The Gilf D has been found only at the southeastern part of the southern plateau to date, represented by very few sites.

6.2.3.3 Chronology

The four-phase chronology to be developed, combining the data from Wadi el-Bakht and Wadi EI-Akhdar, has been mentioned above (Gehlen *et al* 2002; Linstädter 2005a, 2005b). The Gilf A (8300-6800BC) is a hunting occupation represented by elongated triangles, backed points and microlithic and burins on blades, dating from 8100 BC (Gehlen *et al* 2002). Gilf B, formerly called the Middle Neolithic and corresponding to Wendorf and Schild’s Middle Neolithic (Gehlen *et al* 2002), is a much better represented hunting occupation with pottery (6800-4300BC). Following a period of abandonment pastoralists moved into the area during Gilf C with cattle, sheep and goat, taking advantage of the temporary lakes formed behind dunes that crossed dry wadis (4300-3500 BC). Gilf C was formerly called the Late Neolithic and corresponds to Wendorf and Schild’s Ru’at el-Baqar (Gehlen *et al* 2002). The character of sites was very different from Gilf B (Gehlen *et al* 2002; Fäder 2005; Linstädter 2003, p.136; Linstädter 2005g, p.366; Schön 1996b, p.127; Von Czerniewicz 2005, p.223-5). The Gilf D is a more ephemeral period, with a return to hunting and gathering and, if the identification of cattle is correct (Cziesla 1996) perhaps with small numbers of livestock (3200-2700 BC).

6.2.4 Case Study 4 – Dakhleh Oasis

6.2.4.1 Introduction to the Bashendi B

Dakhleh Oasis is located in the Western Desert, one of a crescent of four very large discrete oases running south to north, west of the Nile. Dakhleh is 600kms south of Cairo, 250kms west of the Nile. Its overall area is 2000 square kilometres, extending some 80kms east to west and 25kms north to south (figure 6.11). Today Dakhleh has a population of around 75,000 inhabitants spread across a number of small towns and agricultural villages throughout the oasis. The oasis sits in a depression c.92-140m above sea level and is bordered by the

300-500m high Egyptian Limestone Plateau to the north, the southern edge of the Libyan Plateau (Kleindienst *et al* 1999, p.1-2; Riemer 2011, p.24-28).

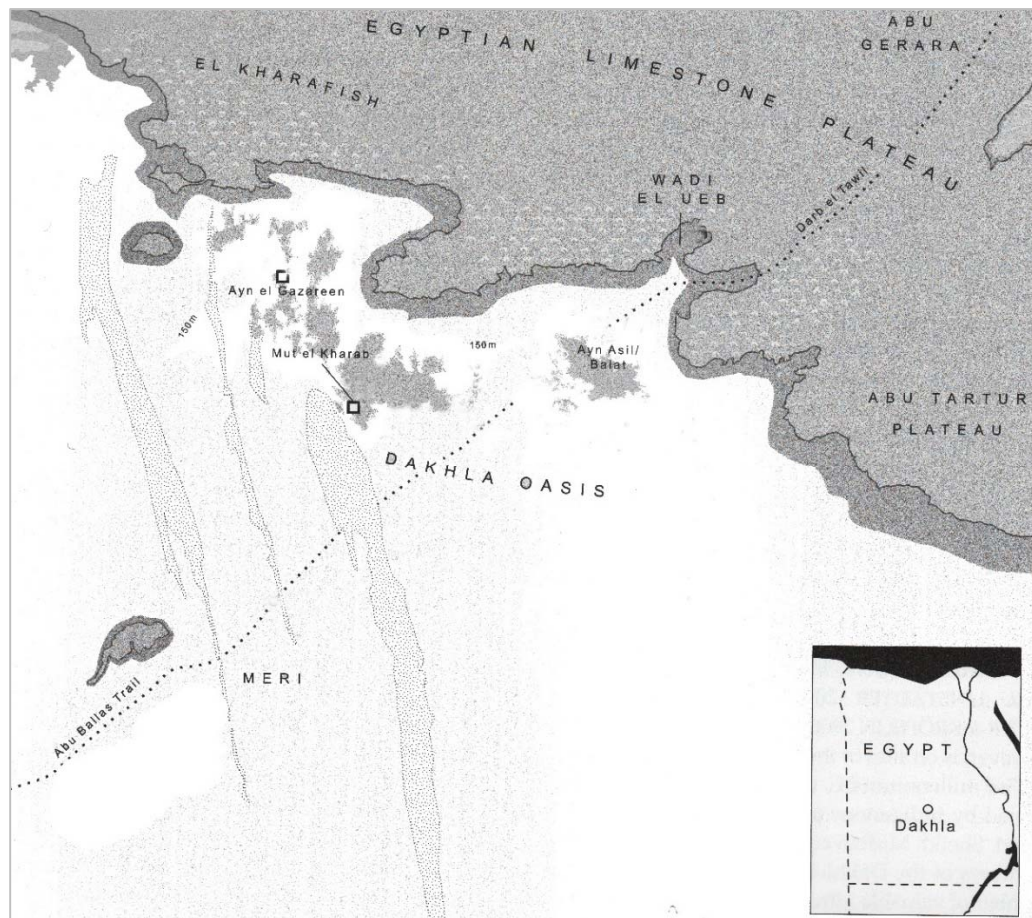


Figure 6.11 - Map of Dakhleh Oasis showing the Limestone Plateau behind it.
(Source: Riemer 2011. P.18, figure 1)

The prehistoric remains belonging to the Bashendi B follow occupation from the Lower Palaeolithic onwards, and the oasis provides an interesting example of a nearly complete sequence from prehistoric to historic times. The oasis is fed by the Nubia Aquifer described in chapter 3, and also seems to have benefitted from bimodal rainfall supplied by the collision of monsoonal and temperate weather fronts. Examples of the lithics and ceramics from the Bashendi B are shown in figure 6.12 and figure 6.13.

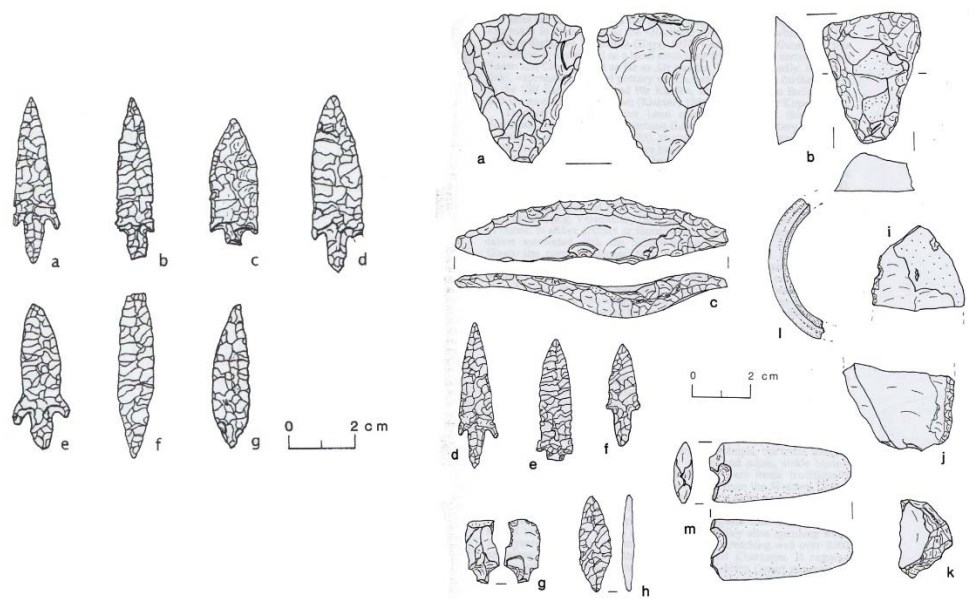


Figure 6.12 - Lithics from Dakhleh Oasis. (Sources: McDonald 2013, p.185, figure 7; McDonald 1991, p.49)

6.2.4.2 History of excavation and analysis

The Dakhleh Oasis Project was established in 1977, and was granted the concession for the entire area of the oasis not covered by the Institut Français d'Archéologie Orientale, who were investigating historical periods and were not concerned with prehistoric sites. The Dakhleh Oasis Project (DOP), which adopts a multi-disciplinary approach, covers the entire span of Dakhleh's past from earliest prehistory to recent historical times. Dr Mary McDonald is the lead prehistorian for the DOP, with contributing specialists focusing on specific periods and areas to build up an integrated understanding of the past of the oasis. In 1985 Lech Krzyżaniak joined the DOP project to set up the Petroglyph Unit for studying the engraved rock art in the oasis, on behalf of the Archaeological Museum in Poznań and the Polish Centre of Mediterranean Archaeology based at the University of Warsaw (Polkowski *et al* 2013). In addition the ACACIA team, based at the University of Cologne, have found Bashendi B and the subsequent Sheikh Muftah material remains in the desert areas beyond the oasis, expanding knowledge of the use of the combined use of desert and oasis at this time (McDonald 2016; Riemer 2003, 2006, 2011, 2013; Riemer and Kindermann 2008).

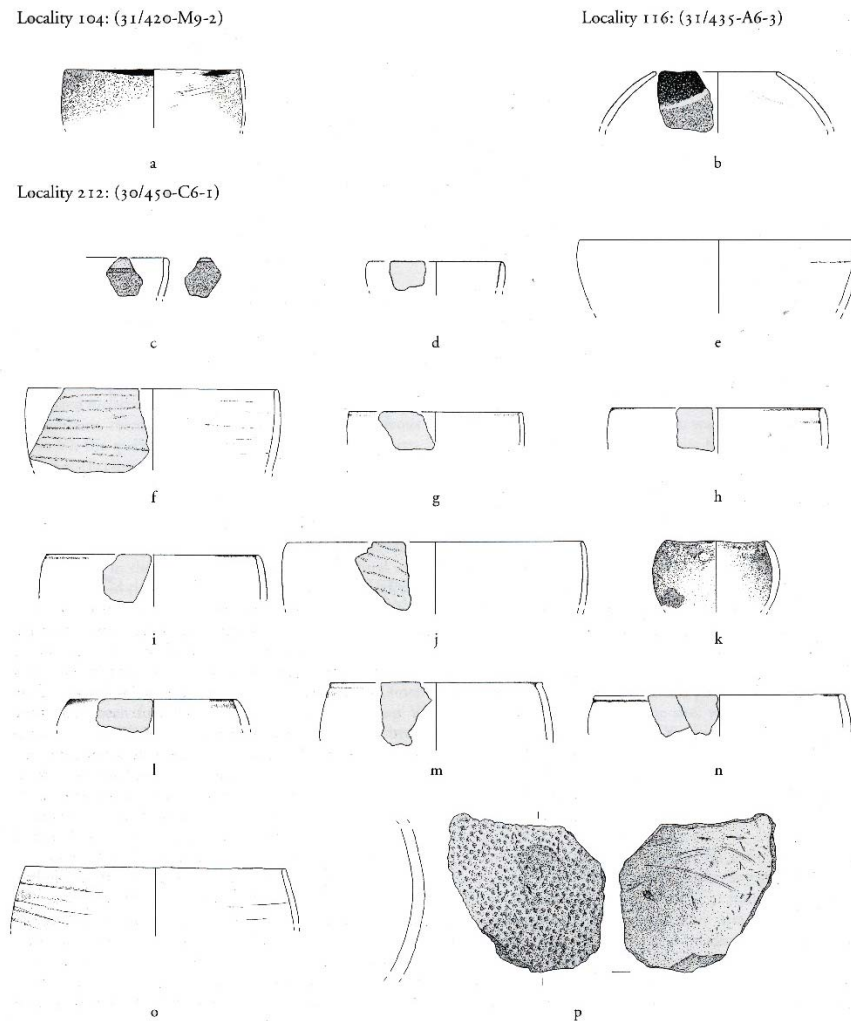


Figure 6.13 - Ceramics of the Bashendi B. (Source: Hope 2002, p.44, figure 2)

Most of the sites are in areas that are now desert around the edges of the modern oasis. Some are undoubtedly under cultivated land, as is the case in the Nile valley. Because they are essentially desert sites, they are often in highly deflated condition, but as well as the usual inorganic remains, some organic remains have been found including bones, pollen and macrofossils and radiocarbon dates are available from numerous sites (McDonald 2016, p.182).

Some of the results of these strands of research have been presented at a four-yearly conference and are published regularly in the Dakhleh Oasis Papers monographs (Churcher 1999; Churcher *et al* 2008; Hope 2002; McDonald 1990, 1999, 2001, 2002b, 2008; Warfe 2003b). Papers are also scattered through various journals and edited volumes, for example: Churcher (2008), McDonald (1991a, 1991b, 1993, 1996, 1998a, 1998b, 2002a, 2006, 2009, 2013, 2016) and Warfe (2003a, 2003b). Warfe recently produced a volume dedicated to the ceramics of Dakhleh in 2018, based on his 2008 PhD (Warfe 2018). No equivalent exists for the lithic technology, and no detailed data has been published on core and debitage types, so

there are some significant differences in the availability of the data between this and the other case studies. So far there is no single overview of the prehistory of Dakhleh and nor is there any web source dedicated to the subject, although various brief references to the prehistory investigated during the 2000-2008 field seasons are incorporated into reports saved on the Monash website: <http://artsonline.monash.edu.au/ancient-cultures/excavations-in-dakhleh-oasis-egypt>. The research by Woods (2016) into religion and ritual in the prehistory of the Western Desert includes Dakhleh but is exclusive to undated rock art and is not incorporated into the case study.

Similarities between Dakhleh and Kharga oases suggest that they should be treated as a single unit or units with close ties (McDonald 2006, p.4). Although work by the Kharga Oasis Prehistoric Project is still in its early stages and there are only a few publications to refer to (Briois 2007, 2012; Briois and Midant-Reynes 2010; Lesur *et al* 2011), Kharga will be mentioned occasionally throughout the case study.

6.2.4.3 Chronology

Research has resulted in a multi-phase chronology for Dakhleh's prehistoric period. Following the onset of the early Holocene Dakhleh was re-occupied during the Epipalaeolithic, named the Masara. It is followed by the Bashendi A (6400-5600BC), at the end of which limited domesticated livestock was introduced. This was in turn followed by the fully pastoralist Bashendi B (McDonald 2002a). In the Early Bashendi A the most common sites are those associated with playa silts and extensive scatters of hearths. By the Late Bashendi A there is a clear indication that settlement was becoming more permanent, at least in parts of the oasis, with the introduction of goats supplementing the livelihood strategy (McDonald 2016). One of the main differentiators in the Bashendi B (c.5300-4000BC) is the addition of a substantial pastoral component based on cattle and goats, supported by traditional hunting activities and an increased use of ceramics, with significant changes in lithics and the absence of Bashendi A type stone-built hut circles. Bashendi B has the most evidence for connections with the Nile before the following Sheikh Muftah period (McDonald 2016). The long-lasting Sheikh Muftah period (3900-2200BC), which began during a period of aridification, lasted into the Pharaonic Old Kingdom period (c.2686-2181BC) (McDonald 2002a; Riemer 2011). The Sheikh Muftah appears to have been restricted to the oasis, probably due to the aridification of the surrounding area, but there is no indication of permanent settlement sites. Rock art data is not included in the case study as it has so far not been possible to tie in the rock art to the archaeological data (Polkowski *et al* 2013). This agrees with related research by Kobusiewicz and Kuciewicz (2015) and Polkowski (2015a, 2015b) who are unable to correlate Bashendi archaeological sequences and rock art data reliably.

6.3 Conclusions

The above summaries provide a brief introduction to each of the case studies. Each case study uses data that has been mined from published material, with a view to seeing how published material can be put to use within the SRL model. The most complete case studies are the Ru'at el-Baqar and the Badarian due to the better quality of data and the greater information about the periods selected for discussion. The Gilf Kebir as a whole has been the subject of some excellent fieldwork, and publications have captured some of this, but the Gilf C remains somewhat elusive in publications. The Bashendi B of Dakhleh Oasis is the smallest of the case studies due to shortages of both actual and published data. All sources cited in the case studies are listed in the thesis bibliography.

Chapter 7 discusses the process by which archaeological data was incorporated into the SRL model. A template was created as a tool to assemble the case studies introduced above and to ensure that data was collected in a consistent and structured way in order to represent each area as completely as possible, bearing in the caveats discussed above.

7 - Applying the SRL Approach to the Case Studies

7.1 Introduction

In Chapter 2 the Sustainable Rural Livelihood approach was introduced, and in Chapter 5 ways in which risk and uncertainty in dryland environments are handled by modern pastoralists were described. This chapter builds on that information by focussing on how the SRL approach can be applied to archaeological data, selecting diagnostic elements supplied by published field reports in order to answer questions about livelihoods that shed light on risk management, sustainability and response to opportunities.

Three tasks were identified and are carried out below:

- 1) Creation of a template for data collection
- 2) Identification of indicators for the Asset Matrix components
- 3) Demonstration of how a template is populated with data, using work-streams from the case studies as examples

7.2 Template for the Archaeological Analysis

When I completed a test case study on the Hadendowa of northeastern Sudan from the descriptions provided in Manger *et al* 1996, I created a template for presenting the output from the SRL model a structured way. The template was then adapted for archaeological data and is as follows, in table 7.1. It breaks the SRL model down into both a methodology for data collection and a format for presenting the data.

Section numbers in this chapter	Content
n/a	Each case study is provided with a brief introduction outlining the temporal span of the period under discussion, and maps showing the main sites under discussion in a given locality, the location of the locality within Egypt and, where relevant, its geographical relationship to sites with which it may have had connections.
7.3.1	Three tables provide essential contextual information: 1) A table to show which data is and is not present at a given locality in the period under discussion under the categories show in table 7.2. 2) A table showing the names of the main sites mentioned in each case study, the type of site it represents and the key features of the site. The example below is from Nabta Playa (table 7.3). 3) A table shows the radiocarbon dates available for each locality (table 7.4).
7.3.2 – 7.3.8	1) The analysis of the Asset Matrix under each of the headings and sub-headings shown in table 7.5.
7.4	2) The Livelihood Variables (section 3.2) consisting of the Vulnerability Context, Opportunity and External Livelihood Structures and Processes; and the Livelihood
7.5	3) Livelihood Outcomes (section 3.3), consisting of Economic Impacts, Environmental Impacts and Cultural Impacts.
7.6	Lists and answers to the Key Questions described in chapter 1
n/a (discussed in the case studies)	Overview of the gaps that were identified in the data during the course of completing the case study, which makes the full potential and limitations of the data completely transparent.
7.7	The conclusions, discussing the strengths and weaknesses of the SRL approach as applied to each of the case studies.

Table 7.1 - Template for Presenting SRL Data

7.3 Building the Case Studies

Using the above template (table 7.1), criteria for assessment (table 7.5) and the proposed archaeological analogues for these indicators in Appendix G (Potential Archaeological Indicators) the case studies were assembled for each of the four localities. Although the format is very straight forward, populating of the template with data requires the assembly of the basic units of description, the material published about each locality, together with research that explores some of the issues raised within the SRL model. Some of the research, for example, into concepts of ethnicity and the best practices of herding for different types of locality, were applicable across all four case studies, whereas other issues, like the use of ceremonial complexes and the associated ideas of symbolic risk, were only fully applicable to the Nabta Playa case study, and to a limited extent the rock art of the Gilf Kebir.

The steps required to complete the model are now discussed, using summaries of data taken from the case studies to illustrate each aspect of how the SRL model is completed.

7.3.1 Introduction to the Case Study

Section 1 consists of a single paragraph of introduction, with national, regional and local maps to put the localities discussed into their geographical context.

Section 2 consists of three tables, listed in Table 7.1. Table 7.2 demonstrates the range of data for each case study. The data for Nabta, for example, is patchy with initial gaps identified in personal/symbolic objects, few settlement structures and a shortage (although not total absence) of human, faunal and botanical remains. At the same time, it is strong on inorganic assets like stone and ceramic tools, ceremonial structures. Although the table lacks detail and does not comment on the quality of the data, it is a useful tool for identifying where some of the gaps may lie before completing the model and for considering whether it is actually worth trying to apply the model to the data.

✕ Not present / ✓

Present

Category	Data	✕ / ✓			
		Nabta	Badarian	Gilf Kebir	Dakhleh
Site type	Settlement	✓	✓	✓	✓
	Cemetery (concentration of multiple burials)	✕	✓	✕	✕
	Ceremonial (monuments and ritual structures)	✓	✕	✕	✕
	Unknown	One site	-	-	One site
Architecture	Domestic shelters / foundations	✕	✕	✓	✓
	Hearths / Steinplätze	✓	✓	✓	✓
	Storage	?	✕	✕	✕
	Ceremonial structures	✓	✕	✕	✕
Type	Stratified	One site	One site	✕	✕
	Palimpsest / Chronologically undetermined	✓	✓	✓	✓
	Cave / rock shelter	✕	✕	✓	✕
Funerary	Burial structures	Few	✓	✕	✕
	Human physical remains	Few	✕	✓	✕
	Grave goods	✕	✕	✓	✕
Diet	Faunal remains	✓	Few	Few	Few
	Botanical remains	✓	Few	Few	Few
Environment	Faunal remains	Few	Few	Few	Few
	Botanical remains	Few	Few	Few	Few
	Sedimentary and geomorphological data	✓	✓	✓	✓
	Other environmental / climatic indicators	✓	✕	✓	✓
Tools/ Craft items	Stone tools	✓	✓	✓	✓
	Grinding stones	✓	✓	✓	✓
	Pottery	✓	✓	✓	✓

Category	Data	x / ✓			
		Nabta	Badarian	Gilf Kebir	Dakhleh
	Ostrich eggshell	Few	✓	✓	✓
	Basketry, cordage etc.	x	✓	x	x
	Animal products	✓	✓	x	x
	Other artefact types	✓	✓	x	x
Personal or symbolic material	Beads / other jewellery	x	✓	Rare	✓
	Portable art	x	✓	x	✓
	Palettes	x	✓	x	✓
	Cultural components on everyday tools / pottery	✓	✓	✓	✓
	Rock art	x	x	✓	Undated
	Prestige objects (potentially)	x	✓	x	✓
Dating	Radiocarbon dates	✓	✓	✓	✓
	Relative / stylistic	✓	Partial	✓	✓

Table 7.2 - Data available for each of the case studies

The second table lists the main sites at the locality and provides a brief overview of their character (table 7.3, below). This provides a useful introductory summary of the type of archaeology present at the locality.

Site	Type of site	Key features
E-75-8	Stratified occupation	The largest of the Ru'at el Baqar sites. Late Neolithic layer 7, 9 and 10 overlying earlier levels. Hearths, pits, hut, lithics, pottery, worked shell and bone, grinding implements
E-77-1	Occupation	Hearths, lithics, pottery
<i>Other sites</i>		

Table 7.3 - The main sites discussed in the case studies are listed in a table in section 2

Finally the uncalibrated radiocarbon dates listed are included in another (here table 7.4), together with calibrations made using quickcal2007 ver1.5 (Cologne Radiocarbon Calibration and Paleoclimate Research Package (University of Cologne) <http://www.calpal-online.de/index.html>).

Area	Site/Feature	Uncalibrated c-14 dates bp	Calibrated dates BC	Material	Lab. No.
Nabta Playa	E-75-8, Bed 2, A-B/18	6440±80	4660 - 4330	Charcoal	SMU-487
Gebel Nabta Playa	E-94-3, Hearth 2	6550±60	4470 - 4480	Charcoal	CAMS-16590
<i>Other areas</i>					

Table 7.4 – Example, showing the radiocarbon dates available for sites in the case studies

After these initial introductory steps have been taken, the SRL Model is completed, beginning with the Asset Matrix.

7.3.2 The Asset Matrix

The Asset Matrix is the descriptive element of the model, in which every category listed in table 7.1 is explored. As discussed in Chapter 2, the data provided in the Asset Matrix needs to be as detailed as possible to ensure that explanations are grounded in detailed knowledge of each locality. In anthropology and development economics, many of these fields of investigation, for example intra-group relationships, ethnicity, nutrition, types of mobility practiced, settlement structures, social hierarchies, can all be approached via observation and interviews. In archaeology proxies must be identified to explore these areas and these are captured in Appendix J. Table 7.5 lists criteria for assessing the components, a simple tool to ensure that all aspects of the asset matrix are captured. In the case studies, each of the indicators defines a sub-heading under each of the asset component headings.

Asset Components (headings)	Potential Indicators (sub-headings)
Natural	<ul style="list-style-type: none"> • Topography • Hydrology • Light and temperature • Aeolian conditions • Edaphic conditions • Vegetation • Fauna • Stone, minerals and ores • Seasonality
Physical	<ul style="list-style-type: none"> • Settlement location, character and size • Shelter • Raw material acquisition • Food acquisition and production technologies (lithics, ceramics, ground-stone) • Craft skills and infrastructure • Mobility (aspects of mobility required to secure infrastructure and raw materials) • Structures to support economic activity • Cemetery/religious structures • Food storage systems • Transport • Fuel
Social	<ul style="list-style-type: none"> • Status, role and organization • Religion, ideology and spiritualism • Ritual and rites of passage • Tradition, social values and social guidelines

Asset Components (headings)	Potential Indicators (sub-headings)
	<ul style="list-style-type: none"> • Material/cultural expression • Mobility (to support social infrastructure) • Internal relationships of trust and care • Inter-group relationships • Ethnicity • Symbolic and social risk
Subsistence	<ul style="list-style-type: none"> • Evidence for types of food production (evidence for herding, hunting, foraging, fishing) • Subsistence assets (physical assets that promote sustainability of subsistence strategies) • Practice of subsistence activities (i.e. that activities that support food production and livelihood management) • Indications of animal diseases, viruses, pests and parasites • Evidence of trade networks • Savings and credit • Labour • Mobility • Land tenure
Human	<ul style="list-style-type: none"> • Potential nutrition values of food consumed • Evidence of physical condition of people • Potential medicinal components • Skills and knowledge • Sex and gender • Age • Population numbers • Gene pool
Personal	<ul style="list-style-type: none"> • Individual status • Personal well-being • Security • Ability to influence decisions

Table 7.5. Indicators for the Asset Matrix

In the following pages, (7.3.2 – 7.3.8) each of the above assets is defined and described, and illustrated with brief examples from the case studies.

7.3.3 Natural Assets

The Natural Assets category is described by the DFID (1999, p.11) as follows: “Natural capital is the term used for the natural resource stocks from which resource flows and services (e.g. nutrient cycling, erosion protection) useful for livelihoods are derived.” The Natural Assets category forms the environmental context for each case study, indicating the constraints and opportunities within which people lived their lives on a permanent and shifting basis.

In many ways the Natural Asset category is the most straight-forward to complete because it is an entirely empirical profile of an area under the sub-headings formed by the “Potential

Indicators” in Table 7.5. In the Nabta Playa case study the information comes from a variety of sources, including archaeological research from survey and excavation reports, climatic, geographical, geological and geomorphological surveys. Additional research was required to improve understanding of environmental conditions by looking into the habitats preferred by plant and animal species recorded at the locality and what these said about seasonality.

The Natural Assets category is introduced with a table indicating types of environment available at each locality, shown here in table 7.6. Five hydrological zones are defined, comprising the full range of natural assets available in the case study areas. Zones that do not appear in a region in a case study are both scored through and greyed out. The purpose of the table is to give an instant impression of the landscape features that contribute to the hydrological character of the area.

Zone 1	Sahel type / savannah conditions	In a largely featureless landscape, light seasonal rains produce a savannah and scrub type ecology similar to the modern day Sahel, with grassland and shrubs suitable for seasonal but not necessarily year-round herding
Zone 2	Highlands, low hills, escarpments, Plateaus	Orographic conditions produce occasional rainfall producing perennial and annual vegetation, attracting game, sometimes offering multiple topologies and ecological niches
Zone 3	Riverine / spring	Permanent water source with floodplains or green margins, attracting vegetation and game often on a year-round basis
Zone 4	Playa / temporary water source	Seasonal rainfall providing temporary water sources and pasture, with the potential for aquatic plants but not fish or other aquatic zoological species
Zone 5	Groundwater zone	Runs along the edge of water-filled basins and supports permanent and seasonal vegetation, attracting game on a temporary or permanent basis

Table 7.6 - Natural Asset zones

In each case study the unique combinations of natural assets is then described. Capturing the environmental context is essential for exploring the types of choices that may have been available to the pastoralists who occupied the site, and understanding what sort of nutrition would have been provided by the locality.

In an area of largely undifferentiated desert with sandstone outcrops, Nabta sits on the edge of a natural depression with a number of basins that filled with rainwater in the summer months. The flora and fauna are examined with a view to understanding what the conditions may have been like during the Ru’at el Baqar period, and local geology is described so that sources of stone for tools may be identified. The Badarian, which flanks 35km of the Nile floodplain, which was flooded annually and was flanked by low desert that was intersected by wadis. It

was a rich natural environment. In Dakhleh bimodal rainfall and permanent springs combined with a variety of topographical features and environmental niches gave the oasis a distinctive set of natural attributes. The Gilf Kebir, a 300m high plateau is characterized by deep dissected wadi systems, two of which were blocked by dune barriers to form seasonal lakes fed by rainfall regimes influenced by the local highland topography. In all the case studies, the unique combination of geology, geomorphology, environmental indicators and hydrology are all discussed. The four areas demonstrate the variety of landscapes and resources available to herders in the mid-Holocene eastern Sahara.

7.3.4 Physical Assets

Physical assets are described by the DFID (1999, p.13) as follows:

Physical capital comprises the basic infrastructure and producer goods needed to support livelihoods.

- Infrastructure consists of changes to the physical environment that help people to meet their basic needs and to be more productive.
- Producer goods are the tools and equipment that people use to function more productively.

At Nabta occupation data was assessed and was found to be fairly ephemeral, mainly hearths with surrounding surface scatters, with one deep stratified site that allows some degree of stratigraphic resolution (Close 2001; Nelson 2001). The only evidence of shelter is confined to one possible hut (Nelson 2001). Raw material for lithics, a key physical asset, is well represented in all the case studies. At Nabta this permitted a comparison of stone types that were available locally and those that were from further afield, providing insights into different approaches to stone tool acquisition.

During the Badarian both opportunistic and more specialist lithic technologies are introduced. Ceramics are a particular speciality of the Badarian and pottery manufacture is discussed in terms of what it might have contributed to subsistence activities and how pottery manufacture was organized. Craft infrastructure using organic matter, which has had to be inferred in other case studies, is present including matting, basketry and textiles in graves, as well as some items made of bone and ivory. For the first time there are model boats, suggesting that boats were used for transport of people, or goods, or for deep water fishing and the implications for Badarian life are examined in the case study. The presence of multiple types of decorative stone available only from the Eastern Desert is examined in terms of acquisition costs, as illustrated by the schematic in figure 7.1, which is discussed in the Badarian case study.

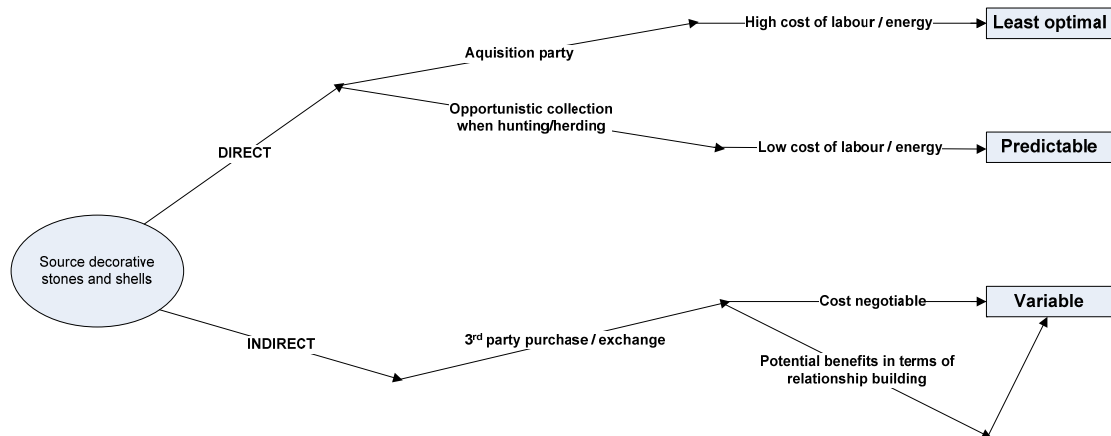
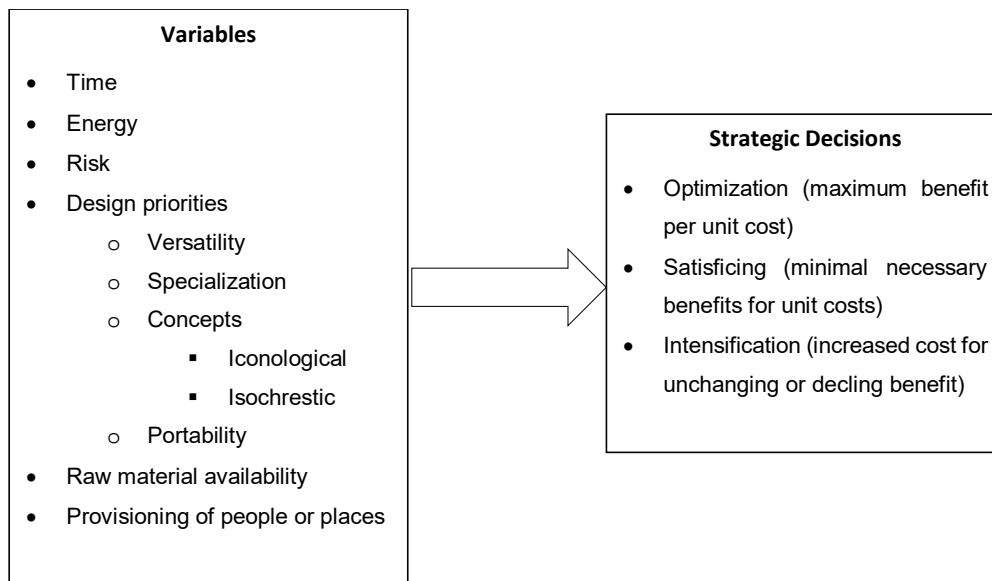


Figure 7.1 – Potential mechanisms for acquiring decorative stones and shells from the Eastern Desert

During Gilf C ephemeral sites belonging to the Gilf C from a number of different topographical locations were excavated and are described. Raw material sources are discussed and used to consider different resource acquisition strategies for stone tools and ceramics.

The ephemeral Dakhleh sites are described and some of the difficulties with the data that they produce and the lack of raw material descriptions and images available in publications is highlighted as a problem with the analysis of the Bashendi B. The role of ceramics, their decoration and their origins, are examined with a view to shedding light on some of them connections that may have taken place beyond Dakhleh. Exotic stones and groundstone, neither of which were available within Dakhleh oasis, are also discussed in this context.

Toolkits in all case studies were discussed with a view to characterizing the industry in terms of costs and benefits following Shea's analysis (2013, p.39-45) (see figure 7.2 below) and as "objects of thought" following Edmonds (1995, p.42). Groundstone and ceramics are also described and assessed, in terms of local verses imported objects and the relative significance of each.



*Figure 7.2 - Criteria for assessing tool manufacturing strategy
(based on Shea 2013, p.39-45)*

7.3.5 Social Assets

The Social Asset category is described by the DFID (1999, p.9) as follows:

There is much debate about what exactly is meant by the term 'social capital'. In the context of the sustainable livelihoods framework it is taken to mean the social resources upon which people draw in pursuit of their livelihood objectives. These are developed through:

- networks and connectedness, either vertical (patron/client) or horizontal (between individuals with shared interests) that increase people's trust and ability to work together and expand their access to wider institutions, such as political or civic bodies;
- membership of more formalised groups which often entails adherence to mutually-agreed or commonly accepted rules, norms and sanctions; and
- relationships of trust, reciprocity and exchanges that facilitate co-operation, reduce transaction costs and may provide the basis for informal safety nets amongst the poor

The development of the ceremonial centre at Nabta provides plenty of scope for a multi-layered discussion under this heading, together with an assessment of suggestions that it may include elements of a cattle cult (e.g. Brass 2003; di Lernia 2006; Herskovits 1926; Wengrow 2001), and Woods's suggestion that there is evidence for shamanism (Woods 2016). Different types of social structure are considered and it is suggested that a plausible model for Nabta

would be a heterarchy. The distinctive ceramics enable a discussion about where else the occupants of Nabta visited or were based, what sort of connections they may have had with Nile populations to the southeast and south and how these relationships may have impacted the material record of the Ru'at el-Baqar.

In the Badarian case study the presence of cemetery data, potentially a rich source of information, is somewhat undermined by the lack of an agreed chronology for the Badarian, as noted in chapter 6. The presence of numerous cemeteries suggests a strong affinity with the stretch of the east bank of the Nile along which they extend, and this feature is discussed in terms social organization, co-operation and a sense of place. The grave goods and some distinctive artefact types enable a discussion of concepts of religious belief, ideology, identity, ethnicity and social structure. The concept of tradition combined with innovation is explored by looking at both new elements and the survival of older practices. The contrast between the expedient character of the lithic industry and the investment in fine ceramics is assessed.

The Gilf C occupants of the Gilf Kebir took advantage of a dune playa and seasonal pasture. Although more archaeological investigation is needed in the neighbouring Jebel Uweinat, it has still been possible, mainly through the medium of rock art, to discuss concepts such as territoriality and management of relationships with other groups. Rock art images are dominated by livestock, with an emphasis on cattle, and offers the potential for raising questions of territoriality, nomadic routes through the landscape, as well as concepts of important places, ideology and religion.

The Bashendi B is the most difficult to assess although it initially seemed to have the most potential for looking at land use and the rules that governed access to desirable resources. The specialized bifacial tools are discussed in what information they may convey in the definition of a particular identity common to the oases. Ceramics are do not appear to have been a dominant component of cultural expression but their role is considered. There is little to suggest social complexity, but McDonald's proposal that exotic stones are prestige goods (McDonald 1999; McDonald 2008) is discussed. Connections with other areas are investigated, suggested by bifacial tools, ceramics and exotic stones.

7.3.6 Subsistence Assets

The DFID has a category called "Financial Assets" (1999, p.15), which I have altered to Subsistence Assets in order to reflect a different economic paradigm for prehistory. The DFID describe their Financial Asset category as follows (DFID 1999, p.15):

Financial capital denotes the financial resources that people use to achieve their livelihood objectives. The definition used here is not economically robust in that it includes flows as well as stocks and it can contribute to consumption as well as production. However, it has been adopted to try to capture an important livelihood

building block, namely the availability of cash or equivalent that enables people to adopt different livelihood strategies.

In the above definition the concepts of stocks (e.g. livestock, tradeable goods), consumption and production are relevant, all describing a situation where production may generate the ability to trade for alternative goods, adopt new livelihood strategies or where subsistence merely permits sustainability of livelihoods.

Nabta, which could only be occupied on a temporary basis, has evidence for the use of domesticated cattle, sheep and goat and wild animals (Gautier 1980; Gautier 2001), and some evidence for the gathering of plant foods (Barakat 2001; Wasylukowa 2001). The combined data is used to assess how subsistence practices may have been arranged at Nabta, and what the perceived benefits may have been in bringing livestock to the playa lake, and possible subsistence strategies are discussed in detail by comparison with ethnographic research.

The Badarian is discussed in terms of the equivocal nature of the data for cereal cultivation, and the low volume of skeletal remains of domesticated species. Settlement data is poor, and although there are what appear to be storage pits, a lack of surviving content makes their function debatable. Plausible risk management strategies and a possible seasonal schedule over a two year period are proposed (figure 7.3) and discussed in the case study.

	Autumn Flood Season				Winter Post-Flood				Summer Pre-Flood				Autumn Flood Season				Winter Post-Flood				Summer Pre-Flood			
	Au	Se	Oc	No	De	Ja	Fe	Mar	Ap	May	Jun	Jul	Au	Se	Oc	No	De	Ja	Fe	Mar	Ap	May	Jun	Jul
Flood																								
Winter rains																								
Summer heat																								
Wheat cultivation																								
Barley cultivation																								
Floodplain grazing																								
Winter pastures																								
Fishing																								
Freshwater Mollusk																								
Game hunting																								
Fowling																								
Plant gathering																								

Figure 7.3. A seasonal schedule over 2 years, assuming the possibility of cereal cultivation and herding. Based on Butzer 1976; Hassan 1984, Midant-Reynes 1992, p.140 and Yokell 2014

There is only minimal subsistence data for Gilf C. Occupation remains are described in terms of settlement strategy. Potential stocking strategies are discussed based on site distribution and topography. McHugh's functional analysis of tools at Gilf Kebir (1971) is used to fill out the range of activities that might have taken place. A consideration of labour requirements and organization is made, and the use of local knowledge and potential exchange of

information are inferred from settlement patterns. The extent of the mobility of groups during Gilf C is also discussed, and within this context rock art is considered as a possible indicator of land tenure arrangements. A seasonal calendar, such as the one shown above for the Badarian (figure 7.3) is also attempted.

Dakhleh during the Bashendi B also lacks satisfactory subsistence data. Although the availability of water in various forms may suggest a strong foundation for subsistence activities, and the oasis is likely to have had rich plant foods available and would have had plenty of fuel, the ability to exploit those resources may have been limited by the constraining geographic circumstances under which groups lived. Potential stocking strategies within these constraints are proposed and archaeological data is combined with ethnographic data to suggest seasonal usage patterns of the oasis and its multiple topographies.

7.3.7 Human Assets

The DFID guidelines define human assets as follows: "Human capital represents the skills, knowledge, ability to labour and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives" (DFID 1999, p.7). As well as water, daily nutritional requirements for humans are captured in Appendix F, but there are four main intake requirements: fat, carbohydrates, proteins and micronutrients consisting of minerals and vitamins (Bender 2014, p.1-2; Hale 2005, p.124). Protein has a role beyond providing energy, making up 14% of the human body and is required for growth in both foetus and child. Adults also have an ongoing requirement for protein because it breaks down in the body and needs to be replaced to maintain health (Bender 2014, p.31-33). At Nabta this would have been available from game hunting, with a minor intake from wild cereal grains, and any domesticated animals that were consumed. It was also present in animal blood, which could have been secured whilst the animal continued to live. Vitamins and minerals, only required in very small quantities, are usually only available from the diet because they cannot be manufactured by the human body (exceptions are vitamin D and niacin). Deficiencies in any of the essential minerals and vitamins can have serious results, described in Appendix F. Fats are not actually a dietary requirement but it is difficult to make up energy requirements from carbohydrates and protein alone, and malnutrition in developing countries is often caused by the lack of fat in the diet (Bender 2014, p.23).

This was the most difficult asset to assess, partly because judging human health is difficult even with good quality data. First, arid-dwellers have a high tolerance for poor nutrition so direct comparisons with Western models of nutrition are not always appropriate (Seeley 2006; Sen 1999) and there are also substantial differences in the requirements and tolerances of different groups and different areas (e.g. Galvin 2009) so that minimum nutritional intake requirements cannot be transposed directly from one region to another. Next, mobility, fluctuations in water availability and seasonality in plant availability (domesticated and wild) result in fluctuating nutritional intake, impacting the condition of people within the groups

throughout the year. Drought will also influence availability of food, as can unusually high or low floods that deny riverside dwellers access to floodplain resources. The value of nutritional components (plants and animals) vary depending upon context, so any assessment of nutritional value from prehistoric remains is a very crude evaluation. Finally, in the areas under discussion, it is impossible to know which foods were preferred and which relegated to hunger foods, or even banned due to social proscription (Bender 2014, p.1-2; Cliggett 2005; Hobbs 1989, p.91; M.L. Smith 2006).

In the case studies the lack of human physical remains everywhere, except the Badarian, and the poor preservation of plant materials at most sites, meant that information on health and nutrition are sparse. Similarly, data about population size and demographics is largely unavailable. In spite of these difficulties, nutrition is important to understanding the potential for good health the overall quality of life of individuals so the findings of botanical and faunal remains in each of the case study areas is treated as a collection of options – the way in which people could have navigated the known nutritional possibilities at their disposal. All known species were considered as potential sources of food. No attempt has been made to follow the excellent example of Diehl (2015, p.353-353) to divide the plant remains into a number of resource groups and nor is there any attempt to distinguish between preferred foods and hunger foods. The quality of the data is simply insufficient.

The Badarian demonstrates the value of having human remains to supplement the remains of consumables. Zakrzewski's stable isotope analysis and examination of dentition (2012) suggest that ground plant foods, particularly cereals, made up part of the diet. The presence of domesticated and wild animal species, aquatic resources and a mixture of different plant species would suggest that the people who occupied a 35km stretch of the Nile should be healthy, but another of Zakrzewski's findings suggested that stunted growth was experienced by men and women of the Badarian, possibly caused by variable food availability (2003, p.225). At the same time, an analysis of skeletal remains (Stock *et al* 2011, p.359) suggest that there was a reduction of "habitual loading" of both the upper and lower limbs in males is consistent with a new type of livelihood, which Stock *et al* suggest is the adoption of agriculture in the Badarian region. This type of analysis, of which more would be helpful, can be combined with information about the environment and surviving plant and animal remains.

Data from Nabta suggests that occupants did not go short of good quality food. Although the use of wild cereals can be inferred from the large number of grinding items at the site, only a few conclusions can be drawn from the surviving botanical remains. The relative sizes of domesticates and wild species means that during the Ru'at el Baqar, cattle and small livestock made up around 85% of the meat diet (Gautier 2001, p.632). The significance of these findings is explored and the potential value of nutrition at Nabta is evaluated against the few remains.

Evidence for subsistence and human assets during the Gilf C are both rather poor but between wild and domesticated animals and wild plants, sufficient nutrients should have been

available to enable the group to function normally for the short number of weeks that they occupied the Gilf Kebir.

The data for potential nutrients at Dakhleh is minimal, but suggests that reliable water in savannah type conditions attracted both plants and animals that don't occur in the other areas. What little survives suggests that fruits, wild cereals and fruit were available, providing basic essentials in the diet. Analysis of cattle bones at one site suggests that herds were kept for consumption, not merely dairy (McDonald 2002a). Domesticated livestock were supplemented by gazelle, hartebeest and carnivore species as well as freshwater molluscs providing a range of potential nutrients, discussed in the case study.

7.3.8 Personal Assets

The DFID guidelines were written prior to the addition of the Personal Asset by Hamilton-Peach and Townsley (2007) who introduced the new asset as follows: "It is intended to emphasise people's internal motivations, their will to act and promote change (for themselves or others), their drive to assert their rights, and the spiritual side of their lives. It also incorporates their desire to engage in political activity (while "social" assets includes the mechanisms by which they may be able to articulate that activity)" (Hamilton-Peach and Townsley 2007, p.4).

The Personal Asset is the most nebulous of all the asset categories in prehistory. It is impossible to know what individuals considered to be desirable for personal utility. Basic health and safety seem to be the safest measures, although the ability to influence outcomes and acquire status may also have been increasingly important after domesticates were adopted and ideas of ownership and access rights to rangeland became more prominent.

In each of the case studies, the need for decisions in various parts of the livelihood and may suggest opportunities for contributing to the decision-making process, and these are considered. Sustainability is used as a measure of safety and security. Towards the end of the mid-Holocene, here as elsewhere, aridification may have introduced a certain level of anxiety about the ability to diversify geographically for economic, social and economic reasons. Where individuality is expressed, this may imply that personal choices were possible, and this is discussed.

7.4 Livelihood Variables

The Livelihood Variables are made up of the **Vulnerability Context**, **Opportunity** and **Livelihood Structures and Processes**, all of them components that shape livelihoods.

The **Vulnerability Context** is defined by the DFID as follows:

The Vulnerability Context frames the external environment in which people exist. People's livelihoods and the wider availability of assets are fundamentally affected by critical trends as well as by shocks and seasonality – over which they have limited or no control. (DFID 1999a).

The Vulnerability context may include changes to variables that could impact food production and social organization including, but not exclusive to: Changes to variables that enable food production and social organization including seasonality, resource shock (disease, drought, failed flood etc), unfavourable climate change, over-use of landscape, loss of skills/knowledge, population pressure and conflict. In each of the case studies the system devised by Nelson *et al* (2016) to assess overall vulnerability was used to explore the types of vulnerability that were experienced during the mid-Holocene. Naturally this has more chance of reflecting reality where there is a wide spectrum of data to assess, so the case study results were somewhat variable.

In the original SRL Model there is no reference to **opportunity**. In the original SRL model this would be incorporated into the Structures and Processes segment, because opportunities often derive from governments, institutions and their policies. In prehistoric contexts there are no formal mechanisms that determine where opportunities come from. I have therefore modified the SRL model to reflect this. Sources of opportunity may include: favourable climate change, new technologies, new economic resources, new natural resources and new ideas and skills. At Nabta, for example, the most likely scenario is that formerly nomadic pastoralists, confronted by deteriorating climate, chose to adopt new livelihood strategies and formed new links with other groups to improve sustainability.

Finally, the **Livelihood Structures and Processes** component diverges slightly from the original SRL model as shown in the DFID guidelines, adapted for use in archaeology. The DFID define this component as

“The institutions, organisations, policies and legislation that shape livelihoods. Their importance cannot be overemphasised. They operate at all levels, from the household to the international arena, and in all spheres, from the most private to the most public. They effectively determine:

- access (to various types of capital, to livelihood strategies and to decision-making bodies and sources of influence);
- the terms of exchange between different types of capital; and
- returns (economic and otherwise) to any given livelihood strategy.

In the DFID approach, this incorporates national government, regional government, state institutions, the private sector and NGOs and their laws and policies. These are not, however, relevant to prehistoric contexts, where structures and processes are sometimes framed within kinship networks but are often highly localized. Instead, the DFID categories have been replaced with: kinship, markets, law/tradition and regional politics, where “kinship networks”

may influence access to resources, support, and decision-making bodies, where “law/tradition” refers to the agreed ideologies and rules by which people manage community behaviour, and “regional politics” is a broad brush referring to any recognized hierarchy or decision-making unit. In the case studies, each of the areas was assessed in terms of both what types of natural and human processes that could have influenced both the character of each period and the sources of those processes. This was the most frustrating part of the SRL model as applied to these case studies, as the data was simply insufficient to do much more than speculate.

7.5 Livelihood Outcomes

The DFID definition (DFID 1999a, p.25) is only useful up to a point in archaeology:

Livelihood Outcomes are the achievements or outputs of Livelihood Strategies. . . . In particular, we should not assume that people are entirely dedicated to maximising their income. Rather, we should recognise and seek to understand the richness of potential livelihood goals. This, in turn, will help us to understand people’s priorities, why they do what they do, and where the major constraints lie.

Whilst it provides a useful warning that livelihood strategies are based on more than economic gain, the techniques available to development researchers for extracting this material are not available to archaeologists. The DFID also defines outcomes as a hybrid between a community’s objectives and those of the DFID acting on the community’s behalf (DFID 1999a, p.25). Instead, “Outcomes” is defined here as the output of livelihood variables acting upon the asset matrix, a matter of interest for archaeologists who are intent on observing change rather than influencing it. This makes the SRL model a continual loop, with variables acting on assets and producing outcomes, right up until the point where a livelihood is no longer sustainable. In the case studies, increasing aridity meant that Nabta and the Gilf Kebir ceased to be habitable, but in the Badarian and Dakhleh, other options were available and the result, in each case, was a notable change in the material record. In the case of the Badarian this included an expansion of occupation out of the Qau el-Kebir - Matmar area, and a change of material output, with many surviving elements. In the case of Dakhleh, the Bashendi B disappears but the Sheik Muftah, representing an impoverished and highly mobile livelihood, was able to mete out a livelihood well into the Old Kingdom.

Although abandonment seems like a simple outcome, studies of migration have shown that it is far from straight forward, and may involve a variety of decisions along a continuum, from migratory drift at one end of the scale (Stenning 1957) to decisions at the household level about long distance migration, usually dependent upon contacts in destination areas (Cliggett 2005, Winkels and Adger 2002). Where no existing ties exist, incoming households and

groups have no access to support networks and or rights to land, and conflicts may arise (Silberbauer 1981; Stenning 1957; Winkels and Adger 2002, p.6). In all cases, the trauma of abandoning livelihoods and familiar areas may cause social and ideological crisis (Cliggett 2005; Spencer 1998, chapter 5). A flow chart representing some of the choices that would have been available in the Gilf Kebir at this time is shown in figure 7.4. It is probable that after leaving the Gilf Kebir at least some of the occupants moved south to Laqiya, some 400km away (Kuper 2007, p.9). Similar flow diagrams for the choices available in the case study areas at the end of the mid Holocene are shown in Chapter 9.

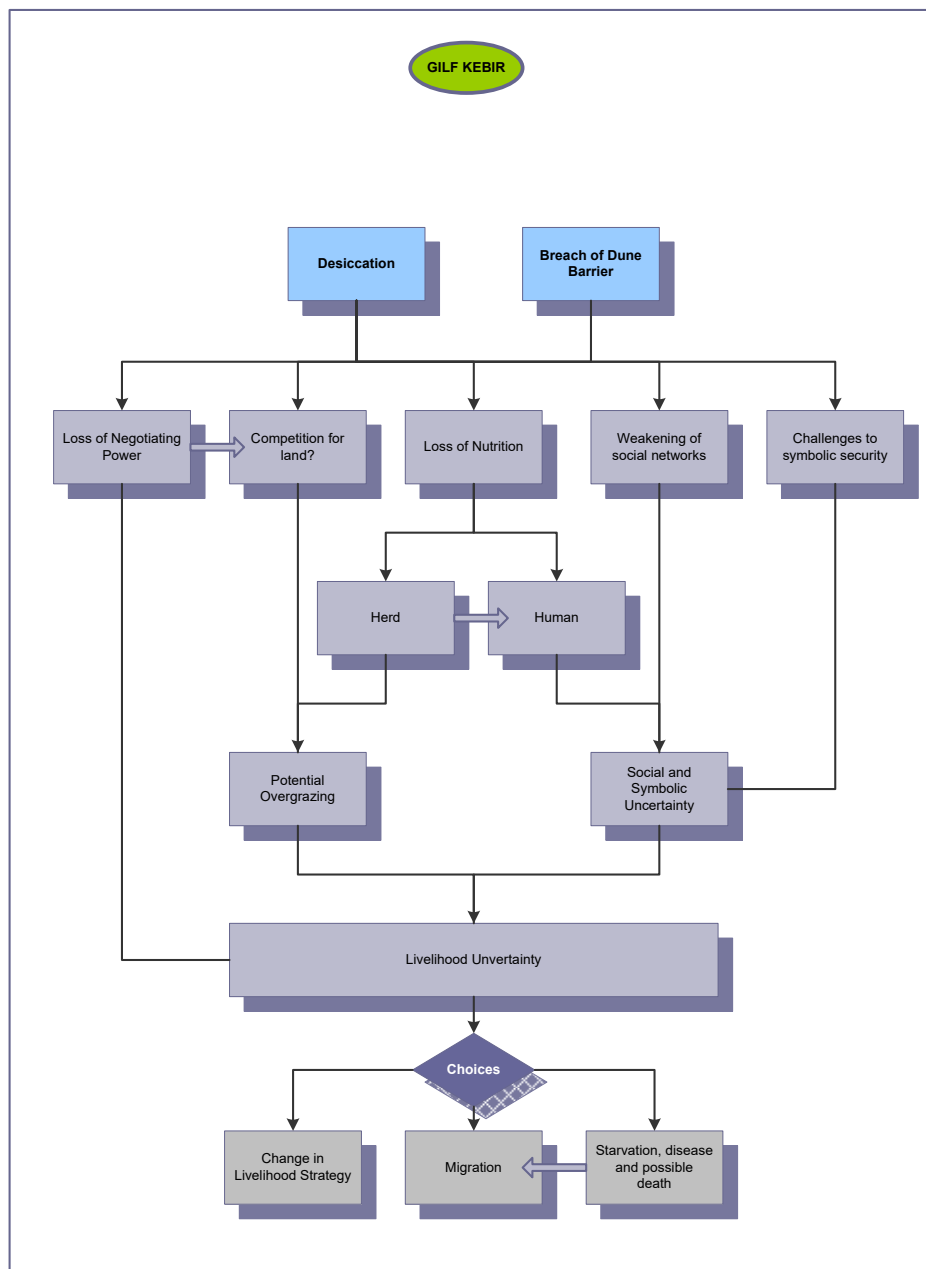


Figure 7.4 – Choices facing occupants of the Gilf Kebir at the end of the mid-Holocene

7.6 Key questions

The same questions will be asked in each of the case studies in order to bring out similarities and differences that will form the basis of a comparative study. The key questions are based on the research questions described in Chapter 1, and are informed by the analysis of risk and uncertainty in Chapter 5.

1. What drew occupants into the area, or why did the occupation change?
2. What types of risk (natural and human) were experienced
3. How were risks managed?
4. How can the livelihood be characterized in subsistence terms?
5. Has it been possible to identify where decisions have been made and what they were?
6. How has group identity manifested itself in the archaeological record?
7. Were opportunities taken up in times of insecurity or stability?
8. Can the livelihood be characterized as sustainable?
9. Why was the area abandoned / why did the type of occupation change?

Key Question 2 is supported with table 7.7, which tabulates the best documented risk strategy options. Table 7.1 assembles the data presented in the case studies, based on the research into modern pastoralists described in Chapter 5. A simple yes/no/? rating is used to indicate presence or absence of a technique, together with a confidence rating in its presence of High (H), Medium (M) and Low (L). The table is used to begin a top-level assessment of the risk management strategies adopted in all four areas.

Risk Strategy		Ru'at el Baqar	
Food diversification		✓	H
Food specialization		✗	L
Storage		?	L
Mobility		✓	H
Habitat management		✓	M
Social networks		✓	H
Trade/exchange		✓	M
Ideology/religion		✓	H
Communication of knowledge		✓	M
Exchange of information		?	M
Leadership / roles		?	M
Division of labour		?	M
Technological specialization		✗	M
Opportunity / innovation		✓	H
Conflict		✗	L
Stint/hunger foods			L
Handling Uncertainty	Migration	✓	H
	Remaining to experience impoverished conditions/ death	✗	L

Table 7.7 - Risk management strategies employed at Nabta Playa during the Ru'at el Baqar

7.7 Conclusions

In the introduction to this chapter it was stated that there were three tasks: 1) to describe the template, 2) to identify archaeological indicators for each of the asset components, using information taken from the case studies and 3) to demonstrate, with examples, the process by which the template is populated with data. This having been completed, the next task is to provide a case study to show the SRL approach in action by providing an abridged version of the Nabta Playa (Ru'at el Baqar) case study. This is provided in chapter 8. The next step was to use the data from all four case studies to compare the four areas in terms of vulnerability and sustainability, and this set of tasks is carried out in chapter 9.

8 - Case Study 1 (Abridged): Nabta Playa in the Ru'at el-Baqar

8.1 Introduction

This is an abridged version of the case study, and is 50% smaller than the original which is included on the attached CD-ROM or can be found online at www.polstudy.wordpress.com. It discusses the the Ru'at el-Baqar of Nabta Playa, also referred to as the Late Neolithic. Background information about excavations at Nabta and its diachronic record have been introduced in Chapter 6. The Ru'at el-Baqar dates 7350 – 6600 Cal BP or 5400 – 4650 Cal BC. The site with the most complete stratigraphic record of the Nabta Playa archaeology, E-75-8, provides dates of 6550-5800bp (5200-4850 Cal BC). In this chapter published information has been combined within the framework of the SRL model to demonstrate the SRL approach and to explore the Ru'at el Baqar period.



Figure 8.1 - The location of Nabta Playa, also showing other places mentioned in the text (Source: Google Earth)

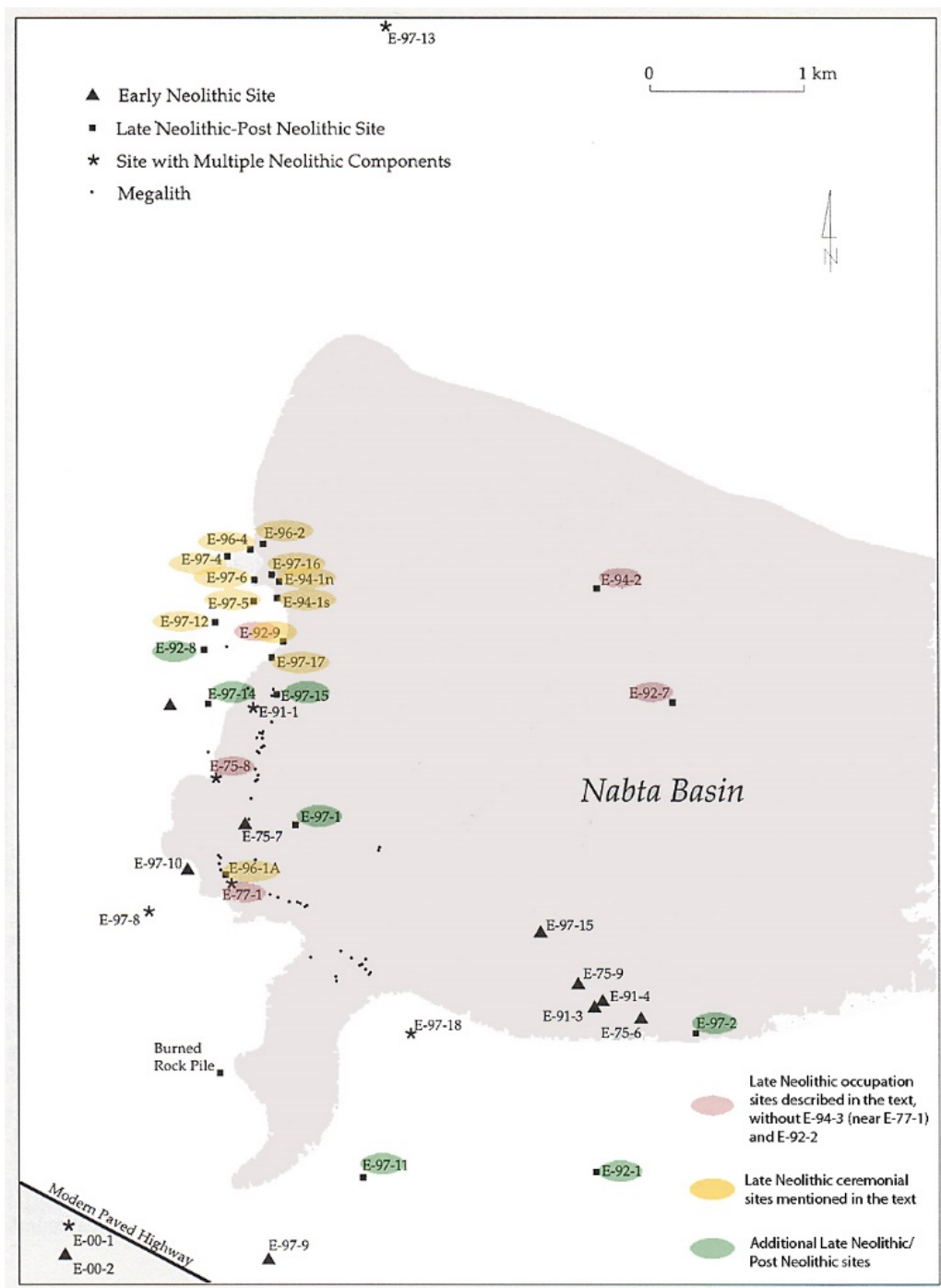


Figure 8.2 - Map of Nabta Playa. Modified from Wendorf and Schild 2001a, fig 1.2, p.5

8.2 The data available for each phase

The main forms of data are summarized in Table 8.1, below. Variations in quality of that data will be discussed throughout the text. The sites discussed in the text are summarized in Table 8.2.

✕ Not present / ✓ Present

Category	Data	✕ / ✓
Site type	Occupation	✓
	Cemetery (concentration of multiple burials)	✕
	Ceremonial (monuments and ritual structures)	✓
	Unknown	-
Architecture	Domestic shelters / foundations	✕
	Hearths / Steinplätze	✓
	Storage	?
	Ceremonial structures	✓
Type	Stratified	Partial
	Palimpsest / Chronologically undetermined	✓
	Cave / rock shelter	✕
Funerary	Burial structures	✓
	Human physical remains	Few
	Grave goods	✕
Diet	Faunal remains	✓
	Botanical remains	✓
Environment	Faunal remains	Few
	Botanical remains	Few
	Sedimentary and geomorphological data	✓
	Other environmental / climatic indicators	✓
Tools/ Craft items	Stone tools	✓
	Grinding stones	✓
	Pottery	✓
	Ostrich eggshell	Few
	Basketry, cordage etc.	✕
	Animal products	✓
	Other artefact types	✓
Personal or symbolic material	Beads / other jewellery	✕
	Portable art	✕
	Palettes	✕
	Cultural components on everyday tools / pottery	✓
	Rock art	✕
	Prestige objects (potentially)	✕
Dating	Radiocarbon dates	✓
	Relative / stylistic	✓

Table 8.1 – Data types available for the Ru'at el-Baqar Late Neolithic

Site	Type of site	Key features
E-75-8	Stratified occupation	The largest of the Ru'at el-Baqar sites. Late Neolithic layer 7, 9 and 10 overlying earlier levels. Hearths, pits, hut, lithics, pottery, worked shell and bone, grinding implements
E-77-1	Occupation	Hearths, lithics, pottery
E-92-2	Occupation	Three separate groups of hearths. Associated with wells and ostrich eggshell
E-92-7	Occupation (extensive finds, 400 x 360m)	Late and Final Neolithic overlying Al Jerar Early Neolithic. NE part of Nabta. Surface finds of 100s of large hearths in different states of preservation, 18 of which examined (3 types), lithics, grinding implements, pottery, bone of domesticates (cattle, sheep/goat).
E-92-9	Stone circle	With surface debris and hearths, possibly associated with the circle.
E-94-1N ("Northern Tumulus")	Tumulus	Semi-articulated cattle burial in a pit beneath sandstone slabs forming tumulus with piece of wood overlying fill. Sheep/goat or Dorcas gazelle remains in tumulus fill.
E-94-1S	Tumulus	Sandstone slabs forming tumulus. Disarticulated cattle (up to x3) and sheep/goat remains (x1) and sheep (x1). Lithics (x3)
E-94-2	Occupation	Late and Final Neolithic. Hearths (3 groups), lithics, pottery, notched stones, grinding implements, sparse faunal remains on deflated surface
E-94-3	Occupation	Hearths, lithics, potsherds, grinding implements, notched stones
E-96-1 - A	Complex Structure	Earliest in series of sandstone features constructed over pieces of tablerock. This is the only one dating to the Late Neolithic; the others date to the Final Neolithic
E-96-2	Tumulus	Undetermined function. Only 19 relatively small slabs and no animal or other remains or artefacts
E-96-4	Tumulus	Remains of disarticulated cattle (x4) and a possible canid. Two lithic tools.
E-97-4	Tumulus	Disarticulated cattle (x2) with tethering stones added to sandstone tumulus
E-97-5	Tumulus	Fragmentary tumulus over remains of single young male human, cranium and other bones absent
E-97-6	Tumulus	Sandstone slabs forming tumulus. Disarticulated cow
E-97-12	Tumulus	Southernmost. No faunal remains. Lithics (x2)
E-97-16	Tumulus	Sandstone slabs forming tumulus. Disarticulated cow (x1)

E-97-17	Burials	Three burials without artefacts, all poorly preserved on the same dune as E-92-9, the surrounding surface dominated by Ru'at el-Baqar material.
Alignment A	Stone row	Apparently the earliest of a series of stone rows, this one aligned towards Sirius.
Alignment C	Stone row	Stone rows aligned towards circumpolar star Dubhe

Table 8.2 - Ru'at el-Baqar Neolithic sites mentioned in the text (Wendorf, Schild and Associates 2001)

Table 8.3 provides a list of the dates listed in Wendorf, Schild and Associates (Schild and Wendorf 2001c, p.53-54, Table 3.1) and calibrated using quickcal2007 ver1.5 (Cologne Radiocarbon Calibration and Paleoclimate Research Package (University of Cologne) <http://www.calpal-online.de/index.html>).

Area	Site/Feature	Uncalibrated c-14 dates bp	Calibrated dates BC	Material	Lab. No.
Nabta Playa	E-75-8, Bed 2, A-B/18	6440±80	5408±66	Charcoal	SMU-487
Gebel Nabta Playa	E-94-3, Hearth 2	6550±60	5522±45	Charcoal	CAMS-16590
Gebel Nabta Playa	E-77-1, Hearth 2	6530±95	5484±89	Charcoal	DRI-2877
Nabta Playa	E-75-8, Bed 3a, Lowest Hearth	6500±80	5459±74	Charcoal	SMU-435
Nabta Playa	E-75-8, Hearth, 10-20cm bs	6430±75	5403±63	Charcoal	SMU-2504
Gebel Nabta Playa	E-77-1, Hearth 4	6350±60	5340±88	Charcoal	CAMS-16590
El Ghorab Playa	Gd-926, Hearth near burial	6330±100	5295±124	Charcoal	Gd-926
Nabta Playa	E-75-8, Hearth? Bed 4, A-B/15	6310±90	5271±116	Charcoal	SMU-441
Bir Murr	Tumulus? Hearth B	6310±70	5294±73	Charcoal	SMU-1120
Gebel Nabta Playa	E-77-1, Hearth 6	6290±60	5269±58	Charcoal	CAMS-17292
Gebel Nabta Playa	E-94-3, Hearth 6	6280±60	5238±77	Charcoal	CAMS-19294
Gebel Nabta Playa	E-77-1, Hearth 3	6260±60	5212±87	Charcoal	CAMS-17395
Gebel Nabta Playa	E-94-3, Hearth 3	6250±70	5199±97	Charcoal	DRI-2873
Nabta Playa	E-94-2, Area A, Hearth 5	6220±90	5172±112	Charcoal	DRI-2879
El Balaad Playa	E-79-5B, Hearth B	6180±70	5132±90	Charcoal	SMU-965
Nabta Playa	E-75-8, Feature 1	6155±105	5096±131	Charcoal	DRI-3547
Gebel Nabta Playa	E-94-3, Hearth 1	6120±95	5062±129	Charcoal	DRI-2880

Area	Site/Feature	Uncalibrated c-14 dates bp	Calibrated dates BC	Material	Lab. No.
Gebel Nabta Playa	E-77-1, Hearth 1	6120±70	5073±107	Charcoal	DRI-2872
Gebel Nabta Playa	E-94-3, Hearth 8	6070±60	4997±94	Charcoal	CAMS-19591
Nabta Playa	E-75-8, Bed 8, top	6030±195	4952±235	Charcoal	DRI-3552
Gebel Nabta Playa	E-94-3, Hearth 2	6020±60	4921±74	Charcoal	CAMS-16592
Nabta Playa	E-94-2, Hearth 9	6000±60	4898±75	Charcoal	CAMS-17287
Gebel Nabta Playa	E-94-3, Hearth 7	6000±50	4897±62	Charcoal	DRI-2879
Nabta Playa	E-94-2, Hearth 10	5980±60	4875±73	Charcoal	DRI-2884
Nabta Playa	E-94-3, Hearth 5	5970±90	4869±110	Charcoal	DRI-2876
Nabta Playa	E-94-2, Area A, Hearth 6	5970±50	4868±63	Charcoal	DRI-2883
Nabta Playa	E-92-7, Area A, Hearth 8	5940±110	4837±133	Charcoal	Gd-10114
Nabta Playa	E-94-2, Area A, Hearth 4	5910±50	4790±54	Charcoal	DRI-2881
Nabta Playa	E-94-2, Area C, Hearth 8	5860±70	4712±89	Charcoal	DRI-2871
Nabta Playa	E-94-2, Area A, Hearth 1	5840±60	5698±77	Charcoal	DRI-2869
Nabta Playa	E-94-2, Area B, Hearth 7	5830±60	4688±77	Charcoal	DRI-2882
Nabta Playa	E-75-8, Hearth	5810±80	4666±96	Charcoal	SMU-473
Nabta Playa	E-97-6, Tumulus, offering	5500±160	4326±185	Charcoal	DRI-3354
Nabta Playa	E-94-1, Burial Pit	6470±270	5363±272	Wood	CAMS-17289

Table 8.3 - Late Neolithic Radiocarbon Dates (Schild and Wendorf 2001, p.53-4, Table 3.1).

8.3 The Livelihood Status

8.3.1 Asset Matrix

8.3.1.1 Natural Assets

Table 8.4 summarizes the main types of zone available for exploitation during the Late Neolithic Ru'at el-Baqar, with zones unavailable shown greyed out and crossed through. These aspects of the landscape are discussed below.

Zone 1	Sahel type / savannah conditions	In a largely featureless landscape, light seasonal rains produce a savannah and scrub type ecology similar to the modern day Sahel, with grassland and shrubs suitable for seasonal but not necessarily year-round herding
Zone 2	Highlands, low hills, high escarpments, Plateaus	Seasonal vegetation, attracting certain vegetation and game, sometimes offering different topologies and ecological niches
Zone 3	Riverine	Permanent water source with floodplains, attracting vegetation, game and containing aquatic resources
Zone 4	Lake / Playa / spring	With the potential for aquatic plants but not fish or other aquatic zoological species
Zone 5	Groundwater zone	Runs along the edge of water-filled basins and supports seasonal vegetation, attracting game on a temporary or permanent basis

Table 8.4 - Natural Asset Zones

Topography

Nabta Playa sits between 22° and 23°N (latitude) and at 32°E (longitude). The central part of the basin measures 14km (east to west) by 10km (north to south) with wadis draining into the basin (Schild and Wendorf 2001b, p.11). A prominent hill called Gebel Nabta sits c.5km to the west of the playa, composed of Nubian sandstone capped with limestone, with another hill of the same composition 32km southwest of Gebel Nabta (Wendorf and Schild 1980, p.82). The surface of Nabta Playa is characterized by sands that stretch in plains interrupted by scarps, low sand dunes, some of them forming strings, and higher fossil phytogenic sand dunes (Schild and Wendorf 2001b; p.11; Wendorf and Schild 1980, p.82). Nubian sandstone forms the bedrock of the Nabta area and appears on the surface in outcrops. Other outcrops of durable basement complex occur to the north and northeast, including pink granite (Wendorf and Schild 1980, p.82). The basement complex is the oldest layer of rock in Egypt, comprised of Pre-Cambrian and Cambrian igneous and metamorphic rocks (Sampsell 2003, p.17). Nubia Formation sandstone and shales form small rises in the east, south and west (Schild and Wendorf 2001b, p.11-2). Approximately 200km to the north,

is an Eocene scarp and plateau, c.90m high, formed of Eocene limestone with sandstones, shales and marls. The average elevation of the Nabta area is 240m above sea level (Wendorf and Schild 1980, p.83). The landscape is marked by numerous basins and sand-infested wadis (Wendorf and Schild 1980, p.82, 84).

Hydrology

The main source of water at Nabta Playa was rainfall that collected in basins and remained in place before evaporation eventually dried them out (Schild and Wendorf 2013, p.128). A wadi to the northwest of the basin, the “Valley of the Sacrifices,” was the main low-energy drainage route by which water drained into the main Nabta basin (Wendorf and Schild 2004, p.11, p.44-45). The entire basin was not flooded, but water filled sub-basins (Mohamed 2001, p.426; Schild and Wendorf 2001b, p.45). Water was also held in the deep sandy substratum adjacent to impermeable layers, again meaning that wells could be employed to access water as it retreated (Kobusiewicz 2003, p.97; Schild and Wendorf 2001b, p.47). Sites E-77-1 and E-94-3 were both located on the site of a wadi that became blocked by sand dunes and into which water drained and became trapped, potentially forming deep seasonal lakes depending on rainfall (Wendorf and Schild 2001c, p.427). In the plains of the Western Desert there was little topographical variation to shelter open areas of water from severe evaporation (Kröpelin 2005, p.51). The Nile was only one to three days walk from Nabta Playa, providing another potential water source for the occupants of Nabta.

Edaphic Conditions

Ibrahim and Ibrahim (2003, p.52-3) describe desert soils in Egypt as aridisols and sandy-rocky desert surfaces with low humus content, little biological activity and coarse to medium texture. Mid-Holocene conditions would have been superior, with some perennial vegetation helping to secure soil and build up a certain amount of topsoil. The underlying sandy soils can produce earlier and fast-growing species, which is of benefit to herders (Schareika 2003, p.20). Animal dung may have contributed to the quality of the soil in rangelands, particularly in places where animals sheltered from the sun.

Vegetation

During the mid-Holocene the Western Desert consisted of dry savannah, with Sahelian type conditions, consisting of “just a little grass after the rains in the summer” (Schild and Wendorf 2004, p.11). The species represented in the archaeological record at Nabta are shown in Table 8.5.

Plant Species				
Species	Sites	Sample size	Habitat	Reference
<i>Acacia ehrenbergiana</i>	E-75-8, E-94-2, E-92-7	286	The most drought and high temperature tolerant of trees in Egypt today. Tolerant of animal browsing.	Barakat 1996, p.64; Barakat 2001, p. 599, Table 22.7; Barakat 2001, p. 597, Table 22.4; Barakat 2001, p. 598, Table 22.5; Springuel 2006, p.68-70
<i>Acacia nilotica</i>	E-75-8	33	Prefers moist conditions, will grow beside pools in oases, tolerant of short droughts and some soil salinity.	Barakat 1996, p.64; Barakat 2001, p. 597, Table 22.4; Springuel 2006, p.74-5
<i>Acacia tortolus raddiana</i>	E-75-8	1	Desert adapted with a preference for non-saline wadis, oases and depressions.	Barakat 1996, p.64; Barakat 2001, p. 597, Table 22.4; Springuel 2006, p.81-82
<i>Capparis decidua</i>	E-94-2, E-92-7	1036	Drought resistant with preferences for silt alluvium.	Barakat 1996, p.64; Barakat 2001, p. 599, Table 22.7; Barakat 2001, p. 598, Table 22.5
<i>Carex</i> sp.	?	?	Wet marshy areas	Wasylikowa <i>et al</i> /2001, p.605
<i>Chenopodiceae</i>	E-94-2	1	Drought and highly saline tolerant.	Barakat 1996, p.64; Barakat 2001, p. 599, Table 22.7; Barakat 2001, p. 598, Table 22.5
<i>Cyperaceae indet.</i>	?	?	Wet, marsh areas	Wasylikowa <i>et al</i> /2001, p.605
<i>Maerua crassifolia</i>	E-92-7	3	Tolerant of high temperatures, drought and salinity.	Barakat 2001, p.598, Table 22.5; Springuel 2006, p.94-5
<i>Panicum turgidum</i>	Ceramic impression		Remarkably drought tolerant, and highly tolerant of grazing.	Magid 2001, p.608; Heneidy and Halmy 2009
<i>Salvadora persica</i>	E-94-2	37	Drought tolerant but not saline tolerant. Thorny scrub or grassland along river banks or on seasonal floodplains.	Barakat 2001, p.596; Barakat 2001, p. 599, Table 22.7; Springuel 2006, p.100-101
<i>Scirpus maritimus</i>	?	?	Wet marshy areas	Wasylikowa <i>et al</i> /2001, p.605
<i>Setaria</i>	Ceramic impression		Unspecified	Magid 2001, p.608
<i>Tamarix</i> sp.	E-94-2, E-92-7	1110	Tolerant of sandy and saline conditions.	Barakat 1996, p.64; Barakat 2001, p.599, Table 22.7; Barakat 2001, p.597, Table 22.4
<i>Ziziphus spina-cristi</i>	E-92-7	71	Not saline tolerant. Prefers alluvial deposits.	Barakat 2001, p.596; Barakat 2001, p. 598, Table 22.5; Springuel 2006, p.107-108

Table 8.5 - Plant taxa present in the Ru'at el-Baqar

Heavy deflation and poor survival of plant remains prevent the reconstruction of the botanical profile at Nabta, but the few remains provide a useful insight into the local environment. The species shown in table 8.5 are typical of arid and semi-arid environments. Their saline-tolerant root systems form phytogenic hillocks and pioneer water beds, wells, depressions, wadis and water tables up to 8m deep (Barakat 2001, p.596). At E-75-8 *Acacia* taxa were well represented. *Acacia* is very resilient in arid environments where it shares an environment with pastoralists, in spite of frequently intensive grazing. Seeds are propagated by browsing herbivores, meaning that *acacia* has a high recovery rate (Selemani *et al* 2013, p.146). *Tamarisk* taxa pioneer around open water bodies, wells and in wadis and are saline tolerant. Sedges from E-75-8 and club-rush, suggest marshy environments along playa edges (Barakat 1996, p.64; Barakat 2001; Wasylkowa *et al* 2001). At E-94-2 charcoals from all hearths produced *Tamarix* sp., *Acacia ehrenbergiana*, *Capparis decidua*, *Salvadora persica* and *chenopodiaceae*, showing a tendency towards contracting desert vegetation (Barakat 2001, p.598). Schild and Wendorf summarize this as “contracted groundwater-bound desert vegetation” (2001b, p.49).

Fauna

The species present in the archaeological record are shown below in Table 8.6 in sample size order, assembled from Gautier (2001, table 23.1, p.610-611, p.612-629), showing the type of environment to which the represented species were adapted.

Faunal Species		
Data	Sample	Habitat
<i>Gazella dorcas</i> (Dorcas gazelle)	198	Dry-savannah but not hyper-arid adapted. Can manage without water for long periods, depending on plant moisture
<i>Zootecus insularis</i>	186	Arid and semi-arid adapted gastropod
<i>Lepus capensis</i> (hare)	176	Desert adapted
<i>Gazella dama</i> (Dama gazelle)	45	Desert adapted – can manage without water entirely, and can depend on food moisture
<i>Arvicanthis niloticus</i> (Field rat)	42	Human commensal
Small birds	29	Arid-adapted quails and migratory species
Reptiles	22	Arid adapted
<i>Canis lupus</i> (dog)	14	Human commensal / domesticated
<i>Vulpes vulpes</i> (Jackal)	13	Savannah adapted

<i>Struthio camelus</i> (Ostrich)	8	Arid adapted, chicks need water but adults can survive for long periods on plant moisture
<i>Hystrix cristata</i> (Porcupine)	7	Preference for savannah to semi-desert
<i>Paraechinus aethiopicus</i> (Desert hedgehog)	3	The most desert adapted of the hedgehog species
<i>Ammotragus lervia</i> (Barbary sheep)	2	A preference for lower mountain and stony slopes (somewhat anomalous for the Nabta environment)
Small carnivores	1	Fenec fox is found in the Western Desert today

Table 8.6 - Animal species present in the Ru'at el-Baqar (MNI)

As with the plant species from Nabta, faunal species were arid-adapted, again indicating that this was a very marginal environment.

Stone, minerals and ores

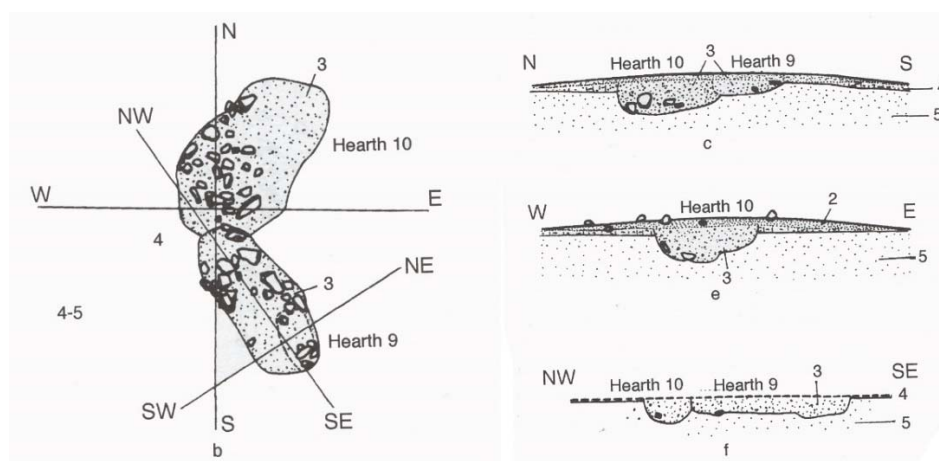
Although the Western Desert seems fairly barren of stone at first glance, Nabta lies on Nubian Formation Sandstone, which is plentiful in outcrops. Additional sandstone and shale outcrops are found to the east, south and west (Schild and Wendorf 2001, p.11). Intrusions of igneous rocks from the basement complex can be found in the vicinity, notably granite (Schild and Wendorf 2001, p.11; Zedeño 2002, p.54). Observations on the ground indicate that most of the stones used at Nabta were available locally, including chert. The nearest source of flint for stone tools was a limestone escarpment 70km to the north (Krölik and Fiedorczuk 2001, p.340; Mohamed 2001, p.422).

8.3.1.2 Physical Assets

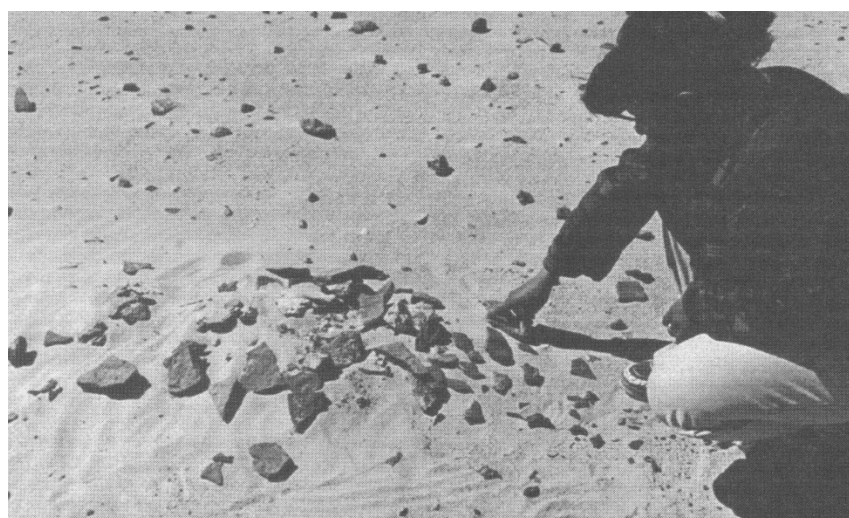
Occupation location, character and size

Unlike the Early and Middle Neolithic at Nabta, during which settlement structures were constructed, the Ru'at el Baqar Late Neolithic has a far more ephemeral settlement arrangement. The most prominent and durable remnants of occupation are deflated hearths, where only the lower portions were well preserved (Krölik and Fiedorczuk 2001; Schild and Wendorf 2001b, p.38). Hearths were apparently unenclosed and were used for only brief periods (Wendorf and Schild 2001c), but some of them were very substantial, although usually quite shallow, with carefully shaped profiles, and were often stone-lined. The hearths (figures 8.3 and 8.4) were accompanied by other deflated occupation remains, including surface scatters of lithics, ceramics, grinding equipment, occasional tethering stones and some bone fragments (Krölik and Fiedorczuk 2001; Schild and Wendorf 2001b, p.37. Some were covered with stone, presumably to protect them for future visits. Three wells were associated with E-94-2. Occupation appears to have been brief, but hearths and grinding stones formed site

furniture indicative of the intention to return, exemplified by E-75-8 (Close 2001), E-77-1 (Wendorf and Schild 2001b), E-92-2, E-92-7 (Krölik and Fiedorczuk 2001), E-92-9 (Applegate and Zedeño 2001), E-94-2 (Mohamed 2001) and E-94-3 (Wendorf and Schild 2001b), which are described in the full case study.



*Figure 8.3 - Site E-92-7. Area A Hearths 9 and 10.
(Source: Krölik and Fiedorczuk 2001 p.343, fig 9.10)*



*Figure 8.4 - Site E-94-3, showing a small stone-filled hearth before excavation
(Source: Mohamed 2001, p.456, p.figure 13.14)*

Nabta is a good example of what Schlanger (1992) refers to as a “persistent place,” a concept that has been used in many studies since that date, and incorporates the idea that certain localities were used repeatedly over the long term, due to their suitability of their particular characteristics for certain activities, natural features that attract repeated occupation and the accumulation of material remains at those localities (Schlanger 1992, p.91). At Nabta, groups were drawn repeatedly to the rain-activated playa basin and the resource potential of

pasture and game. Repeat visits date from the beginning of the early Holocene to the end of the middle Holocene. Hofman emphasises that repeated use of the same areas and sites reinforces knowledge about those areas and improves the chances of livelihood sustainability means that scheduled return visits are desirable (Hofman 1994), whilst Hunn and B. Smith both describe how this type of knowledge becomes embedded in traditions based on a background of memory and past experience (Hunn 1993, p.13; B. Smith 2011, p.263), which also contribute to sustainability.

Shelter

Nelson (2001, p.389-391) describes a possible hut, Hut 1, at E-75-8, which was semi-subterranean and accompanied by a stone-lined hearth and two pits. It is the only known example dating to the Ru'at el-Baqar and its purpose is unknown.

Raw material acquisition

The following graph (figure 8.5) shows debitage raw material frequencies at three excavations reported in Wendorf, Schild and Associates 2001 (Table 9.9, p.346; Table 10.5, p.364; Table 11.5, p.402), indicating a dominance of quartz, followed by flint and chert. Unfortunately raw materials frequencies were not shown for all sites, so could not be compared, but this does indicate that quartz often replaced flint, which had dominated in the Ru'at el-Ghanam Middle Neolithic.

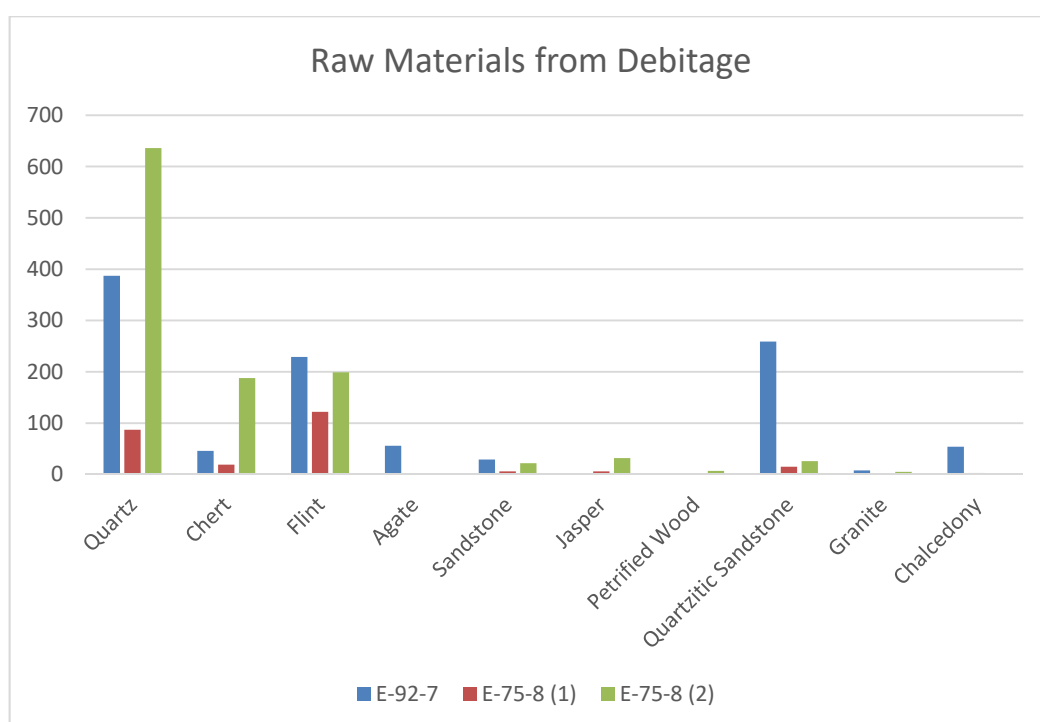


Figure 8.5 - Raw materials found in debitage at three sites at Nabta Playa in the Late Neolithic (totals compiled from Wendorf, Schild and Associates 2001, tables 9.9, p.346; 10.5, p.364; 11.5, p.402).

Apart from the excavations by Nelson (2001), (referred to in the graph as E-75-8(2) to distinguish it from the excavations by Close (2001) referred to as E-75-8(1), quartz is at least as important as flint and often more so. Agate and jasper were not available locally and although Krölik and Fiedorczuk (2001) mention that it may have been sourced from the Nile, it is equally possible that it came from the Eastern Desert, where it is certainly found (Aston *et al* 2000). Specialized knowledge may have been required to identify and locate the material. Otherwise no particular difficulty was associated with the acquisition of appropriate materials for tool manufacture. Chert, petrified wood, quartz and quartzitic sandstone, the main materials used, were available within a 10km distance (Wendorf and Schild 2001c, p.435). Chalcedony, used to make a number of microliths, was probably available locally in the form of small pebbles in playa silts and wash (Nelson 2001, p.395). Flint required no special skills to identify but its nearest source was 70km to the north of Nabta (Mohamed 2001, p.422; Krölik and Fiedorczuk 2001, p.340).

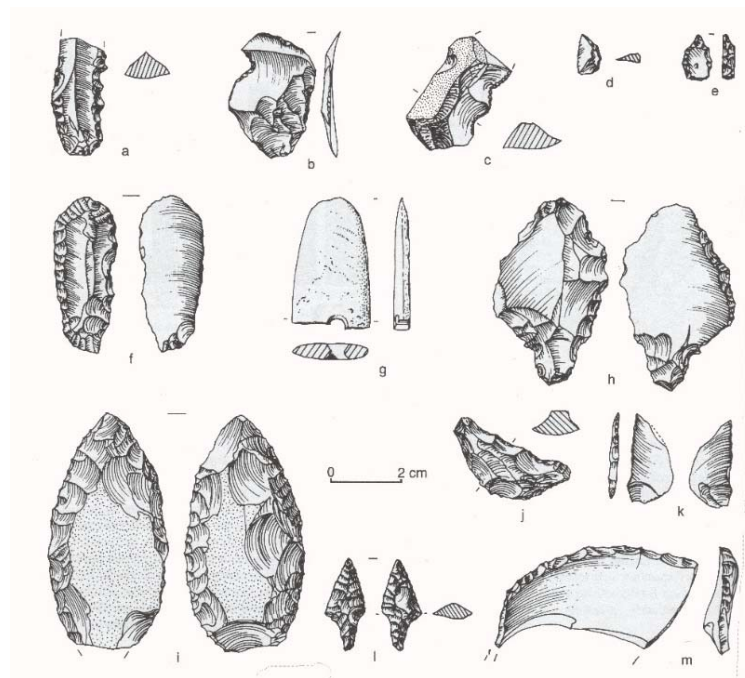
Ground-stone equipment was made of sandstone, granite and basalt, which were available locally (Wendorf and Schild 2001c).

The tumuli and the stone circle were made of the local Nubian Formation sandstone, which was in plentiful supply (Schild and Wendorf 2001b, p.11). It may have been selected to ensure the durability of the structures themselves, or because more pliable materials, like wood, were in short supply.

Food acquisition and production technologies

Lithic tool technologies

The main fabric to survive in the form of implements is stone. As above, most tools were made partly on locally available materials but flint was also important, which was not available locally, and there are some from outlying areas as well, particularly agate and jasper. At E-92-7, 1060 pieces of debitage, were found, as well as 57 cores and 72 retouched tools made on quartz, quartzitic sandstone and flint (materials that made up 83.8% of the total debitage), as well as agate, chert and chalcedony. Of the cores, most were single platform cores, but multiple platform, opposed platform are also found, most of very similar size and made mainly on quartz and flint. Of the retouched tools, dominant forms are notched flakes, denticulated blades and denticulated flakes, making up nearly half of the tools, but some microliths in a range of forms are also present, including 20 pieces with continuous retouch. Debitage at E-75-8 consisted primarily of flakes, with blades in a minority. Single platform cores again dominate at 58% of the total cores, with ninety-degree platforms next (17.2%) and the other types making up less than 10% between them (Close 2001). Examples of lithic tools are shown in figures 8.6, 8.7 and 8.9.



**Figure 8.6 - A selection of Ru'at el Baqar lithics from E-75-8 (Nelson 2001, p.396).
a, c denticulates; b, notch; d, lunate; e, varia; f, endscraper; g, groundstone;
h, retouched Aterian point; i, biface; j, crescent/lunate; k, backed piece;
l, bifacial projectile point; m, retouched side-blow flake**

Different techniques were used for reducing fine-grained and quartz cores and for the use of primary, secondary and tertiary flakes (Close 2001, p.376), with quartz largely left without retouch, indicating that different materials had different roles and were perceived differently. There was very low usage of coarser materials and these too were treated differently from quartz and fine-grained materials (Close 2001, p.376). Whilst materials changed, the need for fine-grained materials remained the same (Close 2001, p.375; Nelson 2001, p.401). Materials were clearly carefully selected for different roles in the subsistence strategy. Wendorf and Schild (2001c, p.438) suggest that the shift from flint and chert in the Ru'at el-Ghanam Middle Neolithic to quartz in the Ru'at el-Baqar may be due to technological changes accompanying the shift from blades to flakes.

Of the retouched tools, dominant forms are notched flakes, denticulated blades and denticulated flakes, truncations, and projectile points but some microliths are also present, including pieces with continuous retouch. There are no burins and only very few microliths, most of which were made on fine-grained and easily worked chalcedony (Nelson 2001, p.395). Geometric microliths are rare (Close 2001; Nelson 2001, p.401-403). Sideblow flakes appear for the first time at Nabta (e.g. figure 8.6-m), as do bifacial tools (figure 8.6-l, 8.7-d) (Nelson 2001, p.410).

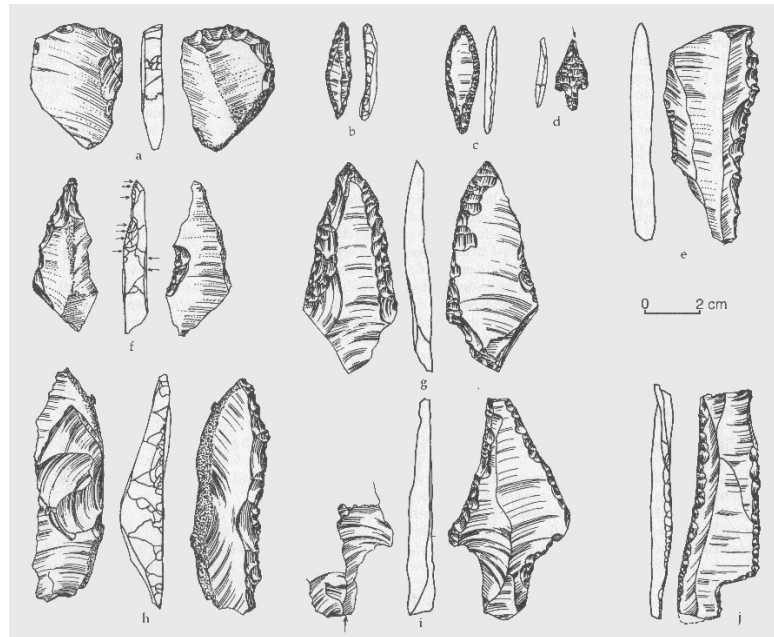


Figure 8.7 - Site E-94-3 Retouched Tools. *a, endscraper on reused Levallois flake. b and f, perforators; c and d, points; e and h, denticulates; g, i and j pieces with continuous retouch (Source: Mohamed 2001, p. 459, figure 13.15)*

Considering the assemblage in terms of Shea's cost benefit analysis (figure 8.8) the industry of the Ru'at el-Baqar is "a less skilled and less formal, almost casual, character" than the Ru'at el-Ghanam Middle Neolithic, perhaps indicating that Late Neolithic stone working was either less important or that the strong sharp edges available without effort on quartz became particularly desirable (Wendorf and Schild 2001c, p.438): "With little energy investment in the acquisition of this raw material, informal quartz flakes could be produced, used and discarded at minimum cost" (2001c, p.440). The industry is one of minimal investment of time and energy, representing a low risk strategy. Tools were versatile rather than specialized, although the tasks for which they were required may have been highly specific, requiring large numbers of denticulates and notches, and some bifacial tools as well as a selection of other tools in smaller numbers. The dominance of single platform cores, making up 58% of the assemblage (Close 2001) also argues for an opportunistic approach to tool manufacture, with low cases of either core or tool curation. However, emphasis was placed not only on tool manufacture but on raw materials on which certain tools were made (figure 8.5) and represents more investment in output than the manufacturing approach implies.

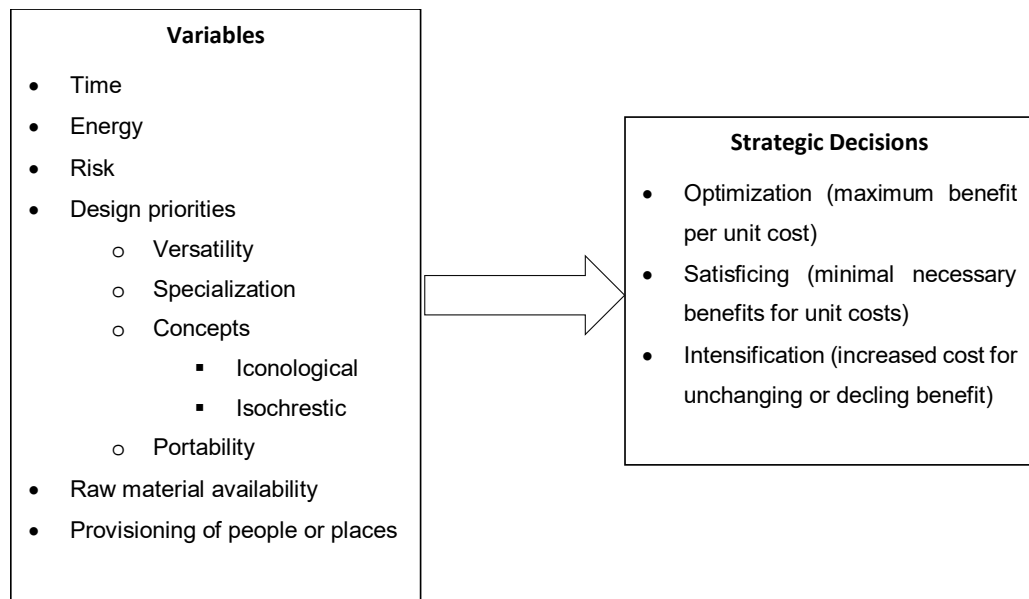


Figure 8.8 - Criteria for assessing tool manufacturing strategy (based on Shea 2013, p.39-45)

At the same time, bifacially worked tools appear for the first time, suggesting a dichotomy between a high level of expedient optimization on the dominant part of the assemblage and an intensified effort in a very limited part of the assemblage. These may fit into the category of “objects of thought” defined by Edmonds as partly symbolic as well as portable and functional, requiring a high degree of preparation and anticipation (Edmonds 1995, p.42) or demonstrating an affiliation with certain tasks, ideas, or areas or a combination of task-related production and cultural outputs.

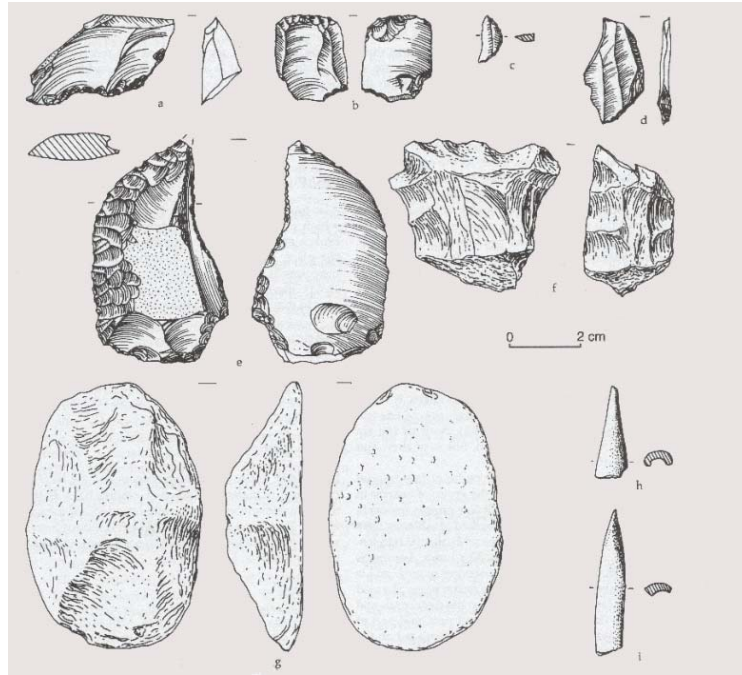


Figure 8.9 – Lithics and worked bone from E-75-8 (Source: Nelson 2001, p.399, figure 11.10. a, perforator; b, endscraper; c, lunate; d, truncation; e, retouched piece; f, denticulate; g, groundstone; h,i, worked bone.

Groundstone equipment

Grinding implements were made of sandstone, quarzitic sandstone, granite, petrified wood, basalt, and quartz (Close 2001, p.382; Nelson 2001, p.403). Examples are shown in figures 8.6-g, 8.9-g and 8.10. The shapes varied considerably, as did the sizes, but most featured shallow dips in the surface. Some had grinding areas on opposing surfaces and one had two grinding areas on the same surface. Lack of standardization suggests that grinding equipment was made by individual households and that there was no cultural pressure towards uniform types.

Throughout the Late Neolithic, large notched stones were found (e.g. figure 8.10-c), but they are particularly prominent at E-94-2, where 22 were found, made of Nubia sandstone with two or more notches midway along opposing edges. They are found near the hearths and it is proposed that they may have been tethering stones (Mohamed 2001, p.424).

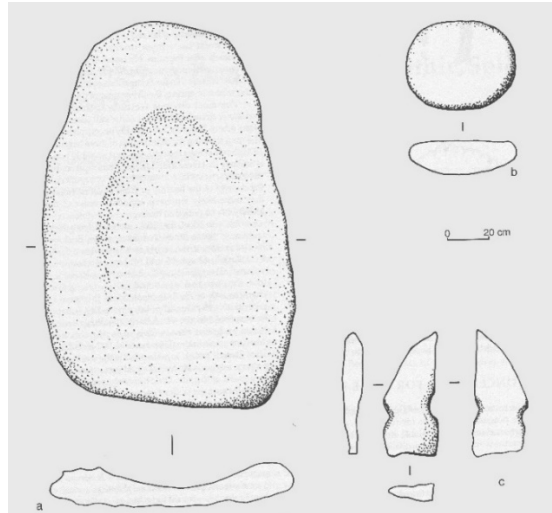


Figure 8.10 - Site E-94-3. Groundstone artefacts. a, milling stone; b, handstone; c, notched stone (Source: Mohamed 2001, p.461, figure 13.16)

At E-75-8 two items described as palettes were found. They were unknown in the Ru'at el-Ghanam Middle Neolithic so are an innovation in the Ru'at el-Baqar. Both are made of coarse-grained sandstone which was pecked into shape, producing thin artefacts, one that was sub-rectangular and one sub-circular.

Ceramic container technologies



Figure 8.11 - Black-topped pottery (Source: Nelson and Khalifa 2001, p.148, figure 4)

Whilst the changes to lithic technology were relatively minor, the differences between the Ru'at el-Ghanam Middle Neolithic and Ru'at el-Baqar ceramics were considerable.

Following an eastern Saharan rocker-stamped tradition established in the Early Neolithic and retained throughout the Ru'at el-Ghanam, a range of new ceramics was introduced in the Ru'at el-Baqar, showing “no points of resemblance” to earlier forms (Zedeño 2002, p.52). The new hand-made, coiled types are characterized by fine paste, a relatively small volume of fine temper made of ground sherds minerals, sand and/or organic materials. Vessels were usually small and beaker-shaped although there were some small bowls, with thin walls less than 7mm thick, which show the first evidence of controlled firing (Nelson 2002a, p.7). Whole-surface treatments included the use of burnishing, smoothing, scraping and slipping, often in combination (Nelson 2002a, p.7). These comprise Black-topped Ware (figure 8.11) and Red Wares (figure 8.12). Ceramics represent much greater technological complexity than in previous periods and are conceptually more sophisticated, representing a new paradigm in ceramic treatment. The implications of this are discussed in **Social Assets**, below.

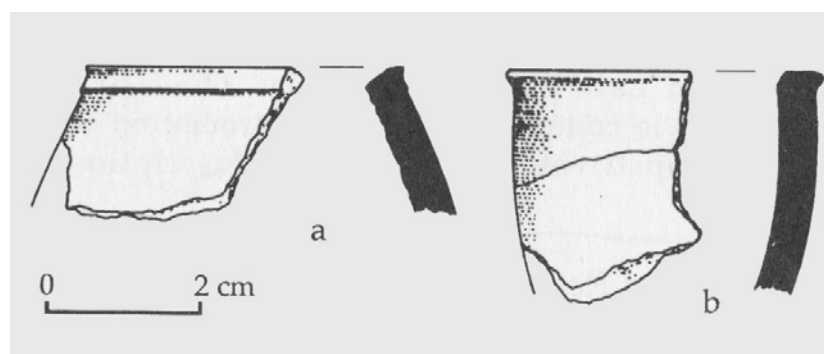


Figure 8.12 - Site E-94-2 Red Ware bowl rims (Source: Nelson 2002, p.36, figure 3.19)

Craft skills

There is no evidence for basketry, matting, rope, textiles, or leather goods, although these must have been present as it is difficult to imagine that life would have been possible without them (Hurcombe 2014). All the raw materials would have been available in the form of the trees and shrubs that have been noted at Nabta in the Ru'at el-Baqar archaeological remains, particularly the drought-tolerant *Acacia*, *Tamarix* and *Panicum turgidum* species, which today provide fibre for matting, rope and related goods (Mahmoud 2010; Springuel 2006). Tannins from *Acacia nilotica* could have been used for tanning leather, as it is today (Springuel 2006).

At E-75-8 three pieces of worked bone were found, including two projectile points (see figure 8.9-h and i) and one awl, all burned, as well as the fragment of another bone point that was 10mm long and 3mm wide at its widest diameter and was polished all over (Close 2001, p.381). These suggest that a bone tool industry might be under-represented in the archaeological record.

Ostrich eggshell beads are still found and although they are much less frequent than in the Ru'at el-Ghanam Middle Neolithic, there are no other observable differences. They were made by perforating an unshaped piece, which was then chipped into roughly circular disks, to a mean diameter of c.6.2mm, before being polished (Close 2001, p.379-381).

Structures

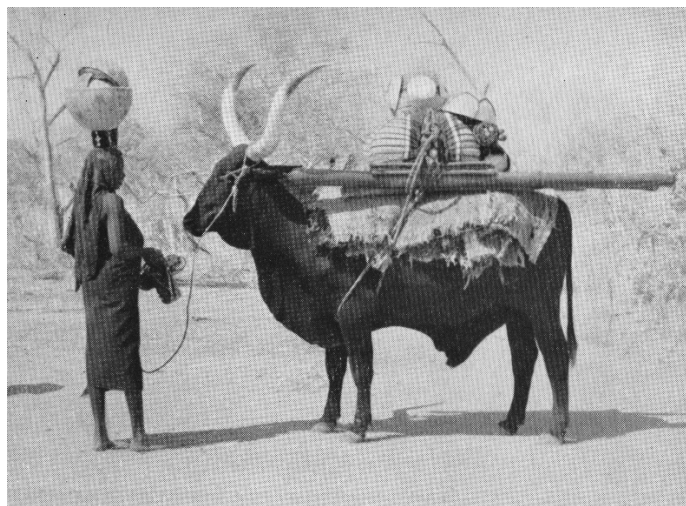
Tumuli, complex structures and so-called megalithic alignments were all constructed from Nubian Formation sandstone that was quarried locally. General stone-working skills were required in their shaping and erection, and labour would have been required to move and position the larger components of the megalithic alignments, as discussed in **Social Assets**.

Food storage systems

Other than livestock used as storage on the hoof, the only signs of food storage systems are at E-75-8 where a possible hut was associated with two pits of undetermined function. Given the short-term occupation of the site and the fairly sparse vegetation predicted for the area at this time, it seems likely that there was not sufficient wild plant food to merit storage.

Transport

It is possible that cattle, sheep or goat were used as pack animals (figure 8.13). Walking was also a perfectly viable means of transporting items that were lightweight and could be strapped to the body, carried or dragged. Some heavy items, like mortars, were left *in situ*.



*Figure 8.13 - Fulani woman moving camp in the dry season prior to a 28km walk
(Source: Stenning 1959, p. ii, plate 1)*

Fuel

Given the available wild and domesticated fauna, dung should have been readily available, particularly concentrated beneath trees that would have provided shelter (Butler

2002, p.181-2; Evans-Pritchard 1940, p.258; Hassan 1988; Hobbs 1989, p.90, p.104-6; Linseele *et al* 2010).

Wood was a relatively scarce resource that was not readily renewable. It would have been a high-risk strategy for the long term security of the environment, as recognized by pastoralists, who enforce strictly encoded social and religious prohibitions established to protect living trees (Bollig 2006, p.336-7; Harir 1996; Hobbs 1989, p.53; Hobbs *et al* 2014; Krzywinski *et al* 1996; Simpson 1992; Wendrich 2007, p.74). However, in Nabta the number of Late Neolithic hearths containing plenty of wood charcoal suggest that either dead wood was being used in order to protect live trees, that there were mechanisms in place for ensuring that the host tree was left intact, or that wood was not considered to be in danger of being over-exploited. All of the woods that were present at Nabta would have been suitable for fuel, particularly *Acacia ehrenbergiana* which has a relatively low moisture content and burns very slowly, providing heat over long periods (Belal *et al* 2009, p.70-71; Springuel 2006, p.4).

Craft infrastructure

No kilns or equipment associated with pottery manufacture are found at Nabta. In so far as lithics are concerned, debitage occurs around hearths, so tool manufacture was not isolated from living areas. There is no evidence of specialized craft production areas.

8.3.1.3 Social Assets

Status, roles and social organization

Wendorf and Schild believe that during the Ru'at el-Baqar the creation of the tumuli, their contents and the stone circle would have required a considerable level of social organization, backed by a degree of social complexity embedded in religious or political authority (Wendorf and Schild 2001 p.9). The act of materializing ideas as structures indicates a fundamental need to act upon beliefs, and to co-ordinate ideas about how these conceptualizations should be translated into ceremonial structures. Whether or not this required leadership, implementation would certainly require discussion, agreement and teamwork. Symbols of power of the sort discussed by MacDonald for the Pokot of Ghana (MacDonald 1998) and di Lernia for the Messak Plateau (di Lernia 2013) are completely absent. For example, there is no evidence of religious paraphernalia, individualized symbols of power, luxury goods, or burial of elders.

In pastoral societies status is often conferred by hereditary systems but may also be embedded in perceived wisdom, experience, craft skills, negotiating skills, healing or spiritual mediation, or other valued characteristics (Klima 1970; Manger *et al* 1996; Niamir 1991; Olupona 2014, p.40; Schareika 2014, p.4; Smith, A.B. 1996, p.30). As researchers in both ethnographic and archaeological fields have demonstrated, socially stratified societies and pastoral livelihoods are fully compatible (Dika Godana 2016; Honeychurch 2014; MacDonald

1998; Robertshaw 1999) but may take a variety of forms, often including fluid arrangements whereby leadership is earned on an ongoing basis (e.g. Wengrow and Graeber 2015 p.603-4) or when leadership for a specific task is required. Layton *et al* suggest that nomadic pastoralist mobility and the inherent risks involved lead to mainly egalitarian communities (Layton *et al* 1991, p. 258) but it is by no means clear that Nabta pastoralists were fully nomadic.

An alternative model, given the presence of processes and activities that required the organization of both ideas and labour, is one of heterarchical organization, which is defined by Crumley as “the relation of elements to one another when they are unranked in a number of different ways” (1995, p.3). Whilst status may exist, the nature of power, and the people with whom it lies, may shift and change due to changing circumstances and inputs (Klima 1970, p.87). In such a scheme short-lived leadership could be acquired on the basis of skills and abilities that are suitable for specific tasks, but may be fluid depending on the season or needs of the community on a temporal or geographical basis. If the Nabta pastoral and hunting groups were seasonal offshoots of a larger transhumant community, the arrangement of authority and roles is likely to have been extremely flexible, based on discussion, the pooling of ideas and the availability of skills of certain members of society “for bringing together different points of view into some imaginative synthesis that stretches beyond parochial interests” (Spencer 1998, p.249). This does not argue against social complexity but does favour a range of possible models for organizing people. As Wengrow and Graeber observe, “It is simply not possible to have an evolutionary progression such as ‘band’ – ‘tribe’ – ‘chiefdom’ – ‘state’ if your starting point is a society that moves effortlessly between institutions” (Wengrow and Graeber 2015, p.608). As there are no obvious signs of social stratification it maybe that individual projects were organized on an *ad hoc* basis by whoever was most qualified at the time. That is not to suggest that such leadership roles would be allocated informally; it is entirely possible that such agreements and allocations of status were highly formalized. More permanent leadership roles would be expected where potential conflict over pasture and water sources might arise, that might leave a more definitive archaeological signature (Bardhan and Ray 2008; Bollig 2006, p.325-339; Dasgupta and Heal 1979; DFID 2000a; Ostrom 2008; Tiffen 1996; Vivello 1977, p.15) but there is no indication of that at Nabta.

Woods discusses the ceremonial centre in terms of religious authority (Woods 2016, p.176-199). Her interpretation, like that of Wendorf and Schild, focuses on the location of the ceremonial centre on the edge of a major drainage wadi, “the focal point for rituals to the supernatural entities responsible for rain” (Woods 2016, p.188). She suggests that there may have been a rainmaker bridging between the physical and non-physical and overseeing rain-making rituals at Nabta, in a period characterized by unpredictable rainfall (2016, p.84-4, p.194-5). Rain-making rituals are not uncommon in ethnographic data (e.g. Lienhardt 1961, p.85, 92-93, 101) but the evidence for such an individual is nebulous. The individual buried in E-97-5 was a young male (Applegate *et al* 2001, p.477-478) but he was unaccompanied by

grave goods or personal ornamentation and there is no indication that he had any specific status.

The presence of pottery of identifiable and consistent appearance and raw materials suggests that there were individuals who inherited the knowledge of pottery manufacture, were themselves in a position to communicate knowledge and respond to economic drivers. There are no indications, however, that this was a centralized industry.

Ideology and Religion

A number of sites at Nabta may have incorporated ideas about religion and spiritualism including a set of 15 tumuli within a wadi that is the drainage of rainwaters into the Nabta basin (Schild and Wendorf 2012 p.422), the small stone circle E-92-9 at the end of the valley (Applegate and Zedeño 2001; Schild and Wendorf 2015; Wendorf and Schild 2001c, p.668), the so-called “complex structure” E-96-1A (Wendorf and Królik 2001b; Wendorf and Schild 2001c, p.669-670) and two megalithic alignments named Group A and Group C (Wendorf and Królik 2001a; Wendorf and Malville 2001).

The tumuli are all concentrated on the northwestern edge of the main basin, where playa silts, a large phytogenic dune and sandstone bedrock are all present. All are built of broken sandstone blocks, placed along the west bank of a wadi that flowed into the Nabta basin. Of the fifteen identified, 9 have been excavated. They are often located on prominent geomorphological features, like the top of a dune, on the edge of a bedrock outcrop or a knoll, although E-97-6 was built in a small hollow between knolls and the early Late Neolithic site E-94-1N was built directly within the playa (Applegate *et al* 2001, p.468). Each is about 3-5m in diameter, composed of unshaped and roughly shaped sandstone blocks to form a dome shape in some cases. Height is only given in one case, and this is 85cm at E-97-12 (Applegate *et al* 2001, p.479). Stone counts are not given for most of the tumuli but E-97-5, the human burial, was topped with around 100 slabs, E-96-2 had only eighteen, and E-97-4 had gaps in the tumulus stone and appeared to be incomplete and included tethering stones amongst the tumulus stones (Applegate *et al* 2001, p.475). Although usually divided into two categories (animal and human) there are arguably six types of tumulus based on contents (data assembled from Applegate *et al* 2001):

- 1) An articulated young female cow laid on its left side in a backfilled pit (figure 8.14) over which was a tumulus in which sheep/goat or Dorcas gazelle bones were scattered in the stone (the articulated cow and pit are unique to E-94-1N)
- 2) Tumuli with cattle bones scattered into the stones of the tumuli (E-97-4 and E-97-16)
- 3) Tumuli with mixed cattle and sheep/goat bones scattered into the stones (E-94-1S and E-97-6)
- 4) Tumulus with mixed cattle bones and canine (E-96-4)
- 5) A human burial without a cranium, mandible, teeth and the majority of scapulae (E-97-5) (figure 8.14)
- 6) Empty tumuli (E-96-2 and E-97-12)

The remains of individual cattle in the tumuli containing only disarticulated cow (figure 8.14) remains varied from one to four, totalling a maximum of nine individuals, comprising two juveniles, 4 sub-adults, 4 young adults and 1 possibly elder example, the latter an exception. The total number of sheep/goat represented are three. Artefacts were found in the stones of some of the tumuli, but amounted to a maximum of two in a tumulus (Applegate *et al* 2001). The disarticulated remains appear to have been butchered prior to being deposited, apparently at random, among the stones of the tumuli, and the animal bones appear to have been added throughout the construction of the tumuli. Gautier suggests that the cattle tumuli may have been used repeatedly with each animal representing one event (Applegate *et al* 2001, p.483). The poorly preserved human burial in E-97-5 (figure 8.14) was located on a white bedrock knoll in a tumulus composed of less than 100 sandstone slabs. The single adult is semi-articulated and flexed on its right side, spine to the east and head to the north. The cranium, mandible, teeth and major scapulae are missing, suggesting that the body was either incomplete at the time of deposition or that the components were removed later. Analysis indicates that the remains belong to a young and healthy male, 1.70m tall (Applegate *et al* 2001, p.477-478). Without excavation of the other six tumuli it is impossible to draw any general conclusions about the tumuli contents. The area around the tumuli consists of uncharacteristic small dispersed individually or in small groups around the tumuli” (Applegate *et al* 2001, p.468) perhaps implying that the area was reserved for specific socially important activities. Applegate *et al* 2001, describe them as “shrines” (p.487).

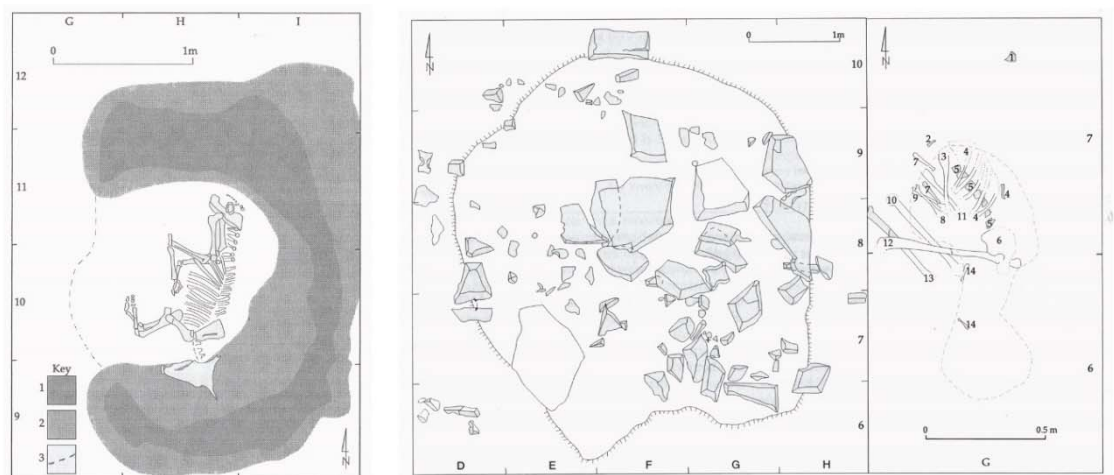


Figure 8.14 – Plan views of tumuli E91-1N, the articulated cow burial and E-97-5, the human burial (Applegate *et al* 2001, p.470, figure 15.1 and page 477, p.15.6)

At the end of the wadi was a small stone circle on top of a small sandy knoll that the excavators concluded was a ceremonial circle, site E-92-9 (Schild and Wendorf 2001a; Applegate and Zedeño 2001), shown in figure 8.15 and 8.16:

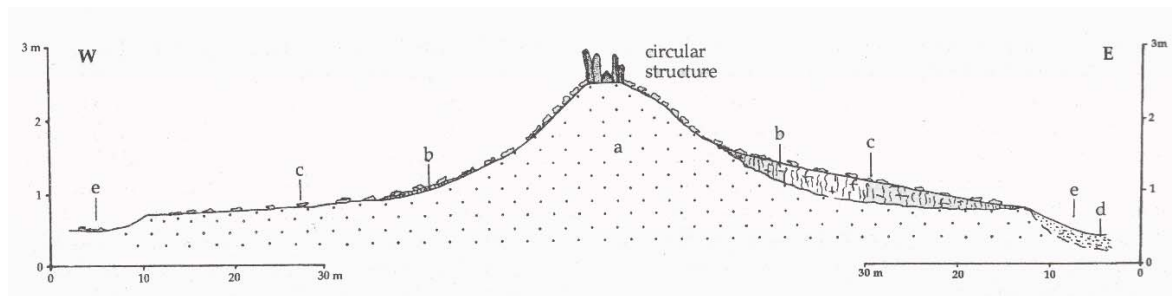


Figure 8.15 - Site E-92-9. Stone Circle (Schild and Wendorf 2001a, p.37, figure 2.27)

The stone circle consists of pairs of narrow upright slabs, two lines of sights, one north to south, which parallels the line of the tumuli to the north and megalithic alignments to the south, and one of which points approximately to the place where the sun rose at the summer solstice at the start of the rainy season some 6000 years ago (Applegate and Zedeño 2001; Malville *et al* 1998). The 55 Nubia sandstone slabs range in height from 20cm to 70cm and do not exceed 20cm in width and 10cm in depth and enclosed an area of 49m² (Applegate and Zedeño 2001; Schild and Wendorf 2001b, p.37). The arrangement was re-interpreted during work carried out to move the circle to the protection of the Nubia Museum in Aswan, and a ring of slabs has been proposed (Wendorf and Schild 2015, p. 366-367). Malville *et al* 1998 emphasize the proximity of Nabta to the Tropic of Cancer at this latitude, where the sun achieves its zenith on two days, approximately three weeks before and after the summer solstice: "Vertical structures cast no shadows under the zenith of the sun and within the tropics the day of the zenith sun is often regarded as a significant event" (Malville *et al* 2008, p.490). The four pairs of gates form two distinct axes, one of which marks the position of the rising sun at the summer solstice at c.6000 years ago (Applegate and Zedeño 2001, p.466). Malville *et al* say that "No evidence of astronomical orientations has been reported, and none is readily discernable in photographs of the circle" (Malville *et al* 2007, p.3).



Figure 8.16 - The E-92-9 stone circle (3.6m diameter) F(Schild and Wendorf 2015, p.367, figure 24)

Complex Structure A has been placed in the Ru'at el-Baqar at c.4800BC - a calendrical not a radiocarbon measurement (Wendorf and Królik 2001, p.520) whilst the others excavated to date, around 30 in total, belong to the Bunat al Ansam Final Neolithic (Wendorf and Królik 2001). E-96-1A consists of roughly shaped and unshaped rocks that look very much like bedrock. There are no traces of animal or human remains. Alignment Group A ends in Complex Structure A, also called E-96-1A, which lies c.200m to the south of E-95-8 (Wendorf and Królik 2001b, p.490). It is one of a number of similar structures known as "complex structures" (collectively E-96-1), consisting of upright and horizontal stones arranged in an oval with between one and three larger stones at the centre constructed over tablerocks some 2-4m below the play clays and silts, and all located away from settlement areas (Wendorf and Królik 2001). There are no traces of animal or human remains. Of all the structures in the ceremonial centre, these required the most labour. Just digging down to the tablerocks would have required considerable effort. It is not known how the tablerocks (figure 8.17-1) were located but once they were reached, they were usually deliberately shaped. Sections had been removed from the tablerock in Complex Structure A to create a curved surface. In the case of Complex Structure E-96-1A, a quartzitic sandstone block greater than three tons was placed 50cm above the tablerock and 80cm below the surface and was shaped and smoothed, with one convex side pecked smooth and a projection at one end, set upright, with the projection slightly west of north and held in place by two large slabs (figure 8.17-5). Although it is usually referred to as cow-shaped, the authors originally commented that "it could represent almost anything" (Wendorf and Królik 2001b, p.510). The pit was then refilled to surface level and an oval of 71 tightly packed quartzitic sandstone uprights was erected over the top, with a diameter of 5m x 4m, with three partially shaped slabs in the centre. That they were important is clear from the investment of time and energy that went into building

them but it is impossible to choose between the various functions proposed for them (Wendolf and Królik 2001, p.510).

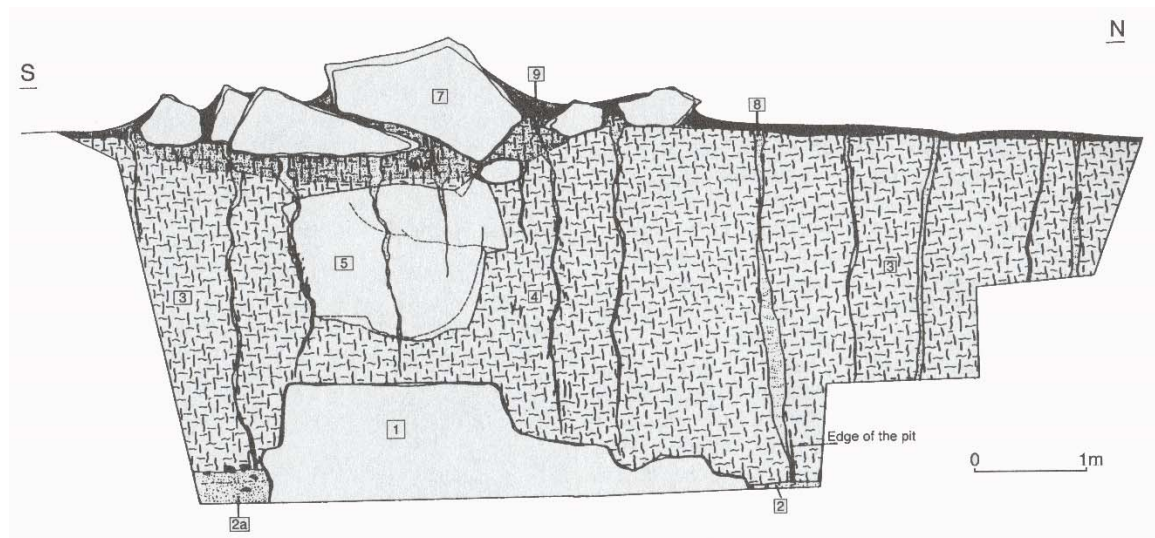


Figure 8.17 - Site E-96-1 Complex Structure A showing : 1, the tablerock; 2, cemented sand with small rock slabs; 3, playa silt; 4, silt backfill inside pit; 5, sculptured stone; 6, laminated sand and silt; 7, surface stones (Wendolf and Królik 2001 p.509, figure 17.8)

Megalithic alignments radiate outward from Complex Structure A. Those that appear to belong to the Late Neolithic are Group A (figure 8.18) and Group C, dated on the basis of the stars towards which they were aligned (Wendolf and Malville 2001, p.502). The alignments in Group A1, A2 and A3 point towards the rising of Dubhe. Alignment C extends towards the rising of the star Sirius. There is an estimated 80 years between alignments C1 and A1, and the alignments A1, A2 and A3 appear to represent adjustments over time to the rising of the circumpolar star Dubhe (Wendolf and Malville 2001, p.500-501). All the alignments were built of quartzitic sandstone, which could be sourced locally. Stones were either roughly shaped or unshaped, and many were fractured. Group A consists of clusters of stones, aligned roughly north to south, located c.100m southeast of E-91-1 (Wendolf and Malville 2001): “The entire group represents three sub-alignments, all with lines of site converging on the largest of the Complex Structures located about a km to the southwest” (Wendolf and Malville 2001, p.490). Alignment Group A1 is formed by A-6 to A-10 and Complex Structure A. Each consists of groups of fractured stones, some of which have been successfully refitted and although now may consist of up to seven blocks were probably only one or two large blocks originally. A-10 is still vertical, its base deeply embedded, and probably stood about 1m above the surface at the time of its construction (Wendolf and Malville 2001, p.493). Its azimuth orients it to the rising position of circumpolar star Dubhe, the largest star of the Big Dipper, at a date of c.4742BC (Malville *et al* 2008; Wendolf and Malville 2001, p.500), which pointed to the north celestial pole when no Pole Star was visible for navigation (Malville 2009, p.14). Alignment C, consisting of C1 to C7, was aligned towards Sirius, and refitting suggests that blocks reached a maximum height of around 2m, and a width

of 1.5-2m, and were substantial constructions. Sirius is the brightest star in the night sky and rose after a 70 day absence just ahead of the sun between 27th and 30th May and would have been clearly visible throughout June and July at 4820BC±50 (Malville *et al* 2008; Wendorf and Malville 2001, p.500). Wendorf and Malville state that “[T]he rising stars of Sirius in the dawn, coupled with the northernmost excursion of the sun at summer solstice, may have been viewed as harbingers of the summer rains” (2001, p.500).



Figure 8.18 - Alignment A, Megalith A-2. Tilted and collapsed, originally composed of four upright stelae (Schild and Wendorf 2015, figure 9).

Astronomical knowledge is usual amongst pastoralists. The Wodaabe, for example, act upon the knowledge that when the Pleiades and Orion are set, rains are imminent (Schareika 2003, p.38), and use lunar cycles to time movements to new pastures, maintaining a strict system of moving camps every 2-3 days and moving out of an area every week (Niamir 1991, p.4). In purely functional terms it would not have been necessary to provide a marker to point to the solstice or the stars because such knowledge would have been fundamental. Marking them would not have been about locating them. Instead, the importance of the structure may have been focused on a) incorporating the solar and stellar features into the inhabited environment, b) activities related to renewal of rainfall or similar interests, and c) its actual functions, which may have been multiple, capable of acting as a predictive tool for weather, a scheduling tool for movement, a celebration of the predictable in a stochastic world, an interface to a religious mythology associated with celestial body or a trigger for certain rites of passage. It may also have been a signal of territorial affiliation, communicating the presence of a certain ethnic identity or allegiance.

Whatever its exact purpose, the ceremonial centre seems to have become invested with meaning beyond its value for subsistence. Sapignoli (2014, p.48) says that “virtually all small-scale and middle-range societies have strong locality ties. That is, they have a common territory or area to which they feel a strong connection” whilst Frederick (2014) observes that some sites that are used in a seasonally mobile routine have associations that reinforce identity, ideas and social stability. Above all, the ceremonial elements seem to materialize a

concept of place, in the sense of Tilley when he says that identifying with place “requires work, repeated acts which establish relations between peoples and places” (2006, p.14). Tilley’s view that “self-identity and social identity are bound up with the contingencies and uncertainties of the present and that non-verbal forms of expression are an essential part of that process” (2006, p.16) seem to fit well with the different elements of the ceremonial centre and the need to negotiate and re-negotiate different aspects of the landscape under conditions of variability and vulnerability through time.

The subject of time is raised by Olupona (2014, p.6), who points out that many indigenous African religions have a combination of linear and cyclical time. Bell and Walker (2005, p.11) who also point out that whilst cyclical time (such as repeated daily activities and movements of celestial bodies) may be the usual way of experiencing time, linear time may be marked by unusual events, disasters, and specific memories. It is often difficult to detect an awareness of linear time archaeologically (i.e. one-off events in history or prehistory) but Nabta provides two examples: sequential construction events and repeated depositions of animal and human remains. Nabta also demonstrates an awareness of cyclical time (astronomical observation, re-use of the ceremonial centre for burial events). Crandall (1998, p.109-11) discusses Himba concepts of time in Namibia, where gods live in an eternal realm and humans live within a fragmented, transient temporal scale that is quite different. These may be represented at Nabta by the enduring character of the ceremonial stone structures and the ephemeral nature of the settlements. As Whittle discusses (2003, p.105) time also encompasses ideas of memory and times past: “looking back is a central part of the identities of people.” Again, experience takes place at different scalar levels at Nabta: that of conceptualization followed by erection of monuments and then the repeated actions that take place in relation to it, reinforcing certain memories at the expense of others, but not constraining them. Memories, like Chinese whispers, mutate. Nabta is a “persistent place” (Schlanger 1992; Shiner 2009), attracting visitors for thousands of years. Certainly the surface scatters of previous occupations will have given a sense of both continuity and change, as different cultural materials made up the living landscape, and with each generation the earlier ceremonial components may have entered the realms of myth and oral (Whittle 2003, p.124; Kavari and Bleckmann 2009).

It is important not to overstate the size and number of components that existed at any one time. The stone circle, the varied contents of the tumuli, and the addition of one Complex Structure and two megalithic alignments were not a preconceived design, but something that evolved, building upon original conceptual ideas with new ones. Barratt (1994, p.13) argues against complexes of this sort being the outcome of “a planned intention” and instead suggests that architectural components “should be viewed as a series of localized spaces, created as ongoing projects by builders who rarely glimpsed the totality of their creation” (p.14). Whilst there are running themes throughout the ceremonial centre that indicate a unified conceptual scheme it was not known what the conceptualization was, but it was

sufficiently valuable to be elaborated over time. In other words, there was a demand that the constituents of the ceremonial centre supplied.

Wendorf and Schild see developments in the Late Neolithic as the emergence of the “African Cattle Complex”, in which cattle serve to symbolize status and power (Wendorf and Schild 1998, p.113). However, the tumuli, with mixed cattle, sheep, goat and, in one case a canine, do not seem to amount to strong evidence for a cattle cult, a concept introduced by Herskovits in 1926 and discussed exhaustively ever since. There are no direct analogues between the burials at Nabta and the complex burials in the Sudan. In Sudanese cemeteries bucrania were found buried with human interments (Chaix *et al* 2012; Paris 2000; Reinold 2001, p.2-10; Schild and Wendorf 2001, p.16-17; Wengrow *et al* 2014), and cattle were also important in central Saharan mid-Holocene contexts, where cattle burials have been found (di Lernia 2006). A number of writers have recently discussed the importance of relationships of herders with their livestock (Dittrich 2017; Honeychurch and Makar 2016, p.350-351; Oma 2010; Orton 2010; Russell 2010; Sykes 2014) and emphasize how there is often not a clear delineation between human and animal members of the community. Whatever symbolic role cattle may have had during the Ru’at el-Baqar at Nabta, they should not be isolated from goat, sheep, canine and human, which are also represented in some of the tumuli.

Woods, conflating the Ru’at el-Baqar and the Bunat el-Ansam Final Neolithic, believes that wadis were “places of potency and power since they were channels for run-off of the life-giving rains as a result of rains” (2016, p.188) and interprets the ceremonial components as rituals centred on wadis relating to supernatural forces when rains failed, as they must have done during the mid-Holocene, overseen by a special rainmaker (2016, p.194). This echoes Wendorf and Schild who say that the wadi was “an ideal place to bribe the gods and beg for rains” (Wendorf and Schild 2004, p.12). Woods describes a conceptual worldview incorporated into the ceremonial centre, “a three-tiered cosmos: the heavens, the earth and the underworld represented by the pits under the complex structures” with the carved stone in the shape of a cow perhaps representing “a shamanic rain animal” employed by the shaman in rainmaking rituals (2016, p.194-5). Given the lack of any concrete evidence for any shamanic activity at Nabta and the lack of any data about the economic dependency of groups on Nabta, I prefer a more abstract interpretation that accepts the importance of the different components without attempting to nail a specific religious framework or function to them.

With elements repeated but not duplicated, the ceremonial components seem to have formed a narrative over time. It could be the perfect illustration of Tilley’s belief that places “are in flux rather than static nodes or points in a landscape” (Tilley 2006, p.21).

Ritual and rites of passage

At Nabta the only signs of ritual activity are the deposition of animal and human remains within the tumuli described above. As discussed above, construction and ongoing ritual activity exist within two separate types of time: linear (the construction of the monument as a fixed point in space and time) and ongoing (where the place is fixed but the activity is

repeated and possibly cyclical). At the same time it is embedded in memory, which may have been described in myth or other oral history (Whittle 2003, p.124; Kavari and Bleckman 2009).

Except in the case of the articulated young cow found at E-94-1S, animal remains are disarticulated and scattered throughout tumulus components (e.g. sites E-97-4, E-97-16, E-94-1S, E-97-6 and E-96-4), perhaps in series of repeated events, each tumulus growing as new animal remains were added. The human remains in E-97-5 were in poor condition but it is certain that some skeletal components were missing, either lost before deposition, deliberately excluded, or removed after burial, leaving open the possibility that specific ritual activities surrounded the treatment of the young male with the tumulus. Whittle emphasizes that “an important element of creativity in the renewal of tradition” may be a part of how rituals were enacted (2003, p.124), and this might account for the differences in how the tumuli were used and what was deposited within them. The deposition of bones that had apparently been butchered prior to burial, suggests that some sort of socially motivated activity, such as group sharing of meat, or ritual offerings may have taken place prior to deposition. Important occasions like rites of passage or sacrifices to deities might merit the killing of an animal, which represents a loss of resources, including milk, blood, meat and reproductive value. Russell (1988, p.74) calculates that cattle provided over 3½ times more calories than sheep and over 4½ more than goat, indicating even when assessed in purely economic terms, the slaughter of cattle is a considerable act of sacrifice.

Wendorf and Malville suggest that the various components making up the ceremonial centre “may have been motivated, in part, by the diminishing availability of water at Nabta and a consequent attention to rainmaking rituals” (2001, p.502). Beyond the contents of the tumuli, any evidence for rituals no longer remains. Stone, however, remains the dominant feature, acting as a durable bridge between the people, the local landscape, including the sky, and beliefs and seem to serve much in the same way as Renfrew’s “attention focusing devices” (Renfrew 1994, p.51-2).

Tradition and social values

The main theme of the Ru’at el-Baqar is a break from previous traditions in the Nabta area and the establishment of distinctive new material output. The idea that objects are involved in communication and social reproduction means that they are often connected to ideas of social change and new ideas, and may reflect major decisions about livelihood strategies (Sørensen 1999, p.185). In the Ru’at el-Baqar there is a remarkable change in form of ceramic material expression. There is no sign of an enforcing hierarchy imposing values, so any form of communication of identity and kinship affiliation is presumably either isochrestic, *sensu* Sackett (1986), or stylistically comparative, *sensu* Wiessner (1984). Sackett’s isochrestic concept is a form of transmitting social relations unconsciously, whereas Wiessner’s stylistic comparison is far more deliberate, a way of negotiating and creating identity and relationships. Hassan emphasizes that people “tend to cling to the paradigms, values and institutions that have proved to be successful in their own past . . . As a result they

are reluctant to undertake corrective actions that go against their social grain” (Hassan 2008, p.41-2). If Garcea and Hildebrand are correct in thinking that Saharan pottery from the early and mid-Holocene acted as “significant cultural markers” (Garcea and Hildebrand 2009, p.310) then the distinctive design of the black-topped ceramics and red wares may be indicative of a broad set of shared values and attitudes, as well as a shared knowledge and skillset amongst craft specialists, together with a rejection of earlier ideas and traditions in favour of new ideologies and concepts. The need to diversify livelihood strategy may have involved experimentation with new areas and the establishment of new contacts. Nelson and Khalifa speculate that greater interaction would have been necessary between groups and that these new spheres of interaction might have led to cultural exchange, eventually leading to the “melding of cultures” as mobility became increasingly constrained (2010, p.140), consistent with Sam and Berry’s observation that increasing interdependence and some assimilation, potentially involving psychological stresses, could lead to cultural responses (Sam and Berry 2010, p.474)

Gatto discusses the implications of “fluidity of group affiliation in boundary areas” and sees the desert and Nile as a nuanced continuum between the Nile and the nearby deserts (Gatto 2009, p.127). Although she is discussing later phases, corresponding to the Final Neolithic onwards, her comments seem to be just as valid for Nabta in the Ru’at el-Baqar. Crumley’s research has shown that in frontier situations there may be multiple boundaries crosscutting each other including social, linguistic, topographic, climatic, administrative and commercial elements, forming a “complex dynamic system” (Crumley 1995, p.2). As Gatto suggests (2009, p.127) the work of Lightfoot and Martinez (1995) is valuable in this context. They suggest that frontiers are “socially charged places where innovative cultural constructs are created and transformed” involving processes of creolization or syncretization (Lightfoot and Martinez 1995, p.472). In the Ru’at el-Baqar Nabta there are four potential frontier-type situations. First, whereas Nabta lies in modern Egypt, it is very near the modern Sudanese border and has more in common with the archaeology of northeast Sudan or Nubia than it does with northern Egypt (Edwards 2004; Gatto 2011; Gatto and Hildebrand 2009), although Nabta is often discussed as a phenomenon contributing to later Egyptian soci-economic development (e.g. Wendorf and Schild 2004). The second scenario focuses on the Nile. Even though Nabta is only a couple of days walk from the river there may have been a perceptual dichotomy between desert and Nile not unlike the Pharaonic period’s mythological distinction between the black land of the Nile floodplain and the red land of the deserts (Sidebotham *et al* 2008, p.21). Whilst there is a third boundary, the natural granite barrier across the Nile at Aswan called the First Cataract, this was only really relevant if water transport was an important factor at the time, which it does not appear to have been. Model boats only appear from the later Badarian (Brunton 1928, p.34; 1937, p.7, 57) and there is no other evidence of water transport in this period. A fourth, and perhaps more realistic type of barrier is each group’s own identity, expressed via material culture, which would have had to be negotiated between groups in a number of ways. As Klima points out in his discussion of

the new knowledge brought in and implemented amongst the Barabaig by exogamous marriages, adoption of new ideas does not necessarily challenge group or kinship identity (Klima 1970) but can reinforce the strength of a group's risk-handling abilities.

As environmental conditions influenced and constrained patterns of movement for all groups using the Western Desert as a resource, people will have circled more closely together. What was happening at Nabta Playa may well be explained by a blending of different traditions, where new ceramics are a component of a revised way of thinking, an outlook that incorporated new conceptualizations of the material world to establish a new and mutually compatible approach to living.

Material articulation

The new ceramic types may be seen as “objects of thought” (Edmonds 1995, p.41), a deliberate response to aspects of economic life, movement through the landscape, stochastic weather conditions, negotiated relationships with Nile valley inhabitants and the cascade of new decisions that these implied. Wobst (2000, p.47) suggests that uniformity of design is a way of reinforcing ideas and routines that are under threat – an act of social interference to preserve certain conditions. In the case of Nabta what began as a way of reinforcing a new way of negotiating between tradition and innovation may have become a way of reinforcing identity over generations, particularly in the face of environmental deterioration.

The ceremonial centre also represents the materialization of concepts. Building on the work of Barratt, Richards focuses on stone circles, in particular, as a negotiated outcome leading to “a reaffirming of relations between people” (Barratt 1994, p. 13-23; Richards 2013, p.7-8). Also appropriate is Tilley's description of landscapes as “systems of signs” that are incorporated into identity and become agents of that identity. The monuments may have been a concrete way of both connecting with the group's relationship with the Nabta basin. Incorporating ideas of time (linked to appearances of celestial bodies), navigation (a familiarity with the night skies) and space (enclosure or definition of space) there are different types of idea built into the circle. The tumuli closely resemble fragmented outcrops, and the all of the monuments were manufactured from local stones rather than imports. This suggests that either the exact material was unimportant to the purpose of the construction or that the material, being local, was a fundamental part of the conception.

Mobility

Whilst most of this case study focuses on the character of the immediate vicinity of Nabta, and the resources that brought people into that area, the perception held by the people who visited Nabta will have comprised a much larger world of multi-vocal landscape use and understanding, as groups moved between areas along familiar routes, where activities were carried out and memories were formed as part of a process of aggregation and dispersal (Bender 1992, p.735; Bender, Hamilton and Tilley 1997; Honoré 2017; Sheller and Urry 2006, p.210; Whittle 2003, p.43). Helpful in this area is Schareika's assessment of the Wodaabe of

southeastern Niger (2003, p.18), where mobility contributes to an individual's status as a good manager of herds which is the only means by which stock loans became available. In the Wodaabe's worldview both animals and men become integrated with the environment "and the rhythm of life exercised therein" (Schareika 2003, p.18). Turton's analysis of mobility amongst the agro-pastoral peoples of the lower Omo valley (southwest Ethiopia) concludes that it is not just a practical necessity but that it is essential to a sense of self: "the very *idea* of movement was a defining feature of what it meant to be Bodi, Mursi, Nyangatom, Daasanach etc . . . In a sense they *were* movement." (2011, p.165, author's italics). Amongst the Ababda of Wadi Allaqi where today women are based at a permanent water source to supervise children and small animals and carry out small scale cultivation, men depart to herd livestock because "being at one with the desert" is important to the sense of identity of many of the men (Belal *et al* 2009, p.131). A similar point was made by Roe (2008) who says that knowledge of the desert confers status on men.

Travelling to Nabta and beyond Nabta may have combined economic activity with the spirit of a pilgrimage, endowing the process of travel with a spiritual component with the route as much as the playa basin containing associations that were unique to that destination (Claassen 2011; Sheller and Urry 2006, p.213). Nabta was a destination that had been materialized both by broadly contemporary site furniture and the development of ceremonial features. Nabta was a place embodied in both the physical and numinous realms of the landscape. This landscape endured but fluctuated and the features at Nabta suggest more than mere adaptation but rather an intention to exert control.

Inter-group relationships

Relationships between Nabta and other areas, presumably mainly to the southeast where material cultural has considerable similarities, are likely. In the Kerma area the mid-Holocene is associated with an intensification of pastoral activity in the 6th Millennium, with settlement sites from Kadruka featuring cattle, followed by sheep and goat and only rare wild remains (Honegger 2014, p.27-28). The spread of the pastoral livelihood strategy could be an indication of links between the two areas, although much more work needs to be done to relate different phases between the two areas, perhaps as a dedicated project. Grandval emphasises that today in Africa mobility relies on a mixture of scouts and extensive social networks for understanding where grasslands are available and what sort of quality they represent (2012, p.3). The maintenance of kinship relationships, the acquisition of marriage partners and the reaffirmation of religious and ideological connections may have made such connections imperative (MacDonald and Hewlett 1999; Whallon 2006). At the same time, the need to negotiate for territory and expand into new areas may have created the "shared visions of space" identified as a concept by Calvo *et al* (2016), a mutable concept that might undergo change as increasing variability in environmental conditions required land use and territorial boundaries to be negotiated. As groups gradually dispersed from increasingly inhospitable desert areas, some converging along the Nile valley (Hassan 1986, p.71) new

ways of mediating relationships and handling resources must have become necessary. The abandonment of a wider regionally relevant symbolic repertoire for a more localized and newly innovated ceramic output could be an indicator of the sort of social mechanism in which “formal and regular relations of mutual accommodation and generalized reciprocity” were established (McIntosh 1993, p.212).

The acquisition of flint has been mentioned, with the closest source 70km to the north, but it is possible that another source was the Kharga or Dakhleh oasis, some 200km away. That there was contact with people from Dakhleh or Kharga is supported by the presence of bifacially worked tools in the Ru’at el-Baqar. There is generally a north-south divide in tool technology, with bifacially worked tools being confined mainly to the north of Egypt (Kuper and Riemer 2013, p.41). The south of Egypt belongs to a different tradition, more closely linked to the Sudan. The presence of bifacial tools in the Nabta assemblage suggests a connection with the contemporary Bashendi B of Dakhleh Oasis or Late Baris of Kharga Oasis.

Freshwater bivalves (Gautier 2001, p.620) reinforce the idea of connections with the Nile, whilst Red Sea *conid* shell (Gautier 2001, p.620) suggest contacts across the Eastern Desert. Agate and jasper may also have been sourced from the Eastern Desert where they are available (Aston *et al* 2000). Acquisition expeditions to acquire flint from 70km to the north may have put people into contact with contemporary oasis inhabitants from Kharga and Dakhleh, as suggested by the presence of bifacials in Ru’at el-Baqar assemblages.

Close (1992) has suggested that E-75-8 might be an aggregation site, an idea also proposed by Woods for the ceremonial centre at Nabta (Woods 2016, p.194). Hofman defines an aggregations as “a means of conducting important large-group activities in environments where situation where continuous long-term large-group coexistence is not viable or economically/socially effective,” the purposes of which could include socially impelled activities, information exchange, sourcing of marriage partners and maintenance of group identity (Hofman 1994, p.346-8). Permanent rather than temporary water sources tend to be preferred (Hofman 1994, p.346), so if one were to predict this type of aggregation, the Nile would be a more attractive candidate. However, predictability of resource availability is another factor, as is the apparent importance of the area from a spiritual and ceremonial point of view. If the waters at Nabta were reliable enough to make it a fixed seasonal destination, this would significantly improve the likelihood of aggregation (Hofman 1994, p.351). None of this either supports or eliminates the possibility that Close was right. Although the size of E-75-8 suggests a concentration of people, and the three separate groups of hearths found at E-94-2 (Mohamed 2001, p.412) might suggest a division of groups based on something other than time, the homogenous nature of the lithic and ceramic assemblage and the shortage of exotic materials do not immediately suggest multiple groups converging on Nabta.

Ethnicity

Cultural output is often used to form and renegotiate identities, meaning that cultural output can sometimes be identified as measures of broad ideas of ethnicity in archaeology

(Barth 1969; Knapp 2014, p.43) but may also disguise more subtle processes. Díaz-Andreu's view of ethnicity is as something perceptual and fluid, rather than something embedded in the material (Díaz-Andreu 1998; 2015), a perception based on "identification with one or more broader groups on the basis of perceived cultural differentiation and belief in a common descent" (Díaz-Andreu 2015, p.102). As Díaz-Andreu says (2015, p.102) "people can identify with one or more broader groups . . . multiple ethnic affiliations usually coexist and overlap in the same person." These larger units of membership may also be subject to challenge and change. How this sort of ethnicity can be identified archaeologically continues to be debated (Bentley 1987; Cribb 1999, p.44-58; Díaz-Andreu 1998; 2015; Knapp 2014; Jenkins 2015; Shennan 1989/1994). The greater understanding of the role of adoption of symbols, trade, exchange and social fluidity (Hodder 1982c, 1982d, 1985, 1990; Kratz and Pido 2000, p.47) indicates that materials are not always unambiguously associated with individual communities but may be more representative of manipulated messages about larger units of membership to which communities belong or with which they associate.

For the mobile pastoralists at Nabta ethnicity may be temporary for the individual and may change in both the short and long term for the community as a whole as conditions change, and particularly if groups are in the habit of forming and reforming and moving through different territories. Social fluidity may exist, and often clearly does (Cliggett 2005; Hobbs 1989; Manger *et al* 1996) within a larger identification with kinship groups, religious beliefs and other core ideas of identity, belonging and differentiation. A general correspondence between ceramics and animal remains in particular, as well as lithics, suggest a broad ethnic association between Nabta and the Middle Nile (Edwards 2004; Honegger 2014; Midant-Reynes 1002/2000; Nelson and Khalifa 2010; Tassie 2014) but ceremonial elements at Nabta are quite unlike anything elsewhere. If Tilley is correct in thinking that places or landscapes can be viewed as agents that actively produce social identity (2004, p.31), and that social identity "always requires specific concrete material points of reference in the form of landscapes, places, artefacts and other person" (Tilley 2004, p.217) then the ceremonial centre may be part of the process by which the groups that came to Nabta differentiated themselves from other groups within and beyond a broader ethnic grouping, with ideas expressed along a continuum between ethnic and kinship group identities.

8.3.1.4 Subsistence Assets

Data for subsistence activities

Food Production

As I have described in chapter 3, the character of the Western Desert rangelands was becoming increasingly unpredictable throughout the mid-Holocene, with water sources both drying up more rapidly and becoming increasingly saline. This would have provided a challenge to subsistence strategies, and in Nabta there seem to have been a variety of

responses, although the data is limited. In the following tables the potential for food production and consumption is examined; in the next section, the mechanisms by which these could have been leveraged is discussed. Tables 8.7, 8.8, 8.9, 8.10 and 8.11 show only samples that have been confidently labelled Ru'at el-Baqar. Those where contexts are unclear have been excluded.

Evidence for domesticated animal species in Nabta Playa			
Specie	Site	Data	Reference
Cattle (<i>Bos primigenius</i> f. <i>Taurus</i>)	Settlement E-75-8	Surface: Upper milk molar, a few tooth fragments and a distal subadult metatarsus, several enamel fragments (surface)	Gautier 2001, p.624-5
		Unit 5: Several tooth fragments , scapula fragments, a proximal half of a first phalanx and possible juvenile sesamoid, a carpal, a distal half of a meta-tarsus,	Gautier 2001, p.624
		Spit 1: Several fragments derived from at least 4 jugal teeth, a scapula fragment and perhaps a metacarpus shaft fragment	Gautier 2001, p.625
		Spit 2: Several fragments derived from at least 7 jugal teeth	Gautier 2001, p.625
		Spit 3: Several fragments derived from at least 6 jugal teeth	Gautier 2001, p.625
		Spit 4: Lower molar fragment, an enamel fragment, a mandible fragment and a metacarpus fragment	Gautier 2001, p.625
	Complex Structure E-96-1	Surface: three enamel fragments	Gautier 2001, p.625
	Tumulus E-94-1N	Articulated cow burial probably about 2½ - 4 years old.	
	Tumulus E-94-1S	Disarticulated cattle remains – up to three individuals, a subadult, a young adult and an older individual. A distal humerus, radius, complete metacarpus, first and second phalanges, other leg elements, part of a vertebral column, two fragments of horncore, two upper molars and one lower third molar.	Applegate <i>et al</i> 2001, p.473
	Tumulus E-96-4	Remains of disarticulated cattle representing four individuals, a one juvenile, one subadult and two juveniles. An astralagus and tarsals of the right leg, left and right distal humerus, pair of petrous temporal bones and a larger left one, two upper third molars, a thin walled long bone.	Applegate <i>et al</i> 2001, p.475

Evidence for domesticated animal species in Nabta Playa			
Specie	Site	Data	Reference
	Tumulus E-97-4	Disarticulated cattle, probably two individuals, a juvenile and subadult represented by a mandible fragment containing five teeth, lumbar vertebrae , a metacarpus shaft and a first phalanx	Applegate <i>et al</i> /2001, p.476
	Tumulus E-97-6	Disarticulated cow - longbone splinters	Applegate <i>et al</i> /2001, p.479
	Tumulus E-97-16	Disarticulated cow, possibly subadult, represented by a mandible, a skull tooth fragment, two molars and some longbones splinters of <i>Bos</i> .	Applegate <i>et al</i> /2001, p.481
Sheep/goat (<i>Ovis ammon</i> f.aries / <i>capra aegagrus</i> f.hircus)	Settlement E-75-8	Bone fragments	Close 2001, p.324
		3 horncore fragments	Gautier 2001, p.624
		Lower 1 st /2 nd molar (spits 1-4)	Gautier 2001, p.624
		Horncore (South Trench B, Hearth F7, subsurface)	Gautier 2001, p.625
		Horncore	Gautier 1980, p.333-334
		A horncore from a young or castrated sheep	Gautier 2001, p.625
	Tumulus E-97-6	Possible anterior cannonbone flake	Applegate <i>et al</i> /2001, p.479
Sheep	Tumulus E-94-1S	Remains of one individual – one front leg and two hind legs	Applegate <i>et al</i> /2001, p.473
Sheep/goat or Dorcas Gazelle	Tumulus E-94-1N	Remains of one individual, semi-articulated. Over two dozen bones including rib and subadult tibia	Applegate <i>et al</i> /2001, p.471

Table 8.7 - Evidence for domesticated animals at Nabta Playa in the Ru'at el Baqar

Hunting and foraging

Evidence for wild animal species in Nabta Playa			
Data	Site	Data	Reference
Dama gazelle	Settlement E-75-8	Unspecified	Close 2001, p.384; Gautier 2001; p.632, Table 23.6
Dorcas gazelle	Settlement E-75-8	Unspecified	Close 2001, p.384; Gautier 2001; p.632, Table 23.6

Evidence for wild animal species in Nabta Playa			
Data	Site	Data	Reference
Hare	Settlement E-75-8	Unspecified	Close 2001, p.384; Gautier 2001; p.632, Table 23.6
	Tumulus E-97-12	Intrusive	Applegate <i>et al</i> 2001, p.479
Barbary sheep (<i>Amotragus lervia</i>)	Settlement E-75-8	2 individuals	Gautier 2001, p.624
<i>Zootecus insularis</i> (land snail)	E-96-1, tumulus (sub)surface	1 individual	Gautier 2001, p.620, Table 23.1
Unidentified small bones	Settlement E-94-2	Heavily burned and too fragmentary to be identified	Mohamed 2001, p.425

Table 8.8 - Evidence for wild animal species exploited in the Ru'at el-Baqar

Evidence for bird species in Nabta Playa			
Data	Context ID	Data	Reference
Ostrich	Eggshell survives throughout Nabta Playa		Gautier 2001

Table 8.9 – Evidence for plant species exploited in the Ru'at el-Baqar

Evidence for plant species in Nabta Playa			
Data	Context ID	Data	Reference
<i>Acacia ehrenbergiana</i>	E-94-2; E-75-8 Area A, top of dune; E-92-7	Charcoal	Barakat 2001, p.599, Table 22.7; Barakat 2001, p.597, Table 22.4; Barakat 2001, p.598, Table 22.5
<i>Acacia nilotica</i>	E-75-8 Area A, top of dune;	Charcoal	Barakat 2001, p.597, Table 22.4
<i>Acacia tortolis raddiana</i>	E-75-8 Area A, top of dune;	Charcoal	Barakat 2001, p.597, Table 22.4
<i>Capparis decidua</i>	E-94-2; E-92-7	Charcoal	Barakat 2001, p.599, Table 22.7; Barakat 2001, p.598, Table 22.5
<i>Cassia</i> sp.	E-92-7	Charcoal	Barakat 2001, p.598, Table 22.5
<i>Chenopodiaceae</i>	E-94-2; E-92-7	Charcoal	Barakat 2001, p.599, Table 22.7; Barakat 2001, p.598, Table 22.5

<i>Maerua crassifolia</i>	E-92-7	Charcoal	Barakat 2001, p.598, Table 22.5;
<i>Panicum turgidum</i>	E-94-3 / E-94-1*	Imprints in pottery	Magid 2001, p.608
<i>Salvadora persica</i>	E-94-2	Charcoal	Barakat 2001, p.599, Table 22.7
<i>Setaria</i>		Imprints in pottery	Magid 2001, p.608
Tamarix leaves, fruits, containing seeds (<i>Tamarix aphylla</i> and <i>Tamarix</i> sp).	E-94-1; E-94-2; E-75-8 Area A, top of dune;	Charcoal	Barakat 2001, p.599, Table 22.7 Barakat 2001, p.597, Table 22.4;
<i>Ziziphus spina cristi</i>	E-92-7	Charcoal	Barakat 2001, p.598, Table 22.5;
* The imprints were derived from sherds from these two sites, but Barakat does not specify which imprints were derived from which site.			

Table 8.10 – Plant species that may have been exploited in the Ru't el-Baqar

Evidence for aquatic species in Nabta Playa			
Data	No.	Context ID	Reference
Freshwater bivalves	4	E-75-8, S-trench (sub)surface	Gautier 2001, p.620, Table 23.1
	1	E-75-8, spits 1-4	Gautier 2001, p.620, Table 23.1
Small freshwater gastropods	15	E-75-8, C to F, surface	Gautier 2001, p.620, Table 23.1
	1	E-75-8, spits 1-4	Gautier 2001, p.620, Table 23.1

Table 8.11 – Evidence for aquatic species in the Ru'at el-Baqar

The presence of remains of cattle and sheep/goat, together with the presence of tethering stones, are evidence for the presence throughout at least part of the Late Neolithic of herded animals. There has been no question about the domesticated status of sheep/goat and Gautier is confident on the basis of osteometric data from the Nabta tumuli that cattle were “beyond doubt ‘good’ domestic cattle” (Gautier 2001, p.628).

As well as the presumed mixed pasture, there are a number of specific plant species represented at Nabta with properties that are recognized by today's Eastern Desert Bedouin as excellent animal fodder plants, with fruit, leaves and young branches of all *Acacia* species, *Maerua crassifolia*, *Panicum turgidum*, *Crassifolia decidua*, *Tamarix tortolis* and *Tamarix nilotica* and *Ziziphus spina-cristi* providing high value nutrition for herbivores (Goodman and Hobbs 1988; Hobbs 1989; Mahmoud 2010; Springuel 2006). Some of the trees, due to their

shape, would have been particularly useful for providing shade for herds, particularly the umbrella-shaped tree *Acacia tortolis*.

Of the wild animal species, all are arid and semi-arid tolerant (Gautier 2001). Bone assemblages indicate that gazelle and hare were dominant, making up 61.1% of the assemblage (with hare at 41.1% and gazelle at 58.9%) (Gautier 2001, Table 23.6 and 23.7, p.632-3), but see **Human Assets** for how this is measured in dietary terms.

In human burial E-97-17 although no mandible survived, thirteen friable teeth were available for analysis, and these have suggested to Irish (2001, p.523) that the individual was probably an older adult who consumed a large amount of plant foods, the wear being consistent with agricultural diets, and probably the result of eating intensively gathered wild seeds. This is supported by the presence of grinding stones and the admittedly small number of botanical remains (Irish 2001; Magid 2001, p.608). Chenopods may have been used as a subsistence asset. Harlan (1989, p.70) quotes Gast (1968) who describes how *Chenopodium vulvaria* L. was subject to grazing bans by the Kel Ouilli of Hoggar for two months until wild seeds had matured and could be harvested. Harlan emphasizes the importance of *Panicum turgidum*, which is the primary grass in the southern Sahara and is still harvested in some areas (Harlan 1989, p.71). A deep-rooted perennial, it can be collected by beating with a stick and is often ground into a form of porridge. As a perennial, *Panicum* is vulnerable to over-grazing, which can threaten soil stability as its root system forms a loose mesh of stolons.

Practice of subsistence activities

Numerous grinding stones are indicative of the exploitation of plants, particularly seeds. Research by Lucarini (2014b) suggests that in mid-Holocene Farafra oasis, where grinding stones were also present in large numbers, “small and unretouched flakes or blades, probably hand-held and used without being hafted, may have been used to cut a limited amount of plants” (2014, p.366). The wear on teeth from the burial at E-97-17 also supports the proposal that intensive plant collection took place (Irish 2001, p.523). This is given additional support from the plant impressions of drought-resistant *Panicum turgidum* (Magid 2001, p.608), the grains of which are used by the Tuareg in the central Saharan Ahaggar Mountains in the central Sahara for grinding into a flour to make into porridge (FAO Grasslands Species Projects *n.d.*). The Sahelian annual *Setaria* (Magid 2001, p.608), a member of the millet group is also used for making porridge today (FAO Grasslands Species Projects *n.d.*) and has been found at other Holocene archaeological sites (Garcea and Mercuri 2007, p.97). Both species can be used for human consumption and are valued today as animal fodder (Magid 2001, p.608). The umbrella-shaped tree *Acacia tortolis*, which is recorded from Ru’at el-Baqar contexts, is known for promoting the growth of palatable grasses beneath its canopies.

According to Edwards and O’Connell (1995, p.772) seeds were probably most important “when groups were closely tied to permanent or near-permanent water sources and entirely dependent on foods available within a day’s round-trip walk” and after the depletion of

higher-ranked resources, which would suggest that intensive plant collection would have taken place towards the end of each visit to Nabta, when a pattern of “lower risk foraging” around a plentiful water supply with a wide area of pasture and forage became “higher risk foraging” (Ramsey *et al* 2016). Edwards and O’Connell estimate that without factoring in travel and search times, it takes between two and seven hours a day to collect and process seeds for just half of the daily calorific intake for a family of five (2005, p.775). Other examples of time-consuming seed gathering are provided by Cliggett (2005, p.4) and Brokensha (1975, p.25). However, there are clearly exceptions. Kuper and Riemer cite the cases of the Tuareg in Mali where one man can gather 50kg of grass seeds in a day, and the MahMahria nomads in northern Darfur where 33 women harvested about 375kg per season (Kuper and Riemer 2013, p.55). Out *et al* (2016), have found substantial evidence of mid-Holocene plant processing in the mid-Holocene along the Nile in cemeteries R12 (Upper Nubia) and Ghaba (Central Sudan), describing the findings as evidence of “a plant-based economy” (Out *et al* 2016, p.50).

Cattle are a minority in the bone assemblages, making up 12% of the remains, whilst small livestock represent 27% of Late Neolithic remains. Gautier (2001, p.631) concludes that either cattle herds were never large at this time, or that there was a reluctance to slaughter animals for consumption. In practice small herds produce sufficient milk for small communities and today most herders only maintain large herds for social status and bridewealth (Little and Leslie 1999, p.242; Richerson 2001, p.78; Schareika 2003, p.9) but some still accumulate large numbers as a buffer against risk (Næss and Bårdsen 2013; Richerson 2001, p.78). Research by Dahl and Hjort indicated that only 4-8% of herds were slaughtered each year in modern pastoral groups (1976). This is in keeping with the suggestion by Nelson and Khalifa that most of the vessels found at Nabta were too small and open-mouthed for grain storage purposes and that they may, instead have been used to collect, process and serve milk and blood (Nelson and Khalifa 2010, p.139), although Daniel Miller’s comments about the failure of pottery forms to match functions in at least one ethnographic example should be remembered (Miller 2010, p.47).

It seems likely that livestock stocking rates were heavily influenced by the perceived reliability of Nabta as a source of wet season pasture and water deposits. Although there is insufficient data to inform a firm answer, Campbell *et al* (2006) suggest that on a continuum between a constant stocking rate (where a low or high constant number of heads of herd is maintained) or a variable/ “tracking” stocking rate (where numbers vary in dry and wet years and are either within ecological carrying capacity or at the level of ecological capacity) constant strategies are followed when tracking rainfall is difficult (Campbell *et al* 2006, p.76-78, 82). Groups moved away with herds only after digging wells to access the groundwater down to around 2-3m (Kobusiewicz 2003, p.97). The Nile was only a one to three days walk away and plenty of water would have been available when the Nile was reached.

Hunting of arid-adapted species took place, with the evidence of a small number of animal bones supported by the presence of a microliths and bifacial arrowheads, both a minority in the Ru'at el-Baqar assemblage. Preferred species appear to have been gazelle and hare (Gautier 2001). Both were lightweight, with a maximum weight of 75kg, and would have been relatively easy to transport from the point of kill to where it was needed for consumption. Little discrimination was made between male, female, adult or juvenile, suggesting that both gazelle and hare were hunted opportunistically (Gautier 2001, p.632). Heavily burned and fragmentary faunal remains from E-94-2 probably represented small mammals and birds Mohamed (2001, p.425).

Wendorf and Schild (2001c, p.480) suggest that when compared to the Ru'at el-Ghanam Middle Neolithic a shift in raw materials and fewer blades indicate a decline in hunting. Combining hunting, foraging and herding as well as craft manufacture will have required much more skill than exclusively hunting and gathering livelihoods in terms of mobility, scheduling and perhaps territorial negotiations (Dale *et al* 2004; Marshall and Hildebrand 2002, p.112) leading to new ways of handling subsistence, potentially involving separate parties for herding, hunting, foraging and livestock management both close to settlements and over distances.

The potential for and indications of trade networks

Exchange depends on both demand and a source of supply. Products with the potential for trade locally, between households or groups at Nabta, are domesticated animals, dairy products, ceramics and marriage partners. Objects that might have been exchanged both within groups and between neighbouring groups, like basketry, cordage and leather goods have not been preserved (Hurcombe 2014) but are likely to have capital value.

Where longer distance trade is concerned, direct or indirect, the most obvious line of archaeological investigation is to identify items that could not have been sourced locally, determined by materials or other suitable criteria. Shirai proposes (2006, p.14) that following the diffusion of goats and sheep from the Eastern Desert, there would have been ongoing movements between the Red Sea coast and the Western Desert, with trade and exchange links expanding through time, beginning with Neolithization and developing with the wide dispersal of Red sea shells and other items from the 6th Millennium BC. Whilst freshwater shells from the Nile would have been easy to acquire, the presence of Red Sea shells (Gautier 2001, p.633) suggests either long distance movements or exchange networks. The latter is perhaps a more likely scenario given the specialist knowledge that would be required to acquire the shells and navigate the Eastern Desert.

Hand-made ceramics might have been used for exchange both between households and between groups but there is no sign of specialized or centralized production, and it seems likely that pottery was produced by each group as required, rather than traded, possibly on a household basis (Arnold 1985; Balfet 1965; Needler 1984, p.184; Rice 1987, p.183-91). The expedient character of the lithic toolkit renders it unsuitable for trade. Although flint itself, as a

raw material, may have been desirable there are no indications that this was stored at Nabta for export. The presence of bifacials at Nabta, probably originating from Dakhleh or Kharga, gives some support to the idea that these were acquired rather than made at Nabta, but it is not clear what might have been offered in return. Given the lack of any indication of items used in exchange, it seems most probable that any trade and exchange negotiations took place not at Nabta itself but at other places on the seasonal round.

Labour

It is probable that the availability of labour was an important influence on how many livestock were moved at any one time, by either households or by chosen members of the group (Belal *et al* 2009, p.101; Wendorf and Schild 1980, p.271). The task of moving mixed herds to Nabta will have required healthy and knowledgeable herders and suitable participants for any additional activities that needed to take place. In the quieter periods, raw material acquisition and tool and craft production are probable activities, although care must be taken to that livestock does not wander too far, particularly during the rainy season (Vivelo 1977, p.86). Table 8.12 shows Schareika's break-down of pastoral activities amongst the nomadic Wodaabe, who manage herds on a household basis but include options for aggregation, with each family (a man, wife, their children and sometimes including two generations of married men with their wives and children) owning around 44 head of cattle and 11 sheep (Schareika 2003, p.2, 16).

Time of the Day	Herd Activity
Just before sunrise	Inspecting the herd
After sunrise	Milking the cows; freeing calves from calf rope
Morning hours	Morning pasture
Noon	Cattle rest; calves separated from herd
Afternoon hours	Afternoon pasture, sometimes without herder
Late afternoon	Calves tethered to the calf rope
Early evening	Herd comes back from pasture; lighting herd fire
Before sunset	Milking the cows
Before sleep	Tethering older calves to the calf rope
During the night	Night pasture, only supervised when in the vicinity of fields

Table 8.12 - Herders' daily routine (Schareika 2003, p.16, Table 1)

In table 8.12, putting the herds out to pasture “is an activity that supplies the animals with grass, browse and water, and structures their own and the herders’ daily routine” (Schareika 2003, p.13). As water is essential for the health of the herd and particularly for lactating females (Little and Leslie 1999, p.12) water provision would have been a major part of both the daily and seasonal rounds. Where multiple groups use the same pastures and water sources this is also the time when herders and their livestock come into contact with others, exchanging information and negotiating access to limited resources (Cligget 2005, p.81-83; Bollig 2009; Johnson 1999). Towards the end of the seasonal occupation at Nabta it is possible that animals would have been watered manually as the lake evaporated and the water table dropped and had to be extracted from wells (Kobusiewicz 2003, p.97; Schild and Wendorf 2001b, p.47).

Plant gathering is a more intensive activity requiring the gathering of a substantial amount of plant foods to feed a household, particularly if seed is a major component of that plant intake (Edwards and O’Connell 1995, p.772; Cliggett 2005, p.4; Brokensha 1975, p.25). It is possible that this was carried out by women and children if they were present at Nabta, thereby dividing the labour within the community. Although organized hunting expeditions among pastoralists may be an activity carried out co-operatively (Vivelo 1977, p.86) wild animal capture might also be opportunistic, based on animals coming to drink at the playa. As well as meat, fat, blood and bone marrow, wild specie carcasses were almost certainly used for extracting bones, horns, hides, feathers, and other materials for craft manufacture (Abati 1998, p.127).

Unfortunately there is again not enough data to look at opportunity costs in the distribution and deployment of labour. However, if a balance between hunting, herding, foraging and collection of plant materials for crafts was required, the main decisions governing the composition of the groups visiting Nabta would be based on the skills required in each of those areas, so could well have included women and children. Whether the entire community was present at Nabta, or just a mobile proportion of it is unknown. There are options along a continuum of group membership that permits a certain amount of fluidity, so the occupation at Nabta might, at any one time, represent no more than a few households, for example, from a much larger community (Belal *et al* 2009, p.135; Schareika 2003, p.2; Wendorf and Schild 1980, p.270).

Knowledge and information

Both the transmission of knowledge and the ability to acquire information are represented at Nabta. Knowledge is embedded in mobile lifestyles, in knowing how and where to move and how to behave, *en route* to and on arrival at the destination (Al-Tabini *et al* 2012; Klima 1970, p.25; Muller *et al* 2007; Schareika 2014). At Nabta knowledge is embedded in both economic and social dimension of life and would have been transmitted from one generation to the next. Amongst the Ababda of Wadi Allaqi, for example, “women have developed a deep environmental knowledge of the different types of grazing available in

their immediate surroundings,” which enables them to ensure that livestock eat the correct species, both terrestrial and aquatic, at the correct time, avoiding other species that livestock may choose to consume but which will cause health problems (Belal *et al* 2009, p.135). Children and young livestock can grow together “in a way that intertwines their life histories” (Dittrich 2017, p.72) leading to the development of both practical pastoral skills and an embedded understanding of the role of animals in society.

Information, more transient, is less easy to observe archaeologically but is implied by the repeat presence of groups at Nabta who must have known, either by sending scouts (Grandval 2012, p.3) or by obtaining information from others (Galaty 1991; Harir 1996, p.95) that water and pasture were available and was sufficient to support herds and attract game.

Mobility

The Ru'at el-Baqar was a period during which groups set up temporary camps in the vicinity of the main basin and sub-basins in order to take advantage of the ephemeral waters that gathered following seasonal rainfall. By being fully nomadic or transhumant, pastoralists can optimize the productivity of their herds by driving them to rich resources to ensure that they gain weight, improve the quality of the meat they provide and maximize dairy production (Grandval 2012, p.2; Harir 1996, p.97-98; Manger 1996c, p.179; Schareika 2003). The view that these visits were no more than a few weeks or months at most in duration is supported by the number of hearths that were used for short periods, the lack of substantial concentrations of artefacts and the absence of habitation structures and the ephemeral nature of the playa lake and pools (Close 2001; Nelson 2001a; Królik and Fiedorczuk 2001; Mohamed 2001; Wendorf and Schild 2001b).

There is sufficient similarity in pottery styles between Upper and Lower Nubia and Nabta at this time (Garcea and Hildebrand 2009, p.307) to suggest that the movements of Nabta groups brought them into contact with pastoralists of the Sudanese Nile valley. Certainly an east-west or northwest-southeast movement would be a good strategy for optimizing different types of environment at different times of the year and it seems unlikely that the Nile was not part of the seasonal round (Garcea and Hildebrand 2009, p.319) and there is evidence for a north-south axis in the 5th millennium BC (Edwards 2004; Gatto 2011; Gatto and Hildebrand 2009).

The presence of Eocene flint, the nearest source of which was 70km to the north (Mohamed 2001, p.422; Królik and Fiedorczuk 2001, p.340), suggests a 140km round trip to that part of the seasonal round. It is unlikely that the Nabta groups extended north of Dakhleh, due to the marked difference in cultural remains between the Nabta area sites and those to the north of Dakhleh and the lack of any data to substantiate contacts (Riemer *et al* 2013). 100km from Nabta, very small sites at Bir Safsaf revealed late Neolithic stone tools, and may have been part of the resource base of Nabta, the source of pools of water and patches of vegetation, used for only very brief periods (Close 1990, p.92; 1996; 2000a as part of a risk-spreading practice. If the Kharga and Dakhleh area was used a 400km round journey

could have been completed, but it is only a matter of speculation that this happened. Further work in Kharga should help to clarify if Nabta had connections with the oasis during the Ru'at el-Baqar.

The Fulani/Borani model of perpetual movement (Binns 1992) does not seem to apply in this case. A more plausible one is that of the G/ui and G//ana where groups depend upon rain-filled depressions in the central Kalahari for up to two months in the rainy season and then disperse into smaller family sized groups in the dry season (Hitchcock and Ebert 1989; Sapignoli 2014, p.44). Another plausible model is that of transhumance (Wendrich and Barnard 2008, p.7-9), where part of the community stays behind and a group detaches to take herds into the wet season grasslands. Wendorf and Schild (1980, p.270) cite the example of the Nile-based Awazim Bedouin, in Central Egypt who still use six playa lakes, limestone basins and blocked wadis. The wadi of Ramdin was used for at least 200 years by the Awazim, and is cultivated. Nearby wadis are used for sheep and goat grazing every three to five years. The area can only be used following rainfall and produces good quality crops. A group of twenty, taking one to two days remain for around a month. A plausible model is that in order to take advantage of pasture, the desert was used in the wet season, and that the zones immediately surrounding Nabta were more intensively used as the wet season came to an end and pastures dried, until it had to be abandoned for the seasons.

Land Tenure

During the period of occupation at Nabta, more than one group could theoretically have been in residence at the end of the wet season. Binns (1992, p.177) points to the need for reciprocal arrangements between groups using marginal areas, and Sapignoli observes that connection to place is a strong driving force that can exceed shared language and identity (Sapignoli 2014, p.48-49). Lenssen-Erz (2012) has argued convincingly that rock art and archaeology (6000 and 4300BC) in the Ennedi highlands of Chad, where rainfall was between 150-250mm demonstrate that different groups of pastoralists occupied the area simultaneously. He believes that the rock art depictions, which can be grouped according to a number of criteria "are pictorial manifestations of localised identities," the means by which the landscape is appropriated (paragraph 30) and one of the devices by which territories are negotiated. He also suggests that whilst several groups were using the same resources, the wide open plains would have made cooperation more practical than conflict (paragraph 31). Whilst there is no rock art at Nabta, it is possible that the ceremonial components formed a similar function, establishing a right to access the basin area. McCorriston *et al* proposed that social strategies, particularly cattle sacrifice, may have been used as devices of risk management, specifically "boundary defense behaviour" in the Neolithic of southern Arabia in the early Holocene (McCorriston *et al* 2012, p.47). Similar arguments have been proposed for areas in northern Africa where signs of social complexity, the presence of burials and the

introduction of storage and less mobile lifestyles have been connected with the idea of ideas of land tenure in the early Holocene to mid-Holocene (di Lernia 2001; Garcea 2004; McDonald 2008; Sereno *et al* 2008). However, assessing Nabta in these terms has produced no evidence of either conflict over or sharing of resources.

The appearance of new types of pottery at Nabta in the Late Neolithic requires some explanation and one possibility is that following the better conditions of the early Holocene the Nile became more important to both hunters and herders, who found themselves in increasingly close proximity, sharing land on a rather more formal basis than before, and creating new ways of creating and sharing identity whilst maintaining and supplementing livelihoods, with traditional toolkits. These features could relate strongly to the need to share land or to identify ownership of land that was in close proximity to other parcels of land that was held by other communities as part of what Sam and Berry refer to as “acculturation” (Sam and Berry 2001).

8.3.1.5 Human Assets

Potential nutrition

This section represents the optimal nutritional possibilities under conditions of maximal use of all options visible in the archaeological record at Nabta. The data presented in **Natural Assets** suggested that the visitors to Nabta practiced hunting, herding and foraging for wild grasses, and were mobile for at least part of the year. Seeds, roots, tubers and other plant resources that were almost certainly employed but are not found, will not be referred to.

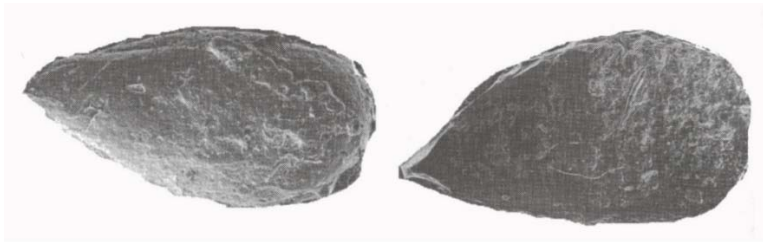
The following tables, 8.13 and 8.14 list the complete data available for the Ru’at el-Baqar from the point of view of nutritional requirements.

Nutritional Values of Plant Species	
Species	Use
<i>Acacia ehrenbergiana</i>	Used today by the Bedouin for making a type of coffee.
<i>Acacia nilotica</i>	Edible gum can be obtained from the bark and soft inner bark may be used to curdle milk. Seeds and pods are also sometimes eaten. Traditionally used for medicinal purposes.
<i>Acacia tortolis raddiana</i>	Traditionally used for medicinal purposes.
<i>Capparis decidua</i>	Edible and well flavoured fruits with high quantities of phosphorous and calcium, and useful quantities of fat and protein. Traditionally used for medicinal purposes.

<i>Chenopodiaceae</i>	Used as herbs and leaves for human consumption. Provides nitrogen and absorbs salt, so is a useful source in human diets.
<i>Maerua crassifolia</i>	Fruits are valued by the Bedouin for their sweet taste and they are a good source of nectar for honey. Leaves are a good source of calcium, linoleic acid and alpha-linolenic acid.
<i>Panicum turgidum</i>	Contains high levels of potassium, phosphorous, sodium and calcium. The grains are used by the Tuareg in the central Sahara for grinding into a flour to make into porridge
<i>Salvadora persica</i>	Fruit can be eaten fresh, cooked, dried and stored or made into a fermented drink. Leaves are eaten as a green vegetable or made into a sauce. A source of nitrogen, phosphorus, potassium, and calcium
<i>Setaria</i>	A member of the millet group which has again been used for making porridge
Tamarix leaves, fruits, containing seeds (<i>Tamarix aphylla</i> and <i>Tamarix</i> sp).	Traditionally used for medicinal purposes.
<i>Ziziphus spina cristi</i>	Fruits are well flavoured and have a high vitamin C content. Traditionally used for medicinal purposes.
Sources of nutritional data: ARKive n.d.; Cook <i>et al</i> 1998; FAO Grasslands Species Projects <i>n.d.</i> ; Heneidy, S.Z. and Halmy, M.W. 2009; Kew Gardens: Useful Plant and Fungi <i>n.d.</i> ; Mahmoud 2010; Springuel 2006; van Wyk <i>et al</i> 2011.	

Table 8.13 – Ru’at el-Baqar period plant species

As Layton *et al* suggest, wild grasses tend to rank low in an optimal diet regime in dryland environments (1991, p.260), but the contribution of wild cereals can be inferred from the large number of grinding items at the site. *Panicum Turgidum* (figure 8.19-a) and *Setaria* (figure 8.19-b) grain impressions on pottery (Magid 2001) are evidence of the use of cereal plants at Nabta, and it can be assumed that much greater quantities than those represented by these two examples were present and consumed, providing valuable nutrients, including calcium. Both are illustrated in figure 8.13. *Panicum* is one of the most important grains in Africa today, the most abundant and the first to ripen after rains. It requires little preparation, is easy to digest and can be stored with little loss of quality for up to two years (S.E. Smith 1980, p.471). *Setaria* is often used as a form of porridge in the Sahara and is also eaten by animals as fodder, which also contributes to human nutrition (Magid 2001, p.608). Out *et al* (2016) suggest that during the mid-Holocene wild grasses and fruits were very important in subsistence strategies, but at Nabta, without knowing what else was employed it is impossible to comment. The fruit available provided sugars, carbohydrates and calories, as well as vitamin C in the case of *Ziziphus spina cristi*. At E-97-17, Irish has confirmed that wear on teeth are consistent with high volumes of plant food in the diet (Irish 2001). It is



a

b

Nutritional Values of Animal Species		
Species	Seasonal availability	Value
Antelope (various African species of the family Bovidae that are not sheep, goat, cattle), but most likely to be gazelle	At any time	Meat products: protein; iron, zinc, fat
Barbary sheep	At any time	Meat products: protein; iron, zinc, fat
Cattle	<p>Dairy products: Only when animals are lactating (3-8 months)</p> <p>Blood: available all year round but less during dry-seasons and not at all during drought</p> <p>Meat; at any time</p>	<p>Dairy products: Calcium, Vitamins A, C, D, zinc, phosphorous, fat (4-5.5%), carbohydrates</p> <p>Blood products: Iron, zinc, protein, some calcium and phosphorous.</p> <p>Meat products: protein; fat; folate/folic acid; Vitamins A, B2, B3, B6, B12</p>

Dama gazelle (<i>Gazella dama</i>)	At any time	Meat products: protein; iron, zinc
Dog (<i>Canis lupus</i>)	At any time	Meat products: protein; fat; folate/folic acid; Vitamins B2, B3, B6, B12, zinc
Dorcas gazelle (<i>Gazella dorcas</i>)	At any time	Meat products: protein; iron, zinc
Fowl	Non migrating species: any time Migrating species: winter months	Meat: protein, fat, Vitamins B2, B3, B6, B12, zinc. Eggs: fat, phosphorous, protein
Goat	Dairy products: Only when animals are lactating (3-8 months) Meat; at any time	Dairy products: Calcium, Vitamins A, D, phosphorous, zinc, fat (3.5%) Meat products: protein; iron, zinc, vitamins A, B2, B3, B6, B12, D, carbohydrates
Hare (<i>Lepus capensis</i>)	At any time	Protein, lipids, cholesterol, sodium, potassium, iron, calcium, phosphorus
Jackal	At any time	Meat products: protein; iron, zinc
Ostrich	Meat: at any time Eggs: winter	Meat products: low in fat but is high in protein, vitamin B12, selenium, niacin, vitamin B-6, phosphorus and zinc and smaller but significant levels of thiamine, riboflavin, pantothenic acid, iron, potassium and copper Eggs: high in fat and contain vitamin A, thiamine, zinc, calcium, iron, magnesium and manganese
Porcupine	At any time	Protein, iron
Sheep	Dairy products: Only when animals are lactating (3-8 months) Meat: at any time Blood: at any time	Dairy products: Calcium, Vitamins A, C, D, phosphorous, zinc, fat (5%) Meat products: protein; fat; folate/folic acid; Vitamins A, B2, B3, B6, B12, D, carbohydrates Blood: Protein, iron, salt

Table 8.14 – Potential nutritional contributions of animal species in the Ru'at el Baqar

Gautier's analysis indicates that cattle are a minority in the bone assemblages (61.1%), whilst sheep/goat represent twice the amount (12%), and wild species the rest. The difference between cattle and sheep/goat can be accounted for by either Nabta groups using cattle herds for blood and milk or being reluctant to slaughter cattle (Gautier 2001, p.631). In purely dietary terms: "if we turn to dietary ratios, it becomes clear that livestock contributed substantially more to the diet, because the live weight and hence dressed carcass weight of sheep or goat (50kg?) and cattle (250g?), exceed markedly that of hare (3.5kg) and the combined gazelles (20kg)." Gautier estimates that by the Ru'at el-Baqar cattle make up about 12% of the diet and and small livestock make up around 26.8% of the diet, whilst wild species

make up 61.1% (Gautier 2001, p.632). Porcupine meat is considered to be a delicacy in North and West Africa and is slow-moving, meaning that it is easy to catch, and it can weigh up to 30kg (ARKive, *n.d.*). Combined with the likelihood that cattle, goat and sheep were used for blood and milk as well as, or as an alternative to meat, this argues that the potential diet for the short season at Nabta was potentially very strong on animal products and high in protein. Ostrich has a number of nutritional benefits. Their meat is rich in protein iron and zinc.

Using the tabulated data in Appendix F and the above tables as guidelines, the above nutritional components could have provided the inhabitants of Nabta with a diet rich in protein, fat, iron and calcium but short of carbohydrates, polyunsaturated fats and certain vitamins that are confined to plant foods, such as vitamins C and E, folic acid, magnesium, and potassium. It is certainly the case that the diet of the Turkana consists primarily of milk during the rainy season in northwest Kenya (Galvin and Little 1999).

These deficiencies, if real, could have led to poor energy levels, high blood pressure, slow healing of wounds, scurvy, and muscle weakness. Fortunately, the occupants of Nabta were not present long enough for any of these conditions to develop, and the lack of green vegetables in the archaeological record is very unlikely to be an accurate reflection of the available vegetation.

Evidence of physical condition

The only burial that is securely dated to the Ru'at el-Baqar is the one in tumulus E-97-5. Although not particularly well preserved, and missing its cranium and other parts of the body, the skeletal data "suggest a young and healthy individual" with no sign of stress on lumbar vertebrae (Applegate *et al* 2001 p.478). It is impossible, however, to extrapolate from this one example. The much less securely dated burial at E-97-17 relateds to old age at the time of death, with severe dental attrition consistent with an "intensive gatherert" type diet and the teeth and mandible are suggestive of Sub-Sharan affinties (Irish 2001, p. 523).

Skills and knowledge

Although much knowledge may be transmitted with ease between generations, specific technological skills may require more investment. Probably produced at the household level on an *ad-hoc* basis, (Arnold 1985; Balfet 1965; Rice 1987, p.183-91) this was entirely compatible with a pastoral, mobile lifestyle (Grillo 2014; Eerkens 2008). The knowledge of pottery manufacture may have travelled within and between households over the generations. These types were already in use in the Nile Valley (Gatto 2002b; Nelson and Khalifa 2001), suggesting that they represent the adoption of a pristine invention by one or more groups, and the transfer of knowledge to others who seized both the technological and cultural opportunity.

8.3.1.6 *Personal Assets*

Individual status

Whether pastoralism led to new perceptions of roles is unknown, but the potential for new roles based on scheduling and external negotiations regarding trade and land use may have led to differentiated status amongst some individuals in society, if only on a temporary basis. The design of the ceremonial centre suggests that at least amongst a part of the population there may have been the opportunity to make an individual contribution to some of the ideological decisions that were made and the activities that took place at Nabta.

Security

There are no signs of conflict or competition for resources, and the use of Nabta over a period of centuries argues that it was regarded as a secure and attractive resource. Towards the end of the Ru'at el-Baqar conditions were certainly highly variable as aridification leading up to the arid phase became more obvious and was eventually accompanied by abandonment of the desert areas. Feelings of security may have been undermined towards the end of the Ru'at el-Baqar when Nabta, and whatever ideas were tied up in the ceremonial centre, had to be abandoned.

Ability to influence decisions

Most pastoral societies include a number of individuals in decision-making processes (e.g. Schareika 2014) and it can be proposed, on the basis of the complexity and social arrangements that are visible together with the lack of any indication that power was centred in one person, that decisions were required on an ongoing basis and that there were multiple participants involved. Although we cannot identify the contributors to these process we can be confident that they existed and that their opinions were factored into livelihood decisions.

8.4 The Livelihood Variables

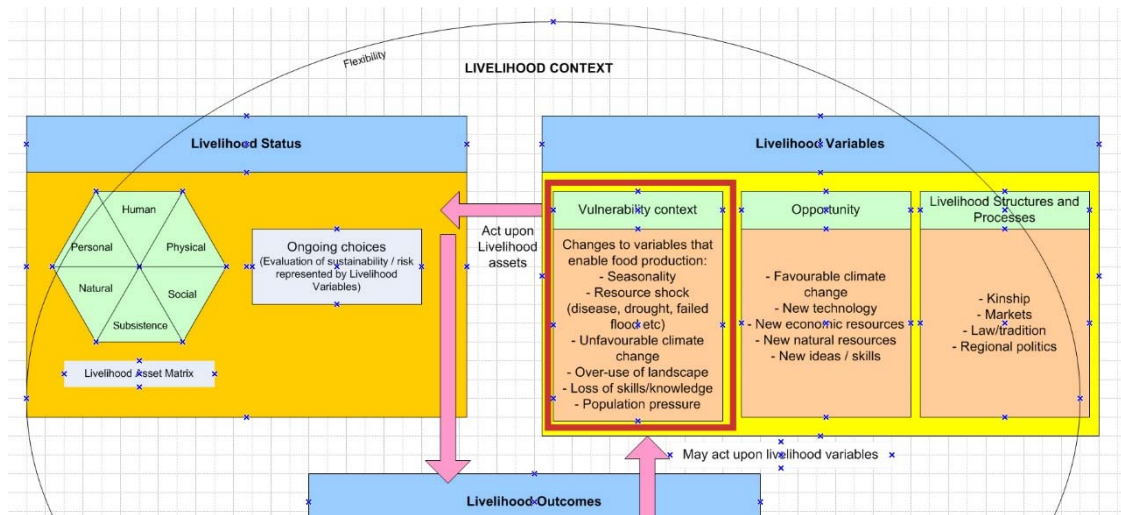


Figure 8.20 – The Livelihood Variables section of the SRL Model, framed in red

Figure 8.20 shows the components of the Livelihood Context. These are the explanatory elements of the SRL model, the variables that act upon the components of the Asset Matrix. Impacts can exist on a continuum between positive and negative. Each of the variables is discussed below.

8.4.1 Vulnerability Context

The Asset Matrix captures many of the important features of a community, but all the components that make up the matrix are dynamic and in a constant state of flux. During the Ru'at el-Baqar the dominant vulnerability is that of climatic deterioration at the end of the early Holocene caused by the southward movement of the ITCZ. This caused increasingly stochastic rainfall regimes and rangeland availability. Risk was mitigated by employing new economic systems based around herds, and new social systems based around the shifting character of the livelihood base. The most obvious areas of vulnerability that would have impacted life around Nabta is variable rainfall, influencing the availability of pasture during the rainy season and the availability of floodplain resources. As Nelson *et al* state (2016, p.298) "Managing disasters, especially those that are climate-induced, call for reducing vulnerabilities as an essential step in reducing impacts." Nabta Playa during the Ru'at el-Baqar required a strategy of managing vulnerability via economic, social and ritual devices.

In this section, the system developed by Nelson *et al* described in Chapter 2 (Nelson *et al* 2016, p.300) is used to gauge vulnerability in access to food, and will be used to give a top-level assessment of the food resource situation at Nabta Playa (table 8.15).

Vulnerability variables		Evidence for vulnerability	Value for variable for resilient food system
Population-resource conditions			
V1	Availability of food	Insufficient calories or nutrients	Balance of available resources and population reduces risk of shortfall
V2	Diversity of available, accessible food	Inadequate range of resources responsive to varied conditions	Diverse portfolio reduces risk, increases options
V3	Health of food resources	Depleted or degraded resources, habitats	Healthy habitats, contribute to managing risk and change
Social conditions			
V4	Connections	Limited connections with others experiencing different conditions	Social networks expand access to food and land
V5	Storage	Insufficient, inaccessible storage	Stored foods reduce risk in times of shortage
V6	Mobility	Inability to move away from challenging food conditions	Movement to alternative places, landscapes and social groups offers potential for addressing resource shortfall through access to food/land
V7	Equal access	Unequal control and distribution of land, water and food resources	Equal access avoids challenges to coping and adaptive capacity in disaster risk management
V8	Barriers to resource areas	Physical barriers limiting access to key resource areas	Lack of barriers enhances capability of people to provision themselves with food

Table 8.15 – Vulnerability variables

The variables are ranked using a simple qualitative scale to measure its contribution to overall vulnerability. The qualitative ranking scheme is as follows for measuring each variable, based on contribution to vulnerability (Nelson *et al* 2006, p.300):

1. No contribution
2. Minor contribution
3. More substantial contribution
4. Substantial contribution

As there are eight variables the maximum vulnerability score is 32 (100%).

V1 Availability of Food: It is inferred that access to food and water was a short term requirement in Nabta, where the playa lake was only a seasonal phenomenon. For that time both the lake and the surrounding resources were sufficient to support herders and their livestock. All indications are that low numbers of people occupied temporary camps. It has been proposed that more secure resources were returned to after the lake dried up. If this was the case, food vulnerability should have been relatively low.

V2 Diversity of available, accessible food: Although preservation of plant materials is poor, the availability of a suitable mixture of plant foods can be inferred from the species including fruits and cereals. Wild and domesticated faunal remains and the availability of dairy argue that Nabta occupants had adequate resources to compensate for shortages in any one resource area.

V3 Health of food resources: All data points to temporary use of Nabta. Late rainfall and drought could reduce the value of plant and wild resources, and introduce vulnerability into the seasonal visit, impacting the effectiveness of livelihood management.

V4 Connections: It is inferred, on the basis of seasonal occupation and cultural indicators, that Nabta occupants had connections with Laqiya to the south, the Nile to the southeast at Abka, or further to the south in the Kerma region. If these connections were secure, inhabitants at Nabta potentially had access to both dry season resources and support networks.

V5 Storage: There are almost no signs of storage, apart from the herds themselves. This might suggest failure to provide themselves with a fall-back supply of food for the duration of the stay, but is probably of marginal importance due to the brevity of the occupation and is unlikely to represent a serious vulnerability.

V6 Mobility: Mobility was clearly at the heart of the Nabta livelihood strategy, because the basin could only be occupied on a seasonal basis.

V7 Equal access: There seem to have been serious attempts to establish a symbolic and physical identity at Nabta, which may suggest that access rights had to be defended, but may also have been a reflection of the security that Nabta represented.

V8 Barriers to resource areas: The desert itself forms a barrier to food provision in times of low rainfall. Even with the Nile to fall back on, this might represent a form of risk, particularly if arrangements at the Nile required herds to be removed during the wet season.

The variables for Nabta, using best judgement best on the data captured in the assets are as follows in table 8.16:

	Population-resource conditions			Social conditions					Total
	V1	V2	V3	V4	V5	V6	V7	V8	
Data	3	3	3	2	4	2	?	2	19/32
Extrapolation	2	2	3	2	2	1	3	2	17/32

Table 8.16 - Vulnerability estimates for the Ru'at el-Baqar

This table suggests that throughout the mid-Holocene occupation at Nabta, access to food for the short period of occupation was deemed to be sufficient for the area to be used throughout the Ru'at el-Baqar, and visits to Nabta would therefore have been relatively low risk. It seems indisputable that Nabta was only occupied for short periods, and both the proximity of the Nile and the Nile-affiliated ceramics support the idea that the river was part of the Nabta subsistence strategy. However, should the proposal that Nabta was only used seasonally in conjunction with more permanent occupation along the Nile be incorrect, these findings would need to be completely revised.

8.4.2 Opportunity

Although Nabta was in an area of low rainfall in the mid-Holocene, there were various options for pastoralists and their herds. For a few weeks of the year, water accumulated in basins and behind dunes, and penetrated the thin soils as groundwater, promoting the regeneration of pasture and annuals as well as the maintenance of arid-adapted perennial species, and species that thrived under marginal aquatic conditions. Vegetation would fix limited organic nutrients into otherwise impoverished soils, helping to renew pasture annually. Conditions were probably not dissimilar from those pertaining in arid parts of the Sahel today, stochastic but offering variable subsistence opportunities for pastoralists. Although environmental change was detrimental to early Holocene subsistence strategies, the opportunities represented by domesticated species allowed dryland areas to remain in use.

Although domesticates were present in the Ru'at el-Ghanam, they were confined to sheep and goat in relatively small numbers. By contrast, in the Ru'at el-Baqar cattle were added to the livelihood mix, suggesting that the Ru'at el-Ghanam Middle Neolithic experiment was a successful one, and eventually became the strategic solution for the prevailing environmental conditions. By taking up the opportunity to diversify livestock, different benefits could be obtained for little more investment in terms of ongoing maintenance and knowledge acquisition.

The new livelihoods were accompanied by new cultural outputs, with new ideas and priorities reflected in the material record. These changes are probably connected to patterns of

acculturation representing both the costs and benefits of taking up new livelihood opportunities in an increasingly constrained landscape of environmental stress and regional differentiation (Kuper and Kropelin 2006; Riemer 2007a; Riemer and Kindermann 2008).

8.4.3 External Livelihood structures and processes

The Nabta occupation, seasonal and dependent on the presence of a playa lake, gives few opportunities for exploring the potential impact of external structures and processes. It seems clear that during the arid phase between the Ru'at el-Ghanam Middle Neolithic and Ru'at el-Baqar the inhabitants of Nabta, already in possession of sheep and goat, came into contact with new ideas, in both subsistence and the social and symbolic realms, and that these were due to communication with other communities along the Nile Valley. However, the nature of those contacts cannot currently be examined from the Nabta evidence.

8.5 The Livelihood Outcomes

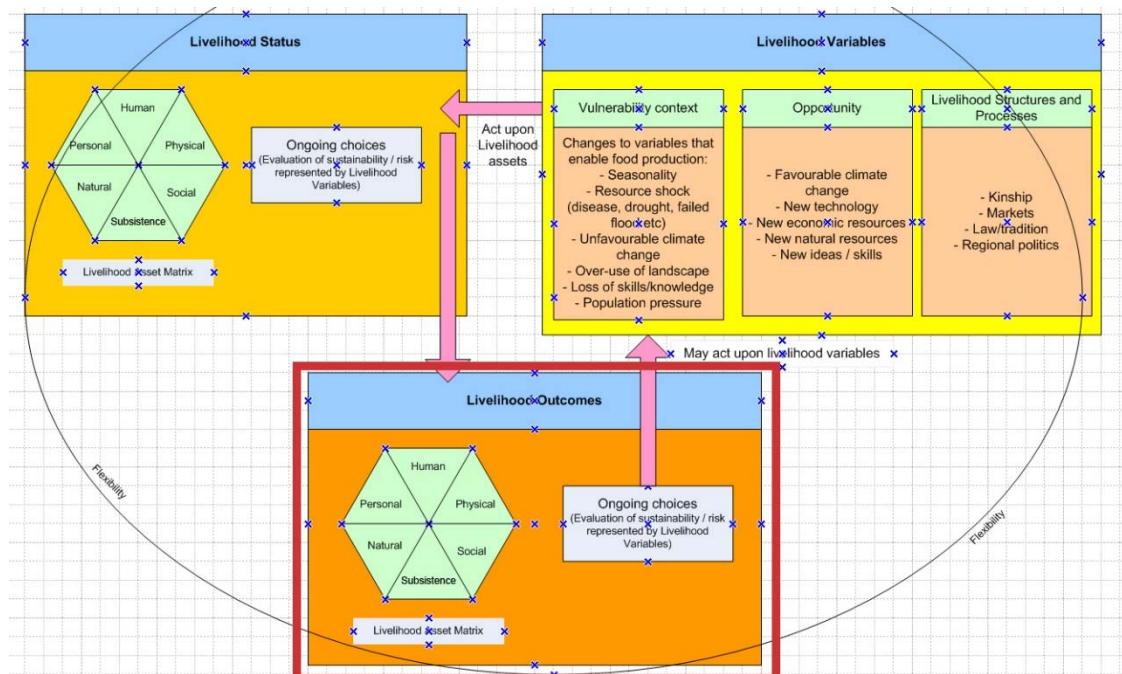


Figure 8.21 – The Livelihood Outcomes part of the matrix, framed in red

The Livelihood Outcomes reflects changes that take place when the Vulnerability Context acts on the Asset Matrix (figure 8.21). This is discussed below in terms of three outcomes: economic, environmental and cultural.

Economic Impact

Following the abandonment of Nabta there are no signs of what happened next to the people who had occupied the playa. Just as it was impossible to trace with confidence a seasonal round for the Nabta inhabitants, it is not possible to track them after they left as the new arid phase caused increasingly stochastic conditions. Climatic downturn was accompanied by new patterns of usage of the available environments as suggested by Garcea and Hildebrand's work on Sai Island: "In the end, riverside sites such as 8-B-10C may have been the receiving grounds for Saharan peoples as desiccation forced them to the Nile. The evident sedentary or near-sedentary use of 8-B-10C . . . indicated by closely spaced dwellings with numerous substantial support posts – might indicate that people became increasingly tethered to the Nile as rainfall decreased in the early middle Holocene" (Garcea and Hildebrand 2009, p.319). It is probable that Nabta occupants were forced to take up similar patterns of residence along the Nile in areas like Sai Island, and modify their livelihood strategies accordingly.

Environmental Impact

Small-scale societies often modify their local environments in a number of ways as part of a livelihood management process that Smith calls "cultural niche construction" (B. Smith 2011, p.264-5). Barakat believes that there are no patterns in any of the woody taxa from R'at el-Baqar Nabta to indicate that human presence at the site had any significant impact on the vegetation of the region, with the possible exception of *Acacia nilotica* and *Ziziphus*, both of which could have been introduced either as food waste or by animals eating and passing the fruit and seeds (Barakat 2002, p.599-600). The impact of these on the environment would have been negligible. It is unlikely that herds were present long enough to do serious damage to the ecology and they brought benefits. These include compacting of seeds and plant matter into soil to improve soil quality and water penetration; removal of dead biomass at the end of the dry season; reduction of bush fires; the revival of forage and the provision of dung as fertilizer (Grandval 2012, p.2). Savory (2015) describes how in today's arid environments, desertification can actually be reversed by livestock herding. The extensive presence of wood in hearths may indicate that wood was either considered to be sufficiently abundant to use without negative consequences to trees, or that there were measures in place to prevent over-exploitation (Bollig 2006, p.336-7; Harir 1996; Hobbs 1989, p.53; Hobbs *et al* 2014; Krzywinski *et al* 1996; Simpson 1992; Wendrich 2007, p.74). It is impossible to pick between them. A climatic downturn at the end of the Ru'at el-Baqar, the Post-Late Neolithic Arid Phase, resulted in the abandonment of most of the Western desert (Kuper and Kröpelin 2006; Kuper and Riemer 2013; Schild and Wendorf 2002, p.24).

Social Impact

The Ru'at el-Baqar was followed by the Post-Late Neolithic Arid Phase (Schild and Wendorf 2002, p.24), which was in turn followed by the Bunat el-Ansam Final Neolithic during the Final Neolithic Humid Interphase and the final developments of the ceremonial centre with the addition of new Complex Structures, megalithic alignments and, a new feature, cemeteries, at Gebel Ramlah, 20km from Nabta (Kobusiewicz *et al* 2010; Wendorf, Schild and Associates 2001; Schild and Wendorf 2002, p.24-5). Heavy deflation has denuded the final occupation at Nabta, severely limiting information about subsistence and domestic aspects of the livelihood. The cemeteries relate to Nile rather than desert traditions, with similarities to burial traditions in the Badarian and in the Sudan at Kadruka, North Dongola Reach, El Kadada, Kadero and Geili, with an emphasis on single inhumations accompanied by grave goods including an emphasis on personal ornamentation (Kobusiewicz and Kabaciwski 2010, p.252). The shift of pastoralists into more constrained conditions along the Nile apparently coincided with and may have contributed to the growing importance of funerary traditions along the Nile and at Gebel Ramlah in the Final Neolithic, as an affiliation between groups and particular sections of land developed. Sapignoli's observation that a connection to territory is common in small-scale societies (2014, p.48) and Frederick's observation that some sites when used repeatedly throughout a year's seasonal movement are part of what reinforces identity, ideas and social stability (2014) both seem to be applicable to Nabta. The cultural transformation of the Nile landscape and the erosion of links between people and the deserts were probably the main outcomes of the drying of the Sahara.

Ultimately, Nabta was abandoned permanently. The risks associated with the abandonment of Nabta obviously investigated those trying to continue to use it, but they could have been considerable, including the costs of devising new livelihood strategies, the risk of abandoning any divine entities associated specifically with the ceremonial centre, and the loss of an embedded tradition of seasonal mobility and geographical diversity.

8.6 Answering the key questions

8.6.1 Why was the area attractive to occupants on an ongoing basis?

The dominant feature of Nabta Playa was the main basin and series of sub-basins that filled with water during the wet season, providing a temporary resource that continued to be accessed by wells after the water had retreated beneath ground level. The wet season was also responsible for sustaining a number of tree and shrub species which presumably created sufficient pasture to attract herders repeatedly to the area throughout the mid-Holocene. It was easily accessible from the Nile, so could have been used in conjunction with a Nile

territory without major commitment of resources. Nabta is a “persistent place,” a locality used repeatedly over the long term due to the suitability of its particular characteristics including the accumulation of cultural remains as well as social and economic drivers (Shiner 2009; Schlanger 1992, p.91). Hofman emphasises that repeated use of the same areas and sites reinforces knowledge about those areas and improves the chances of survival, so scheduled return visits are desirable (Hofman 1994), a type of knowledge that becomes embedded in traditions based on a memory and past experience (Hunn 1993, p.13; B. Smith, B.D. 2011, p.263). Substantial ceremonial constructions indicate that as well as encampments there were activities that may have contributed to the perceived value of the Nabta area.

8.6.2 What types of risk were experienced?

8.6.2.1 Natural and economic risk

Most of the plant resources at Nabta would have been seasonal, with only a low density covering of tree and shrubs. Vegetation was dependent on rainfall, which could vary both temporally and spatially. As the mid-Holocene advanced, precipitation would have become increasingly stochastic, reducing the dependability of Nabta as a seasonal resource. High evaporation would have been responsible for lowering the water levels even in good years. If Nabta was a vital component of subsistence, it would have represented high risk. However, it is unclear to what extent the economy of the Nabta occupants actually depended upon a seasonal visit to Nabta. If the purpose was to rest dry season pasture elsewhere, any failure of precipitation would have required decisions to be taken about how best to manage the situation. It is probable that the annual trip to Nabta was based at least partially on social and symbolic rather than exclusively economic drivers.

8.6.2.2 Social risk

For individuals social risk lies in the loss of perceived status or prestige (Richards 2013). There are no signs at Nabta of status or prestige associated with any individual on an ongoing basis. For the group as a whole, any other social risk was probably to be found in the challenge to existing social arrangements, including affiliations with other groups and challenges to group identity from changing conditions along the Nile.

8.6.2.3 Symbolic risk

Whatever function the ceremonial centre served, it was a symbolic medium, and whatever ideas were invested in it will have derived from conceptual schemes embedded in ideology and religion. At Nabta symbolic risk must have been high. The ceremonial centre was not merely an investment in planning and labour but in ongoing use, a commitment to the ideas and beliefs that were incorporated into it. Failure of the ceremonial centre could have translated into the failure of entire belief systems and the underlying sense of livelihood

security that accompanied them. Intensification of ceremonial activity may have corresponded to increasing subsistence stress, but the ceremonial centre was not destroyed at the end of the Ru'at el-Baqar and was added to in the Bunat el-Ansam, which seems to indicate that either the dating of the ceremonial centre is wrong and it should be placed in its entirety in the Bunat el-Ansam, or that the ideas that were initially expressed in the Ru'at el-Baqar continued to be observed during the arid period between the two phases, although no archaeological indicators have been found.

8.6.3 How were risks managed?

The available data has been checked against the list of risk management strategies in Section 5.4 in Chapter 5 and copied into Appendix B and forms the basis for a comparison of all areas. I have used a yes/no/? judgement on whether there is evidence for an activity, and have also indicated how much confidence there is in the data supporting that the judgement, using a High (H), Medium (M) and Low (L) scale. Table 8.17 shows what types of strategy are evident in the archaeological record. The contents are discussed in brief immediately afterwards.

	Evidence for strategy present ✓ / ✗	Quality of data available	Confidence that strategy practiced
Food procurement Diversification	✓	M	H
Food procurement Specialization	✗	M	L
Storage	?	L	L
Mobility	✓	H	H
Habitat management	✓	L	M
Social networks	✓	H	H
Communication of knowledge	✓	M	M
Exchange of information	?	M	M
Leadership / roles	?	M	M
Division of labour	?	L	M
Technology specialization	✗	M	H
Ideology and religion	✓	H	H
Opportunity and innovation	✓	M	H
Conflict	✗	L	L
Trade/exchange	✓	M	M
Stint/hunger foods	✗	L	L
Migration out of the area	✓	H	H
Remaining to experience impoverished conditions/death	✗	L	L

Table 8.17 - Risk management strategies employed in the Ru'at el-Baqar

- The combination of domesticated livestock, hunted game and the presence of grinders, presumably for processing grasses and other plant materials, combined with a certain amount of mobility, indicate a **diversified approach** to food procurement. Short term occupations combined beneficial effects on animals with the maintenance,

via grazing, trampling and fertilization, of the land to which they returned, presumably on an annual basis, helping to achieve long term sustainability of both livelihood and the environment.

- Apart from Hut 1, there are no signs of **storage**, and even those at Hut 1 had no contents so their function remains unconfirmed
- The strongest risk management strategy, apart from diversification, was **mobility**, with the movement of individuals in and out of Nabta at appropriate times of the year. By taking herds to the richest pasture that was available, the health and value of herds was maximized. The ephemeral character and small size of sites suggest that mobility was probably logistical rather than residential.
- **Habitat management** may be indicated by the very presence of people at Nabta if they were resting dry season pasture elsewhere. It is possible that niche management was practiced by using briefly abundant areas like Safsaf (Close 1990; 1996; 2000a; B. Smith 2011), where small temporary sites were found, may have been used as supplementary zones for herding animals away from Nabta, returning to the basin when resources were depleted.
- **Social networks** are strongly implied by the ceramics, which have strong affiliations to the Nile.
- Successful **knowledge transmission** is also strongly implied by the ceramics, which indicate transfer of skills, as well as the ongoing need to manage herds, familiarity with the landscape, hunting of wild animals and collection the appropriate plant materials.
- There is no evidence for the exchange of **information**, which is archaeologically difficult to identify, but it seems unlikely that this sort of livelihood could be maintained without information about rainfall events, trading opportunities and social aggregation events.
- It is possible that religious **leadership** was required for the commissioning and ongoing use of the ceremonial components, and it seems likely that various projects required more than guidance and direction, but some of these roles could have been transient and there are no personal symbols of status or power or other archaeological indicators of leadership.
- Although there is no data, **division of labour** was almost certainly practiced in order to make the most of all ages and skill sets.
- There are few signs of **technological specialization**. The lithic industry was expedient, with only few distinctive types recognized as diagnostic indicators of the Ru'at el-Baqar, and it seems clear that nothing more sophisticated was required. Ceramics required greater investment of learning, skill and time.
- Risk was almost certainly mediated by **ideological and religious** values embedded in the ceremonial centre and associated with the change in ceramic design, both of which represent investments in activities that don't connect directly with food

production but probably connect to ideas of identity and social reinforcement. The tumuli suggest that people were ideologically pastoralist in their thinking, whilst the alignments and stone circle suggest that some ideas materialized at the site were centred on stellar observation. The ceremonial centre is a materialization of ideas in the enduring form of stone. The design includes multiple components with which, or within which, participants engaged.

- **Opportunity and innovation** have been discussed above.
- There are no signs of **conflict**.
- **Trade and exchange** are again difficult to assess, but indications of connections with a variety of different areas argue for links with different peoples, which may have involved exchange mechanisms.
- With respect to **hunger foods**, there are no indications that Nabta inhabitants were short of food, but choice would have been limited, and as the playa lake dried both food and water for human and animal consumption would have been in increasingly short supply.
- At the end of the mid-Holocene Nabta was **abandoned** and the seasonal occupants of Nabta in the Ru'at el-Baqar presumably migrated towards the Nile and/or elsewhere and re-arranged their subsistence strategies accordingly.

8.6.4 How can the livelihood be characterized in subsistence terms?

The Nabta Ru'at el-Baqar occupants were mobile herders of cattle, sheep and goat, who also used wild resources to provide adequate nutrition and preserve livestock during the wet season occupation. They are perhaps best characterized as herder-hunter-gatherers, or multi-resource nomads (*sensu* Salzman 1972), at least for the part of the year when they were at Nabta. No pastoral livelihoods today are exclusively dependent on herds, and plant nutrients must have been sourced. There may have been years when Nabta was not viable. It is most probable that the mobility exhibited by the Nabta inhabitants was restricted, possibly a form of semi-nomadic pastoralism that involved settlement at one or more Nile-side locations during the dry season, with herds moved to Nabta and perhaps elsewhere during the wet season. Judging by the fact that only a few hearths appear to have been used contemporaneously at some sites, it is possible that in most years only a few households moved to Nabta, or that households were left behind and only herding labour was required for Nabta. The presence of ceremonial components argues a stronger tie with Nabta than the otherwise ephemeral remains would suggest.

8.6.5 Has it been possible to identify where decisions have been made and what they were?

Whilst individual decisions cannot be observed, the accumulation of decisions are implicit in any risk management strategy. From an economic point of view, risk is a constant process of problem solving and decision making (Segal 1994, p.25). Both may be “relatively automatic” when the problem solver is experienced and the problem familiar (Segal 1994, p.26) but in conditions of environmental variability droughts may result in unusual or even extraordinary situations. Most decisions about occupation at Nabta were probably concerned with the interpretation of information about when to move, which routes to take, who should take part in that move and what sort of activities should take place on arrival.

Decisions are visible in the ceremonial centre, where different requirements were met with different solutions. Any proposal to create the various elements required agreement, design, implementation, refinement and reinforcement in the acts of repetition and ritual use of each element (Moser 2014; Olupona 2014). The ceremonial centre is a statement of an intention that was implemented according to a set of specific requirements and may itself have been used in order to inform decisions about when to schedule certain activities, forming a bridge between the physical and the numinous. An example can be given in the case of the table rocks. We know that a requirement was identified and that this was conceptualized in the form of the location and modification of the table rock as a process that was considered to meet that need. At least some individuals were responsible for acting upon the requirement to shape and rebury the table rocks, but they are not necessarily the same people who identified the requirement and decided upon its form. The following elements were combined in the decision making process: identification of a problem or risk (use of knowledge or information); proposal/s of one or more solutions (conceptualization and communication); choice of an appropriate decision (negotiation and conflict resolution); design of the solution (conceptualization and negotiation); planning about how and when to deploy labour (negotiation, co-ordination); supervision of works (leadership, delegation). Additionally, decisions about religious aspects of the process may have required the intervention of ritual specialists. We can assume that the first of these projects was successful, because it was repeated. However, towards the end of the Ru'at el-Baqar negotiating the challenge to the ideas bound up in the ceremonial complex may have been both difficult and traumatic. In lithic tool technology although the toolkit was largely expedient, decisions were made about raw materials that tools should be made of.

The only other decision that is completely unambiguous in the archaeological record is that of abandonment following climatic deterioration at the end of the mid-Holocene. The decision not to return to Nabta may have been fraught with social and religious risk but was unavoidable due to the collapse of mid-Holocene rainfall regimes.

8.6.6 How has group identity manifested itself in the archaeological record?

Mechanisms for expressing cultural identity lie in the ceremonial centre and ceramics. The ceremonial centre expressed a common body of ideas, shared knowledge about its purpose and how it was used and probably included affiliation with and rights over land. The act of using the ceremonial centre may itself have been an integrating and reassuring activity, reinforcing and consolidating group identity by acting out roles that mediated beliefs. The distinctive ceramics seem to extend this sense of identity by incorporating the herders at Nabta within a wider realm of shared culture with the Nubian and Sudanese Nile, a deliberate behaviour of association. With the available evidence the emphasis seems to lie in group identity rather than individual differentiation. There are very few indications of personal identity. Ornamentation was not a big feature of the Ru'at el-Baqar. Although it is possible that other methods were used to express individuality, such as body paint, scarring or tattoos, it is also possible that a lack of any individual expression was a socially imposed constraint (Wiessner 1984, p.226).

8.6.7 What were the drivers for significant change at the end of each period?

The most obvious explanation for abandonment of this area, which had otherwise been used as a resource for hundreds of years is environmental deterioration followed by a hyper-arid phase. The switch from tolerable to intolerable conditions is unlikely to have been sudden, but rainfall at Nabta must have become increasingly unreliable, reducing its value over decades so that other economic solutions would have had to have been implemented to compensate. If the Nabta basin was associated with complex symbolic ideas, the adjustment could have been difficult on more than one level.

8.7 Conclusions – the value of the SRL model in this area

At Nabta there was one of the most comprehensively published of the four case studies, and was excavated using modern techniques, it offered great scope for testing the value of the SRL model and assessing whether it is a viable tool. The range of the questions that the SRL approach demands is considerable, and it was rewarding to apply a tool used by development economists on a much more restricted database. Certain parts of the matrix could not be populated with archaeological data, either because the data was not available or because of the way in which it had been published. Completing the Asset Matrix made such gaps

transparent. These gaps include poor preservation of botanical and faunal remains, an absence of stratified sites, and the absence of skeletal remains that might have produced insights into various aspects of human living conditions that could not be substituted with other types of archaeological data. Where data was available, a very rich understanding of aspects of Ru'at el-Baqar livelihoods could be developed, particularly when supported by insights from ethnographic studies. The development of the **Social Assets** section particularly demonstrated the value of discussing the relationship between data and what it represented in terms of socially embedded concepts like ethnicity, identity and ideology.

Certain questions arose during the completion of the SRL framework that suggested opportunities for future research. Some of these were specific to Nabta, like the investigation of seasonal occupation with phytolith and diatom analysis of playa beds and stable isotopic analysis of data from livestock remains. Others are more general, for example the need to improve understanding of the functionality of stone tools and the requirement for a geological database of Egyptian and the Sudanese stone and mineral types. Other opportunities for future research are discussed in the longer version of the case study and referred to in Chapter 10.

The key questions have provided a test for the SRL approach, indicating that problem orientated research is a suitable use of this method. Although it was not possible to answer some of the questions definitively, or even usefully, this again highlights gaps in the data and might suggest potential areas for future research, some of which are mentioned in Chapter 10.

The case study required considerable investment of time. Although fragmentary data is available in publications, assembling it in the required format and putting it to work was far more time consuming than I had anticipated. It was a rewarding and productive exercise, but the large amount of time required to use the approach in archaeology would need to be factored into any future projects on a similar scale.

9 - Comparative Findings and Future Research

9.1 Introduction

This chapter brings together some of the themes extracted from the data-rich narratives supplied by the completion of the Sustainable Rural Livelihood case studies. The case studies were not always directly comparable in all aspects of the matrix. Each case study was strong in particular types of data, but either due to accidents of preservation or quality of publication some types of data were not available in all the case studies. In terms of subsistence, human and physical assets, none of the case studies was particularly strong, but they were reasonably comparable. In terms of social aspects, each area had something different to offer. The ceremonial centre and ceramics at Nabta, the Badarian cemeteries and grave-goods, the Gilf Kebir rock art and the Dakhleh bifacial tools all provided different avenues to explore, but the findings are not always directly comparable, although certain holistic evaluations are possible. The findings are presented below.

Due to both time and space constraints, it is not possible to compare each and every aspect of the SRL matrix within the scope of the thesis, so two strands of vulnerability and risk management have been isolated for comparison:

1) Risk, vulnerability and sustainability, which were identified as topics for investigation in the introduction, are compared here:

- **Risk management strategies and uncertainty (section 8.3.1)**

Livelihood strategies adopted by prehistoric pastoralists in the case studies are assessed against strategies employed by modern pastoralists as described in Chapter 5. An example of this has been given in Chapter 8, with the abridged Nabta Playa case study, and is also included in each of the full case studies on the CD-ROM.

- **Vulnerability (section 8.3.2)**

The data captured in all four vulnerability tables is compared with a view to demonstrating the overall levels of risk and uncertainty encountered in this part of the eastern Sahara.

- **Sustainability (section 8.3.3)**

The long-term viability of livelihood strategies in the four case study areas are compared by focusing on relevant components of the Asset Matrix

2) **The Key Questions (8.3.4)** that were introduced in chapters 1 and 7.

In each of the case studies nine identical questions were asked to test whether the SRL approach could be used to answer specific questions about livelihoods in marginal environments and were addressed in each of the case studies. Answers to the key questions are compared briefly here.

9.2 Comparative Findings

9.2.1 Risk Management Strategies

The four livelihoods under discussion are all pastoral. In each case of groups developed livelihood strategies to suit geographic and topographic landscapes in dryland zones during a period of increasing aridification. Table 9.1 assembles the data presented in the case studies, based on the research into modern pastoralists described in Chapter 5, to begin a top-level comparison of the risk management strategies adopted in all four areas. A yes/no/? rating was used to indicate presence or absence of a technique, together with a confidence rating of High (H), Medium (M) and Low (L).

Risk Strategy		Ru'at el Baqar (Nabta)		Badarian (Middle Egypt)		Bashendi B (Dakhleh Oasis)		Gilf C (Gilf Kebir)	
Food diversification		✓	H	✓	H	?	L	✓	H
Food specialization		×	L	?	M	?	L	×	L
Storage		?	L	✓	H	✓	M	×	L
Mobility		✓	H	✓	H	✓	H	✓	H
Habitat management		✓	M	×	?	✓	H	✓	H
Social networks		✓	H	✓	H	✓	M	✓	H
Trade/exchange		✓	M	?	H	✓	M	✓	H
Ideology/religion		✓	H			×	L	✓	H
Communication of knowledge		✓	M	✓	H	✓	H	✓	H
Exchange of information		?	M	?	H	✓	L	?	M
Leadership / roles		?	M	?	L	×	L	?	M
Division of labour		?	M		H	×	M	?	H
Technological specialization		×	M	✓	M	✓	H	×	L
Opportunity / innovation		✓	H	?	?	?	M	✓	H
Conflict		×	L	×	M	×	M	×	M
Stint/hunger foods			L	×	H		H	×	H
Handling Uncertainty	Migration	✓	H	×	H	✓	H	✓	H
	Remaining to experience impoverished conditions/death	×	L	×	H	×	M	×	H

Table 9.1 - Risk management strategies compared

Due to word-count constraints five topics have been chosen for discussion; other aspects will be discussed when sustainability is assessed below. The five topics were selected expediently, as they represent aspects of livelihood management that should be detectable archaeologically.

- Food diversification, looking specifically at livestock choices
- Ideology and religion
- Tradition
- Mobility
- Uncertainty at the end of the mid-Holocene

9.2.1.1 Food diversification

The following QFD (Quality Function Deployment) analysis was introduced in chapter 2. Here it is used to discuss choices made regarding cattle, sheep and goat in the four case studies. The QFD table was compiled partly from the data tabulated in Appendix G. The inclusion of pig in the QFD table will be explained below. In figure 9.1 below each species is given a numerical rating against criteria of usefulness. For example, heat tolerance is considered to be of high importance (9) but pig has low tolerance so it is given a rating of only 2. The ratings for each species are totalled to provide an overall value for each one. This is a subjective approach, but gives a sense of the sort of decisions that were available to livelihood managers, and suggests some of the reasoning behind the decisions that were made.

As well as being most obviously a source of meat, livestock represents renewable stores of dairy and blood. The animals are themselves renewable via reproduction. They also represent non-renewable stores of meat, bone, horn, sinew and hides.

	Importance	Cattle	Sheep	Pig	Goat
Heat tolerance	9	■	○	◇	●
Drought tolerance	9	■	○	◇	●
Poor quality food tolerance	8	■	○	●	●
High quality milk provision	7	■	●	◆	■
High quality meat value	7	●	■	○	■
Efficient energy reserves	8	●	■	■	◇
Supply of hides	3	●	■	○	■
Supply of wool	2	◆	●	◆	◇
Ability of herd to recover	7	◇	■	●	■
Numbers of individuals in litter	5	◇	◇	●	◇
Early breeding age	5	◇	■	●	■
Long lifespan	6	●	■	○	■
Traction	5	●	◆	◆	◇
Trampling (threshing)	3	◇	●	○	●
Social value *	9	●	◇	◆	◇
Capital value *	9	●	◇	◆	◇
Absolute importance		391	323	278	324
Relative importance		1 st	3 rd	4 th	2 nd

5 ●
4 ○
3 ■
2 ◇
1 ◆

Highly useful
Middle
Low usefulness

Figure 9.1 - QFD analysis of the relative merits of cattle, sheep, goat and pig

In all case studies cattle and goat were present and sheep were represented in all except Dakhleh Oasis. In a dryland livelihood each has its own merits. Given sufficient water and fodder, cattle are excellent sources of dairy, blood and meat. They are not particularly heat, drought or saline tolerant, require greater quality and more volumes of food and water than

either sheep or goat, and have a gestation period of 9 months and only one calf per year. In their favour, they also have long lifespans, milk is plentiful when cattle are healthy and they have high energy reserves (Dyson-Hudson and Dyson-Hudson 1980). Ovicaprids are more versatile. Goats are useful for arid environments because they are both drought and heat tolerant, will consume poor quality fodder and household waste, and reproduce well. They also have a longer lactation period than sheep (Degen 2007). Sheep are less drought and heat tolerant than goat and are less tolerant of poor quality fodder but reproduce well and the nutritional quality of their milk exceeds that of cattle and goat, although cattle produce greater volumes. Ovicaprids have a six month gestation period, 3 months shorter than cattle, and may produce up to two individuals twice a year (Smith, A.B. 1980). All three therefore offer different benefits to livestock keepers.

Pig was one of a number of species imported from the Near East and present in the Faiyum Neolithic, Saïs and Merimde Beni Salama, both in the north of Egypt during the 6th millennium BC. Thomas (2003) and Dittrich (2017) both refer to the Near Eastern domesticates as a set of options from which those who came into contact with them could select, and this selection process is identifiable throughout the northeastern Sahara at different times. Domesticated plants and pig only became available via the Sinai land bridge or the Mediterranean into the Delta (Close 2002b; Hassan 1988, Tassie 2014, p.187). Ovicaprids separately appear to have followed a second and separate route into the Eastern and Western Deserts via the Red Sea (Dittrich 2017; Vermeersch *et al* 1994; Vermeersch 2008; Shirai 2013), entering Nabta and the oases in the 5th millennium BC. It was not until the 5th millennium that domesticated flax, emmer and barley appeared in the Badarian. Assuming that flax, emmer wheat and barley could have been introduced into the Badarian from the Faiyum or Delta, it is interesting to see that pigs were not adopted whilst flax, wheat and barley apparently were. Logistical difficulties could have accounted for this, but economic reasons are a more plausible explanation. Pigs are demonstrated to be very versatile in terms of how prolific they are in terms of production, and are highly tolerant to poor quality fodder, both features that might have been very attractive in the Badarian. But they are not at all drought tolerant, are poor converters of cellulose, may be in competition with humans for the same foodstuffs, can suffer ill-health in high heat without shade, require water or mud in which to cool down as they do not perspire, do not provide milk, cannot be herded conveniently with other livestock and can be devastating to crops if not adequately restrained (Linseele 2010; Yokell 2004), all of which may be why they were rejected.

In general terms goat and pig are therefore by far the most versatile of the domesticated species represented, with cattle dominating in terms of dairy supply, volume of meat, lifespan and supply of hides. However, although a good source of meat and offspring, pig was associated with predicted difficulties. Ovicaprids would therefore seem to be the ideal solution for all people living in arid and semi-arid environments, occasionally supplemented by cattle when water availability could be reliably provided and where livestock could be moved between good quality pastures. Between them, cattle and ovicaprids are suitable for different

environmental niches, have different tolerances and offer different nutritional benefits, meaning that they complement each other in variable conditions. The combined presence of cattle and ovicaprids is an indication of sensible livelihood management and diversification seems to have been preferred to specialization.

Plant collection will have been important for basic nutritional requirements, with grinders suggesting that processing of plant foods such as seeds, roots and tubers took place. This corresponds to proposals by, amongst others, B.D Smith (2001) and Marshall and Hildebrand (2002) that there is a shifting continuum of activities taking place in many prehistoric communities that are neither hunter-gatherer nor agricultural, nor necessarily transitional between them. The Badarian is unique in the case studies in providing evidence for domesticated emmer wheat and barley. The following schematic from the Badarian case study (figure 9.2) shows what sort of decisions would have been involved in a choice of cereals from a purely technical point of view. Sorghum, included for comparison, was potentially available given that although it was not domesticated it was a staple in both the Sudan to the south (Haaland 1995, p.128-171; Lucarini 2014b) and in Farafra Oasis to the west in the Western Desert (Lucarini 2006), with which the Badarian may have had links. However, as a summer-rainfall crop it was not suitable for the temperate conditions that dominated in late mid-Holocene Egypt. Barley and emmer were both available from the north and were suitable for the prevailing environmental conditions. Both were equally suitable for subsistence needs and, should it be required, to generate a surplus and contribute to nutrient intake, minimizing the labour required for grass seed collection.

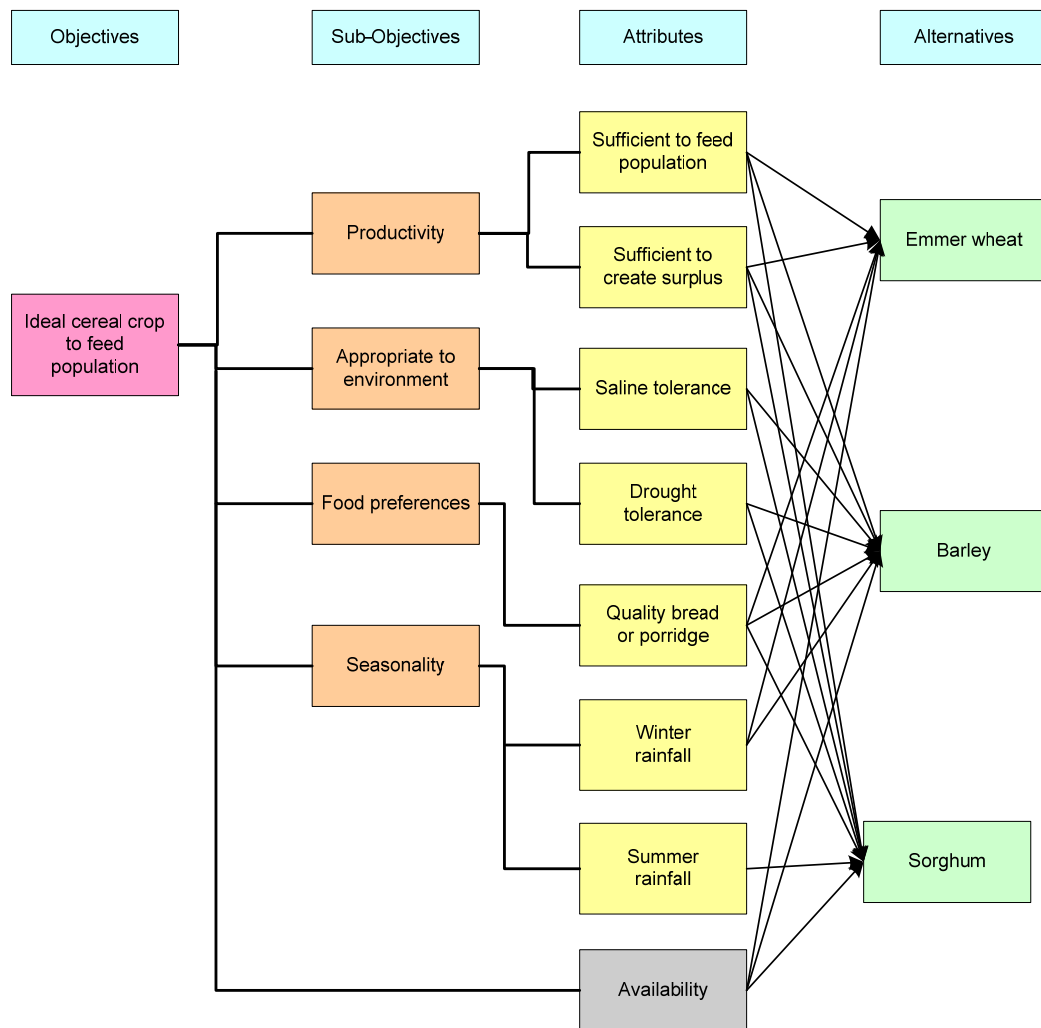


Figure 9.2 - The relative benefits of emmer wheat, barley and sorghum

The benefits of barley include a shorter growing season than wheat, being planted later and harvested earlier than wheat. Planning and harvesting of cereals could have been staggered, which may have had benefits in terms of labour provision, the ability to make and consume cereal products over an extended period and to allow herds to graze on the parts of the crop that were not used. Barley and wheat were probably planted in different zones to take advantage of their tolerances, with drought and saline tolerant barley confined to the floodplain edges and wheat cultivated in the wetter floodplain.

9.2.1.2 Ideology and Religion

As discussed in the case studies, in terms of risk management, concepts of group identity and cohesion are important to ensure that livelihoods are not merely economically viable but support community cohesion, particularly when communities separate and re-assemble at

different times of the year. A common set of religious beliefs, the rituals that materialize them and the underlying ideologies may be expressed through material output, and is often an important symbolic component of livelihood systems (Berkes *et al* 2000; MacEachern 1994; van de Leeuw 1993), allowing complex social organization to function. In each of the case studies considerable effort has been expended in demonstrating how communities invested in ideology, religion and tradition. One of the interesting results of the assessment is that three of the areas exhibited strong indicators, and all four are conspicuously different from one another.

Funerary activity was represented in one of the case studies. Although there are burials in the Ru'at el Baqar of Nabta consisting of stone tumuli containing the remains of cattle and ovicaprids and one human male, they appear to have more to do with a symbolic statement related to Nabta and its seasonal use than any embedded funerary tradition. They have a closer resemblance to shrines than cemeteries. The earliest of the tumuli contained the articulated cow; it is possible that subsequent tumuli were built to reinforce whatever message was contained in E-94-1N. A completely different and infinitely more elaborate and intensive funerary tradition took place in the Badarian where 42 cemeteries in three main concentrations contained c.500 excavated graves (Brunton and Caton-Thompson 1928; Brunton 1937, 1948). The Badarian is characterized by these cemeteries, composed of individual graves, mainly individual inhumations, most orientated with their heads at the south on their left side facing west, but there was considerable variability (Castillos 1982). Animal burials are also recorded (Flores 2003). Individuals were accompanied by grave goods including ceramics, items of jewellery, cosmetic objects, exotic shells, amulets and stones, as well as rare small sculptures. The burials in both the Badarian and Ru'at el-Baqar, whether human or animal, suggest a strong affinity with the land, but those of the Badarian are more explicitly part of a strong funerary tradition in which the individual is an important concept, and was apparently equipped for an afterlife. The absence of funerary remains in Dakhleh and Gilf Kebir, suggest that alternative methods were used for disposing of the dead (e.g. Klima 1970, p.102).

In each of the case studies personal and group identity appear to have been expressed materially, albeit in very different ways. Sillar and Tite discuss how "materials and techniques may be dependent on wider cultural values and ideological concepts that stretch beyond any single technology" (2000, p.9) whilst Gosden (2001, p.166) talks about "highly charged objects" that mediate between people's physical activities and their more abstract evaluation of their lives. Personal ornaments in the Badarian suggest an increasing sense of individual identity, perhaps a manifestation of increasing individuality and the importance of defining a group's identity, but also potentially indicating differential access to certain goods. Ornaments were found in Dakhleh, but the volumes and contexts are not published and may be a minor component of assemblages in settlement contexts. It is, of course, possible that body painting or other forms of marking were used instead of ornaments, especially in the Gilf where painting (on rock shelter walls) was a feature of the Gilf C, and where ochre was available locally (Krause *et al* 2013, p.59-61; Leisen *et al* 2010, p.9-10). Rock art in the Gilf C may

have been an expression of group identity and the connection of groups with particular areas of the landscape. Lenssen-Erz has suggested that differences in rock art may reflect connections with different groups in different parts of Jebel Uweinat (von Czerniewicz *et al* 2004; Lenssen-Erz, T. 2012), and Gilf Kebir may be a northern extension of that pattern. In Dakhleh the production costs of bifacial tool technology (Shea 2013, p.39-45; Gero 1989, p.94) were higher than the remainder of the more expedient toolkit and may have been connected with ideas about affiliation with other oases and desert sites, including Farafra and Djara, which shared the same type of intensified bifacial tool manufacture (Edmonds 1995, p.41-2; Gero 1989). In this sense, it is the meaning rather than the activity that was specialized. Bifacial technology may be part of an abstract language of expression where choices of cultural output materialize identity.

Livestock also have an important role in social mechanisms and ideologies including religion and may be part of a group's worldview (Dittrich 2017; Oma 2010; Orton 2010). At Nabta the burial of one whole cow and dispersed pieces of cattle, goat and dog indicate that their importance in other tumuli exceeded the purely economic. At the Gilf Kebir, cattle and some ovicaprids in rock art suggest that various aspects of livestock were particularly revered. The presence of animal burials at Nabta and in the Badarian are both suggestive of the importance of livestock to the worldviews of both places. Whereas at Nabta the animal burials in the tumuli are of domesticated species, in the Badarian gazelle also appears to have been included, although the identification is not completely secure, Brunton placing question marks against his identifications (Brunton and Caton-Thompson 1928; Brunton 1937, 1948).

The main form of expression in the Ru'at El Baqar was the ceremonial complex that took considerable planning and some investment in construction. It has no parallels in any of the other case studies, or anywhere else in the eastern Sahara but may be an extension of the ideas connected with localized group identity, a sense of place, and the importance of engaging with seasonal aspects of the livelihood (Jesse *et al* 2013; Lenssen-Erz 2012; Turton 2005, 2011; Wendorf and Schild 1980, p.270).

Gillian Woods has suggested that a shamanic element may exist in all four of the case study areas, based in Nabta on the human burial, in the Badarian on the presence of steatite bead belts in a small number of graves, and in Dakhleh and the Gilf Kebir on rock art (Woods 2016). This was considered in each of the case studies except Dakhleh, where rock art is present but was not employed in the case studies due to the difficulties of dating it. In the areas represented by the case studies there was insufficient data to confirm or deny a shamanic presence in these areas.

The evidence for ideology and religion may be connected with the intricacies of mobile pastoral lifestyles that also need mechanisms for managing shared natural resources and negotiating access to special resources like springs and temporary water sources. Ecological management strategies are almost always regulated by social mechanisms, often mediated by various aspects of religion and worldview (Berkes *et al* 2000, p.1256). Distinctive cultural

output seems to relate to new ways of organizing life based on the adoption of delayed return strategies, dairying, new concepts of ownership, new patterns of mobility, and new ways of sharing both resources and products. MacEachern's research into shared symbolic components over wide areas suggests that material was used both to express connections and to differentiate groups from one another, reflecting the complexity of relationships and social mechanisms (1994, p.211). He suggests that symbolic components could remain stable for centuries, but are also subject to manipulation (p.214) and do not express ethnicity but connectivity. Most of the above case studies are consistent with this type of explanation, where characteristics unique to each area are combined with features shared in other areas. Dakhleh is the exception; there are no clear indications of how ideologies and religious beliefs were expressed, and this may be due to lack of surviving data, a different way of organizing social connections, or an entirely different way of expressing ideas and beliefs based around resource management in an oasis environment.

9.2.1.3 Tradition

Tradition is a useful concept because it suggests a connection with the past, a sense of linking with ideas that emanate from an earlier time and give significance to current ways of doing things a validation based on long established knowledge, wisdom and ideology. Tradition may be a powerful tool for reinforcing power structures, group identity, kinship links and community laws (MacEachern 1994; Wobst 2000). It is therefore useful to try and identify where it might lie in the archaeological record, particularly when many of the religious and ideological manifestations described above emphasize change from previous periods rather than representing continuity. Wobst (2000, p.47) suggests that when ideas and routines are under threat certain cultural norms will be adhered to in order to preserve tradition. It is therefore not surprising if in the face of economic and social change some aspects remain the same as forces of change and conservatism both act on people.

Tensions between innovation and tradition of the sort discussed by Wobst may be found in two of the case studies. At Nabta the ceramic assemblage is consistent with types found in the Nubian Nile and may indicate a strong affinity with groups who moved into the Nile area after the more humid early Holocene, adopting new cultural components at the same time. The combination of a unique ceremonial complex with a ceramic assemblage influenced by the Nile may suggest that Nabta was the survival of a much earlier tradition, as exemplified by the tumuli at E-06-4 (Bobrowski *et al* 2014) a tradition that may have grown to be increasingly important as the desert dried and connections with desert communities became more difficult. A similarity between ceramics and tradition seems to occur during the Badarian where ceramics may have had an important role in defining identity by associating the group with earlier ceramic production in the Sudan. Black-topped ceramics, in particular, seem to have developed out of a tradition that was found both in the Sudan and in the desert (Nelson and Khalifa 2010), and suggest an affinity with an idea of heritage, but there were many forms and treatments that have no precedent and serve to emphasize the individuality of the Badarian.

Gilf C rock art builds on an earlier but very different rock art tradition in the Gilf Kebir and Jebel Uweinat apparently located deliberately in the areas of Gilf B rock art, some considerable distance from Gilf C settlement sites. On a shorter timescale, some scenes were clearly superimposed on earlier ones, indicating that they were used repeatedly, but with a consistent underlying purpose. Together, the ceramic condition suggesting a regional affinity and the localized but long-term traditions of rock art that may have a role in expressing affinity or rights of access to certain resources suggest that the role of time, repeated use and reference to longstanding traditions, are all important parts of the way in which the livelihood was managed at multiple timescales over different areas. The Bashendi B in Dakhleh is in many ways a continuation of the Late Bashendi A in terms of the presence of domesticates and bifacial tool technology, but there are also substantial changes including a decreasing reliance on wild fauna, a dependence on domesticated cattle and goat, the loss of hollow-based arrowheads from the bifacial toolkit and the absence of Bashendi A stone-built structures. Items of personal ornamentation change, and site distribution is different. The published data is limited, making it difficult to speculate, but the continuation of bifacial technology does seem to be based as much on tradition as functionality. Although there are clear differences, there seems to be a balance between continuity and change.

Bringing together all the case studies there is a suggestion that as well as changes in worldview connected with new livelihoods, there was a drive to maintain links with the past, to reinforce economic and social aspects of livelihoods by reference to ancestry or cultural heritage. Ideas of economic and cultural innovation were combined with an impulse to reference the past. This may have been an integral part of the incipient funerary tradition that emerged along the Sudanese Nile, in the Nabta Bunat el-Ansam (Final Neolithic) and in the Badarian.

9.2.1.4 Mobility

Different patterns of mobility, the most flexible form of adaptation to arid environments, can be observed in each of the case studies. As discussed in Chapter 5 and in the case studies, mobility has both subsistence and social benefits. As well as allowing dryland rangelands to recover and rest, it enables livestock to benefit from new pasture and build up strength. Being aware of good pasture is a prime function of mobility among pastoralists, which is also facilitated by social interaction and inter-group relationships. Social benefits are demonstrated in a number of examples in the case studies, where mobility may be essential to exchange, to connecting with kinship groups and support networks, and to how groups define themselves.

In Nabta during the Ru'at el Baqar it seems probable, based on the similarity of ceramic styles, that the occupants practiced a pattern of transhumance between the Nile and, for a short part of the year during the rainy season, the desert. It is possible that part of the community remained behind at a Nile valley location, probably in Upper or Lower Nubia, whilst herding parties were dispatched to the desert to make use of seasonal rainfall and pastures. One

possible linkage between the Nile and Nabta is the short distance between the Nile and the playa basin (between one and three days away), but judging from affinities in cultural output between Nabta and the Sudan (Gatto 2002b; Lange and Nordström 2006; Wendorf and Schild 1998, p.108) it is possible that groups moved along a north-south axis, which could have taken up to several weeks between Nabta and Nubia or further south into the Sudan. There are also indications that raw material acquisition took Nabta herders to the north, where a source of flint was available 70km away. The social and subsistence risks were mitigated by a number of mechanisms and it is possible that whilst climatic failure undermined economic systems, religious beliefs reinforced confidence, whilst also continuing to fortify social identity. The lack of evidence of Nabta assemblages to the west beyond Safsaf or beyond the Nile to the east suggests that Nabta occupants were circulating between Nabta and one or more other locations including the Nile valley. Nabta's role as a wet season pasture and ceremonial centre suggests that it would have had a strong pull on herders for both economic and more numinous reasons. The risk of travelling to a temporary rainfall reservoir was considerably diminished by the proximity of a permanent water source (the Nile). Although also partially transhumant, the Ru'at el-Baqar scenario differs considerably from the Gilf C.

Gilf C occupants were mobile over a large area. The main pattern of larger scale mobility detectable is that between and around Gilf and Uweinat 120km to the south and Jebel Kamil, less than c.50km to the southeast. Gilf C occupants certainly used a transhumant combination of residential and logistical mobility, using the Gilf as an extension of Jebel Uweinat, and they may have roamed further afield as well. The practices of regional and localized mobility were combined to make the most of different resources, marking points in the landscape for either territorial purposes or as ritual focal points, or both. Within the Gilf Kebir it is probable that a high degree of logistical mobility was practiced, and this is certainly suggested by the Gilf C the network of base camps within the wadis and smaller camps and ateliers proposed by Linstädter (2003). The distribution of "Gilf type" grinding stones and herringbone-decorated sherds at Laqiya c.350km to the south, in the Sudan, Abu Ballas 150km to the northeast, all suggest that the Gilf Kebir and Uweinat were part of a network of communication (Kuper 1989, p.200) suggest links between these areas. Unlike the Nabta scenario, the Gilf C groups were weeks away from generous perennial water sources. Although springs came to the surface in the Jebel Uweinat area, these were probably shared by numerous herding groups in the area, and being focal points, herds would have run the risk both of over-grazing surrounding grasslands and coming into conflict over access to water (Adriansen 1999, 2008; Binns 1992; Hunn 1993; Rodríguez-Estrella 2012).

In contrast to Nabta and Gilf C, water shortages were a low risk for Badarian inhabitants and the food production system would not have required similar patterns of mobility. Although it is probable that Nile-side occupation shifted seasonally when the floods arrived, and that when rain fell wadis and low desert were used to herd livestock there is not sufficient data to assess what combination of mobility practices were employed. Nor is there currently any evidence to confirm that wadis and low desert were used in periods of rainfall, but it seems probable and in

this scenario logistical mobility would have been practiced due to the benefits of providing herds with new pasture, avoiding illness and disease in the waterlogged floodplains. If it is accepted that the Badarian included a component of small-scale cultivation, herds of domesticated animals would need to be maintained away from the floodplain following retreat of water to prevent trampling and crop consumption. One model for managing these two resources was that of the Himba in Namibia, where during the dry season only lactating animals are kept close, and herds are moved to dry season pastures, whilst during the wet season grazing was around households and near river soils (Müller *et al* 2007, p.1871).

The Bashendi B is different again, demonstrating high mobility on a year-round basis within the oasis, making use of areas beyond the oasis during wet periods. Being bound by increasingly arid desert, and benefiting from bimodal rainfall and natural springs, Dakhleh had both advantages and disadvantages. A relatively rich environment would have been easy to over-exploit and a model of perpetual movement, such as that of the Fulani/Borani (Binns 1992), where groups move at least once a fortnight and sometimes every few days, might be appropriate. Mobility would also have been required to support social activities like trade, reinforcement of kinship links, religious aggregation and the sourcing of marriage partners (MacDonald and Hewlett 1999; Whallon 2006) and may have extended to Kharga Oasis and beyond Kharga to the Nile (Brirois *et al* 2010, Brirois *et al* 2012; Lesur *et al* 2012). More fieldwork (and its publication) is needed to confirm this.

Although it is not possible to be precise in most cases about the types of mobility practiced, the case studies demonstrate that eastern Saharan pastoralists were very adept at employing mobile patterns suitable to multiple environments. Different topographies, rainfall regimes and water sources offered different opportunities and constraints. All four case studies differed in their form of livelihood management, indicating variability and the implementation of solutions that are familiar amongst today's pastoralists. This indicates that there are many livelihood strategies available to mobile pastoralists.

9.2.1.5 Handling uncertainty: the end of the mid-Holocene

Risk is a manageable situation, handled with inherited knowledge and experience.

Uncertainty is the point at which risk cannot be handled by existing knowledge and wisdom (Knight 1921). In only one case do inhabitants appear to have remained in the area to experience impoverished conditions and early death. Some of the options available are shown below in figures 9.3-9.9.6

In the case of the Gilf Kebir (figure 9.3) it is probable that after leaving the Gilf Kebir at least some of the occupants moved south to Laqiya, some 400km away (Kuper 2007, p.9). In the case of Dakhleh Oasis (figure 9.4), some people clearly left, possibly to the Mediterranean or elsewhere, whereas others remained (McDonald *et al* 2001). In the case of Nabta (figure 9.5), the seasonal occupation simply ceased during for many decades, with groups presumably either concentrating activities in other areas that made up their seasonal round, or finding

alternatives. In the case of the Badarian (figure 9.6), there is no clear end to the cultural phenomena, some of which were retained in the subsequent Naqada I period over a much greater area and it seems probable that desert and Nile traditions merged as expanding population density required the establishment of new territories and negotiated new social relationships.

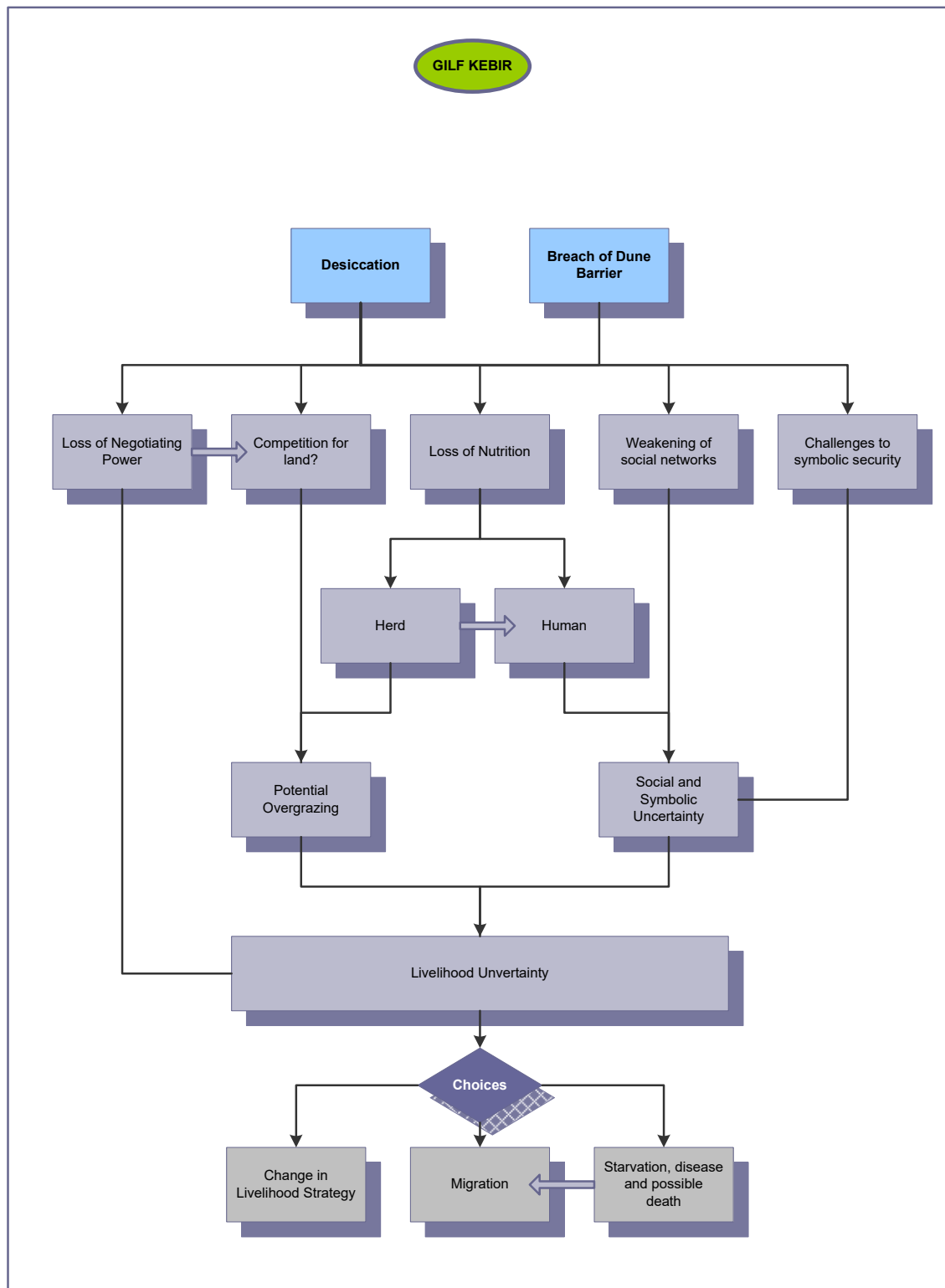


Figure 9.3 – Choices facing occupants of the Gilf Kebir at the end of the mid-Holocene

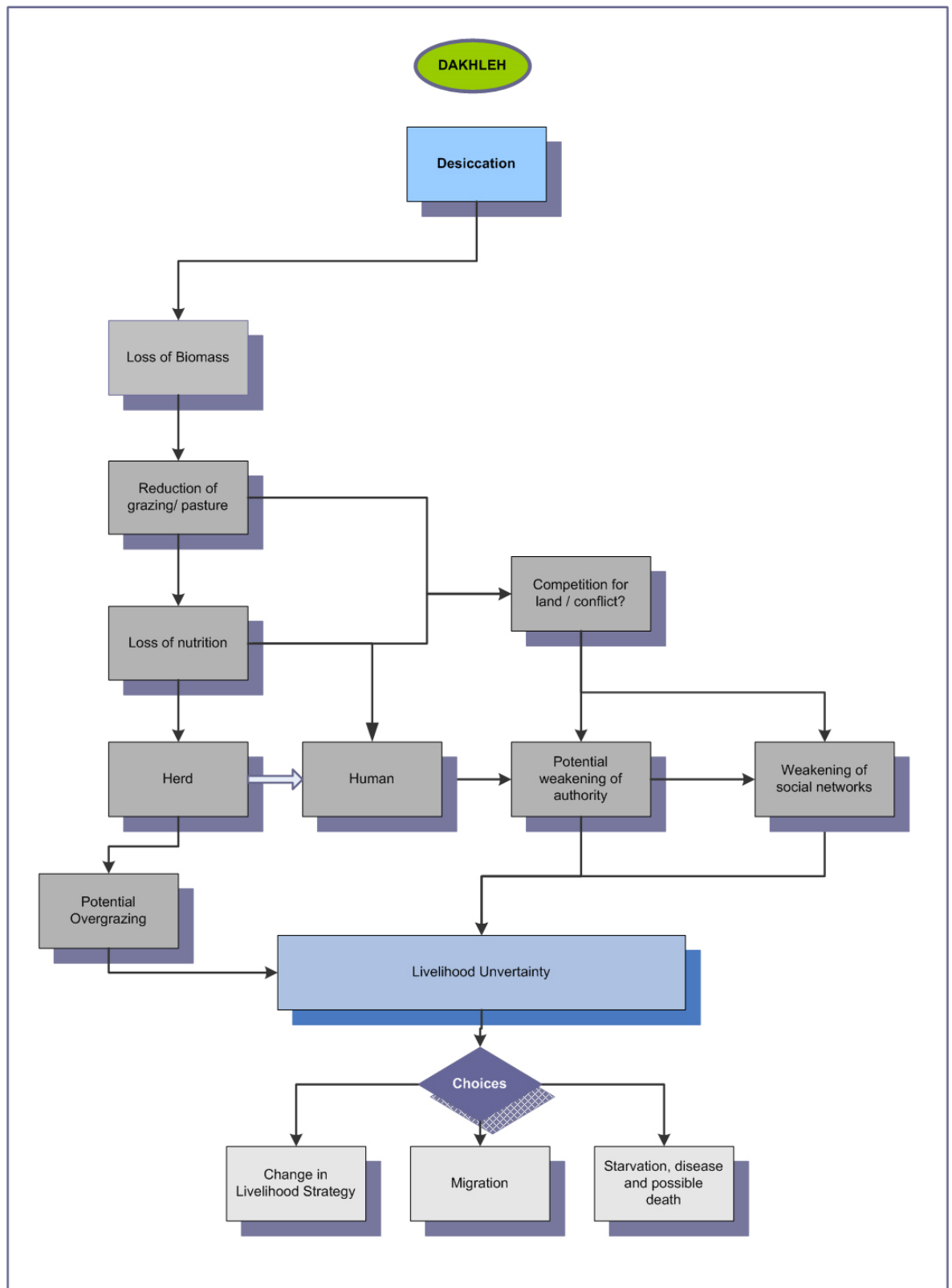


Figure 9.4 - Choices facing occupants of Dakhleh Oasis at the end of the mid-Holocene

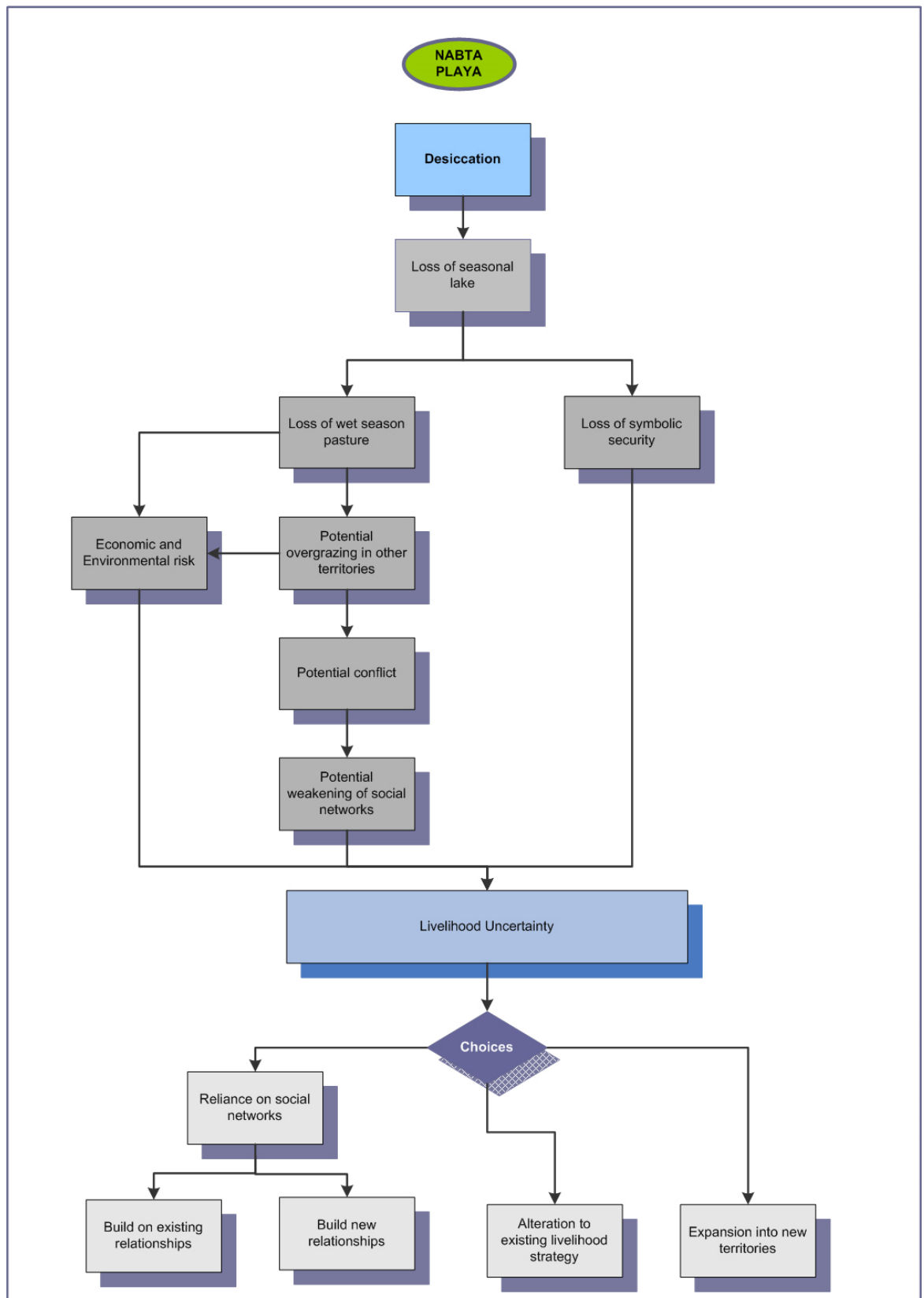


Figure 9.5 - Choices facing occupants of Dakhleh Oasis at the end of the mid-Holocene

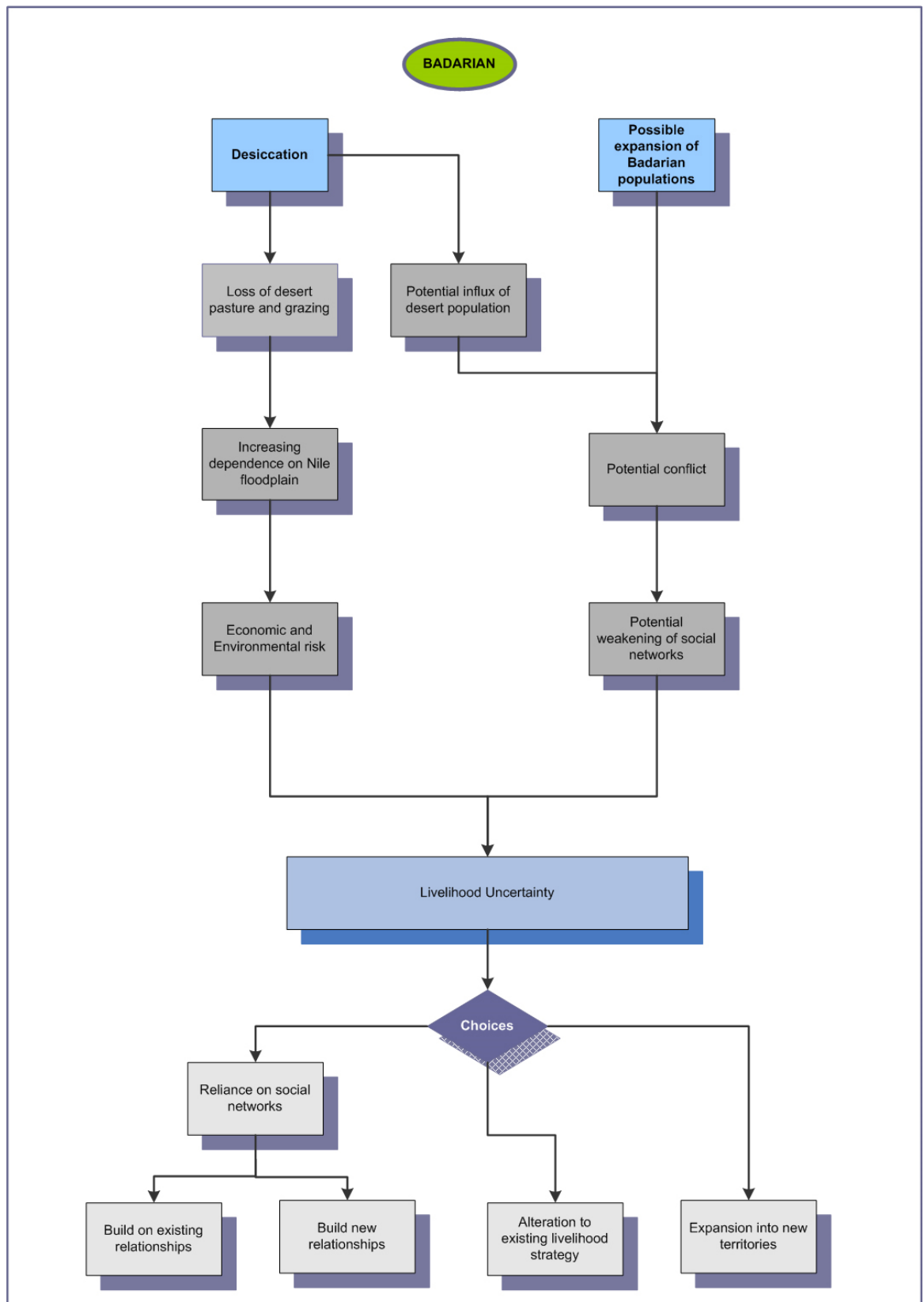


Figure 9.6 - Choices facing occupants of the Badarian at the end of the mid-Holocene

9.2.2 Comparing Total Vulnerability

The main objective of the Vulnerability Table, which has been used in each of the case studies, is to assess *individual* areas of vulnerability and to generate a cumulative figure by which to assess the *overall* vulnerability of each of the livelihoods described. Designed by Nelson *et al* (2016) the variables used are somewhat holistic and inductive, but include both natural and human influences, and result in a qualitatively derived number on a scale of one to four that represents the approximate vulnerability of each livelihood. The Vulnerability Table in Table 9.2 shows how the cumulative vulnerability variables are assessed, and table 9.3 shows the results from the case studies.

Vulnerability variables		Evidence for vulnerability	Value for variable for resilient food system
Population-resource conditions			
V1	Availability of food	Insufficient calories or nutrients	Balance of available resources and population reduces risk of shortfall
V2	Diversity of available, accessible food	Inadequate range of resources responsive to varied conditions	Diverse portfolio reduces risk, increases options
V3	Health of food resources	Depleted or degraded resources, habitats	Healthy habitats, contribute to managing risk and change
Social conditions			
V4	Connections	Limited connections with others experiencing different conditions	Social networks expand access to food and land
V5	Storage	Insufficient, inaccessible storage	Stored foods reduce risk in times of shortage
V6	Mobility	Inability to move away from challenging food conditions	Movement to alternative places, landscapes and social groups offers potential for addressing resource shortfall through access to food/land
V7	Equal access	Unequal control and distribution of land, water and food resources	Equal access avoids challenges to coping and adaptive capacity in disaster risk management
V8	Barriers to resource areas	Physical barriers limiting access to key resource areas	Lack of barriers enhances capability of people to provision themselves with food

Table 9.2 - Vulnerability variables (after Nelson *et al* 2016)

Vulnerability factors are scored out of 4, with 4 representing a variable giving the highest vulnerability and 1 the least, with a maximum score of 32 (100%).

	Population-resource conditions			Social conditions					Total /32 /%	
	V1	V2	V3	V4	V5	V6	V7	V8		
Ru'at el Baqar	2	2	3	2	2	1	3	2	17	53%
Badarian	2	1	2	4	3	2	2	3	19	55%
Gilf C	3	2	2	2	4	1	4	2	20	63%
Bashendi B	4	2	4	2	3	3	2	3	23	72%

Table 9.3 - Vulnerability variables for the case studies (extrapolated)

As table 9.3 demonstrates, there is a degree of vulnerability in all areas, but the figure seems relatively low for marginal environments. This is because the scale is one established just for areas that are inherently vulnerable, meaning that results are on a continuum that reflects situations where risk is the norm. The table reflects quite a high degree of vulnerability, requiring multiple livelihood strategies and considerable flexibility to counter natural conditions.

The results suggest that the Ru'at el Baqar and Badarian are the least vulnerable of the four case studies, although for very different reasons. The Badarian is in an area of multiple environment options that provided year-round water, pasture and human nutrition. The community had social structures to support group identity, ideology and subsistence systems that were suitable for the conditions along the Nile. Some degree of mobility was practiced, providing flexibility. Some evidence of storage was found and social connections over a wide area were probably in place. By contrast the main strength of the Ru'at el Baqar is that it was a purely seasonal occupation, with strong affinities to the Nile, only a few days walk away, suggesting that the main strength of this phase in Nabta was based around the Nile with Nabta providing an important secondary source of pasture and water.

Gilf C was heavily dependent upon the lakes formed behind dune barriers. Whether or not it was perceived at the time, it was an inherent risk that the dunes might be breached. The breaching first of the blocking dune at Wadi el-Akhdar, leading to its abandonment in favour of Wadi el-Bakht, and then of the final dune barrier led to the abandonment of the Gilf Kebir.

The Bashendi B, perhaps surprisingly, seems to be the most vulnerable of all the areas. Although Dakhleh experienced bimodal rainfall and the underlying aquifer produced perennial springs, the use of a limited territory may have been associated with the risk of the over-

exploitation of resources together with the danger of conflict over water and land. At the same time, these risks were probably mitigated by social networks, specialized tool technology, high levels of mobility and perhaps access to resources in neighbouring Kharga Oasis.

9.2.3 Comparing the Assets: Sustainability and Vulnerability

The Asset Matrix is made up of six asset components broken down into a series of analytical units. Each of the asset categories has been discussed thoroughly in the case studies, producing insights into some of the strengths and weaknesses of each asset for each livelihood strategy. Whilst the final scores in the vulnerability table, above, suggest a very similar level of vulnerability for all case studies, in this section the livelihood assets are explored for each of the case studies to see where each livelihood is most likely to experience difficulties. When the comparison between the areas under each of the asset categories has been completed, radar diagrams are employed to provide a visual comparison between the livelihoods, again captured by scoring the assets on a scale between 1 and 4, with 1 the most vulnerable, 4 being the least vulnerable.

9.2.3.1 Natural

The Ru'at el Baqar at Nabta and the Gilf C at Gilf Kebir plateau were both locations that could only be used on a seasonal basis, due to the temporary nature of the playa lake on the one hand and the dune lake on the other. This means that whilst some drought and saline tolerant tree species and perennial vegetation and grasses were present on a year-round basis, most of the plant species were annuals, which unlike perennials do not support soil formation and nitrogen fixation (Shorrocks 2007, p.37-8) but provide good grazing for livestock (Coppock 1993, p.59). Both areas were at the mercy of rainfall, which could be, and almost certainly was, unpredictable in both timing and volume, particularly towards the end of the mid-Holocene. Rates of evaporation will also have impacted how long a visit would have been, and although this was probably quite consistent from one year to the next it was very high, which would be particularly disastrous in periods of low rainfall. The Gilf C benefitted from orographic winter rainfall and possibly occasional summer rainfall via the biogeographical land bridge with the Jebel Uweinat (Darius 2007, 2013). Both Nabta and Gilf occupants were within a few days walk of permanent water sources essential to livelihoods.

By contrast, Dakhleh in the Bashendi B and the Badarian could be used on a year-round basis due to permanent water sources. Those water sources, however, were very different in character and required different livelihood management practices. Whereas the Bashendi B occupants were contained within a relatively constrained zone of increasing aridification requiring frequent movements using all types of environmental and topographical resource available, the Badarian people could always travel along the Nile as well as using wadi and low desert resources after rainfall. On paper, both look as though they were in areas of

natural wealth, but in practice it should be remembered that different management strategies were required to capitalize efficiently on resources.

9.2.3.2 Physical

The Badarian represents the highest access to physical assets and the Ru'at el Baqar the weakest. The strength of the Badarian lies in the sheer variety of raw materials available. Its location on the edge of the floodplain provided access to riverine conditions suitable for fishing, mollusc collection, harvesting wild species for food, fodder, craft activities and construction, for growing flax and hunting game, including water fowl and hippopotamus. Nile clay was available locally for pottery production and flint for tool manufacture was available locally. Although there is no evidence for permanent or semi-permanent structures, the materials for construction were available in the form of wood and reeds, which are attested in graves, these were either not required, unsuitable for Badarian livelihoods or are buried beneath the floodplain. Floodplain resources were suitable for both herding and cultivation, whilst wadis and low desert would have offered rainy season pasture if required. The uplifted geological formations of the Red Sea hills gave access to exotic stones.

Although Gilf C and the Ru'at El Baqar share some features, they differ in lithic tool technology. The expedient Ru'at El Baqar assemblages contained more clearly identifiable artefacts types with the use of different types of stone for different types of tool, whereas the Gilf C assemblages were more opportunistic and easily produced, requiring little investment of labour or skill. The Gilf C assemblages were made exclusively on local materials whilst the Nabta toolkit was made on a variety of materials, some not available in the vicinity of Nabta and must have been acquired elsewhere and transported to the playa. Both used grinders made of locally available sandstone. The ceramics of both places are highly distinctive and surface treatment was provided. Sherds were found at most sites and although hand-made, pottery was manufactured with competence. A craft infrastructure has to be inferred for both. Settlements were generally small and temporary, consisting of a hearth and a scatter of tone tools and pottery sherds. Only at Nabta is there one conspicuously larger site at E-75-8, which may have had a special purpose. During Gilf C the sites were of variable size depending on location. Larger base camps were used in conjunction with smaller ateliers, some for temporary herding, possibly on the household level and some for the exploitation of raw materials, which could be used by just one person.

Dakhleh during the Bashendi B was a much more abundant environment than Gilf Kebir and Nabta Playa. The oasis probably provided plenty of wild grasses and water-based species for craft activities and plenty of fuel would have been available in the form of dung from livestock or, less sustainably, wood. There was plenty of stone for tool and grinder manufacture. Other stones and aquatic shells were imported for items of personal ornamentation although it is unclear from the published material how common these were. Although some pottery seems to have been imported, most was made locally. Ironstone and limestone were used to

manufacture palettes, and were available locally. Groups were highly mobile, their sites ephemeral, possibly consisting of only a few households at certain times of year, and use was made of all available topographies.

All areas share a heavy dependence on local resources, although in all cases materials were also brought in from outside the core areas.

9.2.3.3 Social

The two areas with the strongest rating of social assets in the vulnerability output table (table 9.3) are the Gilf C and Ru'at El Baqar. In both cases the cultural output demonstrates substantial investment and strong affinities with other areas, which must have made up part of the annual pastoralist pattern of mobility. The surface treatment of ceramics in Nabta was quite unlike that of the previous Ru'at El Ghanam but has strong affinities to Nilotic cultural elements, indicating both a departure from former lifestyles and former ideologies as well as the increasing importance of social links with other areas. The story is similar with the Gilf C where there are some differences between Gilf B and Gilf C pottery, and where rock art indicates that the Gilf was used in close connection with Jebel Uweinat. Both also invested heavily in numinous components of their lives, with the ceremonial centre at Nabta and the rock art in enclosed rock shelters and caves in Gilf Kebir and Jebel Uweinat. Both suggest ideologies and perhaps religious belief, and both were closely tied in to a sense of location. Social connections, which would reinforce subsistence strategies, provide access to marriage partners and goods for exchange as well as potential support under conditions of stress are indicated by a number of factors. In Nabta these lie primarily in the Sudanese Nile valley. During Gilf C they are found primarily at Jebel Uweinat, Laqiya, and perhaps the Upper Nubian Nile. There is no sign of status expressed in Gilf C, although rock art may have been the particular concern of specialist artists and religious figureheads. At Nabta the planning for, and the construction of the ceremonial centre implies that a number of roles were required, but not necessarily on a permanent basis. The use of the ceremonial centre may have required the expertise of someone who bridged between the living and the supernatural. Tradition appears to have been embedded in both cases in ceramics, subsistence strategies and numinous activities but not in stone tool technology.

The Badarian stands out for its investment in cemeteries and grave goods, and the distinctive personality of its extensive cemeteries. Identity, tradition, religion and ideology all appear to be tied up in this remarkable data, which argues a strong social profile, with both individual and group identities being communicated. However, the Badarian is probably the least robust of the case studies in the area of inter-group connections because although its cultural identity seems to have been derived from the Sudan and may have been maintained (Gatto 2009; Wengrow 2006), the distances involved may have created certain barriers to regularly maintained connections, which may have led to difficulties in terms of, for example, exchange, support networks and genetic diversity.

The Bashendi B is more difficult to assess and compare with the other areas. There is clearly a dependence on external sources for some pottery and exotic stones suggesting long distance networks, and initial indications suggest that further fieldwork at Kharga Oasis so the east is likely to reveal linkages between the neighbouring areas (Briois *et al* 2012; McDonald 2006, p.4; Storemyr 2014). McDonald suggests that prestige items may indicate differential access to goods and increasing social complexity (McDonald 1999; McDonald 2008, p.100, table 1, and p.102) and ornamental objects suggest ideas of identity or status. Equally, however, they could be connected with rites of passage (e.g. Abati 1998; Lambrecht 1996). In short, it is difficult to assess social assets, and this is reflected in the low score on the radar diagrams below (figures 9.4 and 9.5), which may be artificially low due to lack of data.

9.2.3.4 Subsistence

All of the livelihood strategies included domesticates, hunting and plant gathering. In the Badarian a more diversified livelihood combining plant gathering, fishing and small-scale cereal cultivation with the flexibility of at least partial mobility makes it seem particularly robust. Some storage was apparently practiced, and from cemetery remains it appears that there was no shortage of healthy group members. The ability to move axially along the Nile and to exploit desert and wadi resources could have been invaluable, but archaeological research has yet to investigate aspects of land use. Likewise, the Ru'at El Baqar and Gilf C both came out quite strongly, also operating a diversified stocking strategy, incorporating cattle, sheep and goat, combined with hunting local game and foraging for plant foods. Both groups were seasonally mobile, using these locations as outliers from other bases that were either inhabited on a nomadic or more sedentary basis. Neither had the rich natural resources available to the Badarian people, but the subsistence strategies made excellent use of the resources available, employing a variety of risk management strategies to mitigate the inherent constraints of the environment. Both were located within several days walk of much richer areas, and the use of outlying areas was probably concerned primarily with resting pasture elsewhere, maximizing the value of playa and environments, and ensuring that herds benefitted from the freshest possible feed. The benefits of this were good quality milk and meat and the ongoing fertility of the herd. Judging by the manpower invested in the bigger ceremonial features at Nabta, there was no shortage of labour that could be mobilized when needed. The activities carried at the Gilf sites were not labour intensive so it is impossible to make any judgements about labour availability and composition during the Gilf C.

The weakest scenario for the sustainability of a particular livelihood in all its dimensions is Dakhleh's Bashendi B. The availability of perennial water initially suggested a strong foundation for subsistence activities, and the oasis is likely to have had rich plant foods available, attracting wild game. However, the ability to exploit those resources may have been limited by the constraining geographic circumstances under which groups lived, particularly as

the surrounding desert became increasingly inhospitable. This could have been managed by keeping populations and herds small, or varying herd size in response to changes in circumstances, but there are no data to measure whether or not this was the case. Groups were highly mobile, possibly consisting of only a few households at certain times of year, and use was made of all available topographies. Social networks were apparently in place, and this could have helped to mitigate difficulty in times of stress.

In all cases there are indications that certain items were exchanged, suggesting that social networks included a certain amount of trading, but beyond noting indications of inter-regional connections it is impossible to comment on exactly what form this may have taken.

9.2.3.5 Human

The lack of human physical remains everywhere except in the Badarian area, means that demographic data is largely unavailable. Knowledge and information are similarly nebulous. For this reason I have confined the comparison to nutritional information, although this too is meagre. As described in Chapter 7, no data is available about socially proscribed restrictions or preferences, so any plant and animal remains found are treated as options for occupants, a range of nutritional options from which they could select.

In all areas cattle and goat were herded. Sheep was present in all areas except Dakhleh, which may represent a choice but may also be an accident of preservation or represent difficulties of identification. In all cases herding was supplemented by hunting. In all cases wild plants were certainly gathered, and there are some indications of this although preservation has been poor. The species preserved are different in each of the four case studies. The Badarian is unique for having indications of small-scale cereal production. The following tables (tables 9.4 and 9.5), combined from the case studies, show the different food resources identified in each area and their potential value.

✓ / ✗ = present or not present

Nutritional Values of Plant Species					
Wild species					
Species	Value	Ru'at el Baqar	Badarian	Gilf C	Bashendi B
<i>Acacia ehrenbergiana</i>	Used today by some Bedouin groups for making a type of coffee.	✓			
<i>Acacia nilotica</i>	Edible gum can be obtained from the bark and soft inner bark may be used to curdle	✓			

Nutritional Values of Plant Species					
Wild species					
Species	Value	Ru'at el Baqar	Badarian	Gilf C	Bashendi B
	milk. Seeds and pods are also sometimes eaten. Traditionally used for medicinal purposes.				
<i>Acacia tortolis raddiana</i>	Traditionally used for medicinal purposes.	✓			
<i>Acacia sp.</i>	Traditionally used for medicinal purposes. Year round availability.		✓		
<i>Avena sp.</i> (Oat)	Carbohydrates, fat, protein, calcium, vitamin B, magnesium, phosphorous, potassium. Early winter availability		✓		
<i>Balanites aegyptiaca</i>	Evergreen tree. Up to 8m high with edible, bitter-sweet fruit, which is rich in phosphorous, potassium, calcium, iron, zinc, copper, sodium, magnesium and manganese. In some areas seeds are crushed to make oil (Feyssa <i>et al</i> 2015; Mahmoud 2010, p.45; Van Wyk and Van Wyk 2013, p.438)			✓	
<i>Capparis decidua</i>	Edible and well flavoured fruits with high quantities of phosphorous and calcium, and useful quantities of fat and protein. Traditionally used for medicinal purposes.	✓			
<i>Caster ricinus communis</i> L.	High fat content – 47% oil. Leaves and seeds are toxic and special sill is required to convert it for use as an oil (Serpico and White 2000, p.391). Year round availability		✓		
<i>Chenopodiaceae</i>	Used as herbs and leaves for human consumption. Provides nitrogen and absorbs salt, useful in human diets.	✓			

Nutritional Values of Plant Species					
Wild species					
Species	Value	Ru'at el Baqar	Badarian	Gilf C	Bashendi B
<i>Cucumis sp.</i> (melon seeds)	Vitamin A, vitamin C, carbohydrates. Summer availability		✓		
<i>Cyperaceae</i> (sedges)	Fruits, seeds, green parts, tubers and rhizomes can all be consumed. Flowers during rainy season but can be consumed by humans and animals all year round				✓
<i>Desmostachya bipinnata</i> (Halfa leaves)	Often used in traditional medicine, and as animal fodder.		✓		
<i>Linum</i>	Vitamin C, K, potassium. Summer availability.		✓		
<i>Maerua crassifolia</i>	Fruits are valued for their sweet taste and they are a good source of nectar for honey. Leaves are a good source of calcium, linoleic acid and alpha-linolenic acid.	✓		✓	
<i>Paniceae</i>	Wild cereals which can be consumed but also provide animal feed and fuel. A mainly wet season resource but can provide animal fodder in the dry season				✓
<i>Panicum turgidum</i>	Contains high levels of potassium, phosphorous, sodium and calcium. The grains are used by the Tuareg in the central Sahara for grinding into a flour to make into porridge	✓			
<i>Poaceae</i> (formerly <i>gramineae</i>)	Wild cereal tubers and rhizomes. One of the most important sources of human food. A mainly wet season resource but can provide animal fodder in the dry season				✓
<i>Salvadora persica</i>	Fruit can be eaten fresh, cooked, dried and stored or made into a fermented drink. Leaves are eaten as a green vegetable or made into a	✓			

Nutritional Values of Plant Species					
Wild species					
Species	Value	Ru'at el Baqar	Badarian	Gilf C	Bashendi B
	sauce. A source of nitrogen, phosphorus, potassium, and calcium				
<i>Setaria</i>	A member of the millet group which has again been used for making porridge	✓			
Tamarix leaves, fruits, containing seeds (<i>Tamarix aphylla</i> and <i>Tamarix</i> sp).	Traditionally used for medicinal purposes. Fruit ripens in the cold season	✓	✓	✓	✓
Typha sp. (bulrush/cattail)	Vitamin K, vitamin B6, calcium, magnesium, potassium, phosphorous, manganese, iron. Traditionally used for medicinal value in Europe and America for antiseptic and coagulant properties		✓		
<i>Vicia</i> sp. (vetch)	Protein, nitrogen, potassium. Commonly used today as an animal fodder due to high feed value, but may also be used as an alternative to lentils. Seeds appear over summer months. Herbivores can eat it at all stages of growth		✓		
<i>Ziziphus spina cristi</i>	Fruits are well flavoured and have a high vitamin C content. Traditionally used for medicinal purposes.	✓		✓	
Domestic Species					
<i>Hordeum vulgare</i> (barley)	Carbohydrates, vitamins B complex, E, small amounts of protein, magnesium, calcium, potassium, chromium, zinc. Harvest is from March to May.		✓		
<i>Triticum dicoccum</i> (wheat)	Carbohydrates, vitamins B complex, E, small amounts of protein, magnesium, calcium, potassium, chromium, zinc. Harvest is from April to May		✓		

Nutritional Values of Plant Species					
Wild species					
Species	Value	Ru'at el Baqar	Badarian	Gilf C	Bashendi B
Sources of nutritional data: ARKive n.d.; Belal 2009, p.68; CABI 2008; Campbell 2009; Cook <i>et al</i> 1998; FAO Grasslands Species Projects <i>n.d.</i> ; Heneidy, S.Z. and Halmy, M.W. 2009; Kew Gardens: Useful Plant and Fungi <i>n.d.</i> ; Mahmoud 2010; Reznicek, A.A. 2008					

Table 9.4 - Nutritional Values of Plant Species

Nutritional Values of Animal and Aquatic Species					
Wild species					
Species	Value	Ru'at el Baqar	Badarian	Gilf C	Bashendi B
Antelope (various African species of the family Bovidae that are not sheep, goat, cattle), but most likely to be ibex and gazelle.	Meat products: protein; iron, zinc, fat	✓	✓		
Dog (<i>Canis lupus</i>)	Meat products: protein; fat; folate/folic acid; Vitamins B2, B3, B6, B12; zinc	✓	✓		
Fowl (various)	Meat: protein, fat, Vitamins B2, B3, B6, B12, zinc. Eggs: fat, phosphorous, protein Non migrating species available at any time; Migrating species available during winter months		✓		
Fox (Red or Rüppell's fox)	Protein; iron				✓
Gazelle (Dama and/or Dorcas - <i>Gazella Dorcas</i> or <i>Dama</i>)	Protein; iron, zinc	✓	✓	✓	✓
Hare (Desert hare, <i>Lepus capensis</i>)	Protein, lipids, cholesterol, sodium, potassium, iron, calcium, phosphorus	✓		✓	
Hartebeest (<i>Alcelaphus bucelaphus</i>)	protein; iron, zinc, fat				✓

Nutritional Values of Animal and Aquatic Species						
Wild species						
Species	Value	Ru'at el Baqar	Badarian	Gilf C	Bashendi B	
Hyaena (<i>Hyaena hyaena</i> or <i>Crocuta crocuta</i>)	protein; iron, zinc				✓	
Ostrich (<i>Struthio camelus</i>)	Meat products: low in fat but is high in protein, vitamin B12, selenium, niacin, vitamin B-6, phosphorus and zinc and smaller but significant levels of thiamin, riboflavin, pantothenic acid, iron, potassium and copper. Eggs: high in fat and contain vitamin A, thiamine, zinc, calcium, iron, magnesium and manganese. Eggs available in the winter.	✓	✓	✓		
Porcupine (<i>Hystrix</i>)	Protein, iron	✓				
Spoonbill (<i>Platalea</i>)	Protein; fat. Available in the winter		✓			
Wildcat (<i>Felis silvestris lybica</i>)	Protein, iron, zinc				✓	
Domesticated Species						
Cattle (<i>Bos primigenius / taurus</i>)	Dairy products: Calcium, Vitamins A, D, zinc, phosphorous, fat (4-5.5%), carbohydrates. Blood products: Iron, zinc, protein, some calcium and phosphorous. Meat products: protein; fat; folate/folic acid; Vitamins A, B2, B3, B6, B12 Dairy products only available when animals are lactating (3-8 months). Blood available all year round but less during dry-seasons and not at all during drought	✓	✓	✓	✓	
Goat (<i>Capra hircus</i>)	Dairy products: Calcium, Vitamins A, D, phosphorous, zinc, fat (3.5%) Meat products: protein; iron, zinc, vitamins A, B2, B3, B6, B12, D; carbohydrates. Dairy products available only when animals are lactating (3-8 months)	✓	✓	✓	✓	
Sheep	Dairy products: Calcium, Vitamins A, D. phosphorous, zinc, fat (5%) Meat products: protein; fat; folate/folic acid; Vitamins A. B2. B3.	✓	✓	✓		

Nutritional Values of Animal and Aquatic Species					
Wild species					
Species	Value	Ru'at el Baqar	Badarian	Gilf C	Bashendi B
	B6, B12, D, carbohydrates Blood: Protein, iron, salt. Dairy products: Only when animals are lactating (3-8 months)				
Aquatic Species					
Crocodile	Protein		✓		
Fish	Protein; fat; Vitamins A, B3, B6, D, phosphorous, zinc		✓		
Hippopotamus	Meat products: protein; fat; folate/folic acid; iron, Vitamins B2, B3, B6, B12		✓		
Molluscs (fresh water)	Vitamin C, Vitamin B2, B3, B12, phosphorous, protein, iron, zinc, copper, magnesium, selenium	✓	✓		✓
Turtle	Protein; calcium; Vitamins A, B1, B2, B6; phosphorous; zinc		✓		

Table 9.5 - Nutritional Values of Animal Species

Tables 9.4 and 9.5 show the range of potential foodstuffs available in each area, some of which may also have been used for medicinal purposes. As one would expect, the Badarian had the most to offer communities because of the presence of riverine, floodplain, wadi and low desert resources. Elsewhere, there are two surprising omissions. The absence of sheep in Dakhleh may also have been due to poor preservation or the difficulties of distinguishing between some sheep and goat bones. Alternatively, sheep could have been judged to be in competition with cattle and therefore unsuitable. Desert hare seemed a surprising omission at Dakhleh, because it was desert-adapted, was found in the previous Bashendi A and was present in many mid-Holocene sites, where it seems to have been a staple of the diet (Pöllath 2009, p.94), making up 41.4% of the wild species in the Ru'at el-Baqar at Nabta (Gautier 2001), but is also only represented in small numbers at neighbouring Kharga oasis site KS43, where preservation of animal remains is good (Lesur *et al* 2011). Other than that, there are no surprises. The narrow range of animal and plant species actually represented is assumed to be due to poor preservation given the exposed palimpsest nature of sites.

The available data on plant and animal resources suggests that Badarian nutrition ought to have been suitable, with no significant shortages of vital nutrients, assuming that milk was consumed. Protein and fat was available from both domesticated and wild animal resources, as well as fish, whilst Zakrzewski's analysis of dental remains indicates that large amounts of ground plant food, particularly cereals, were consumed. Having said that, Zakrzewski's analysis of skeletal data suggests identified examples of stunted growth (Zakrzewski 2003, p.225), suggesting at least temporary periods of nutritional stress. It is impossible to compare this data directly with any of the other three case studies due to the absence of human remains for analysis in those areas, but it is a useful warning that data obtained from plant and animal remains gives only a very partial picture.

Dakhleh, with its bimodal weather regime and natural springs, supported species that were absent in the Gilf Kebir and Nabta Playa, including freshwater molluscs, hartebeest and plant species that favour standing water. With its varied topography Dakhleh potentially offered multiple different habitats for species to colonize, many of which could have been exploited, albeit by managing access right to water sources and leading very mobile lives. Depending on population levels and rainfall variability, there may have been periods of environmental stress and food shortage, difficult to alleviate except by concentrating on springs or temporarily leaving the area.

Nabta and Gilf Kebir occupations, both based on temporary rainfall lakes and pastures, were just as dependent upon the availability of water as in the Badari and Dakhleh regions, but less dependent on the availability of other resources due to the temporary duration of their presence in those areas before their return to more productive and sustainable environments. However, as emphasized in the Nabta case study, bone remains indicate that domesticates made up 85% of the diet (Gautier 2001, p.532) and the number of grinding stones implies extensive processing of wild grass seeds. Although superficially similar to Nabta in terms of temporary water supply, the data for Gilf C subsistence and nutrition is poor.

The skills and knowledge required for livelihood sustainability is traditionally passed from one generation to the next, as children learn from their older siblings and the previous generation. This is evident in the maintenance of industrial and cultural output throughout each of the periods under discussion, combined in each area to engage in overtly economic activities, supported at least in the cases of the Ru'at el Baqar, the Badarian and Gilf C by religious or ceremonial activities. Although many of the skills were easily transferrable, some technical tasks were more specialized, like the manufacture of very fine-walled pottery during the Badarian. More complex were the social and diplomatic skills required to engage in trade, such as the acquisition of exotic stones in Dakhleh and the Badarian, and knowledge of religion, rites and rituals that may have resulted in the Nabta ceremonial centre and the rock art at Gilf Kebir. In the case of all four case studies, Hunn's definition of traditions as "the products of generations of intelligent reflection tested in the rigorous laboratory of survival" (1993, p.13) seems applicable.

9.2.3.6 Personal

The strongest opportunity for meeting these requirements seems to have been the Badarian. Individuality or recognition of the individual's progress through life via rites of passage is suggested by ornamentation and the choice of grave goods. Status could have been expressed through access to exotic goods. There is also the possibility that glazed steatite belts were a badge of office for some members of the community. The least secure area, at least from the published data, seems to have been Dakhleh, where geographical constraint may have limited the expansion of population and limited the ability to secure status, although exotic stones may have been prestige items and the need to manage aquatic resources may have led to certain individuals becoming important in negotiations. The Ru'at el-Baqar and Gilf C seem to be fairly comparable, with the possibility of religious specialists mediating between the living and the supernatural, and at Nabta there is the possibility that the design and implementation of the ceremonial centre enabled certain people to influence outcomes and take on leadership roles, but which would have been subject to social and/or symbolic risks. In both cases a sense of security could have been engendered by social networks that could be used to facilitate a number of benefits.

9.2.3.7 Summary

The brief summaries above, derived from each case study, summarize potential points of strength and vulnerability in the asset mix and enable comparison. As described in the introduction to this section, the analysis is used to allocate qualitative scores to each of the asset components in each of the four case studies as follows in figure 9.3 in order to represent these areas of strength and weakness graphically and make them transparent.

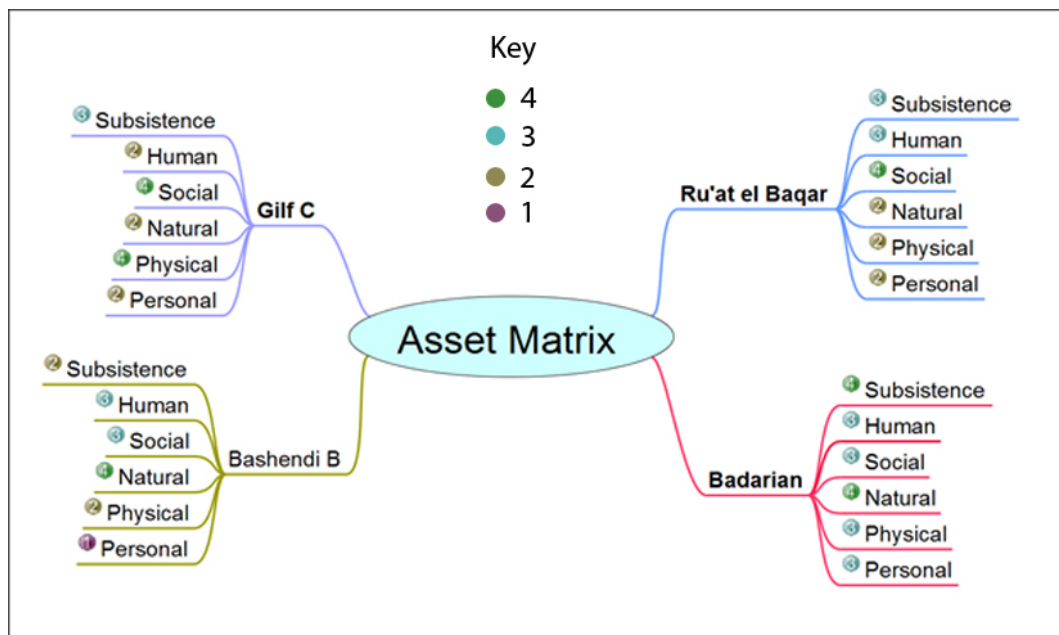


Figure 9.7 - Assigning values to the Asset Matrix

This enables the resulting strengths and weaknesses for all four case studies to be shown on a radar diagram for comparative purposes as follows in figures 9.4.and 9.5. Rather than just showing overall vulnerability, the radar diagrams help to demonstrate where problems with sustainability might lie in each of the areas represented by the case studies.

The result is four different patterns in table 9.4, combined in 9.5, highlighting that although some of the areas may have experienced similar levels of total vulnerability, there are considerable differences in where those vulnerabilities lie. Whilst there is real danger that interpretation of components has been skewed by differential survival of data, in most cases it has been possible to extrapolate from the data to a best-case scenario, as described in each case study. I have made it clear below where this has not been possible. It should also be noted that livelihoods will have responded to challenges on an annual or seasonal basis, so this represents a holistic representation of the situation, but does not incorporate variability on a seasonal or annual basis.

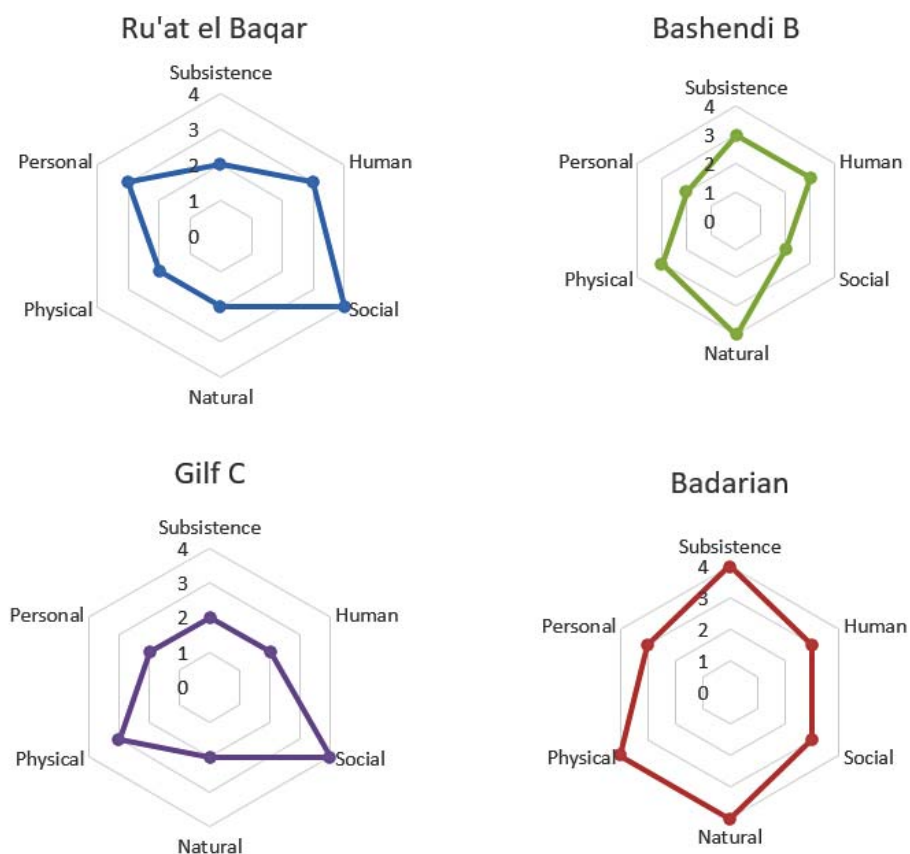


Figure 9.8 - Radar diagrams showing strengths and weaknesses of each asset category

For comparative purposes they can also be seen on a single radar diagram as follows:

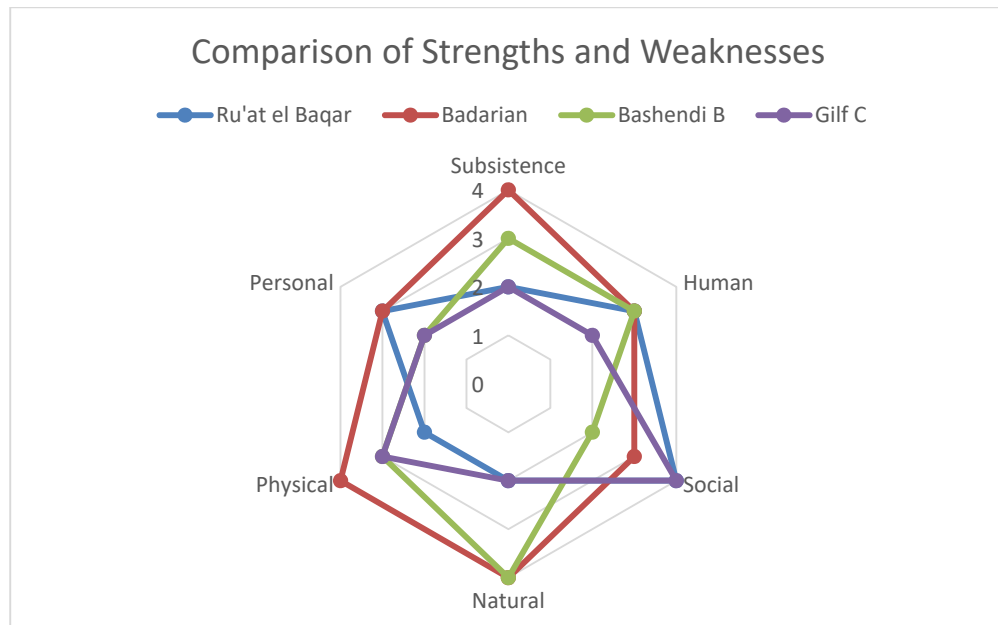


Figure 9.9 - The combined radar diagrams of the archaeological case studies

The Badarian seems to have been generally well provisioned with no obvious points of weakness. Zakrzewski's analysis of skeletal data suggests that some individuals experienced stunted growth (Zakrzewski 2003, p.225), and whilst this may be indicative of poor nutrition throughout the Badarian, it may have reflected an episode of several years or decades, perhaps caused by multiple failed Nile floods or disease amongst livestock. There does not seem to have been any reason why the area should not have supported people and their livestock sustainably. It may be surprising that the Social asset is rated low, because all the signs are that plenty of inter-group mechanisms including ideology, religious belief and traditions were at play to support households. However, inter-regional contacts cannot be demonstrated definitively, and it is possible that this would have been a serious weakness, leaving Badarian populations dependent upon their own internal support mechanisms without recourse to assistance from elsewhere.

The Ru'at el Baqar was generally strong in the main points where it mattered on the basis of a seasonal occupation. The main components that were important for a short stay were subsistence strategy and natural resources. Although the natural environment of the Ru'at El Baqar could not support extended human life, the objective of the visit was for water and pasture, and the wellbeing of herds are generally prioritized today over the wellbeing of herders. However, there will have been years of failed rainfall when Nabta was not viable, or when minimal rainfall led to much shorter visits than usual, and towards the end of the mid-

Holocene these effects will have been exacerbated. Physical assets were sufficient for the needs of a limited stay, but raw materials for many of the tools were not available locally and had to be imported. Social assets, embedded mainly in the ceremonial centre and the traditions incorporated into ceramics, are very strong but the ceremonial centre may reflect a response to deteriorating climatic conditions, and could therefore be a marker of vulnerability.

The Gilf Kebir, like Nabta Playa, was inhabited on a seasonal basis, and part of its strength lies in the ability of inhabitants to occupy it when conditions were optimal for herds and to return to a richer and more reliable area when water and pasture were depleted. The main weaknesses were the temporary nature of the natural assets and the lack of ongoing nutrition, which will have been confined primarily to seasonal grasses and some perennial fruits. The main benefits of the Gilf were the value of water and pasture for herds and the ability to acquire raw materials on an *ad hoc* basis. As with the Ru'at El Baqar, activities based on religion and tradition seem to have supported the livelihood system but may also have been a response to difficulties such as environmental stress and conflict over territory. Whilst at Nabta it is possible that individuals were able to adopt roles of leadership and status during some activities, there are few signs of the individual in the Gilf C.

Although the archaeological record is ambivalent on the subject, it is difficult to imagine that the Bashendi B of Dakhleh was not rich in flora and fauna, with year-round water available, which would have supported the establishment of perennial plants that would have been beneficial for the development of soil. However, it was geographically constrained so for subsistence purposes it may have required a very strict livelihood management strategy, with both human and livestock populations placed under limits. The Personal asset has been rated fairly low because of the ephemeral nature of the sites and the possibility that population growth was limited by geographical boundaries. In addition, although it has been suggested by McDonald (1999; 2008 p.100, Table 1) that exotics may represent prestige items, there were probably few opportunities for individuals to contribute any extraordinary degree to either the community as a whole or to their own status. Bifacial tool technology and handmade pottery are both skilled crafts, but both can be learned from childhood and do not represent specialist technology, so are not indicators of specialist craft producers. However, although this shows as a dip on the radar diagram, there is no reason why it should have contributed to vulnerability.

It is interesting to compare this to the Hadendowa test study radar diagram shown in Appendix H and copied here in figure 9.6, showing the difference that modern government and non-government agencies make on livelihoods and options. Following the severe droughts of the 1980s, the expansion of urban centres, the introduction of agricultural schemes, the degradation of the natural environment and the intervention of aid agencies and NGOs, the radar profile captures an interesting situation. The Personal assets were high, due to opportunities for individual males in the urban centres, with NGOs and in agricultural schemes, at the same time giving more independence to women. Physical assets are also high, due to

the low physical investment required for the Hadendowa livelihood. However, the declining condition of natural resources has a very negative impact on both economic and social assets. Aid agencies assisted with the immediate problem of food provision and put in place infrastructure to assist with human (health and education) and livelihood options, but the core values of the Hadendowa were under serious threat from the impact of these activities as well as the loss of adult males to wage labour in Port Sudan. The radar diagram captures the highly vulnerable situation in which the Hadendowa found themselves in the 1990s.

Asset Category Strengths and Weaknesses

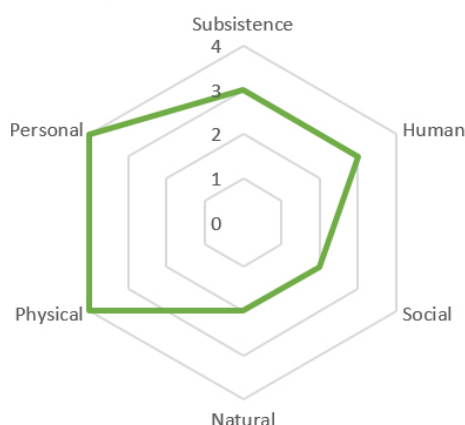


Figure 9.10 – Radar diagram for the modern Hadendowa

9.2.4 Comparing the Key Questions

The key questions composed for the comparative study are as follows:

1. What drew occupants into the area and why did they remain?
2. What types of risk (natural and human) were experienced?
3. What types of risk management strategies were employed?
4. How can the economy be characterized?
5. Are decisions identifiable in the archaeological record?
6. How has group identity manifested itself in the archaeological record?
7. Were opportunities taken up in times of insecurity or stability?
8. Can the livelihood be characterized as sustainable?
9. What were the drivers for significant change at the end of each period?

9.2.4.1 What drew occupants into the area and why did they remain?

In all of the case studies, the main driver to occupation was hydrology – the availability of water on a seasonal or year-round basis. There may have been other incentives, including

competition for land elsewhere, but these are not visible in the archaeological record. Traditional affinity with the area, which would fit the Nabta and Gilf data, or continuity of occupation, as in Dakhleh, are other explanations. Dakhleh was the only desert area that may have had sufficient hydrological resources for year-round occupation. At Gilf Kebir and Nabta rainfall was highly seasonal representing an opportunity to rest dryland resources and maximize the opportunities offered by these temporary refuges. The Badarian was located on the Nile. Another factor in most areas, with the possible exception of Nabta Playa, was topographical variability, meaning that there were different types of environment to exploit for potential grazing, wildlife and the acquisition of material resources.

9.2.4.2 What types of risk (natural and human) were experienced?

Risk has been discussed in each case study and has been compared in detail above in 9.2.1 and will not be repeated here. As indicated, risk management employed economic, social and symbolic mechanisms, as part of livelihood management strategies where risk management was an integral part of the livelihood. Each of the areas experienced a different set of risks and different approaches to risk management were deployed.

9.2.4.3 What types of risk management strategies were employed?

This question has also been addressed in 9.2.1, but a number of themes can be isolated for comment. Mobility was necessary to all four areas, although they were different forms of mobility. Whereas Dakhleh groups were probably highly mobile, Badarian groups were only forced to abandon floodplains on a seasonal basis due to the annual Nile flood whilst, by contrast, the Gilf and Nabta were only attractive on a seasonal basis. All economies were diversified. The combination of mobility and diversification suggests in all cases similar concerns with habitat management, but all differed in their implementation. Ideological and religious beliefs suggest an investment in symbolic means of risk management in all cases except Dakhleh, where there are no unambiguous indicators. Social and exchange networks are implied in all case studies, although how they operated is completely opaque. When environmental conditions began to undermine livelihood strategies and people had to make choices about how to respond, only Dakhleh and the Badarian areas could support ongoing occupation, and in the case of Dakhleh those who stayed to live in impoverished conditions. Nabta and the Gilf Kebir were abandoned.

9.2.4.4 How can the economy be characterized?

All three desert livelihoods were based on diversified pastoralism, some degree of mobility to spread the load on the landscape, and plant foraging. At Gilf Kebir different sized groups, possibly specialized work and foraging groups, appear to have split off from the main camps to different parts of the landscape for short periods. The finds at Safsaf (Close 1996, 2002a) may suggest something similar for Nabta, but may also be evidence of a completely unrelated activity. Dakhleh appeared to lack sheep, but that might be a bias in the survival of the data.

The Badarian population had access to fish and riverside vegetation, which would have been unavailable at Dakhleh or Gilf Kebir. Nabta ceramics show strong affinities to sites on the Nile which may indicate that Nabta occupants had access to riverine resources for parts of the year when they were there. At least some of the Badarian groups may have cultivated crops imported from the Near East. Exchange, difficult to observe, probably formed part of a network of supply and demand, but it is very opaque. Some signs of storage have been suggested by minimal data everywhere except Gilf Kebir, but it is again nebulous.

9.2.4.5 Are decisions identifiable in the archaeological record?

Whilst realizing that the palimpsest character of the data would complicate the question of whether decisions are visible in the archaeological data in the four areas, it was still of interest. Decisions can be broadly categorized as individual (where the efforts of one person can be observed), household or group. Table 9.6 below suggests some of the decisions that take place in this areas. It emphasizes that some important Segal (1994) emphasizes that risk is a constant process of problem solving and decision making, and that this is captured in decisions such as when and where to move during the seasonal round might take place at either the group or household level, whereas others, like repairing broken pots or manufacturing and curating high-cost bifacial tools in specific forms, are in the realm of the individual. Ceramics in the areas of the case studies are probably manufactured on a household basis as there are no signs of centralized industrial areas. Motivation for these decisions may, of course, lie elsewhere. For example, although bifacial tools are manufactured on an individual basis, their purpose may serve the group as a whole in the form of expressing group identity or regional affiliation (see table 9.10). Some decisions may be on behalf of the group but made by an individual, for example the location and execution of rock art or the activities that take place in the ceremonial centre, but as this decision-making process is unknown, both are situated in the Group column as they represent decisions that are made on behalf of the group.

	Individual	Household	Group
Ru'at el Baqar		Exchange Mobilization	Exchange Mobilization User of ceremonial centre
Gilf C	Individual forays onto plateau Execution of rock art	Exchange Mobilization Ceramics	Exchange Mobilization Composition and location of rock art
Bashendi B	Bifacial lithic manufacture	Exchange Mobilization Ceramics	Exchange

		Acquisition of exotics	
Badarian	Bifacial lithic manufacture Repair of broken pots Choice of grave goods?	Exchange Ceramics Acquisition of exotics Choice of grave goods? Mobilization	Exchange Choice of grave goods? Absence of infants in burials Mobilization

Table 9.6 – Suggested group sectors in which decisions may be visible

At a group level, the ceremonial centre at Nabta represents a series of decisions to make certain monuments, decisions about what forms they took and choices about how and when to use them. Similarly, the placement of new cemeteries in the Badarian and who was interred within them must have involved discussion and choices. At both Gilf Kebir and Nabta the decisions about when to mobilize people and herds may have been made on a household or group level. The Badarian site of Mahgar Dendera provides evidence of a range of decisions. Unlike the core Badarian sites, this was a specialized occupation, representing choices about when to move, where to move, which livestock to take and what sort of toolkit was necessary.

As well as these broad observations, micro-decisions can be identified. In the Badarian the mending of broken pottery was a decision to curate an item rather than replace it. At Dakhleh the production of labour-intensive bifaces involved a whole series of decisions about the final form of the object and the best way to achieve it. At the Gilf Kebir, rock art represents decisions about composition, features to include or exclude, and the precise execution of the paintwork. Individual scenes or at least individual components were executed by individuals to produce unique scenes and depict individual animals. The decisions that went into the execution were subsumed into their function, combining group impetus with individual skills. In the Badarian, the grave goods that accompanied the dead were clearly a matter of choice, although who made those choices is unknown. Each grave was unique, each person accessorised in a unique way either due to a) their own preferences or ability to secure items, b) the requirements and means of the bereaved or other interested parties, or c) the dictates of an invisible formula.

9.2.4.6 How has group identity manifested itself in the archaeological record?

Group identity has been defined in the glossary (Appendix A) as any set of characteristics that suggest not only a common identity but also the desire to express that identity. Throughout the case studies cultural output has been discussed as having a specific function as a cohesive force. Table 9.10 suggests some levels at which identity might be deliberately displayed at the individual, group and regional levels.

	Individual	Group	Region
Ru'at el Baqar		Ceremonial centre	Ceramics
Gilf C		Rock art	Ceramics
Bashendi B	Ornamentation	Ornamentation	Ceramics Bifacial lithics
Badarian	Ornamentation Grave Goods	Ornamentation Grave Goods	Ceramics Bifacial lithics

Table 9.7 - Suggested group sectors in which identity may be expressed

The best case for group identity expressed in the archaeological record is the Badarian, where fine ceramics and individual ornamentation are defining characteristics of the community and how it perceived and expressed itself. Items in graves may suggest that this sense of group and personal identity extends into whatever lay beyond death. At the very least, it is suggestive of how people negotiated the complexities of life via cultural media. At Dakhleh too, albeit to a much lesser extent, items of personal ornamentation were found. The carefully composed rock art at the Gilf Kebir is associated not with individuals but places, usually hidden, and its themes suggest that the identity of people was closely tied to their relationships with herds in a way recently explored by a number of writers (e.g. Dittrich 2017; Oma 2010; Orton 2010; Russell 2010; Sykes 2014). In all areas the distinctive character of the ceramics may have been produced to a basic regional pattern book of styles both linking dispersed groups and differentiating them from communities from other areas. This tripartite view of identity is simplified but does demonstrate that it can operate on multiple scales.

9.2.4.7 Were opportunities taken up in times of insecurity or stability?

As discussed in Chapter 2 and illustrated in Appendix D opportunity potentially offers something both new and possibly improved, but may simultaneously represent risk, both economic and social. In Nabta, Dakhleh and the Gilf Kebir, small numbers of domesticates were introduced in the Ru'at el Ghanam Middle Neolithic, Late Bashendi A and Gilf B respectively, incorporated into a livelihood strategy significantly dominated by hunting and foraging. It was only as climate and environment became significantly different over time that domesticates became the dominant element in subsistence strategies. At Dakhleh a new approach to subsistence was apparently built on existing resources. People now consumed the meat of domestic species for the first time, rather than using them for their exclusively for renewable products. At Gilf a new style of ceramics is accompanied by a new style of rock art, and domesticates become central to the livelihood strategy. Changing climatic conditions altered the rainfall regime and the environment in a way that favoured herding, and at the

same time, cultural output seems to have reflected the change in livelihood management. This suggests that at Gilf group identity changed in response to the instability of a changing environment and the opportunity offered by pastoral herds. At Nabta the absence of information about where the Nabta occupants came from hinders any discussion, but the innovation and elaboration of the ceremonial centre coincides with climatic deterioration, suggesting a response to increasingly difficult conditions, the undermining of a way of life. The Badarian is the most difficult to assess. It emerges in Middle Egypt, with a material culture that shares most affinities with those in the Sudan. If this indicates a breakaway group that moved north, it implies that the social and symbolic identity of the group remained intact, whilst conditions in the originating area incentivized migration north. In these case studies my conclusion is that opportunity, in this case the adoption of domesticates, occurs under conditions of relative stability, where routines and traditions are well established and livelihoods have been sustained for many generations, but that intensification is driven by a perceived need to modify livelihoods to make them more resilient against environmental deterioration.

9.2.4.8 Can the livelihood be characterized as sustainable?

Sustainability turns out to be rather less useful as a concept and tool for measuring livelihood adaptability that I anticipated. In a sense, all of the case studies suggested that the livelihoods identified in the archaeological record were sustainable, simply because they lasted for such a long time. In the three desert case studies the livelihoods only became unsustainable when climate changed. Because there is no granular information about how well these livelihood strategies worked out on year to year basis within any of the case studies, any real measures of success or failure are impossible to find.

9.2.4.9 What were the drivers for significant change at the end of each period?

No innovation would have enabled rain-fed areas like Nabta and Gilf Kebir to have survived the climatic downturn. Migration was the only viable solution. It is unknown where the Nabta occupants were based, but it is most likely that they moved on a permanent base to the Nile valley. Gilf Kebir occupants probably moved south to Laqiya, some 400km away (Kuper 2007, p.9). Dakhleh Oasis was never abandoned completely, but the Bashendi B groups appear to have left when rainfall led to drying of the plateau, plains and wadis. They left behind the Sheikh Muftah groups whose material and skeletal remains produced signs of a very impoverished livelihood strategy. The Badarian region was not abandoned, but there are indications that people dispersed, mainly to the south, innovating economically and culturally to achieve a new way of life based on mixed agriculture that is labelled Naqada I. Why this dispersal took place after so long is unknown.

Perhaps the most useful conclusion is that when abandonment took place, it only occurred as a result of uncertainty. Up until that point risk management strategies had been able to sustain groups in increasingly difficult marginal conditions.

9.3 Conclusion

In this section I have isolated certain aspects of livelihood management to compare across the case studies to demonstrate that as well as using the SRL model to build up a comprehensive view of archaeological data in a given area, it is also possible to use the SRL format to ask specific questions of the data, and to compare that data across geographical areas. This was time-consuming and it was impossible to compare all the components in the SRL model. I also believe that the key questions, whilst potentially useful as a comparative device, could have been better chosen.

Perhaps the most useful aspect of the chapter was the potential for taking research forward. For example, the comparison of total vulnerability and assessing the individual strengths and weaknesses in each asset matrix using the radar diagram. This workstream made it was possible to bring out areas of investment that would have needed to be made by each individual community in order to ensure survival. Where the solution was abandonment rather than the very high risk strategy of trying to manage uncertainty, the findings suggest future lines for research into alternative migratory destinations for households or larger migratory groups, and the livelihood changes that were made in order for these migrants to establish themselves in new areas. Similarly, some of the key questions could themselves form the basis for hypotheses to be tested in future research.

I believe that this chapter has demonstrated that the SRL model has the potential to be a very good tool for comparing livelihoods, the risks that communities might have faced at the end of the mid Holocene and their vulnerability to existing and future problems. In addition, the findings indicate that the approach can be used to generate future research questions about regional change.

10 - Final Conclusions

10.1 Introduction

In Chapter 1 the research question was introduced as follows: “Can a model derived from development economics describe and characterize mid-Holocene livelihoods in the eastern Sahara and elsewhere, in terms of risk, opportunity and sustainability allowing them to be directly compared and contrasted?” This was translated into a set of hypotheses. To address these, the thesis employed an approach pioneered in development economics to assess livelihoods practiced under conditions of risk, opportunity and sustainability in marginal environments of the eastern Sahara during the mid-Holocene. The focus was on the development of a new methodology for maximizing the value of published data rather than addressing problem-oriented questions about Saharan prehistory.

The first three chapters introduced and discussed the Sustainable Rural Livelihood model and how it compared to archaeological theory. Chapter four describes the climatic background and chapter 5 captures the current state of knowledge on risk and uncertainty in dryland environments. The next two chapters introduced the case studies, the SRL template and methodology for data collection with examples. Chapter 8 consists of an abridged form of the Nabta Playa case study. All four case studies were then compared to one another in chapter 9. Finally, this chapter brings together the findings of the thesis.

10.1.1 Assessing the hypotheses

Five hypotheses were introduced in Chapter 1 to test the SRL model. These can now be addressed, together with concerns expressed in the introduction. Observations on the design of the research follow.

A - New approaches to modelling in archaeology, derived from approaches in development economics that exist explicitly to analyze livelihood sustainability, can improve data capture and analysis in archaeology.

The Sustainable Rural Livelihood approach, by combining a descriptive matrix with explanatory variables in a dynamic context of vulnerability, has proved to be a versatile tool for capturing and analysing archaeological data. With modifications for use in archaeology it has provided a useful methodology for discussing livelihood strategies. Where there were considerable gaps in some of the available data, the SRL approach made these clear. This both enabled suggestions for future field research and for flagging where livelihood reconstruction will remain incomplete. The case studies demonstrated that the SRL approach

was a useful tool for translating archaeological data into information about livelihoods and how they were managed.

B - The Sustainable Rural Livelihood (SRL) model provides a new way of bridging between ethnographic and archaeological data in a way that enables archaeologists to maximize the value of sometimes sparse data in marginal dryland environments.

The starting point for investigating risk, opportunity and sustainability in the archaeological record was to use ethnographic data to inform my understanding of modern communities and the approaches they took to minimizing risk and achieving sustainability in economic, social and symbolic aspects of life. This was used as a knowledge base from which to investigate archaeological data in terms of how livelihoods may have been managed. The organization of the model means that the ethnographic record was an important resource for exploring a diverse range of livelihood strategies, external processes and outcomes. The SRL framework did not produce a new way of bridging between archaeological and ethnographic data but it did emphasize the value of ethnographic data for understanding livelihood aspects of the archaeological record as captured in the SRL model.

C - The SRL Model improves comparative studies between contemporary sites by presenting data within the same formal framework of analysis.

The SRL approach was not designed for comparative studies but the formal arrangement of the model suggested that it would work very well and this was confirmed by the comparative study in chapter 9. The difficulties were not with the framework but with the data. This made the more granular aspects of localities difficult to assess and compare. However, at a more holistic level it proved to be a splendid tool for comparative studies, offering the opportunity to pull out specific areas of interest to compare and discuss.

D - Variables involved in decision making that may lead to changes in the archaeological record can be suggested by completing the SRL Model

The SRL approach isolates variables that may have been involved in decision making from the resulting livelihood outcomes. As this was essentially a study of different locales and groups, and the data was mainly in the form of palimpsests, this aspect was not brought out strongly in the case studies. Although the SRL model includes all the assets and variables required for such a study, gaps in archaeological data mean that this aspect of the framework could not be captured. Although this aspect of the investigations was not overwhelmingly successful in many of the case studies, and was discussed in chapter 9 (section 9.2.4.5) there is no reason why it should not be more successful with better datasets.

E - The SRL Model will help to clarify priorities for data collection

The SRL approach makes gaps in the existing evidence transparent and should be able to assist with establishing priorities for data collection if integrated into research planning. In each of the case studies I have highlighted some of the gaps identified, and although in some cases it is clear that the data is simply unavailable and will remain so, in others there are

opportunities for revisiting either sites, museum collections or newly published material with a view to extracting more information. During the planning stages of new fieldwork the SRL approach could be used as a design tool to decide on the direction that fieldwork should take. For ongoing projects it could help with identifying gaps in existing results and inform priorities for future work.

F – The SRL Approach is suitable for answering specific key questions about livelihood management in marginal environments

Two tests were undertaken for addressing specific questions about livelihood management in the four areas used in the case studies. The first test the Key Questions at the end of each case study were deployed to test whether identical problem-orientated questions could be answered using the SRL approach. The second was a comparison of the data in Chapter 9 where the key questions were also compared. In spite of the variable quantity and quality of published data, and inherent problems with the data itself, an inductive approach suggested plausible answers to key questions in all of the case studies. Where questions could not be answered, this usefully highlighted gaps either in the raw data or the published data.

10.1.2 Concerns expressed in the Introduction

It was identified at an early stage that an essential risk with hypotheses A – D was that the archaeological data might be too impoverished to fulfil the requirements of the SRL model, meaning that extrapolation from the data collected would be either difficult or impossible in part or in total. These concerns were justified. First, in eastern Saharan prehistory there is a tendency to produce interim reports and to provide papers proposing ideas on the basis of data that is not available in publications to enable independent assessment. The fragmentary nature of publications was a challenge to any form of descriptive and explanatory model that relies on accessibility of the excavation data. Second, in all areas occupation was mainly in the form of palimpsests, which was far from ideal, deflation having eliminated stratigraphic integrity and any opportunity for discussing subtleties of chronological sequences. The resulting conflation of periods that may have displayed diachronic variation resulted in a broad-brush approach to the complexities of social and economic variability, but was necessary. Some of the data was used to extrapolate in ways that may well be challenged by other researchers. For example, I have interpreted patterns of mobility in the Nabta and other case studies based on only partial information. These inferences may well be negated by later discoveries, and would require considerable alterations in the descriptive Asset Matrix, leading to revisions of the explanatory sections. This type of extrapolation was necessary for investigating the value of the SRL approach, but was sometimes based on limited data meaning that some findings are less than robust. Nevertheless, if the SRL approach can be productive with such impoverished contexts and fragmented publications it suggests that this and similar models may have a broader archaeological value, and have a useful role in handling palimpsests.

With respect to Hypothesis E, although it was expected that research gaps would be identified it was possible that they would not. In fact, various research gaps have been identified, and these were highlighted in the case studies and are discussed in detail in 10.2.2 below.

10.1.3 Observations on the design of the study

Whereas most models are “deliberately stripped down representations of the phenomena out there” (Dasgupta 2007, p.9) the SRL approach enables impoverished data to be used successfully to extrapolate from material remains so that even in such cases, the results are rich and the volume of output considerable. Although this was a positive outcome, each case study was too long to incorporate in the main body of the thesis. The volume of work did not lie merely in familiarization with all the relevant strands of the research together with extracting the data from excavation reports and becoming familiar with the relevant ethnographic data, but in researching and learning how to explore each component of the Asset Matrix. A broad range of topics like religion, ethnicity, exchange, identity, land tenure, cultural transmission, phenomenology, transmission of knowledge and others all required a considerable investment in research. I seriously underestimated the time it would need to acquire the knowledge necessary to complete the matrix, and to complete both descriptive and explanatory aspects of the model. The need to shift constantly between basic natural and physical data and the conceptual worlds of religion and symbol required continual shifting between modes of thinking and the adoption of different analytical skillsets. In producing the four case studies, I blew my word-count spectacularly, leading to problems incorporating the case studies into the thesis. I suggest that it is, realistically, a task for a small team of specialists rather than one person, and that solutions for handling the output would need to be incorporated into a future project design.

It was a concern that by discussing a livelihood within the framework of the Asset Matrix sections the research would not be a realistic representation of livelihoods. The case studies combined different types of approach to produce results that were inductive and speculative rather than deductive. At the same time the SRL approach is essentially empirical in concept. Whilst the data was pushed to its limit to explore both the archaeology and the value of the SRL approach, I believe that each case study explores the data with a thoroughness that provides the basis for a realistic approximation of livelihoods in these areas. Some extrapolations, like suggesting that the Nabta data might represent a heterarchy, are included to demonstrate how the SRL approach can help to develop hypotheses and open up discussions.

This thesis has been focused to a great extent on questions that can be asked of the available data. The palimpsest nature of both the data itself and the fragmentary nature of the publications restricted the questions that could be explored empirically. For the palimpsest character of the material, the descriptive aspect is of considerable value, maximizing the information that can be derived from it, but the explanatory element, whilst vital, was much

more difficult to deploy. When I carried out a test case study using an ethnographic study of the Hadendowa Bedouin in the Eastern Desert (Appendix H) I was able to write with some confidence about external variables and outcomes. Trying to infer such variables from the archaeological record available in my case study areas was far more difficult than I had anticipated. A different set of case studies might have brought out the value of the explanatory component of the model more effectively.

Archaeological measurables were sometimes difficult or impossible to suggest for aspects of the Asset Matrix. For this reason the section in the case studies that looks at internal relationships of trust and care was impossible to complete in any of the case studies. A better understanding of the processes that take place and theorizing of them in archaeological terms might improve this component, but it might remain invisible. Similarly, territoriality and land tenure were frustratingly difficult to assess.

The SRL Model was used for comparing geographical areas with overlapping periods in part of the far eastern Sahara. It would have been useful to have included at least one case study that compared two different phases in the same place to see how well the SRL approach deals with change other than abandonment in the archaeological record, enabling a proper exploration of the impact of variables and their outcomes. This would also have contributed to a discussion of the “longue durée” in nomadic pastoralism (Rosen 2008). A comparison of the Dakhleh Bashendi B with the preceding Bashendi A, or the Nabta Ru’at el-Baqar and subsequent Bunat el-Ansam would have enabled the value of the SRL approach to an exploration of diachronic as well as geographic comparisons.

Finally, I had serious doubts about the value of the radar diagram that is used to assess the strength of the livelihood represented by the Asset Matrix, which I considered to be too subjective and simplistic, so although I used it because it is part of the SRL methodology, I also chose to use a second way of assessing the vulnerability and viability of a livelihood, using the method set out by Nelson *et al* (2016). This was time-consuming and produced yet more information that needed to be handled within each case study and in the comparative study.

10.2 Case Study Findings

10.2.1 Eastern Sahara Archaeology

The four case studies demonstrated that in marginal areas local topography and rainfall patterns provided both opportunity and constraint for livestock herders who used multiple scales of mobility and diversified risk management strategies to sustain livelihoods in mid-Holocene Egypt. Groups in all four areas organized themselves in different ways, making choices based on local conditions and connections with other areas. In all the case studies

except the Gilf C there is evidence for prestige goods and in all except the Bashendi B there are indications of activities that were religious, ideological or in other ways spiritual, indicating that pragmatic and conceptual approaches to livelihood management were combined to ensure sustainability of both the economy and each group's traditional values and identity. Whilst the palimpsest nature of the data meant that patterns of variability were suppressed, the nature of the environment and the deteriorating climate suggests that all livelihoods were highly flexible and adaptable. The skilled use of multiple topographies is a feature of all of the case studies.

In the early Holocene Nabta Playa and the Gilf Kebir were part of an earlier Sudanese tradition that did not extend as far north as Farafra Oasis (Tassie 2014, p.184; Kuper and Kröpelin 2006; Riemer and Kindermann 2008, p.621-2; Riemer *et al* 2013). However, by the end of the 5th millennium BC, Dakhleh Nabta and the Badarian were part of a new landscape of shared cultural elements and subsistence strategies based on pastoralism. Dakhleh also shared features with Farafra, Djara and the Faiyum (Riemer 2007a; Riemer *et al* 2013) whilst the Gilf Kebir was part of a separate tradition. At the same time all shared elements with Sudanese cultural features in the same period (Garcea and Hilderband 2009, p.307; Gatto 2002b, 2009; Kuper 1989, p.200; Lange and Nordström 2000; Wengrow *et al* 2014). Thomas's observation that people could pick and choose from bits of a "repertoire" of what became available in Neolithic Britain (Thomas 2003, p.72) also applies in the eastern Sahara. All groups in the case studies had the option of cattle, sheep and/or goat, different patterns of mobility and preferred cultural output, including ceramic treatments and numinous components. Cultural elements are often shared with other areas and rather than being passive, they probably served to enable and reinforce these connections by expressing social congruence. Thomas also emphasises that not every part of the cultural assemblage that was adopted should be considered as meaning the same things to different people (Thomas 2003, p.72), a point also made by MacEachern (1994), and given the large distances involved in the dispersal of cultural similarities throughout the Nile in the mid-5th millennium, cultural similarities in terms of artefactual output and burial tradition must also be considered in terms of the differences between them. In each of the case studies the mixture of individual livelihood management approaches and the shared cultural elements with other areas express the dual importance of group identity and of wider networks of support.

Livelihoods in arid environments must be adaptive and may therefore be highly differentiated (Bollig and Schnegg 2013; Brass 2007) and over the period of the mid-Holocene, it is clear that various livelihoods responded to a variety of opportunities, incorporating the benefits of local geology, geomorphology and existing traditions. The case studies undoubtedly represent only some of a number of livelihood options available in an array of risk management strategies. Perhaps the most important conclusion is that environmental change, even when fairly extreme, does not need to lead to social collapse when a) access to water sources can be secured, b) new options are both available and c) those opportunities are adopted. Mobile pastoralism at long-distance and localized scales was a solution to a

problem, and a successful one, via a number of different strategies. As Bell and Walker observe (2005, p.140) the availability of multiple strategies invalidates deterministic approaches to human responses to environmental and other changes. In every one of the desert case studies risks were being handled sustainably until the climate again intervened. The Badarian groups were sufficiently robust to handle whatever climatic fluctuations they encountered and their livelihoods formed the basis for the succeeding Naqada I. In Dakhleh, whilst the Bashendi B inhabitants moved elsewhere, others remained behind to eke out an impoverished existence, represented by the Sheikh Muftah unit.

It seems clear from the comparisons in the previous chapter that the division between Nile valley and desert is somewhat arbitrary in the mid-Holocene. This is demonstrated by the presence of Nile components in the assemblages of mobile populations whose presence is found in the desert but whose assemblages suggested that the Nile was either included in their seasonal round, to facilitate social interactions or as part of a more dispersed network of contacts and connections. It would probably be better to characterize the vast region of land occupied by Egypt and the Sudan as a continuum of occupation represented by mobile groups who both crossed cultural boundaries and shared cultural traits. At the same time, each of the localities under discussion represents a different way of doing and seeing, with functionally differentiated toolkits, specific world-views, ways of expressing identity and ideology, and different approaches to conceptualizing the landscape.

Wendorf and Schild (1998) proposed that Nabta, with its evidence of social complexity in the form of megalithic constructions, alignments and the stone circle, indicates that African cattle pastoralists had a significant role in the rise of Egyptian civilization. It seems irrefutable that the concentration of populations along the Nile valley was due at least partially to the punctuated arrival of herding households and groups during the drying of the Sahara towards the end of the mid-Holocene. However, the rise of civilization was at least partly dependent upon the Near Eastern cultivars of wheat and barley. The development of Dynastic Egypt was built on a blend of risk management strategies adopted during the mid-Holocene, but its distinctive character emerged only after cereal production had been intensified.

10.2.2 Future research opportunities

Specific archaeological problems were not part of the scope of the thesis but some did emerge during the research into each of the case studies.

Hassan's call for the archaeology of the eastern Sahara to "move toward long-term inter-regional projects" (1986a, p.72) has not yet been fully met, although the excellent research projects inaugurated by the ACACIA group based at the University of Cologne (<http://www.uni-koeln.de/inter-fak/sfb389/>) are moving in that direction. For over twenty years they have been conducting fieldwork on a transect of 1500km stretching from the north to the south of eastern Sahara, from Egypt to the southern Sudan, using 5000 radiocarbon dates as a chronological database (Kuper 2006; Kuper and Kröpelin 2006). However, there has been little research

focused on the relationship between these regions and the archaeology to the west, in Libya and Chad, which might help to understand seasonal movements, inter-regional contacts and long-term migration. The Jebel Uweinat, which may be related to occupation in all these regions, remains a largely untapped resource. There is a real opportunity to take the expert examination of individual areas and tie them into a broader understanding of the desert areas to the west of the mid-Holocene Nile.

Similarly, the relationship between different environmental and topographical niches is being explored, but more emphasis on the plains surrounding focal nodes like the Gilf Kebir and Nabta could potentially improve understanding of how the landscape between nodes of occupation was used to extend resource availability and to clarify routes taken. Small camps, rock art sites, water sources, well worn routes, large settlements and other locales can produce multiscale patterns of repetition to tie in localized activities with larger regional pursuits (Frachetti 2008b; Hildebrand and Gatto 2012; Honeychurch and Makarewicz 2016, p.349). In 1980 McHugh wrote of his surprise at the discovery of temporary Neolithic encampments in the desert between Kharga Oasis and the Gilf Kebir (McHugh 1980, p.64). Peroschi *et al* (2014) used satellite surveys to assemble a database of 567 sites and 4119 stone structures, a figure that ignored blurred or questionable sites. The plains around Gilf Kebir and Jebel Uweinat has potential to valuably expand research into how landscape was moved through and used (Honoré 2017, p.7; McHugh 1980, p.64; Peroschi and Cambieri 2010, 2011; Peroschi, *et al* 2014).

Although it was difficult to draw any inferences about territoriality and differential access to resources, recent work in rock art research may provide some options (Honoré 2015, 2017; Lenssen-Erz 2012). Rock art is notoriously difficult to use as an archaeological dataset, and although there is distinctive engraved rock art in Dakhleh, I excluded it because it is not yet firmly dated. In the Gilf Kebir and the Jebel Uweinat, however, there are opportunities for developing better insights into the way in which rock art was used to identify groups and territories, and how it related to group movements and territories. Rock art research methodologies are improving, and the rich dataset in the Jebel Uweinat may be a useful testing ground for some of this work.

Scientific techniques applied to skeletal remains of humans and animals have been applied elsewhere to explore information about livestock exchange and seasonal movements, and might lead to some useful insights in Egypt and the Sudan. Strontium isotope analysis has produced some interesting results for exploring seasonality and patterns of mobility in Libya (di Lernia *et al* 2013; Tafuri *et al* 2006). Similar studies would be invaluable in the far eastern Sahara for exploring relationships between areas and patterns of nomadic pastoralism. Honeychurch and Makarewicz (2016, p.350-351) draw attention to advances in geometric morphometric analysis (GMM) applied to animal skeletons for improving insights into livestock exchange and nitrogen isotope analysis for analyzing the seasonality of fodder consumed by livestock.

The end of the mid-Holocene was associated with the dispersal of groups out of the desert into areas where they could survive. Some of these movements will have been piecemeal and punctuated, others more co-ordinated. Understanding this process would help to understand response to uncertainty and the impact that migratory groups had on areas that were already occupied. Developing a methodology to achieve this with archaeological data would seem to be a priority for understanding both nomadic practices and migratory movement. An unfortunate and unresolvable void of information is represented by the permanent flooding of archaeological landscapes by Lake Nasser. The above-mentioned scientific methods being applied in archaeology could contribute to this.

Further survey and excavation or publication of existing findings may yet address questions about subsistence and livelihood management in most of the case studies. A notable exception is the Badarian, which almost certainly represents a lost opportunity in terms of re-excavating the Brunton and Caton-Thompson sites or extending the areas that they investigated. Land has been swallowed by agriculture, villages and cemeteries, and little of the original archaeological areas survived when Holmes and Friedman were investigating in the 1980s and 1990s (Holmes 1992; Holmes 1993; Holmes and Friedman 1994). It would, however, be of value to investigate wadi systems and low desert with a view to seeing if Badarian herders and hunters used these zones as well as the floodplain to diversify not only livelihood options but geographical scope. In the same spirit, it would be interesting to see if there was any potential for exploring the west bank, particularly given the presence of the model boats in graves. The Badarian is well represented in museums, with both inorganic and organic materials surviving. It would be of great value to build on the existing research that has been carried out on museum collections to establish a much better understanding of both the materials used and how they were employed. Current PhD research into the Badarian by Maarten Horn is expected to move this research in precisely that direction.

Petrographic research would merit more investment in research. There is a real need for more research into and information about the composition of stone types and their sources. Regional geological databases are not yet available for most of Egypt or the Sudan meaning that sourcing artefacts made from specific materials, even when these materials are correctly identified, is not always straightforward. There have been few attempts to provenance ancient Egyptian material based on the petrography of artefacts (Aston *et al* 2009, p.69). A central online geological database would be invaluable, extending the online resources provided by geologist James Harrell (Harrell *n.d.*). This would enable invaluable research into stone objects that survive in museums from older excavations, applying modern techniques to analyze raw materials in order to pose questions about the importance of material types, the costs of sourcing raw materials and mechanisms by which raw materials are acquired and exchanged.

The economic function of lithic assemblages would benefit considerably from more research (Shea 2013, p.44). Statistical analysis of industries associated with clearly defined livelihoods

might assist the evaluation of specific industries in order to understand their function. For example, agricultural settlements with good survival of botanical and faunal remains in the Nile Delta could help to correlate livelihood information with tool assemblages to identify what types of tools consistently occur with which types of livelihoods. This could help to provide livelihood insights at sites when few botanical and faunal remains survive.

One of the issues common to all the case studies was the viability of using palimpsest data to represent livelihoods, already discussed in Chapter 1 (section 1.3.2). There is an ongoing tension between the palimpsest that concatenates all data onto one surface, and the knowledge that variability is concealed in that data (Bailey 1987; Binford 1981; Bradley, P. 1998a; Haselgrove *et al* 1985; Schiffer 1985; Schofield 1991a, 1991b, 1991c; Thomas 1991; Vaquero 2008). Whilst this sort of data is far from ideal, there is plenty of it, and it would seem to be productive to develop more formalized approaches to palimpsest data so that all fieldwork and post-excavation analysis is carried out using similar methodologies to ensure that approaches are consistent and that the value of the resulting inferences is fully understood and recognized. A number of writers acknowledge the value of palimpsests, whilst acknowledging their limitations, and their work may offer opportunities for developing standardized methodologies for collection and analysis in the future (e.g. Allen 1991; Bailey 2007, 2008; Bradley, P. 1998b; Foley 1981a, 1981b; Fanning and Holdaway 2001; Gordon 2006; Hey 1999; Lisk *et al* 1998; Lucas 2005; Schofield 1995; Snashall 2002; Vaquero and Pastó 2001).

A recurring problem has been the level of detail and consistency presented in published material. In eastern Saharan archaeology the field is dominated by interim reports and short discussion papers, many lacking sufficient quantification of data and only including few images, which are repeated in later papers. There are few volumes that bring together all the raw data, and those tend to be collections of papers loosely themed around a particular site or area. The Nabta Playa volume that collected together short excavation reports (Wendorf, Schild and Associates 2001) presented very similar types of data in different ways, meaning that they were not directly comparable. In addition, some periods were favoured over others so that in the Gilf Kebir, Nabta Playa and Dakhleh research has tended to focus on the periods prior to and/or following the ones in which I was interested, presumably due to certain unique properties singled them out. Publication of images is sometimes quite poor and is usually insufficient for comparative purposes. The piecemeal approach to archaeological publication means that it is often difficult to assess data in livelihood terms. Using the Internet to develop databases and image banks would be of enormous value, particularly when hosted by well-funded universities, which may have the resources to maintain them. At the same time, now that many universities are publishing PhD research online it would be of considerable value to have a central searchable Boolean index to improve accessibility and maximize the value of such research.

10.3 The limitations and benefits of the SRL Model

10.3.1 Limitations

Sampling

In development economics, researchers using the SRL approach experienced difficulties when a) sampling large number of villages with complex hierarchies, b) were restricted access to certain important sectors of the community and c) experienced limits to funding and the time available to complete and collate interviews (Morse *et al* 2009). Archaeological data is inevitably fragmented and heterogeneous. Fragmentary data is analogous to interviews in ethnography where people may invent answers, say what they think the researcher wants to hear, or become confused. In both ethnographic and archaeological projects, the researcher may misinterpret the data that she or he has assembled due to the sample available or the sampling technique chosen. Sampling inevitably involves compromise, choices that may be criticized later (DFID 2000b, p.189). In archaeology the attempt to recreate all aspects of a livelihood may also be restricted by the sample available and the sampling technique chosen (Hodder 1999, p.52-53; Lucas 2001, p.60-61; Lucas 2012, p.63-66; Trigger 1996, p.402). Examples are the restriction of excavations to test trenches, early excavation techniques that did not collect and publish all available data, and data that is missing due to deflation, decay and weathering. The tendency to produce interim reports rather than published detailed accounts of raw data also limits the ability to carry out successful data mining. These all constrain the ability to apply the SRL approach successfully.

Archaeological indicators

Some aspects of the model were difficult to complete. This was often due to lack of data, which was a problem that was predicted early on in the research. For example important aspects of livelihoods like demographic indicators were simply impossible in the majority of the case studies because of the absence of burial data. A less straightforward problem was that some areas of livelihoods are inherently difficult to explore in archaeology, I suggested some archaeological indicators of all aspects of the SRL Model in Appendix G but where nomadic groups are concerned the ephemeral nature of the livelihood itself, together with the invisibility of some livelihood aspects in the material record causes problems. I would suggest that subjects like land tenure, relationships of care, information exchange and territoriality need more work to consider whether theoretical and methodological approaches and plausible archaeological indicators can be developed, but they may remain intractable.

Measurables and comparisons

As I mentioned in 10.1.3 the radar diagram developed as part of the SRL approach for measuring strengths and weaknesses in livelihoods is particularly problematic. The Forum on Operationalizing Sustainable Livelihoods Approaches reported that in one case project

planners perceived the robustness of each asset differently, producing different results (DFID 2000b, Annex II). The radar diagram is particularly weak when apparently contradictory information is included. For example, when land is abundant and ownership is not disputed (which is a positive indicator) but is of very low quality (a negative indicator) this cannot be represented on the radar diagram. More subtly, a high score for one asset might counterbalance a poor score in another. For example, a good social infrastructure could well compensate for a lack of strong subsistence resources. The radar diagram offers no way of reflecting inter-dependence between the assets, giving an excessively simplified view of the strengths and weaknesses of a livelihood. I used a secondary measure to compensate for this but I would suggest that further improvements could be made in this area. Finally, whether on a numerical or alternative scale, establishing a qualitative scale on which to apply measurements like 1-4, present/absent or high/medium/low, has also proved to be difficult because these ways of evaluating information are considerably subjective.

The identification of decisions in the archaeological record was a secondary objective. Although this was attempted it was not a great success and the SRL model might be criticized for failing to address these types of thought process and output. This, however, was a result of the palimpsest nature of the data and in a different archaeological environment should be able to incorporate such details with greater ease. The degree to which such multi-scalar episodes are incorporated into a study is the choice of the archaeologist. Operable at multiple spatial and temporal scales, the SRL model can handle both momentary actions and larger scales of generalization, although this was not always demonstrated in the case studies.

Comparative analysis proved to be a challenge because the data included in excavation and interim reports is not standardized, even within the same research project. Even when using the SRL approach to present data in ways that enables different sites to be compared directly, it is often a difficult task. In an ideal scenario, archaeological projects should include the same data and present it in the same formats according to agreed standards for publication.

Description and Explanation

In order to populate the model, decisions have to be made about where descriptive data belongs in the matrix, and this is itself a step towards interpretation and explanation. It equates certain materials and objects with certain economic, social and individual concerns. In addition, in this thesis where interpretation has already been attempted in existing publications, for example on linkages between areas, it has been incorporated as part of the task of discovering how dryland livelihoods operate and experience life. A lot of discussion of archaeological indicators and their possible interpretation takes place throughout the Asset Matrix. The result is therefore substantive but not empirical.

One criticism levelled at the SRL approach is that people can appear to be invisible (Morse *et al* 2009, p.14) but as emphasised above, the matrix is a way of gathering data that gives information about people's needs and interests, an attempt to structure the complexity of human livelihoods. In modern contexts one can ask what people value and what their

personal goals may be, but in prehistory it is impossible to make assumptions about any values that people hold or hopes they may have, but archaeological discussions of agency are probably the best way to pursue the role and experience of individuals in archaeology. Agency was difficult to locate in the data that I worked with, but the Personal asset category introduced by Hamilton-Peach and Townsley (2004) does allow for explorations of concepts like the phenomenology of individual experience, and it is not the SRL approach that limits an exploration of agency.

The SRL approach was designed as a part of a toolkit to reduce poverty and create sustainable livelihoods in impoverished communities as opposed to wealthier or more asset-rich societies. This made it realistic for applying to prehistoric subsistence societies, but may be more of a challenge to use for complex hierarchical societies that demonstrate extremes in lifestyle, with different levels of access to power, to labour, to desirable products and to economic security (Small 2007, p.31-2) and diverse ways of displaying these contrasts.

Output

The main problem with the descriptive and explanatory approach of the SRL approach is the sheer volume of output. The upside is that the amount of information generated produces unprecedented insight into all aspects of livelihoods. The downsides in archaeology are that 1) acquiring the necessary familiarity with all aspects of archaeological data and modern livelihoods takes up a considerable amount of time, 2) it is time-consuming to convert thematic research and archaeological data into an interpretative scheme, 3) there is extensive repetition due to the fact that the same data may be relevant to several asset categories and occurs several times in the explanatory sections and subsequent analysis and 4) this process produces a staggering amount of information. As development economists discovered (Morse 2009), and as I also discovered, the SRL approach translates into delays and potential costs. The SRL approach is designed to make analysis available to other researchers for discussion as well as to suggest solutions to development problems, but the value of the output means that publication costs would probably be prohibitive. An alternative would be to publish executive summaries of the findings in print form and make the full output available in the form of a CD-ROM or web pages. Problems here are that electronic media become obsolete, web pages have a nasty habit of changing address or vanishing completely.

Finally, a considerable amount of theoretical and thematic research is required to employ the methodology. A sound and detailed knowledge of ethnographic records for each of the six asset components on the Asset Matrix must be built up in order to use it as a bridge between modern and prehistoric livelihoods. A good understanding of archaeological theory is required in order to get to grips with maximizing the value of the available data. A considerable amount of time was taken to understand the problems with and potentials for palimpsests, and I would suggest that understanding the value of different archaeological datasets would, and should, make up any attempt to use the SRL approach to evaluate data. This is again very time-consuming.

10.3.2 Benefits

As the above points make clear, the Sustainable Rural Livelihood approach is not without its challenges. However, it does have excellent benefits for use as a data handling and analytical tool.

A powerful descriptive and explanatory tool

At its most basic level, the SRL approach is a remarkable tool for bringing together disparate data published in multiple journals and books for the purposes of analysis and discussion. Its focus is on looking at how lives could have been lived, given the constraints and options available. It situates archaeological data within a descriptive and explanatory framework, a powerful tool for addressing all aspects of how people lived, and the types of decision people would have been confronted with on a daily, seasonal and ongoing basis, and why they made the choices they did.

Lucas (2001, p.104) suggests that archaeology needs to “heed the social context of production” in order to move archaeology away from typologies and reconsider categorizations. Even today most survey and excavation reports are organized according to data types and rarely move on to assess the livelihoods that produced them. The SRL model helps to address the problem of older and reductive archaeological approaches that concentrated on categorizing objects as classes and types, decontextualizing and dehumanizing them (Barratt 1994; Ingold 2013; Hodder 1991; Hurcombe 2014; MacFadyen 2010). By re-configuring the data in terms of how human life is organized rather than how excavation results are presented, the data is put to work in a different way, moving towards what the data represents in terms of human activity rather than in terms of archaeological specialisms.

By incorporating explanatory components within the Livelihood Variables, the SRL approach takes the research beyond description. It includes concepts such as risk, opportunity, decision making and external influences into a framework of explanation. The potential assessment of vulnerability and risk in particular provides a mechanism for assessing sustainable different livelihood strategies were and where their weaknesses lay. As Atherton emphasizes (1983, p.98) one of the advantages of this type of approach is that it can include known components and variables that will act on both known and unknown variables, representing interplay between them. Due to the number of variables included and the emphasis on flexibility, the framework can include evidence which may have an influence on social and economic activities incorporating detailed ecological and climatic data without implying climatic determinism.

Mitchell (2005) emphasizes that frameworks and models can be restrictive when they evade or conceal deficiencies in the archaeological record. The completion of the SRL model,

however, enables gaps in either the available data or the research parameters of a project to be clearly identified. By making gaps explicit, the value of the data can be better appreciated and ensures that the value of the output of a given SRL project is fully understood. This might form the basis of future research projects in order to source missing data.

The model was not designed for use in comparative studies but its structure has obvious qualities that favour its use in comparative work in archaeology. John Shea (2013, p.294) observes that whereas narratives focus on patterns of similarity, comparisons focus on differences. The SRL approach effectively enables the two to be combined in both spatial and diachronic comparisons. I used it to compare different places that are contemporary with each other, but it would be particularly useful for diachronic investigations of change, comparing different strata from the same site, or different periods in a given region in order to understand transformations.

The use of the SRL approach has the potential to be far more reflexive than its use here, with the potential to include collaborative working to incorporate new ways of looking at data in experimental exercises in the spirit of those pioneered by Ian Hodder in his excavations at Çatalhöyük (Hodder 1997; <http://www.catalhoyuk.com>) or Bender *et al* in survey work (Bender *et al* 1997). It can be revisited and modified as new data becomes available or new theoretical approaches are tried on existing datasets. In this sort of working environment it could help to answer Ingold's quest for "transformative" approaches that help to move knowledge forward by basing it in experience (Ingold 2013, p.6-7).

Like any experiment, the output can be subjected to testing. The same procedure can be carried out multiple times against the same set of data, and can be adapted to include newly available data. Where new data becomes available, the model can be re-evaluated and modified to incorporate the new information.

As a supplement to conventional forms of archaeological reporting

Conventional forms of reporting, with emphasis on archaeological specializations rather than human livelihoods will not be replaced by the type of approach taken in this thesis. Rather, it would suggest that it has potential as a) a potential component of research design, b) a component of post-excavation analysis to identify research opportunities for the future, both in the field and in terms of interpretative work and c) a tool to build on valuable excavation reports to produce interpretative narrative dialogues.

As a means of improving qualitative assessments of archeological data

The SRL approach encourages dialogue. Each case study pushes the data to the limit by applying multiple research threads in order to explore every aspect of the data. This produces a rich narrative that is structured to provide the development of dialogue about both the data under discussion, and about descriptive and explanatory approaches in archaeology. Within my case studies, I am certain that there will be disagreement about how I have extrapolated from the data to the interpretation, but I see this as a very positive step to achieving

understanding of each of the areas discussed in the case studies. My intention is to make the case studies available online to continue the discussion.

Although quantitative techniques have not been employed in this approach, there is no reason why such analysis should not be incorporated, should the raw data be made available. Such techniques might make the SRL approach more robust.

As a powerful tool for assessing livelihoods

Chapter 5 look at risk and uncertainty in dryland livelihoods, with a view to isolating some of the risk management options that might have been available in the past. It was possible to explore some of the livelihood assets that would have contributed to risk within the asset matrix, but this was brought out most closely in the exploration between the vulnerability context and the assets when the status of each case study was analysed using the radar diagram and the vulnerability assessment tables. This final workstream in each case study provided a holistic understanding of how the various threads explored in the SRL model give an insight into the sustainability of each settlement area, and where its strengths and weaknesses may have resided. In modern development economics this is used in order to determine which areas require more external investment for future sustainability. In archaeology the vulnerability assessment makes it clear which areas would have to receive investment by the community itself to ensure its sustainability or, if that investment could not be made due to conditions beyond internal control. At the end of the mid Holocene the key driver for migration was climatic deterioration, but future publication of field findings may provide some clues as to decisions that were made about the direction of migration and modifications that were made to livelihoods to ensure survival in new areas.

To improve understanding of the livelihood strategies across the eastern Sahara, the SRL approach can be used as a comparative tool, comparing like with like to highlight similarities and differences and build a perspective on how archaeological variations can be accounted for, and what sort of communications networks might have existed. The SRL approach could also be used to effectively compare research from different periods with a view to exploring the relationship between assets, variables and outcomes in considerably more detail. John Shea (2013, p.294) observes that whereas narratives focus on patterns of similarity, comparisons focus on differences. The SRL approach effectively enables the two to be combined. It would, for example, be useful to compare the Bashendi B with the preceding Bashendi A and the Badarian with the subsequent Naqada I.

10.3.3 Verdict

The SRL model was created to provide development economists with a tool to assess the sustainability of modern communities by taking into consideration all influential factors that communities themselves consider intrinsic, as well as those external processes over which

they have no control, to suggest ways in which they could improve their viability. Problems experienced by interviewers attempting to discover information from living people include concern the precision of information provided and the difficulty of accessing certain members of the community. In archaeology, interrogating the data is also subject to misunderstandings and a high risk of missing information. In both cases, the findings are an approximation of reality, not a direct empirical representation of it. Having said that, there were a number of key benefits.

It was impressive how using the SRL model as a tool focused attention on aspects of livelihood organization that created a richly informative narrative based on the data itself. It is a powerful tool for bringing together fieldwork findings and connecting them in a way that translates archaeological remains into functional livelihoods.

The SRL model provided an approach that makes the most of published data. As discussed in Chapter 1, section 1.3.2.4, publications do not follow a standardized format and are often difficult to use as sources for researchers. The situation would be much improved if excavation reports were standardized in terms of the information they provided, and if archaeological missions would commit to regular and comprehensive publication of their work. The excavation records that I was able to access were highly selective in terms of the material published, and very variable in the volume of information and its quality. Even within the same publications, the choices made regarding tabulation of data meant that materials from one site could not be directly tabulated with another. Frequency tables for lithics occur in the combined Nabta reports in Wendorf *et al* (2001), for example, but are not consistent from one report to the next, meaning that statistical tests of significance about the role of certain artefact classes and the choice of certain core types could not be attempted. At least within each archaeological mission, it would be extremely helpful if mission directors would maximize the information provided and standardize its presentation across all sites. It would be even more helpful if all archaeological missions would agree a standard for publication that would enable future researchers to use published reports attempt interpretation and comparison on national and regional scales, with a view to understanding how individual locales fit into a broader scale of livelihood management. At the moment, the fragmented nature of publication and the preference for publishing interpretative pieces without presenting the raw data that informs those interpretations is extremely unhelpful. Field archaeologists might themselves benefit from using an SRL or similar approach for organizing both their research priorities and their findings for the purposes of publication. In the future, online innovations that enable data sharing and the development of the semantic web might help to make the output of fieldwork available for wider interpretation (e.g. Berners-Lee *et al* 2001; Peebles 2001).

Even with certain difficulties, my experience of pulling together the case studies argues that the SRL approach is, with caveats, a very useful one, moving on from the raw data made available in excavation reports to attempt extrapolation and interpretation. It has the potential to be a useful tool for generating discussion. Although it is not a perfect tool, it is highly

effective for interpreting archaeological data, where that data is published to sufficiently high standards.

10.4 Conclusions

As discussed above, there are limitations to the Sustainable Rural Livelihood approach, and there were a number of problems implementing it. Although it was impressive to discover how much discussion was possible around sometimes impoverished datasets, the explanatory components of the model would have been much more effectively tested on a richer dataset. I find the emphasis on representing archaeological data in terms of livelihoods particularly useful, but missing data must be acknowledged in order to ensure that the livelihood reconstruction is not misinterpreted. Methods for measuring vulnerability in prehistoric livelihoods need revising, and solutions for handling the volume of output need to be found. My main concern is that the volume of data that it produces renders the SRL approach at best both time-consuming and expensive and at worst impractical. However, at its best, the SRL approach is a very versatile and flexible tool that translates specialist archaeological reports into an interpretative format that combines rich descriptive interpretation with explanatory components. It does not replace traditional archaeological investigation and analysis but builds upon it to create something that is more than the sum of the parts that inform it. The case studies demonstrate to my own satisfaction that this is a realistic goal and that it was worth pursuing, particularly as it makes the most of fragmentary datasets and palimpsests. As with all formal models, the SRL model incorporates flexibility into its design. As new data emerges this can be included and various components and findings re-written in an iterative way that reflects new discoveries and new inferences. The SRL approach performed well with specialist archaeological reports to develop a cohesive understanding of the communities that the raw material represents. It requires immense commitment but I would suggest that the rewards justify the undertaking.

Appendices

Appendix A - Glossary of Terms

There have been various problems with the definition of terms in archaeology, with terms being employed in different ways by different writers (Harris 1989, 1996b; Smith 2001). The key terms used in the thesis have therefore been listed here to clarify how they are being used.

Adaptive Strategies

Application of a combination of strategies, traditional or new, to meet survival needs or living preferences for sustainability.

Archaeological record

The Archaeological Record

There is a process of translation between what lies in the ground and what might emerge in interpretative schemes (Barrett 1994, p.5; Lucas 2012; McFayden 2010, p.46). Ever since Linda Patrik's question "Is there an archaeological record?" in which she draws attention to five different ways in which the term is commonly used (Patrik 1985, p.29-30), it has become necessary to be explicit about how the term is being employed. In essence the term record implies that archaeological remains have information to impart. Patrik distinguishes between physical versus textual models (1985 p.33), both of which accept that there are patterns to be found, with each prioritizing aspects of the archaeological data over others. Lucas, in reconsidering the issue of the archaeological record in a book dedicated to the subject (Lucas 2012) adopts an approach that centres the discussion in archaeological theory but ultimately puts the onus on his readers to reconsider the role of archaeology and what it can realistically achieve.

I am using the term in the most basic sense that an archaeological record consists of material remains that will later be subjected to interpretation. This is an inductive rather than deductive process. The term "record" implies no more than that the data is potentially informative. If the record is fragmented, represented by a small sample or is otherwise incomplete, it will be less likely to produce information for interpretation and may be misrepresented.

Capital

In prehistoric communities the security or sustainability of a community cannot be measured in terms of a currency value. Other ways of rating and comparing items as something of value

must be achieved. Numbers may still be used to assign value to commodities (capital assets), but they will be based upon subjective evaluations. These numbers make comparisons explicit and transparent, but do not imply an inherent capital value or statistical significance.

Community

A human grouping that is both mutable and renegotiable, composed of people who recognize and acknowledge each other and define themselves in terms of each other either temporarily or permanently and are bound together by more than locality or language, and share locations but may split into smaller groups and reform as required. Communities may be porous, accepting new members and losing members to other communities. Communities share ideologies and may conceptualize and materialize identity based on ideology, and may include herds and the dead in their own definitions of their communal identity.

Coping strategies

The techniques used to tackle declining food availability in abnormal seasons, as an extension or diversification of an otherwise successful system of livelihood management.

Culture

The material expression of ideas held within a society.

Cultural Outputs

The components produced by the society and economy in terms of, for example, products, quality of life, waste, environmental improvement and damage.

Data

I use the term data to indicate the raw materials of the archaeological record that later become subject to interpretation. The moment that any attempt is made to translate the data into information, a transition has occurred.

Drylands

The FAO (Food and Agriculture Organization of the United Nations) defines a dryland as a region with a growing period of between 1 to 179 days, which includes arid, semi-arid and dry sub-humid environments (FAO 2000, p.19). Further, “dryland areas are ‘fragile’ in that they are extremely vulnerable to land degradation resulting from over-grazing and other forms of inappropriate land use” (FAO 2000, p.17). This definition has been adopted in this thesis.

Ecosystem

The combination, at any given time, of biodiversity and water availability, the two essentials for food acquisition and production.

Ethnicity

I have borrowed Diaz-Andreu's definition of ethnicity as “that aspect of a person's self-conceptualization and his or her conceptualization by other individuals that results from

identification with one or more broader groups on the basis of perceived cultural differentiation and belief in common descent” Diaz-Andreu (2015, p.103). She expands this to state the ethnicity is multidimensional because people are not confined to identifying themselves with one category, group or broader scheme of identity and may have broad affiliations. The emphasis here is on how a person perceives themselves and how they define themselves in relation to other groups of peoples, including communities, and accepts that these may change over time. Ethnicity is about highly dynamic differentiation and identity, not merely living arrangements. It may be fluid both on an individual and a group basis. In an earlier paper Diaz-Andreu also emphasized that archaeologists “cannot study ethnic identity in isolation from other types of identifications – gender, religion, status etc – as all of them will be at play” (1998, p.199) and this is an important consideration, making comments on ethnicity particularly difficult for archaeologists.

Groups

Small units of people who identify themselves with each other and co-operate, or components within communities when communities retain the flexibility to divide and reform when expedient. Functional and socially defined units.

Group identity

Any set of characteristics that suggest not only a common identity but the desire to express that identity.

Heuristics

Experience-based techniques to assist with decision analysis and problem solving.

Identity

The concept of identity that is adhered to throughout is expressed by White and Beaudry 2009: “The concept of identity is complicated, paradoxical, and culturally situated in time, place, and society. Identity is at once both imposed by others and self-imposed, and is continuously asserted and reasserted in ways that are fluid and fixed. Identity can lie at the individual level and at the broadest of imaginable scales as it defines a person both as part of a group and as an individual.” As such, identity can be sought at the individual and the community levels and at all points in between. I suggest that identity can be located in the repeated signals incorporated into material output. Indicators such as personal ornamentation, ceramic decoration and lithic style all fit into this picture.

Ideology

Ideals, ideas, beliefs and values that act together to inform social and economic structures and processes.

Inputs

All costs (energy, capital, weather etc) associated with a given economy. They may include purchased items (e.g. those exchanged/traded) and non-purchased items (e.g. light, temperature, rainfall). Inputs may have positive and negative impacts. For example the introduction of livestock which requires pasture may have an immediate benefit to the community but may have a long term detrimental effect on the environment.

Landscape

The term landscape is used throughout the thesis to indicate the contemporary topography and environment, as well as the overlays of meaning allocated to them by successive generations of inhabitants who move through them, settle within them, employ their multiple benefits and return to them. A locality is defined as an area that is occupied within that landscape, and can be made up of sites, camps and events, as well as localized topographical features and environmental settings. A site is a concentration of human activity, usually termed a settlement in archaeological literature, and may be any size. Camps are small concentrations of human activity away from the main settlement. They tend to be specialized and short term, used as hunting bases, material acquisitions and manufacturing sites, amongst others. Events are the smallest of all, and may consist of a single hearth, a single manufacturing site, or the temporary presence of one or two individuals. In all cases they may represent interactions between economic, ethnic and cultural spheres (Lightfoot and Martinez 1995).

Livelihood

The term "livelihood" is used to incorporate both economic activities and social values. Both components are included within a community's overall objectives for a sustainable and satisfactory existence. It is assumed, however, that where risk and uncertainty exist the requirement for economic sustainability will override all other objectives except, perhaps, those embedded in religious belief and deeply felt social tradition. However, religious traditions very often incorporate ideas about the safety of the community. An understanding of livelihood requirements is central to an understanding of decision making criteria.

A number of writers (e.g. Harvey 2000; Sen 1999) have pointed to the value of livelihood requirements in the context of understanding decision making criteria. Religion often incorporates those ideal utility requirements but are usually difficult to detect archaeologically.

Model

A device that conceptualizes a set of ideas about how something operates. It is a simplified representation of a much more complex set of operational systems or processes used with a view to understanding how they work.

The Neolithic

Wherever possible, I have avoided use of the term Neolithic, a term originally identified with early food production in the Near East and Europe, which has crept into Saharan terminology.

One of the main problems with the term is that has become clear that there is single set of characteristics that defines a homogenous "Neolithic." (Bailey *et al* 2005; Bailey and Whittle 2005; Bernbeck 2008; Casey 2005; Gifford-Gonzalez 2005; Jarman 1971; Shaw 1989a; Shirai 2013; Smith A.B. 2013; Stahl 1999; Sinclair *et al* 1993; Thomas 2003, p.72). In "(Un)Settling the Neolithic" (Bailey *et al* 2005) the contributors each demonstrate how standard assumptions about the form and character of the Neolithic are flawed, that type-sites can set expectations that are not necessarily valid, and that the amount of variation is considerable. There is plenty of evidence that many so-called Neolithic sites were actually associated with a variety of mobile lifestyles at different scales (Bailey and Whittle 2005; Boric 2005; Halstead 2005; Jochim 1991; Kent 1989; Milner 2005; Rafferty 1985). Garrard *et al* (1996, p.218) have shown that the Near Eastern model of a fully mixed agricultural package is only valid for a few areas in the Near East, whilst in other areas more specialized choices were made (e.g. Smith, A.B. 2014, p.5-22). A number of writers have challenged the idea that there is a firm split between a mobile way of life and a sedentary agricultural one (Bernbeck 2008, p.45-49; Bogucki 1995; Dennell 1995; B. Smith 2001).

In the Sahara, the pattern of "Neolithization" reverses the Near Eastern pattern of domesticated plants and pottery followed by domesticated animals (Marshall and Hildebrand 2002). In the semi-arid areas of the eastern Sahara there is no evidence that in the early and mid-Holocene plants were ever domesticated. The presence of pottery and a lithic toolkit that differed substantially from the preceding ones required a different designation and the terms "Neolithic" and "Neolithization" were widely adopted by scholars like Arkell (1953), Marks and Mohammed-Ali (1991) and Wendorf, Schild and Associates (2001) and are common in introductory syntheses of Egyptian prehistory (Bard 2008; Midant-Reynes 1992; Tassie 2014; Wengrow 2006; Wenke 2009). Wendorf and Schild (1980) considered alternative terms for Nabta Playa but opted to retain the term Neolithic because "satisfactory substitutes could not be found" (1980, p.279).

Although the term Neolithic has not been used consistently in eastern Saharan research, it has been impossible to avoid the titles for archaeological units that have been applied by publications.

Numinous

Something that possesses a strong spiritual, supernatural or religious quality, which may or may not be associated with a deity or deities. The term is useful because it avoids assigning a specific modern concept of belief or divinity to often ambivalent archaeological material.

Palimpsests

Primary Context Palimpsests

The horizontal spatial organization of a site refers to the way in which artefacts and other materials have been deposited on a surface at any one time, reflecting different periods, activities and ideas. Where such horizontal levels are superimposed, a chronological

relationship exists, and occupation histories may be reconstructed to a greater or lesser degree, depending on the quality of the raw data. In some cases, however, objects that were deposited over time find themselves sharing the same surface. One example of this is deflation, where lighter materials and soils are carried away by the wind leaving objects of multiple periods on the same surface. Where sites are undisturbed by further processes these are often called **in-situ scatters or primary context palimpsests**, also termed "**spatial palimpsests**" by Bailey (2007) and may preserve the original spatial distribution of the artefacts as they were deposited, although it may be difficult or impossible to know which objects were contemporary with others. This is the main sort of palimpsest encountered in the eastern Sahara.

Cumulative Palimpsests

Where horizontal distribution has been disturbed by human interference or natural processes, causing even contemporary objects to lose their spatial relationship with each other, these are often referred to as **artefact scatters** (Historic England 2012, p.9), **surface scatters** or **cumulative palimpsests** (Bailey 2007), because the original organization of objects has been literally scattered near to but out of their original context (Historic England 2000, p.2). A classic example of this is found in northwest European ploughed fields, which are rich source of prehistoric lithic and ceramic objects, which have been removed from both their original temporal and spatial context, and which may or may not overlie earlier deposits. Not only is temporal resolution lost but any attempts at spatial analysis would be redundant.

Secondary Context Palimpsests

Artefact scatters are at their most extreme in cases when artefacts have been removed from their original context by forces, usually natural, that have placed them at some distance from their original context. These are **secondary context sites** which "may comprise large aggregations of artefacts which provide important evidence on the early human occupation of a particular catchment or region" (Historic England 2012, p.9). Early and Middle Palaeolithic sites in areas of glacial activity in northwest Europe, or in the fluvial activity of wadis of the eastern Sahara are both good examples: in both cases natural forces have carried materials away from where they were originally discarded, depositing them in new locations. In these cases there is no temporal or spatial information available and only the tools themselves survive.

Other types of palimpsests are Bailey's **true palimpsest**, in which all traces of previous activity has been removed except for the most recent, and his **temporal palimpsest**, which form part of the same deposit but include items dating to different ages. A museum is a temporal palimpsest, containing items from different periods, but an archaeological example might be a grave that includes ancestral as well as contemporary objects. Bailey also adds **palimpsests of meaning** to his list: "the succession of meanings acquired by a particular object, or group of objects, as a result of the different uses, contexts of use and associations to which they have been exposed from the original moment of manufacture to their current

resting place" and may be applied to individual objects or buildings, and which may be perceived in different ways by different individuals (2007, p.208).

Finally, it should be noted that there is a case to be made for seeing all archaeological layers as palimpsests, whether or not they occur in a stratigraphic sequence (Dunnell and Dancey 1983; Foley 1981b; Vaquero 2008). For example, the excavations at the Middle Palaeolithic cave occupation of Abric Romaní near Barcelona in Spain are interpreted by their excavators as a series of superimposed palimpsests that include multiple occupation events and there is a concern that approaches that see each level as a discrete contemporaneous floor will distort an understanding of both the temporal and the spatial organization of each layer (Vallverdú *et al* 2005; Vaquero 2008; Vaquero and Pastó 2001).

Settlements, camps and other occupation sites

The terms "settlement," "occupation," "camp" and various other related terms can be used rather sweepingly. "Occupation" is used to indicate that an area was visited and used by human groups who left evidence of their visit or visits behind. A "settlement" is defined as any evidence of an occupation that endured for weeks or months - a sufficiently substantial presence to enable discussions about potential spatial organization and structural features. "Camp" indicates a brief occupation, sometimes used for a single event, sometimes for a specific purpose, usually confined to a small scatter of artefacts with minimal features. The terms are by no means exhaustive and other descriptive terms will be applied and explained when sites do not fit into any of these categories. These definitions are practical descriptive tools and do not attempt to capture how sites were experienced.

Rangeland

Land on which native grasses and shrubs grow, and are suitable for grazing or browsing by domestic herds.

Risk

Risk is defined here using Knight's classic 1921 distinction between risk and uncertainty in which risk is a situation where the outcome of a given situation is unknown but an informed decision can be made based on knowledge and information. Risk and uncertainty require that decisions be made, and these involve the application of probability. Probability is the data used to decide whether a decision is more or less likely to succeed than any other action also being contemplated, and is a way of measuring risk (Bennett 1998).

Risk management

The mechanisms put into place in order to minimize the impact of fluctuation and occasionally unpredictable levels of risk.

Ritual, Ideology and Religion

Ritual is defined throughout as the material expression of repeated actions carried out in support of ideology and religion. Rites of passage are defined as the ceremonies and activities surrounding important transitions that occur through the lives of individuals. These may or may not take place in or around religious monuments, which are structures designed to enable the performance of ritual activities. Ritual is an activity that formalizes and reinforces beliefs, ideologies, rules and obligations (Rappaport 1999), and acts as an information flow between the natural and transcendental (Robbins 2001, p.599), serving as a formalizing bridge between ideas and livelihoods.

Social and Cultural Complexity

Social complexity is defined as internal organization and institutions that lead to social stratification, and may be based on kinship/ancestral, political, and/or religious authority. Cultural complexity is defined as the material outcome of the processes of social complexity, which may or may not be visible in the archaeological record. It is suggested that defining characteristics of social complexity might be status visible in the uneven distribution of symbolic resources (in the form of elites or leadership); elements of heterarchy; elaborate religious practices requiring organization, labour and ongoing mediation and management; increasingly complex relationships with other members within and beyond the community; storage of surplus; indications of intensified trade/exchange networks; signs of territorial legitimation; craft specialization; increased aggregation; increased sedentism.

Stress

A situation that occurs when the energy needs of a human community fail to be met under existing social and economic regimes. Stress is an expression of both unpredictable uncertainty and risk.

Subsistence

An economic system that focuses on meeting the needs of a population and enabling it to sustain itself throughout successive years.

Subsistence Strategy

"Subsistence strategies are the set of systems that human groups use to organize themselves, society and economy in a territory with the aim of guaranteeing the survival of their community" (Rosell *et al* 2012).

Sustainability

The ability to ensure the ongoing productivity of economic outputs and transitions, and the ability to recover from stress and shock, in order to maintain productivity and meet requirements for minimum utility - whilst at the same time ensuring that this is not at the detriment of environmental stability.

Trade and exchange

Trade and exchange are treated as the same. Both involve a transaction between a producer or supplier and a consumer but whereas each trade negotiation is a finite entity, ending when the sale is closed and the purchase completed, exchange may involve longer term and ongoing relationships based on complex relationships in which the exchange of goods helps to define and redefine relationships (Agbe-Davies and Bauer 2010, p.15). They are not distinguished from each other in this thesis because none of the case studies lends itself to that degree of precision, so following Summerhayes (2015, p.481), trade and exchanged are defined as “the movement of materials or goods between individuals, social groups or organizations.”

Tradition

I follow Spencer in his definition of tradition: “the notion of tradition, not merely as some immutable practice, but an expression of collective wisdom and accumulated experience that adapts to changing situations” (1998, p.249).

Uncertainty

The condition under which unexpected occurrences are beyond the ability of usual solutions applied by the community to cope, and where the safe and preferred options are unavailable and emergency measures are required.

Vulnerability context

The shocks, trends and seasonal influences that affect people's ability to support their livelihoods. Vulnerability refers to circumstances beyond predictable uncertainty, and frequently incorporates high risk situations, like repeated drought.

Wealth / Poverty

The terms wealth and poverty have little value in discussions of prehistoric groups, in spite of the heavy use of both terms in the literature on development economics. The term "poor" is often used by modern western writers to describe subsistence pastoralists and cultivators who may live marginal lifestyles which prevent them creating and making use of significant surplus, but who may have perfectly sustainable livelihoods which meet or exceed their everyday needs. The following statement by Livingstone and McPherson (1990) is fairly typical: "The pastoral people of Africa are among the poorest in the world. They accumulate limited material possessions and their wealth and security lies in their animals. Their mobile lifestyle means that very few acquire technical skills or education and consequently only possess knowledge to operate and maintain the most simple of water supply systems." In this research I have used "vulnerable" and "unsustainable" to replace "poverty" and have otherwise avoided terms that compare subsistence societies unfavourably with more complex systems.

Appendix B – Templates and Evaluation Criteria

B.1 The SRL framework

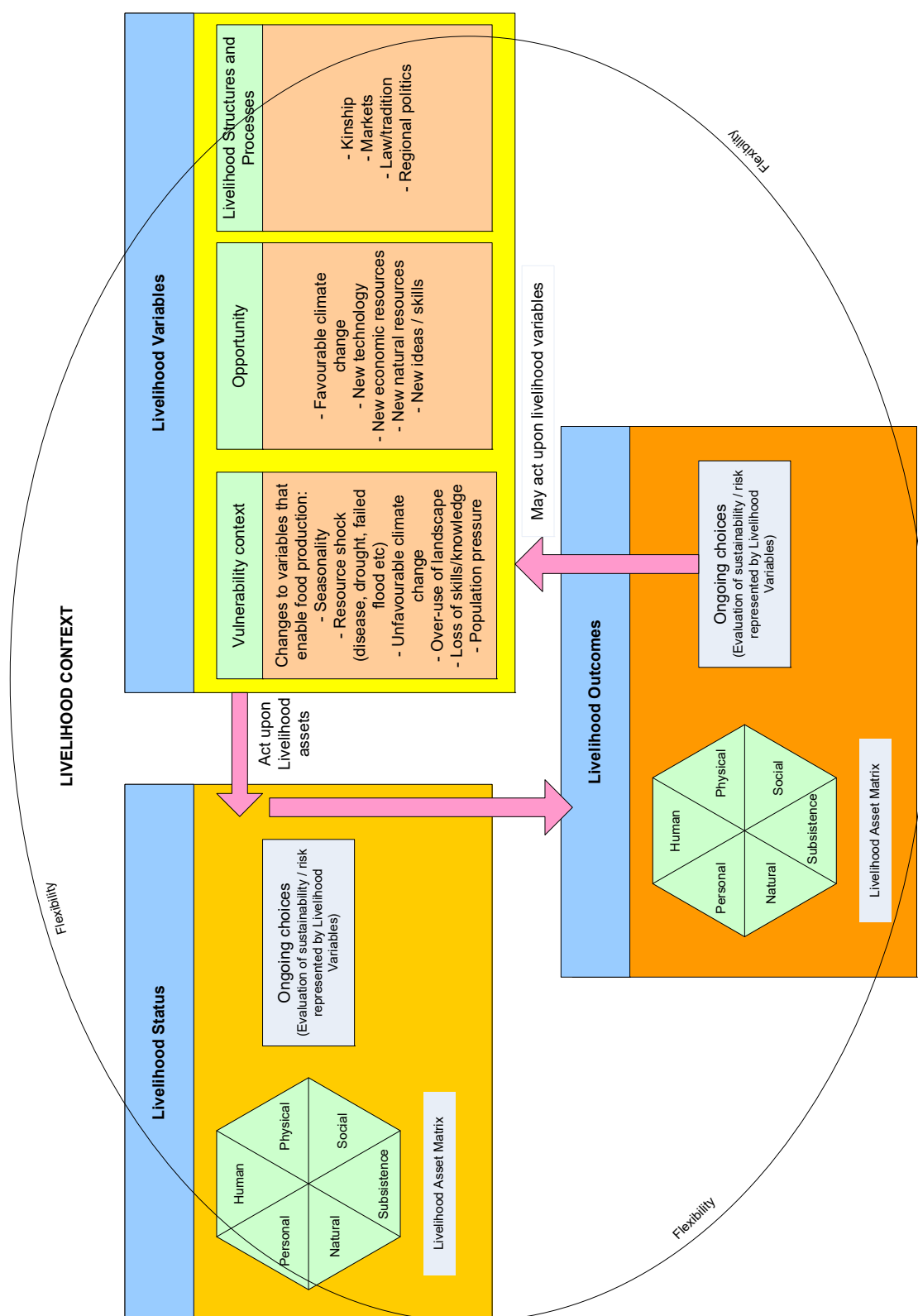


Figure B1 – The SRL Model

B.2 Data types available at each site/sites

The available data is presented in tabular form in order to enable anyone reviewing a completed SRL framework to see what types of information are available at a glance. It is not intended to provide detailed information, but to give an instant impression of what type of data is available at the most superficial level. This table has been assembled for the types of data likely to be found in the eastern Sahara; it would later for different regions, periods and different types of dataset.

Key

✗ Not present

✓ Present

Category	Data	✗ / ✓
Site type	Settlement / occupation area	
	Cemetery	
	Ceremonial	
	Industrial	
	Unknown / Other	
Structures	Domestic shelters / foundations	
	Hearths / Steinplätze	
	Storage	
	Ceremonial structures	
Type	Stratified	
	Palimpsest	
	Cave / rock shelter	
Funerary	Burial structures	
	Human physical remains	
	Grave goods	
Diet and Nutrition	Information about climate regime	
	Faunal remains	
	Botanical remains	
	Human remains	
Environment	Faunal remains	
	Botanical remains	
	Sedimentary and geomorphological data	
	Other environmental / climatic indicators	
Tools/ Craft items	Stone tools	
	Grinding stones	
	Pottery	
	Ostrich eggshell	

	Basketry, cordage, matting, textiles and other perishable plant materials	
	Hides, bone and ivory tools, and other perishable animal materials	
	Other artefact types	
Personal or symbolic material	Beads / other jewellery	
	Portable art	
	Maceheads	
	Palettes	
	Cultural components on everyday tools / pottery	
	Rock art	
	Prestige objects (potentially)	
	Tattoos, body painting, cosmetic accessories	
	Other	
Dating	Radiocarbon dates	
	Relative / stylistic	

Figure A2 – Data types present in Case Study areas

B.3 Data Collection Template

Asset Components (headings)	Potential Indicators (sub-headings)
Natural	<ul style="list-style-type: none"> • Topography • Hydrology • Light and temperature • Aeolian conditions • Edaphic conditions • Vegetation • Fauna • Stone, minerals and ores • Seasonality
Physical	<ul style="list-style-type: none"> • Settlement location, character and size • Shelter • Raw material acquisition • Food acquisition and production technologies (lithics, ceramics, ground-stone) • Craft skills and infrastructure • Mobility (aspects of mobility required to secure infrastructure and raw materials) • Structures to support economic activity • Cemetery/religious structures • Food storage systems • Transport • Fuel
Social	<ul style="list-style-type: none"> • Status, role and organization • Religion, ideology and spiritualism • Ritual and rites of passage • Tradition, social values and social guidelines • Material/cultural expression • Mobility (to support social infrastructure) • Internal relationships of trust and care • Inter-group relationships • Ethnicity • Symbolic and social risk
Subsistence	<ul style="list-style-type: none"> • Evidence for types of food production (evidence for herding, hunting, foraging, fishing) • Subsistence assets (physical assets that promote sustainability of subsistence strategies) • Practice of subsistence activities (i.e. that activities that support food production and livelihood management) • Indications of animal diseases, viruses, pests and parasites • Evidence of trade networks • Savings and credit • Labour • Mobility • Land tenure
Human	<ul style="list-style-type: none"> • Potential nutrition values of food consumed • Evidence of physical condition of people • Potential medicinal components • Skills and knowledge • Sex and gender • Age • Population numbers • Gene pool

Asset Components (headings)	Potential Indicators (sub-headings)
Personal	<ul style="list-style-type: none"> Individual status Personal well-being Security Ability to influence decisions

Figure A3 – The data collection template for the SRL Model

B.4 Risk Management Summary from Chapter 5



Figure A4 – Summary of risk management strategies described in Chapter 5

Appendix C – Milk and Lactose Intolerance

C.1 Introduction

Questions concerning how livestock were used have been complicated by the issue of lactose intolerance in adults. Meat and blood (mainly protein and iron, with some fat content) and secondary products are all valuable uses of livestock, but today their main value to pastoralists lies in milk. Milk products can be consumed, stored, exchanged and used to provide essential parts of the diet like iron, vitamin C and vitamin D that would have to be obtained elsewhere if not consumed in milk. Lactose is a major component of milk. Up until weaning, children have an enzyme called lactase, which breaks down lactose in milk, but this is biologically switched off after weaning. After weaning humans become intolerant of milk, which can cause various unpleasant symptoms when unmodified milk is introduced into the stomach, rarely sufficiently serious to be life-threatening on their own, but potentially leading to dehydration and hunger, which may be sufficient to kill weakened or sick individuals in marginal environments.

If pastoralists were incapable of consuming milk products, there is a major question mark over why they adopted livestock at all. If they were able to consume milk products, the spread of pastoralism throughout the eastern Sahara is easily explained by the combination of storage on the hoof and the ability to remain mobile that herds conferred upon human groups.

The question of lactose intolerance is critical to an understanding of how livestock was used in early pastoral communities.

C.2 The Value of Milk to Humans

Milk contains fat, proteins, minerals (of which calcium is the most important), vitamins (particularly vitamin C) and carbohydrates in the form of the milk sugar lactose (Mulville *et al* 2005, p.2). Mulville puts particular emphasis on the value of fat, saying that "In economically marginal areas, the full exploitation of available fat resources may make the difference between the viability of that society and situation." Lactose promotes calcium by the production of lactase, without which there is the danger of osteoporosis and rickets. Without milk, all of these components would have to be secured elsewhere on a regular and ongoing basis (Outram and Mulville 2005) as soon as a child is weaned. Today more calories are obtained from milk than meat in pastoral societies (FAO 2001) and the Maasai obtain up to 64% of their dietary energy from milk (Ryan 2002, p.99). Other benefits derived from a protein called lactoferrin, which plays a role in the absorption of iron, and also has antioxidant and anti-carcinogenic effects, whilst peptides from another protein called casein are thought to influence the behaviour of immune cells and restrict the impact of harmful bacteria (Geddes 2015, p.37).

The following table, from Degen (2007, p.10, Table 2) provides the relative values of sheep, goat and cattle milk:

Species	Fat %	Protein%	Lactose %	Solids %
Sheep	6 - 8.5	5.5 – 6.5	3.9 – 4.7	16.0 – 20.0
Goat	3.4 – 4.5	2.8 – 3.7	3.9 – 4.8	11.5 – 13.5
Cattle	3.4 – 5.5	3.3 – 4.0	4.6 – 4.9	12.3 – 14.5

Table C1 – Relative values of milk

Milk is not only of value in its untreated, soured and fermented forms. It can also be made into dairy products including butter, yogurt, ghee and hard curd cheese. Cheese is generally only made when there is a milk surplus during the rainy season, and hard cheese can be kept for over a year (Smith, S.E. 1980, p.470). In these forms it can be stored, shared, distributed and exchanged. There is no need to slaughter the animal in order to obtain these benefits, meaning that the livestock are an ongoing investment, a machine that turns cellulose that is indigestible by humans into a continual and renewable supply of nutrition.

There are two mechanisms by which milk can be digested by humans. The first is by treating the milk to make it digestible. The second is by the spread of a genetic mutation that allows for the persistence of lactase production into adulthood.

C.3 Milk Consumption by Lactose Intolerant Humans

There are two strategies for consumption of lactose by humans who are lactose intolerant: Consumption of small quantities or modification of the milk itself to make it more digestible, and the conversion of milk into other products.

Some lactose intolerant people report that they can consume milk without side-effects if they drink little amounts spread out over the day, and this is supported by research that demonstrates that genuinely lactose intolerant people can consume up to 240ml at a time, and perhaps twice this quantity if consumption is spread over the course of a day (Geddes 2015, p.35).

However, the most common solution is to process the milk into other forms. This depends on bacterial action. The bacteria feed on the lactose, which helps to reduce its content in the milk (Outram and Mulville 2005). Three principal mechanisms are employed: separation, souring and fermentation.

Cattle dairy products created to reduce lactose may include hard whey cheese, butter, ghee, which contains no lactose, sour milk, yogurt and fermented milk, which tastes a little like yogurt. It should be noted, however, that the lactose in goat and sheep milk contains similar levels in cheese and yogurt

as it does in milk (Geddes 2015, p.35). Finally, goat milk has lower concentrations of lactose than cow milk and may have been used to supplement cow milk.

Today, the most usual form of milk consumption is sour milk. The milk is placed into smoked pot and left in a warm place to sour. Butter is made by various churning techniques, but a common form is to place the milk into an inverted goat skin, which is suspended and rocked until butter granules are produced, which are drained or scooped out. This leaves buttermilk which can be consumed or turned into white cheese curds by being placed in a pot and heated gently for 10 minutes until it separates into curds and whey. Over a period of up to 30 days the liquid is poured off and the curds are kneaded with salt before being formed into balls and dried. Ghee is of particular value as it has no lactose content and can be stored without refrigeration. In the Middle East butter is heated gently and stirred continually in a pot to which salt is added first, then water is added and then crushed barley. Over 20 minutes later the butter separates out as a clear yellow liquid. It is filtered into a container and the liquid solidifies out as storable ghee. The barley, swollen with water, is then usually eaten. (Degen 2007, p.10-11).

C.4 Lactase Persistence

The enzyme that breaks down lactose is called lactase, which works by breaking down the sugars in lactose into glucose and galactose. But following weaning, the genetic programme of the human body decides that the enzyme is now longer required and switches it off (Check 2006, p.994). However, amongst some geographical areas, groups and individuals there is a condition called "lactase persistence" where the lactase function is not switched off, and lactase continues to be produced in adults, enabling them to digest milk.

In two papers the team of Sarah Tishkoff has identified several different genetic mutations that have allowed for lactase persistence in African populations (Tishkoff *et al* 2007 and Ranciaro *et al* 2014). In the first sample DNA was collected from 43 ethnic groups in three African countries, and in the second, 819 samples were collected from 63 populations, whilst 54 samples were obtained from outside Africa for comparative purposes. The combined results of the studies demonstrated that the mutations spread very quickly. In the Tanzanian sample it had spread between 3000 and 7000 years ago (Tishkoff *et al* 2007). From the second study, the team were able to chart the spread of the mutation across Africa, and found that the history of the mutations corresponds to the beginning of livestock domestication and, in particular, to the spread of the mutation from the Middle East at c.12,300-5000 years ago into northern Africa, which in turn corresponds to the spread of domesticated livestock in the same direction. Intermingling of populations allowed the mutation to be spread, and a second wave of its evolution corresponds to the spread of pastoralism to eastern Africa between 6800 and 2700 years ago (Ranciaro *et al* 2014).

Some individuals may be able to consume lactose without ill-effect even without the genetic mutation. Ranciaro *et al* 2014 give the example of some members of the hunting and gathering Hadza of Tanzania.

C.5 The Ecology of Pastoral Milk Production

Milk is produced following the production of offspring so that the mother can feed her child, so the availability of milk depends on regular production of calves, lambs and kids. Humans are therefore in a position where they share the milk production with the offspring of their livestock. In the Middle East the Assawi fat-tailed sheep usually lactates for around 250 days, during which lamb is fed for 100 days and the ewe is milked for 150.

Sheep and goat tend to be more tolerant of arid conditions and diseases, with goat better adapted to aridity than sheep. However, whereas goats generally produce more milk and have a longer lactation period than sheep, sheep milk has a higher fat and total solids content than goat milk (Linseele 2010). In the present day Negev desert of Israel, eastern Sinai and in the Jezaz of Saudi, the Bedouin goat is adapted to requiring water only every 2-4 days, and although efforts are made to ensure daily watering during lactation this is not always necessary (Degen 2007, p.9). Goat is probably the most viable of the three species for arid conditions (Degen 2007, p.9) although a diversified livestock holding will have ensured greater insurance against loss in the form of disease.

Conception and birth usually take place in rainy seasons (Dahl and Hjort 1976, p.142-146). In marginal dryland environments cattle can only breed during one part of the year and may lactate for up to 8 months in very favourable conditions but only 3-4 when conditions are unfavourable (Dahl and Hjort 1976, p.142). The rate and volume of lactation are influenced by the nutrition and water available (Ryan 2002) so the fat and protein value of milk is lower in the dry season, when pasture and water are low, than in the wet season when they are readily available (Degen 2007; Linseele 2010).

Guletat's research into the Himba, Herero and Demara groups of northwest Namibia, in an area of 100-200mm average rainfall per annum, found that individual cows produced an average of 1.3 litres of milk per day during the dry season and an average of 4.8 litres a day during the wet season. Goat, by contrast, produce an average only 0.24 litres per day during the dry season and 0.68 per day during the wet season (Guletat 2002, p.44). Goats are milked during droughts and when no cows are owned, but cows are seen as the principal source of dairy (Degen 2007, p.12). Degen noted that each household consisted of c.7.9 individuals and that each household had, on average 213 heads of livestock, of which 73% were goat, 18% cattle and 6% sheep.

C.6 Archaeological indicators of milk consumption

The earliest clear evidence for milking in Egypt is the tomb of Hor-Aha, the second king of the First Dynasty (c.3050 - 2890BC), where funerary vessels were subjected to chemical analysis and suggested that the contents was cheese, which was confirmed by the hieroglyphic inscriptions (Simoons 1971). There is earlier evidence from residues in pottery sherds in Libya that at least half of the fats in 29 of the 81 residue samples were from dairy, dating to 6000-3000BC (Dunne *et al* 2012). Rock art shows cows being milked (Le Quellec 2001), although the dating remains controversial.

Evershed *et al* 2008 have demonstrated that milk-based dairy products, as opposed to other animal fat products, were in use by the seventh millennium BC, albeit with marked regional differences in the onset of milk consumption at this time (Evershed *et al* 2008, p.530). In Egypt the earliest evidence for milking is at Saqqara, where residues were found in vessels dating to around 3000BC, but there are earlier examples elsewhere in the eastern Sahara. Although there are images of milking captured in Saharan rock art, dating these is difficult (di Lernia, and Gallinaria 2010). Animal bone remains preserve few indications of how cattle were used (Dunne *et al* 2012, p.390) however there are positive identifications of dairy residues in prehistoric pottery vessels in the Sahara, (Dunne *et al* 2012) and low numbers of cattle bones at eastern Saharan sites suggests that cattle were kept either in very low numbers or primarily for purposes other than meat consumption. Goat and/or sheep tend to be found in higher numbers and could therefore have been used for both purposes. Most telling is that potsherds from the Takarkori rock shelter in southwest Libya, produces evidence for “extensive processing of dairy products” during the Middle Pastoral Period (5200-3800 BC), (Dunne *et al* 2012, p.394).

C.7 Conclusions

Although Linseele considered it doubtful that the earliest pastoralists considered milk to be an important staple and that the milk yield of early domesticates did not exceed that of wild herbivores (Linseele 2010, p.59) it has been shown that milk had a high potential value to early food producers. The presence of milk in prehistoric contexts in the Near East from the 7th Millennium BC and from the southwest Libyan Sahara from the 4th Millennium BC supports the proposal that milk was a significant source of nutrition for pastoralists. It seems plausible that a) they made use of milk products even if they were lactose intolerant by means of modifying milk into lactose-reduced products and that b) over time individuals, groups and communities may have been recipients of the mutated gene by which they acquired lactase persistence from the time of the introduction of the first domesticates that were brought from the Near East. In the long term, lactase persistence would have made dairy farming viable and sustainable throughout later prehistory and into historic times.

Appendix D – Opportunity and resistance to change

This short case study looks at how opportunities may or may not be taken up by groups when presented with them, even when pressure is applied for the opportunity (in this case a new economic paradigm) to be adopted.

D.1 Opportunity

Opportunities are ideas, technological innovations or imports, new production possibilities (including new animal and plant types, favourable climatic change, production surplus or any other innovation, adaptation or adoption that may be leveraged by an individual, household or group in order to improve livelihoods. As Ingold says (1981, p.126) every innovation “whether of local origin or introduced from outside, represents just one of a potentially infinite range of possible solutions to a given problem.” Some of the solutions to vulnerability will depend on new opportunities but opportunity may also represent improvements and refinements to an already successful lifestyle. Diversification of resource base, knowledge about new technologies and the availability of new products or materials or new markets may be entirely dependent on new options becoming available (Dixon *et al* 2001, p.13). The introduction of sheep and goat into northern Africa and the decision of groups to adopt them, followed later by the introduction of domesticated wheat and barley are examples of opportunities that were taken up and which that can be detected archaeologically (Shirai 2010).

In both present and past communities they may represent an ambivalent component because as well as bringing something potentially positive, what are presented as opportunities frequently represent risks (Abrahams 1996; Eyhorn 2006; Vlasich 2005). Lightfoot and Martinez (1995, p.485) emphasize that although new ideas and materials often come from other ethnic groups in the process of exchanging goods and marriage partners, people often choose to resist innovation, preferring loyalty to their traditional livelihoods and ideologies. Even when opportunities are taken up and incorporated into an existing livelihood system they may also be regarded as high risk, alien interlopers that present as much of a threat as a potential benefit not only to existing economic practices but to family well-being and community identity (Vlasich 2005). The lesson from development economics is, perhaps unsurprisingly, that the only changes that will ever be acceptable to groups being challenged with environmental deterioration or unsustainable livelihoods are those that emphasise that new technologies and innovations only work when they are compatible with existing environmental conditions, social mechanisms and traditions (Masood and Schaffer 2006; Streeten *et al* 1981; Terrell and Hart 2008). The value of traditions to groups has often been underestimated (Morgan 1992; Ness 1994; Seeley 2006; Ortiz 2005; Vlasich 2005) but it has become clear that groups will fight to preserve their traditions in the face of the need to change livelihood strategies (e.g. Koenig 2006), will resist attempts to change them to systems that, whilst offering apparent improvements in productivity may undermine traditional processes (DID 2000; Vlasich 2005), and will suffer when changes imposed on them force changes in their routines and values (e.g. Cliggett 2005). Even when modern groups are willing to adopt new technologies and strategies, adaptation is not a foregone conclusion

when choices about livelihoods have to be made and education is required to introduce them (DID 2000). Sayer and Campbell (2004, p.69) emphasize that innovation is an inherently social process rather than a logistical matter of technological transfer.

Opportunities are often taken up slowly, on an experimental basis and in a way that does not radically redesign existing functional strategies (Dennell 1983, p.175-6) and are only considered to be innovations if accepted by the group (Torrence and van der Leeuw 1989, p.11). The costs of taking up an innovation that fails may be high so must be carefully weighed (Mellor 2008, p.214-226). The risk of taking up a novel idea is judged on the basis of past experiences (van der Leeuw 1989, p.316) but also, when available, on the experiments of others. There may be a period during which some members of a community, early adopters, choose to take a risk by incorporating a novel way of doing things, whereas others will wait to see how that risk pays off (Bargatzky 1989; Layton 1989). Mokyr (1990, p.158) suggests that heads of extended families will be more cautious than heads of nuclear families because of the greater number of people depending upon their decisions. In this way the perceived values of a new production technique, idea or strategy can be evaluated without being committed to absolutely. The following account from an analysis of cotton farming in India is telling, repeated at length in order to illustrate the point (Eyhorn 2006, p.44-5):

During exploratory studies in the research region we interviewed organic cotton farmers about their decision to convert to organic farming. Some of them preferred to follow farmers who had adopted the new system earlier and whom they considered as being progressive farmers. Others initially were afraid of yield losses which 'would make them feel ashamed in front of their neighbours.' It became obvious that the personality of the individual farmer, his self-image, and his aspirations concerning the future of his family also played an important role in the decision making process.

Emotional attachments to the agricultural practices of their ancestors were emphasized by some farmers . . . These statements and observations illustrate that rural livelihoods are not a mere combination of different assets, but also involve dimensions such as world views, traditions, role models, gender aspects, emotions, personal attachments, ambitions and self-image."

A similar scenario is described by Sayer and Campbell (2004, p.69) when talking of a resource management problem in southern Zimbabwe, illustrating again that even internal innovation can be difficult:

The social pressure and norms in the society did not leave much freedom for individuals to innovate. 'Natural' innovators were the object of jealousy and were often avoided and victimized rather than copied.

They go on to discuss differentiation between passive and active adopters: those who watch the experiments of others and wait to see what happens and those who carry out experiments and try difference things.

Active adaptive management requires that managers probe the systems to explore the fullest range of outcomes. It is important to recognize that leaving by day is a long and time-consuming process. It is clearly a risky strategy – and particularly so when the experiments are being implemented on the only set of resources of a kind: the ones upon which you and your family are totally dependent. It is understandable that people who are dependent upon poor resources are cautious in their experimental management: they tend to be conservative as they cannot afford to take risks (Sayer and Campbell 2004, p.102).

One view is that those most likely to accept economic change are those who are living under conditions of high security and sustainability and low risk. In Mali conditions were sufficiently secure to encourage some groups to adapt to new crops, and cotton growing became successful (Lavigne-Delville 1997, p.151). On the other hand, there are also circumstances under which groups may adopt new livelihood strategies and accompanying social structures when they interact with, or are imposed upon, by different systems, handling both risks and benefits (Cliggett 2005; DID 2000). According to the DID benefits could include increased income, sustainability of natural resources and security, together with reduced vulnerability.

In all scenarios, leaders and groups must be able to incorporate new knowledge, ideas and technology into their own reality and their own value systems. Suggestions can come from outside but the impetus and the mode of assimilation with existing ideas and ways of doing things has to come from within (Hagmann *et al* 2002; Mortimore (1998). Where opportunities were taken up and change did occur, corresponding changes in cultural output and ideological conceptualization could also be expected (Hesse 1982; Smith, A.B. 2005, p.201).

An example of the tension between opportunity and tradition is given below, taken from the analysis by Vlasich (2005) of the resistance of Puebloan Indians to new ideas, subsistence strategies and technologies imposed on them from outside.

D.2 The Puebloan Indians of southwest North America

The Puebloan Indians of southwest North America provide a long history of examples of resistance to any changes that might impact on their traditional practices and beliefs. The Anasazi established settled agriculture in a semi-arid region and this endured for 3000 years until the arrival, in 1540, of Spanish forces and, in their train, a complete Spanish economic and agricultural infrastructure. The Puebloan Indians found themselves confronted by a culture that tried to impose new crops, implements, and regulations among the natives Puebloan Indians. James Vlasich says that some of these new ideas were adopted, “but generally speaking only the most expedient blended in with native institutions” (Vlasich 2005, p.8). In the early 1600s the new governor of New Mexico brought sheep, horses and cattle and range animals were introduced into the Puebloan lands for the first time. Without fencing, and without sufficient management, these animals moved towards the richer land that flanked the river, both consuming Puebloan crops and causing damage to irrigation channels (Vlasich 2005, p.23), which only stopped when legislation was introduced to provide a zone of exclusion of animals from farm land.

Puebloans did take up stock raising, encouraged and trained by the Spaniards but only as a secondary activity. Attempts by the government at the turn of the 20th Century to bolster Pueblo agriculture with new ideas, technologies and education were only successful to a very limited degree, due to the conflict that these new ideas represented with the Puebloan traditions and was confined mainly to the introduction of new crops into the Pueblo cultivation mix, together with some implements: "Agriculture defined the Pueblos throughout their history. It became a symbol for their culture in much the same way that buffalo identified Plains Indians" (Vlasich 2005, p.xv). Pre-Spanish foods dominated over new introductions like fruit trees, wheat and barley: "Acceptance of the new items did not change the Pueblo standard of living since they continued limiting their crop production to community needs." (Vlasich 2005, p.27). Traditional tools were preferred even where more efficient Spanish tools were available. Even children in the Puebloan culture rejected modern practises, learning instead from the experience of their families.

Frank Hamilton Cushing, who became inducted into Zuni life in the 1800s, observed that even with the introduction of new animals, plants and some tools, the basic agricultural procedures and processes were all traditional, and the results were undeniably successful (p.97-8). It still involved subsistence level agriculture with surplus produced for acquiring necessities. Adoption of new ideas was highly selective and happened only where there was clear benefit and only where cultural traditions were not interrupted.

By the mid-1800s the US supplanted the Mexican government. A more active attitude was now taken to an involvement in Puebloan agriculture, with an economic motive for modernizing them. The US wanted to change Puebloans from a subsistence to a credit economy using trading posts to exchange goods. In the 1870s new schools were introduced to modernize Pueblo farmers. By the late 19th century the most significant change was the introduction of metal tools on a widespread basis, replacing bone and wood items, even though metal tools were difficult to replace when broken. They were basic tools but they raised efficiencies, which meant that less manpower was needed and people were freed up to diversify their economic base. Between 1890 and 1920 the Bureau of Indian Affairs agents "offered numerous suggestions on ways to maximise acreage. While their advice would have led to increased production, many of the Indians were satisfied to raise only enough crops to feed their village" Resistance to outside change had been a Pueblo characteristic for centuries, and because of this attitude, the agents' innovations were accepted slowly" (Vlasich 2005, p.131-132). In the late 19th century there was increased interest in developing arid regions so training programmes were introduced to update Indian methods, with government farmers working with Puebloans to introduce crop rotation, new plant choices, new ploughing and planting techniques and new standards of crop maintenance. "Anthropologists have noted that the Pueblos had a proclivity to resist dramatic changes in their culture while adopting certain foreign modifications. This practise, dubbed 'compartmentalization' entailed integration of only those innovations that did not cause major alterations in the Pueblos' ancient cultural traditions The Bureau of Indian Affairs recognized that any farm program it initiated that ignored this Pueblo trait would be doomed to partial acceptance at best." (Vlasich 2005, p.188). In addition, engineering projects were introduced to improve irrigation. In 1912 the first threshing machines were installed to replace the prehistoric

methods employed. This increased efficiencies and raised production, reducing the need for manpower and freeing up Puebloans to find other incomes and diversify the economy.

The more ambitious of the new ideas were only accepted when modernization programmes took Puebloan beliefs into consideration and, at the same time, economic stresses combined with a considerable growth in population reduced Puebloan resistance to change during the Great Depression: "As their population grew and money became tight, a culture heretofore resistant to change gradually adjusted" xiv. The Puebloan population had increased by 20% to 11,346 from 9000 at the turn of the 20th Century, and the income that had been derived from craft and leisure activity dried up as Americans faced a jobless future. Even in the face of real economic problems, the Puebloans resisted government programmes to improve the land and its physical infrastructure and to introduce modernization, preferring their traditional subsistence approaches. Eventually it was via school rooms rather than adult training and legislation that changes in attitude began to be introduced, which bore fruits particularly during the Second World War when manpower was taken away from the Puebloan lands, girls were given vocational training in modern agricultural techniques and labour saving technology was accepted to replace the loss of Puebloan men. For the first time fertilizers were successfully introduced, an innovation repeatedly rejected by the Puebloans due to its incompatibility with existing traditions.

After the Second World War some Puebloans abandoned some of their ceremonies for the growth of crops and hopes for good climatic conditions and even those involved in agriculture needed to diversify economy to survive. New employment opportunities included mining, recreation and ranching, but others still hung onto traditions even with the adoption of modern techniques and establishment of a more diversified economy. Ranching presented its own particular problems: "In some ways the problems for Pueblo ranchers were more difficult than those of strict agriculturalists. The vastness of the areas they controlled meant higher cost in applying soil and moisture conservation methods. Plants and animals need water, but stock required feed that was expensive to produce" (Vlasich 2005, p.254).

Between the 1960s and 1970s there was a tension between the need to engage in the modern world due to the decline of the effectiveness of Puebloan agriculture and the desire to reject ideas and methods that were inconsistent with their own traditions. By 1964 one quarter of the Puebloan Indians were living off the reservation and those remaining eked out an existence, taking advantage of new government programmes to regenerate land, improve ranges and improve access to water. Problems continued throughout the 1970s, with Puebloan agriculture struggling. Many explanations have been offered to explain the decline of Puebloan agriculture at this time, but appears to have been caused by a mixture of different pressures all occurring more or less simultaneously. These include water shortages due to drought, siltation, disputes over water rights, soil erosion, significant population increases, the upheavals of the Second World War, the introduction of welfare and the corresponding decline of self-reliance, transfer of land from one generation to another resulting in small and highly dispersed holdings, the inability to afford new technologies, and the economic unviability of agriculture when it was no longer the primary system (p.222-241 and 285-286) More

problem-orientated government initiatives and the improvement of education helped to enable some Puebloans to survive and in the 1990s there was a revival of traditional methods and some regeneration of Puebloan land. Puebloan life continues in a modified form, still supporting economic and cultural traditions.

All of the above demonstrates that it is very difficult to change traditional methods when existing methods are both successful and bound up with clearly defined social traditions and land ownership and management systems. "It was inevitable that some of the colonial innovations would be adopted by the Pueblos. This does not mean that the Pueblos became assimilated into the mainstream of Spanish culture. On the contrary, they resisted dramatic changes in their lifestyles and integrated only those changes that did not cause major alterations in their ancient cultural traditions" (Vlasich 2005, p.24).

Appendix E – Human Nutritional Requirements

Vitamin/mineral	Comment	Sources	Role	Results of deficiencies
Vitamin A - Retinol	Critical when reliable sources of carbohydrates are absent	Fats Oily fish Liver Carotenes Leafy vegetables Soft-shelled turtle Dairy (Milk, cheese)	<ul style="list-style-type: none"> • Reproduction • Vision • Growth • Maintenance of surface tissue • Essential for vitamin D and thyroid processes 	<ul style="list-style-type: none"> • Blindness / poor night vision • Morbidity • Mortality • Reduced resistance to infections
Vitamin B Group	A group of water-soluble vitamins which work together in they cannot be stored in the body so must be regularly replaced and need to work together. They are depleted through storage, processing and food preparation. Vitamin B1 absorption can be impeded by the high consumption of alcohol	<p>B1 (thiamine) - Pork, ostrich eggs, soft shell turtle, liver, legumes, peas, whole cereal grains, seeds, nuts</p> <p>B2 (riboflavin) - Offal, molluscs, soft-shell turtle, dairy, leafy vegetables, liver, kidneys</p> <p>B3 (niacin) - Beef, offal, fish, molluscs</p> <p>B6 - Beef, some whole grains, some vegetables, chickpeas, soft-shell turtle, ostrich</p> <p>B12 (cobalamin) - Offal, meat, fish, seaweed, molluscs, ostrich, ostrich eggs</p>	<ul style="list-style-type: none"> • Normal cell function • Healthy nervous system • Food digestion • Healthy metabolism • B1 - helps to metabolize certain carbohydrates; releases energy from carbohydrates; supplies brain and nerves with energy • B2 - Releases energy from fat and protein; provides healthy skin and mucous membrane • B3 - Helps to release energy • B6 - Metabolizes protein; healthy blood • B12 - Formation of blood cells and nerves. Required for normal functioning of brain and nervous system. 	<ul style="list-style-type: none"> • B1 – Beriberi; Wernicke-Korsakoff syndrome; loss of short-term memory in alcoholics • B2 - Sores in mouth (stomatitis); light sensitivity; skin rashes; loss of energy; anaemia (impacts iron absorption) • B3 - Pellagra; loss of energy • B6 - Rare but extreme deficiency can include microcytic anemia, electroencephalographic abnormalities, dermatitis with cheilosis; glossitis; depression; weakened immune function • B12 - Pernicious anaemia, nerve damage, megaloblastic anaemia (cognitive dysfunction); fatigue; depression
Vitamin C - Ascorbic acid	Partial value lost in storage, processing, preparation and cooking	Fruits, particularly citrus, and vegetables (particularly dark leafy greens). The only vegetables with none are	<ul style="list-style-type: none"> • Healthy immune system • Healthy connective tissue, bones and teeth • Healing wounds and fractures 	<ul style="list-style-type: none"> • High blood pressure • Risk of heart attack • Bleeding gums • Poor healing of injuries • Low resistance to infection • Scurvy

Vitamin/mineral	Comment	Sources	Role	Results of deficiencies
		unsprouted grains and dried pulses.	<ul style="list-style-type: none"> Helps absorption of iron 	
Vitamin D - Cholecalciferol		Sunlight Dairy Oily fish	<ul style="list-style-type: none"> Absorption of calcium and phosphorous Helps to form bones and other mineralization 	<ul style="list-style-type: none"> Rickets Osteomalacia
Vitamin E - Tecopherols		Vegetable oils Nuts Seeds Green leafy vegetables	<ul style="list-style-type: none"> Protection of cell membranes Protection of arteries Protection against heart disease Improvement of the body's immune response 	<ul style="list-style-type: none"> Peripheral neuropathy Ataxia Skeletal myopathy Retinopathy; Impairment of the immune response
Vitamin K		Dark green leafy Vegetables Skins of fruit and vegetables	<ul style="list-style-type: none"> Normal clotting of blood 	<ul style="list-style-type: none"> Rare, but bleeding and haemorrhage may occur in extreme cases.
Folate - Folic acid		Offal Leafy green vegetables Whole grains Pulses Nuts Ostrich eggs	<ul style="list-style-type: none"> Formation of blood cells Development of foetus and infants Normal cell division 	<ul style="list-style-type: none"> Birth defects (e.g. spina bifida) Megaloblastic anaemia
Calcium	Insoluble fibre (whole grains) and oxalates like spinach and rhubarb can hinder calcium absorption	Cheese Yogurt Milk Dark green leafy vegetables	<ul style="list-style-type: none"> Major constituent of bones and teeth Helps muscle function Assists blood clotting Improves nerve function 	<ul style="list-style-type: none"> Osteoporosis Muscle cramps Rickets
Iron	Wheat may reduce iron absorption	Offal Red meats Dark green vegetables Nuts Seeds Pulses Some fruits Dried herbs	<ul style="list-style-type: none"> Carries oxygen from lungs to all body cells Increases resistance to infection 	<ul style="list-style-type: none"> Anaemia (tiredness, weakness, pallor, reduced productivity)
Zinc	Absorption may be impaired by high wheat and barley consumption	Meat Dairy Whole grain Pulses Soft-shell turtle	<ul style="list-style-type: none"> Normal growth and development Healthy reproductive system Healthy foetal development Healthy skin 	<ul style="list-style-type: none"> Retarded growth Delayed onset of puberty and sexual development Risk of infections Slow wound healing Impaired sense of taste Night blindness

Vitamin/ mineral	Comment	Sources	Role	Results of deficiencies
			<ul style="list-style-type: none"> Wound healing Regulates sense of taste 	<ul style="list-style-type: none"> Hyogonadal dwarfism
Chromium		Whole grains	<ul style="list-style-type: none"> Glucose tolerance 	<ul style="list-style-type: none"> Diabetes
Selenium		Plants Herbivores Nuts Lentils Molluscs	<ul style="list-style-type: none"> Protects from heart disease Normal growth Fertility Healthy skin and hair 	<ul style="list-style-type: none"> Risk of lung and heart diseases Miscarriage
Magnesium		Whole grains Nuts Seeds Green vegetables Molluscs	<ul style="list-style-type: none"> Healthy bones Helps release energy Healthy heart 	<ul style="list-style-type: none"> Muscle weakness Abnormal heart rhythms Tiredness Loss of appetite
Potassium		Fruit Vegetables Pulses Nuts Garlic Onions	<ul style="list-style-type: none"> Regulates body fluids Functioning of cells Regulates heart, nerves and blood pressure 	<ul style="list-style-type: none"> Heart problems
Phosphorous		Milk Eggs Cheese Meats Fish Soft-shelled turtle Molluscs	<ul style="list-style-type: none"> Healthy development of skeleton Body cells Regulation of protein activity Helps release energy 	<ul style="list-style-type: none"> Fragile bones and stiff joints Fatigue Weakness In children, poor bone and tooth development
Sodium	Excess of salt can lead to high blood pressure and heart disease.	Salt	<ul style="list-style-type: none"> Regulates body's fuel balance Nerve and muscle activity 	<ul style="list-style-type: none"> Cramps Weakness Fatigue Nausea
Carbohydrates		Sugar Fruits Pulses Rice Cereal grains Nuts Seeds Tubers Roots	<ul style="list-style-type: none"> Provision of energy 	<ul style="list-style-type: none"> Lack of energy
Protein - Amino acids	Non-essential and essential amino acids. Essential amino acids must be supplied by diet and comprise: Isoleucine, leucine, lysine, methionine, phenylalanine,	All eight: Animal and bird fleshes Dairy Fish Molluscs Eggs (including ostrich) Partial: Pulses (must be	<ul style="list-style-type: none"> Growth and development in children Cell maintenance and repair (especially muscles) Regulation of body functions 	<ul style="list-style-type: none"> Loss of body mass Loss of body strength Impaired immune function Impaired recovery from illness and injury IPDS (Infant Protein Deficiency Syndrome) during period from 18 to 24 months old, resulting in permanent

Vitamin/mineral	Comment	Sources	Role	Results of deficiencies
	threonine, tryptophan and valine. Some contain high fat content	combined with grains/nuts/seeds) Low levels in cereals compared to animal products (particularly lysine and threonine)	<ul style="list-style-type: none"> 22 amino acids used to make body's protein like muscle 	damage to mental development
Fats	All fatty foods contain three types of fatty acids in varying quantities: saturated, polyunsaturated and monosaturated. The best sources of all fats are those under the skin (adipose) and within bones (marrow fat and bone grease). Essential Fatty Acids (EFAs) are only available from food.	<p>Saturated:</p> <p>Meat Milk and cream Eggs Lard Cheese</p> <p>Polyunsaturated:</p> <p>Nuts Liquid oils Oily fish Flax (linseed) Flaxseed oil Leafy vegetables Palm oil Butter</p> <p>Monosaturated:</p> <p>Nuts Dairy Egg Fish Meat</p>	<p>Saturated</p> <ul style="list-style-type: none"> Energy <p>Polyunsaturated</p> <ul style="list-style-type: none"> Lower cholesterol Provide essential fatty acids alpha-linoleic and linoleic (omega 3 and 6), which in turn provide cell membrane construction, sources of energy and have an anti-inflammatory value <p>Monosaturated</p> <ul style="list-style-type: none"> Lower cholesterol Lower heart disease Lower obesity Often provides more vitamin E 	<ul style="list-style-type: none"> Saturated: High cholesterol leading to heart disease Osteoporosis Depression Dementia Atherosclerosis

Table E1 – Human nutrition: Sources, roles and results of deficiencies

Sources:

- Bender, D.A. 2014
- Cordain 1999
- Outram and Mulville 2005.
- National Institutes of Health - Office of Dietary Supplements Fact Sheets
<https://ods.od.nih.gov/factsheets/list-all/>
- Nutrition Data website <http://nutritiondata.self.com/help/about>
- Wills, J. 1998, 2002

Appendix F – Comparative values of livestock

	Minimum Breeding age	Gestation period (months)	Breeding season	Months between gestation periods	Max. number of offspring per year	Max. Lifespan (years)
Cow	2 years old	9	Spring	2-4 (good pasture) 12 (poor pasture)	0-1	13
Sheep	1-2 years old	3-6	Autumn (but may breed twice a year)	2 (if good pasture)	4	9
Goat	1-2 years old	3-6	Autumn (but may breed twice a year)	2	3	9

Figure F1 – Reproductive value of each specie

	Drought tolerance	Saline Tolerance	Preferred forage
Cow	Low	Low	Pasture
Sheep	High	Medium	Pasture
Goat	Medium	High	Browse

Figure F2 – Environmental preferences

	Milk yield (litres)			Milk value		Lactation period (months)
	Cold season	Hot season	Wet season	Fat	Casein (dairy protein)	
Cow	3 - 4	2 – 3	2	4%	2.5%	10-15
Sheep	2	0	1	7.5%	5%	7
Goat	0 – ½	1	2	4.5%	2.5%	7-8

Figure F3 – Availability and value of milk

	Maximum no. days without water*		Max no, days without food (hot season)	Maximum kms a day
	Cool season	Hot season		
Cow	3	2	2	20
Calves	1	0 - 1	/	10
Goat	30	1-2	2	30?
Sheep	15	2	2	20?

* Depending on the quality of pasture

Figure F4 – Ability to tolerate drought, hunger and travel

Pigs are demonstrated to be very versatile in terms of how prolific they are in terms of production, and are highly tolerant to poor quality fodder, both features that might have been very attractive in the Badarian. But they do not provide milk and can be devastating to crops, because they are very difficult to constrain and cannot be herded, which may be why they were rejected. They may have been too much of a challenge in a confined riverine environment.

In all case studies, cattle remains were found. Cattle may have had multiple roles. They are excellent sources of dairy, blood and meat, may be socially constructed and may be associated with religious belief. At Nabta the burial of one whole cow and dispersed pieces of cattle in tumuli indicate that their importance in this area exceeded the purely economic. Although cattle are not particularly heat, drought or saline tolerant, require greater quality food than either sheep or goat and have only average quality milk value, although it is plentiful when cattle are healthy. Goat are wonderful for arid environments because they are both drought and heat tolerant, will consume poor quality fodder and reproduce fairly well. Sheep are less drought, heat and poor fodder tolerant but produce fairly good numbers in a litter and the quality of their milk exceeds that of cattle and goat. Goat and pig are therefore by far the most versatile of the domesticated species represented, with cattle dominating only in terms of its energy reserves, lifespan and supply of hides (the latter not specifically recorded in Badarian graves). Sheep and goat would therefore seem to be a good solution for Badarian people, supplemented by cattle.

The data in the above tables has been assembled from data presented in the following publications:

Aboul-Naga *et al* 2014

Dahl and Hjort 1976

Dyson-Hudson and Dyson-Hudson 1980

S.E. Smith 1980

Yokell 2004, chapter 4

Appendix G – Potential Archaeological Indicators

G.1 Asset Matrix

Under each asset component possible archaeological indicators are suggested for exploring elements of each asset. This is a simple tool to act as a prompt for the researcher, but has the potential for developing into a more formal device for data collection.

Natural Assets

Climate

Use of climate research for specific areas with specific focus on geology, geomorphology, topography and rainfall/evaporation regimes (see Chapter 3)

Investigation of localized climate indicators, such as lake sediments, lithology, pollen, charcoal and other proxies for climate, inter-annual variability and seasonality in temporal and spatial variability (see Chapter 3)

Assessment of the types of geological, geomorphological and landscape features of the area

Assessment of plant and faunal remains as environmental indicators

Isotopes in bones indicative of environmental changes

Hydrology

Geomorphological and geological analysis; digital elevation models to calculate palaeodrainage systems

Topography

Field survey and satellite analysis

Light and temperature

Faunal and particularly floral regimes; Comparison with other similar types of environment with a view to understanding the potential influences on livelihoods.

Aeolian conditions

Loss of vegetation caused by human activities may increase the impact of wind erosion

Edaphic properties

Floral remains

Sealed contexts

Analysis of sediments

Vegetation

Floral remains

Hydrological conditions

Light and temperature

Animal remains (as indicators of browsing potential and annual versus perennial species).

Fauna

Faunal remains

Hydrological conditions

Vegetation suitable for fauna

Wood

Floral and faunal remains

Rocks and minerals

Sourcing of raw materials

- Foot survey of the local region
- Vehicle survey of larger regions
- There are a number of analytical methods that can source stone materials (e.g. petrographic analysis, atomic absorption spectroscopy and neutron activation analysis for flint; x-ray diffraction for basalt, dolerite, gneiss, steatite and others, thermoluminescence for granite, sandstone and limestone).
- Technical pottery analysis including optical microscopy, chemical analysis, x-ray powder diffraction, UV emission spectrometry, x-ray fluorescence, neutron activation analysis, photon activation analysis.
- Where aquatic shells are present, it may be possible to determine which body of water supplied them

Seasonality

Floral and faunal remains

Understanding of hydrological systems

Observation of settlement types and artefact types with a view to observing patterns of seasonal mobility

Physical Assets

Raw Materials

Sourcing of raw materials

- Foot survey of the local region
- Vehicle survey of larger regions
- There are a number of analytical methods that can source stone materials (e.g. petrographic analysis, atomic absorption spectroscopy and neutron activation analysis for flint; x-ray diffraction for basalt, dolerite, gneiss, steatite and others, thermoluminescence for granite, sandstone and limestone).
- Technical pottery analysis including optical microscopy, chemical analysis, x-ray powder diffraction, UV emission spectrometry, x-ray fluorescence, neutron activation analysis, photon activation analysis.
- Where aquatic shells are present, it may be possible to determine which body of water supplied them

Manufacturing outputs

Analysis of tool technologies in conjunction with other technologies to understand manufacturing objectives, including evidence of re-use and recycling, portability, specialization and broad spectrum subsistence practices

Analysis of material objects with a view to understanding their cultural role within society. Where lithics are the main or sole form of evidence remaining, the main problem will be how to infer settlement patterns and social practices from the available data.

Absence or presence of pottery may be indicative of different types of activity

Labour availability and composition

Primary and secondary raw material availability and systems of resource exploitation or, in the absence of locally available resources, methods of acquisition

Settlement location

Geology, geomorphology, topography

Hydrology and other natural resources

Tradition of site use, including settlements, rock art, ceremonial sites, cemeteries

Settlement type

Structural components and features, if present

Scale of settlement and definable areas (e.g. households) within

Distribution of objects within structures/defined zones and across a settlement area
Density of objects and waste materials
Use of tools, animal bones and craft items to determine uses of sites
Mobility and otherwise of objects
Spatial distribution of artefact concentrations
Temporal distribution of artefact concentrations
Presence of objects that might be diagnostic about site organization
All the above considered in relation to one another to derive the most information possible

Storage

Presence/absence of storage devices / systems
Contents of storage devices
Potential longevity of items stored
Potential uses of items stored

Transport

Determination of mobility and its characteristics (or otherwise)
Importance of heavy items
Availability of pack animals
Capacity of population to move heavy goods without pack animals (e.g. physical fitness)

Mobility

Indications of occupation and abandonment cycles
Indications of landscape use
Location of similarly fabricated and styled artefacts in multiple locations
Isotope analysis of human bones to suggest mobility patterns via dietary variability

Social Assets

Social organization, differentiation and status

Cemeteries / burials differentiation
Architectural complexity
Cultural complexity
Prestige items and iconographic emblems
Craft specialization

Spatial organization

Religion, ideology and spiritualism

Cemetery / burials (and character of grave goods)

Ceremonial activities including rock art

Cultural indicators including specialized forms of craft work and decoration

Specific architectural elements such as monuments and ceremonial sites

Spatial organization

Tradition, social values and social guidelines

Traditions of technology, form, style, material decoration in lithics and pottery

Expenditure of time

Funerary practices and grave-goods

Indications of religious and ceremonial activity

Internal relationships of support

Cultural traditions, religious indicators and artefacts, and iconographies

Distinctive manufacturing traditions

Spatial organization

Intra-group relationships

Cultural traditions, religious indicators and artefacts, and iconographies

Distinctive manufacturing traditions

Spatial organization

Material expression

Phenomenology

Persistent places

Cultural components

Luxury items

Mobility/sedentism

Subsistence Assets

Practice of subsistence activities

Remains of foodstuffs

Storage facilities

Bone analysis of faunal remains to detect

- Butchery patterns
- Age of animals at time of death in order to learn more about animal use
- Analysis of animal fat residues to learn more about food uses
- Seasonality of food assets

Absence or presence of pottery may be indicative of different types of food preparation and storage.

Analysis of vessels to detect plant and animal residues

Reproduction cycles of available animal resources

Analysis of lithic tool types; indications of presence or absence of silica gloss

Presence or absence of grinding equipment; residues

The potential for and indications of trade networks

Analysis of raw materials

Analysis of style in cultural objects and technology

Production potential of community

Presence of foreign materials

Presence of luxury / exotic goods

Indications of cultural connections

Labour availability

Analysis of economic activities that would have been required for any given economic strategy, in order to understand what types of labour would have been require

Analysis of burial remains to determine types of labour carried out in economic and household contexts

Analysis of tools employed in economic and household activities

Knowledge and information

Subsistence and technological skills

Risk management strategies

Maintenance of cultural traditions and manufacturing techniques

Cultural idiosyncrasies

Mobility

Types of herd animal employed

Remains of domesticated animals

Artefact composition (portable, multi-functional, curated)

Settlement size and character

Hydrological and vegetational resources

Land tenure

- Rock art analysis
- Settlement analysis at aggregation sites (e.g. water sources)

Savings / Storage

Biodiversity

Economic system

Structural remains

Stored items

Butchery practices

Evidence of harvesting in tool assemblage

Inter-Group Information Exchange

Localized techniques for manufacturing and cultural expression

Well defined manufacturing techniques employed across generations

Maintenance of traditions

Human Assets

Nutrition

Examination of the available nutrition represented by plant and animal resources in the environment and on site (including imprints within ceramics) in terms of functional values (carbohydrates, vitamins etc)

Analysis of residues in vessels

Analysis of human bones discovered in graves for signs of nutritional deficiencies

Bone isotope analysis

DNA analysis (for example to identify the -13.910*1T lactose gene)

Gender

Cemetery / burial data

Status indicators

Settlement analysis

Age mix

Cemetery / burial data

Gene pool

Bone (isotope) analysis

DNA analysis

Dental biodistance analysis

Population sizes

Cemetery data

Density of settlement / campsites

Number of households in a village

Personal Assets

Indications of potential for good nutrition

Absence of conflict

Social complexity

Well balanced Asset Matrix components

G.2 The Livelihood Variables***Vulnerability Context***

Climatic change

Environmental conditions

Analysis of animal and human remains for signs of health problems and disease

Signs of conflict

Cultural changes

Technological changes

Opportunity

New technologies

New food production resources and methods

Blending of new and old technologies and food production techniques

New forms of cultural expression

External Processes

Indications of trade and exchange

Indications of aggregation for social or economic reasons

Indications of cultural similarities over a wide area

Linguistics

Human morphology; DNA analysis

Symbols of power

Signs of conflict

G.3 The Livelihood Outcomes

Natural Assets: Assessment of the relationship with the natural environment and the maintenance of natural ecology whilst sustaining livelihoods; isotopic analysis of faunal and human bones for environmental change

Capital/Subsistence Assets: Changes in the ability to accumulate of capital assets (livestock, plant surplus) or acquire and wild resources; ongoing or reduced access to territory and raw materials; ability to sustain current livelihood without the need for innovation or modification

Physical Assets: Observable changes in the assets that help to support the infrastructure of a given subsistence strategy and social organization

Human Assets: Indications of ability or otherwise to maintain a healthy and informed population will be indicated by the conditions of human remains or suggested by the mixture and volume of food types chosen, as well as the strengths of links with other groups to ensure ongoing gene pool diversity.

Social Assets: Observable changes in the complex combination of ideologies, social organization and networks that define group identity and potential.

Personal Assets: Observable changes in the conditions that might provide individuals with the ability to achieve personal goals and make their own decisions, which are probably only sustainable under conditions of social and economic stability.

Appendix H - Test Case Study: The Hadendowa of the Beja

H1 Introduction

In 1987 the Red Sea Area Programme (RSAP) began, a project designed to a) improve local food and security and b) to improve the natural ecological base in order to create sustainable production systems (Manger *et al* 1996, p.9). It was based in the area of the eastern Sudan occupied by the Hadendowa of the Beja, a Bedouin group of pastoral-cultivators who had been hit very badly by the 1984-85 drought and had lost both human lives and herds. The project also had a broader goal, which was to develop improved research techniques for use on future applied projects. The emphasis on gathering data before any attempts to apply solutions to the problems experience in the area was an important one. Their two main focal points were natural and social aspects of Hadendowa life, as these were seen as central to the future sustainability of the groups that made up the Hadendowa. The Hadendowa are part of the Beja, which consists of a number of groups. The Hadendowa are based to the south of Port Sudan from Sinkat to the Gash Delta (Manger 1996d, p.19).

In 1996 the RESAP team produced a book detailing much of their research: *Survival on Meagre Resources. Hadendowa Pastoralism in the Red Sea Hills*. The RESAP team carried out research at the landscape level, covering three climatic types along an east-west axis. Because of the size of the area involved the publication includes many generalizations about Hadendowa behaviour which vary from one group to another. However, the generalizations are based on research into commonalities and are useful for understanding how the Hadendowa managed livelihoods both in their home areas and over larger distances.

Although there are other publications that provide details of the Hadendowa, this case study only uses this one publication (Manger *et al* 1996), as this was not intended as an analysis of the Hadendowa but an early test of the SRL Model. The full case study was worked through in some detail but has been excluded from the main text of the thesis due to the volume of the output, but a bullet-pointed version is included in this appendix.

H.2 The Livelihood Status

H.2.1 Asset Matrix

Natural Assets

Topography of Hadendowa territory

- The coastal plain
- Red Sea Hills west of coastal plain

- Plains west of the mountains in four key areas: Hadarbab, Gebeit al Ashraf, Summit and Odrus.

Hydrology

- The area is estimated to receive less than 200mm of rain annually, which puts it into the arid category of climatic areas.
 - Highly variable
 - 2 season precipitation regime, summer and winter across the territory
- Climatic variation on an east-west axis, with three different types of climate represented across the topographical range.
 - The Red Sea coastal plain has limited winter rain and depends on surface run-off from Red Sea Hills.
 - The Red Sea Hills receive more winter rain than the coastal plain.
 - The western plains have a drier climate and only receive rain during the summer months.
- Tokar and Gash rivers
- Unlike the Western Desert it is provided with only very minimal water from aquifers, has low groundwater retention and, apart from the Tokar and Gash rivers, the most productive source of water are the seasonal khors (systems of dry river beds)

Temperature

- From highest mean temperature on plains south of Red Sea Hills 32°C to Erkowit in Red Sea Hills 22°C.
- Hottest months June and July

Edaphic Conditions

- In the Red Sea Hills, aeolian silt, sand and gravel, generally poor fertility
- In khors and wadi beds alluvial soils, which are often fertile, mixed of organic and inorganic detritus
- In river floodplains fertile silts
- In coastal area silt, sand and gravel, saline and of poor fertility

Vegetation

- Wide variety of plant taxa are present in different areas. Arid-adapted vegetation dominates, but varies across the three topographical areas.
 - Along the coastal plain salt-marsh vegetation dominates, with saline-resistant species thriving.
 - In the Red Sea Hills open woodlands, annuals and ephemerals (herbs and grasses) dominate.
 - In the plains and valleys bushes, trees, ephemerals and annuals thrive that are typical of Sahel-type environments.

- In all areas trees under threat from cutting for wood-fuel and charcoal following the 1980s drought

Fauna

- Wild animals are not mentioned – hunting is not practiced.
- Domesticated animals must be drought tolerant and carefully managed to preserve the environment
 - Goats, which browse and graze
 - Camels, which browse
 - Cattle, which graze

Stone, minerals and ores

- Pre-Cambrian Basement Complex rocks
- Volcanic rocks

Physical Assets

Shelter

- Ephemeral campsites formed of structures made of woven goat hair over wooden structures
 - Tents, the domain of women. Each wife has her own tent
 - Shuffat, the domain of men and visitors

Raw material acquisition

Not specified – would need investigating

Food acquisition and production technologies

Not specified – would need investigating

Craft skills

- Basketry and matting
- Pottery
- Charcoal manufacture

Structures

None, apart from the ephemeral camps mentioned above

Food storage systems

Not specified – would need investigating

Transport

Pack animals

Fuel

- Wood
- Animal dung

Social Assets

Status, roles and social organization

- Patrilineal lineage is of key importance and association with particular tribes and groups helps to confirm territorial rights.
- The main units amongst the Beja are *adat* (maximal lineage), *duwab* (sub-lineages) and *dua* (camp cluster).
- Social organization is egalitarian but there are co-operative leadership roles for administration, justice, and land tenure disputes.
 - Political and military administration is organized by tribal leaders (*weileliab*)
 - Ordinary justice administered by courts (*mejlis*) based on traditional (*urf*) and Islamic law (*shari'a*)
 - Can be escalated to the *galad* (council) of tribal leaders, wise men and *neetural* members outside lineage
 - Religious rulings a mixture administered by *shidobinab*.
- A household usually consists of a man, wife and unmarried children and is the basic productive unit, responsible for the management and distribution of resources amongst family members. Marriage partners are usually selected from close relatives.
- A strict male/female dichotomy always observed.
 - Men herd camel, sheep and goat and milk the herds as well as cultivating crops.
 - Women are confined to the domestic realm.
 - Women live in tents with their families, whereas men congregate in communal dwellings where visitors also stay.

Ideology and Religion

- Islamic with traditional elements
- Important concepts of honour embedded into economic and social life

Rites of passage

- Boys and girls are given livestock by their father on important occasions in their lives.
- When a couple marries the animals are taken from the father's herd and becomes the responsibility of the new husband.
- Male and female circumcision

Tradition and social values

- Primary tradition of importance is a concept called *salif* which is a continuity of tradition, centred on honour, handed down from the ancestors.
 - Honour governs the management of land and resources.
 - Protection of tribal heritage
 - Protection of weak within tribe
 - Incorporates the need to be generous and hospitable
 - Both a collective and individual responsibility
 - Two conceptual systems
 - Badaweit, full membership of Hadendowa honour system based on traditional livelihoods
 - Balaweit, life away from Hadendowa territory, primarily in urban contexts, where different values adopted and the honour system is not maintained. Within Hadendowa closely linked to concept of ayb, shame

Management of resources

- Trees are culturally and legally protected.
 - However, after the 1983/84 drought the cutting of trees for charcoal production and sale to the urban sector increased dramatically:

Mobility

- Traditional mobility with livestock
 - Important for exchange of information within tribe
 - Involves meeting people from other tribes and lineage groups
- Modern mobility between traditional livelihood zones and urban areas for wage work, often placing tension on relationships between those who stay, and those who move between the two livelihood systems.

Intra-group relationships of support

- Livestock form the core means of offering support to tribe members who have suffered loss of livestock
 - Dangit, where a man borrows animals and uses only milk and returns animal where crisis is over
 - Tait, where an animal is transferred to a new owner, creating a new bond between the persons involved

Inter-tribe relationships

- Confined mainly to aggregation areas where groups from many different areas converge to take advantage of seasonal resources
- Tribes can have rights to land in other areas, meaning that there are often tensions over land ownership

Subsistence Assets

Data for subsistence activities

Food Production

- The character of the Eastern Desert has become unpredictable in the last few decades, with drought periods, of which the worst was in the early 1980s.
- There are two main productive resources in the Hadendowa system:
 - Livestock (goat, sheep and camels and in some rare cases cattle)
 - Livestock used as a source of milk, butter, cash and also part of a system of social reproduction because used as bride-wealth, and for compensation in instances of crime.
 - Land (for small scale cultivation and grazing).
 - New opportunities in Port Sudan and Sinkat for wage labour in local industry both during drought and as the demand for newly available goods (e.g. sugar, cloth, coffee) grows.
 - Sale of charcoal to Port Sudan industry is another form of income, but one which is undermining the local ecology.
 - Famine relief aid also enables the Beja to make purchases of essential items during drought periods.

Practice of subsistence activities

- Animal husbandry is a year-round responsibility and carries with it an ongoing need for labour.
 - Movement is required in order to utilize grazing/browsing all year.
- In all areas during the rainy season cultivation is possible on wadi banks and in the wadi bottoms following floods, some plains, and there is a “bund” system to retain water run-off, using branches and sand. Each area has its own particular subsistence strategies.
 - Hadarbab: Plains transacted by five big khors, rich for pastoral and cultivation lifestyles, not much need to move, so when movements of herds in December and June others stayed in the area. Grazing and browsing and rainy season cultivation; June cultivation; December move to winter grazing on coast or to khors.
 - Gebeit al Ashraf transhumance with two movements, in the winter and summer, where rights to land held for both livestock and cultivation activities
 - Summit Agro-pastoral and railway work, the latter meaning it was much less vulnerable when the droughts hit.
 - Odrus grazing and browsing and June cultivation took place during the rainy season, whilst in December there was move to winter grazing on coast or in khors.

The potential for and indications of wage and trade networks

- Local goods markets
- Government cultivation schemes

- Wage labour opportunities in towns

Labour

- Division of labour between economic (men) and domestic (female) realms
- Adult males responsible for camels, teaching young males and livestock milking and sales
- Males under 20 years of age assist with herding and cultivation and milk livestock
- The elderly tend young animals within half a kilometre of tents
- Share-cropping arrangements frequent
- Co-operative labour system when required
 - Agriculture
 - Livestock
- Problems experienced recently
 - Loss of some men to urban centres
 - Retain rights in Hadendowa territory

Information

- Essential to Hadendowa life, formalized in “sakanab” greetings
 - Rainfall and pasture availability
 - Market prices
 - Availability of work in urban centres
 - Activities of other tribes

Mobility

- Transhumant movement between areas is increasingly important, although a wholly migratory lifestyle was pursued in the past.
 - These traditional occupations are now supplemented by activities both outside the region and outside their traditional livelihood in the industrialized zone of Port Sudan,

Land Tenure

- Rights to cultivable land determined by ancestry, membership of a group by descent and by marriage
- Amongst the Hadendowa land is inherited or fought for and is imbued with concepts of honour and heritage.
- Only lineage members can obtain water rights and the right to build a permanent residence
- Non-lineage members can obtain access for grazing but are not allowed to make permanent structures. This allows demonstrations of generosity. Land clearance (removal of trees) may only be done with the agreement of the entire lineage group (*duwab*), irrespective of who holds the original right to the land.
 - If deemed as detrimental to livestock activities then land clearance may be refused, especially where large number of trees are under threat.

- Conflicts over rights of tenure are frequent and must be resolved by claimant's tribal representatives.
 - Disputes over land are carefully managed, with a tribal council taking part and a way of escalating to higher authority.

Human Assets

Potential nutrition

- Staple food is dhura porridge accompanied by milk
- Meat only consumed on death of an animal or on special occasions

Evidence of physical condition

- Decreased mortality and improved standards of health
 - Due to better health care provision, reduced warfare and increasing sedentism.

Skills and knowledge

- Knowledge and skills communicated from father to son and mother to daughter
- Formal education only introduced since droughts in 1980s, and only available to a few

Demographics

- **Population:** Although there were censuses taken in 1956, 1973 and 1983 demographic information remains poorly understood due to changing district and provincial boundaries.
 - District thinly populated with overall density 8.4 person per sq km in 1983 increased to 9.7 person in 1989
 - Better health
 - No ability to slough off excess members to new areas due to expansion of urbanism and inability to open up new territories
- **Gene pool:** The Hadendowa prefer to marry close family members.
- **Gender/age mix:** Although there is a good balance between men and women, there is an increasing tendency for the younger generation to seek work outside the traditional livelihood system, seeking work in urban areas
 - Between 1955 and 1983 the urban population of the Red Sea area has decreased from 53 to 25%

Personal Assets

Individual status

- Although there is no hierarchy within Hadendowa tribes, various positions are available to male members in order to participate in and contribute to Hadendowa life.

- Outside traditional Hadendowa life there are many more opportunities due to the availability of agricultural schemes and urban wage employment
- Although women traditionally have no status, recently the departure of male family members to urban areas has led them to head households, manage livestock and sell produce at truck-stops.

Security

- Since colonial rule in the 19th Century, war has been largely outlawed, although occasional disputes over land may become violent.
- Economic security is in decline, partly due to environmental deterioration and partly due to the departure of younger males into urban wage trades

Ability to influence decisions

- Decision making is an ongoing feature of Hadendowa life, and for men there are options for men to hold positions where they can contribute to individual decisions that support Hadendowa values, honour and ideas of justice.

H.3 The Livelihood Variables

Vulnerability Context

- Increasing aridification and unreliable rainfall
 - Droughts of the early 1980s, which caused serious difficulties for the Hadendowa, and this has been used here as a useful demonstration of the vulnerability context confronting the Hadendowa. The RESAP study identified three phases of disaster response during drought:
 - Phase 1
 - Male animals and unproductive females sold
 - Buy food
 - Reduce fodder requirement
 - Look for ways to diversity income
 - Use of unfavoured wild plants
 - Migration begins, with some family and most possessions left behind
 - Phase 2
 - Female animals sold, putting herd in jeopardy
 - Essential tools and possessions sold
 - Money and goods borrowed from outside kin
 - Increasing dependence on charity
 - Phase 3

- Mass migration to towns and relief camps
 - Nothing left behind
 - Tribe members becoming beggars and destitutes
 - Human and animal deaths
 - International aid agencies stepped in with short term relief and longer term support
- Regional differences in response to disaster can be observed in the region occupied by the Hadendowa depending on opportunities available:
 - Hadarbab
 - Droughts hit them severely
 - Lost most of livestock
 - Turned to charcoal production for Port Sudan, at the cost of the environment.
 - Gebeit al Ashraf
 - Drought was combated by linkages with relatives and tribal links with relatives in Sinkat (modern industrial) where men were employed as middle-men
 - Summit
 - Agro-pastoral and railway work
 - Much less vulnerable due to low dependency on livestock
 - Odrus
 - Wide plain with khors for pasture and cultivation
 - But drought has meant reduced livestock and most families don't do the seasonal movements, so plains are under increased pressure
 - Increase in charcoal production, threatening biomass

Opportunity

- Agricultural schemes managed by the government in the southern Hadendowa territories
- Expansion of urban centres, particularly Port Sudan, connected to other commercial areas by rail and tarmac road
 - Male migration
 - New middle-man roles for the young outside the traditional system
 - Wage labour for Hadendowa
 - Increasing independence for women who now head households, tend livestock and sell craftwork at roadsides
 - Sale to urban centres of wood fuel and charcoal
- International aid agencies and NGOs
 - Emergence of new elite with greatly improved strategic position within communities
 - Positions as interpreters and administrators

External Structures and Processes

- International aid agencies and NGOs
 - Short term provision of food to counter impacts of drought
 - Increase of social services, including health and education
 - New work opportunities for young Hadendowa males
- Urban development and connection to road and rail networks
 - Reduction of territory for traditional activities
 - Degradation of natural resources
 - Departure of young males for wage labour
 - Breakdown of traditions
 - Stress on Hadendowa economy
 - Changes in roles of women
 - Imposition of national and regional market trends on local markets
 - Excessive drainage of sub-surface acquirers, depriving rural population of essential resources
 - Heavy demand on biomass for building materials (e.g. dom palm for roofing and any trees for fuel)

H.4 The Livelihood Outcomes

Environmental Impact

- Destruction of trees for wood-fuel and charcoal sales into urban centres has destabilized the environment, reducing browsing options and altering biomass so that pasture is also under threat, confining browsing and pasture to wadis and khors
- Centralized social services improved longevity,
 - Increased population
 - Encouraged sedentism
 - Dry season pasture now occupied on a year-round basis, causing harmful change of biomass and reduction of trees

Economic Impact

- Declining condition of environment
 - Increased economic dependence on government and NGO schemes
 - Increasing dependence on urban work
 - Increasing sedentism
- Increasing urban spread reducing land available for livestock herding and cultivation of dhura
- Fluctuating prices in national and regional markets make it difficult for Hadendowa to forecast whether they will be able to sell livestock and other products at a reasonable price to enable them to purchase grain and optional consumer products

Social Impact

- The demolition of trees in defiance of social and cultural sanctions has undermined traditional laws, values and all-importance concepts of honour
- Appearance of NGOs and aid agencies, as well as government sponsored agricultural schemes has changed the balance of leadership of the Hadendowa
- Centralized social services improved longevity, increased population and encouraged sedentism
- Perception of Hadendowa as increasingly out of touch with modern times, leading to their marginalization

The radar diagram below (figure H.1) is a graphical representation of the current state of the Hadendowa as a whole. A more precise way of understanding the Hadendowa would be to take them geographically and look at how each duwab (sub-section of the tribe) is coping, but that is out of the scope of the thesis. What the radar diagram indicates is that the Hadendowa are strong in Personal and Physical asset categories for opposing reasons. The Hadendowa livelihood strategy requires very little investment in physical infrastructure, so it is easy to maintain. The Personal category reflects new opportunities in urban centres and agricultural schemes, many of which will undermine the Hadendowa way of life, but will enable men to support their families and may give women more autonomy. Subsistence strategies were still sustainable in the 1990s, but were increasingly undermined by the expansion of urban centres, the undermining of the environment and the growth of population. Human assets are fairly good, but as a result of outside intervention in health and education. Natural resources are increasingly vulnerable, undermining every aspect of Hadendowa life, and placing their much valued Social assets under serious threat.

Asset Category Strengths and Weaknesses

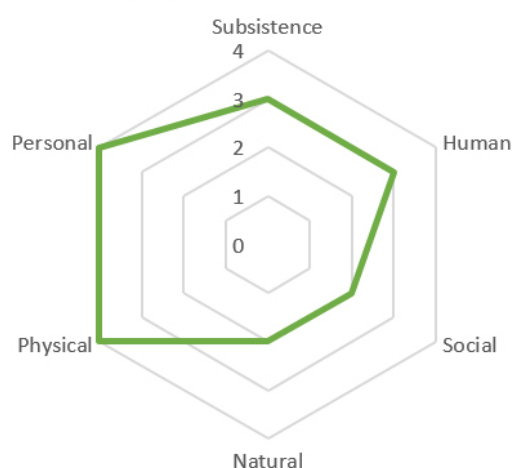


Figure H.1 – Radar diagram for the Hadendowa in 1996

H.5 Top Level Conclusions

The role of this initial test study was to see if the SRL Model could be applied successfully to a modern ethnographic example. The purposes were two-fold: 1) to see how the data conformed when being fitted into a model, and 2) to look for problems with the application of the model to archaeological data.

- 1) The model worked well with the data, even though there were gaps in the published survey. These could have been filled by using other sources, but it was sufficient to identify the gaps and decide upon how they could be filled. The emphasis in the RESAP survey on the Hadendowa as a series of continuities and traditions that were also always in a state of flux allowed external influences and outcomes to be isolated and highlighted.
- 2) It was obvious that certain aspects of modern livelihood management amongst pastoralists, like lineage organization, land tenure arrangements and religious beliefs, might be difficult if not impossible to recover archaeologically. The need to explore archaeological analogues for some of the economic and social structures that might have been employed in present and past was identified as a priority in the thesis.

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Please note that where last names begin de, der, di, van, von etc, these are listed under the following name proper. e.g. the name “di Lernia” is listed under L and “de Finetti” is listed under F.

The bibliography includes references for the four case studies as well as the main thesis.

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