Strategic work between agencies in the planning system for sustainable flood management: The Case of Oman

By

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البداية " بسم الله الرحمن الرحيم"

Initially the" name of Allah the Merciful"

DEDICATION

This thesis is dedicated to my beloved wife Hanan Al-Jabri, my daughters Shahad and Fajr, my son Amer, my father Suleiman and my mother Sulyma.

Abstract

The history of Oman's planning system has passed through many different stages, each requiring developers to enact different procedures. Current planning strategies and developments reflect present day concerns that new developments should be modernised to incorporate contemporary processes. Rapid urban development in the Sultanate has resulted in many policy overlaps, in relation to economic development and urbanisation. Oman has recently suffered from a recurrence of floods in successive years. After the two incidents, Guno and Phet, it became evident that it is necessary to create a planning system that can offer effective management of both water and city planning. It is also essential to create a sustainable flood management approach to preserve greater amounts of water while also controlling water flow.

This thesis will focus on improvements to flood management and city planning systems, to protect the population of Oman from risk during flooding events. The research undertaken for this thesis combined quantitative and qualitative methods. These included 34 interviews with planners, experts, middle-aged/elderly people and specialists in both water management and meteorology, and 392 questionnaires to other stakeholders. The results show poor co-ordination between the different parties, and limited cooperation between administrators and planners within the government, leading to carelessness with regard to changing land uses and the 'individual' in decision-making. Furthermore, the acceleration in plot extensions for development and the creation of the new development plots on floodplains exacerbated flooding. There is evidence that the drainage system is very poor throughout most of Oman. The Muscat Municipality and the Haya Company have made some effort in some areas of Muscat; however, these efforts concentrate only on commercial and domestic wastewater. There is no clear strategy, however, for rainwater drainage, except along roads and related culvert systems. In addition, despite their potential benefits, some culvert systems, such as those in Al-Hail, create a major problem for flooding because of their location.

The majority of the interviewees stated that they hoped the Supreme Council for Planning would resolve such issues, but others claimed that they were still unclear about whether the council was a supervisory, economic or planning body. To achieve sustainable flood management in Oman, and to address those phenomena that will

negatively affect the Oman's cities if flooding occurs requires considerable effort, partnership and co-ordination between different agencies and members of the community. It is also important to involve the water resources agencies in any planning procedures to limit conflicts between water projects and planning projects.

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Glossary of Abbreviations

Defra	: Department for Environment Flood and Rural Affairs
EI	: Educational Institutions
Falaj	: Traditional irrigation system
GCC	: Gulf Cooperation Council
IPCC	: Intergovernmental Panel on Climate Change
KSA	: Saudi Arabia
MA	: Ministry of Agriculture
NCRM	: National Committee for Risk Management
MD	: Ministry of Defence
MECA	: Ministry of the Environment and Climate Affairs
MF	: Ministry of Finance
MH	: Ministry of Health
MOH	: Ministry of Housing
MM	: Muscat Municipality
MRMWR	: Ministry of Regional Municipalities and Water Resources
MTC	: Ministry of Transport and Communications
MTI	: Ministry of Trade and Industry
NCCD	: The National Commission for Civil Defence
NCD	: National Committee for Disaster
NFCDD	: National Flood and Coastal Defence Database
PAEW	: Public Authority for Electricity and Water
ROP	: Royal Oman Police
Sabkhas	: Natural lands near the sea mixed between water, sand and salt
Sheikhs	: The person who represents the tribe or tribes
SCP	: The Supreme Council for Planning
Sharja	: Very small wadi
SH	: Shura Members (A representatives of citizen)
Subdivision plans	: Method used in Oman to divide land into smaller plots for different uses
Wadi	: Dry river beds, which flow following rainfall and flooding

Chapter 1

Thesis introduction

1.1. Introduction

This chapter describes the background, problem and justification for the research, the research aims and objectives, the chapters of the thesis, and the thesis structure. The purpose of this chapter is to clarify the aims of the thesis and explain its contribution to current understanding of the impact of flooding and the future solutions for flood management in Oman.

1.2. Background

Flooding is a natural disaster and a huge threat to human settlements worldwide (Lamond et al., 2010). It can endanger human life, demolish vital infrastructure, and damage urban and regional investments (UN ISDR, 2004). Kafle et al. (undated) argue that *'one third of the total economic'* losses caused by natural disasters in the world are due to flooding events, and floods are '*responsible for two thirds of people affected'* by natural disasters worldwide. Turcotte et al. (1993) demonstrate that flood frequency, magnitude and effluence depends on variables, such as area of drainage, soil saturation, volume of rainwater, type and situation of catchment, type of soil, topography, and the extent of vegetation in the drainage area. NERC (1975) explains that floods are a serious climatic phenomenon with severe implications for humans, the economy, land and property (Diganta, 2009).

Flooding can be categorised into four types: river, coastal, flash and local flooding. All types of floods cause enormous damage. In the areas around the Arabian Sea, floods and cyclones are familiar occurrences. They generate torrential rainfall causing the sea level to rise, resulting in flooding in the region; notably in Oman, India and Pakistan. Tariq and Giesen (2011) report that around 230 people died in Punjab, and a casualty rate of approximately 60% occurred after flash flooding in

Pakistan in 2010. They further state that one cyclone per year is typical in the Arabian Sea. 75% of these cyclones affect Omani coastal waters, with the potential to cause significant levels of damage to coastal areas, as was the case with the Guno and Phet cyclones in 2007 and 2010 (Al-Barwani, 2009).

Oman is one of the Arab Gulf States, and is located in the south-eastern area of the Arabian Peninsula. Oman covers approximately 309,500km^2 (Al-Kindi, 2008) and has a long coastline of 3165km, extending from the Strait of Hormuz in the north, to the Yemeni border in the south (World Health Organization, 2010) see Figure 1.1. Oman's population was approximately 2,743,499 in 2007, 29.9% of whom were non-Omani. Around half of the Omani population are below the age of twenty, and 3.7% are aged sixty and over (World Health Organization, 2010). The country has eleven administrative regions, known as governorates, and sixty wilayates. Approximately 71.5% of the Omani population lives in urban areas, with half located in the Muscat and Albatinah governorates, which are situated between the Arab Sea and the Gulf of Oman (World Health Organization, 2010). The Omani economy is dependent on oil resources.

Figure 1.1: Oman Map

Source: http://www.namnewsnetwork.org/v3/country.php?nn=ODE

Muscat has been the official capital of the Sultanate of Oman since 1970, but has been the capital of Oman for more than 400 hundred years. At one time, the name of the country was Muscat. Since 1970, Muscat has been the seat of government and the site of the country’s Ministries and commercial interests. It is located north of the Tropic of Cancer ‘at 24°00N 57°00E / 24°N 57°E / 24; 57’ and is a port city in the north-east of Oman.

The Sultanate of Oman has had to contend with damage to its infrastructure, poor planning leading to loss of life and property during devastating floods. In the last eight years in Oman, two enormous cyclones have caused huge damage to the country: Guno in 2007 was the biggest flood event since 1890, resulting in forty-nine deaths, with an estimated financial loss of around $4 billion (Al-Barwani, 2009). The most recent cyclone, Phet, struck in May 2010, causing slightly less damage, although six people died and the financial losses totalled $2 billion (Global Voices, 2010; Al-Barwani, 2009). According to Al-Hattali et al. (2008), the flooding in 2007 caused substantial damage to infrastructure, people, databases, properties and land, especially in the capital Muscat and other cities, such as Sur and Masera Island, with effects felt in most of Oman’s coastal cities.

Flooding in Oman has been reported in recent years, with recorded incidents in 1974, 1981, 1987, 1990, 1997, 2003, and 2007 (Al-Barwani, 2009), continuing into 2010, 2011, 2012 and April 2014 (Global Voices, 2010; REUTERS, 2011; Oman Daily Observer, Oman TV, 2012). These floods have occurred in different regions, and more than 175mm of rain was recorded in some regions during the meteorological depression in 2012 (Oman TV, 2012). An announcement by the Royal Omani Police stated that three people died and others required evacuation because of this disaster, which also destroyed numerous properties (Oman TV, 2012). The Omani government has taken action to protect its people and their property from flood hazards, by offering diverse forms of practical help, such as organising flood alerts and evacuation through the National Commission for Civil Defence (NCCD) and by implementing new planning strategies (Inceruh, 2009; Al-Barwani, 2009). Some areas of planning and water management emerged as needing more attention in the aftermath of flood events; such as coordination between different parties and the future integration of planning systems and water management (Al-Farsi and Kaumi, 2007; see Chapter 3). Organising flood alerts and arranging the relocation of residents from floodplains during periods of rising water levels are further measures designed to protect the population from this threat.

Urban floods in Muscat have had a significant impact, frequently causing pollution hazards and threats to human health. Disruption to transport and essential services is another common consequence of inundation in the area. In addition, the built environment was one of the sectors badly affected in 2007 and 2010. Damage occurred to plots and houses, making it necessary to compensate residents (Al-Badi et al., 2009). This created further problems for the MOH, as in Muscat there is a lack of open land available to relocate the resident population. Al-Farsi and Kaumi (2007) argue that some homes and buildings flooded because they lie adjacent to either the sea or wadis. Certainly, those buildings and plots built on the floodplains suffered damage that was more extensive; for example, those in Al-Hail (see Figure 8.3). In addition, during cyclones and storms, heavy rain creates rivers of water that run from the mountains and higher areas into the wadis (Al-Barwani, 2009). Although these riverbeds run directly to the sea, the volume of water generated by the cyclone events meant that the land flooded before it reached the sea. As a result, many people, animals, properties, and the natural environment suffered.

The combined dangers and disruptions caused by flooding have prompted huge concerns among the majority of Omani stakeholders, including members of the public and the government. Repeated flooding presents a challenge for the Omani government, requiring that it review former strategies and planning policies to assist its citizens and protect their property in the event of further inundations (Al-Barwani, 2009). By employing innovative strategies and integrating a range of approaches, the government is aiming to effect change to decrease the impact of floods. It is also looking to improve the management of flood risk. One of the most significant factors in protecting people, property and land from flood hazard is urbanisation control, especially in the floodplain areas. People, the environment, property and land are the main elements requiring protection worldwide (Howe et al., 2004; Cloke et al., 2009).

In Oman, the development of flood forecasting systems to provide a more accurate estimate of rainfall volume and timing would help reduce the distress caused by flooding (Cloke et al., 2009). Moreover, analysis, both regionally and nationally, of the flood risk scale, should be at the core of any discussion and data collection to assist in flood management decision-making. Furthermore, social participation and cooperation are also important (WHO, 2002). These factors can help address society's anxieties and facilitate the implementation of flood management strategies, including the development of sustainable infrastructures, the identification of locations for growth areas, the protection of vegetation, and the renewal of sewer systems. Moreover, understanding the causes and intrinsic factors associated with flood occurrence would contribute to reducing the negative effects of modern living on the earth's atmosphere, for example with regard to greenhouse gases (GHGs) (Hale, 2005).

GHG emissions require a solution, as they have a negative environmental impact, resulting in rises in temperature and water levels that will trigger an increasing number of natural disasters (IPCC, 2007). Kay et al. (2005) state that many areas around the world are likely to witness an increase in the magnitude of flooding over the next few years due to climate change (see Chapter 3). On the other hand, Hall et al. (2003) argue that the effect of flooding on floodplain inhabitants, as well as the development of public and private infrastructure might further increase environmental pollution. Mansell (1997) illustrates how the increase in rainfall trends could escalate the amount of run-off, resulting in engorged rivers, whereas an increase in temperature is likely to escalate water evaporation in catchment areas, consequently decreasing the opportunity for run-off, which may help to minimise river flooding (see Chapter 3).

Oman can learn from other countries that have suffered similar flooding phenomenon, particularly in terms of watercourse and disaster management. Reviewing flood management systems elsewhere, McMinn et al. (2010) explain that many European states (e.g. Northern Ireland) still face significant challenges, as they are required to implement the EU 2007 Flood Directive, which details strategies relating to flood protection and drainage infrastructure. These strategies target improving flood management, flood protection, and drainage infrastructure. McMinn et al. (2010) state that the use of traditional engineering as a solution for flood management can be applied in urban and rural areas and is often used in European countries. Furthermore, Tariq and Giesen (2011) maintain that flood protection pools are popular for protecting towns and villages, as well as for controlling irrigation systems in Pakistan during flooding (see Chapter 4).

White (2010) demonstrates that historically the protection of cities from flooding has passed through many stages; from early engineering approaches, such as dykes and dams in the Netherlands, to modern scientific models, such as the Thames Barrier in the UK. Pottier et al. (2005) argue that flood management should aim to maximise the performance of different types of rivers catchments, rather than concentrating solely on water loss into the sea. This would allow the development of land even on floodplains, albeit with zoning management, as demonstrated by the French planning experiences of flood management since the 19th century (Pottier et al., 2005). In contrast, England and Wales employ an approach to controlling floodplains based on a land use strategy. Pottier et al. (2005) suggest there is no clear policy informing the design of flood risk zones in England and Wales, whereas in France, a zoning map shows both development areas and flood risk areas. The Flood Risk Management (Scotland) Act 2009, on the other hand, employs the specialist knowledge and expertise required through the collective work of different authorities, implemented under the supervision of Scottish ministers. The Scottish government, because of the new Act, has distributed flood management to government agencies and corporate partners, to ensure that the new Act is able to protect land, properties and human health from flood risk. These organisations are the Scottish Environment Protection Agency (SEPA), Scottish Water, Local Authorities and flood management Groups. Chapter 4 provides more details of the flood management experiences in different countries.

Undoubtedly, understanding the experiences of others could contribute to the creation of a comprehensive approach to Omani flood management in the future, which in turn will have the potential to benefit the Omani planning system and reduce the impact of flooding. Therefore, the literature review for this research (see

Chapters 3, 4, and 5) takes into account four main areas (planning system, partnerships, reducing damage, and flood risk). Chapter 4 will also explore these themes in relation to the experiences of other countries.

Evidence from other countries shows that partnership strategies could counteract the limitations inherent in the decisions taken by individual agencies to create a consensus based on different perspectives (Forchner, 2006). Such strategies serve the community in the form of land use and planning systems based on the relationship between stakeholders. According to Carley (2006), partnerships between stakeholders was the principal tool used in Scotland during the 1990s; this approach continues to be a key strategy in rural regeneration (Carley, 2006; Edwards et al., 2000). This partnership approach is clearly stated in the Flood Risk Management (Scotland) Act 2009, which brings together different stakeholders to implement legislation. The objective criteria for partnership work and co-operation between stakeholders contributes significantly to their success (Brinkerhoff, 2002; Baeten, 2001; Davey, 1998). The range of skills and areas of expertise are essential to sustainable co-operation between partner organisations (Albrechts et al., 2001; Kitchen, 2007) (see Chapter 4 for more details about partnership strategies).

1.3. Problem and Justification

At present, the Omani planning system is facing numerous challenges, ranging from deficiencies relating to effective participation and governance to the shortfall in communication between the different agencies responsible for flood management (Al-Farsi and Kaumi, 2007). These include planning bodies such as the MOH, water management bodies like the Ministry of Regional Municipality and public bodies like the Shura Council (Al-Farsi and Kaumi, 2007; Al-Shueili, 2011). To date, many of the problems that have arisen (such as poor coordination) are attributable to planning mistakes. This is the case with regard to identifying suitable areas for new development and the re-planning of old developments (Al-Farsi and Kaumi, 2007).

Alwati (2011) discusses the adverse impact of administrative authorities rather than city planners, taking on the role of decision-makers. He mentioned that not adhering to planning regulation rules, such as a preference for administrative rather than technical suggestions, is likely to result in challenges for the MOH. These can include issues such as overlaps when altering land use, for instance from leisure purposes, such as parks and playgrounds, to residential and investment uses; this was the case in Boucher in Muscat. Additional problems include permitting the creation of new plots and the extension of old ones into wadi and flood plain areas, for example those created in Al-Sharadi and Al-Hail in the wadi zone.

The lack of public participation and the failure to anticipate potential problems may indicate additional areas are associated with flooding. Thus, establishing a new approach to protecting new settlements and developments from flooding is a key area of research that should improve planning methods. According to research undertaken into the planning of new cities, there is considerable controversy surrounding the regulations that define the uses and development of floodplain areas, and consequently many problems have arisen (Woltjer and AL 2007; Nuvel and Knaap 2010).

However, the Omani situation may differ slightly, since the lack of local participation and the problems mentioned above might reflect additional issues; such as might occur in locations where subdivision plans overlap previously owned lands. In addition, problems could relate to a lack of sufficient expertise amongst planners, in terms of ability to determine the various possible contingencies to put in place to serve the community and protect it from natural hazards. This problem may also originate from the residents themselves requiring specific areas in which to create new plots and extensions; ultimately, however, the decision must lie with planners.

The main problem encountered by Omani town planners relates to servicing the requirements of society, with site-specific demands in areas that are subject to hazards such as flooding. Problems are clearly associated in part with former subdivision plans and extensions to wadis and developments in the floodplain areas. This has led to a huge number of claims for compensation for plots and represents a major difficulty for the planning system. However, as referred to in Chapter 5, the current Omani planning system has only been in place since 1970. As a result, some subdivision plans are not available, and some incorporate undeveloped empty spaces. For these cases, the regulation of subdivisions remains a possibility to protect future residents from predicted flooding and to prevent flood damage to other dwellings.

Since this topic has not been previously researched, all researchers in this field are in a position to impact positively on planning for new cities by taking into account the factors aggravating Omani contemporary planning. Research into wider planning issues may therefore also improve planning for new cities in terms of land use management, to determine regulations concerning the passage of water. Narrowing the thesis to a particular objective within the Omani planning system is not easy, due to the complicated overlap between city planning and the water projects commissioned by agencies operating independently; such as, for instance, the Ministry of Housing (MOH) and the Ministry of Regional Municipality. Individual efforts related to matters involving plot planning and water-related planning affect each other. However, issues such as water management, drainage systems and the mitigation of factors contributing to climate change could be key elements for determining the success of flood management.

This thesis asks ‘How can the planning system in Oman enhance partnership working to reduce the damage from flood risk?’ It will focus principally on specific topics such as the planning system in Oman, partnership working, damage limitation, and flood risk. The consolidation of efforts between the planning department and other bodies associated with regulatory matters relating to inundations will determine future protection. The intention is to identify a method to implement contemporary legislation within the planning system that allows the efforts of different parties to be coordinated, to reduce the effect of flooding events in Oman (see Chapters 6, 7, 8 and 9).

1.4. Research Aims and Objectives

Main Aim of the thesis: To determine how the planning system in Oman can be enhanced through a partnership formed to reduce the damage from flood risk.

Key Objectives:

- To examine the effectiveness of the Omani planning system to cope with flooding;
- To understand the relationship between climate change and the incidence of flooding;
- To examine the relationship between spatial planning and water management;
- To understand the extent to which partnership effects flood management strategies;
- To investigate the co-operation and partnerships between stakeholders and their physical impact on flood management, as well as failings in the strategic and planning system as a whole;
- To understand the current flood management system in Oman and to suggest improvements to the planning system to support people and protect them and their property from flood damage;
- To make recommendations about how to improve the Omani planning system so that it can cope more effectively with flooding.

Since the researcher will be concentrating on three aspects (how, why, and who), the thesis will explore concepts of understanding, explanation and stakeholders. These connect positivism and interpretivisim, therefore, the author will combine qualitative and quantitative approaches in his fieldwork research. Linking science with nature through various interviews and questionnaires focusing on skills and experience can facilitate greater understanding of associated factors, such as the national planning systems that contribute to the occurrence of floods in Oman (see Chapter 2 on meteorology).

1.5. Thesis Chapters and Structure

This thesis is divided into nine chapters, comprised of one introductory chapter, one methodology chapter, three literature review chapters, three analysis chapters, and one concluding chapter, which provide a discussion, summary, and recommendations (see Table 1.1 for a detailed outline of the thesis structure). It addresses multiple themes related to flood management; including climate change, flood management planning, and scope for partnerships to manage flood events. Each of these themes will enable the researcher to evaluate flood management from a different perspective.

The literature review requires three chapters to clarify all the issues highlighted elsewhere in the thesis in relation to the Omani planning system and flood management practices. The first of these (Chapter 3) focuses on the causes of flooding in Oman, highlighting the relationship between flooding and climate change; emphasising the diverse environmental factors influencing flood occurrence. The second (Chapter 4) explores flood management strategies implemented in other countries, such as the Netherlands, by examining policies for city planning and partnership work, to provide sustainable flood management to protect cities from flooding. The third (Chapter 5) concentrates on the systems already in place in Oman, evaluating city planning and flood management strategies and plans to understand how the system works at present. Three main issues connect these three chapters and appear as themes in each: flood risk and cause, response levels and strategies for flood risk management, and potential future improvements in the domain of flood risk management. The information presented in all three chapters serves to illuminate the four main areas of interest mentioned in Section 1.3: the planning system in Oman, partnership working, damage limitation, and flood risk (see chapter 3 for more detailed information about the literature review chapters).

The methodology chapter is located at the beginning of the thesis (Chapter 2), prior to the literature review, to inform the reader of the research strategy and methods used. This arrangement ensures that the reader understands the data in the literature review fully within the context of the thesis. A brief summary of the content of each chapter follows.

Chapter 1 Thesis introduction: This chapter presents the background to the topic concerning flooding and its impact worldwide and in Oman in particular; it identifies the problem and provides justification for the research aims and objectives and thesis structure.

Chapter 2 Methodology: This chapter explores the research perspective, aims, philosophy, and strategy of the research, employing a mixed method combining qualitative and quantitative methods. In addition, it considers the techniques and methods used in this research for data collection and analysis.

Chapter 3 Profile of Oman and flood incidents: This chapter profiles Oman, in terms of political, economic and social aspects, explaining the current Omani planning system and associated challenges, plans and policy for Omani city planning, and predicted incidence of flooding in Oman. It also reviews research on climate change and flooding, which is a prerequisite to understanding the main causes of climate change, its extent and effect on flood events. In addition, it details global concerns about climate change in general and its impact on Asia and the Gulf States, and Oman in particular.

Chapter 4 Comparative Analysis of International Plans for Sustainable Flood Management: This chapter offers an exploration of different aspects of urban planning and water management, as components of good city design, and as suitable land use strategies to manage flooding. It presents the benefits and disadvantages of working in partnership and the effectiveness of such an arrangement in the context of the planning system. It also introduces some issues related to the integration of spatial planning and water management for sustainable flood management. Incidences of flooding in other countries, and their plans and strategies for flood management are reviewed, with the aim of improving the implementation of co-operative strategies by Omani flood management agencies.

Chapter 5 How Effective is Omani Flood Management?: Research into Omani flood management and current strategies should provide a wide range of information on current laws and regulations in Oman in the field of planning and emergency cases. The chapter states the position of the relevant authorities involved in responding to floods, addressing risks and coordinating their efforts during and after flood events, to protect people and their property from flood damage.

Chapter 6 Capability of Omani City planners to manage flood events: This chapter studies the current situation regarding city planning to understand the relationship between the planning department plans and their effectiveness in the ground. It explores the effectiveness of current urban planning authorities, in terms of the challenges faced by the system and the improvements necessary to manage flooding.

Chapter 7 Cooperation for the future of Omani flood management: This chapter studies the current situation regarding water management and drainage systems, to understand the relationship between their effectiveness and city planning management. It considers the co-operation between them to draw up a key strategy for sustainable flood management based on the views of interviewees and questionnaire participants, and presents comparisons with examples of good management, as identified in Chapter 4.

Chapter 8 Al-Hail Case Study: This chapter provides a case study of one of Oman's cities. The city was once a village, and it has grown naturally through a process of urbanisation. Both water management projects and city planning influence in the area have been detrimental to flood management, with the result that urban areas flooded in both 2007 and 2010.

Chapter 9 Discussion, conclusion and recommendations: This chapter elaborates the discussion, and submits a summary of recommendations to the Omani government for developing sustainable flood management systems to avoid harm to people and damage to property, as well as to maintain the infrastructure of the state.

Table 1.1, on the following page, presents the structure of the thesis in greater detail to give the reader a clear picture of the thesis' content, aims, and objectives, as well as of the key questions posed and the principles guiding the methodology, data collection and analysis strategies employed.

The four areas mentioned in Section 1.3 (the planning system in Oman, partnership working, damage limitation and flood risk), focus on current and future practices in Omani flood management. By examining each area, it will be possible to answer the main research aim and main research question through the medium of sub-questions and objectives, as shown in Table 1.1. When combined, these four areas provide a clear overview of the issues associated with flood management. By addressing the different themes mentioned and sub-questions in Table 1.1 below, the key research aims will be met. Both the sub-questions and key aims presented in the matrix below are integrated into the chapters that comprise the thesis, with the intention of providing a comprehensive understanding of flood management and related issues.

Table 1.1 below also explains how the researcher uses qualitative and quantitative methods to investigate the main themes in the thesis, using different techniques, such as interviews and questionnaires. The researcher evaluated the collected data using different techniques, including SPSS for questionnaire analysis, and both categorisation and interpretative techniques for interview analysis (for more details see Table 1.1).

Title: Strategic work between agencies in the planning system for sustainable flood management: The Case of Oman

Main Aim:
- To determine how the planning system in Oman can be enhanced through a partnership formed to reduce the damage from flood risk

Main Question:
- How can the planning system in Oman enhance partnership working to reduce the damage from flood risk?

Key Aims:
- To examine the effectiveness of the Omani planning system to cope with flooding
- To understand the relationship between climate change and the incidence of flooding
- To examine the relationship between spatial planning and water management
- To understand the extent to which partnership effects flood management strategy
- To investigate the co-operation and partnerships between the stakeholders and their physical effect on flood management, as well as failings in the strategic and planning system as a whole
- To understand the current flood management system in Oman and to suggest improvements to the planning system to support people and protect them and their property from flood damage
- To make recommendations about how to improve the Omani planning system so that it can cope more effectively with flooding
- Since the researcher will be concentrating on three aspects (how, why, and who), the thesis will explore concepts of understanding, explanation and stakeholders. This can connect positivism and interpretivisim; these philosophies can combine the qualitative and quantitative approaches used by the author in his fieldwork research. Linking science with nature through various interviews and questionnaires from skills and experience can facilitate greater understanding of factors such as the national planning systems that contribute to the occurrence of floods in Oman (see Chapter 2 on meteorology)

Hypothesis: The lack of coordination between different agencies in implementation of planning system can increase the damage from flood risk and this therefore could decrease the opportunity for successfully sustainable flood management.

Conceptual key themes:
- Climate change resulting in flooding
- Relationship between water management and spatial planning management
- Governance and partnership in planning
- Omani planning system and flooding
- Implementation of subdivision plans

Literature review chapters: (Chapter 3 to Chapter 5)
- Profile of Omani and flood incidents
- Comparative analysis of International Plans for Sustainable Flood Management
- How effective is Omani Flood Management?

Literature review sources: secondary data
- Internationally produced books, textbooks, journals, articles, Ministries' websites and conference papers.

Fieldwork chapters: (Chapter 6 to Chapter 8)
- Capability of Omani City planners to manage flood events
- Cooperation for the future of Omani flood management
- Al-Hail: Case Study

Fieldwork sources: Primary data (Quantitative &Qualitative methods)
- In-depth interviews (unstructured and semi-structured interviews): (face-to-face interviews-audiotape, and transcribe the interview) with specialist people and different cultures who have a power in decision-making
- Life-history interview: (face-to-face interviews- Al-Hail residents transcribe the interviews)
- Questionnaire: closed questions: different people from Omani society and Al-Hail residents
- Site visit: taking some pictures of reality for flood management from Al-Hail and other places showing the existing water and planning management as evidence for the research

Discussion, conclusion and recommendation:
- Literature review + Fieldwork: (secondary data & primary data)

Sub-questions:
- What is the relationship between climate change and incidence of flooding?
- How can the integration between spatial planning and water management improve the planning strategic work for sustainable flood management?
- How can the partnerships work to improve city planning to protect against flooding?
- How effective is Omani flood management?
- How effective is the planning system in Oman at coping with flood management?
- How effective is flood management in Oman at safeguarding people and property from flood risks?
- How can the planning system help improve the situation and reduce the effects of flooding in Al-Hail?

Methodology: Combination of quantitative and qualitative research

Methods:	Justifications:
➢ Literature review ➢ Interviews (Unstructured interview - Semi-structured) Case studies ➢ Life-history interview ➢ (Questionnaires)	➢ Contradictory planning system ➢ It is the first thesis in this field. ➢ Frequency of flood that affected the contemporary subdivision plans became very worrying matter for the planning system and community, thus required very effective way to protect these subdivisions from flood risk ➢ Poor coordination ➢ No clear strategy for planning in Oman ➢ No clear flood management in Oman ➢ Mistakes in projects implementation such as culverts

Analysis:
- Audiotape, and transcribe the interview
- (Univariate analysis) in this case make a possibility to use a frequency table and diagrams throughout SPSS
- (Ad hoc Analysis) in this case make a possibility to use a different approaches and techniques regarded to outcome of analysis, of both (categorization and interpretation)

Table 1.1: Structure of the thesis

Sources: Author

Chapter 2

Methodology

2.1. Introduction

The objective of this research is to investigate the current flood management system in Oman and to suggest improvements to the planning system to support people and protect them and their property from flood damage. This research therefore aims to provide sufficient information to achieve a better understanding of flood management in Oman in general, and Muscat in particular, to facilitate improvements to the planning system.

To evaluate the effectiveness of the planning system in Oman effectively, the use of public resources and contacts within communities, is essential to understand both their requirements and the main factors that can protect them from flooding risk. This approach was strongly supported by Clough and Nutbrown (2002, p.11) who stated that, “the need to research particular issues grows from the context in which the researcher operates, and what is an appropriate research question in one context often lacks relevance in the other”.

Accordingly, the success of this research is highly dependent on a review of aspects of planning and water management as described in Chapter 1. The sustainability aspects of city planning aim to address the risk of flooding and increase people’s confidence in flood protection. Creating flood management strategies and a good working partnership between the government and private sectors is important. Integrating water management and spatial management can create effective strategies to overcome any conflict between these areas.

These aspects also include:

- The reality of the Omani planning system operation;
- The effectiveness of the current city planning system in Oman;

- The contradiction between planning and reality; the Supreme Council for Planning and the development of the national comprehensive strategy;
- Illegal land holding and the public role in planning mistakes;
- The extent to which the Omani city planning system is creating environmental problems and flooding;
- The extent to which the development of Oman is affecting flood-plain areas and precipitating flooding issues; and
- Current planning challenges and ways of improving Omani city planning to manage flooding.

The thesis evaluates the current planning situation in Oman to determine the areas where improvements are required, by introducing current debates and new research in this area. This will lead to suggestions intended to improve the quality of the Omani planning system, to keep pace with global changes and to lay the foundation for sustainable planning to protect people and property from exposure to flood risk. This chapter outlines the different criteria used to evaluate the literature reviewed, and the critical analysis and techniques used in the data collection and fieldwork.

Choosing the research topic and question: McNeill et al. (2005: p.11) stated, “The choice of research topic is not done in a vacuum, but is influenced both by the researcher and by the context in which the research is to be done.” The choice of topic must therefore conform to criteria that support the research if it is to be of value. Some of these criteria might have an extremely influential impact on people’s lives and behaviour. For this reason, ethics and methods must be a major focus for the research to protect the research participants from harm. Additionally, the public should clearly understand the purpose of the research and their role as participants. The inclusion of different Omani communities and even non-Omani ones (in the case of the planners and specialists who participated in this research) resulted in the need to consider ethical issues. The specific criteria obtained from the literature review strongly support the validity of the research.

The research topic was chosen in accordance with diverse aspects related to the areas of planning and water management. These two areas are very much associated with the causes of flooding events in Oman; therefore, any insufficiency in one of these aspects could affect the flood management strategy (see chapter 5). In addition, aspects related to cooperation and harmonisation between different stakeholders, to arrive at the main goal of flood management recommendations are implied.

Therefore, the title of the thesis is: *Strategic work between agencies in the planning system for sustainable flood management: The Case of Oman*. The literature review covers the main aspects of the study, namely the planning system, flood risk management, partnership, and cooperation between agencies to reduce the risk of flooding. The main research question is: *How can the planning system in Oman enhance partnership working to reduce the damage from the flood risk?* Answering this question is the basis of the main aim of the thesis, and will also encapsulate four main areas, such as the situation in the Omani planning system, the enhancement of partnership working, and reducing the damage and the flood risk. From this, and by breaking down the main question (see table 1.1), a thesis structure has been created to cover the main areas necessary to improve the expectation of success from Omani flood management strategies (see the research design in tables 2.1).

This chapter describes the background to social research, research design, the aims of the social research and philosophy, quantitative and qualitative approaches, the pilot survey for the fieldwork questions, data collection and methods for collecting data for social research, techniques and methods for data collection in this research, data analysis and an overview of the writing of the research report. Combinations of quantitative and qualitative methods are therefore used to deliver a mixed methods methodology. Books, journals and edited books will be introduced as relevant data sources.

2.2. Background to social research

"All social research sets out with specific purposes from a particular position, and aims to persuade readers of the significance of its claims; these claims are always broadly political" (Clough and Nutbrown, 2002, p.14). Nevertheless, McNeill and Chapman (2005) and Bryman (2008) suggest that hypotheses relating to a researcher's opinions might also be formulated through the use of questions and indicators, which may provide good evidence to support or challenge hypotheses. Each thesis identified is therefore associated with various hypotheses, depending on the subjects in question and the methods used.

Accordingly, McNeill and Chapman (2005) observed that the unstructured interview method is often of great benefit to sociologists, as it allows them to obtain a greater understanding of social action and the situation in question. Conversely, with structured interviews, the interviewer has the right to manage the interview, as he or she sets and decides the types of questions asked. For that reason, this type of interview is very helpful and worthwhile for researchers wishing to obtain objective scientific results. The questions used in structured, unstructured or semi-structured interviews result from the concepts generated when forming research hypotheses. Therefore, to be successful, these types of interviews classify people as either: professional, intermediate, semi-skilled or unskilled workers. A good example of this classification is the "The National Statistics Socio-Economic Classification (NS-SEC)" shown in Figure 2.1.

1 Higher managerial and professional occupations

- 1.1 **Employers and managers in larger organizations**
  company directors, senior company managers, senior civil servants, senior officers in police and armed services
- 1.2 **Higher professionals**
  doctors, lawyers, clergy, librarians, teachers and social workers

2 Lower managerial and professional occupations
nurses and midwives, journalists, actors, musicians, prison officers, lower ranks of police and armed forces

3 Intermediate occupations
clerks, secretaries, driving instructors, telephone fitters

4 Small employers and own account workers
publicans, farmers, taxi drivers, window cleaners, painters and decorators

5 Lower supervisory, craft and related occupations
printers, plumbers, television engineers, train drivers, butchers

6 Semi-routine occupations
shop assistants, hairdressers, postal workers, bus drivers, cooks

7 The never-employed and long-term unemployed

Figure 2.1: "The National Statistics Socio-Economic Classifications (NS-SEC)"
Source: McNeill and Chapman, 2005, p.36

This division, as shown in Figure 2.1, enables all classes of society to participate in research, enabling the collection of diverse opinions. This enhances the research by the collection of data from different places, covering all segments of society and their requirements. Simple modifications can be made depending on the traditions, policies and geography of individual countries, as appropriate to the environment and population targeted. For this research, the author has classified the segments of Omani society into different groups, i.e. professionals, specialists, and ordinary citizens. In addition, to collect useful data, the questions asked of each group will differ, and the techniques and methods used for data collection will vary.

Clough and Nutbrown (2002) maintain that research that complies with the following three factors should produce excellent data: choice of topic, practical considerations and research methods. Therefore, all these factors were considered throughout the research process, including the title, main question and the content of all the chapters. “Reliability”, “validity “and “representativeness” (McNeill and Chapman, 2005:10) are essential for this type of research. A good method to represent the problem is essential; as this will then create as accurate an understanding of the phenomenon of flood management and flood risk as possible. However, it is important to recognise that any questions asked limit the data collected; thus, they must effectively address the research objectives. The following six key issues need to be considered: ethics, objectivity, relevance, coverage, feasibility and accuracy (Clough and Nutbrown, 2002). The following section further explores these issues, and the research topic is discussed in this chapter.

2.3. Research design

This research draws on a mixture of primary and secondary data, and data collected for the literature review determined the research topic and question. The research question was divided into sub-questions, and primary and secondary data collected to answer all aspects of the main question. Table 2.1 shows the thesis design and the method used to obtain the data required.

Chapter number	Type of Data required	Research approach	Method used to collect data
Ch.1	Primary and secondary data	Qualitative and quantitative	Used all sources of chapters
Ch.2	Secondary and primary data	Qualitative and quantitative	**Methodology:** Internationally produced books, textbooks, journals, articles
Ch.3	Secondary data	Qualitative and quantitative	**Literature review:** Secondary data Internationally produced books, textbooks, journals, articles, Ministries' websites and conference papers.
Ch.4	Secondary data	Qualitative	Literature review: Secondary data Internationally produced books, textbooks, journals, articles, government websites
Ch.5	Secondary data	Qualitative	**Literature review:** Secondary data Internationally produced books, textbooks, journals, articles, Ministries' websites and conference papers.
Ch.6 Ch.7	Primary data Fieldwork	Qualitative data: Open questions Quantitative data: Closed questions	**In-depth interviews:** (Unstructured and Semi-structured interviews): (face-to-face interviews-audiotape, and transcribe the interview) with specialist people and different cultures who have a power in decision-making **Questionnaire:** Closed questions: different people from Omani society and Al-Hail residents
Ch.8	Primary data from fieldwork Case study	Qualitative data: Open questions Quantitative data: Closed questions	**Life-history interview:** (face-to-face interviews with Al-Hail residents - transcribe the interview) - Questionnaire: Closed questions: different people from Omani society and Al-Hail residents **Site visit:** taking some Pictures of reality for flood management from Al-Hail showing the existing water and planning management as evidence for the research
Ch.9	Primary and secondary data	Qualitative and quantitative	Used all sources of chapters

Table 2.1: Thesis design
Source: Author's own

McNeill and Chapman (2005) argue that research in general aims to describe and explain situations and problems and answer questions, either in the social field or in other areas related to life. In research, philosophy informs the concepts studied and the type of data required, determining the methodologies and methods selected to acquire the target information. This research is focused on the social and scientific elements of flood management, as understood based on peoples' situations and needs. However, there is also a role for specialist knowledge, skills and experience, in improving Omani flood management. To succeed, therefore, it is necessary to concentrate on a philosophy, which permits the use of both quantitative and qualitative approaches.

2.4. Aims of social research and philosophy

2.4.1. Aims of social research

"The term research is for me a way of describing a systemic investigation of a phenomenon or area of activity. It can sometime be accurately measured scientifically or data collected can be analysed compared to identify trends, similarities or differences" (Clough and Nutbrown, 2002, p.5). According to Clough and Nutbrown (2002, p.15) "reliability, validity and representativeness" are essential to success in social research. Therefore, the author of this research is enthusiastic about involving people in the research, from the government sector and from elsewhere in Omani society. Participation from a broad spectrum of people is sought in the research study. In addition, to provide information from countries who have experienced similar trends, the experiences of countries that have dealt with flood risk management, such as the Netherlands and the UK will be reviewed in Chapter 4.

2.4.2. Research philosophy

Scientists and researchers in different fields of research have selected from both positivist and interpretivist philosophies for many years. Positivists believe that sociology functions in the same way as scientific data, and therefore the behaviour of human beings can be measured objectively using the same scientific methods as those used in the natural sciences (Crotty, 1998; McNeill and Chapman, 2005). They justify this by referring to the social structure of the community as responsible for forming people's actions and behaviour, according to certain principles as highlighted below:

- Objective and free values, with no political or personal opinions interrupting the data collection process.
- Reliability is considered imperative for objective scientific research.

- Methods should aim to collect quantitative data from social surveys, including questionnaires and structured interviews.
- Human behaviour also extends to external influences.

The alternative philosophy is “interpretivisim”, which replaces the dogma of positivism that prevailed for several decades, developing a strategy that recognises the differences between people and meets the various objectives of the natural sciences. Hence, researchers must understand social work, intellectual heritage and traditional phenomena as well as symbolism (Bryman, 2008).

Table 2.2 Comparison of positivism and interpretivisim.

Positivism	**Interpretivisim**
- Objective and free values (Epistemology: Objectivism) - Reliability is considered to be most objective for a scientific approach - Quantitative data in the form of charts and schedules - Human behaviour extends to external influences - Ontology: Science (knowledge from the outside limited) - Data from social surveys including questionnaires and structured interviews	- Subjectivity and variables (Epistemology: Subjectivism or Constructionism) - Social actions and understanding - Qualitative data in the form of words - Social actions and understanding - Social participants - Understanding the social standpoint - A true picture of people’s lives - understanding the phenomenon and translated to action - Ontology: Social interpretation according to situations within different individual views) - Data from in-depth interviews, observation

Table 2.2: The differences between positivism and interpretivisim
Source: Summarised from Crotty (1998), McNeill and Chapman (2005) and Bryman (2008)

Since the author of this thesis will be focusing on three important aspects: how (understanding), why (explanation) and who (actors/stakeholders), the study is in accordance with a philosophy that combines both “positivism” and “interpretivisim”. This study links science with nature, and “objectivism” with “constructivism”. This needs, in the first instance, to deliver an understanding of those aspects that inform the occurrence of floods in Oman, such as the planning system.

From here, it is necessary to identify the different research approaches that correlate with these philosophies, and which are considered preferred strategies (McNeill and Chapman, 2005 and Bryman, 2008: 13-19). By employing qualitative and quantitative strategies, a resolution of the barriers between nature and science can be attempted. Combining quantitative and qualitative strategies also supports triangulation of the data.

2.5. Quantitative and qualitative approaches

According to McNeill and Chapman (2005: 23): “Usually triangulation involves combining quantitative and qualitative methods to check on the accuracy of the data gathered by each method”. That is, it involves utilisation of different methods to comprise a comprehensive and broader picture of the research area (Creswell, 2009); whereas, at the same time the use of multiple methods can have certain advantages and disadvantages, as mentioned in Table 2.3 below:

Advantages	Disadvantages
- Greater understanding about the subject. - Increased opportunity for research success - Involves more people and data - Verity in choosing techniques - Combination between statistic, graphs numbers and data in the form of words	- Multiple data - Significant amount of data - Expensive - Difficult to analyse - Possible that there is a contradiction in the results - Takes more time

Table 2.3: Advantages and disadvantages of using the multiple methods approach
Source: summarised from McNeill and Chapman (2005) and Creswell (2009)

According to Bryman (2008) the mixed methods approach combines both quantitative and qualitative research strategies, as it is currently widely used by social researchers. Each of these strategies differs slightly with regard to several aspects of philosophy, and each has particular strengths and weaknesses, as discussed in Table 2.4 below. In addition, each method serves a different technique, as shown in the following chapter components.

Principles	Quantitative	Qualitative
Theory related to research	Deductive ⇨ testing theory	Inductive ⇨ generating theory
Epistemological orientation	Positivism	Interpretivisim
Ontological orientation	Objectivism	Constructionism
Strengths	- Greater generalisation. - Has numbers that are easier to measure. - Charts and scheduling. - Uses closed questions.	- More in-depth - Has numbers that are difficult to measure - Analysis in words - Uses open questions - Requires a smaller survey sample
Weaknesses	- Significant amount of information - Needs analysis of charts and schedules (double work) - Interviewee guided by the researcher's questions	- Lesser amount of information - More discussions - Depends on the openness of the interviewee

Table 2.4: Differences between quantitative and qualitative methodology
Source: summarised from McNeill and Chapman (2005) and Bryman (2008)

McNeill et al. (2005) state that the majority of researchers currently prefer a multiple methods approach, since this builds a fuller and more comprehensive picture of people's lives. The combination of quantitative and qualitative methods also allows researchers to recognise the factors influencing problems from multiple angles, enabling clarity and solutions to problems to emerge (Creswell, 2009). The use of a number of different research approaches, such as social surveys, structured and unstructured interviews, observation, and participant observation supports research and allows all aspects of the study to be organised effectively. This should improve understanding of the particular research area and build progress and knowledge, helping the researcher to obtain valuable results to investigate public opinion. However, the use of multiple methods can be expensive and produce a surplus of data, which requires more time for analysis. Although not all the data is always used, it is beneficial for obtaining a clearer picture of the research area. Its significance lies in examining the subject of the study from all perspectives to avoid losing of control of the information (McNeill and Chapman, 2005).

Since quantitative data consists of numbers, and qualitative data consists of texts and images, to blend these two methods it is necessary to combine research questions philosophy and interpretation. The mixing of quantitative and qualitative methods can be achieved at different stages of the research. According to Creswell (2009), mixed methods could be employed during data collection, data analysis and during the interpretation stages of research.

Since the researcher of this thesis intends to use both questionnaires and in-depth interviews, and each of these techniques applies a different method, a combination of quantitative and qualitative data is implied. Moreover, to provide comprehensive knowledge of the research subject, it is necessary to involve specialists from the government sector and from different categories of Omani society. It is evident that using of multiple methods can deliver unnecessary information and have other disadvantages, as mentioned previously in both Tables-2.3 and 2.4, but it will provide the researcher with sufficient data to address the thesis aims from multiple angles. This will ultimately involve analysing the data in a way that will not cause conflict, and will serve the main objectives. The secondary analysis resulted from a wider review of flood management from different countries, such as the Netherlands. A review of partnerships was included in the form of a matrix for each country (see chapter 4). A thematic data analysis was performed, involving transcription and recording in-depth interviews to create a matrix for each group and to translate the data into a more efficient narrative, linking this to a discussion of the research objectives (see chapters 6, 7, 8 and 9).

2.6. The pilot survey for the fieldwork questions

A pilot survey to test the questions was undertaken prior to the actual interviews and questionnaire distribution, to ensure both the clarity of the questions, and that jargon and vagueness would not by a problem.

While preparing questionnaires the researcher must "try out the questionnaires on a number of people who are similar to those who will be investigated in the actual research" (McNeill and Chapman, 2005: 45). In addition, a pilot survey can help to avoid confusion among study participants and encourage them to respond in a particular manner. Therefore, the researcher distributed the questions to a number of different people, including academics, ordinary people and specialists involved in Omani city planning and flood management. These people were selected based on their knowledge in the field of study, their position in Omani society, their understanding of current flood management strategies, and awareness of terms of flood events. This initial study resulted in the formation of the actual questions used in the fieldwork. The pilot survey confirmed that use of Arabic rather than English for the questions would help make them more understandable, especially, as some of the participants do not understand English. Therefore, the questions were translated into Arabic to facilitate data collection. In addition, following piloting, the researcher amended some questions so they would be more specific, and focus on the selected areas in greater depth.

2.7. Data collection and methods used for the thesis

McNeill and Chapman (2005) illustrate that the use of multiple methods and techniques for social research may improve the research from many different aspects. McNeill and Chapman note that researchers have employed multi-layered research techniques extensively in recent years. Such an approach is especially convenient for those wishing to include a wide variety of methods in a social research study (McNeill and Chapman, 2005; Bryman, 2008).

In view of that, the following section describes the methods and techniques used in this research. A combination of quantitative and qualitative methods may create more opportunities to reconstruct different information about all aspects of the subjects investigated, and may enable understanding of a range of opinions from people in different situations. Therefore, four techniques will be used in this research: a literature review, a case study of a Muscat governorate, questionnaires, and interviews.

2.7.1. Case studies

As Bryman (2008) notes, the use of case studies can lend strength to a thesis; the case study is therefore very significant in this research. This importance is because it strengthens the subject and is effective at describing the shortcomings and positive aspects of the topic under discussion. Flick (2007) agreed that the use of a variety of methods in a case study could increase the expected success of the process and its outcomes. Additionally, Bryman (2012) illustrated this, when he demonstrated that a combination of quantitative and qualitative methods could inform the success of a research study. Whilst qualitative methods, such as unstructured interviews, can be valuable in a case study, quantitative methods can also yield critical information using questionnaires. Thus, a combination of quantitative and qualitative methods will be used in this case study, including questionnaires with local people, and semi-structured and unstructured interviews with specialists in the government, the private sector, and local people (elderly people and others).

The researcher chose Al-Hail for the case study after extensive reading about flood management in books, journals and other sources in the literature. This reading, together with primary observations in different locations in Muscat, and meetings with some specialists, was very helpful when selecting the case study. The case study examines an area in which development was contained in the centre of an urban area. The choice was made to obtain diverse opinions from stakeholders, by conducting a research survey, in a location under threat of flooding where people may be wary about the development of the infrastructure projects and buildings. Furthermore, due to the close relationship between planning and water management, this case study includes both areas of interest. The Al-Hail case study examines how planning management might affect water management, as it relates to planning expansion in the area of the wadis. Additionally, it looks at how water management could affect planning strategies, as related to building bridges and culverts in front of existing dwellings. Both might create problems for those already resident in these areas.

By using these various techniques, it might be possible to improve Omani flood management to protect people and their property from risk of flood. The selection of this case study, the results expected from using these research techniques, and the literature review data, should enable the researcher to explain how this new form of management might be extended to all Omani governorates in the future.

Choosing Al-Hail in the Muscat governorate as a case study: The case study choice Al-Hail was made because the area was affected by flooding in both 2007 and 2010, making it a suitable location to assess the previous issues that arose during flooding in the area. In addition, the author has experience of the area gathered during his employment in the planning department, and a good understanding of the compensation policy. As a resident of the area, the author had first-hand experience of the Guno flood of 2007. It was also judged beneficial to choose an area that has been affected by flooding, as this afforded multiple opportunities to gather information about planning faults and drainage problems, and some mistakes made in wadi management and in planning management and water management, which both contribute to flooding problems.

The case study area contains two wadis; both of which pass through Al-Hail and flooded during the Guno 2007 and Phet 2010 events, affecting the residents living on both banks of both wadis. Many people suffered damage to their properties or lost them entirely. This study will address all the aspects that led to the flooding of the wadis to determine the extent of their impact on neighbouring houses on both sides of the wadis. Drawing on previous evidence, the researcher will also review and evaluate planning aspects, and the interdependence between the regions and central government, in the form of compensation and other priorities and plans for the future, to avoid future flooding in this region.

2.7.2. Questionnaires

Identifying the survey population assists the researcher in deciding the questions to include in a questionnaire. The age and context of the research sample is intrinsic to the survey design, as answers determine the research outcomes. Conducting pilot interviews with stakeholders can be helpful for identifying key issues to include in the study questionnaire and interviews (McNeill and Chapman, 2005; Bryman, 2008). The questionnaire participants for this study were resident in areas subject to flood risk and chosen according to their experience of the impacts of floods and their knowledge of planning and flood management.

Closed questions (for 273 Omani people): The data collected via closed questions concerned participation in the planning system and knowledge and understanding of town planning. In addition, they clarified the social responsibilities associated with flood management before, during and after flood events; and collected ideas about how to improve the planning system and flood management in Oman. This group included employees, householders, students and tenants.

Closed questions (for 120 Al-Hail residents housed along the wadi banks): These subjects comprised the case study participants, and questions sought information about compensation, planning and water management. In particular, if the government was going to compensate them for their homes, make changes to avoid the risk of flooding, or re-plan the wadi's banks, to beautify the city and zone the floodplain area.

The level of responses was excellent; all the questionnaires were returned fully completed. This was because of the time given for responses, the clarity of the questions (due to changes made following the pilot study), the information concerning the study shared with participants, and the ease with which completed questionnaires could be returned. For more details about the questionnaire strategy and responses, see Table 2.5 below:

Principles	Classification	Way People were chosen	Survey distribution	People involvement	Result received
Questionnaires	Different people	- People from different Omani's (segments, regions, culture, situation and knowledge)	Submitted by hand to the people in Masjids and different places	- Good views and participation - Very helpful - Very interested	- All questionnaires returned back and questions answered
	Al-Hail residents	- Homeowners in the areas under threat from flooding - people with flooding experience	Submitted in the houses Submitted in Masjids in the area under study	- They were happy to participate - Very interested	- All questionnaires were returned back and answered

Table 2.5: Questionnaires strategy and people responses
Source: Author

2.7.3. Interviews

Interviews can utilise open and/or closed questions and be structured, unstructured, or semi-structured (McNeill and Chapman, 2005; Bryman, 2012). McNeill and Chapman (2005) observed that an interviewer collecting statistical data should use closed questions; for example, "yes", "no", "don't know", or "agree", "disagree", "strongly agree", "disagree" or "have no opinion". Open questions result in variable answers, and allow respondents to answer in depth, although prompting may be required. Open questions might create difficulties at the data analysis stage, but can produce new and unexpected material. Most researchers, therefore, prefer semi-structured interviews, beginning with closed questions before moving to open-ended questions. Questions should be posed in simple language, and if necessary interviews can be conducted via telephone or post rather than face-to-face; although, when a researcher requires specialist information about a subject, face-to-face interviews and open questions are preferable. Face-to-face interviews have a response rate double that of telephone interviews and postal questionnaires (McNeill and Chapman 2005:37).

McNeill and Chapman (2005) categorise the interview methods used in social research as follows: (1) A formal interview consists of a structured interview composed of closed questions, requiring respondents to make choices from a list of fixed choice responses. This method produces only quantitative data, but can be useful for identifying individuals for later involvement in a qualitative interview. (2) An informal or unstructured interview based around specific topics to answer the research questions. This method includes open questions to prompt discussion and to produce qualitative data. The researcher provides respondents with an opportunity to say whatever they want without interruption (Kvale, 1996). (3) A semi-structured method, which combines the two previous approaches, drawing on the advantages of both; the process is designed to collect both factual and attitudinal data. Researchers using social research methods, including interviews, might encounter difficulties arising from social class, ethnicity, age and gender, so caution is necessary to manage factors that can result in bias (McNeill and Chapman, 2005).

The interviewees in this study were specialists in the fields of city planning, water management, meteorology, and flood management. In addition, they all had experience and knowledge of flood management, flooding events and evacuation procedures, in the role of decision maker (see Table 2.6). Some interviewees offered information freely; however, others were concerned about their professional standing and were less open. The author emphasised the confidentiality of the study and explained how the respondents' knowledge was going to be used to help improve the future of Omani flood management and explained that the data would be used for the purposes of this research only. Table 2.6 below lists the interviewees who participated in the data collection for this thesis.

No	Abb.	Position	Degree	Grad.	Experiences
1	P1	General Director in Planning department	Planner	US	- City planning more than 20 years - Decision-maker in city planning - Director in planning department for around 10 years - DG in planning department for more than 10 years - An expert in dealing with flood management
2	P2	Assistance of general director in planning department	Planner	KSA	- City planning in Muscat& governorates -Decision-maker in city planning
3	P3	Director in planning department	Architectural	Egypt	- Dealing with planning issues
4	P4	Director in Natural Planning	Planner	UK	- Planner governorates
5	P5	The supervisor of the main station - MOH	Planner	UK	- City planner governorates, An experts in planning
6	P6	planner in General Directorate of Planning and Survey	Planner	Egypt	- Omani City planning since 1984, Dealing with planning issues, Was planner in Egypt from 74 to 84
7	P7	planner in General Directorate of Planning and Survey	Planner	Egypt	- City planner in Oman since 2008 - Was planner in Egypt from 2003 to 2008
8	W1	General Director - MRMWR	PhD	Russia	- An expert in water management -Decision-maker in water management
9	W2	Expert in water management-MRMWR	PhD	UK	- An expert in water management - An expert in dealing with flood management
10	W3	Director in Directorate-General of Water Resources Assessment-MRMWR	W/Engineer	UK	- Specialists in dams and water resources management
11	W4	Expert on water resources - MRMWR	W/Engineer	UK	Specialists in dams and water resources management
12	W5	Hydrological in the Directorate of assessment of surface water and groundwater - MRMWR	Hydrological	-	- Dealing with assessing surface water and groundwater
13	SP1	General Director in High Planning Council	Architectural	KSA	- An expert in the city planning - Dealing with planning strategies - An expert in dealing with flood management
14	SP2	Director in High Planning Council	Engineer	Australia	- An expert in the city planning - Dealing with planning strategies
15	M1	Assistant of DG in General Directorate of Meteorology	PhD	UK	- An expert in the science of meteorology - Academic - Decision-maker in meteorology projects
16	M2	Director in General Directorate of Meteorology	Specializes in meteorological	-	- An expert in the science of meteorology
17	MU1	Director in Muscat Municipality	Engineer	US	Dealing with studies of MM projects
18	MU2	Director in Technical Affair - Muscat Municipality	Engineer	UK	- Dealing with implementation of developments and infrastructure issues
19	ASM	Shura Member	education	Oman	- Businessman, -society services - education field
20	BSM	Shura Member	Telecom. Engineer	-	- Businessman - society services
21	MSM	Shura Member	course in Architecture study	US	- Businessman - society services
22	SSM	Shura Member	education	-	- Businessman -Society services - education field
23	MM1	Municipal Member	education	Oman	- society services - education field
24	CE	Strategic Advisor in RTV International	Water engineer	Oman	- was Director General of Water Resources Management (MRMWR) - was Director General of Water Resources Assessment (MRMWR) - In water field for 15 years - participated in design of many water technical engineering approach and studies such Wadi Dhayka dam - company supervisor of Musandam development plan
25	Ten of Al-Hail residents (Elderly people and others)				

Table 2.6: Interviewees in the thesis
Source: Author's own
(Abb.: Abbreviation - Grad. Graduated from)

A mixture of formal and informal interviews was used in the fieldwork thesis, as follows:

Unstructured interviews (7 specialists): This group specialised in, either, planning (MOH), municipalities, weather, climate, or the environment. These people are key participants in the development of policies and general strategic planning. The interviews included warm-up questions, before progressing to open questions. Open questions enabled the respondents to speak without interruption, giving them the opportunity to provide beneficial information about former, current and future plans. During the interviews, some direct questions were included to ensure coverage of the research questions. The researcher made recordings and took notes for the purpose of recollection at the data analysis stage. The interviewees ranged in age from 25 to 60 years, and the group included General Managers, assistants of General Managers, degree holders in related fields, and members of consultancy companies.

Semi-structured interviews (15 specialists and representative from the community): This group specialised in, either, planning, weather climate, water management and environment. The members of this group were directors, heads of departments, planners and engineers, and members of local communities with a role in decision-making (e.g. Shura council members and municipal council members). They were chosen for their understanding of the field, to reveal more information about the problems faced, and elicit proposals to improve governance between different parties, and views about old, current and future flood management strategies. The researcher also asked for their suggestions regarding improving the quality and quantity of responsibilities held, in terms of managing the planning system to ensure its suitability for purpose. These interviews comprised blended open questions and closed questions. Again, recordings were made and notes taken (see Chapter 6, 7 and 8).

Life-history interview (10): These interviews involved middle-aged/elderly people and other residents with experience of flooding in Al-Hail, before and after the current subdivision plans. The information gathered relates to the case study of two wadis in the same area. These individuals all had knowledge about flooding in the area both past and present, and unique understandings of how contemporary plans affected the area during recent floods events, especially those in 2007 and 2010. These interviews created a clear understanding of the causes and effects of flooding. The age range of this group was from 40 to 80 years, and all the interviewees were original residents (see Chapter 7). For more details about the interview strategy and people's responses, see Table 2.7 below:

Principles	Classification	People chosen	Survey done	People involvement	Result received
Interviews	Specialists-1	-Professionals in planning -Professionals in water -Professionals in meteorology -Professionals in environment	Unstructured interviews	- Helpful and very interested - They were happy to answer all questions	- Good views - Great information - Good suggestions
	Specialists-2	Shura council members, Municipal council members	- Semi-structured interviews	- Helpful and very interested - They were happy to answer all questions	- Good views - Great information - Good suggestions
	Representatives from the community	Shura council members, Municipal council members	- Semi-structured interviews	- Helpful and very interested - They were happy to answer all questions	- Good views - Great information - Good suggestions
	Al-Hail residents	- middle-aged/elderly people and other residents from of Al-Hail	- Life-history interview	- Helpful and very interested - They were happy to answer all questions	- Great information - Good suggestions - Shared their experiences about flooding

Table 2.7: Interviews strategy and people responses
Source: Author's own

2.7.4. Interviews, ethical issues and validation

The author showed all the potential interviewees the letters from both the University and the researcher’s sponsor, explaining the scope of the research and requesting their participation. After the researcher explained to the selected experts, the significance of the research themes, and the importance of their participation in the research (i.e. due to either their roles as decision-makers or their experience and expertise in fields related to flood management), they were very enthusiastic about the prospect of being able to participate. The author then arranged appointments with them for interviews, and elicited their formal agreement to record them.

For the purpose of validation, the interviews were conducted based on open questions posed by the researcher. This gave the interviewees the opportunity to speak confidently without interruption, giving them an appropriate length of time to answer the questions directly and confidently. The individuals interviewed were all specialists in their field; therefore, their answers were directed toward issues related to the question and their area of research, without any departure from the subject raised in the questions. When discrepancies arose in the responses, the researcher asked the same questions to other interviewees.

2.7.5. Site Observation (with photos)

Site visit to old dams and catchment projects: To measure the effectiveness of such projects in reducing the impact of flooding and the shape of water runoff.

Site visit to affected areas: visits to areas such as Al-Hail and Alamerat-7/1 to understand the factors resulting in problems, and the mistakes made on flood plain and dams areas.

Site visit to new road projects: Visits to Alamerat and Aseeb to view new culverts for comparison with those on old roads, and to identify improvements in road planning strategies to benefit future flood management.

2.7.6. Limitations of the methods

Some of the specialists interviewed displayed bias in some of their responses. This was due to their concerns about protecting their related entities/ministries, which inhibited them from giving comprehensive information about all the critical issues arising in relation to planning and water management. To overcome this, the researcher explained all the questions to them, reassured them of confidentiality and the protection of their anonymity, and reaffirmed that their views are crucial to the research. A further limitation was the fact that the planning system in Oman is not well developed and the community is not widely involved in planning process. This resulted in some of the participants who responded to the questionnaires being unfamiliar with some issues connected with planning and water management. Therefore, participants required additional clarification from the author on some points, to enable them to relate their views to current and future planning practices.

2.8. Data analysis and writing the research report

After processing the questionnaires and interviews, analysis of the data and the results took place. The researcher processed the information gathered in the interviews systematically; first by transcribing the recorded interviews, and then by interpreting and analysing the transcriptions using categorisation and narrative approaches. The questionnaires were analysed using SPSS to facilitate the generation of graphs, pie charts and tables for analysis. Since the language used in the interviews and questionnaires was Arabic, it was then necessary to translate all the information into English for categorisation into themes, as shown in Appendix 1. These themes included taking responsibility, partnerships in Omani flood management, the current situation regarding the Omani planning system, the implementation of legislation, and strategies and other themes (for additional details see Appendix 1). These key themes were extracted from the literature review after reviewing the strategies and areas related to planning management, water management and flood management, and the experiences of other countries in these fields, and then matched with the thesis' aims (see Table 1.1).

For the purpose of categorisation, the questionnaires were inputted into the SPSS programme by theme, with responses in columns (Yes, No, Don't know). It was then possible to generate pie charts, tables and graphs (see Appendix 1) to illustrate the questionnaire responses returned by different people from within Omani society in general, and people from Al-Hail specifically (Case study). These pie charts, tables and graphs appear in Chapters 6, 7, and 8, and depict the primary quantitative fieldwork data.

In addition to the questionnaires, the author analysed the interviews, first by listening to them all, then by transcribing them into Arabic carefully to avoid the omission of any information offered by the interviewee, and then translating them from Arabic to English, and grouping the responses according to different themes. The qualitative data from the interviews provided different themes to augment the content of the analysis chapters. Chapters 6, 7, and 8 present the data from both methods, and inform the thesis recommendations. For additional information describing the fieldwork and analyses, see Table 2.8.

Key questions driving the fieldwork: (**Main Question** How can the planning system in Oman enhance partnership working to reduce the damage from flood risk?)
How effective is the planning system in Oman at coping with flood management?
How effective is flood management in Oman at safeguarding the people and property from flood risks?
How can the planning system help improve the situation and reduce the effects of flooding in Al-Hail?
How can the planning system in Oman enhance partnership working to reduce the damage from flood risk?

Aims:
Improving the effectiveness of the Omani planning system to cope with flooding
Effectiveness of the flood management in Oman in safeguarding the people and their propriety from flood risks
Understanding the effect of the planning system in the ground and the improvement required to cope with flooding in Al-Hail

Concepts for the fieldwork trip	Key detailed questions for fieldwork	Concepts from the literature review	Authors of the concepts identified in the literature review
- Idea that cooperation between the different stakeholders could increase the opportunity for success in terms of planning system quality and flood management in Oman	- To what extent does the unification of effort between different stakeholders contribute to planning sustainability to reduce flooding problems in Oman? What issues result in effective coordination for flood management in Oman? To what extent is flooding associated with the Omani planning system? - To what extent is the conflict now between the changes in land use, extensions and the creation of new plots with water management?	- Relationship between the demands of sustainable land management and good development - Relationship between the population and local nature forces in shaping the urban place -Cooperation between economy, politics and society - Flood risk mapping, education, engineering approaches and flood warning and emergency responses - Reinforce the coordination efforts of both spatial planning management and water management - Effective partnership in planning can improve flood management	(Healey (1997); Forchner (2006); Davey, 1998; Baeten (2001); Brinkerhoff (2002); Talen (2000); Piper (2005); Wates (2008); Fainstein (2012); Fincher and Iveson (2008); Meijerink and Dicke (2008); Flood Risk Management (Scotland) Act 2009; SWFRAR 2,(2009); Baeten (2001); Albrechts et al. (2001); (Kitchen (2007);
- Building a good relationship between water management and city planning management can increase the success of flood management	- What are the water management strategies that Oman employs currently? How can we improve the quality of flood management in Oman through enhancement of the efforts strategy of planning system and water management? Why? Who are the right stakeholders to involve in this unification? To what extent is there conflict now between the changes in land use and the creation of climate change in Oman?	- Technical engineering approaches could increase the level of mitigation and adaptation during the flooding - Climate change resulting in flooding - Mistakes in land use management resulting in climate change - Using different types of renewable energy sources might contribute to decrease emissions	Brower and Van (2004); Saul et al. (2007); Nuvel and Knaap (2010); Tariq and Giesen (2011), Reeves (2005); Kitchen (2007); Oosterberg et al. (2005); IPCC (2007); The Met Office (2009); IPC (2011); (Kumetat, 2009); IMD (2006); Rauf, M. (2007); (Arnella et al. (2004); WHO (2002); David (2004); McMichael et al. (2006), Ghaddar (2010); Al-Badi et al. (2009) and Al-Yahyai et al. (2010); IPPC (2007); Kitchen (2007); Brower and Van (2004)

Is planning and leaving space for the water to flow the issue which Omani planners need to concentrate on in future city planning	- What about the strategy of leaving a space for water to flow – is it a good strategy for managing flooding in Oman? Or might technical engineering approaches prove more workable? How can benefits be gleaned from the international flood strategies and experiences, to improve the planning system and flood management in Oman? What about the strategy of living with water – is it a good strategy for managing flooding in Oman?	- Good land use management can reduce emissions -Leaving space for the water to flow can avoid people suffering during flooding - Living with water - Integration between water management and spatial planning management helps with flood management - Understanding of flood management experience from different countries can contribute in creating a successful strategy for flood management in Oman	Grbant (2002); Kitchen (2007); Woltjer and AL (2007); Nuvel and Knaap (2010) Reeves (2005); Kitchen (2007); McMinn et al. (2010); Woltjer and AL (2007); Meijerink and Dicke (2008); Meijerink and Dicke (2008); Brower and Van,(2004) Nuvel and Knaap (2010); Reeves (2005); Kitchen,(2007); Woltjer and AL (2007) and Nuvel and Knaap (2010) Pottier et al. (2005); Dodds et al. (2010); Nuvel and Knaap (2010); Tariq and Giesen (2011); Reeves (2005); Meijerink and Dicke (2008); Woltjer and AL (2007); Brower and Van (2004); Dodds et al. (2010); Brinkerhoff (2002); Piper (2005)
- Understanding the current situation in the Omani planning system	- Can the Omani system and legislation build up greater freedom for people in order for them to become more politically economically and socially confident? What is the role of the community in the planning and the extent of their participation in the process of plans? How can we improve this?	- Contemporary planning system in Oman could be a cause of flooding - Individuals involved in decision-making may affect the quality of city planning in Oman - Administrative pressures may affect planners decisions in Oman - Lack of flood risk maps might cause planning that permits building in the flood prone areas	Al-Farsi and Kiymi (2007); Alwati (2011) Al-Shueili (2011); Alwati (2011) Nuvel and Knaap (2010); Reeves, 2005; Foglesong (2012); Harvey (2005); Al-Shueili (2011); Alwati (2011) Dodds et al. (2010); Pottier et al. (2005); Al-Farsi and Kiymi (2007); Al-Barwani (2009)
- People's views might help to increase the ability to create successful flood management strategies in Oman	- What is the technique used by the planning authorities to protect the plans from flood risk? What are the lessons learned from dealing with previous floods that will help create a clear strategy both in the issues related to planning or other issues? - How does the government respond to people who claim compensation during and after flooding?	- Stakeholders strategy in flood management is a good strategy for management cooperation	Healey (1997); Piper (2005); Forchner (2006), Dobbins (2009); Kelly (2010); Wates (2008); Lombardo et al. (2002); Fishman (1977)

Fieldwork strategy and sources

Primary data fieldwork and analysis	Data source	Primary data case study and analysis	Data source
Methods approaches, techniques and analysis: ***In-depth interviews (Unstructured and Semi-structured interviews):*** (face-to-face interviews- audiotape, and transcribe the interviews) with specialist people and different cultures who have a power in decision-making (Qualitative method)- (Ad hoc analysis) in this case make a possibility to use a different approaches and techniques regarded to outcome of analysis, will use properties of both categorisation and interpretation)	***7 specialists:*** Interviews with specialist people in planning, municipalities, weather and climate and the environment. (recording interview) ***17 members of Omani society:*** specialists in planning, weather climate, water management, environment and these people will be directors, heads of departments, planners and engineers. some people from the community such as Shura council members and Municipal council members (recording interview)	**Methods approaches, techniques and analysis:** ***Questionnaire:*** Closed questions to domestic residents on the wadi banks in Al-Hail (Univariate analysis) in this case makes it possible to use a frequency table and diagrams using SPSS	***Questionnaires:*** (120) of Al-Hail residents living by the wadis banks will be the target of the case study
		Life-history interview: (face-to-face interviews- audiotape, and transcribe the interview) (Qualitative method)- (Ad hoc Analysis)	***Interviews:*** middle-aged/elderly people/ other residents who have experienced flooding in Al-Hail flooding, before and after the contemporary subdivision plans. (Recording interview)
Questionnaire: Closed questions: different people from Omani society (Quantitative method) - (Univariate analysis) in this case makes it possible to use a frequency table and diagrams	***Questionnaires (273):*** different people from Omani society	***Site Observation:*** site visit to different effected areas and water management projects (Qualitative method)	***Site visit and photos taken:*** Visiting many places to understand the causes contributing to the many problems in flooding and the mistakes made in these flood plain areas, technical engineering projects such dams bridge and culverts and roads projects. Taking pictures as evidence of the current situation

Table 2.8: Description of the fieldwork and data analyses
Source: Author's own

2.9. Conclusion

This chapter has described the research methodology employed in the study, by discussing the research paradigms of positivism and interpretivism, with reference to the physical and social sciences. The methods used in the research were also described with reference to reality, as explored through the application of a combination of quantitative and qualitative methods. A mixed methods approach makes it possible to examine the topic from different angles, and to understand the problems raised by participants; thus, the research rationale was also established. The research tools were introduced, and these will include questionnaires, semi-structured and unstructured interviews, and site observations.

The chapter also elaborated on the tools used, explaining that using simple language, framing closed and open questions, was the approach taken to collect factual and attitudinal data. Potential issues concerning social class, ethnicity, age and gender were also mentioned, and the diverse methods used to reflect on and reconcile the views of various segments of Omani society were also identified. The chapter then explained how analysis of the data collected will be performed using a frequency table, and diagrams.

The next chapter discusses the predicted incidence of flooding in Oman and the Gulf States.

Chapter 3

Profile of Oman and flood incidents

3.1. Introduction

This chapter begins the literature review (which includes chapters 3, 4 and 5), which draws on a mixture of internationally produced books, textbooks, journals, articles, Ministry websites and conference papers. As explained in Chapter 1, the literature review is arranged into three chapters to provide a logical progression, whilst also breaking down the key components of the research question into three key aspects. First, it is essential to present the current background to the Omani planning system, climate variables, and flood management procedures, including current strategies to deal with the subject of flood management from the perspective of city planning, water management and flood risk management, and current flood risk and causes of flooding, to clarify the situation in Oman (see Chapter 3). Second, by introducing the experience of 'best practice' elsewhere in the world, such as the UK and Netherlands, it is possible to deliver further knowledge on the subject of flood management, to identify strategies to address flooding problems in Oman (see Chapter 4). Third and finally, to identify key points to answer the research question related specifically to Oman, by introducing the unique issues that arise there; specifically, in relation to the planning system and flood management, as linked to city planning, climate change, strategies, existing flood management plans and partnerships (see Chapter 5).

Thus, these three chapters cover existing knowledge pertaining to flooding risk and cause, response level and strategies for flood risk management, and proposals for future improvements to flood risk management. By understanding the causes and scale of flooding in Oman, it is possible to devise strategies and create an effective plan to reduce the risk of flooding, based on experiences gained from international practices, while also understanding the planning and strategic features unique to flood management in Oman. The literature review chapters provided ample criteria and factors to address during fieldwork, which will involve gathering new information from experts in the field and residents affected by flooding in Oman. The data presented in the literature review chapters is also referenced subsequently when presenting the study findings.

This chapter presents key information regarding the study context, Oman. It details socio-spatial elements including factors pertaining to the people living in Oman, flooding problems and causes, the current Omani planning system and the challenges facing Omani city planners. In addition, it addresses climatic issues and related factors concerning greenhouse emissions and their impact on flooding, to provide an accurate profile of Oman and the extent to which it is subject to floods. It refers to the consequences and causes of the Guno (2007) and Phet (2010) cyclones, and the tropical storm Keila (2011), which affected Oman as a whole and Muscat in particular, causing massive destruction to property and services and resulting in deaths. Finally, it touches on incidences of flooding in other Gulf countries.

In summary, this chapter also concentrates on the following key objectives:

- To examine the effectiveness of the Omani planning system to cope with flooding; and
- To understand the relationship between climate change and the incidence of flooding.

In doing so it addresses, Omani flooding (causes and flood types) and the current Omani planning system and associated challenges; discussing plans and policies for Omani city planning, monitoring and climate readings in Oman, mitigating the effects of climate change and flooding incidents in accordance with climate change in Asia and Oman. The chapter ends with concluding remarks.

The following section presents a profile of Oman.

3.2. Sultanate of Oman

According to the Ministry of Information (2010), Oman is located strategically; a fact that has afforded it political influence throughout its history, and ensured it good security and a stable economy, based on its proximity to the Arabian Sea. Furthermore, Omani merchants were instrumental in protecting the Omani coast and coastal areas, which extended from the Arabian Gulf into the Indian Ocean and East Africa between 1624 and 1744. Oman had excellent access to trading opportunities, and was known for Omani frankincense. It is located to the very south of the Arabian Peninsula, and positioned 3165 kilometres from the entrance to the Arabic Sea and the Indian Ocean to the south via the Strait of Hormuz, the southern entrance to the Arabian Gulf. Oman covers an area of 309500 square kilometres, and its terrain includes mountain ranges; for example, Jabel Alakhdar at 3000 metres; sand dunes; coastal areas; agriculture land; and, residential areas (Ministry of information, 2010). (For details about the Omani population and lifestyle factors see Chapter 1.)

Oman's modern history began when Sultan Qaboos became its leader in 1970. Many changes occurred at this time, affecting different aspects of life, involving changes to political, economic and social policies. Oman opened up to the modern world, introducing economic and political progress. The Statute of the State, which was issued by his Majesty Sultan Qaboos on 6 of November 1996, outlined fundamental principles and a policy framework to adhere to when constructing the Sultanate's future strategic position as explained below (Ministry of Information, 2010).

Oman politically: Despite the isolation of Oman prior to 1970, it had good international relationships with most countries. It pursued a foreign policy based on peace and dialogue when engaging in political relations with other countries. Oman does not interfere in the internal affairs of other countries, other than to promote friendship and peace. In addition, the Sultanate has forged good relationships with its neighbours, establishing the demarcation of its sea and land borders, thereby avoiding potential for future disputes and easing trade and the exchange of interests (Ministry of Information, 2010).

Oman's Economy: Oman trades successfully in frankincense, copper, and wood, with many other countries, including India and Iraq. After 1970, the development of different resources to build the country led to advancements in multiple areas, including fishing, agriculture, petroleum, and industry, such as cement factories (Ministry of Information, 2010). Oman is principally dependent on its oil revenues, and its GDP was about 15,512 million Omani rials (RO) in 2007. Although the Omani economy is diverse, oil production comprises the highest percentage of its output at around 80%. The World Health Organisation (2010) asserts that liberalisation of the Omani markets through economic harmonisation with the Gulf Cooperation Council (GCC) countries, the

European Union, Japan and China, and with the World Trade Organisation was confirmed in 2000.

Social aspects of Oman: Omani society is based on binding human rights; under which all people are equal under the law in terms of rights and duties. Thus, everyone in the country is free to exercise their own religious and personal freedoms, without any distinction made between race and social status. In addition, Omani people can access good healthcare, education and exercise freedom of opinion and expression. The 1996 law also gave citizens the right to live a decent life, and vote to choose Shura council members (see Glossary of Abbreviations and Chapter 6 and 7 for more details about Shura council members). The Royal Opera House in Muscat is an important project, providing the opportunity for social and cultural improvement, through engagement in traditional music and the arts, as well as embracing international events (Ministry of Information, 2010).

People's livelihoods, activities and traditions in Oman: The variations in Oman's geographical terrain, which includes mountains, sand dunes, coastal areas and villages, as mentioned earlier, have resulted in variations in housing types, traditions, clothing, lifestyles and occupation. These differences afford the Omanis many opportunities to use their surrounding environment to conduct their daily activities and work, utilising the resources of the particular areas in which they live. For example, people living in sand dune areas have tended to work in occupations associated with livestock and crafts, whereas people living in mountain villages have worked in different types of agricultural and creative occupations, while people living in the coastal areas are frequently involved in fishing. In addition, the traditions and activities in the north of Oman are slightly different those in the south (Ministry of Tourism, 2015). After the 1970s, people from the different areas in Oman began working in the government and private sectors, although some continued to pursue traditional occupations, as mentioned above. Figure 3.1 presents an overview of Omani lifestyles, traditions and activities. The next section, 3.3, explores the problem of flooding in Oman.

Figure 3.1 Examples of Omani life, traditions and activities
Sources: Ministry of Endowment & Religious Affairs, 2015; Ministry of Tourism, 2015
And http://www.theguardian.com/music/gallery/2012/feb/18/week-in-music-in-pictures

3.3. Omani flooding (Causes and flood types)

In recent years, due to global warming, rising sea levels and cyclones generating torrential rainfall have caused flooding to occur regularly in the areas surrounding the Arabian Sea. Tariq and Giesen (2011) state that one cyclone per year is expected in the Arabian Sea (for example, the Guno and Phet cyclones); 75% of these arise in Omani coastal waters and can cause significant levels of damage to coastal areas (see Figures 3.2 and 3.3).

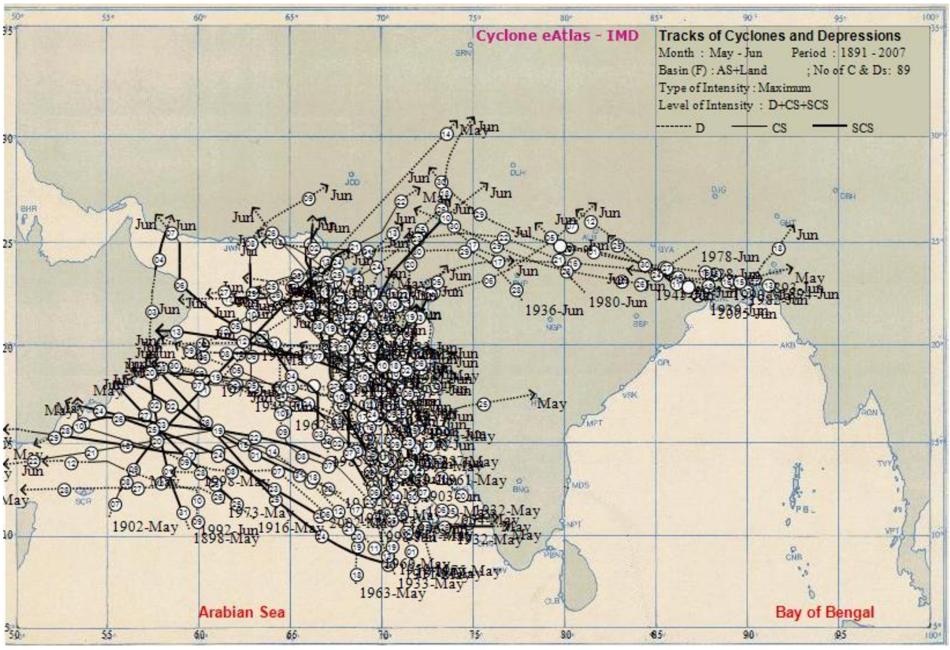

Figure 3.2: Movements of Cyclones in the Arabian Sea
Source: Ministry of Transport and Communications-Oman, 2012

Figure 3.3: Effects of flooding on Omani coastal areas
Source: Source: Al-Barwani 2009

3.3.1. Flash flooding and coastal flooding

As stated in Chapter 1, flood risk threatens millions of people around the world. According to Jonkman (2002), different types of floods, such as those caused by rises in sea level, overflow from estuaries, rivers flooding, surface water/flash floods, and flooding of sewers have created serious problems for people and their properties.

The Sultanate of Oman comprises dry and semi-dry climate areas; thus, flooding in Oman is usually flash flooding or coastal flooding (see Table 3.1 for more details about floods in Oman). Flash floods, where rain falls into the wadis running off the mountains, have caused considerable destruction, especially in Alhamrea and near Wadi Uday (Al-Barwani 2009; Al-Farsi and Kiymi, 2007). This type of flooding is especially dangerous, according to the Global Water Partnership (2008), because the water carries large amounts of sediment and debris. Sediment and debris were also a problem during and after Guno in 2007 (Al-Barwani 2009). By contrast, coastal floods are caused by a rise in sea level, resulting from rivers flowing into the sea, storms, tides and climate change (see Chapter 1 for more details about the effect of flooding in Oman). Unfortunately, flooding in coastal areas and along river estuaries can linger, causing considerable damage to properties and land, due to additional sea erosion during high tides (WHO, 2002). Typically, coastal floods in the form of cyclones and storms, which affect Omani beaches, are generally driven off the Arabian Sea (Tariq and Giesen, 2011). These events have greater potential for damage to property than those anticipated from the proximity of housing to the wadis and coastal areas. For this reason, it is important to protect the stability and sustainability of ground water, so that floodwater can be trapped for use elsewhere. The flooding history of Oman is summarised in Table 3.1 on the following page:

Town name	Source of flood	Month/Year	Height of water
Muscat	Tropical Cyclone Cyclone Guno Cyclone Phet	June 1890 June 2007 June 2010	285mm 626mm 603mm
Sohar	Tropical Cyclone	June 1890	285mm
Salalah	Tropical Cyclone Tropical Cyclone Tropical Cyclone Deep low pressure Cyclone Storm	May 1963 November 1966 June1977 October 1999 May 2002	269mm 202mm 122mm 69mm 58mm
Masirah	Cyclone Storm Tropical Cyclone	December 1971 June 1977	99mm 430mm
Sur	Low pressure	October 1999	Not mentioned
Eastern Oman	Cyclone Guno	June 2007	626mm
Eastern/interior Oman	Cyclone Phet	June 2010	603mm

Table 3.1: Flooding history in Oman
Source: Al-Awaidy et al., 2007

Al-Farsi and Kiymi (2007) argued that in many cases, developers in both the housing and the commercial sectors failed to consider flood risk zones when planning; allocating plots very close to the wadi. The flood risk areas in Muscat are those close to the wadis: Wadi Alkabeer and Alseeb. Al-Farsi and Kiymi (2007) illustrated in their conference paper that urbanisation in the Muscat Governorate includes development by the wadi channels. They presented topographic maps and flood risk maps to support this assertion, and physical plans for housing and other uses approved by the MOH. They also made site visits to different cities in the Governorate of Muscat to understand how flood hazards should inform future developments in different sectors.

In the Muscat governorate, flooding damage typically arises from coastal erosion, huge tidal flooding and flash flooding, all of which represent a significant threat to property and human life. According to Saul et al. (2007) flood defences and other techniques like tidal barriers, longitudinal dykes and sea walls might be fundamental tools that could be used to protect coastal areas from erosion and thereby reduce the impact flooding has on at risk cities (see chapter 4). Such constructions must be high enough to prevent water entering urban areas. These projects might be costly, but they offer good flood defences and protection for urban areas and can also provide a visually appealing border for the area concerned.

Recent construction programmes have resulted in 67 surface storage dams and 32 ground water feeding dams across the Omani Governorates. These dams were constructed with the authority of the Ministry of Regional Municipalities and Water Resources, as a physical tool to improve flood management (Tariq and Giesen, 2011; Oosterberg et al., 2005). The previous ministry implemented around 11 dams for groundwater and 22 surface storage dams (MRMWR, 2011) (see Chapter 5). If correctly positioned to reduce upstream flow during rainfall, this number of dams could be very effective for water management, and might protect people and property from the risk of flash floods (see Chapter 7). However, they are not helpful in terms of coastal flooding, since a barrier method is essential to prevent seawater from flooding the land. Consequently, flood defences are advised (Saul et al., 2007). However, during a cyclone or heavy rainfall event damming can manage the consequences of a temporary rise in sea level. According to Ministry of Regional Municipalities and Water Resources (MRMWR) (2011), the Ministry has completed studies and prepared designs for the implementation of a number of additional dams in Muscat, which are currently subject to consultancy (see Chapter 7 for more details). These new dams might effectively protect Muscat against flood risk, as the national Hydro-meteorological network, that covers many areas within Oman, supports them.

3.3.2. Damage and the Sustainable Urban Drainage System (SUDS) in Oman

According to Saleh and Hatrushi (2009) Muscat’s roads and related culverts, in areas like Alqurom and Alseeb city, also require maintenance and reconstruction, because in some cases the roads have either no culverts for the water to pass through, or very narrow culverts. This can result in blockage of the water during floods and rains, which might lead to damaged roads, inconveniencing road users. Blockages may also result in the water flowing into the nearest commercial or residential areas. Building new tidal barriers coastal defences, sea walls, defence walls and longitudinal dikes are recognised effective flood management techniques (see Chapter 4). They can reduce the probability of flooding and the erosion of wadis into the sea in urban areas. The Muscat Municipality (MM) is responsible for constructing bridges, culverts and flood defences in floodplain areas and in areas at threat from cyclones, wadis, and sea floods. The Alqurom urban area is under frequent risk of flooding, and is often affected. Saleh and

Hatrushi (2009) state that this area is a significant commercial area in Muscat, and that it was effected by the Guno cyclone in 2007, because of its location on the flood plain beside the wadi bank. In addition, there is poor drainage, inhibiting the flow of the wadi downstream to the sea. There are also narrow culverts or pipes in and around the streets that are also subject to threat from flooding. In addition, the fact that this area is both on a floodplain and in a depression means it has the potential to become a lake during flooding events (see Figures 3.4, 3.5 and 3.6).

Figures 3.4: Alqurom Urban area during the Guno cyclone 2007
Source: Al-Barwani, 2009; Inceruh, 2009

Figure 3.5: Alqurom Commercial area during the Guno cyclone 2007
Source: Inceruh, 2009

Figure 3.6: Alqurom Commercial area-2 during the Guno cyclone 2007
Source: (Inceruh, 2009)

MM has implemented some amendments to its projects; for example, adding bridges and defensive floodwalls around the Alqurom Urban commercial area, to protect the shopping centres and companies located there. However, because this area is one of the main floodplain zones in Muscat, these projects are unlikely to be adequate to protect the land on which McDonald's and the Capital Commercial Centre stand (Figures 3.5 and 3.6). However, since the recent experiences of flooding (the Guno, Phet and Keila floods), improvements to the drainage system and the construction of new ones, especially in Muscat, have been considered urgent. Therefore, the government plans to take action to improve the drainage system network throughout Oman in the future, especially in coastal areas and floodplain areas like Muscat.

In addition, wastewater management does not yet extend to all of Muscat. To address this, Hyah Water began a wastewater management project in 2003, intended to serve around 90% of the Muscat population by 2017. However, a drainage system is also required to support floodwater management in Muscat, to release water from urban areas. According to Haya Water (2011), the project undertaken by the company includes the planning, design, and construction of wastewater infrastructure and water treatment. The project has three phases: supply service to the majority of Muscat city, use wastewater for irrigation purposes following a treatment process, building sewerage treatment plants at key locations. According to Aquastat (2008), around 25000 m3/day of the wastewater collected is used by MM for irrigation and agricultural purposes, and this amount is expected to increase to about 70 000 m3/day in the near future (see Chapter 8 for more details and fieldwork findings).

Flooding can create additional water supplies, to assure a sustainable water supply throughout Oman. Al-Barwani (2009) commented that one of the main advantages of flooding is that it recharges ground aquifers. However, the usability of floodwater depends on the strategies employed to maintain and purify it. This means, creating high-quality drainage systems and recharging dams, in addition to constructing flood defences to assist in realising this important objective. The next section will concentrate on the current Omani planning system.

After the Guno and Phet incidents mentioned previously, it became necessary to renovate the wadi channels and build dams to reserve greater amounts of water and control water flow. Many people in Oman claimed compensation for land affected by flooding following the Guno cyclone, and many of the regions of flooded land were found to be either in the wadi channel or on floodplain areas (especially Alamerat number-7 subdivision plan in Muscat, and throughout Alseeb). Some plots in Alkhoudh were also located in the floodplain area and the wadi channels (see chapters 6, 7, and 8), although others were located in the orange zone by the Alkhoudh dam. According to Al-Farsi and Kiymi (2007), problems had clearly arisen because of the subdivision of plains and extensions into the wadis and developments in floodplain areas. This prompted a huge number of claims for compensation from the MOH in respect of plots, creating major difficulties for the planning system (Alwati, 2011). Another significant cause of flooding in Oman is storms and cyclones, which have worsened in recent times, as discussed in Chapter 1. To review the relationship between the planning system in Oman, section 3.4 identifies planning issues.

3.4. Omani current planning system and challenges

What are the planning strategies currently applied in Oman? How do these strategies work? Who takes responsibility for them?

Modern urbanisation is a result of the huge industrial revolution that took place in western countries during the 19^{th} and 20^{th} centuries (Grbant, 2002; Kitchen, 2007), and which later extended into other countries. This revolution involved the introduction of new technologies, and new economic and industrial sectors. Economic and industrial development gave rise to cities and it became necessary for governments to create a formalised planning system. Transformation in many aspects of the built environment has led to the formulation of land use policies, and Oman's planning system has passed through many different stages, each requiring developers to meet different criteria.

Omani planning procedures originally involved discussions between the families in each village; this approach has since evolved into the current planning system, which is characterised by subdivision. Contemporary planning strategies and developments reflect the present day concern that new developments should be associated with modernisation and contemporary processes. These changes include consideration of many different environmental aspects, such as climate change, changes in public requirements and even alterations in the use of the built environment. Accordingly, changes to planning approaches in Oman should be seen as reflecting global developments and management, especially in relation to climate change, which is one of the main factors precipitating the flooding incidents affecting Oman (and other countries). Decreasing the harmful emissions that contribute to climate change, can be achieved in different ways, such as encouraging people away from using private cars to using public transport and renewable energy sources. At present, there is no significant movement toward reducing emissions in Oman, aside from some efforts to use renewable energy. Therefore, identifying the theories, strategies and stages of planning can assist legislators to understand the newest developments in planning worldwide to improve Oman's planning strategies.

3.4.1. Subdivision plans

The development of subdivision plans occurred at a time when Muscat was witnessing the migration of people from different regions, leading to huge developments in all sectors. This is similar to the situation witnessed in large cities worldwide (Grbant, 2002; Reeves, 2005; Kitchen, 2007). The Omani planning system conflicted with many of the new land uses, highlighting the need for an up to date strategy. The 1991 report proposed a ten-year planning strategy, but the huge extension to the city and changes in land use resulted in many mistakes. Al-Farsi and Kaumi (2007) argue that many of these mistakes involved plot extensions into water flow channels. Such extensions should not have been permitted, because, in addition to issues related to the floodplain and wadi channels, the developments conflicted with regulations to restrict plot extension numbers 160/2004 and 63/2006 (MOH, 2012). The questions raised here are: *Why do plots receive extensions that go beyond the area that is required to build a house? Why does the MOH not implement decisions more strictly? Who is responsible for the extensions to floodplain areas? What possible solutions could be proposed to manage the problems caused by previous extensions?*

Alwati (2011) has argued that the MOH has faced many challenges involving plot extensions, land use change and claims for land ownership. He identified incidences of disregard for planning legislation, and of organisations preferring an administrator's suggestions to technical suggestions, creating difficulties for the MOH. Al-Shueili (2011) claims that the lack of coordination between Ministries has gradually led to a process of change in land use by the MOH without concern for other Ministries' views; concentrating on individual plots of land, not comprehensive areas. He illustrated this by detailing some of the changes to plots made because of the shortage of new land in Muscat. The question raised here is: *Who should safeguard land use and how can the government control changes?* He suggested two approaches to refining the planning system: improving coordination among different Ministries, and good governance. Kitchen (2007) suggests improving coordination among Ministries to improve Omani spatial planning strategies. Alwati (2011) hopes to improve on the Omani National Spatial Strategy (ONSS), which is still in its early stages.

Further questions to be answered in Chapters 6, 7 and 8 include: *To what extent will the Omani National Spatial Strategy (ONSS) play a role in Omani planning and, therefore, participate in future flood management plans? What can the Omani National Spatial*

Strategy (ONSS) add to the planning system that would differ from what already appears in the Urban Planning Guide prepared by the Supreme Committee for the Town planning? How can areas particularly prone to flooding be identified, and who is responsible for doing so?

The problems currently facing Oman in relation to planning can be separated into three main areas: change of land use and extension and creation of new plots. Land use change is one of the main causes of climate change globally, especially where former agricultural land is transformed for industrial or semi-industrial use (IPCC, 2007). Furthermore, extension often impinges on the wadi channels, or other areas inside the boundaries of the floodplain, resulting in the occurrence of flooding events in urban or intra-urban areas. This problem might then extend into other areas unless the ONSS takes evasive action. This might in turn affect the efforts of other Ministries, although the MOH has presented another solution involving plot extensions number 160/2004 and 63/2006. Site visits during the process of creating subdivision plans and detailed surveys should be required prior to the approval of any relocation initiative.

3.4.2. Plans and policies for the Omani city urbanisation

The MOH and the Supreme Council for Planning are the entities that oversee planning issues. The harmonisation between these two parties results from their joint responsibility for subdivision plans; as they define land use in floodplain areas and built up areas according to zoning policy. In addition, the two entities are responsible for compensating people, either financially, or by moving them to plots that are more suitable. An example of this is the Alamerat compensation offered to people affected by the location of the dams after the Guno cyclone; they received alternative plots.

The Omani town planning system has passed through different stages, which have transformed urban planning in Oman. The history of new town planning developments started in 1939, with the establishment of the Road and Housing Organisation in Muscat and Muttrah. The establishment of other institutions and Royal Decrees by Sultan Qaboos followed, when the country became the Sultanate of Oman in 1970 (see Chapter 1). These Royal Decrees and the drawing up of five-year development plans have since influenced town planning and set out new strategies for future planning in Oman (Al-Shueili, 2011; Ministry of National Economics, 2006). The MOH published the Muscat strategy (1990-2010) in 1991; this delimited the significant change in land use and population expected. According to MOH Report No 4 (1991), the strategy set out a structural plan for development in different sectors and subdivision plans for the upcoming era. The report includes figures related to the expected population growth in the Muscat regions and planned development (see Table 3.2). Using these plans, plot classification could have mitigated flood risk (see Figure 5.1) by ensuring development restrictions in the floodplain area; although the implementation phase (as mentioned by many authors such as Alwati (2011)), might not necessarily have concurred with the plans.

population	1990	1995	2000	2010
Greater Muttrah	160,700	169,000	176,850	185,000
Baushar	108,100	119,000	130,000	150,000
Alseeb	113,300	150,000	197,000	330,000
Alamerat	33,4000	42,000	49,000	85,000
Total	415,5000	480,000	552,850	750,000

Table 3.2: The predicted population of Muscat (according to 1991 estimations)
Source: MOH, 1991

The area of each land use category in each city in Muscat (as shown in Table 3.3) only illustrates expected developments within the city, without considering those areas that are most developed or unrestricted. This is a significant problem facing the current planners when restricting development in floodplain areas. Thus, this issue must be at the core of any Omani National Spatial Strategy (ONSS) drawn up by the Supreme Committee for Town Planning. Since land is limited, development in all sectors is very competitive.

Land use	Muttrah	Baushar	Aseeb	Alamerat	Muscat
Residential	614.60	1938.70	5132.10	1082.30	8767.70
Residential/Commercial	243.00	51.20	89.50	28.90	412.60
Commercial	21.50	99.00	637.70	84.50	842.70
Industrial	192.00	1355.10	781.60	98.50	2427.20
Facilities	232.60	392.40	507.30	94.20	1226.50
Public Utilities	52.70	82.80	117.80	19.10	272.40
Transport	191.50	240.40	3206.50	127.40	3765.80
Special Use	25.30	495.80	956.40	3.80	1481.30
Government	36.40	304.20	1434.20	1.50	1776.30
Agriculture	5.80	172.50	957.00	79.90	1215.20
Total developed area	**1615.40**	**5132.10**	**13820.10**	**1620.10**	**22187.70**

Table 3.3: Land use composition (2010): including the Airport area covering about 2800 ha
Source: MOH, 1991

The huge number of extensions and changes in land use cases brought to the MOH, especially to the Muscat Planning Directorate, explains why planners are too busy solving problems relating to cases to focus on wider planning issues and making improvements to planning quality. In addition, dealing with public enquiries and serving people who require decisions, limits the number of investigations performed by planners (Alwati, 2011) (see Chapter 6). Therefore, systematic use of authority by planning organisations is necessary to manage problem cases. This could involve revising all subdivision plans and making amendments according to a detailed survey of all the plans. Although this approach takes time and has associated financial costs, it protects the wadis and floodplain areas and restricts their use. Site visits reveal that in some cases the extensions required are close to the wadi channels in floodplain areas. Plot extensions in some of these areas have resulted in problems with sustainability and threaten the surrounding areas in the event of flooding because the extensions narrow the wadis (see Chapter 6).

3.4.3. Conflict between urbanisation and strategy implementation

According to Alwati (2011), the MOH has faced a number of challenges because of cases involving extensions, land use change and claims for lands owned. Disregard of the planning legislation and failure to take on board administrator's suggestions over technical issues have resulted in problems for the MOH. This proved true in cases where changes in use were transferred from government and entertainment land use to residential use. For example, planners respect Regulations No. 160/2004 and 63/2006, which restrict extension, but at times, administrators have ignored them (see Table 3.4).

Demand for residential areas rose significantly after applications were opened up to females. This posed a problem for the Muscat Planning Directorate, as open areas of land are limited (as mountains and wadis surround Muscat) and many of the undeveloped areas are unsuitable for urban building. This affected the strategy drawn up in MOH Report No 4 (1991), which sought to reserve some areas for different uses to ensure coverage of the requirements for development in all sectors for the period 1990 to 2010. The acceleration of different development sectors in Muscat also resulted in confusion over land requirements and planning issues, increasing the urgent need for lands, while undermining planning quality.

In a MOH paper, Alwati (2011) claimed that the Ministry aims to improve this situation by contributing to the Omani National Spatial Strategy (ONSS). This plan is still under the remit of The Supreme Council for Planning (SCP), and other experienced agencies in this field. With regard to the management of land use, the ONSS states that restrictions on areas can still be addressed (see Chapter 6). Additionally, that social management systems are in place to manage the emigration of Omanis from different governorates to Muscat; as the capital attracts many migrants due to its modern facilities. These plans can usefully develop areas on the borders of Muscat, to include a variety attractions and services.

As mentioned earlier in reference to change of land use, the extension and creation of new plots results in a number of problems in terms of encroachment into the wadis and climate change issues. Al-Farsi and Kiymi (2007) emphasise the fact that extensions often impinge on the wadi channels or other areas inside the boundary of the floodplain, creating flooding events in urban or intra-urban areas, for example in Al-Hail. Creation of new plots or small strips inside the subdivision plans might be an essential principle to limit flooding incidence (as mentioned by P2 in Chapter 6). New owners wish to live or build commercial or industrial property in developing urban areas; however, these areas should be restricted for temporary uses, due to the need to manage floods by incorporating passages into local/subdivision plans.

In the majority of cases, the creation of new land in areas that already have open spaces between buildings creates problems related to multiple urban related issues, unbalancing the planned city structure, and ultimately causing ecological change. According to Gehl (2010), including planned spaces between buildings creates good ventilation and excellent facilities for residents and users, providing opportunities for walking and leisure. Additionally, because the creation of new lands and extensions into the floodplain area creates a problem with flooding, it is important to retain such areas as open spaces. Alwati (2011) highlights the effect of the administration's decision on issues such as planning and technical decision-making on reality (see Chapter 6). This issue has so far remained largely unaffected by laws and regulations in planning.

Certainly, the Omani planning system also faces political challenges, including administrators' technical suggestions, which could affect the strategies put in place to improve the quality of future planning systems. Table 3.4 presents the strengths, weaknesses and threats currently faced by Omani city planners.

The City Planning situation in Oman	
Strengths	**Weaknesses and Threats**
- Providing land for residents - Regulations 160/2004 and 63/2006 - MOH report No 4 (1991) - Royal decrees and Omani five-year development plans - Classification of lands for different uses	**Weaknesses:** - Lack of a clear national plan - Muscat strategy (1990-2010) not implemented - Oman spatial strategy not clear and not yet drawn up - Inaccurate survey details or negligence during site visits in the design stages of the plan - Flooding occurs possibly from natural changes to the area caused by flood events - No public participation in the planning - No clear direction for urban growth - Cooperation is very poor - Villages have developed inside the flood zone - Subdivision plans only - Ignoring planning legislation - Preference for administrator's suggestions over technical suggestions - Town planners very busy solving problems caused by previous planning mistakes and not focusing on improvements to planning quality - Mistakes occurring because of plot extensions in the wadi channels - No effective Urban Planning Guide - No comprehensive national plan for planning - No implementation of the regulations **Threats:** - People claiming compensation for lands affected by floods - Shortage of open lands in some governorates like Muscat - Claims for lands already owned - Land use change claims - Extension claims, Mistakes arising from plot extensions in wadi channels - Some governorates surrounded by mountains and wadis like Muscat - Confusion about land requirements and planning issues accelerating - Many migrants to Muscat - Damage to property - Intervention of administrators in planning issues

Table 3.4: Current situation of the City Planning in Oman
Sources: Adapted from Al-Barwani (2009), Alwati (2011) and Al-Farsi and Kiymi (2007) MOH Report No 4 (1991)

3.4.4. Planning situation and flooding

As mentioned previously, the Omani town planning system has been adapted at different times, altering the overall approach to urban planning in Oman. In view of previous problems associated with disregard for planning regulations and strategies, it is necessary to study the vulnerabilities in planning system management, to advise on the development of an integrated system (Kitchen, 2007; McMinn et al., 2010; Woltjer and AL 2007; Meijerink and Dicke, 2008; Meijerink and Dicke, 2008; Brower and Van, 2004) (see also Chapter 4). The errors that have beset the Omani planning system have heightened flooding risk and the threat to life and property from flooding events (Al-Farsi and Kiymi, 2007). These errors may have resulted from inaccurate surveys, or negligence during site visits at the planning design stages; natural changes to the area caused by flood events might also have altered the topography. The local community's failure to observe the decisions and rules made by the planning department might have created additional problems, as the inhabitants of an area often understand the wadi channels and other impediments best (see chapter 6).

Servicing and development management by individual parties occurs in some intra-urban areas of Muscat. The organisation of sewage and water channels in areas such as the Alsaroug area is visible and workable. Meanwhile, in the suburbs of the governorate there remains a need for greater co-operation, especially in those areas upstream of the wadis. Al-Barwani (2009) observed that villages have developed inside the flood zone, identifying villages adjacent to the wadis. This creates greater risk of damage arising when flooding of the wadis occurs.

3.5. Monitoring and climate reading in Oman

Al-Barwani (2009) noted that the Sultanate has a history of having recognised the importance of flood hazard mitigation measures, dating to the first rain gauges established in Muscat in 1893. Since then, rain and wadi gauges have provided data regarding water flow to different agencies, in addition to performing their essential purpose of recording the climate situation (see Table 3.5).

Region	Monitoring points										Total
	Wadi flow	Peaks	Dams	Rain Gauges	Wells	flaj	Springs	Khawrs	Discharge	Salinity	
Muscat	16	6	1	30	173	17	5	0	0	67	315
S.Batinah	21	1	9	31	111	72	16	0	0	94	355
N.Batinah	28	10	5	42	275	25	0	0	0	63	448
Musandam	6	0	5	14	53	0	0	0	0	0	78
Al Buraimi	7	1	1	14	242	18				27	310
Dhahirah	11	0	1	28	274	70	0	0	0	95	479
Dhakhliyah	18	1	7	41	347	113	6	0	0	190	723
N.Sharqiyah	13	3	0	43	211	169	0	0	40	184	663
S.Sharqiyah	5	4	1	16	183	40	0	0	0	72	321
Dhofar	10	0	1	56	238	0	37	11	139	497	989
TOTAL	135	26	31	315	2107	624	64	11	179	1289	4681

Table 3.5: The National network station data for Oman Hydro-meteorological
Source: Al-Barwani, 2009

Obviously, understanding the climatic situation is crucial to accurately predict future events and determine any vulnerabilities. Therefore, the Gulf regions have many weather stations in different areas, to observe changes in the climate and water levels. The location of Oman is very close to both the Arabian and Gulf Sea, meaning warnings about sea levels are essential. Danger can result from Asian floods and cyclone events and variations in ice melt rates, as well as seasonal temperature rises. The weather in Oman has however been overlooked previously (Hassan et al., 2008) (see Figure 3.7). The Directorate General of Civil Aviation and Meteorology, which records weather and climate change data in Oman, identifies these stations (see Chapter 6).

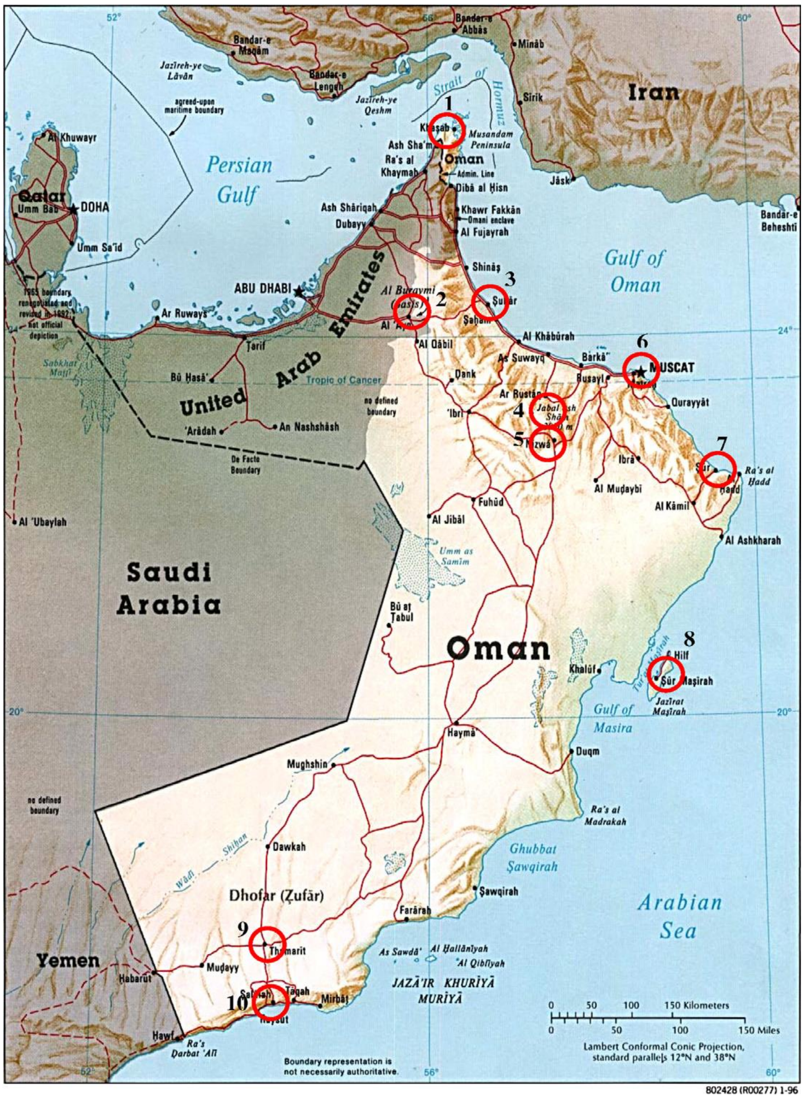

Figure 3.7: The Location of Weather Stations
Source: H.F. Hassan et al., 2008: 1686

3.5.1. Oman and climate change

What are the main issues that could affect climate change in Asian and Gulf countries?

This section discusses the role of climate change in Omani flooding. Climate change is a global phenomenon and results from emissions of GHGs associated with burning fossil fuels, changes in land use, and industrial processes (Arnella et al., 2004; WHO, 2002; David, 2004). Reducing the level of CO_2 emissions worldwide to approximately 550ppm might decrease flooding incidence by 80 to 90% in countries such as Bangladesh and India (David, 2004).

Raouf (2007) illustrated that Gulf countries are not significantly contributing to the production of world carbon emissions (proportionally they currently stand at about 2.4%). However, according to the World Resources Institute, Gulf countries remain at the top of the world emissions list when using a per-capita calculation. By effecting a decrease in emissions, the probability of natural disasters occurring in these countries, including fire risk, storms, landslides and floods (IPPC, 2007) may also reduce. In addition, unless the Gulf States reduce their emissions and put strong climate adaptation policies in place, flooding in the wadis will only worsen.

Janardhan (2007) has pointed out that predictions claim that CO_2 emissions in the Middle East will increase at an annual rate of 2.3%; and by 2030, will reach 201 billion tonnes. However, this is less than the CO_2 production of China, which will average 3.5 to 7 trillion tonnes over approximately the same period (Raouf, 2007). This huge rise in global CO_2 emissions will contribute to the problems associated with the ozone layer and climate change and may be associated with climate instability, whether in China or elsewhere. On this subject, USAID (2008) stated that the huge emissions from developing countries such as China, Indonesia and India have now become a major contributor to global GHG emissions.

3.5.2. GHGs emissions sources in Oman

The IPPC (2007) has identified the transition of pastoral-farm land, from green to drought regions, as generating further potential for desertification, thereby contributing to a rise in overall temperatures. Such a change in land use may support the absorption of CO_2 emissions; but would create another problem in the form of increased temperatures. This may not be an issue for Oman, however, since most Omani lands are already either classified as drought or semi-drought regions. The WRI (2003) observed that CO_2 emissions associated with Oman were the result of multiple factors, as shown in Table 3.7. Such emissions may be a source of significant climate change and flooding events. However, although this may be true, there is a query over the actual relationship between emissions and the rise in overall sea level; specifically, between emissions and progressive rises in temperature. Conversely, there is a query regarding whether there is any relationship between climate change and desertification in Oman. Finally, we should ask: *What is the main link between drought and flooding in this region?* Previous studies have not addressed these questions. Therefore, there is a need to consider their impact on Omani climate change, in contrast with other factors known to have a direct effect on the Omani climate, such as the inequitable use of the surface and groundwater.

In addition, The WRI (2003) illustrated that CO_2 emissions associated with Oman could arise from a number of different sources, as shown in Table 3.6.

Solid Fuels	Liquid Fuels	Gaseous Fuels	Gas Flaring	Cement Manufacture
0%	28%	58%	11%	3%

Table 3.6: CO2 Emissions by Source (1998)
Source: Summarised from WRI, 2003

Fossil fuels and the generation of liquid fuels generate huge volumes of CO_2 emissions, whereas cement manufacturing has minimal impact. Liquid fuel emissions are mainly the result of inadequacies or defects in the Omani transport system, which have resulted in multiple uses of private vehicles by the population. This has created a greater demand for new roads in all parts of the country. The rise in road development and private car use presents further challenges to the Omani government, which is aiming to provide alternative modes of travel, such as public transport. Therefore, current problems will endure until a reliable public transport network, including trains, comfortable buses, environmentally friendly 'green' cars and trams is widely available (see Chapter 7). Thus, there is a desire to reduce CO_2 emissions produced from the transport sector, to improve the climate, and as a result decrease the occurrence of natural risk events such as floods. Continuous improvements may result from improvements to other types of CO_2 sources, to protect the area from risks associated with emissions.

Source values provided by the WRI (2003) may have changed slightly, however. This is because of the significant developments that have taken place specifically within the cement manufacturing industry, leading to an increase in the number of new factories and green building techniques. Such techniques may also provide good solutions, in terms of reducing overall emissions. In addition, emissions by capita, as reported during the years 1950 to 1998, significantly increased as illustrated in Table 3.7. This resulted from various factors, such as the rise in development and urbanisation. Unfortunately, emissions have continuously increased according to per-capita emissions, as provided in 2004 (see Figure 3.8). However, overall, the Omani population is small comparative to other countries. There are also future government plans to reduce population growth. Conversely, the equation for per capita emissions may rise. Although, in practical terms, general emissions will decrease if the government improves its targets across different sectors, and if the Ministry of the Environment can play a successful role in managing environmental issues.

Country	1950	1975	1998
Oman	0.0	8.3	8.5
Middle East & North Africa	.8	2.5	4.0
World	2.5	4.1	4.1

Table 3.7: CO_2 emissions (thousand metric tonnes per capita)
Source: WRI, 2003

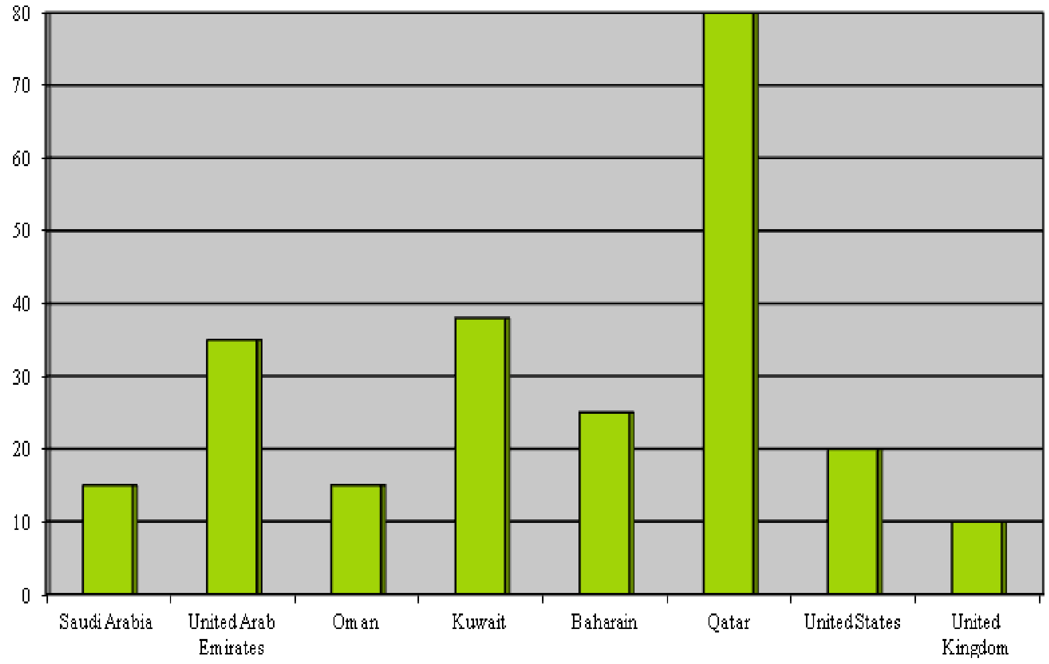

Figure 3.8: CO_2 Emissions per-capita in tonnes during2004
Source: Hertog et al., 2009

Table 3.8 illustrates that the electricity and heat production sectors account for 30% of CO_2 emissions, and the manufacturing and construction sectors for 28%. This confirms the details above, with regard to the consequences of various developments in Oman. Any new development will result in different and new forms of pollution, and will lead the government to face a number of significant new challenges. According to the World Bank, the consumption of per-capita energy in Oman rose from 4,763kWh in 2007 to 5,724 kWh in 2009. Therefore, significant growth in the demand for electricity generation within Oman has encouraged the government to make plans to meet these requirements. In addition, the government also needs to improve water capacity capabilities to meet the cumulative consumption of the population and industry. Because this is a very intensive energy consumption industry, GHG emissions will increase because of water scarcity.

Electricity and Heat Production	Other Energy Industries	Manufacturing and Construction	Transportation	Residences	Other Sectors
30%	17%	28%	12%	1%	12%

Table 3.8: CO2 Emissions by Sectors in Oman (1999).
Source: WRI, 2003

3.5.3. Temperature and sea level rise

McMichael et al. (2006) illustrated how IPPC models forecast a momentous rise in temperature by 2100, with an average expected change of between 1·5ºC and 5.8ºC. However, the International Panel on Climate Change (IPCC) (2007) suggests a rise in Asian temperatures of 3ºC by 2050 and 5ºC by 2080. This may create problems by increasing annual rainfall and global flooding; and may exacerbate dryness in lower and mid latitude countries (McMichael et al., 2006; IPCC, 2007). Table 3.9 shows the significant temperature rises predicted in a number of different Asian regions over a number of years; many related to the melting of permafrost. This evidence of the extent of the temperature change may substantiate previous arguments relating to changes in the atmospheric temperature in Asia.

Country	Region	Permafrost Temperature change/trends °C/year
Russia	1960 to 1992: East Siberia (1.6 to 3.2 m). 1960 to 2005: West Siberia (10 m).	+0.03°C/year. +0.6°C/year.
China	1975 to 1989: Qinghai-Tibet Plateau.	+0.2 to +0.3°C/year.
Kazakhstan	1973 to 2003: Northern Tian Shan.	+0.2° to +0.6°C/year.
Mongolia	1973 to 2003: Khentei and Khangai Mountains; and Lake Hovsgol.	+0.3° to +0.6°C/year.

Table 3.9: Recent trends in permafrost temperatures measured at different locations throughout Asia.
Source: Adapted from IPCC 2007: 477

The Met Office (2009) has predicted the world temperature will increase by 1.8°C by 2040 and reach 3.6°C by 2070. The IPCC (2007) report has also predicted that mean warming in Asia could average around 3°C by the 2050s and an additional 5°C during the 2080s. This may have been a significant factor in the obvious rise in the 1998 temperature by 2°, resulting in an average of 35.3°C in the Gulf countries. This rise in temperature was the largest since 1870, especially in the southern region of the Gulf.

This increased air temperature may explain the rising temperature of the surface of the sea over the last 50 years, which has risen by approximately 0.2°C per decade (Richer, 2008). Increased temperatures, combined with rising sea level in Asia, represent a serious concern for people in the region, and a threat to the ecosystem (IPCC, 2007). This will result in significant difficulties within the area, based on the frequency and intensity of geographical droughts and tropical cyclones. In addition, this temperature increase could also prompt a rise in sea level and among coastal countries, and islands, ultimately leading to the destruction of the coral reefs (IPC, 2011; IPCC, 2007).

The IPCC (2007) report illustrated how significant increases in sea levels throughout the South-East and South Asia would ultimately result in significant losses for coastal ecosystems. This could lead to a number of associated threats, relating to flooding risk for those inhabiting coastal areas, being realised, thereby affecting over a million people. Whereas, McMichael et al. (2006) clarified the expectation of global climate change over the coming decades, due to increasing emissions from a number of sources leading an increase in atmospheric temperature.

More recently, a senior environmental researcher at the Gulf Research Centre argued that the main problems encountered by Gulf countries, and those predicted in the future with regard to climate change, depended mainly on factors such as fossil fuels (IPC, 2011). He evidenced his argument by referring to the transformation of nature through developments by lakes in green areas and close to water resources. Insufficiency in these areas will expand GHG problems related to these developments, and will contribute to cyclones and flooding events. In addition, the temperature rise in Asia and in the Gulf region in particular is anticipated to increase incidences of flooding. The temperature change resulted in ice melting, in northern and southern Asia, and an increase in sea level in mid Asia, also prompting changes to land use in the Arabian Gulf (The Met Office 2009; IPC, 2011). According to MEUAE (2006), rainfall and temperatures will change in the UAE by 2050 and 2100, and rainfall is likely to increase to 5.3% by 2050 and 11% by 2100. In addition, the temperature will increase by 0.2°C by 2050 and about 0.3°C by 2100. This will increase the probability of a rise in sea level and of flooding events.

3.6. Mitigating the effects of climate change

How is Oman going to mitigate the effects of climate change?

3.6.1. Electricity and water demand can cause environmental effects

Energy consumption: The majority of the Gulf countries, including the largest oil producing countries (Saudi Arabia, the UAE, Kuwait and Qatar) have invested around 450 million US dollars in finding technological solutions to lessen the climate change phenomenon (IPCC, 2011). According to Kumetat (2009), climate change and a rise in sea level may create losses affecting fauna and flora, specifically in Qatar; or may negatively affect coral species. Thus, the IPCC emphasises that supplementary pressure from climate change in economic and political terms is potentially visible. This may relate in a significant increase in humidity and temperature and a rise in the sea level, even within the GCC.

Richer (2008) illustrated that the Arabian Peninsula is an area associated with environmental turbulence, enhanced by frequent increases in air temperature, low rainfall and strong winds. In addition, increased demand for energy in the region has always its accompanied economic growth; flexibility in energy rates in Gulf countries may explain the high rates of per-capita emissions of CO_2. This can be seen in the per capita emissions level increases in Qatar, Kuwait and the United Arab Emirates, which exceed those of the US and the UK (Figure-3.7).

The EIA (2011) predicts that energy consumption will increase significantly worldwide. By 2035, it will be around 53% more than its current level; thus, renewable energy such as solar and evaporation energy and wind farms will be an important power source to replace declining fossil energy. According to Ghaddar (2010), a number of Gulf countries are now interested in nuclear power generation (e.g. the UAE), whereas others prefer the options of solar and wind energy (e.g. the solar project built in Joubeil in Saudi Arabia (KSA)). However solar and wind energy may be safer for the environment than nuclear power generation, since this type of energy uses the natural resources readily available in the GCC. Nuclear power generation can be vulnerable when subjected to phenomena such as earthquakes or flooding; this was very apparent following the 2011 disaster in Japan. Unhealthy emissions, such as uranium, can also be extremely hazardous to human life, and the environment, and can contribute toward climate change.

Water consumption: Some sectors are likely to be more susceptible to climate change; i.e. the water and agriculture sectors. The IPCC (2007) has stated that evidence of this appears in the form of reduced agricultural productivity, due to the increase in temperature and severe droughts in a number of regions. Meanwhile, the Indian Meteorological Department (IMD, 2006) has demonstrated that the drought in Pakistan and India during 2000 and 2006 occurred because of the sharp decline in the water table. Meanwhile, the augmentation of runoff and flooding in several regions in northern Asia have resulted from global warming and the melting of the permafrost regions, in Asia and worldwide, because of effects from the Asian growth in industry. This volatility in the weather might subsequently result in consequences similar to those reported by Tariq and Giesen (2011) and seen previously along Oman's coasts.

The current poor management of water resources has resulted in many problems, effecting water consumption and water related disasters. In arid and semi-arid regions, there is a high demand for water to supply/satisfy consumption needs in various sectors for domestic, industrial and agricultural use (Raouf, 2007). The insufficiency of water resources could lead to a greater imbalance in the demand for, and storage of water resources. Conversely, countries might also suffer from increased rainfall in the form of flooding. Thus, consideration of climate change within a global context, attending to the dangers to human life resulting from the water situation is important (IPCC 2007). The Middle East has generally suffered from a scarcity of water resources, in particular the Gulf Regions and Oman, so there is a need to manage rainfall events when they occur, as demand for water resources is rising due to population growth in arid and semi-arid zones (Al-Barwani, 2009).

The widespread and heavy use of ground water sources has increased the salinity of ground water and has been responsible for the complete disappearance of springs in some areas of the Gulf. In addition, the 15 desalination plants currently operating in the seas along the coast of the Gulf countries (Kumetat, 2009) are responsible for emitting carbon and/or hot brine into the sea, which has affected marine life, triggering a rise in sea level. Table 3.10 shows the significant growth in demand for a ‘Desalination Water Supply Share’ in the Gulf States between 1990 and 2005 (Kumetat, 2009, p.3).

Country	1990			2005		
	Desalination Production (mcm)	Domestic Demand (mcm)	Desalination Demand ratio (%)	Desalination Production (mcm)	Domestic Demand (mcm)	Desalination Demand ratio (%)
Bahrain	65	103	54	122.7	133	92
Kuwait	240	303	80	589.1	610	96.5
Oman	32	86	37	67.932	170	40
Qatar	83	85	98	250.13	252	99
Saudi Arabia	795	1,700	47	1,063.28	2,458	43
UAE	342	540	63	812.61	951	85
Total	1,548	2,817	55	2,905.75	4,574	63.5

Table 3.10: Desalination Water Supply Share in the Gulf countries (1990 to 2005)
Source: Kumetat, 2009:3

There is an option to use treated water and green fuel to drive water desalination plants, to ensure they are as environmentally friendly as possible. The IPCC (2007) has shown that using natural gases instead of oil for desalination and electricity generation is appropriate. This may create an opportunity for the Gulf States to reduce their CO_2 emissions in the water and electrical sectors. Gandhidasan and Abualhamayel (2005) have reported on a successful renewable scheme in the KSA, which procured fresh water from the atmosphere using dew created by cooling pigmented polyethylene foils. This is a new trend in water production and is more environmentally friendly than the brine pumped out as waste by the water desalination plants along the Gulf Sea. This output may also help to reduce some climate change issues. Conversely, it may not be sufficiently adequate to meet all the water requirements, when compared with the products from desalination plants.

Howari et al. (2008) offered another idea to improve the use of clean electricity to nourish water desalination plants in the UAE; they suggested using hyper-saline as salinity gradient solar ponds from flat sabkhas, which surround 47% of the lagoons in Abu Dhabi. This method uses natural resources to generate clean electricity at desalination plants. These types of sabkha land may need to be reserved by the planning system for water and electrical use. This reservation of land use initiates a scheme to find alternative techniques to produce safe energy. Additionally, this will lead to appropriate land use, which could help to limit further climate change.

Because Oman is unable to separate itself from the other Gulf regions, it is necessary to explain the magnitude of the effect of CO_2 emissions and their impact on climate change throughout the whole area. The governments of GCC countries are researching this particular area to protect their countries from the danger of CO_2 emissions and subsequent climate change. Al-Badi et al. (2009) and Al-Yahyai et al. (2010) investigated the feasibility of implementing solar and wind energy in Oman. Their data, which was received from various existing weather stations (i.e. Qayroon Hyriti and Rahs Alhad), showed good potential for renewable energy. This type of energy could improve air quality in the area, shape the future electricity market and establish environmentally friendly practices. Additionally, desalination plants in the GCC could run on this form of energy.

Although responses from the GGC regions have shown climate change has been effectively studied and well managed; the trepidation arising from natural events such as flooding has led these countries to be concerned about solutions when reducing emissions associated with climate change problems. The best plans for land use involve a mixture of usage and leaving natural water channels as required. Therefore, water should be allowed to flow easily during periods of rainfall, and flooring should be protected as much as possible to prevent flooding (see Chapter 4). The following section concentrates on the relationship between climate change and flooding.

3.7. Flooding incidents in accordance with climate change in Asia and Oman

The IPCC (2007) has argued that extreme weather and temperature increases in the majority of Asia have resulted in significant climate change. Rainfall variability, changes to marine life and marine diseases have occurred as a consequence of climate change in many parts of Asia. These could also be responsible for the significant predicted reduction in crop yields, of about 10 per cent by 2020 and around 30 per cent by 2050. The decrease in the water level of rivers, such as the Changjiang, and an increase in sea-level can readily be observed. In future, this may create an imbalance, increasing the risk of human deaths and starvation. The rise in sea level in the coming 10 to 30 years of around 24% to 30% will also result in the loss of the Asian coral reefs. Additionally, Zafar (2005) found a substantial loosening of the mangrove in the south and south east of Asia during the last 50 years of the twentieth century, which matched the expectations of severe climate change. In addition, changes within the natural ecosystem have contributed to forest fires in different areas of Asia, intensified rises in temperature, and contributed to changes to the natural use of the lands. Meanwhile, the IPPC (2007) has reported that rapid industrialisation and urbanisation resulted in developing countries within Asia losing many of their natural environmental resources. This could alter privacy in these areas and affect natural land use.

The Indian Meteorological Department (2006) has shown that extreme weather events in Asian tropical and temperate countries demand appropriate strategies to enable local populations to adapt to climate change and the increased sea level. Manton et al. (2001) and Tran et al. (2005) stated that extreme weather events in the last century, and in the early years of this century, in Southern Asia and Oman were a consequence of the frequency and intensity of temperature increases during summer months (Al-Barwani, 2009) (see Chapter 1). In both cases, the frequency and intensity of tropical cyclones in the Arabian Sea and in some other parts of Asia, such as Iran and Japan had increased significantly since the 1970s. These events resulted in significant damage in many affected countries, and the recurrence of extreme weather events is increasingly likely (GCOS, 2005). Changing weather in Oman continues to be very evident; for example, in June 2015, hailstones hit Fanja, whilst just 30km away in Muscat it was 50°C. In addition, the areas of the Omani interior, such as Izky, around 100km from Fanja, experienced rainfall.

3.8. Conclusion

In summary, whilst flood events are natural disasters with life threatening consequences, when they occur in arid countries they also carry the potential for benefit if well managed. Floods can recharge groundwater aquifers and fill reservoirs. We recommend here that up to date flood hazard maps should be prepared to protect the investments of those seeking to construct new developments in floodplain areas close to the wadi channels. These would then form the basis of legislation associated with planning application administration. If Oman is to manage flooding successfully in the future, it might usefully seek out knowledge in the form of the experience of those countries already familiar with managing the dangers of floods events and related natural disasters.

Asia is contributing significantly to GHG emissions and atmospheric problems. Climate change, in accordance with increased temperature and CO_2 emissions from different sectors in Asia, and in Oman particularly have been a causative factor for floods and cyclones. Production, transportation and gaseous fuels have all contributed to GHG emissions in Asian and Oman. In addition, factories, electricity and water plants and their energy sources contribute emissions; some of which relate to water demand, and others to plans and land use. Undoubtedly, land use must be at the core of new strategies for improvement in Oman and the other Gulf countries, to protect the region from the danger of climate change. Consequently, a reduction in the effects of climate change is required to decrease the impact of natural events, such as rising sea level, floods and cyclones.

Floods events have been horrific for Omanis, but it is hoped that they will prompt the government to think more deeply about the vulnerability of the country's infrastructure, in particular concerning the location of crucial services. Such events could motivate the authorities to resolve the vulnerabilities in the planning system and to state 'mitigation of the effect of the flooding' as an objective. The record of flood events in Oman to date shows the frequency of their occurrence, establishing a need for the Omani government to focus more on national strategic planning that will result in the design of a functional and forward thinking development strategy. This chapter has established a strong relationship between flooding and climate change. This relationship derives from both the rise in temperature and that in sea level. Temperature rises can result from the effects of manufacturing, such as electricity and water production, or from poor land use management and desertification. These factors exacerbate the risk of flooding from the sea, in the aftermath of cyclones. The next chapter discusses the effectiveness of the planning system with regard to flood management and related issues.

Chapter 4

Comparative Analysis of International Plans for Sustainable Flood Management

4.1. Introduction

This chapter comprises the second part of the literature review. It focuses on urban planning and water management, covering diverse approaches that comprise good city design and flood management internationally. The conflict between planning strategies, or processes, and water and flood management requirements, can adversely affect the management of potential flooding (Nuvel and Knaap, 2010). Woltjer et al. (2007) revealed that one of the aims of spatial planning in at risk areas is to regulate flood risk by altering land use in floodplain areas. Woltjer et al. (2007) and Nuvel and Knaap (2010) state that, to improve flood management, it might first be necessary to reinforce the coordination of both spatial planning and water management efforts. This can be achieved by asking key questions: “How can the integration between spatial planning and water management improve the planning strategic work for sustainable flood management?” And, “How can the partnerships work to improve city planning to protect against flooding?” Answering these two questions is essential and closely related to the sustainability aspects of Omani flood management. Since social rights in planning are an important consideration, partnerships ensure local participation in shaping the surrounding built environment according to lived experiences (Reeves, 2005; Kitchen, 2007). In addition, people understand their own living requirements and the need to improve the surrounding area in a way that serves them and protects what already exists.

The objectives focused on in this chapter are:

- To examine the relationship between spatial planning and water management, and

- To understand the extent of the partnership effect in flood management strategies.

Woltjer et al. (2007) revealed that one of the aims of spatial planning is to regulate flood risk by altering land use in floodplain areas. Reeves (2005) strongly supported this in his discussion concerning the effect on communities and the public contribution to the implementation of spatial planning. Kitchen (2007), recommends effective integration between governments, individuals and communities, to allow everyone to participate in designing cities and appointing land use. Reeves, however, agrees with Grbant (2002) that spatial planners need to consider a number of associated fields, including economics; traditions; civic administration; and environmental protection. Woltjer et al. (2007) and Nuvel and Knaap (2010) state that, to improve flood management, it might first be necessary to reinforce coordination efforts between spatial planning and water management.

Building on the points mentioned in Chapter 3, with regard to flooding problems, climatic issues, and the current situation in terms of city planning in Oman, this chapter will explore issues related to planning management and water management elsewhere in the world. The methods used in other countries could provide applicable tools to evaluate the situation depicted by the case study. Moreover, once some of the planning management strategies used in other places have been identified, they could be introduced to contribute to Omani flood management, thereby improving both spatial planning and water management. This discussion will therefore form an integral part of the assessment process for the case study.

This chapter will focus not only on how flooding plans and strategies can deliver more effective flood management, but also on their implications for social rights in those areas subject to planning and space shaping. It will highlight incidences of flooding and the flood management strategies pursued in countries such as the UK, the Netherlands France and Pakistan, with the aim of benefitting from their experience. The review of these strategies will include examining plans and legislation passed in relation to spatial planning and water management, capacity building amongst partners, and partnership assessment. In addition, the wider experiences of these countries, including measures to safeguard the population and their property from the risk of flooding will be scrutinised (see sections 4.6 and 4.7 for more detail), and implications for Oman outlined. The chapter ends with concluding remarks.

4.2. Planning for sustainable flood management

Woltjer et al. (2007) and Nuvel and Knaap (2010) observed that to improve flood management it might be necessary to first reinforce coordination efforts between spatial planning management and water management. Therefore, to achieve this, it will be necessary to access the experiences of flood management in different countries, such as the UK, France, the Netherlands and Pakistan. These countries either have very active flood management strategies, such as the UK, France, and Netherlands, or have the same weather conditions as Oman with regard to flooding, such as Pakistan (see Chapter 3 and sections below). The experiences of different countries can provide useful data on flood management, which could be applicable to managing Oman's wadis. By combining understanding from lessons learned elsewhere it should be possible to create a multifaceted approach to the future of Omani flood management, and to benefit Omani planning systems, offering a variety of options for understanding and evaluating experiences in this significant field. When reviewing the data collected from foreign countries, it should be possible to observe benefits, conflicts and improvements associated with flood management strategies. The main objective here is to create effective spatial planning strategies that can offer Oman a functional and workable strategy for flood management.

Sustainable flood management encompasses many factors, requiring collective implementation to reduce the risk of flooding. These measures are flood risk mapping, education, engineering approaches, flood warning systems and emergency response systems. Flood management can provide safety for people living in or near floodplains and close to areas of erosion (Marino et al., 2001). In the UK, the government expects costs of approximately £15 billion annually in the absence of new steps to avoid flooding. Damage arising from failures in urban drainage systems causes surface water to collect, and so flood risk management is essential to protect cities and towns in England from flooding due to poor drainage (Government Office for the South East, 2007). In addition, when a developer receives permission to develop in a floodplain area, it is their responsibility to construct a sustainable and high standard drainage system (Carter et al., 2008). In addition, a gauging station system "peaks-over- threshold (POT)" is used in many different areas around the UK (Black et al., 2002, pp 69). This can meet the objectives of flood management as defined by Marino et al. (2001) and save the lives of people living on or near floodplains and close to areas of erosion. For example, in England one in six homes is under threat from flooding and 2.5 million properties are at risk of river and sea flooding, with half a million at significant risk of flooding. In addition, one million of these properties are vulnerable to flooding from surface water (Defra2, 2013). According to Defra2 (2013), overflowing rivers, sea rises, overflowing reservoirs, ground water flooding, and surface water flooding all represent a threat. The following sub-section concentrates on city planning.

4.2.1. City planning

Grbant (2002) commented that increasing the density of land use might be of value when categorising uses of the same type, for example, as occurs with mixed types of housing. By mixing types of housing, social interactions might well improve, as occurred during the 1970s. Kitchen (2007), on the other hand, attributed improvements in urban life to the following three main guidelines: the need for the public to be secure from development; communications between pivotal elements within the urban system; and the requirements of cities in general. In addition, Grbant (2002) recognised that the mixing of other uses with residential uses might create an opportunity for people to work and shop near where they live. Grbant (2002) shows that mixed use is the core of new developments and sustainable urbanisation; such as that which occurs downtown and in the centre of towns where planning principles are in effect, as for instance in many Canadian cities, which have had positive experiences creating cityscapes with economic and social benefits.

Meanwhile, Kitchen (2007) illustrated that successful planning must improve across three integrated areas, to result in a positive relationship between the demand for sustainable land management and good development. These areas will include improving the clarity of the planning vision, the problems and requirements of communities, and integration between construction activities and the city’s regeneration and development. In contrast, Reeves (2005) argues that sustainability in spatial planning is most effective when it meets the needs of society, analysing problems and offering solutions that also consider future concerns and approaches to the design of the built environment. Reeves agrees with Grbant (2002) that spatial planning must encompass multiple fields; such as economics, traditions, civic administration and environmental destruction.

Historically, the development of urban areas was driven by economic and social needs, supporting requirements pertaining to work, leisure, shopping and socialisation. These activities reflected people’s diversity and ability to understand their own communities. Lombardo et al. (2005) illustrated that integration between social needs and other social, cultural and economic needs are the main issues, which have contributed to shaping spaces. Additionally, Dobbins (2009) illustrates that during the nineteenth and twentieth centuries, as well more recently, the design of urban areas has been subject to three important elements, i.e. the economy, politics and society. Furthermore, modern urban design also reflects the relationship between the social and public environment, and between local and centralised institutions that oversee the planning and shaping of spaces. For these reasons, the future planning and division of urban environments must be subject to basic criteria: the culture of the people in each region, and the relationship between the population and nature. The final criterion pertains to the organisers of the places and their activities, all of which must be included as crucial to the planning and shaping of urban settings (Dobbins, 2009). In addition, cities need to be protected from flooding as clarified in the following section.

4.3. Protecting cities from flooding

Planning strategies should centre on flood management schemes, combined with land use management. Land use strategies can help to improve planning systems, and to address the problem of flooding, by leaving space for water to flow (Pottier et al., 2005). Therefore, natural channels and alterations to land use, including adapting buildings to leave ground floors empty for temporary use only, such as car parking and warehouses, can reduce loss of human life and decrease the damage resulting from floods. These strategies have been implemented in residential planning on flood plain areas in most European countries, such as the Netherlands and the UK (they are also in line with the 2000 EU Water Directive on flood management) (see Section 4.7).

Pottier et al. (2005) argued that flood management should strive to maximise the performance of catchment methods, rather than concentrating exclusively on water loss. This could allow developments to grow, even in floodplain areas, but with zoning management. An example of this would be the French planning experience, which has been in place to deal with the flooding problems since the 19th Century (Pottier et al., 2005); France has a zoning map that shows safe development areas and flood risk areas. Elsewhere, England and Wales employ a strategy for controlling floodplains based on land use strategy and insurance. This strategy of flood management has proven successful when overseen by local planning authorities and regional planning bodies (Dodds et al. 2010). This argument is subject to some criticisms, since planning in the UK has been subject to considerable censure, for allowing building on flood plains (historically). The widespread flooding in 2014 led to many questions about the policy, and raised suggestions that some areas had flooded because of failure to dredge rivers (CIWEM, 2014). Pottier et al. (2005) illustrated that there is no special arrangement informing the designing of flood risk zones in England and Wales. Regardless, development in floodplain areas has occurred (Pottier et al., 2005). Dodds et al. (2010) illustrated that similarities are very noticeable between England, Wales and Northern Ireland, especially in agriculture and land drainage, and in terms of the attitude to both, regarding the National Rivers Authority and Environment Agency.

Meijerink and Dicke (2008) stated that modern flood risk management requires collaboration between the state, society and the market, in terms of visibility and experience. This is because flood management takes place under new rationales, involving the interests of private parties and the participation of the public themselves. Often local inhabitants are very actively involved in establishing policy and legislation for development in floodplain areas. These approaches support the welcoming of water onto the land, rather than seeking to block it, differing from the strategy employed in Pakistan. The next section will concentrate on city planning strategies, which can offer an appropriate design system to ensure water can flow properly.

4.4. Strategies of flood risk management

4.4.1. Spatial planning quality and conflict

Nuvel and Knaap (2010) illustrate that spatial planning depends on two main factors, the physical landscape and the activities undertaken in that landscape. Both these factors rely on the requirements and demands of society and on the physical structures, which serve that society; such as roads and houses. They might also depend on agricultural and industrial activities located throughout an area. Conversely, spatial planning is also apparent in policymaking processes, which serve to organise the planning system to meet set objectives, such as flood risk management, transport and urban planning. In this case, spatial planning could distinguish between integrative and holistic coordination, and between different sectors to amalgamate their specific claims. For example, water retention or the requirement for a residential development. Some of these points might be associated with the works of both Reeves (2005) and Grbant (2002) in relation to planning, but do not support Kitchen's (2007) thinking regarding sustainable land management, which depends on the three areas mentioned previously (see section 4.2.1). However, this information might result in the physical organisation of space as described by (Nuvel and Knaap, 2010).

What does a good planning process depend on in relation to flooding? What conflicts could be countered with a planning system that improves planning quality and the implementation of planning strategies?

Nuvel and Knaap (2010) have illustrated that efficient planning processes depend overly on aspects that might shape planning quality and improve flood risk management. These aspects can be summarised into three areas, spatial planning and design, spatial planning and decisions and results, and the management of conflicts that might arise at any stage when planning substantive and procedural aspects. In addition, Nuvel and Knaap (2010) and Reeves (2005) clarified that conflicts can result from the involvement of "local actors", and their participation in policymaking, which determines their roles (Nuvel and Knaap, 2010: p. 284). However, Woltjer and AL (2007) and Nuvel and Knaap (2010) have illustrated that one aim of spatial planning is to regulate flood risk by altering land use in floodplain areas. Spatial planning could help to deliver regulations for the built-environment, including the zoning of lands. It may also reduce the effect of emissions by increasing the proportion of green areas.

What is a popular approach to resolving conflicts in policymaking processes and planning issues?

4.4.2. Approach to resolving spatial planning conflicts

Nuvel and Knaap (2010) and Reeves (2005) have argued that an effective approach, which can be employed to resolve conflicts that might arise in the policymaking process, could be derived from interactive policymaking. This might also significantly increase support for local stakeholders when planning. Nuvel and Knaap (2010), Kitchen (2007), and Grbant (2002) illustrated different types of interactive policymaking based on how people are influenced by knowledge, interests, norms, convictions and values. This may be characterised by the extent to which people have an opportunity to influence different styles of governance. Reeves (2005) strongly supports these assertions, arguing about the effect of communities and the public's contribution to the implementation of spatial planning. In contrast, Nuvel and Knaap (2010) argue that the style and levels of governance/participation should be dynamic, as these can change depending on the situation and time spent consulting on specific issues.

Pottier et al. (2005) illustrated that interventions by policymakers in the management of floodplains should be aimed at emphasising the most dangerous areas; i.e. those most likely to be subject to flash flooding. Their argument is that flood management should focus on maximising the performance of different catchments, not concentrate on water loss alone. By increasing and improving the efficiency of catchments in floodplain areas, it may be possible to minimise flood damage. However, strategies for developments on floodplains, as mentioned by individuals and community leaders, are interesting, since they yield a good profit from increased land values and may be very worthwhile for the government in terms of taxation, for example, when undertaking developments in coastal areas. For this reason, applying traditional solutions (such as the embankments and floodwalls used by Dutch engineers since the seventeenth century) might contribute to a reduction in the problem of flooding in certain areas (Wight, 2010; Nuvel and Knaap, 2010). This strategy may also be included in building regulations and land use planning strategies, although at the same time it is argued that such a strategy might vary from one country to another depending on culture and geography. However, on a larger scale, this approach might be very interesting in terms of protecting the area and overcoming the effects of flooding.

Nuvel and Knaap (2010) argued that spatial planning is not the only way to regulate land use; they suggested that people should work together to avoid the impact of flooding. This argument might apply to Muscat, where people take responsibility for planning to meet their requirements. However, planners should take care to observe those planning standards that already exist, i.e. in areas such as Alamerat-7 subdivision plan. Nuvel and Knaap (2010), on the other hand, have illustrated the creation of functional responsibility associated with water quality and quantity, through a hierarchical land management strategy culture; this is evident in current Dutch flood management schemes. Meanwhile, Meijerink and Dicke (2008) reported on a major national project that the Dutch government was working on, to create more space for river waters to flow, and to protect new developments from flooding.

The objectives of this approach are to avoid effects resulting from the failure of dams and dikes during flood events, and to implement the EU Water Directive. The next section will concentrate on the role of partnership in flood management.

4.4.3. Role of Partnership in flood management

"How can partnerships work to improve city planning to protect against flooding?" This question is essential to achieve an understanding flood management, because lack of coordination between parties can create a huge gap when dealing with flood management. In addition, it relates closely to the sustainability aspect of Omani flood management. The previous chapter referred to partnerships in relation to the current unclear flood management strategy, and the lack of coordination between the different parties responsible for strategies informing both water management and city planning. A partnership strategy is important to create a collective working environment, involving different agencies that are knowledgeable about previous difficulties within the Omani planning system. Partnerships, collective work, and cooperation between different agencies is achievable.

Forchner (2006) illustrated the importance of the partnership arrangements, for their ability to overcome difficulties in policy implementation and to set out a framework for governance. However, establishment of such partnerships face many challenges, in terms of resources, political issues and continuity, for example. In contrast, other authors (e.g. Davey, 1998; Edwards et al., 2000; Carley, 2006) consider that partnership is the main organising principle of local governance and can strengthen relations between the various institutions and individuals in the development and regulation of villages and rural development. A partnership that works in one place or country may not work in another (Forchner, 2006); although highlighting examples of effective partnership relationships could result in the identification of transferable features.

During the 1990s, partnerships became a principle tool for achieving the organisation of local governance and relationships between different institutional stakeholders and individuals in Scotland (Carley, 2006). They are currently used in the development and regeneration of neighbourhoods and villages and could be a primary strategy in the development of rural regeneration (Edwards et al., 2000; Carley, 2006). The relationship and engagement between planning and local communities could improve planning issues and services on the one hand, whilst meeting community ambitions on the other. However, in most cases, partnerships focus either on strategies for general services and private property, or on future visions and plans (Carley, 2006). For example, partnerships in Scotland became a main factor in determining funding for many services, such as "Social Inclusion Partnership (SIP) funding from the Scottish Executive to European Regional Development funding" (Carley, 2006: 251).

According to Forchner (2006, p.4) a partnership may be initiated using two approaches: either "bottom-up" or "top-down". At the country level, a "bottom-up" approach can be created according to local requirements; for example, residential community groups may arise from the collective efforts of the householders themselves. The alternative approach is that a partnership may grow from "top-down"; this type of partnership is created according to government decisions, which could consolidate public and private sectors across various classes. Nevertheless, such partnerships cannot be effective and meaningful if there is no cooperation between partners, or in the event of non-application of specific goals. Partnerships in the provision of services and the social environment, as well as the renewal of cities, benefit from the accumulated experience of involved parties and are in constant evolution due to efforts that contribute significantly to their success.

Effective partnerships in flood management arise in some countries in the form of strategic cooperation between different authorities. A good example of such partnership work is summarised in Sections 4.6 and 4.7, such as the flood management cooperation in the Netherlands and Scotland. Strategies concerning water management and spatial planning and the duties of relevant agencies in the Netherlands provide a good example of shared responsibilities between stakeholders (see Table 4.1). This strategy has created good integration between water management and spatial planning, which underpins this collective work on the sustainability of city planning and flood risk management. The Flood Risk

Management (Scotland) Act 2009 is also an example of a good flood management partnership at work. The private sector and the government share responsibility with the different staff members responsible for creating flood risk plans, collecting information on flooding information and supervision procedures.

Why is partnership an important requirement in the planning system and flood management?

Partnerships between various stakeholders are an essential requirement, especially in those areas that serve the community and public; exchanges and discussion of views and the provision of information for development of concepts are vital (Forchner, 2006). This motivates different stakeholders to develop their opinions, leading to the creation of good ideas that can constantly participate in increasing the performance and survival opportunities of the partnership. Therefore, for features that are essential for community service, partnerships are organised to unify views on quality of service and the way it works. The use of partnership arrangements helps to limit individual decision-making, which, in most cases, does not adequately take into account the public interest (Forchner, 2006). Confusion can arise within projects not based on a collective opinion, with adverse consequences for all stakeholders.

Social rights in planning and space shaping partnership: The social relationships in the planning location create a kind of interdependence between social interests, politics and stakeholders, resulting in the necessity of cooperation between different groups taking into account their different experiences and experimental techniques. This cooperation, according to Healey (1997), will generate active participation between official agencies and users. This may eventually result in the decentralisation of planning and community involvement, as well as providing an opportunity for local government initiatives and for participation in planning.

Dobbins (2009) illustrated that at the beginning of the 1960s, the public began to take a role in the official decision-making process with regard to their living environment. Since that time, there have been many changes in approaches to citizen participation; particularly over the past ten years because of the development of the internet which facilitates additional opportunities for participation (Dobbins, 2009). The internet provides citizens with access to significant information to help them use their rights more effectively to participate in the decision-making process. However, Kelly (2010) has observed that such channels do not appeal to everyone. Therefore, it is necessary to employ different techniques to encourage public participation in planning, such as advertising in newspapers and at shopping centres, or through local meetings and consultancy at different stages of the project process to ensure effective community based governance (Kelly, 2010). This progress has enabled the community to transition from participating in small-scale decision-making, e.g. designing streets and neighbourhoods, to larger scale planning such as determining amenities and the character of towns and cities in a wider context (Dobbins, 2009). Dobbins (2009) has argued that to improve the quality and design of urban spaces planners should seek to cooperate, listen, and coordinate with communities through an active participation process. His argument confirms that posed by Wates (2008) regarding the importance of public participation in planning. Transparency through a democratic process can result in the improved utility of urban places and the avoidance of land use problems before they arise.

Capacity building amongst partners and achieving efficiency in the partnership: Capacity building allows people space and time to offer their ideas and provide information enables efficient identification of priorities, while also reducing the gap between the public and regulatory bodies. Piper (2005, p.5) suggested meeting objectives through the media of “publication, workshops and other events” (M1 also raises this point in Chapter 6). Additionally, within organisations, trust and the main tasks upon which partnerships rely, form a foundation that integrates diverse issues with the perspectives of members (Forchner, 2006). Consequently, waivers and flexibility in cooperation between partners could be the best approach to absorb conflicting views and proposals. To achieve all desired objectives, each member must adhere to the tasks entrusted to him or her, to activate the role of the partnership and strengthen relations. Expertise in the relevant field is essential to build a partnership and is very important to coordinate activities. Therefore, capacity building between stakeholders, when converted into acts, will necessarily improve the organisation (Albrechts et al., 2001). Healey (1997) emphasised cooperation in planning to determine key features informing the success of spatial planning, by meeting both the interests of stakeholders and institutional requirements.

To ensure efficiency and progress in any partnership, multiple considerations inform success in meeting set objectives. In addition, the sustainability of any partnership depends on each partner’s skills and experience. A partner’s skills and experience in his or her field (Albrechts et al., 2001) affects the quality and usefulness of their contribution. This also applies to the planners themselves, who must have considerable knowledge and experience of the planning system to keep pace with developments and provide expert advice for planning (Kitchen, 2007). Planners must be very conversant, not only with substantive approaches, but also with procedural guidance. In addition, planners must be well educated, with sufficient expertise to combine aspects of both experience and knowledge when discussing planning topics, to facilitate thoughtful and practical decisions upon conclusion of the dialogue phase.

Assessment and evaluation of the partnership: Brinkerhoff (2002) illustrated that the assessment of any partnership is challenging. In addition, few authors have written guidelines to apply to the evaluation and assessment of relationships or partnerships. There is a need, however, to apply a framework when evaluating networks in the public sector, to encompass assessment of the community, the participants, and the network itself (Healey, 1997; Brinkerhoff, 2002). A network evaluation could identify good or bad connections between partners by considering network outcomes, in relation to the variety of services provided. In addition, it is important to establish whether the quality of participant relationships and the outcomes related to their quality are likely to improve (Brinkerhoff, 2002). The role of the community in the network can be measured in terms of final views and proposals, which arise.

Partnership assessment methods: According to Brinkerhoff (2002), there are three main methods for assessing a partnership’s efficiency and success. Observation and assessment of programme activities, the documents used, and data analysis is the first of these methods. The second is to undertake surveys periodically, such as staff and organisational surveys, to understand the progress toward agreed indicators already identified for the partnership. These indicators can also be used to measure the degree of improvement within a partnership. The third method for assessing the effectiveness of a partnership is to interview each partner, using indicators to understand coordination, the value added by each partner and their objectives, efficiency and performance. In this case, and to use collective methods for assessment, a neutral organisation or external actor is preferred to create, design and prepare an assessment to avoid bias.

Outcome of the partnership: The success of any partnership depends upon harmony between the partners and willingness to resolve conflicts in terms of objectives. This could reflect dialogue between different partners by ensuring continuous communication in any circumstances. Achievement of outcomes based on previously identified factors is very easy to exercise in practice (Piper, 2005). Meanwhile, Brinkerhoff (2002) considered that outcomes could result from partnerships with cohesive objectives, and mutual agreement concerning services improvement. He observed that absolute legitimacy of principals and a general framework agreement is essential to avoid clashes. The next section will focus on incidences of flooding in the France, Netherlands, the UK, and Pakistan.

4.5. Incidences of flooding in the France, Netherlands, UK and Pakistan

France experienced a considerable amount of severe flooding, particularly in January 1953 (which also affected a number of other countries, including the UK and the Netherlands), resulting in the loss of many lives and a considerable amount of land. In 2010, France experienced a storm, which flooded around 50,000 ha, causing around 47 deaths (Lumroso and Vinet, 2011). Pottier et al. (2005) state that France has been addressing the issue of development on floodplains since the 19th century; therefore, it has experience managing such developments.

In the Netherlands, flooding in 1993 and 1995 forced the government to evacuate around 10,000 people from floodplain areas (Brower and Van, 2004).

Flooding took place in the UK during June and July 2007, causing over £3.5 billion of flood damage (FRMRC, 2008). Over 2.4 million properties in England and Wales are subject to risk of direct flooding from rivers and the sea, and 2.8 million properties are vulnerable to surface water flooding (i.e. from heavy rain or by rising groundwater from blocked sewers) (Defra, 2008). Dodds et al. (2010) note that around three quarters of Northern Ireland has conservation orders in place to protect coastal areas from floods and coastal erosion. A National Flood Assessment was conducted in Northern Ireland in 2007, revealing that there are approximately 63,000 properties located in floodplain areas and subject to risk of flood and coastal erosion. Coastal flooding is therefore noted as the main threat, whilst lowland areas around Loughs (such as Strangford Lough) are highly vulnerable to river flooding.

According to the Department of Communities and Local Government (2014); and the Geographical Association (2014) in 2013 and 2014, the UK experienced two very wet winters, causing widespread flooding in South England and Wales. Consequently, 7,800 homes, and around 3,000 commercial units, were flooded, costing the government £14 million to support the recovery of communities. In total, the amount allocated to local authorities to cover losses, repair highways, and conduct other emergency maintenance, was an estimated £183.5 million. The flooding in 2014, forced all agencies in the south of England and around the Thames Valley to work together in a good partnership to protect infrastructure and properties (Department of Communities and Local Government, 2014).

Tariq and Giesen (2011) have illustrated that on occasion, damage to small dams in Pakistan has resulted in flooding. They cite the example of flooding that occurred in Shadi Kor dam in Pasni, which killed around 135 people. Additionally, breaches of large dams resulted in damage across Sindah province, as floodwaters generated by return water overflowed riverbanks and embankments. This return water extended the duration of the inundation, causing considerable damage to the area (Tariq and Giesen, 2011). It has been reported that around 230 people were killed in the Punjab and a casualty rate of approximately 60% was recorded following flash flooding in 2010. Tariq and Giesen (2011) argue that this destruction and loss of life was largely attributable to a lack of disaster response planning. This lack of preparation meant that in 2010, the majority of embankments and floodwalls were washed away, resulting in considerable damage to a population ill-prepared to respond to such disasters. The use of non-structured approaches (for example, dams, as mentioned earlier in Chapter 3) could assist in avoiding the failures of dams and dikes during floods events. The next section will introduce the plans and strategies in place for flood management in the France, Netherlands, UK and Pakistan.

4.6. Plans for flood management

4.6.1. Plans for flood management in France and the UK

After severe floods in 1953 and 2010, both France and the UK improved their levels of flood risk management, focusing on river maintenance, warning operations and coastal forecasting. The Environment Agency is now responsible for managing 46,000 flood defences in England and Wales (Lumroso and Vinet, 2011).

In France, the 'Predictable National Hazards Plan-PPR' (MATE, 1997, 1999, 2002) regulates and locates hazard zones (i.e. areas exposed to flooding, along with other events, such as earthquakes) (Pottier et al., 2005, p.5). This zoning of lands with control measures is restricted according to geographical area by the French central government, to safeguard people and property from assorted disasters. This strategy of zoning also informs the spatial planning system, determining the current and future use of buildings and land under threat of flooding and other natural hazards. In addition, a new law issued in 2003 aimed to improve damage compensation strategies and encouraged the public to participate in decision-making to reduce risk (Pottier et al., 2005).

England and Wales employ a strategy for controlling floodplains based on a land use strategy similar to the French zoning policy. This strategy of flood management has the potential to prove successful, because it is organised by local planning authorities and regional planning bodies. Pottier et al. (2005), however, indicate a lack of any detailed arrangements behind the designing of the flood risk zones in England and Wales, which contrasts with the French zoning maps that reveal both development areas and flood risk areas. In Scotland, the Flood Risk Management strategy under the (Scotland) Act 2009 assigned the Scottish Environment Protection Agency (SEPA) to manage the potential effects of climate change in flood events, including creating maps showing river borders, coastal areas, land topography and land uses. The 1990 Shoreline Management Plans (SMPS) (created by Defra to construct sustainable coastal defences for the shoreline) were updated in 2001, and PPS 25 was issued in 2006, to provide additional protection of developments from flooding risk in England (Defra1, 2010). However, development in floodplain areas is also controlled by decisions relating to the planning requests (Pottier et al., 2005).

Dodds et al. (2010) state that concerns are evident in Northern Ireland; where improved flood warning measures, flood protection and risk mapping, increased spatially after the fluvial flooding of 2008. Such measures (associated with the experience of flood frequency in England and Wales) have raised awareness of flood risk amongst the population of Northern Ireland. However, Dodds et al. (2010) argue that the new law exists because the 1994 Act related to coastal protection (in force in England, Wales and Scotland) excluded North Ireland, resulting in the lack of any specific acts to manage coastal erosion. The 1973 Drainage Order, put in place a defence structure and drainage infrastructure along the majority of the country’s watercourses. There is thus a noticeable similarity between England, Wales and Northern Ireland in terms of the attitudes of the National Rivers Authority and the Environment Agency towards agriculture and land drainage. Additionally, the planning systems in England and Wales and Northern Ireland are strict concerning development on floodplains, especially where land is at risk. Risks are calculated according to the level of flooding experienced in each geographical area, and current plans aim to eventually safeguard both the public and property from the risk of flooding (Dodds et al., 2010). The following section examines Flood Risk Management in Scotland.

4.6.2. Plans for flood management in Scotland

The Flood Risk Management (Scotland) Act 2009, identifies a specialism for each partner, includes limits, and is under the supervision of Scottish ministers. The Scottish Environment Protection Agency (SEPA) and other authorities are required to prepare a number of strategies and plans for flood management. They need to adapt to 21st century urbanisation, protect Scotland from future flood hazards, and meet the European EU Water Framework Directive (The Flood Risk Management Act, 2009). As a result of the new Act, the Scottish Government has distributed flood management to a number of key partners (including SEPA; Scottish Water; Local Authorities; and flood management groups), to ensure its effectiveness in protecting land, property and human health from the risk of flooding.

Planning for flood management in Scotland relies on an effective partnership of members from both the private and government sectors, as supervised by the Scottish Parliament (Flood Risk Management (Scotland) Act 2009). SEPA, Scottish Water, local authorities, and a number of other groups, participate in the following: providing technical advice; creating policy; advising on flood management; and visiting different areas to provide information. Each of these parties has a different duty to perform, thereby providing SEPA with relevant information and data, while all participate in the achievement of the general aim of flood management. Scottish Water, for example, is responsible for managing water volume and the types of sewerage systems in use in all the areas identified by SEPA, in consultation with other partners. Meanwhile, local authorities are required to prepare maps for water bodies (such as ground, surface and seawater) taking into account any change in the water levels and any emergencies, such as floods.

SEPA is responsible for the identification and evaluation of areas at risk of flooding, climate change calculations, and the preparation of maps, both for watercourses in general (i.e. for river corridors, coastal areas, use of lands and topography) and for flood zones specifically, both before and after flood events. Although different members of the partnership provide information, SEPA acts as a central body under supervision of Scottish ministers, receiving all recorded information and data (Flood

Risk Management (Scotland) Act 2009; SWFRAR 2, 2009). This system is comprehensive, with high levels of cooperation between the agencies involved. It therefore provides a useful example of a possible sustainable flood strategy for Oman.

4.6.3. Plans for flood management in Pakistan

There was no clear comprehensive national flood management plan in Pakistan before 1978. After this date a strategy intended as a '10-year National Flood Protection Plan' (NFPPs) was initiated. This is a long-term national plan concentrating on three aspects: (1) flood management; (2) institutional setup; and (3) legislative framework (FFC, 2010: p 13-15; Tariq and Giesen, 2011).

The Federal Flood Commission (FFC) approved criteria for the planning of new flood projects designed to address the issues associated with local flooding. Integrated measures aim to manage economic losses with the support of loans from the Asian Development Bank, at a rate of return of 12% (Tariq and Giesen, 2011). Tariq and Giesen (2011) note that flood management in Pakistan typically utilises two measures: (1) structural measures; and (2) non-structural measures. (1) Structural measures include the following: embankments; spurs; dikes; gabions walls; floodwalls; dispersions; structural diversions; delayed action dams; bypass-structures; and, canalisation of floodwater. Spurs, constructed wherever land erosion occurs to regulate the river's course, support embankments in the majority of flood areas on rivers banks. Currently, Pakistan has approximately 6719km of constructed embankment along its main rivers, protected by 1375 spurs. Flood protection bands protect towns and villages in Pakistan in conjunction with the irrigation system (Tariq and Giesen, 2011). Thus, Pakistani flood management employs a legislative and technical approach, rather than zoning and land use management. However, there is a concentrated strategy for blocking water using structural engineering approaches, with the majority of the water channelled along rivers into the sea. The following section summarises plans for flood management in the Netherlands.

4.6.4. Plans for flood management in the Netherlands

Nuvel and Knaap (2010) state that after identification of a number of areas in the Netherlands as being in danger of flooding (particularly those close to rivers), the government created a new strategy intended for use as a guide to natural water management. This was based on a European strategy, which involves leaving a natural space for excess water, to reduce the risk of flooding (Meijerink and Dicke, 2008). This also follows the Scottish practice, which accords with the European strategy (Flood Risk Management (Scotland) Act 2009; SWFRAR 2, 2009). In the Netherlands, this refers to specifically designed measures and techniques, including clearing floodplains of obstacles and the construction of water channels to bypass urban areas. This strategy is similar to Pakistan’s strategy for flood management, the objective of which is to increase the number of water channels and bypasses in rivers (Nuvel and Knaap, 2010; Tariq and Giesen, 2011).

Reeves (2005) illustrates that the Netherlands is one of a minority of countries that follows an integrated approach to planning in relation to the environment. Meijerink and Dicke (2008) suggest that the planning strategy in the Netherlands conforms to the European strategy of leaving a natural space for water to flow to reduce flood risk. This strategy might not conform to that of other countries (e.g. England) due to Defra4’s (2013) statement that development was already in place in these particular areas. Nuvel and Knaap (2010) note that the creation of functional responsibility in water quality and quantity has taken place as a consequence of current Dutch planning strategy and flood management, as it occurs through a hierarchical association of culture within a land management strategy.

The following section will concentrate on strategies and approaches to deal with flood management in each country (France, Netherlands and the UK).

4.7. Practical systems for flood management

4.7.1. The French flood management system

The 1935 Submersible Surface Plan and the Risk Perimeter System were extended into the Planning Code in 1955. The second policy revisited two serious side effects of the former policy and concentrated on hydraulic issues and allowing floods to flow away from flood prone regions. The second policy also concentrated on protecting people and property by defining potential risks associated with a particular area (Pottier et al., 2005). Compensation for those affected by a natural disaster led to concerted action, relating specifically to flooding and systemising strategies and laws from governments. According to Pottier et al. (2005), compensation legislation covers damages resulting from natural disasters, even though land use planning and flood insurance were implemented in 1982 and associated with risk zones in France.

4.7.2. The Dutch flood management system

Brower and Van (2004) state that the flood risk management strategy in the Netherlands has developed over many centuries, principally concentrating on raising dikes and drained land. They note that approximately 50 dikes exist, protecting the majority of the areas below sea level. According to its primary water policy, addressing the issue of flooding is central to the Dutch government’s agenda. The expected flood return period as defined in legislation is set at a minimum of once every 1,250 to 10,000 years. This safety level for flood management is focussed on the western region of the Netherlands, as the highest population density is found in Rotterdam and Amsterdam and the Hague; this area is also the location of much of the country’s manufacturing sector.

As well as increasing safety levels, floodplain restoration is a new management strategy. This was initiated after threat from flooding in 1993 and 1995, which forced the government to evacuate around 10,000 people from floodplain areas. This also supported existing engineering approaches, including the long-term strategy of strengthening and raising the dikes. The new approach is to allow water to flow during flooding in a natural dynamic manner, rather than along canals, as was the case in earlier attempts at flood management. Changing land use and restoring the restoration of floodplains has afforded the population many opportunities to learn how to live with floods, and has also led to a number of benefits, in the form of the creation of wildlife habitats and recreational areas (Brower and Van, 2004). This method differs from the Pakistani strategy which welcomes water onto the land. Meanwhile, a new strategy, described by Brower and Van (2004) was extended into the 1998 National Water Policy Document. This national strategy concentrated on enhancing natural development by increasing water system resilience, and then by improving the relationship between policies associated with nature conservation, physical planning and water. This concept is representative of effective spatial planning and the positive management of land use (Reeves, 2005; Kitchen, 2007).

It is apparent that planning improves when considering the development of cities and local factors, resulting in effective town planning and public participation. This improves confidence in the government among the public and stakeholders, thus resulting in higher levels of agreement of the implementation of policies in the field. These objectives have also been approved by consultant committees, as discussed in 'Water Management Policy in the 21st Century' (Brower and Van, 2004: p.2), published in December 2000, relating to the committee report in August of that year. This new water policy includes such documents as: 'A Different Approach to Water'; 'Dynamic Coastal Management'; Room for the River'; 'Water Storage' and 'Spatial planning Memorandum' (Woltjer and AL, 2007, p. 214). Brower and Van (2004) argue that the committee did not include a number of important issues related to flood events, such as climate change, sea level rise and land subsidence. Woltjer and AL (2007) observe that it is significant that the national committee recommended the storage of water and its retention in the rivers and near cities, for future use (e.g. gardening and recreation). These issues were set out in an organised manner by the government in the new 2000 policy. This policy also approved floodplain restoration and changes to land use, alongside establishing approaches to the structural management of water related issues based on technical engineering.

Implementation of any new policy requires verification in comparison with related situations. Here, this applies to the case of the lower delta of two main rivers in the western part of the country, the Rhine and the Meuse. These two rivers have caused considerable flooding; thus, the decision was taken to raise and strengthen their dikes after flooding in 2003 and 2005. Brower and Van (2004) illustrate three main factors related to this policy; highlighting ecological, social and economic impacts. These factors relate to traditional technical engineering approach, as previously mentioned. In the case of the 2000 strategy, cooperation between the Ministries of Economic Affairs and Transport, Public Works and Water Management resulted in the publication of a cost-benefit analysis CAB. Brower and Van (2004) note that this publication drew on principles of economic welfare to assess large projects associated with such infrastructure and their impact on the general economy of the Netherlands.

Brower and Van (2004); Woltjer and AL (2007) and Nuvel and Knaap (2010) all agree that water management and spatial planning, are interlinked and in a number of countries come under the heading of town and country planning. Woltjer and AL (2007) discuss the ways in which recent Netherlands policy has changed from one focussed on regulation strategies to one that relates to water management and socio-cultural considerations; along with the improvement of urban development through land use management and the coordination of efforts between different parties (see Table 4.1).

Water management responsibilities				
Water boards	**Provinces**	**Municipalities**	**Companies controlled by municipalities and provinces**	**Ministries and Provinces**
Flood defence: Dikes, Dams, Dunes ***Water quantity management:*** Water level canals and streams and pumping stations to discharge the water during flooding ***Water quality management:*** Monitoring urban and industrial wastewater and water quality in canals and streams for use in activities such as agriculture and recreation	Ground water	Storm water facilities and sanitary sewage	Drinking water	Determine strategic water policy

Spatial planning management responsibilities		
National government	**Provinces**	**Municipalities**
Strategy for planning and key planning decisions	-Translate the strategies and key planning decisions into regional plans -Incorporate policies into different levels of government, such as province, nation and municipality -Further policy areas, such as transport, housing, water, industry, nature and agriculture and other related uses	Prepare the details of land use, such as roads, housing, industry, canals, parks and railways

Table 4.1: Netherlands Water and Spatial Planning Strategies and Agencies duties
Source: Adaptation of Woltjer and Al, 2007

4.7.3. The UK flood management system

Sir Michael Pitt's recommendations in the summer of 2007 aimed to provide the UK with a framework policy at both local and national levels. This included response and flood emergency plans supported by information and guidance to enhance flood management procedures. The framework states that individuals and authorities (e.g. the Environment Agency, Water and Sewage Companies, and District councils) must work together to minimise the impact of flooding, both locally and nationally. The intention is to encourage contingency planning to avoid flooding, protect the population, and alleviate suffering (Defra2, 2013).

Data collection mechanisms include passing GIS data for England and Wales to the National Flood and Coastal Defence Database (NFCDD), which then supplies a statement regarding the digital database concerning flood defences and related conditions. This database is helpful for preparing flood hazard warnings and for estimating the frequency of future flooding, as well as employed for the design of SUDS (Hall et al., 2005). Subsequent acts also legislate water and flood management in the UK (see Table 4.2). In addition, technical approaches focus on channelling surface water into natural drainage through pipes and manholes, and into treatment plants for use in agriculture (Defra, 2009). Table 4.3 lists the main agencies and their responsibilities for flood management in the UK.

Place	**Acts/ legislations name**	**Effects on People, property and land**	**Effects on environment and infrastructure**
England and Wales	Flood and Water Management Act 2010	- SUDs - Involves the public in flood management - Reduction of flood risk	-Improving the drainage system - Managing the risk of coastal erosion - Improvement of water quality -Sustainability of infrastructure
In Scotland	The Flood Risk Management (Scotland) Act 2009	- Flood assessment in Scotland - Creating maps for land topography and uses, rivers borders and coastal areas - Maps available for public inspection - Creating hazard maps related to flooding - Policymaking - Assistance, awareness and alleviation of flooding	-Studying the relationship between flood occurrence and climate change - Data collection of water situation and movement - Improving the quality of sewage systems in flooding areas - Creating maps of all water types (ground, surface, coastal) - Sustainability of infrastructure

Table 4.2: Flood management Acts in the UK
Sources: Summarised from The Flood Risk Management Act 2009; Defra1, 2010; WAG and 2010

Name of body	Responsibilities
Local Authorities (Councils)	Approving and adopting the new SUDS, alongside regular maintenance, to improve water quality, flood defences, tidal and river flooding, and providing local drainage from roads and highways
Environment Agencies (EA)	- Offering supervision to local authorities and regional authorities - Offering information to local and regional Flood Defence Committees concerning flooding matters and defence. - Preparing the NFCDD for England and Wales
Insurance Companies: Considered the best in Europe and the third globally (Treby, 2006)	- Cover personal life and properties; government insurance; flooding compensation - Considered to be the best companies in Europe and the third globally
Individuals	Decrease GHG emissions; halt development in floodplain areas; use standard drainage system in own properties; decrease change of land use; cooperate with EA and other government parties; listen to warnings concerning flood hazards; helping rescue service employees and volunteering to assist children, the disabled and the old, protecting their homes with sandbags
Internal Drainage, Department of Transport, Local and Regional Government	Members of the flood management and protection systems
Fire and rescue services	Rescue services and dealing with fires
Department for Communities and Local Government	Source of information and providing reports during flood incident on behalf of Defra, at national level; coordinating with and advising Fire Services and Central Government; providing information to the public and media
Defra	- Assess the impact of flooding; coordinate with stakeholders; ensure effective flood management practice; prepare emergency plans
Flood management groups	- Support government in creating policies and legislation and assist with implementation of the Act - Work on site with residents to obtain data and share it with government
SEPA	- Flood risk assessment in Scotland, and evaluation of flood risk management for each region - Maps for river borders, land use, coastal areas and land topography - Consult Scottish Water and other authorities within these maps - Prepare flood hazard and risk maps to monitor water movement to create a database
Scottish Water	Creation of national policies of flood management planning and warning; drainage of trunk roads and motorways in Scotland

Table 4.3: The hierarchy of the most effective agencies in the UK flood management system

Sources: Defra et al. (2003); Defra (2013); Hall et al. (2005, p.148); Huber (2004); Treby (2006); Hansson et al. (2007); Flood Risk Management Act (2009); Scottish Water (2009), Defra (2009); SWFRAR 2 (2009)

Countries that have previous experience of flood management can provide a useful model for Oman to imitate. Thus, focus should preferably be on those known to employ successful strategies with a good record of flood management, such as the Netherlands and the UK (e.g. Flood Risk Management, Scotland). Best practice from any country could have be applicable for implementation in Oman; thus, it is important to consider not only technical approaches, but also tools such as plans and strategies (see Section 7.7.4 for more details). However, the viability of transferring policies from other countries to Oman is dependent on a sufficient level of awareness of differences in culture, political issues and geography. The aim of examining practices in other countries is to help Omani planners to understand how to deal with flooding, from both the spatial planning and water management aspects. Additionally, Oman can learn about selecting agencies as partners in flood management from these countries, and about mutual plans employed to target flooding. In addition, by understanding the weaknesses in these countries' approaches planners in Oman can avoid them when considering future strategies for Omani flood management.

The UK, France, the Netherlands and Pakistan have all experienced flooding, but each country employs different approaches to manage flood events. As shown above, each country applies unique techniques to manage the floodwaters, in line with prior experience. For example, as shown above, the UK has suffered from problems with its drainage systems in some areas, particularly in England, whereas it employs some good approaches in terms of plans and strategies, as exemplified by such features as gauging station systems to control water flow on floodplains and flood defences. This can help protect houses under threat from flooding, as mentioned previously in section 4.2. For example, in England 2.5 million properties are at risk of river and sea flooding. France, meanwhile, defines hazard zones to control its spatial planning for current and future building and land use in areas under threat from flooding and other natural hazards. It represents flood risk areas on zoning maps that also reveal the extent of development in each area.

The Netherlands takes a different approach, leaving a natural space for water, to reduce the risk from flood by employing land use management strategies and coordinating efforts between different parties. This last approach also applies to Scottish flood management, where there is a good level of cooperation between the different agencies and a clear distribution of duties between them, as mentioned previously in section 4.7.4 of this chapter. The idea of preventing building on lands under risk of flooding is most applicable in areas that are not yet populated. For example, in England, the reality is that many areas at high risk of flooding are already highly populated. In 2014, approximately 7,800 homes and 3,000 commercial units were flooded, costing the government £14 million to support the recovery of the affected communities.

McMinn et al. (2010) further note that many European states continue to face significant challenges when seeking to implement flood directives, as evidenced in the case of the European Union. The EU 2000 Flood Directive aims to leave a natural space for water, to reduce the risk of flooding and water damage, requiring implementation in 2015. A number of countries, such as the UK region of Northern Ireland, are likely to struggle to implement the further EU 2007 Flood Directive, which focuses on improving flood management in member countries, by concentrating simultaneously on flood protection and drainage infrastructure. Certainly, in England and Wales, there is a gradual move from a policy of land drainage to flood defence, converting flood risk management into the management of floodplains, rivers and coasts. Thus to help countries make the requisite changes, the members of states involved in the ‘Strategic Alliance for Water Management Action’ (2009) financed a programme to deal with these issues (McMinn et al., 2010: p.1856).

Woltjer and Al (2007) observed that, according to figures from 1996, the total land area requiring future water management exceeds 19% of the entire landmass of the Netherlands. Such a large amount of land being subject to flooding could curb urban expansion; although it could also lead to the potential for floating houses, wetlands and recreational uses. As a result, a new policy is needed to guide improvements in land use, particularly beside major rivers (e.g. the Rhine) and in coastal areas. It would therefore be more effective to decrease the area required to respond to sea level rises, rather than financing engineering approaches to strengthen the structure of coastal defences. Any change in land use can open up opportunities, assuming it also provides adequate areas into which large rivers such as the Rhine can flow (i.e. at a rate of 635,000M3/second of water). Woltjer and Al (2007) note that the expected area devoted to water use in the Netherlands will increase from 19% in 1996 to 31% by 2030, while recreational areas will increase by more than 4% and green areas by a further 8%. However, this will result in food yields dropping by up to 8% in agricultural areas. Based on previous comparisons between countries in this chapter, Table 4.4 offers a critical appraisal of planning and strategies for flood management in different countries.

Principles	Name of Country				
	UK	France	Netherland	Pakistan	Oman
Land use strategy and planning sustainability	✓	✓	✓	Non	Weak
Legislation and strategies in planning and water management	✓	✓	✓	✓	✓
Technical engineering approaches (dams, defence structure, drainage infrastructure, water channels, dike)	✓	✓	✓	✓	Some effort Concerning dams and defences
Integration between water management and spatial planning management	✓	✓	✓	✓	Poor
Plans for flooding and leaving space for water to flow	✓	✓	✓	✓	Very little
Spatial planning implementation (planning vision, analysing problems, offering solutions, society's needs)		✓	✓	Not very well	In some cases
Strategies for flood risk management (flood hazard, flood vulnerability, flood exposure) by: keeping floodwater out of urban areas; preparing urban areas to cope with flood events; keeping urban areas away from the floodplain)	✓	✓	✓	✓	✓
Flood risk zoning map (risk map)	Under process	✓	✓	Not clear	Poor

Table 4.4: Planning and strategies for flood management in different country
Source: Original

4.8. Implications for Oman

Partnership is an approach that can be utilised in any sector; there are several established frameworks for both partnership and partner selection. It is crucial to provide the requirements of any partnership when determining their formulation. For example, the proposed Omani flood management partnerships will require cohesion across all segments of society, because flood management concerns affect multiple services. Therefore, during the preparation of such plans, the reinforcement of planning aspects in relation to the development of the national economy in general, such as the selection and distribution of land use commensurate with the requirements of the public, is critical. In addition, social representation depends on the distribution of the population, the clarification of modes of participation, and the intellectual processes involved in helping to maintain sustainability and reduce the risk from flooding. Political concerns reflect the relevant authorities' emphasis on the development of urban services and related infrastructure, viewing these as key components of the partnership hierarchy. Consequently, the contribution of all actors begins with the preparation of subdivision plans, and continues on to strategy formulation, overseeing the implementation phase, and ensuring solutions that are effective, practical and consistent with all societal, economic, political and environmental development goals. Through consensus, a genuine partnership arises; one not determined by a single individual, but in cooperation with various members of society, to ensure all political, economic and social tendencies represented.

Drawing on the above experiences, certain criteria emerge for testing relative to current planning system and flood management approaches in Oman, either involving reviewing laws and regulations or fieldwork (see Chapters 3 and 5). Coordination between different people and organisations must be the cornerstone of improvements to the planning system in Oman, to reinforce cooperation between parties. Thus, we will test the following elements in the current Omani planning system: presence of partnerships, public participation, capacity building amongst partners in the planning system, challenges that might undermine cooperative efforts, quality and survival, partnership members and their duties, skills and experience and, finally, integration between water management and spatial planning. Each of these themes will contain certain factors, which could be used to measure the effectiveness of the Omani planning system (see Chapters 6, 7, 8 and 9). Table 4.5 demonstrates the main criteria to be tested, as highlighted in the previous discussion.

Main themes	Criteria
Good planning	Shaping planning quality and improving flood risk management Quality of spatial planning (good land use management) Implementation of legislation and strategies Integration between different agencies Public participation Leaving natural places where water can flow
Good partnership	Harmony between partners Continuous communication in any circumstances Integration of economists and other specialists in various fields Capacity building amongst partners Duties, skills and experiences of partnership members
Good flood management	Collaboration, and effective partnerships Integration between planning management and water management Planning well and leaving space for the water to flow Flood risk maps Sustainable urban drainage system (SUDs) Mitigation and Adaptation Renewable energy and reducing emissions

Table 4.5: Main principles and criteria
Source: Author's own

4.9. Conclusion

The need to protect cities from flooding has long been a concern, and traditional and modern approaches are implemented globally to protect urban residents from the dangers associated with living close to water sources and seas. This chapter has explained how collaboration between the state and the local population can improve planning strategies, by ensuring policies account for cities' developmental history; local factors; town planning achievements; and allow for public participation.

Zoning strategies were recognised as unique and effective planning measures, to protect populations and buildings located in areas subject to flooding and related natural hazards. The chapter also acknowledged that spatial planning is essential to understand the relationship between traditional land uses and successful urban development. Oman currently experiences planning and development problems with regard to both water and planning management.

Indeed, evidence shows, the planning system globally experiences conflict between planning strategies and processes and their effect on water management and flood management. Good planning processes rely on improving planning quality and flood risk management strategies. Interactive policymaking is of benefit in this context, as it can reveal how people perceive, and interact with, their environment, and ensuring planning decisions are transparent.

France, the UK, Pakistan and the Netherlands have all experienced flooding, and each country has dealt with it in a different way. After flooding in 1953 and 2010, France and the UK both reviewed their flood risk management strategies, including river maintenance, warning operations and coastal forecasting, while in France the zoning map outlines both areas under development and those at risk of flooding. In Scotland, the 2009 Act allocated SEPA to consider climate change predictions and the effects of flooding, creating maps showing river borders, coastal areas, land topography and land use, and allocating roles to various authorities and groups. In the UK in 1990 (updated in 2001) Shoreline Management Plans were created by Defra to construct sustainable costal defences, with the 2006 PPS 25 provided increased protection of developments from flooding risk. In addition, the UK plans to reduce GHG emissions (the greatest cause of global warming) and thus influence factors relating to the impact of climate change, which leads to unstable weather and environmental damage.

Strategies and approaches to deal with flood management exist in many countries, including The Flood Risk Management (Scotland) Act 2009; the Flood and Water Management Act 2010 in England and Wales; the Netherlands Water and Spatial Planning Strategies and Agencies duties. In addition, the hierarchy of the most effective agencies in the UK flood management system illustrate the fact that the use of traditional engineering as a solution to provide flood management is applicable to urban and rural areas, as evident in both the UK and Pakistan. The EU 2000 Flood Directive proposes leaving a natural space for water, to reduce both the risk of flooding and water damage (implementation was required by 2015).

The combined efforts of different planning agencies can provide effective city zoning to reduce the likely impact of flooding, by ensuring that each area conforms to its planned use. Spatial planning and land use are therefore effective strategies for managing water if implemented in urban areas. Meanwhile, the use of natural channels and alteration of land use (i.e. leaving ground floors for temporary uses, such as car parking) will assist in the dispersal of floodwaters through urban drainage and into surface water sources.

To decrease the conflict facing flood management and to improve spatial planning, it might first be necessary to reinforce coordination between both spatial planning management and water management to integrate these two sectors effectively. A good partnership must combine a good choice for members with good targets set for partnerships since their inception. Therefore, a successful partnership in any field must combine several factors, including the efficiency of partners and programmes. The provision of services to the public may encounter certain challenges that can be addressed through the involvement of influential actors and members of the community, and, through them benefits can be provided to the public. Despite this, the application of integration policies may conflict with different interests, but a good relationship between the partners and a good application of the concept of partnership in terms of concessions can result in cohesion and positive outcomes.

Improving awareness between different partners when planning developments can ensure environmental protection is a priority. In addition, by providing partners with more time and space to consider their ideas and provide information, trust can be built. Moreover, assessment of partnerships can be measured by evaluating community contribution, participants, and frameworks, all of which relate to dimensions connected with culture, society and logic.

The following chapter will explore the current Omani flood management structure.

Chapter 5

How Effective is Omani Flood Management?

5.1. Introduction

Flood management measures provide a safety net for people living in or near floodplains and close to areas prone to erosion (Marino et al., 2001). According to Nuvel and Knaap (2010), poor water management during planning can result in huge problems related to flooding. They observe that spatial planning is not the only way to regulate land use, and suggest that people work together to mitigate the impact of flooding. Water management and spatial planning must be worked on in parallel to improve flood management systems (Woltjer and Al, 2007; Nuvel and Knaap, 2010). According to Meijerink and Dicke (2008), flood risk management requires collaboration between the state, society and the market to keep floods out of urban areas (see Chapter 3). This chapter addresses the research sub-question, *"How effective is Omani flood management?"* through the following sections: Tools of good flood management; Omani Current Flood Management; Emergency Plan for Flood Management; Current Water Management Strategy and Strategy and Plans for Flood Management in Oman. The chapter also appraises the capability and effectiveness of flood management measures in Oman, the tools employed to cope with flooding, the coherence between agencies and the strategies and policies guiding flood management practices.

This chapter is the final chapter in the literature review; it addresses the themes proposed in the previous chapters (Chapters 3 and 4) focusing on flood management strategies currently in place to manage flooding in Oman. It references the previous chapters when examining flooding risk, causes, response level, and strategies for flood risk management and future improvements in flood risk management (see Chapter 3). This chapter concentrates on the Omani context.

The information presented here is available on government websites and those of the different involved parties (both Ministries and government agencies), and in conference papers and additional resources as cited throughout the chapter. The researcher's 15-year experience in the field of planning also informed the interpretation of issues related to this research.

5.2. Tools of good flood management

5.2.1. Flood risk management strategy

Meijerink and Dicke (2008) stated that modern flood risk management requires greater collaboration between the state, society, and the market in terms of visibility and experience. This is because flood management is taking place according to new rationales, with the involvement of private parties and the public, as mentioned above. This shift in thinking might be beneficial in terms of governance, and might also result in flood management strategies that represent improvements compared with those employed 20 years ago. According to Oosterberg et al. (2005), flood risk management concentrates on the reduction of three main factors, flood hazard, flood exposure and flood vulnerability. The strategies for reducing these three factors are summarised in Table 5.1.

Principles	Flood hazard	Flood vulnerability	Flood exposure
Strategies	To keep floodwater out of the urban areas	Prepare urban areas to cope with flood events	Keep urban areas off the floodplain
Methods	Technical methods: by constructing hydrological projects such as dams, barriers and dikes Spatial method: which concentrates on leaving space for the water to flow	Warning and evacuation of people in floodplain areas Improving buildings and infrastructure to withstand flood damage By planning good routes between buildings	To select carefully locations for new urban areas and expansion of old ones

Table 5.1: Three strategies for flood risk management
Source: Adapted from Oosterberg et al., 2005, and Meijerink and Dicke, 2008

Meijerink and Dicke (2008) concluded that policy is essential to organise developments on floodplains, since it can reduce the probability of flooding, and reduce vulnerability and exposure to flood. Therefore, in the case of approaches to flood risk, responses to climate change and increasing flood risk are the main areas to consider when developing strategies. In addition, decision-making in relation to flood events should take into account all types of damage.

5.2.2. Mitigation measures

Chapter 4 explained that measures mitigating flood risk include technical engineering approaches such as dams and defences, and the management of wadis and dikes to reduce their susceptibility to flood risk. Good management allows water to flow in an appropriate way, by leaving a natural space available. Good management will include SUDs and ensure a ground floor level structure to reduce the amount of potential damage to people and property caused by flooding. Flood risk maps and good land use management can assist planners to take steps to decrease flood damage and reduce GHG emissions, thereby decreasing their impact. This chapter will appraise the effectiveness of the current Omani flood management planning system and flood management strategies from a city planning and water management perspective.

The UK government's Flood Risk Management (Scotland) Act 2009 provides a cumulative strategy for dealing with flood risk management. The UK's emergency flood management response plan comprises three main phases: preparation, response and recovery (Defra2, 2013). The difference between the UK and the Omani emergency plans for flood management is that the UK Flood and Water Management Act 2010 provides the framework for a sustainable strategy for flood management (see Chapter 4), whereas the Omani emergency plan focuses only on actions that need to be taken to deal with floods as and when they happen. Section 5.4 below explores the Omani emergency plan in more detail.

According to Al-Barwani (2009), despite the lack of a formal strategy for flood management in Oman, some Ministries are very active in flood management. The Ministry of the Regional Municipalities and Water Resources (MRMWR) regularly provides hydrologic data from multi gauge stations (see Chapter 2). The Ministry offers advice to other Ministries to minimise flood risk to developments. It also locates suitable areas for the construction of new dams and catchments, which sometimes, conflict with subdivision plans (see Chapter 6). Following the Guno cyclone in 2007, the Ministry placed five dams in Alamerat city to manage flooding and reduce water flow. The dams lessened the flooding that had affected some areas in Muscat, but the MOH still had to compensate the owners of the plots of land taken to build the storage and water catchment dams. The shortage of open land in Muscat has created a problem for the MOH with regard to plot compensation (Alwati, 2011). Arguably, these challenges could be avoided if a basic system was put in place to manage urban planning in the city. The following section provides an in-depth look at the current flood management system in Oman.

5.3. Current Omani flood management

Alwati (2011) illustrated that the combined Omani city planning organisation is still not very clear about how to determine sustainable strategies relative to already established developments and strategies. According to Al-Farsi and Kaumi (2007), the lack of a sustainable strategy is because planning decisions do not reflect the reality on the ground. Local authorities propose plans to different Ministries concerning the management of subdivision plans, leading to difficulties in communication and co-ordination among the separate Ministries involved in the plans.

The agencies currently involved in the Omani planning system seem to have a good relationship and are prepared for the Omani National Spatial Strategy (ONSS), in terms of subdivision plans and promoting the participation of the public in planning strategies. According to Al-Barwani (2009) and Alwati (2011) the level of collaboration is still not sufficient, and more effort is needed to ensure an effective management planning system. This research will propose ways to improve the coordination between agencies involved in the Omani planning and flood management, damages and flood management and emergency flood management plans. Such suggestions should help to safeguard people and their property from the significant threats that Oman is expected to face in the future. Random torrential flooding and storms affecting the majority of the Omani coastline require increased contribution from planners to assess events from multiple perspectives, including health and treatment, occupation, rescue, communication and accommodation for the people who are affected. Therefore, the current Omani planning system for flood management functions as three different plans: actions to be taken during a flooding event, which can classified as an emergency plan; a city planning and water management plan; and a flood management plan. There are challenges associated with each of these plans that require further review. The section below focuses on the emergency plan in case of flooding.

5.3.1. Emergency plan for floods management

Al-Barwani (2009) discusses the plans in place for flood management in case of flooding. The National Committee for Civil Defence (NCCD) was established to deal with national disasters including flooding. The committee is chaired by the Inspector General for police and members of different Ministries and organisations including: ministers, undersecretaries and employees in the fields of finance, information, education, social policy, regions and municipalities, transport and communication, health, the interior, DGCD, the armed forces, the Dhofar Municipality, the Muscat Municipality, SQU, oil and gas, trade and industry, and housing electricity and water. The committee members and Chairman worked together very closely during the Guno cyclone. They sought to give advice and clear information to people, to save them from the floods especially in those areas threatened by the cyclone. According to Al-Barwani (2009), the committee created three emergency plans: the first to be implemented before a cyclone, the second to run during a cyclone and the third to resolve problems following a cyclone.

Before the cyclone hit, an NCCD emergency meeting took place to discuss how to manage the predicted disaster; this was particularly concerned with avoiding loss of life. A main operations room was set up in Muscat connected to the subcommittee’s operation rooms in those areas at risk. Additionally, different media channels informed people about the danger of the cyclone, directing them to set up shelters and create plans to evacuate people from the areas under threat, so that they could travel to safe places using helicopter ambulances. During disaster scenarios such as this one, people require food, water and medical attention and care must be taken to ensure there are no deaths due to the lack of such basic requirements. Therefore, the NCCD not only placed some helicopters, ambulances and vehicles on standby to evacuate people from affected areas (Oman TV, 2012) but also communicated the availability of shelters to the public and coordinated the transportation of food, water and medical supplies. According to FEMA (2007), alternative accommodation should have onsite resources to meet critical needs such as portable water supplies, local wireless communications and emergency power generators.

Additionally, during the cyclone the media kept people up to date about the progress of the cyclone, particularly through Oman TV and Radio (Al-Barwani, 2009). This information proved very helpful in assisting the public to understand the gravity and scale of the event and in keeping people from venturing into places that were flooded (FEMA, 2007). Through emergency calls received from different areas affected by the cyclone, the operators in the main operation rooms and subcommittee operation rooms were able to send messages to helicopters, ambulances and vehicles to evacuate people from affected areas to safe areas and designated shelters. Service reconnection was one of the main services required during the disaster (FEMA, 2007), to keep people informed of the situation and protect them from the consequences of the flooding.

Al-Barwani (2009) describes how after the cyclone the NCCD organised local volunteers to provide fuel and goods to local markets. The volunteers were also required to provide emergency supplies and rescue those affected by flooding. In addition, the volunteers helped reconnect services and repair damage, since the organisations responsible for doing so had been affected by the disaster. The NCCD concentrated on repairing damage to roads, bridges, electricity and water surfaces and the reconnection of the telephone network (Al-Barwani, 2009).

Although the NCCD was very effective in its handling of the repercussions of the cyclone and consequent flooding, the question to ask now is: *What are the* *preparations for the future?* The shelters used during the evacuation of people at risk of flooding were school buildings, and as such were only available for short-term use. *What provision has been made for those people who have been left without a roof over their heads for an extended period of time because of extensive flood damage to their homes?* It is important to also ask: *Why is the NCCD not a separate entity with its own employees and a mission to make long-term plans in conjunction with other stakeholders, which go beyond planning a response to emergency events and disasters*? Specialists working with relevant parties, such as the SCP, MOH and MRMWR were asked these questions (as reported in Chapters 6, 7, 8 and 9). Table 5.2 details the flood management situation in Oman from three perspectives: strengths, weaknesses and challenges.

Table 5.2 below shows the strengths of Omani flood and water management in terms of available technologies and strategies. However, the system also has weaknesses in terms of project implementation. In addition, it is clear that many challenges have combined to undermine the efforts of the government in relation to people's properties, as apparent from the cost of damages when flooding occurs.

Principles arising from Chapters 3 to 5	Strengths	Weaknesses and challenges
Current Omani flood and water management	- MRMWR has hydrologic data from multi gauge stations - Locates suitable areas to construct new dams and catchments - Rain and wadi gauges, first rain gauges established in Muscat in 1893 - Adding bridges and floodwalls around the Alqurom commercial area - The creation of The National Committee for Civil Defence (NCCD) to deal with national disasters such as flooding - During Cyclone Guno (2007) the NCCD created three emergency plans: before the cyclone (appointing shelters, creating plans to evacuate people and provide medical attention and water); during the cyclone (evacuating people and providing supplies) and after the cyclone (resolving problems created by the cyclone such as accommodating displaced people and providing emergency services) Urban Planning Guide (SCTP, 2000)	**Weaknesses:** - Poor coordination between the different government parties in planning and water management - On occasion dams are in conflict with subdivision plans. - Non-completion of projects could contribute to further damage to those plots affected by flooding - Wastewater management still does not cover all of Muscat - Flood zone maps very poor - Drainage system very poor - Disconnection of the infrastructure such as roads, the telephone network and communications - No sustainable strategies for flood management **Challenges:** - Repairing the cost of damages caused by floods - Compensation - Current damage from flooding is caused by coastal erosion or huge tidal flooding and flash flooding - Floods represent a significant threat to property and human life - After the cyclone people were very disappointed by the scale of the disruption caused to their homes and families

Table 5.2: Current flood management situation in Oman
Sources: Summarised from SCTP, 2000, Al-Barwani, 2009, and Oman TV, 2012

5.4. Current water management strategy

What is the strategic work that Omani water management employs currently to help in flood management?

The water management system in Oman has passed through various stages of regulation and licensing, which have greatly helped the country to retain its water reserves (MRMEWR, 2005). These are vital because Oman is located in a semi-arid region with very little rainfall. The demand for water is high, with nearly 80% of the supply going to the agricultural sector (see Chapter 3and 7). Therefore, the government is always seeking to establish good water management practices, to conserve as much water as possible and re-use it in different areas of daily life. A key measure taken has been the construction of 143 protection, recharge and storage dams, with further dams planned, including 7 dams in Alamerat. Additionally, the government has been searching for good irrigation methods to help save water (MRMEWR, 2005).

Some conflicts have arisen between water projects and housing projects in certain areas. This is the result of encroachment of water projects in planned areas, requiring the availability of multiple plots for distribution in compensation, especially where subdivision plans are unavailable and land has not yet been built upon, as in Alamerat. In addition, there are difficulties arising in areas with funds where the land is already built up, for example, in Al-Hail.

5.4.1. Zoning map

Currently planners must manage both large and small risks of flooding, to improve planning quality that responds to changes. Al-Farsi and Kaumi (2007) and Al-Barwani (2009) present a flood risk zones map of Muscat prepared by the Ministry of Water Resources experts in 1992, before it was consolidated as a regional municipality. The level of risk is signalled by the colours used (red, yellow and green). These maps have not been updated to the best of the author’s knowledge. Figure 5.1 depicts the flood risk zones in Muscat. These maps could be very useful to different Ministries, especially the MOH and the Supreme Committee for Town

Planning; helping them to take measures to minimise flood risk. They could also help developers evaluate the sites they are developing, to plan how to protect their developments; they reveal whether land planned for development is subject to a low, medium or maximum flood risk (Al-Farsi and Kiymi, 2007). The flood risk map shown in Figure 5.1 below needs to be updated to cover all governorates, especially those frequently affected by floods, to minimise the damage caused when developments are located in unsafe areas.

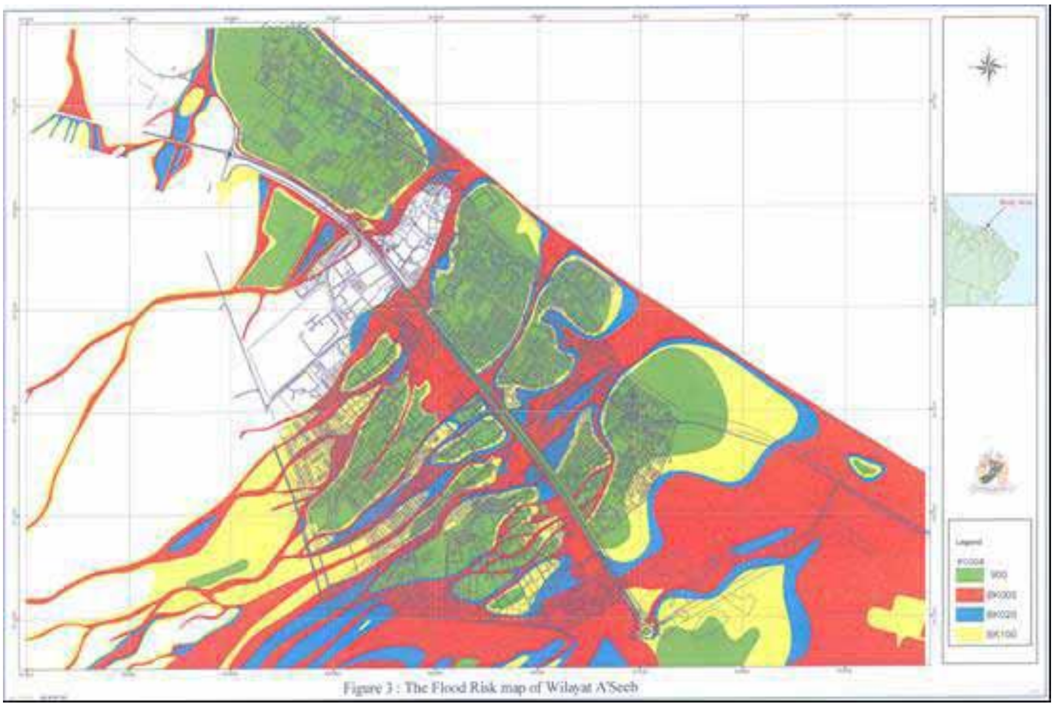

Figure 5.1: Flood risk zone map in Wilayat Alseeb made in 1992
Source: Al-Barwani, 2009

5.4.2. Water management and strategy

According to His Majesty Sultan Qaboos' speech on National day, 18 November 1991, water is a national asset, and therefore the preservation of water resources remains the priority of the Ministry of the Regional Municipality for Water Resources. Royal Decree No 82/88 protects water resources, as do the additional Royal Decrees: No 29/2000, which offers protection to water resources, and No 114/2001, which is a comprehensive law pertaining to the disposal of wastewater containing solids, hazardous waste, and environmental pollutants for sewage treatment (MRMWR, 2012). The laws relating to water and environmental management affect all the Ministries, and should be prioritised when developing a planning system to avoid any conflict between developments and water preservation strategies. To this end, the good relationship between Ministries such as the MOH and the Ministry of Regional Municipality and Water Resources have been beneficial in creating solutions for planning and water management.

Additionally, Royal Decrees Nos 82/88, 29/2000, 114/2001 and Planning Directives Nos 160/2004 and 63/2006 have proven useful in terms of the implementation of water management plans (Al-Shueili, 2011; Alwati, 2011). The flood zone risk maps prepared by the Ministry of Water Resources in 1992 (Al-Barwani, 2009) provided guidance on areas already under threat of flooding prior to the zoning exercise. Furthermore, MRMWR (2005) claims that the Supreme Committee for Town Planning established a new strategy to provide guidelines for development in floodplain areas. Oman usually experiences flash flooding or coastal flooding. For this reason, and to protect the stability and sustainability of ground water supplies, the government must strive to collect floodwaters. To do so there are a number of dams spread across Oman's Governorates; including 67 surface storage dams and 32 ground water feeding dams (MRMWR, 2011). Despite the beneficial nature of many dams and the effective management of reservoirs, there are serious concerns about the management of urban areas in terms of extensions to floodplains and wadi channels. Thus, it is necessary to ask: *What is the Omani strategy for conserving water for re-use in different sectors?*

MRMWR (n.d.) explain that around 90% of Aflaj water is rainwater that infiltrates into the aquifer and recharges it. Floodwater should be used systematically as a sustainable source for irrigation, entertainment purposes and drinking water. There are also large projects in place, such as the Wadi Dhayqa dam, that contribute to good water management in Oman. These projects supply water to Muscat, but pose potential problems for downstream areas during times of flooding, as there is no dike or wall defence to protect the villages should water overflow the huge dam (see Chapter 7). Woltjer and Al (2007) argue that should these dams burst the results would be catastrophic for the people and property located downstream. Thus, the authors emphasise the need to improve flood management systems, as a link between spatial planning and water management systems. For these reasons, the specialists in water management were asked the following questions:

- *Is there currently any conflict between change of land use, extensions and the creation of new plots and water management?*
- *What is a good strategy for future spatial planning in Oman which would achieve a balance between planning issues and water management?*
- *How can water management systems be improved, based on the experience of other countries?*

Their responses are presented in Chapter 9.

5.4.3. Drainage system situation

The drainage system is very poor across the entire Omani governorate (Al-Barwani, 2009). MM and the Haya Water Company have made some efforts in some areas of Muscat; however, these have concentrated on commercial and domestic wastewater (Aquastat, 2008; Haya Water, 2011). There is no clear strategy relating to the draining of rainwater, except in relation to roads and culvert systems. Culvert systems often pose major problems in cases of flooding, as they are often placed opposite commercial and residential buildings in Wadi Ady and Darsite (see Figure 5.2 and Figure5.3), and in some cases they have been created specifically to serve particular buildings (see the case study in Chapter 8), with little attention being paid to adjacent buildings. Furthermore, culverts should be very wide and because buildings are often situated very close to the wadi and have entrances onto main roads, the culverts have become very narrow. This may be a consequence of the interests of an individual being prioritised over the interest of the public by the administrators, leading to an impact on the sustainability of urban planning. Such measures are also inconsistent with the plans approved by the SCTP, which assumes that the floor level of buildings in such areas is over a half metre above the flood level (SCTP, 2000). To address issues which would negatively affect the city if flooding occurs requires a great deal of effort and coordination between agencies and the community. This is why it was pertinent to ask specialists in MM the following questions:

- *Is there a partnership between the Muscat Municipality and the Ministry of Regional Municipalities and Water Resources to address the design, placement and size of initiatives related to water, such as culverts and dams?*

- *What is the situation regarding the main road culverts for subdivision plans and dwellings in Al-Hail? (Muscat Municipality)*

- *Why do the culverts in Al-Hail North wadis not face the same direction?*

- *Is there a published strategy/plan from the Muscat Municipality regarding an integrated sewerage network / drainage system for all areas in Muscat?*

Figure 5.2: Culvert problems in Muscat (2007)
Source: http://infrastructureglobal.com/flooding-of-the-built-environment-in-the-middle-eastern-desert-regions-guest-post-18/

Figure 5.3Problems with culverts and trenches in Muscat (2012)
Source: http://gulfnews.com/news/gulf/oman/rains-flood-streets-in-muscat-1.1290446

5.5. Strategy and plans for flood management in Oman

The Supreme Committee for Town Planning (SCTP) created an “Urban Planning Guide” in 2000, which covered the issue of flooding in its temporary proposals on protection against urban flood risk (SCTP, 2000). The wadi zones were presented in sketch form, with the different zones marked in red, blue and yellow. The sketch did not include the depth of the area to be reserved for each zone, or the type of development that could be created within each zone. Only the frequency of flooding was indicated; specifically, 1 to 5 years for areas exposed to floods of the utmost gravity, 6 to 20 years for areas exposed to floods with an average risk and areas exposed to floods of low risk (SCTP, 2000). Other than this, no mention was made of which areas are particularly prone to flooding, or who is responsible for the identification of flood prone areas. It is useful to have the Urban Planning Guide and the assignment of planning and flood management responsibilities among parties, but implementing actions without cooperation among parties could affect results. The Guide classified duties into three. Table 5.3 presents the parties responsible for general policies for urban planning.

Planning parties in Oman	Responsibilities	Duties
Council of Ministers	Adoption of general policies for urban planning in the Sultanate under Royal Decree No. 26/75. Delegation adopted policy for urban planning under Resolution No. 6/88.	Access to all general policies for urban planning submitted by the SCTP and adoption.
Supreme Committee for Town Planning (now The Supreme Council for Planning)	Responsible for the preparation of general policy for urban planning and associated socio- economic considerations. Presented to the Council of Ministers in accordance with Royal Decree No. 27 / 85-7 / 93.	Follow-up and develop programmes based planning. Values government land and adjusts pricing if the need arises. Consideration of proposals and policies forwarded by concerned authorities and review of reports prepared by the Technical Secretariat to implement the plan approved for cities and overcome the difficulties related to financial and operational constraints.

Table 5.3: General policies for urban planning: the different Ministries and their responsibilities according to SCTP No 9/91
Source: Summary of the Urban Planning Guide (SCTP, 2000)

Table 5.4 presents the parties responsible for managing the detailed policies for urban planning. Table 5.5 presents the parties appointed to draw up policies on infrastructural services.

Planning parties in Oman	Responsibilities	Duties
The Ministry of Transport and Housing (within Royal Decree No 26/75) (MOH)	Planning and Housing: Planning, distribution, coordination with all relevant Ministries on urban planning for all the different land uses - consider land disputes and complaints related to technical planning and provide adequate housing for low and middle-income families.	**Adoption of a planning strategy:** Regional plans: to cover selected regional centres (administrative, commercial and government). Structural plans: including those pertaining to all existing urban areas commensurate with the expected population growth linked to service the necessary infrastructure and identifying land adjacent to planned future expansion. Local area plans: local area planning and development of proposals to address problems existing in the cities and villages to expand the modern sprawl and maintain existing archaeological sites. - Planning to reduce internal migration, especially to Muscat - Future expansion and continued development economically, socially and environmentally - Compensation for affected land. ***Public Housing:*** Provide various land uses near existing areas to avoid the costs of key services. Also take into account the future needs of the land in coordination with the Ministry of Agriculture and Water Resources (not accept infringement on agricultural land) and with the private sector in the reconstruction of residential neighbourhoods. ***Social Housing:*** Building houses, renovating old housing stock and the granting of soft loans to low-and middle-income families without interest to build or buy a house.
Sohar Development Office (within Royal Decree No 11/85 and 91/89)	Limited to supervising the planning and land use in Sohar and matters relating to social housing.	Supervision of general planning and construction of social housing.

Table 5.4: Detailed policies for urban planning (Policies of Urban Planning): the different Ministries and their responsibilities according to (SCTP No 9/91)

Sources: Summary of the Urban Planning Guide (SCTP, 2000)

Planning parties in Oman	Responsibilities	Duties
The Ministry of Transport and Housing (within Royal Decree No 24/93) (Ministry of Transport and Communications)	Roads, civil aviation and meteorology, public transport, maritime affairs.	***Roads and maritime affairs:*** Link the Sultanate's asphalt roads networks; expand roads; supervise construction projects and road maintenance; create ports and airports and follow-up on operation and supervision; control sea pollution.
The Ministry of Electricity and Water (now the Public Authority for Electricity and Water)	Develop plans to provide water and electricity networks throughout the Sultanate.	***Electricity:*** Connect electricity and implement gradual change of diesel-powered stations to renewable energy. ***Water:*** Provide drinking water and gradually abandon reliance on groundwater; rationalise consumption; establish desalination plants and coordinate with MRMWR and Ministry of Agriculture (MA) to implement the national plan for water resources; use treated sewage water to irrigate parks and for gardening.
The Ministry of Regional Municipalities and Environment (within Royal Decree No 18/99) (now Ministry of Regional Municipalities and Water Resources and Ministry of the Environment (within Royal Decree No 18/99))	Develop municipal services and implement the provisions on the environment and pollution control; conduct studies to improve and develop the cities and spread awareness to maintain them; implement national strategies to preserve the environment and meet pollution emergencies; develop plans to safeguard wildlife in line with global developments.	***In municipalities:*** Upgrade services to a global scale and broaden the base of municipal services in various provinces, including Muscat; develop specifications to regulate construction; facilitate the issuance of Building Permits, environmental permits; promote health education; counsel citizens for the development of their communities; beautify and improve cities; take sanitation action to protect groundwater; construct internal roads. ***In environment:*** Develop national strategies to protect the Omani environment and enter in all development plans; create models for dealing with environmental accidents; protect wildlife and rare marine creatures and develop reserves; reduce noise and air pollution; educate the community about reducing pollution; provide information on the environment; share international organisations' inventories and monitor the implementation of sewage plants to avoid impact on the Falajes and groundwater.
Office of the Minister of State and Governor of Dhofar	Assist all Ministries to implement their plans through planning and coordination.	Provide infrastructure in accordance with national plans; provide sewerage network; supply water, roads, electricity network; environmental conservation; draw up specifications and standards for reconstruction.
Muscat Municipality	Ensure that Muscat development is in line with the structural plans of the MOH; implement and maintain roads and public enterprises; sanitation and disposal of all waste.	Implement Muscat development plan and provide roads and networks. Preserve the environment from pollution; protect flood-prone areas; reprocess wastewater for irrigation and gardening; general cleanliness of the city; draw up regulations and standards to regulate. Buildings; connect the sewerage network of buildings; service delivery and issuing environmental permits.
Oman Telecommunications Company (within Royal Decree No 46/99	Provide various communication services.	Provision of telephone services and follow-up maintenance.

Table 5.5: Detailed policies for urban planning (Policies of infrastructure services): the different Ministries and their responsibilities according to SCTP No 9/91
Sources: Summary of the Urban Planning Guide (SCTP, 2000)

Resolution 5/88 - 31/93 adopted interim proposals to protect the construction of flood risk; it appears in two parts: a guidance section and reconstruction requirements of areas at risk of flooding (see Table 5.6).

Methods	Construction requirements in areas at risk of flooding
Implement flood protection measures in existing urban areas prone to flooding if practicable and economically feasible; ease restrictions on reconstruction.	Acquire approval from the Ministry of Regional Municipalities and Water Resources for any project located in flood prone areas before getting final approval from planners.
There are no proposals to compensate for the losses to flooding by the municipalities which are responsible for informing the owners of danger in these flood prone areas.	Introduction of flood-resistant materials for each building that is prone to floods according to the specifications set by the municipality.
Develop criteria to determine the quality of reconstruction in any new scheme to avoid the risk of flooding.	Raise the ground level of flood prone buildings to half a metre above flood levels for all users.
Permissions for reconstruction and planning must take into account environmental considerations and the socio-economic aspects so as to ease flood damage.	The owner of any building has to add alternatives to avoid flooding for large buildings in existing areas prone to maximum-and medium-risk flooding; submit to the Ministry of Municipalities for review.
Does not allow the reconstruction of flood prone areas.	Submit proof to the party responsible for planning and the municipalities that the building will hold the power of water erosion during floods – ensure that construction will not affect the neighbouring property and infrastructure - designed in a way that allows the evacuation of residents from the building during a flood.

Table 5.6: Interim proposals to protect construction against flood risk: Resolution No 5/88 and 31/93
Source: Summarised from the Urban Planning Guide (SCTP, 2000)

It is evident from Table 5.8 that no measures have been put in place to assess the quality of the procedures adopted to protect against flood risk. There is also no mention of who will develop the criteria for the reconstruction of flood prone areas. There is a contradiction between the standards and the fact that reconstruction is disallowed in flood prone areas. The requirements for reconstruction in flood prone areas include: a site study and a presentation to the planning authority for their review and the approval of the Ministry of Regional Municipalities, especially in relation to medium and maximum risk areas. The medium and maximum risk areas are not nominated for Omani governorates, further complication the issue.

5.6. Conclusion

The agencies currently involved in the planning system appear to have a good relationship and are preparing for the ONSS by creating subdivision plans and promoting the participation of the public in planning strategies. These plans, however, are still to be made public (Alwati, 2011). This researcher recommends better coordination in future among the agencies overseeing the Omani planning and flood management systems, emergency plans and the damages caused by floods. Such plans would help safeguard people and their property against the significant threats that Oman is expected to face in the future. The random torrential floods and storms affecting most of the Omani coastline require greater contribution from planners to assess them from multiple perspectives, such as health and treatment occupation, rescue, communication and the provision of accommodation for the people hit. A comprehensive flood management strategy for Oman utilising the tools mentioned above is required.

Omani officials working on flood management plans need to heed advice such as “leave space for the water to flow” and consider policies such as “living with water”, to ensure that the systems adopted are successful. The inefficiency of flood management systems and the lack of partnership among the different government bodies involved has meant that urban planning is tentative and unstable. There is a lack of a clear, comprehensive national plan to combat flooding based on the guidelines provided by national strategies and takes into account the links between developments.

In summary, while floods are classed as natural disasters with life threatening consequences, when they occur in arid countries they also have a potential to be beneficial if well managed, as they can recharge groundwater aquifers and fill reservoirs. It is recommended that up to date flood hazard maps be prepared to protect the investment of those seeking to construct new developments in floodplain areas close to the wadi channels; these should then form the basis of new legislation associated with planning application administration. Flood risk management focuses on the reduction of three main factors: (1) flood hazards; (2) exposure to flooding; and (3) vulnerability to flooding.

The next chapter discusses the capability of Omani city planners to deal with flooding.

Chapter 6

Capability of Omani City planners to manage flood events

6.1. Introduction

This chapter focuses on the issue of *"Improving the effectiveness of the Omani planning system to cope with flooding"* and asks the key question, *"How effective is the planning system in Oman at coping with flood management?"* This question is broken down into sub-questions and discussed under separate headings below.

As shown in the literature review, good city planning requires political, economic and social integration. Kitchen (2007) argues that this encourages everyone to participate in designing cities and designating land uses. Flood management should aim to maximise the performance of different types of catchment, whilst promoting flood awareness. This requires greater collaboration, and effective partnerships between the state, society, and the market. Zoning of the city can assist the strategic work of planning agencies by reducing the impact of flooding, revealing areas to be developed, and flood risk zones. Good integration between planning management and water management, good strategic plans, and effective planning partnerships can all help to improve flood management, reduce planning conflicts and promote sustainable planning. Additionally, water and planning management strategies and plans require integration to ensure space for water to flow, to avoid flooding as the outcome of policymaking processes. Good spatial planning should respect the needs of the population and the built environment. It should also lead to the creation of an effective planning system that sustains flood management procedures as a whole.

In-depth semi-structured and unstructured interviews with professionals and decision-makers in the fields of planning, water management and meteorology, as well as with representatives of different segments of Omani society, provide the source of the information presented in this chapter. Interviewees included Shura and Municipal Council members, planners, engineers, and experts in planning and water management. Additionally, a questionnaire using closed questions was distributed to people from different sectors of Omani society, and a site visit was carried out at different locations (see appendices-1 and Chapter 2 for more information). This visit focused on determining which planning issues might be contributing to flood risk. This chapter displays graphs and tables derived from the SPSS analysis based on the results (see appendices-1).

According to the literature review, governmental and nongovernmental agencies share the responsibility for flood management in Oman. Unfortunately, every party works independently, and in isolation from the other parties involved.

The next chapter will discuss the effectiveness of flood management techniques, such as water management, drainage management and integration between water and planning management, and provide general comments about the Omani planning system. Meanwhile, this chapter concentrates on essential aspects related to the Omani urban planning system's impact on successful flood management. These aspects include:

- The reality of Omani planning system operations; the effectiveness of the current city planning system in Oman;
- The contradiction between planning and the finished reality; the Supreme Council for Planning and the development of the national comprehensive strategy;
- Illegal land holding, and the public role in planning mistakes;
- The extent to which the Omani city planning system is creating environmental problems and flooding; and
- Current planning challenges and ways of improving Omani city planning to cope with flooding.

The chapter ends with concluding remarks.

6.2. Relationship between Chapters 6 and 7

As mentioned previously, in Chapter 4, the success of flood management depends upon integration between city planning and water management. These departments must work together closely to avoid risk from flooding. Therefore, this chapter and Chapter 7 will integrate planning and water management, concentrating on city planning and associated issues, such as those pertaining to the current city planning system in Oman, which will be reviewed in this chapter. Additionally, water management challenges and related issues, such as the effectiveness of water management and the drainage system in Oman will be clarified in Chapter 7. By detailing both city planning management procedures and water management processes in Oman it will be possible to establish cooperative Omani flood management in Chapter 7 (see Section 7.7).

6.3. How the Omani planning system really operates

Omani planning policies take the form of strategies that comprise five-year plans, to which all government departments contribute (for further information on the five-year plans refer to Chapter 5). These plans provide guidance and a schedule to meet legislative, financial and administrative targets within the next five years. No national plan, similar to the national plans of Scotland and the Netherlands, yet exists in Oman to provide strategies for urban development and urban design. Although an Urban Planning Guide SCTP was released in 2000, this is not implemented. However, as mentioned by the General Director of the High Supreme Council for Planning (SP1) and the General Director within the MOH (P1), and various planners, the High Supreme Council for Planning is currently working toward a comprehensive national plan to cover all aspects of Omani urban planning, and guide the development of the country (see section 6.5).

In the absence of a national plan, the five-year plans offer the only guidance for city planning proposals, water management and the management of the drainage system. The plans align with the visions of those in charge of relevant institutions. The individualised nature of the planners' efforts often result in different views, and, even, the implementation of mistakes by each agency, as well as an overlap in duties, as mentioned by Shura Council Members and the General Director of the Ministry of Regional Municipalities and Water Resources (W1) (see below). The interviewees also mentioned a lack of information exchange and techniques, to allow different agencies to work together on projects related to flood management. This, and other issues related to urban planning, will be explored through the views put forward by both professionals at the relevant institutions, interviewees, and questionnaire respondents, who have no particular expertise in the field. The findings will be related to the findings from the literature review. The strengths and weaknesses in city planning management, with regard to the aspects that affect the flood management strategy will be analysed, to determine how readily and effectively city planning deals with the issue; this will be reviewed in the following sections.

6.4. Effectiveness of the current city planning system in Oman

The interviewees stated that the current Omani planning system dates to the 1970s, when the system of dividing lands between local people shifted to the adoption of strategies and urban design, as stated in Chapter 5. According to the city planner from the Directorate General of Planning and Surveying (P6), *"The current Omani planning system started at the beginning of the modern renaissance of Oman in 1970. In the eighties, city planning began very modestly, with a number of detailed plans which were extensions of the towns and villages*". The interviewees and the planners, varied in their assessment and evaluation of the performance of prior city planners (see the following contents of this Chapter). SP1 commented that the planning system in Oman is undergoing a restructuring process, which includes the redistribution of tasks.

According to SP1, one of the top decision-makers in the Omani planning system, *"there is no clear legislation pertaining to urban planning in Oman, and experiences have been individual, so planning needs to be restructured and a new planning guide, to be implemented by any planner should be created"*. This statement shows the necessity for a radical change, not only to transform the planning system itself, but also to manage the system of planners' developments, as will be explored further subsequently.

Another planner (P7) spoke about the fact that old subdivision plans were too crowded, with very small plots and very narrow roads. The width of the plots was only *"10 m, for example Alkhaware's blocks 17/1 and 17/2"*. This led to a lack of future planning for additional services, such as drainage systems and other requirements. In addition, as explored in the Chapter 5, planners seem to have been more concerned with a need to distribute plots and meet peoples' requests for different plot uses, rather than ensuring the sustainability of urban plans. They did not follow the planning guide created by the Supreme Committee for Town Planning, which provides detailed guidelines on plot heights, and road widths (see Table 5.6). The reason some interviewees, including planner P4, consider Omani city planning, flawed from the foundations up, is because urban planning principles have not been followed, even in Muscat.

Urban planning, as discussed in Chapter 4, has a significant role to play in most aspects of city life. Cooperation between the planning department and other agencies, who have a part to play in the development of the city (e.g. water management agencies) would acknowledge this role best. The findings from the questionnaires, however, indicate that urban planning in Oman is still some way from fulfilling this role, as shown in Figure 6.1.

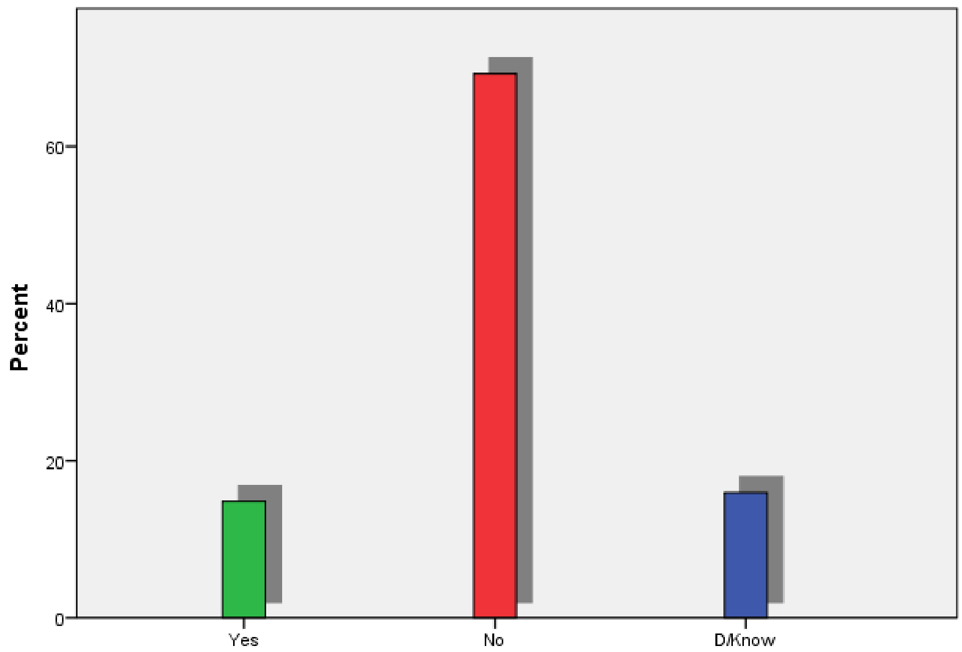

Figure 6.1: Presence of cooperation between city planning agency and other agencies
Source: The author

P1 claims that, whereas previously, cooperation happened through the exchange of opinions on subdivision plans, currently the coordination of planning activities involves the technical committee, and a national comprehensive strategy under supervision of the Supreme Council for Planning, in coordination with the Municipal Council. W1 stated, however, that poor coordination between the various agencies leads to the duplication of, and conflict between, projects, is attributable to the absence of a coordinating body.

This is another area of weakness, as identified within this context. According to some authors (Kitchen, 2007; Meijerink and Dicke, 2008), a planning system requires a unified body to issue legislation and divide responsibilities between different agencies. The Supreme Council for Planning is in a good position to take over this role, although, given the problems identified above, it could be years before the Council resolves the confusion between the remits and tasks of different entities.

According to the Director of Technical Affairs at one of the technical departments of the Muscat Municipality (MU1), and other interviewees, the distribution of plots wastes effort and time on the part of both planners and administrators in the MOH (MOH). It also ignores aspects relating to quality issues in planning. This means, not taking into account the need to leave space for services such as water, electricity, telephony and communication towers, and to mitigate the risk of flooding especially in the wadis, as mentioned earlier. A representative of the General Directorate of Meteorology (M1) commented that: *"what we have observed in the recent floods has given rise to a lot of questions about Omani urban planning, which has been the cause of much damage"*. The encroachment into the wadis may result from both a lack of coordination and a failure to share information about the location of the wadis, their runoff points and blocked passages, and the planning department's tendency to operate in isolation. However, the planners and water engineers noted that collaboration in this field sometimes occurs.

Two planning issues mentioned by MU2 and the Shura Council Member (BSM) were increasing building heights and parking shortages; these features can be observed in the Almobaila commercial areas and in Boucher near Al-Ameen Masjid. The planning department does not currently focus on such issues; it gives approval to build residential complexes and other types of buildings without regard to either of them. According to the SUDs strategies mentioned in Chapter 4, parking areas could provide options for flash flood absorption along channels, allowing the direction of water into natural passages. Parking lots can also act as assembly areas when evacuating people during flooding. According to the Assistant Director-General of the Planning Department (P2), this could be managed through the implementation of regulations obliging building owners to provide car parking spaces for all buildings within the building itself. This regulation is enforced at the design stage, but only as a measure to alleviate the shortage of parking spaces, and not as a way to address other issues, such as those related to flood management, which require a degree of coordination with the entities involved.

Floods, as Al-Browani (2009) and some other interviewees noted are not a new phenomenon to the Omani people. They are accustomed to them, and give them names such as “Jayhat Safer” (see Table 3.1 for more details about flood periods). According to M1, however, the last flood to affect Oman to the same extent as Guno occurred in 1890.

Around seventeen of the interviewees stated that Omani urban planners need to pay more attention to mitigating flood risk by avoiding natural areas prone to flooding, and increasing the number of dams. P2 stated that Omani planners have some experience with wadi channels, which they should take into account to avoid repeating mistakes. For instance, in Al-Hail, the disappearance of many of these channels caused innumerable problems during flooding after Guno and Phet; leading to all areas being submerged under water (more information about this will be given in the case study Chapter 8). P2 claimed that this did not happen because of the amount of water flooding the lands or poor drainage systems, but because of the lack of a natural discharge pathway, and because previous pathways had been filled with building and construction.

This statement from someone in P2’s position is tantamount to a confession that the planning department is culpable for flood risk, because of encroachment of the wadis. He agreed that city planners bear primary responsibility for planning in flood prone areas, and for keeping wadi channels open, but commented that the implementation of projects, such as new roads, might also channel water into urban areas. It must be noted here that, as evidenced in Figure-6.2, planners are not solely to blame for the problems caused by flooding, as sometimes plot owners building homes in the waterways cause this. This is unfortunate as main reason for planning is to protect wadis and avoid flood-prone areas.

Figure 6.2: Shows the encroachment into the wadis
Source: Author's own

Of course, it is possible that road projects are causing flooding in some cases, especially if they lack drainage systems. Around 60% of the participants consider road projects the main contributors to flooding (see Figure 6.3 below). In addition, landowners cannot be blamed for increasing flood zones if they do not have an alternative. SP1 suggested that the planning department carries out road levelling procedures for all subdivision plots, as communities do not always have the funds to spend on road levelling over and above building costs.

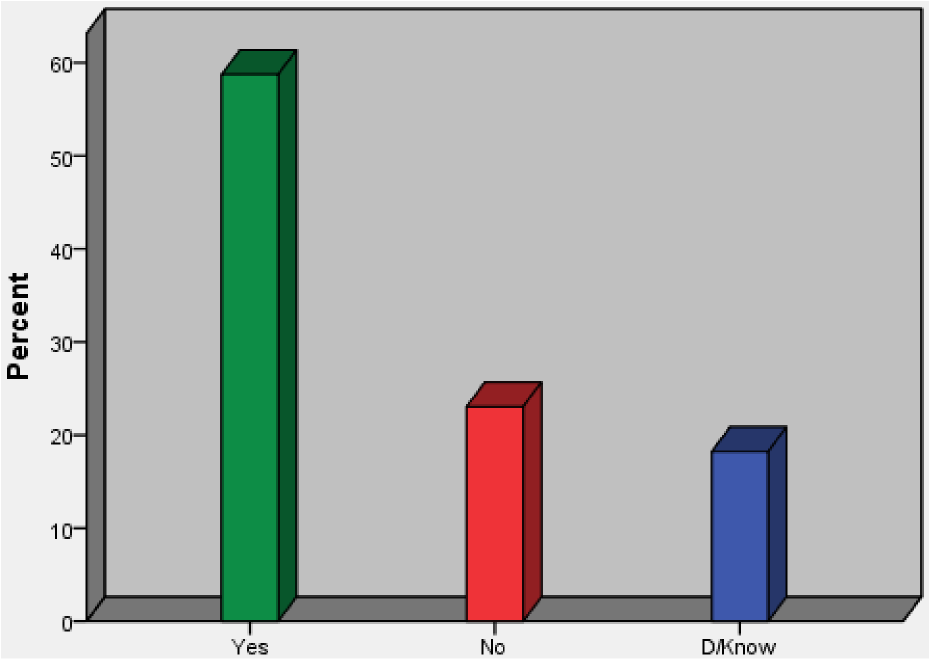

Figure 6.3: projects such as roads, bridges and culverts are the main contributors to flooding
Source: The author

To conclude, according to BMS, planning issues might be caused by rapid changes to the planning system, or lack of a clear vision for city planning; however, whatever the cause, it *"cannot said that we have arrived at a good stage in planning"*. Some interviewees, such as the manager of a consultant company, which carries out flood management studies for regions in Oman (CE), stated, *"there is no complete planning, either in the field of urban planning or urban water management"*. In addition, he stated that although Muscat does have access to a study on storm water drainage, this covers only the draining of rainwater, and not of wadi water. If the issue of water draining from the wadis remains unresolved, the problem of flooding will also remain unresolved. Muscat has four main wadis - Wadi Kabir, Wadi Uday, Wadi Alansab and Wadi Samail; according to CE, these all have huge catchment areas, except Wadi Kabir, which has good drainage channels. The author visited the wadi and witnessed that narrow culverts in need of maintenance punctuate the canals draining water, especially between Wadi Kabir and Darsit. The culverts significantly contributed to the flooding that occurred in 2007 (see Figure 5.2). This example serves to illustrate the subject more clearly and leads to a discussion regarding the real situation with regard to Omani city planning effectiveness.

6.5. The contradiction between planning and reality

There is often a discrepancy between the proposed subdivision plans sent to different parties for feedback, and the approved plans implemented on the ground. This was highlighted by the experts on water resources (W1 and W4) when they spoke about sending preliminary drawings of plans to the Ministry of Regional Municipality and Water Resources (MRMWR) for information and feedback to ensure no conflict with any future plans by other agencies. However, both W1 and W4 claim that often changes to a project are not made at the proposal stage but during the implementation stage. This indicates to the author that those consulted do not follow up the planning application later. This is probably because they assume that the planning department has adopted their suggestions and implemented them. Therefore, projects are not implemented according to the original plans. The implementation of projects should be performed under the umbrella of both the planning department and relevant agencies through ongoing cooperation. Ideally, consultants should follow subdivision plans through the planning and implementation phases, to ensure that the planning department has absorbed all the feedback from different agencies. The goal of collaboration between planners and water specialists in the future must be to mitigate flood risk.

The literature review identifies two possible ways to manage floods: (i) leaving space for the water to flow, which is applicable in the UK, where it is possible to leave sufficient distance between rivers and developments; and (ii) using techniques to drain water to avoid damage to areas of development, which is the strategy applied in the Netherlands. The literature notes failures in terms of the exchange of information between different agencies, and an overlap in responsibilities, which is affecting the planning system. The following sections will assess the capability of the Omani city planning system in terms of its readiness to deal with floods. The main areas covered are: the planning of wadis and flood risk; land use problems; individuality in planning decisions; overlap in responsibilities; the role of Omani city planners, and community input into planning.

6.5.1. Planning of wadis and flood risk

The wadis in Oman are the main natural place where water flows, and Omani city planners need to choose between "leaving space for the water to flow" and "living with the water". A number of the interviewees (P2, M2, W4, W5 and MMS) agreed that there is a huge encroachment into wadis and floodplains, resulting from planning mistakes such as extensions, and new plot creation in spaces allocated to water projects such as culverts and bridges (see Figure 6.2). Furthermore, a specialist in water management (W5) added that the planning department often does not adhere to the information given by the water management agency, and implements projects in wadi areas prone to flooding for long periods.

The Director in the General Directorate of Meteorology (M2) stated that some houses in Alansab are in the wadis and this is of course a planning error. Another example of bad planning, given by the Shura Council Member (MMS) is in Alwattia, where the wadi has two culverts instead of twelve, creating a *"bottleneck"*. A further example is in Wadi Uday, where culverts chocked by sand contributed to the flooding of the Alnahda Hospital mentioned in Chapter 2. Therefore, flooding problems are not only being created by bad planning on the part of city planners, in terms of wadi encroachment, but also by other parties responsible for road culverts and other water management projects. The experts in meteorological studies (M2) have pointed out that the scarcity of rain in recent years, and the intervals between rains, has encouraged the approval of the extension of buildings in the wadi paths. Another contributing factor could be the lack of information and data on wadi passages and wadi levels. However, from the author's point of view this is not a valid excuse, and is not one identified as an obstacle in the literature. These places must be left untouched as natural passages for water; or, if they are to be encroached upon, every effort must be made to direct the water along a natural channel or implement an effective drainage system.

It is clear that MM and the Regional Municipality have tried to reduce flooding risk by cleaning and refining the wadi channels, to enable the water to flow; but that they have faced the problem of buildings being located in the wadi channels, as mentioned by W4 (see Figure 6.2). This situation will endure, unless action is taken to remove the buildings to allow the water to flow easily. The water must be allowed to flow easily into natural channels without obstacles. A flooding specialist in the municipalities reported that floods caused in areas like Al-Hail were caused by the return of water to urban areas, because of the blocking of wadis and the lack of culverts. The floods could also be linked to land use changes, as was mentioned by the Director of Technical Affairs in MM (MU2) and one of the Directors in the Planning Department (P4); blocked natural water passages generally pass through farms and are then blocked by residential or commercial buildings.

With regard to wadi encroachment, city planners P2 and P7 said that, unfortunately, the urgency to identify plots for development within a short period, especially before the adverse weather in 2007, led to encroachment on wadi flood-prone areas by the planning department for example, Alkhoud wadi. This example illustrates a lack of coordination between the different authorities, including the planning authority and the water authority, and the shortcomings in the exchange of information such as risk maps. This error can be attributed to several factors, among them the fact that it is possible that the MOH was put under pressure at the time. Or it might be that water management is not high on the agenda until flooding problems occur, as in 2007 when the importance of adhering to dam zones became apparent too late, such that, when people started the reconstruction process it was difficult to compensate them. In this context, a number of interviewees (W1, MU1, P2 and W5) have mentioned the need to create new projects at the top of the mouth of the wadis to reduce the water pressure on the dams.

Another possible reason for the mistakes made was the lack of coordination between the management of planning and water management at the time, which led to each agency carrying out projects independently, without considering the consequences of each project on the other. It might also be the case that the planning department has the discretion to assign lands for development, without having to consider any issues including geographical obstacles. This points to a lack of clarity of vision in regard to the planning of the city, which should take a number of aspects into account, both environmental and topographic. The final factor was the introduction of water channels, as outlined in the subdivision plan. Using a system of canals, leading from the dam to the sea, should enable the MM or other regional Municipalities, to install defences as designed by planners when making suggestions for linking dams and wadi streams. Therefore, it is evident that there is great latitude for mistakes to occur when land is earmarked for development without coordination with the relevant authorities for water management.

6.5.2. Land use problems

The change in land use sanctioned by the Omani city planning department is another cause of contention. As discussed in Chapter 3, changing land use can create numerous problems, especially if the change is from agricultural to industrial use. Such changes in land use contribute to the emission of GHGs, increasing desertification in many countries worldwide, and creating flooding problems (see Chapter 3). If not handled well, alterations to land use might also create problems in infrastructure and services provision. MMS commented that planning confusion is even apparent in the allocation of parking spaces for commercial buildings, which have *"100% the proportion of construction for a ten storey building in Boucher near Mohammed Alameen Masjid"*, and an absence of planning for roads and other services. BSM mentioned another poor example of land use in Shatti Qurum; the area was carefully planned to include entertainment spaces, parking and even a drainage system, but it underwent a land use change that abused the planning permit. This U-turn proves that the planning department is not effective at managing project implementation. This could be due to either the planners themselves or management; however, such errors might also result from an oversight. In some areas, there is no planning for new development as subdivision plans do not exist, such as in Almawaleh. This situation there was described by city planner (P5) who claimed that *"in my 12 years of experience there has been no strategic dimension to planning and planning has been very random, often based on an individual's decisions, even a new planner who decided to change an entire area to other uses such as industrial"*. Land use changes from agriculture to commercial and residential, or even to warehouses bring about a number of problems. P4 referenced some of these problems; describing a shortage of roads and entrances resulting from changes to agricultural lands, stating that when implementing services such features must be planned (which are calculated at around 10% of the plot area intended for conversion of use).

The confusion arising from change in land use, and other aspects of planning, is evident within communities. According to MMS, the planning department is occupied with strategic works unrelated to planning per se. The majority of the department’s time (up to 90%) is dedicated to the approval of site plans, assessing plot extensions and dealing with changes of land uses.

The planning department should be carrying out both implementation and legislative work; however, implementation issues fall within the responsibility of the municipalities’. The carrying out of legislative and implementation tasks has created an additional burden on planners, distracting them from working on improving the planning system to avoid problems such as flooding risk. MMS suggests appointing consultants to unburden the municipalities and the planning department, as designing buildings in Oman is straightforward, and drawings generally do not require multiple revisions. New strategic plans, approved by the High Supreme Council for Planning in April 2014 for Albatinah, could resolve this issue. This strategy identifies the intended use of areas within a local plan and the parties responsible for supervising the implementation of land use management plans, primarily the MOH and the Ministry of Agriculture. The two Ministries ensure areas marked for housing and agriculture cannot be used for other purposes. As highlighted by P4, there is a shortage of land that can be allocated to these uses in Albatinah, and shifting uses to other areas would incur additional costs from introducing new services. This strategy is significant, in that it shares the responsibility for planning between two Ministries, thereby decreasing the possibility of the individual decision-making, which is currently the norm in the planning department; as discussed below.

6.5.3. Individuality in planning decisions

The lack of coordination between the planning department and other parties, as mentioned by many interviewees, has created a natural excuse for the planning department to carry out planning work without reference to others. CE mentioned that for at least ten years before the Guno and Phet floods, the planning department had ignored the opinions of water management experts, but after the floods, it began to make more effort to coordinate its actions.

The lack of coordination between the planning department and parties responsible for services connection delayed the development of the subdivision plans for many years, according to some interviewees. Consequently, the MOH received many requests for compensation, creating additional work for planners and costing the Ministry additional funds to cover overtime. Time spent on compensation meant that subdivision plans, which take time and effort to develop, were put aside.

Some interviewees, including a city planner (P5), mentioned that some subdivisions were located in very inaccessible areas (even for four wheel drive cars), and were not serviced, making access a challenge for members of the public. In addition, the lack of coordination to deliver services to these lands creates a challenge for the owners of the land, with respect to how to take advantage of the land. This resulted in land not being built on, but resold. P5 mentioned an Egyptian project called *"Build Your Own House"* which defines a certain period, i.e. five years, within which key services are to be provided. It would be possible to implement this project in Oman successfully if the various parties involved agreed to ensure that all necessary services were connected in that time frame, and then to operate their budgets in such a way as to encourage building on these sites. In light of this, the Shura Council Member (AMS) suggested that the subdivision plans comprise common services such as roads, electricity, water and a communication network for full settlement, and a drainage system before land is distributed.

As mentioned above, the planning department plays the dual role of legislator and implementer, and tends to work in isolation from other parties, making decisions such as changing the building height to 10 storeys and increasing construction in the Kuroki by 100%. The Municipality cannot impose any changes, as the owners would take the issue to court if there were any objection from the Municipality, and the owner would then win their case, regardless of the damage caused to the area. It is imperative that the Municipal Councils begin to perform their duties in a way similar to that of other councils worldwide, such as the UK city councils, to stop the encroachment of nature by the planning department. However, according to the MMS, the Municipal Council in Oman does not have any powers, and most of its members are not specialists, unlike in the USA, where "*the members of the City Council have to be legal experts or economic experts or engineers"*. The perception that interviewees have, that the planning department operates in isolation, highlights the huge gap that exists between the agencies responsible for planning and project implementation, and also indicates a great deal of overlap in duties. The following section describes the extent to which these agencies exchange information.

6.5.4. Overlap in responsibilities

As previously mentioned, there is a lack of information exchange between agencies, and the planning department tends to ignore other agencies when it comes to decision-making and implementation. This creates an overlap in the responsibilities of the planning and implementation agencies. In addition, other agencies' interventions can create problems for the planning department, such as in the form of compensation claims. SP1 and the Director in the General Directorate of Urban Planning in the Supreme Council for Planning (SP2) said that cyclones Guno and Phet came as a shock to all government and non-government agencies, because of the huge damage they left behind. Therefore, different entities initiated studies and plans to identify ways to avoid future problems, but the lack of coordination led to omission of a number of aspects related to project implementation. As SP2 reported, each entity is enthusiastically trying to implement its own plans, regardless of the objections raised by other parties.

The dispersion of planning responsibilities across more than three organisations, and the poor coordination among these organisations, is the primary cause of the confusion in planning, and the isolated efforts of many aspects of city planning. Cooperation between the parties responsible for planning, including the MOH and the parties responsible for services like the Municipalities and sewerage companies, has (according to BSM), deteriorated to a level at which it is practically non-existent. There is some hope that the Supreme Council for Planning will take over the coordination of all the agencies involved in planning, but the Council is still new and it will take time for it to start operating efficiently. W1 reported that this Council has launched a number of committees to help organise planning procedures.

Another overlap in responsibilities, mentioned by SP1, is found within the Muscat Municipality, which is in charge of issuing permits, monitoring the issuance of fines, and preventing reconstruction in flood zones on the one hand, and on the other allowing building in flood risk areas, arguing that building plans or Kuroki's are issued and approved by the MOH. The Municipality should protect the wadis from construction, even where the MOH has certified maps. It is possible that the reasons for infringements is the absence of regulations, and the fear of facing citizens, as surmised by PH1. However, this does not excuse the planning department from also participating in this aggressive development in dangerous areas together with the Municipality. The MOH planning department should not approve a site plan for development until it has established that the location does not fall within a risk area. In addition, approval must be issued on the condition that the front, rear and sides setback between developments cannot be changed, since any changes in the setback could change the façade of the entire area. The overlap in responsibilities, even between planners and administrators in the planning system, and also the excuses mentioned earlier, play a significant role in this area. As MMS has stated, the role of the planner and the role of the administrator intertwine, and a political decisions can easily impede the implementation of a plan. The planners' experience and expertise can steer planning strategies in the right direction.

6.5.5. The role of Omani city planners

Speaking about the overlap between the administrators' and planners' decisions, SP2 stated that the Omani planning department is directed by administrators, and that he therefore always works as directed by his administrator. Thus, planning decisions are generally based on administrative concerns, not technical ones, and when a decision is taken for technical reasons, administrative concerns and pressure from citizens can change it. This affect the performance, planning expertise and creativity of the planner.

Interviewees SP2 and P5 mentioned that the absence of appropriate planners, who can deal with both planning and senior management; and the lack of experts participating in the planning process increases the risk of planning errors. One can find planners to correspond with citizens, prepare subdivision plans, modify them, and write memos on cases, but such tasks cannot be performed by one person. The author believes that dedicated persons must be appointed to work only on planning strategies. Procedural mistakes might be made, but as P1 has argued, such errors could subsequently inform for the planning process. In addition, planners can learn from the experience of other countries and communities, and research undertaken elsewhere, to improve the quality of the planning system.

6.5.6. Community intervention in planning

The interviewees could not agree involving members of the community in city planning through the planning department (see appendices-1). Most of the planners in senior positions mentioned the participation of the community in the planning of the city and the majority of the interviewees, including W3, claimed to allow the community to participate in planning. According to P1, the MOH previously managed interventions from the local community, but currently the technical committee, which includes members from different Ministries, has taken over this role. In addition, the Municipal Council now discusses all subdivision plans. P2 also mentioned the involvement of the community, but in a different way, through involving the local committees particularly within governmental bodies such as the Shura Council. Both claim that involving the community in technical matters and prioritising individual interests may create an obstacle for the planning process. They argue that local committees should not be involved in altering the outcomes of planning affairs, such as changes to land use, because of their lack of knowledge of planning principles. Local committees' might reject valid projects. Their suggestions, and the suggestion of other interviewees, is to refer to certain sheikhs only, and not to the many segments of society that are in conflict. The author is in agreement, since people of the region are most familiar with the types of land uses needed in their region. This links to M1's observation, that the planners are also part of the community, and therefore understand how information, culture, and the science of flooding, can successfully help to mitigate risk.

A diversity of views generally creates knowledge, and increases the quality of a decision, but as P1 and P2 commented, often in planning decisions, administrative decisions overshadow the planning decision, even when planners are involved. Shura Council and Municipal Council members might be the appropriate people to give advice on local planning decisions. The social cohesion, which exists between the families and members of the tribe or community in villages, forms the basis of Omani planning (as mentioned in Chapter 5). P6 states that local people help select sites for development in their localities and determine if these specified sites are free from legal complications. It would be more feasible for Municipal Council members to represent the locals in this task because it is unreasonable to expect the entire community to participate in the planning process. According to SP1, the role of the community must be channelled through institutions such as the Municipal Council and the offices of the governors. It is also imperative that their roles be limited only to issues relating to the community's requirements.

The community's participation in the planning of a subdivision can be sought by putting up a visual display or posters in the location to be developed. Locals' feedback can then be integrated into subdivision plans, which can then be developed in line with the actual requirements of the area, and ensure development in areas away from all the natural obstacles like wadis. The Director of the Planning Department (P3) and M2 feel that citizens have a role to play in the planning of their villages and in identifying some land uses, such as Masjids, cemeteries and other buildings of public benefit, because they know more about their requirements than others do. Local communities should be asked to participate in the selection of the sites in villages, but not in the planning standards development. Shura and Municipal Council members can participate in the development of planning laws and regulations instead of the citizens themselves, as they are their elected representatives.

Interviewee W5 stated that the community's role must be according to the level of education and experience within it. For this reason, middle-aged/elderly people who have practical experience should be consulted in planning decisions. For example, middle-aged/elderly people can provide advice on where to live and not to live because of their historical knowledge of the wadis. Therefore, such knowledgeable people must be invited to pass on their knowledge about the wadis' history and to give advice about the locations of community services.

Communities can play two roles in planning; first by cooperating to prevent illegal land holdings, and second by providing their views on city planning and project implementation. However, the planning department sometimes does not take their input seriously. It is true that some local committees play a role in submitting information to planners for their regions, but according to P5, M2, W3 and W4, these local committees mainly exist in urban areas. In addition, although ordinary people are not engineers, some interviewees, including P4, P7, M2, W3, BMS and W4, opined that their elected representatives should be invited to comment, as mentioned above.

The Shura Council member (BBS) highlighted the fact that the re-planning of old areas has to be collaborative; involving local communities via a public hearing, as ignoring the community has led to bad decisions in the past. He mentioned the case of the Albatinah coast road, which called for the relocation of some local people to enable an extension between Saham, Swaq and Alkahboura. People opposed their relocation. Relocating people is very difficult as it affects their lives. For example, moving people who made their livelihood from the sea to a location far from it can irrevocably change their daily lives. This generates resentment of the new location, in cases where it differs dramatically from the previous one. The associated cost to the government is also high. For example, the cost of the Albatinah coast road, according to BBS rose *"from 4 hundred million became 3 billion"*.

After reviewing the arguments, and the opinions gathered from most of the interviewees and questionnaire respondents, it is very clear that the community would benefit from the input of middle-aged/elderly people or their representatives into the process of city planning. Planning knowledge starts with members of the community, as their knowledge about the area in which they have spent their lives is vast. The development of the plan itself must be guided by a plan that sets out all the responsibilities of the different involved entities. It is hoped that the Supreme Council for Planning will take up the role of developing and coordinating such a plan.

6.6. The Supreme Council for Planning – development of a comprehensive national strategy

Royal Decree number 30/2012 set up the Supreme Council for Planning. The council has since issued documents, such as the Comprehensive Urban Development Strategy, which are not only concerned with urban planning, but also include details of economic and social frameworks, tourist, and service areas. The Council also created a social policies document, intended to engage the community in planning for the future of Oman for the next five years, offering a vision for the future. In addition, it provides a new overall strategy for the development of the Musandam Governorate 2040, which hopes to shape the city plans for this governorate (The Supreme Council for Planning, 2014). None of these strategies is very clear yet, and none has been implemented.

Informative seminars discussing their introduction are planned. To date the Council has not carried out a single tangible task with respect to city planning, except for the approval of the local plan for Albatinah, which was explored earlier.

BSM quoted his Majesty as saying *"we are going to start from the other end"*. This implies that the planning system will draw on the best practices of other countries. The aim is to explore different planning views, organise, and distribute duties among different agencies according to their expertise. This was confirmed by SP1, when he said that the future of the Omani planning system would be derived from a national comprehensive strategy. The National Strategy for Urban Development will comprise the preparation and audit, accreditation, implementation, review and monitoring of implementation, modernisation and development of the planning system. From the beginning of the planning process, those responsible for performing associated duties will be included in the assessment of the planning process.

Some interviewees, including P4, have said that fostering cooperation between the Supreme Council for Planning (SCP) and the MOH was the main objective of the new strategy for city planning. However, he also said that a new authority should manage city planning (an *"Urban Planning Authority"*), and concentrate only on planning issues. This authority could be supervised by the SCP and located in Muscat with branches in each governorate. The branches could be designed to function independently, but be managed and supervised by groups nominated by the SCP. In the author's view, this would create an overlap between the groups and the local authorities in the governorates, as they would have to repeat some of the procedures and tasks, which would delay the work and force the government to employ planners at both the SCP groups and local authorities. This arrangement would involve considerable expense for salaries and equipment. A more efficient system would be to offer planning power to local authorities, as is the case in many developed countries, such as the UK. Each local authority could then link up with the SCP through an efficient network such as GIS. Additionally local authorities can involve the Municipal Council in the local organisation, but choose members who are acquainted with planning procedures, or at least those with some technical experience and ability to read the Kuroki or maps. In this way, they could participate directly in the planning procedure and not have to wait for others to decide.

Interviewee BSM said that the Supreme Council for planning must coordinate all the agencies involved in planning; but, because of the huge number of duties that it currently has managing city planning and economic planning, coordinating the agencies might restrict the Council from doing its job. BSM believes the Council should be doing strategic work, but that the implementation of strategies should remain the responsibility of the MOH and the Municipalities.

Planner P6 stated that under the national comprehensive strategy of the north and south; Albatinah, which experienced exceptional adverse weather conditions resulting in Guno and Phet, intends to implement a good strategy for water management by creating protection and storage dams, as well as a drainage system. This strategy will restrict developments in the wadi areas and ensure no new urban areas are built upon flood plains. In addition, P1, P3 and P6 mentioned that the MOH is working very hard with the higher planning council to create a national comprehensive strategy. By applying this strategy diverse types of land uses such as housing, industrial zones, agricultural areas, ports, different logistics areas and development areas could be appointed as determined by a technical committee. This committee, according to P6, existed in the SCP and is responsible for the future of Omani planning, but the specialists, and experts in aspects of this plan, are in high demand, and therefore this strategy will take a long time to implement.

The national comprehensive strategy comprises regional strategy plans, which identify residential areas, project areas and the different land uses within all the governorates in Oman. This has to be linked with the available natural sources that every region has and their future requirements, which form part of a comprehensive development plan for each region. Therefore, this strategy needs to be well managed to serve all the aspects mentioned in the regional plans. It is hoped that this strategy will help decrease the encroachment on the wadis and illegal land holding (which will be explored in the section below) adding to Omani resources and their economic future.

6.7. Illegal land holding and the public role in planning mistakes

To what extent does illegal land holding cause flooding?

Building wooden houses or temporary buildings is one way for citizens to acquire land, as confirmed by interviewees P1, P5, P6 and P7. This might lead to flooding in many areas, especially when such holdings are situated in places that the planners have designated as natural water channels. This has created challenges for city planners, especially in the villages, because, according to interviewee SP1, the residents of these villages continue to extend their buildings onto the wadis, believing that they will not flowing with water again because they have not flowed for 10 to 20 years. These temporary buildings are closing off the wadi channels, causing flooding and damage to neighbouring villages. In such cases, personal interests and abandonment of planning principles should not drive planners. Planners should work to convince citizens of the dangers inherent in occupying these lands.

Interviewees W4 and W5, however, said that the citizens have built on wadis, but in unplanned areas. It is clear that some citizens have built illegally to be near the wadi streams. This could be evidence of a lack of familiarity with the risks posed by wadis, or it could be possible that the acquisition of this territory was solely intended as a way to compel the government to look for site replacement. It could also be a testament to the stubbornness of citizens, who have a desire to impose their control on the ground with the intention of expanding without restriction from regulators far away from the eyes of the supervisory authorities. Whatever the reason, building in the wadi streams is potentially fatal. These illegal buildings are evidence of the confusion in the planning system and the indifference to the consequences of planning actions, which need to be avoided in the new planning system.

Interviewee SP2 said that citizens changing building plans ad hoc, such as building extensions and changing land use, in the absence of planners has created enormous problems with the physical layout of the wadis. This strategy needs to change. P7, similar to the other interviewers and most questionnaire participants, agreed that the planning department is often the cause of such infringements because of planning actions in respect of the wadi pathways. Wadis cannot change their routes, but an increase in the water level in the wadis can create some corrosion. It is possible to conclude from this that infringement is obvious and that the blame can be placed on those people who carry out the infringement, although the planning department is also to be blamed for not doing its job preventing them.

Interviewee SP1 said that another major problem is the lack of regulation and monitoring of unlicensed crushers who excavate and fill up streams in the wadis. This is another illegal issue, requiring more attention and regulation.

Illegal land holding in wadis is a serious offence, which requires emergency attention from planning agencies (e.g. the SCP and the MOH). As mentioned in the literature review, wadis are a red zone; that is a zone, which can be the site of a natural disaster, as happened during the Guno floods. It is known, and was mentioned by W1, that people place huge pressures on the planning department to obtain the land they want; this is one of the reasons why technical errors occur. However, this does not excuse city planners who need to be very strict about allowing development. The Guno flooding led to many deaths, great loss of property and a great deal of infrastructural damage. Interviewee W5 said that extensions can be granted, as did interviewee M1, relating this to unproven scientific grounds. The following section looks at the extent to which urban planning contributes to floods.

6.8. Extent of Omani development acceleration in planning of flood-plain areas and flooding

To what extent is the acceleration in Omani development the main cause of flooding in flood-plain areas?

To what extent does the Omani city planning system cause environmental problems and flooding?

6.8.1. Acceleration in development and flooding

The acceleration in the planning and distribution of plots has brought about a number of issues, such as shortage of services and lack of cooperation with other parties and local people. This created a number of problems in service connections and the planning of wadi channels, because of the lack of information and use of satellite images to plan without checking what is already located on site and the effects on subdivisions. Water management expert W1 does not believe that the acceleration of development should force the planning department to distribute subdivisions in flood-prone areas to provide land. The Ministry cannot be excused for risking people's lives by exposing them to flood risk.

Acceleration in the planning process has even affected pre-owned land, processed after 2000, because of the lack of communication between the planning department and local people. This cost the planning department a great deal of money for compensation in land or money, and, according to interviewee AMS, many of the subdivisions that were distributed 8 to 10 years ago still do not have any type of services.

According to an expert in planning (SP1), the wadis flood plain areas have to be developed, as the drive for urbanisation cannot be stopped. Wadis should provide no obstruction to development because there are technical solutions, which can be applied to mitigate the risk of flooding. His suggestion is to employ strategies such as those followed in the Netherlands (see Chapter 4). SP1 does not agree with P6 and P7's stance, which is to maintain these areas as natural areas, although he agrees with the practice of leaving space for the water to flow. He explains that people can decide whether to benefit from the water or risk its dangers; however, he contradicts himself when stating that water should be guided through natural passages.

Both interviewees BMS and AMS believe that there is no relationship between accelerated urban development and development in the flood plains, as they contend that Oman has vast areas of land to develop and, given its small population, finding land to develop is not a huge problem. They claim this notion of a conflict is a poor excuse by the planning department. The main problem AMS mentioned, is the lack of services and levelling of the plains, which forces people to build in these areas and face flooding problems. Therefore, the only option is to deal with the problem as reality and look to offer improved solutions in future plans. Mistakes created by looking only at the demand for land, causing overlap between industrial, commercial and residential uses, must be avoided.

Interviewees W3 and BSM claim that the Omani city planning system is neither bad nor lacking in expertise, and that it is in line with the acceleration in development but requires more attention to be given to creating drainage channels to drain water from urban areas. It also needs more cooperation between the different parties involved in water management and planning.

6.8.2. Environmental problems and flooding

Experts in the planning department, such as P1 and P6, could identify no problems from the planning side, which would affect the environment. They asserted that planners are always very keen to respect the environment and natural resources. In contrast, interviewee P7 mentioned that the planning department has created a number of environmental problems by approving the removal of mountains, changing natural features and creating unused spaces. Such spaces should be made known to all the Ministries to ensure that they know that they are restricted areas where development is best avoided. In addition, the mountains, which are an issue when it comes to extensions, should be restricted areas, in terms of expansion to avoid changing the natural areas, which might then result in disaster arising from this procedure; for example, when they should have been left as natural defences against flooding. Plot extensions can close roads, increase the ratio of buildings in an area, making a difference to the neighbourhoods and can close off wadis; therefore, the planning department should make it clear at the outset of the creation of subdivision plans that no plot extension permits will be granted.

The most recent floods changed the parameters of the regions and created new streams and new terrain. Here citizens bear some of the responsibility, especially in villages, as they should have known not to accept the allocation of these areas to them. P4 and P5 agree that these lands were known to be situated in areas prone to flooding, or were water catchment areas, and therefore had not been settled on by previous generations. Interestingly, the old areas identified by interviewee P4 were not affected by the latest floods.

Planners P1, P3 and P6 commented on the damage done to areas like Bucher, Quriat and Alamerat 7/1 during the adverse weather conditions of 2007 and 2010. The damage was not due to bad planning, since it was also located in areas far away from flood-plain areas. There is evidence that many of the old houses, not planned by the MOH, were affected during the floods. These houses were mainly illegal holdings. P1 mentioned that Algubra and Alothiba are good examples of developments in flood-prone areas that protect them from flooding. The examples he mentioned however are not ideal, as most of the areas mentioned were affected during Guno, and the water in Algubra reached the first floor of buildings. The planning department developed these areas around 30 years ago, and many people suffered in the areas situated in the flood plains and wadis (see Chapter 3). P1 is of the opinion that if subdivision plans are designed to be valid for 100 or 200 years residents will not be affected by flooding. This is a good indication that experts from the planning department understand that long-term planning strategies, which comprise all aspects of safety from flooding, could help to ensure the sustainability of a development. However, the evidence gathered from other interviewees and participants shows that the truth is otherwise.

Some experts in water management, such as W1 and W5, characterise ignoring the information given by water management experts as a fault on the part of the planning department. Giving out permits for random extensions of either plots or subdivision plans in dangerous flood prone areas is risky. It is very important to leave the flood plain areas and wadi passages as close to their natural state as possible to avoid future damage. Unfortunately, many examples shown by the city planners indicate encroachments into the wadis or in environmentally sensitive spaces, and this is the main cause for flooding in many areas. W1 believes that faulty planning is responsible for the damage to new developments, because all these developments were built according to the plans (e.g. the Alnahda Hospital). It is true that some of the flooding was caused by problems in the drainage system and culverts, as observed by P7 and MMS in their site visit during floods events; however, the planning department is also responsible for this area. Wadi Uday was squeezed by the new development on both banks, and therefore the wadi became like a *"bottleneck"*, as mentioned earlier by MMS. This issue was not very difficult to manage because creating good channels for this water and increasing the ground level of the hospital could get decrease flooding in the area. Another option would be to assign a ground level to be a car park, which is one of the main services lacking in this hospital.

Some interviewees, including planner P7 and Shura Council member AMS, claimed that some plans are drawn up on the basis of satellite images without a site visit, and that this explains the problems affecting some subdivisions. This claim is seen as strong evidence as it is from a planner. Because of the development and changes in land use, the wadis are closed off, which is the main cause of flooding in places like Al-Hail (see case study Chapter 8 for more information). The government will need to spend a great deal of money to divert the water flow from the wadis to rescue developments from flood risk. In addition, MM will face huge problems during rainfall events if it is to secure adequate protection.

6.8.3. Examples of real flooding caused by city planning

Interviewees mentioned multiple examples of flooding caused by poor planning in different areas. The first was Alqurom, a commercial and residential development, which features heavily in the literature review. Some bridges and fences were rebuilt or replaced in the area. Interviewee W1 said that because these developments created a huge risk for the area in 2007, the Regional Municipalities refused extensions proposed for some buildings, realising that this was not the ideal place for development because it lay in a very dangerous area. The three interviewees W1, MMS and P4 suggested compensating the owners of all the buildings and leaving the area as a natural place. The risk might decrease after the building of the seven dams proposed in Alamerat, but the necessary funds to do this are still not forthcoming from the Ministry of Finance. These dams have been at the design stage since 2007. The reason for the money not being forthcoming is either that the Ministry of Regional Municipality and Water Resources did not coordinate sufficiently to access the necessary funds, or that the study was carried out after the great flood carried everything away, and so people forgot what had previously existed there; for example, Alqurom and the Wadi Uday. The floods caused some deaths and destroyed a great deal of data held by some government institutions. Traders and residents in the area suffered material losses (see Chapter 3 for more information).

The second example of flooding, mentioned by a number of interviewees concerned Alamerat 7/1; many cited unlawful planning, which is amply covered in the literature. This subdivision plan (described in Chapter 3) aimed to address issues affecting the flood plain areas surrounding the wadis. The following section will discuss why this subdivision was developed in such a dangerous area, and how effective the planning department was at saving the lands that had already been distributed within that area. In addition, the researcher sought to understand the views of different people on the subject, including professionals and non-professionals.

Interviewees P7 and AMS explained that this subdivision was planned in an office using satellite images. It was located fully in a wadi, which is not a good area for development, even if canals are installed. According to AMS, Alamerat 7/1 is situated at the meeting point of a wadi called *"Wadi Qaaza"* sourced from *"Wadi Alttaeen"* and the whole area is a flood plain area. He stated that this wadi extended to the *"Madenat Alnahda Schools"*, which were built in the 1980s, and protected from the wadi by a protective wall. The lack of consultation with local people, led to the development's location in a dangerous area.

Interviewee W4 explained that wadis change location in response to many factors, such as type of flooding. A small flow of water travelling along a small channel is one thing, but 50 or 100 streams of water flooding a large area might result in flooding of the original channel and create new trenches. This does not happen very often in the mountains, but can happen in plain areas. This was the case in Alamerat 7/1 during the Guno flooding, which affected a plain area. This was confirmed by both P1 and P6 who said that Guno created new wadis, as demarcated in this subdivision plan. Interviewee CW, however, said that it is illogical to assume that the wadis formed after drawing up the subdivision plan. The area was originally in the wadi, but the wadi only changes track when there is no control channel. In this case, there was neither a strategic plan for flood management, nor a strategic plan for the City.

Interviewee W5 stated that the water resources sector asked to carry out a study on Alamerat 7/1 before the plan was drawn up, and recommended that the development be cancelled or transferred elsewhere. Changes were not made, although according to P6 and P1, the consulting company engaged by the planning department in conjunction with the Alamerat 7/1 plan indicated that once the wadi channels were determined the subdivision plans were redesigned to avoid floods. In addition, all those owners whose plots had been affected were compensated and the plots redistributed. From this, one can conclude that the planning department agreed that the subdivision was intended in a wadi region. In addition, the creation of new channels for the wadis, as mentioned by the expert planner (P1) is further evidence of the fact that this area was subject to a flooding problem. Therefore, it is possible to examine this issue from two different perspectives: first, from the perspective that the planning department encroached the wadis; second that the planning department is more effective at flood management than at managing the wadi. It is not accepted that the solution reached was an ideal one in this case, as it may still be rejected by the owners of the distributed lands, who might not agree to return to development in an area that has previously proven to be dangerous and prone to flooding.

The two examples given are real life incidents, and indicate a huge problem within the planning department regarding new developments and the creation of plot extensions into the wadis. These problems, as mentioned earlier, relate to the overlap of responsibilities between planners and administrators, and between planning management and water management. Some interviewees related these issues to increased demand for lands from citizens and investors. The next section will concentrate on the challenges city planners encounter.

6.9. Planning and current challenges

Planning experts, SP1, P1, and P3, mentioned a number of challenges faced by Omani city planners, such as the pressure to meet land requests (from citizens, from investors, and from governments); the challenges posed by topography like mountains and wadis; the challenges posed by environmental and climatic factors, such as cyclones and flooding; and economic factors, such as sourcing funds to implement plans.

Experience in many areas and different regions has clarified that direct intervention from citizens in the planning process can be disruptive. Such interventions can consist of demanding areas be allocated for development, despite being distant from other residential areas or services. This could cost the government millions of Riyals to develop infrastructure to provide for new residential complexes, or even individual houses. According to planning expert P2, the need to find areas for development as far from urban areas as possible, is generally intended for uses that require privacy or distance from other buildings, such as to breed livestock, or for date palm plantations. The MOH could solve this problem by planning areas to allocate to such uses. In some places instead of building schools or installing services for a small number of people it would be more effective to relocate people to a neighbouring urban city already in possession of much needed services. This would save the government a great deal of money.

Studying the requirements of people who wish to set up an establishment outside the main urban areas, and earmarking land for such developments which is not only far from the cities but also free of flood risk may be the only way forward. Settlements should comprise big plots that can house a livestock breeding industry or date palm plantation; these should not be like the ones currently being built for Bedouins, which they have refused to live in, because they have been allocated areas smaller than the ones they are accustomed to. The Bedouins are being asked to live far away from the lands they know, in one thousand square metre government houses, which are very small in comparison to the ten thousand square metre areas they previously owned. The author suggests that these new cities be retained for the new generation, and not given to people from the older generation who are tied to the places of their childhood. The new generation might agree to live in such cities, especially if there is work there, and they are not very far from their original villages and families.

Expert planner P6 stated that planning currently also faces challenges related to old properties like farms, which are on the edges of the wadis, and which were built before modern planning procedures were implemented. Due to various environmental factors, these farms are now close to the wadi streams, and the owners of these lands are consequently claiming compensation. Some of the lands in Muscat are very close to the areas owned by the housing Ministries and include commercial buildings that are now worth millions. The compensation offered to landowners is unlikely to be in the form of land because suitable lands cannot be found, given that Muscat currently suffers from a scarcity of open land. P6 mentioned this issue, because the lands were originally farmed and the MOH decided to leave the land for agricultural use. The author approves this decision, since classification for agricultural use precludes the use of heavy construction machinery, but if the land use were to change, the owner would request permission to build a residence or commercial building, which would then definitely affect and be affected by the wadis, as these lands are situated in the centre of the wadi. It is possible that neighbours would be affected also, because the wadi would be closed off, if certain types of building were constructed in it. If land use remains agricultural, owners would only be able to use it for agricultural purposes as they do now. The only opportunity to develop this land would be to divert the wadi channel from the source, and this will cost the government millions, and is unlikely to happen, as changing the location of the wadi channel requires additional in-depth study. It may be more appropriate for the government to offer compensation rather than divert the wadi.

The expert in planning, SP1, divided the challenges currently facing the planning system into three: (i) Lack of coordination, as subdivision plans are prepared without consideration of the services they will require. (ii) Lack of data, which requires effort to collect information from different parties, to organise it in a simple way (it would then be easy for different parties to use the data to identify the deficiencies or the needs of a particular service, and draw and implement their future plans). (iii) That considerable human resources are required to lead the overall process for all the different, specialised disciplines to draw up comprehensive plans, which comprise those aspects that might preserve the city from hazards such as floods.

The Shura Council members, BSM and ASM, gave some practical examples of the challenges currently facing city planners. The first was an explosion in the water pipes in Muscat in 2013, which highlighted the fragmented state of the collaboration between the agencies, which made it very difficult for the Shura Council and other authorities to determine responsibility. It took an outside party to bring the agencies together around the same table to discuss the problem. The other challenge facing city planning is the lack of planners and the huge workload that the department has to deal with, including change use cases and plot extensions, which are putting pressure on the planners and depriving them of the opportunity to work creatively.

Strategic plans comprising all the elements required for future development, and based on comprehensive studies undertaken by international consultancies, might resolve the above factors. According to P1, consultants could make a detailed survey of all the regions, to identify areas for development, and places for wadis and areas that should be retained in their natural environment. This comprehensive study should include studies of the dams, channels, wadis and topography to ensure the adequacy of any plans drawn up for various land uses, such as residential, commercial, and industrial. This strategy can reduce the challenges currently being faced by city planners, and help improve city planning so that it is more efficient at withstanding the problems resulting from flooding, as will be discussed in the next section.

6.10. Improving Omani city planning to make it more effective in coping with flooding

The challenges mentioned above will always be associated with planning, because more development necessitates more planning processes, and that the public will expect the planning department to perform well. Therefore, development planning should be comprehensive and include safeguards to ensure sustainability and mitigate flood risk. Aspects that should be taken into consideration include the provision of drainage for rainwater, and the development of infrastructure to provide the required services. Many interviewees, including water management expert W1 mentioned these elements among others. Plans must be inclusive and account for all the services needed to ensure that services can be accommodated in the most effective and least disruptive way possible, before construction starts. At present, for example, a road needs to be dug up every time a service needs to be installed. After a short while, the road begins to look old and unkempt and the costs of installing services equates to 10 times the original cost of putting down the road. Laying down all the infrastructural services at road construction stage would provide a more efficient service to citizens.

An expert in water management, CE, said that when embarking on a plan for any city, the infrastructure for conducting both wadi water and rainwater drainage is the most important infrastructure to include. There is a consensus among experts in planning and water management (P4, P5, W4, and W5) that plans should first be reviewed by experts, and then by the joint committee of several parties. Therefore, suggestions for improving the planning procedure include ensuring all entities employ planners (i.e. the municipalities, Ministry of Transport and Ministry of the Environment and Climate Affairs), to aid cooperation between parties. In this case the parties responded that this approach would ensure subdivision plans are studied carefully and potential problems identified early on, not as happens now, when there are rarely, if ever, objections to plans in the absence of site visits leading to problems gradually appearing later. As the author has observed, the MOH is not responsible for any problems that may arise later from subdivisions if the reply from other Ministries about a particular subdivision plan is positive. It is however responsible for any faults that emerge, when it acts in isolation and ignores other parties' views on planning decisions.

Additionally, it is suggested that controls within the planning department be increased and that any planners and administrators caught making intentional mistakes and wrong decisions, which affect city planning with regard to extensions and land use, be reprimanded.

Planners and Shura Council members P4, P5 and AMS also feel that subdivision plans should take into account all relevant services, such as drainage systems, implementation costs, and that the management strategy for the subdivision be clarified from the outset to avoid the lands being used for trade purposes. Drawing up comprehensive plans should help to provide planning services for citizens before they need to ask for them. The Shura Council member's (BSM) suggestion was to take out loans from banks for infrastructure creation, and then repay the loans by instalment over a long period, with the revenue earned by the services themselves. Another solution offered by an additional Shura Council member (AMS), was to take some of the money, which is paid to the MOH to own the new lands and pass it on to the planning department to improve the services offered and provide skilled planners.

Changes in land use from agricultural to other uses must not be made at the expense of services, and the mixing of use of lands adjacent to each other must be avoided. This would avoid instances such as that mentioned by P4 in Barka, where a change of use from agricultural to commercial was allowed without any consideration for the roads that were going to be serving these uses. Therefore, changing the use of whole areas at the same time allows the planners to deduct some land from each farm to widen the roads using a fair procedure for each farm. This will also help the planners plan for, and organise, the area properly and introduce measures to allow the water to flow during rainfall and floods.

P4 claimed that land use changes were only effected by the need to deal with pressing requirements, with no thought for future expansion. However, there is a law within the remit of the MOH, which states that in the case of a plurality of housing units, agricultural lands must undergo a change of use to residential lands and owners must provide a comprehensive division project proposal in line with the requirements of a neighbourhood (see Chapter 5).

Interviewees BSM and P7 proposed the perfect solution for the planning department, which is to build residential complexes, which consist of multi-storey buildings, and then instead of distributing lands, allocate a flat to each family. This would have the advantage of keeping families together as no individual plots would be distributed which could be traded. According to the author, such a measure would not be successful in Omani society, except possibly with newly married couples who may prefer to own this type of residence rather than pay a monthly rent. The suggestion would only work for Omani families if the planning department were to build villas to house family members, and ask them to pay an affordable instalment over a long period. Therefore, using a combination of flats and villas, in areas which if apportioned in the old way would accommodate 500 residential plots, could possibly accommodate twice that number. This suggestion can be implemented in Muscat while the old method for distributing lands could be retained in other governorates to encourage reverse migration.

To reduce the pressure on Muscat Province, the planning department has to create new, attractive cities outside Muscat to encourage reverse migration from Muscat to other provinces, since many residents in Muscat have emigrated from different provinces and still have roots there. Such residents would be happy if their home villages and cities had all the facilities and entertainments available in Muscat, as this might encourage them to return. City planning could be improved by combining the development of existing human resources with the help of experts with the provision of complete technical data to inform planning decisions. These efforts could be compiled under one umbrella, with one agency responsible for the planning and follow-up of developments. This would make it easier for the financial and administrative arms of the state to control the resultant planning errors.

The Shura Council member (BSM) stated that it seems the Omani government is able to learn from others' experiences. However, BSM feels that it would be of benefit to identify examples of good planning from all over the world and implement them in Oman. The United Arab Emirates (UAE), for instance, has created cities that cater for all the daily requirements of the population, so that residents do not need to go to major cities to shop or carry out their business. As well as helping to decrease pollution in the main cities, by keeping people in the suburbs, the facilities available in these cities help serve nearby villages and avoid congesting the main cities. This strategy helps to distribute the population, develop unused lands and solve the problem of land shortages in the main cities like Muscat. Implementing this strategy would lessen the pressure on the planning department to develop flood plain areas in Muscat and would help increase the quality of plans, which would then leave space for the water to flow; which, as mentioned earlier, is good practice in flood management.

Many interviewees, such as the Shura Council member (MMS), stated that Omani city planning strategy is currently unclear, and therefore a new strategic plan should be created to guide planning decisions. In addition, before any area is divided, planners should understand the requirements of that area and aim to meet them, including determining the wadi channels and identifying residential, commercial and recreational sectors. In addition, it is good practice to leave some areas in their natural state, as indicated in Chapter 4, to allow natural environmental settlement and decrease the risk from desertification. In addition, such a strategy would assist in the distribution of services, which should remain in place for long time with few changes needed. The revenues from the services themselves would then cover maintenance costs.

Here, the author proposes that the services need to be identified by specialists in each field in an integrated manner. For example, an urban planner drawing up a plan for a subdivision including heights, uses, and other details, could send the plan to those responsible for services such as electricity, water and drainage, so that the plan could be completed. The specialists could be linked via the internet, using an integrated system, such as GIS or a similar system that allows experts to insert details of each service into the plan at different layers. This differs from what is happening now, as the department of planning sends the development plan to various agencies for approval, thereby creating additional work for them. As mentioned by P1 and others, there are routes present on the subdivision plans, through which it would be possible to pass services. However, as mentioned above, currently services are inserted after the roads have been finished creating fissures in the new roads. This is a waste of public funds as the roads subsequently need maintenance and service companies are not obliged to return them to their previous state. Using the pre-service delivery system in the new plans would mean that no additional maintenance costs would be incurred for at least 20 years or more. Furthermore, the subdivision plan should not be open to any modifications or extensions that would change its original design.

6.11. Conclusion

The effectiveness of the Omani city planning system, in terms of coping with floods, is not easy to evaluate, as it is very complex, comprising a number of administrators and planners with different responsibilities, which at times overlap. We can conclude from the data presented in this chapter, however, that the Omani city planning system is effective in some areas, such as the distribution of lands to citizens to build their own houses, and cooperation with the Supreme Council for Planning on local plans such as the plan for Albatinah. However, it is not as effective when it comes to flood management, such as in the case of Alamerat 7/1. One of the main targets is the drawing up of a comprehensive national planning strategy, which would cover both planning and water management issues, although this strategy has not yet been prepared.

As mentioned by the majority of the interviewees, some of whom are area planners, the Omani city planning system has multiple weaknesses, such as poor coordination with other agencies, ineffective handling of illegal landholders and poor decision-making regarding the distribution of lands situated in flood areas such as Alqurom. In addition, there is an overlap between planners' and administrators' decisions, in addition to overlaps in urban planning and water management projects. Over and above these issues, the encroachment of the wadis and flood risk areas, either by new plots or plot extensions, is a serious problem affecting many subdivisions such as Alkhoudh and Alamerat 7/1. Most of the interviewees and questionnaire participants commented on the confusion over land use change, poor database management, and lack of information exchange between different agencies. The acceleration of development is one of the main issues facing the planning department, as a result of mistakes made when changing land uses from agricultural to mixed use, because of the proximity of farms to water passages. In addition, the planning department has started to encroach on flood-prone areas, because of the huge demand from residents and investors for land. Many interviewees do not excuse the planning agencies from doing this because these areas are very open to flood risk, the consequences of which were experienced during recent floods such as Guno.

The city planning system would be improved with the use of a database system linked with GIS, which could be updated with current information in cooperation with agencies related to flood management. Planners must also seek to continue to update their knowledge through experience in the field, and through intensive courses. A General Committee comprising representatives of all the Ministries and experts or specialists in planning should make planning decisions. Land extensions and changes in use should be approved sparingly, and landowners should abide by the decisions made. Future planning systems should reduce the burden on the service agencies by creating plans, which comprise all the services needed. Land users and homeowners affected by flooding must be compensated and relocated to safer places. Planning of specific sites must be integrated, and the implementation overseen by one body, otherwise there will be many losses and recurrent risks. Most of the interviewees and questionnaire participants mentioned that planners should cooperate with other experts, such as water management experts to learn from them about how to protect future developments from flooding. This could be by creating an independent public body to draw up the vision and strategy for sustainable and safe future planning in Oman. They could also transfer staff to work in each other’s offices. To succeed this body needs to draw upon the expertise of specialists from either the government or the community, to produce complete studies covering all aspects of planning. It would also need to have the necessary scientific and technical ability to develop strategies and oversee their implementation.

The effectiveness of the agencies comprising the Omani planning system and managing flood risk in the city was explored in this chapter. The next chapter discusses water management and related issues.

Chapter 7

Cooperation for the future of Omani flood management

7.1. Introduction

The data presented in this chapter was collected by applying the methods previously described in Chapter 6. The chapter evaluates the extent of the effectiveness of flood management in Oman based on information and opinions provided by interviewees and questionnaire participants. The intention is to build up a thorough understanding, to determine areas of strength and weakness, and identify essential improvements. This is achieved by combining fieldwork findings, and the conclusions reached on the effectiveness of city planning in Chapter 6, with knowledge drawn from the literature review, regarding ideal strategies for flood management and successful planning systems. Effectiveness in flood management is informed by the effectiveness of city planning and design (as explored in Chapter 6, in terms of water management and drainage systems), and the degree of cooperation between responsible agencies. Therefore, this chapter will analyse these aspects, to answer the question: "*How effective is flood management in Oman at safeguarding people and property from flood risks*?" This question has been deconstructed into sub-questions, which are discussed in separate sections below.

As mentioned in the literature review in Chapter 4, good management of water and drainage systems arises from effective planning to reduce the effects of flooding, by regulating lands use, and avoiding overlapping responsibilities. The mitigation of flood risk relies on technical engineering approaches, such as dams and defences, as well as by refining wadis and dikes to increase adaptability to avert floods. Water management includes SUDs, leaving natural places where water can flow, and managing ground floor allocation to reduce damage to people and property in the event of flooding. Flood risk maps and good land use management are among the best solutions to minimise flood damage, and to reduce the GHG emissions, which affect the climate (see Chapter

3). As mentioned in the literature review in Chapter 3, good relationships can prevent problems arising between the planning and implementation stages. Such cooperation is not widely practised in the Omani planning system, as established by the interviewees and questionnaire participants in Chapter 6.

The main questions that this chapter will investigate concern the effectiveness of Omani water management and drainage system management, including technical approaches (sections 7.2 and 7.3.). The questions covered, explore implementation of legislation and strategies, spatial planning, decentralisation of planning, integration between water management and planning management (sections 7.3 to 7.6). Based on the final question, section 7.7 provides a broad overview of the effectiveness of current flood management in Oman and the challenges of building an integrated Omani flood management system. The chapter offers concluding remarks in section 7.8.

7.2. Effectiveness of water management in Oman

To what extent is the water management system effective in terms of flood management in Oman?

Specialists in water management (W1 and W3) presented evidence of the demand for water for irrigation; stating that only around 2% of the profit earned from water enters the national economy; it is distressing that water is lost in sectors like agriculture. Some interviewees attributed losses due to irrigation to some expatriates, who waste water, by using it as they would in their own countries where it is abundant. Another problem is the use of traditional and outdated irrigation systems. Thus, Oman requires a strategy to manage the water that comes from rains and floods to fill aquifers and meet demand.

Interviewees M2 and P2 explained that water management focuses on agricultural issues, such as maintenance and well excavation and related problems, but not the management of surface water. Therefore, wadis, water and discharged floodwaters are not considered in terms of risk management, and so are not given sufficient attention by water management agencies. In addition, the absence of flood risk maps for most Omani cities (see Chapter 5, and interviews with P3, P6), and poor water management, have resulted in encroachment into the wadis paths and flood plain areas.

However, interviewees W3 and W4 claimed the MRMWR has advanced efforts by producing risk maps for large cities like Muscat and Ibra, although these were ignored by the planning departments. These maps showed the degree of flood risk in different colours, yellow for low risk, blue for medium risk and the red for high risk. Nevertheless, as mentioned earlier in Chapter 6, the planning department did not respect these areas, planning developments in areas surrounding the Alkhoudh dam. This was confirmed by P5, who mentioned poor coordination between planning and water management: “Water Management previously was not activated” and “I’m in the planning I did not received a map of Water Resources saying this is a red line restricted for the wadis or dams”. This point may excuse the planning department, but it is also evidence of the absence of cooperation between planners and water authorities.

P2 counters this, claiming there were efforts by the water body to create water studies. He states that some companies have carried out water and hydraulic studies over a 40-year period in Oman in association with the planning department. However, these companies lack credibility and mistakes are likely to be repeated; whereas, if different companies performed studies, different and modern solutions might emerge.

Respondents MU1, P5 and W5 also stated that water management is insufficient, and that current coordination between the SCP, MM and MRMWR requires improvement. Since Guno and Phet, the government has been interested in establishing dams in many areas, and refining wadi passages. The implementation of dams is complicated by their cost, but according to W3, five dams are planned according to a five-year government funding plan. The author wishes to emphasise here that any delay in pursuing dam projects will ultimately increase the cost price of construction (at present this is between 36 and 40 million Omani rials, according to P1, but in future the price may double) and maintenance, as well as delaying protection.

According to M1, while the water management authority currently has a relationship with the Meteorological department in terms of data exchange, compared to previous years, the level of cooperation is poor. W1 and W2 attribute this to the dispersion of water management efforts between various parties. For example, the MRMWR manages, studies, and evaluates dams, springs and licenses. The Public Authority for Electricity and Water manages water delivery to homes. Meanwhile, the Office of the Minister of the Governor of Dhofar also manages water delivery; thereby, duplicating efforts leading to waste in the form of dispersed policies. In contrast, the distribution of tasks can offer effective services to provide a consistent water supply, although in terms of water management, reducing flood risk requires greater unification between different agencies, allowing management by one organisation to achieve a good level of water management (see Chapter 4). CE, who reported that water management sector requires a comprehensive review, cited a need for the unification of management bodies.

According to SP1 and CE, there is no future strategy to maintain water reserves, or to benefit from floodwater by using it for agricultural purposes, even though agriculture drains approximately 80% of the groundwater needed for seasonal crops. Continuous use of high volumes of groundwater result in groundwater depletion, dragging salt water into underground water reserves, and contributing to pollution. Therefore, implementation of a chain of dams should be associated with linked water conservation projects.

7.2.1. Technical engineering approach

To what extent do the engineering technical approaches like dams contribute to Omani flood management?

According to the literature review, dams and defence walls are arguably excellent strategies for flood management; however, one expert in the water management field (W2) stated that dams are a last resort flood management strategy. This view was unsupported by most planners and experts, who favoured damming as a first step, followed by the provision of safe channels for water. Their arguments match strategies followed in countries such as Pakistan (see Tariq and Giesen (2011) and Chapter 4).

BMS states that human safety is intended to outweigh financial difficulties and to benefit water conservation; dams can be expanded to accommodate a large amount of water to avoid waste. Therefore, choosing appropriate locations for dams, by improving and deepening wadis, might be the best way to mitigate flood risk in the cities. According to P3 and P6, this approach has alleviated damage from recent flood events.

Therefore, using the data collected during tropical cyclones and rains, the MRMWR should determine appropriate locations for dams to create protection and benefit from the collected water. P2 and P4 agree that dams should be located between mountains in upland areas, relying on the natural topography to collect rainwater before it reaches urban areas. Some local people object that the presence of dams can lead to shortages in the water flowing to their villages, and subsequently affect underground water and Faljes; thus, negotiation is essential.

Diversity in dam type, whether storage dams or protection dams, also requires an integrated system in accordance with clear scientific standards, so as not to avoid a backlash and increased flooding. Indeed, CE contends that the new Alansab dams, built by Muscat Municipality, will increase the flood risk, as the corridor designed for the wadis is insufficient to absorb the quantity of water. Additionally, in Wadi Sumail there is a plan to build three to four dams, one of which would be a giant dam; this project is currently being subjected to technical and financial analysis. CE stated, this dam will be one of the largest dams, competing in size with Wadi Dhayqa; it will contribute greatly to reducing the amount of water flowing into the Alkhoudh old dam, and protect the Alkhoudh flood prone area (see Chapter 6). There are huge culverts planned to release the water from this area under construction (see Figure 7.1). These dam projects demonstrate the serious efforts of water management agencies to participate in flood management; however, the majority of projects are in Muscat, and there is a need to distribute activity to other governorates.

Figure 7.1: Bridges in Wadi Alkhoudh
Source: Author

Some interviewees, like BMS, stated that projects, which have a direct benefit to people, should be at the forefront of development. In this respect, the author views beautifully designed dam projects, like the Dhayqa dam, as possible tourist attractions, as well as providing essential services (see Figure 7.2).

Figure 7.2: Wadi Dhayqa Dam
Sources: http://www.w-oman.net/vb/showthread.php?t=6099
http://sphotos-c.ak.fbcdn.net/hphotos-ak-ash4/484166_499287396770463_1954410307_n.jpg

People who live below dams are wary during the flood season, fearing explosions or flooding from the dam (see chapter 6). BMS and AMS commented that dams have insufficient absorptive capacity and can become full in a short period of rainfall. Therefore, consulting gauges distributed in the wadis throughout Oman must be used to determine the quantity of water at each damn location. Wadis can also be left as natural areas, and be marketed as tourist attractions.

7.2.2. Challenges for water management and information exchange

Challenges for water management include funding issues and practical challenges. According to W4, quarries and excavations are a practical consideration that cause multiple problems. The substantial random diversion of wadi channels by companies and locals have created fundamental problems for officials performing water monitoring. These problems are a consequence of regulatory failure, since such instruments demand more attention and continuous monitoring. The MRMWR should aim to remove obstacles that affect the wadis in cooperation with other agencies.

Objections from local people also represent a challenge, complicating the search for good locations for potential dams. Environmental impact and the effects on adjoining residential areas and infrastructure must also be considered. According to CE, all these factors require attention, although ultimately, the final decision is a technical one. This decision, on the other hand, will be subjected to funding and final approval from top authorities, depending on cost-benefit ratios and the profits gained from each particular project.

Experts in water management have reported that the MRMWR makes data about flooding and wadis available to companies and individuals. However, according to many interviewees, and a large number of questionnaire participants (as shown in Figure 7.3), the data exchange between the planning department and water management is poor, suggesting information sharing practices are inadequate. This might be because the positions held by the experts require them to present glowing reports about the performance of their agencies. It could also be the result of the challenges, which they have faced, which require them to conceal some information.

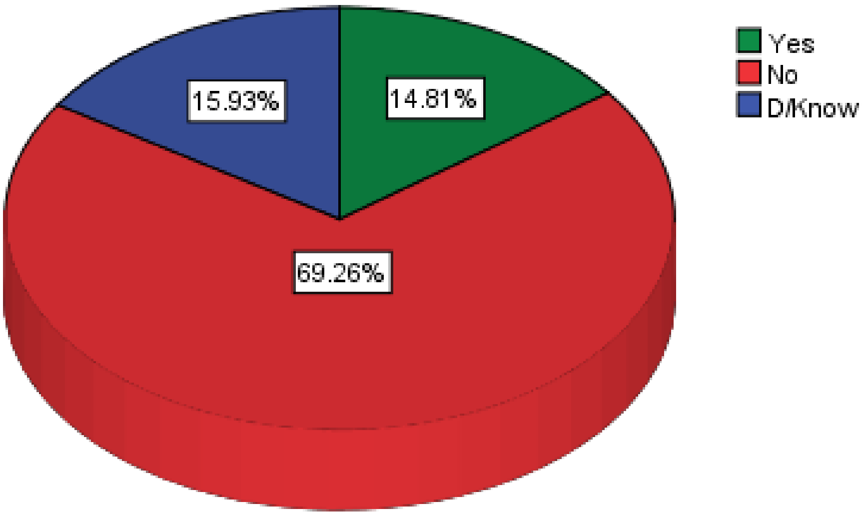

Figure 7.3: Current Omani city planning and water management cooperation
Sources: Author

7.2.3. Improvements to water management

The literature review clarified that water management not only involves creating dams and refining wadis to ease water flows, but also sustained management to provide good protection for developments, and to protect people and properties from flood risk. Therefore, all protection should be integrated to enable the release of water from urban areas into natural passages and ensure good sustainable drainage systems (SUDs). Additionally, residents should create efficient drainage solutions for their homes, e.g. choosing appropriate guttering connected to green roofs, which can absorb rainwater, as well as using flooring materials that absorb the water into the ground, to decrease the amount of water flow into the drainage system. In addition, those agencies responsible for water management and services like roads and parking should make use of filtering systems, such as infiltration trenches filled with stone aggregate and features such as culverts, to allow water to flow away. Therefore, water management must begin with water sources, enabling flow upstream, down to wadis and urban areas, and ending at the sea. However, Oman is a semi-arid region, and SP1 highlighted a need to exploit rainwater, since many areas are currently not benefiting from this significant resource. He favours technical solutions, like dams and letting water seep into the ground to stabilise availability of ground water. At present, as P2 and P4 observed, the management of rainwater on some roads is very poor. For example, on the road between the Almowalih Bridge and Sultan Qaboos University, water floods the roundabouts and the road during periods of rain. This reveals both a deficiency in the drainage system and mistakes when planning the roundabouts.

The shortage of water in Oman requires good management strategies, to oversee the consumption of water, and reduce the amount of water used in the agricultural sector, to retain as much water as possible. W1 suggested that the government situate meters for consumers in private wells, to help people understand the criticality of water conservation.

7.3. The current drainage system in Oman

To what extent is the drainage system in Oman effective and contributing to flood management strategies?

As mentioned in the previous section, and according to the literature review, any drainage system must be comprehensive and sustainable (see Chapter 3). Chapter 6 reported a failure in cooperation between the planning and implementation of services within Oman, such as drainage projects, leading to problems like potholes in the roads. Most interviewees commented that new residential drainage projects focus on draining household sewage only, rather than actively participating in flood management in the event of flash floods. P2, CE, MU2 and W2 have all indicated that the drainage system in Oman is new and yet inadequate. Whilst, it is true that we cannot correlate oversights in drainage systems with flooding, because sewerage is a service and flooding is a situation, it would be beneficial to link services related to expected disasters, in cases such as flooding.

As explained in Chapter 3, the drainage system in Oman has received minimal attention, in very few areas like Alsarooj, although drainage systems were implemented just three years ago in areas in Muscat, like Boucher and Alseeb. P3 pointed out that any change to the height of buildings, will render the sewerage network inadequate. Thus, the sewerage network was not planned considering expansion requirements. Therefore, in new developments flooding incidents will not only arise from rainwater, but also from sewage. Meanwhile, P1 argued that the drainage system currently receives good attention from the government, not only sewage drainage, but also rainwater drainage either under or alongside main streets. This is evidenced clearly alongside some new roads see Figure-7.4

Figure 7.4: Drainage channel parallel to the main streets to drain the rainwater
Source: Author's own

As observed on the author's site visit, the locations of some pumping stations and pipelines suffer from wadi erosion. In addition, interviewees like CE, MU2 and P4 stated that the small size of the pipelines is insufficient to accept sewage over the 50-year period originally intended. This means the government and residents can expect problems in the future, because as MU2 stated, the new process intends to remove septic tanks after connecting houses or buildings to the main sewage network. This, in the author's opinion, is potentially disastrous if the network relies on electricity for pumping; as sewage will flood urban areas during electricity disconnections, such as those during flood events. Therefore, it is essential that the slope of the pipeline enable the sewage to continue to flow away during a power cut. Even then, there is danger of damage arising from water in the wadis.

M2, W2 and W5 claimed the lack of a future vision for drainage has the potential for catastrophe, and therefore, a major plan is essential. M1 referred to a Haya construction project as the only effective drainage system; although, there are many efforts in place, such as new roads including bridges (see Figures-9.1 and 9.4). Despite these concerns, P4 and P7 pointed out there is no experience of a drainage flooding problem in Oman, noting that septic tanks have been used as the main drainage system for many years without difficulties. They opine that this method is best suited to Omani topography and population distribution, because a drainage network will be too costly and only suitable for densely populated areas and not small communities. Interestingly, MMS argued that Haya company's profits from the sewage system do not cover its operational costs. However, we should regard this as a prototype project, so that mistakes can be avoided in future similar projects, to overcome previous faults.

According to MU2, open natural drainage covers approximately 20% of the wadi channels in Muscat, because of extensions and new plots created in the wadis (as will be clarified in detail in Chapter 8). However, in areas outside Muscat, figures are up to 80%, as the wadi channels have been allowed to remain natural. CE and P2 said visitors and non-residents visiting Muscat in the rains, are shocked by the lakes of water in the middle of the roads, on roundabouts and in some residential areas, which are almost submerged. According to CE, the new drainage network in Muscat is expected to accommodate all categories of drainage, including sewerage and rainwater. Thus, Muscat could become an exemplary case for all the Omani regions. Therefore, implementing a comprehensive drainage system for the governorate of Muscat should be executed as soon as possible. This will benefit the city and reduce suffering at times of rain and flooding.

To conclude this section, it should be restated that the drainage system in Oman is still new, and that there has been some effort by Haya Company to construct sewage drainage from homes and other buildings in Muscat. However, according to many interviewees, this project fails to take into account future expansion, and is not comprehensive, concentrating principally on sewage drainage. A large number of interviewees have attributed this to a lack of willingness for specialists to share information from the project outset. The effort in respect to drainage is good; however, it could be improved by including all types of water drainage, such as flash floods, sewage and rainwater, which flows from places like homes, roads, and urban areas in general. In this case, water could be directed toward irrigation, etc., to reduce groundwater pumping. In addition, rainwater can be directed to natural channels and dams to help reduce the water deficit and increase underground water levels. By applying these methods, floodwaters could contribute to the process of filtering groundwater from pollution, resulting from septic tanks, which is noticeable in many areas in Oman; e.g. Alkhoudh, which was mentioned by P6, and Nizowa town mentioned by P2.

7.3.1. Improvement in drainage management

According to the literature review, the sustainability of a drainage system can be measured by both its comprehensiveness and quality. The huge damage caused during the events of 2007 and 2010 prompted the Omani government to think deeply about how it could contribute to reducing the amount of damage caused by flood in the future. According to P7, the project which is under review currently to decrease the amount of flooding in the urban areas of Muscat will be costly, therefore, P2, P7 and the author suggest creating a main trench to service all amenities in one location to avoid digging up roads in future and to reduce compensation. In addition, creating a network program, like a GIS Plan to help partners develop services without causing overlap or damage to other services during the excavation period. The suggestion, already explored by the author in Chapter 6, is connecting plans with a good system like GIS, and referring all services to different layers in one main network. This network could also include land-use, which must remain as it is, without any particular change contributing to climate change (see Chapters 3 and 6). This will be clarified further below.

7.4. Implementation of legislation and strategies

How effective is the implementation of the legislation and strategies of the planning system in Oman?

Chapter 6 showed that planning and water projects sometimes conflict and overlap, as in the case of the Alamerat dams. However, the experts interviewed for this study (P1, P2 and P6) confirmed that the relationship between the planning department and other agencies like water management bodies is excellent, and therefore all plans made by the planning department are shared with interested parties. Particularly after the events of 2007 and 2010, water management and planning management agencies have worked closely to establish flood management strategies and water projects, including deciding dam locations. By contrast, P3 explained that the MOH, which should protect the plans from any radical changes, carried out the development only to modify subdivision plans (see Resolution No 53/1013). In addition, the planning department is keen to implement laws on development and land use change. Evidence shows lack of coordination, developmental mistakes, land use change, transgression of decisions and ignoring other agencies, as exercised by the planning department (see Chapter 6)

According to P7, the land extension and change of land use that occurs in Oman is unacceptable in most Arabian countries' planning strategies. This, he contends, reflects the strength of the impact of the administrative powers in the planning area. Consequently, the frequency of non-applicable and non-binding planning decisions has led to encroachment on plans, as well as poor planning. In addition, SP2 pointed out that the entity responsible for issuing these decisions is the same one that rejects them; therefore, as long as there are exceptions, this will have negative consequences impeding the implementation of a resolution.

P4 claimed that random subdivision plans made by different government departments are often allowed to proceed, as there is no alternative site fit for purpose. This matches MMS's allegation, that even officials at the highest levels in MOH do not implement legislation. P4 suggested creating a new department for monitoring and evaluation, with the responsibility of following-up the implementation of legislation and evaluating and, where applicable rewarding, staff performance. However, this could be done now by the Legal Department within the Ministry itself.

W1 and W4 mentioned the absence of legislation and oversight as a cause for infringement of the wadis flood plain areas, suggesting reform of the legislation and the creation of binding laws will prevent encroachment on these channels and bring about coordination. In addition, P3 suggested that the MOH should share the responsibilities for creating planning legislation with other partners, to create effective regulations for flood management. As mentioned in Chapter 8, and confirmed by the BMS, the intended role of the SCP is currently unclear; i.e. will it only concentrate on the supervision of urban planning? Or, will it also be responsible for planning issues like flood management strategies and planning legislation? The implementation of decisions and legislation is a key concern. As W4 revealed, the mistakes are not only attributable to the MOH, even the implementation bodies participate in these mistakes. This is because, if planning parties ignore the implementation in any way, other parties must negotiate on these issues to achieve an appropriate level of improvement before the implementation of subdivision plans on the ground. Therefore, the following section looks at these issues in more detail.

7.5. Spatial planning and decentralisation in the Omani planning system

What is the most popular approach for resolving conflicts in the policymaking process and planning issues?

Coordination of spatial planning and water management decisions is crucial. This means ensuring the assessment of any information offered by the water management department in conjunction with a planning department survey to ensure wadi channels remain natural places. The aim in this case is to meet the requirements of integration between water and planning management.

According to P3, an exchange of information between water management and planning management in Oman is not straightforward; conflicts can arise during a project's implementation. However, P1, P2 and P6 disagreed, stating that planning information is very easy to obtain from any agency. In addition, SP1 stated the MOH asked the SCP to determine the wadi reserve areas, to avoid them when planning. This suggests a good relationship between the MOH and the SCP, and implies that the information is available to benefit other agencies also. In addition, it is important to leave natural spaces as mentioned by W4, to *"leave space for water to flow"*, as illustrated in Chapter 8. There may be reason to support development on the banks of the wadis after leaving adequate space for water to flow. This a popular strategy, as observed by the author around Scottish rivers, including the Water of Leith, the River Tyne, and the Tweed at Peebles.

An expert in planning, SP2, stated that while centralisation in planning and water management might be a solution, access should be allowed to every governorate, to gather or add data. This suggestion was not favoured other participants, due to the funds needed to provide specialists in water and planning to each governorate (see Chapter 6). However, Municipal councils in each governorate can do this, as in the case of UK local councils, i.e. as in the case of Scottish flood management where tasks are distributed between different agencies, such as SEPA (see Chapter 4).

7.6. Integration between water management and spatial planning

What are the shortcomings in the performance of current planning and water management systems to facilitate the coordination between spatial planning and water management to improve the future of Omani flood management?

The literature review established the value of integration between water management and spatial planning, because unification can help to determine which lands should remain as natural places, which lands are appropriate for development, watersheds, water reservoir locations, risk areas, and locations designated as areas with underground water. This would also identify ecologically valuable places, natural reserves and public resorts, which will contribute to tourism promotion, something the Sultanate is currently calling for. Both SP1 and P6 state that collective work between planning and water management bodies could reduce the potential for drawbacks to affect the integration process and management. Therefore, all the authorities responsible for urban planning need to be consolidated into a single organisation, isolated from the SCP; P7 suggested this should be called the *"council for Muscat development"* however, the author's suggestion is the “Council for Omani Urban Development”, to make it more comprehensive.

As mentioned by many interviewees, including P2 and MMS, gaps between the planning phase and the implementation of planning are evident in the Omani planning system; for example, in the case of the Alkhoudh dam, created by the MRMWR many years ago. The MOH planned the area restricted for the dam, but the planning department identified pathways for wadis from the dam to the edge of the planning area. After this, MM undertook protection work through a subdivision plan, although ultimately its implementation was not realised.

The lack of collective prior coordination could result in negative feelings. For example, SP2 explained that MRMWR and MM prepared plans for the Alamerat dams following adverse weather conditions, in the absence of the MOH. In addition, the MOH planned the area without adequate knowledge about the dams, observing that other parties are unaware of the existence of plans or feel it is impossible to ignore them, in the belief that the MOH will inevitably compensate affected plots. There is a clear need for cooperation when planning development in restricted areas for wadis and places prone to flooding; however, there is some suspicion that neglect for the role of the MOH may be deliberate. This is apparent in the construction of waterways or culverts directly facing the buildings in Al-Hail, where no plans are in place for the buildings that already exist, according to the MOH (see Chapter 8).

P2 and P3 both commented that consensus and harmony are primary concerns in the relationship between water management and spatial planning management. Whereas, P3 said there is a consensus, in some cases, between the MRMWR and the MOH in terms of the exchange of information, but there are some conflicts between water projects and housing projects in certain locations; for example some of the land in Alamerat.

Overlaps in tasks and duties between agencies have generated multiple difficulties affecting decision-making processes, leading to shifting responsibilities and generating excuses, with some agencies blaming others. Therefore, some interviewees, for example BMS, have suggested integrating agencies together in a single body to distribute responsibilities to avoid overlaps in duties and repetition of work. To achieve this W1 and W2 suggest integrating the water sector and drainage system into one authority to reduce duplication and overlaps. Subsequent integration between water management and spatial planning will help to create a strategy to implement a theory that advocates "living with water".

7.6.1. Cohabitation with wadis

The issue of cohabitation with the wadis in Oman allows for two possibilities: either leaving space for the water or living with water. According to the interviewees and questionnaire participants, most Omanis prefer to avoid the dangers of water, but because of the current planning system have no choice about where they live (see Chapter 8). Nevertheless, some experts in planning and water management, like PS1 and W4, stated that cohabitation with wadis is possible by respecting them and avoiding infringement on floodplain areas. Additionally, the creation of dams might reduce the water flowing into flood-prone areas, and thus decrease the width of the flood plains along the wadis; for example, between 4km and 2km, through collective sherja directed into the main wadi. W1 described the compensation of residents of affected areas downstream of the Wadi Dhayka dam with money and land.

According to W1, the municipality cannot force people to leave their homes, even when they are in dangerous areas. This suggests a discrepancy between his opinion and that of SP1 and W4, who emphasised cohabitation with the wadis. This author observes that relocating local people from villages is also contentious as it deprives them of the benefits of tourism, as many people visit the dam, as it is one of the biggest dams in the region (see Figure 7.2). It would be better if nearby villages could be protected and local people encouraged to sell their craft products to tourists, especially as these villages have a natural agricultural landscape, falajes and beautiful topography. This could result in benefits to local people, and enable the government to increase the number of tourists to the country, and attract tourism companies.

Therefore, we conclude that living with water is possible, but leaving space for the water to flow readily is imperative. This can be achieved by applying different methods and flood management strategies, as are explored in the following section.

7.7. The reality of Omani flood management

How effective is the current Omani flood management system to cope with flood risks in future?

The previous discussions in this chapter, and Chapter 8, have revealed that the floods in Oman represent a real danger, and that collective work is essential to deal with them. There is a huge gap between the agencies responsible for water and those responsible for city planning. Mistakes made in respect of planning, or water management have resulted in considerable encroachment into the wadis and flood-prone areas; resulting in many deaths and considerable property damage during the flood events of 2007 and 2010 (see Chapter 3). Chapter 5 also mentioned the positive efforts made by the National Committee for Civil Defence (NCCD). However, according to interviewees, including W1 and SP1, these efforts are inadequate; as was explained by interviewees, such as P6, the efforts were largely made during disasters, rather than continuously improved by knowledge acquisition, skills and experience.

P7 stated that prior to 2007, flood management was poor, and that subsequently, although there were some additional efforts, more attention is needed to identify areas with possible exposure to flooding. P6 and MU2 illustrated this point, stating that studies from various Ministries concentrated on locations for dams, deepening and refining wadi channels, and other temporary solutions like dikes. This matches work done in Pakistan, as mentioned in Chapter 4 (Tariq and Giesen, 2011). However, according to P2, this work was unsatisfactory and not at the required level for flood management. MMS supported his argument, claiming that the Omani government responds to floods rather than managing flooding.

Urban density and rapid development make it essential to accelerate the implementation of rainwater drainage systems to control flash floods. W5 and MU2 stated that efforts were dispersed during the previous floods, so that events required greater cooperation, with each body focusing on the field related to its remit and speciality. This lack of coordination also applied within individual bodies. According to MU2, each Directorate in the MM exercised their remit independently. Therefore, each directorate deployed equipment in its own area, without considering what was happening in other areas. Arguably, this may not have been due to poor coordination, but to damage to roads and communication systems, during the events of 2007 and 2010.

Certainly, as MU1 observed, a lack of historic information about long-term rainfall and flooding in Oman could obscure the reality of flood data, although middle-aged/elderly residents can provide this information, as mentioned by SP1. W1 said that MRMWR has been creating flood risk maps since the 1990s, identifying the degree and location of flooding throughout the Sultanate; however, most Ministries, including the MOH, have not paid attention to these maps. Further, evidence of this are the examples given in Chapter 6, such as Alkhoud.

According to MU1, the MRMWR and MM, some studies have been conducted to determine the drainage of surface water in three areas: Quryat, Alansab and Aljufnan, as well as those areas affected by previous flood events. These studies are, according to MU1 and MMS, still at the improvement stage, and according to previous experience, might take time to implement.

MU1 stated that the SCP, MM and MRMWR cooperated in Muscat to provide quick fixes for urgent cases in flood-prone areas. This effort consisted of dams and channels to reduce floodwaters. For example, there are three dams in Alseeb, awaiting the final approval process; they are linked by around 30km of channels to the sea. This project includes many areas of Alseeb, but according to many interviewees, its scope is now unclear.

Currently, as P2 stated, coordination between water management and planning management in general is at about 50% of the required level, mainly due to limitations in experience and specialisms. Nevertheless, he also claimed that there are flood risk maps covering the majority of the Omani governorates, and that the MOH is working with the MRMWR to draw up flood risk maps for Albatinh. This confirms W1’s claim that flood risk maps exist, but is in opposition to P4’s claim that flood risk maps are not available.

Experts in the planning department, like P2, observed that the problem of planning in flood-prone areas results from the MOH strategy of drawing up small subdivision plans for sites of less than 50 plots, without sending plans to other Ministries. This has led the MOH to extend huge areas using these types of subdivisions, without referring to other parties. Mistakes of this kind, involving individualised planning by the MOH, have had a huge impact on flood prone areas, especially resulting from the adverse weather conditions of 2007 and 2010. In contrast, P1 stated that the planning department always leaves adequate spaces in the buffer zone between the sea and developments (e.g. around 300 metres) to protect the area from beach erosion and to allow a good space between wadis and developments. This contradiction in the evaluation of planning objectives between two experts at the top of the planning department pyramid like P1 and P2 illustrates the lack of coordination in city planning, even within the planning department itself.

The unclear vision for flood management, as mentioned by CE, AMS, P4 and P7, the shortage of historic information about rainfall and flooding (see MU1, M1, M2), and the lack of coordination, even inside the departments themselves (as noted by P1, P2 and MU2), exemplify the deficit in Omani flood management.

Flood risk maps are expected to cover all areas of Oman, because climate change strategies must be amended accordingly. Maps can facilitate the integration of spatial planning and water management, as was shown in Chapter 4 and 6 to be a good solution for flood management. Therefore, the next section will concentrate on these issues, by examining innovative projects.

7.7.1. New projects for flood management

The Guno and Phet floods shocked all the Omani agencies involved in water or planning management. The events prompted the initiation of new projects to support flood management, concentrating on partnership strategies and the avoidance of independent efforts (see Chapter 6).

Wadi Dhayqa Dam: According to W3, the Wadi Dhayqa dam is both a storage dam and a flood protection dam. It is the second largest in the GCC, after Saudi Arabia. The dam provides water for drinking and agricultural use for Quryat, and for domestic and drinking use in the Muscat Governorate. The dam is heavily monitored, and measurements are taken from sites such as the wells around the dam, to show rainfall below the dam, pressure inside the dam, leaks and earthquakes. Nonetheless, W4 points out that the dam is huge and therefore attention is required to ensure good management of the wadi below the dam, to avoid danger from damage to it. Thus, there is a need to open the wadi channel to the sea and to create defences and walls to protect villages lying downstream (see Figure 7.2).

In contrast, W3 stated that although the dam is a storage dam, it also provides a measure of protection against flooding. It reserves 100 million cubic metres of water and the remaining quantity flows over the spillway and into the streams of the wadis safely without causing damage. The author's site visit and discussions with specialists during the conference assured him that the dam is built to high specifications. The main dam is constructed of compacted concrete and there is a side dam of compacted sand and stone. The dam supplies breaker folds of mud to prevent leakage, and supervisory staff inspect it on a regular basis. However, P7 and MMS pointed out that although this huge dam could be a good reservoir for water and cover the water shortage in the Muscat area, all the houses downstream of the wadi below it should be demolished and the owners compensated, because they are subject to threat. A residential complex could be built for these people; although thus far, they have refused to move (see Chapter 6).

Alamerat dams: In addition to the details mentioned regarding this dam in Chapter 6, AMS explained the new dam already built in Alamerat is not in the correct place. It is far from the wadi and the latest rains proved the water flows to other areas not into the dam. The building of this redundant dam cost around *"29 million Omani Rials"*. Consultation with local people, who would have guided planners to the right location, could have averted this costly failure. The Sheikhs and Shura members did not meet with the Wadi before the dam had already been built, and the arguments of locals were rejected, because the dam was planned as one in a chain of seven linked dams (completion of the remaining dams may be a long way in the future as the second one is still awaiting approval).

According to the MMS, although the new wall defences, culverts and bridges built in the Alqurom commercial area represent excellent strategies for flood and wadi management, the government has spent too much money in areas under risk from flooding. This risk will endure, unless dams are built in Alamerat, because the wadi is sourced from there, and the management of water should begin there.

New project for short-term flood forecasting: M1 described how, under the supervision of the "*World Meteorological Organisation"*, forecasters use a network of water resources and radar fixed in different areas. Weather radars use satellite images and sky observations to make short-term numerical predictions associated with the topography of an area, and to provide forecasts for short-term floods in mountainous areas. He states that this project will deliver necessary information about floods six hours beforehand; within this six-hour framework, it is possible to evacuate people from areas expected to be affected by flood. Therefore, *"The national system for emergency management is a member in this project"*, and can send warnings about floods via a communication network to relevant authorities. The project will take a further two years to complete, and another two- to three-year period before it achieves optimum utility. From the author's perspective, this project will represent a good milestone for progress in Omani flood management, but to be complete, it needs to be aligned with similar projects regarding the evaluation and analysis of flood risk and risk assessment in all regions of the Sultanate. Through this comprehensive project, the degree of danger will be determined, and this will complement the work done in the nineties on flood risk plans. M1 believes that this project is suited to analysis and risk assessment, and will include dangers, such as those from Tsunami tidal waves that affected the Sultanate in 2004. He states that such tidal waves threaten Omani cities including Muscat, Salalah, Duqm and Sur. Therefore, these vital areas should have high levels of protection. Indeed, in many areas, huge projects are currently under development, such as in the Duqm economic area.

Musandam development plan: P2 and CE acknowledge this important project, which is currently under study and managed by MOH in Musandam. According to CE the project started with a master plan, and will be followed by a strategic plan and an action plan, distributing tasks to governmental entities to operate services according to the study findings, and in accordance with the deadlines set for implementation, as are already specified, as well as the budgets and resources necessary. The study will cover land uses, wadi channels and defences. The master plan will work to control the flow of wadis to allow the provision of the largest safe spaces for urban planning, and in addition will ease costs to citizens in the development of flood protection. In the master plan, if the authorities take into account all aspects of heritage and urbanisation together, with the proper discharge of water and work on corridors and landscaping employing good architectural techniques, the result will be a modern civilised city. Nevertheless, as CE pointed out the water drainage system in the plan cannot collect sewage, rainwater and floodwater in a combined system, such as that found in many European countries, because Oman does not have continuous rainfall. As he explained, Oman experiences flash floods over a short period, therefore a combined system would not work. This contradicts the opinion of a large proportion of the interviewees, who stated that the drainage system should be in the same channel, although in the author's view, sewage might need to be separated, since other water could be used for domestic use after treatment, but sewage discharge can only be used for specific uses like irrigation.

Walking paths and landscaping along wadi banks lends beauty to the area, as seen in UK riversides. CE stated that this study concerns the gathering of small wadis into the main wadis system, linking them with dams upstream and to the sea downstream. This type of study, which includes both strategic plans and local plans, might need to be carried out throughout Oman's governorates, to work out how to absorb water flow, to save cities, to build confidence with residents, and to add an attractive facade to areas and to protect the developments from flood risk. Implementation of this study will protect Musandam from flood risk and will be part of a larger plan (see P3 and CE).

Protecting the Muscat governorate: According to CE, MRMWR is in the process of undertaking studies in Aljufnan and Alansab to build new dams, which will provide adequate protection to reduce flood risk. In addition, P7 described another study determining wadi locations in Muscat. These cost around *"500 million rials"*, are managed by the SCP, and are subject to approval from the Council of Ministers. The study includes compensation for both lands and buildings, and will be expected to manage the flooding expected five, ten and twenty years hence. However, he pointed out that this was a general study, and details will be sent to other consultants to study land elevations in the wadis in detail. This matches the information provided by SP1; however, if this study takes a long time to proceed, a detailed study might take years to complete, because it will be more comprehensive. Therefore, more damage, caused by either the planning department or people themselves, may arise from delays.

Previous projects, already completed, and those in the review or implementation stages, require effective cooperation between different agencies to deliver good results. Many challenges may arise when there is both practical and financial progress. Therefore, the next section clarifies these challenges.

7.7.2. Challenges facing the new Omani flood management procedures

Flood management in Oman has been subject to a plethora of challenges from different directions. Some of these challenges result from residents refusing to move from flood zones. For example, according to SP2, people in Hail Algaf refused to relocate to new homes, citing the expense they had already incurred restoring their homes following the damage suffered after Guno and Phet. This was despite SP2's site visit to the homes during the floods following Guno, when he observed some were submerged to their roofs. As mentioned in Chapter 6, concerning the same situation in Albatinah, such refusal relates to childhood memories and the sense of belonging to a place, which is common to all. However, the government must relocate these people, since their presence increases the risk of repeated suffering and expense in the future.

This deficiency in information exchange can create difficulties for planners seeking to understand the location of the wadi channels, and this results in increased danger from flooding. Therefore, P3 and P6 see deficiencies in the performance of water and information sharing as contributing to the occurrence of different types of flood damage, because any failure in one could result in a failure in the other, leading to overall failed flood management.

According to W4, Omani flood management requires many improvements and revisions, including the need to revise flood risk maps and subdivision plans; however, this requires multiple partners working together to supervise either water or planning management, and to overcome funding challenges. However, SP1 states that the failure to provide funds for flood management projects is not due to the SCP objection, nor intervention from the Ministry of Finance. The problem is that the Ministries that are implementing the projects lack transparency, and are not seeking permission to access the requisite funds to cover the costs of the required projects; otherwise the money would be available from the Ministry of Finance when requested. Interviewees, such as W1, contradicted this, stating evidence by objecting implementation of the seven dams in Alamerat (a project awaiting funds since 2007).

The absence of reliable studies, which itself indicates a lack of prior coordination in the work of municipalities, represents a challenge. Such studies are essential as a basis of subdivision plans and for achieving an understanding of protection issues. Thus, the overall weakness in a long-term vision of the future, and focus on providing the largest amount of land for distribution has led individuals to consider planning decisions by the MOH, without reflecting on other needs, like the future of dams. According to P3, before hurricane Guno, no study was conducted of the dams by the MRMWR. His assertion may be true; as such studies might have been made but not disclosed to the MOH, thereby confirming a weakness in information exchange between service providers, as mentioned earlier.

P2 described how, after Guno, many areas were transformed as the wadi paths shifted creating new wadis. This created discomfort among residents and changed the water map of Oman. Therefore, collective work between the MM, MOH, and MRMWR, to create protections like dams for different affected areas is a primary objective. Fragmentation of efforts, people refusing relocation, insufficient information exchange, and planning errors will continue to threaten the future of Omani flood management. Therefore, the following sections discuss the search for methods to improve management strategies.

7.7.3. Building an Omani integrated flood management system

It is critical that involved parties cooperate when planning, and implementing plans, without sidestepping responsibility. Additionally, as MU2 suggested, improvements to Omani flood management require a re-visitation of previous studies to assess their deficiencies and prepare new ones that are compatible with present reality.

According to SP2, P5, and P7, improvements to flood management necessitate the combining of stakeholders and decision-makers into a single organisation. SP2 gave an example of a project in Hail Algaf to shift a village from a flood plain to save the area.

According to him, MM had to protect the area and the MRMWR planned to create dams to reduce pressure on the Wadi Dhayqa dam. Prior to a meeting of the two parties with the SCP, they had no knowledge of the other's project. This is a positive indication that the SCP can promote cooperation and a partnership strategy; nevertheless, as SP2 has stated, a coordinating body needs to bring together different parties at the same table, to respond to initiatives from the Ministries themselves, in relation to the huge volume of work being sent to the SCP. This is strong evidence of the absence of coordination in those projects already mentioned in Chapter 6, and in the previous parts of this chapter.

As a specialist in water management, W4 has noticed that in recent years flooding has occurred at frequent intervals: for example, the period between Guno and Phet was only three years. In addition, other floods occurred in 2011 and 2014, affecting Muscat and Ibri. While such floods have happened previously, the time lapse between them has been longer, i.e. up to 50 years. This convergence of flood events could be indicative of climate change, requiring greater concentration on issues that assist flood management, such as the building of systemic technical engineering approaches. SP1, W1 and W4, contend that reducing flooding in urban areas will require the sacrifice of many of the buildings located in the wadis, and a coming together of agencies to create adequate culverts and increase the number of dams.

However, SP1, AMS and W5 state a need for additional studies of previous rains events before determining the locations of future projects. In addition, surface water drainage must start upstream, where the dams are, extending downstream to the sea. This has to be combined with improvements in city planning, which demand a study of human needs and topographies, to create the facilities and services such as sewage and drainage required at first stage of planning. The suggestion of MMS, based on previous experience of flooding, is to re-plan the entirety of Muscat to create a good flood management system, because flood predicting is not very accurate and floods might happen three times in a 20-year period.

M2 said that improved organisation of flood management requires committees with members who are knowledgeable about the science of flood management. In particular, he suggests a need for the provision of training opportunities and visits to other countries to benefit from global experience and new technology in flood management.

They must also undertake continuous field visits to assess what is happening on site, to make work plans that fit the reality of nature.

According to M2, during May and June, October and November depressions and typhoons come from the Arabian Sea, while winter depressions come from Iran, between November and March. Therefore, there must be coordination between NCRM, NCCD and NCD, to concentrate on areas under threat of flooding, and to distribute the right information to people to prepare shelters and effect evacuations before flooding occurs.

W4 and W5, claim that a merger between water management and spatial planning would ensure sensible land use that will not damage the ecological system. Thus, W4 suggests that implementation of flood management in one wadi might provide an experimental case study to enable communication of knowledge about success, and help to improve future plans.

Furthermore, the natural wadi channels must be maintained to facilitate the flow of water; as pointed out by MMS. There is also an urgent need to remove buildings blocking wadis and to re-locate properties to safe places to open wadi channels to receive water, since flooding can happen at any time. Continuous rain might result in the dumping of huge amounts of water; therefore, developments in the field of meteorology and studies of changes over previous years, compared to predictions of future floods is urgently required. Knowledge derived from global experiences in this field can assist Omani planners when contemplating different forms of water management such as dams, wadis channels and defensive walls.

7.7.4. International experiences in new Omani flood management

How effective is the international experience of flood management when applied in Oman?

Strategies of flood management that work in other countries might be unsuitable for Oman, because of differences in culture, planning systems or strategic contexts. Omani flood management, as mentioned earlier in Chapter 3 and subsequently in Chapter 5, is not overseen by a single team, but by independent parties working in isolation until emergencies occur (see Chapter 5 for more details). In addition, there are no flood risk zoning maps readily available to create a clear picture for developers wishing to protect their developments from flood risk. Although, solutions pursued in other countries, such as the UK and Netherlands, involve integration between planning management and water management, this can only be applied to Oman with a comprehensive appreciation and sensitivity of the socio-political context. McCann and Ward (2013) also illustrated that transferability of policies depends on multiple variables, such as, traditions, geography, the nature of the policy itself and the actors involved. They mentioned that policy transfer between countries works best when adaptations are made to suit the context and steps are taken to avoid any observed problems.

Aggregating the advantages of various global experiences is the most important method assisting in the creation of the integrated management of floods in Oman. P2 strongly supported this view, citing different consulting companies used by the Sultanate; i.e. French, Belgian and Australian. Each company brings different experiences to help to create robust flood management practices in Oman. P6, MU2 and M2 agreed and highlighted the benefits of drawing on the experiences in countries with similar weather, e.g. Saudi Arabia, Yemen, and East Asia. P1, W3, and M2, argued that countries like the UK, the US, Netherlands, Germany, France and Japan all have useful experiences of flooding that they can offer to benefit Omani flood management.

CE stated that the Netherlands exemplifies how to protect land from flooding and rainwater drainage. As large parts of the Netherlands lie below sea level, planners there have established networks and channels, which collect discharged river water and rainwater drainage in the city, then pump it into channels and out to sea. He particularly emphasised the gate that protects the city of Rotterdam, preventing seawater flooding the land. The gate operates electronically, and is possibly one of the largest water portals in the world. The Netherlands also embraces new experiences and projects on the ground immediately they prove beneficial. Indeed, any country with good experiences in flood management can be a useful target model for Oman, but preferably those with good strategies for a flood management and drainage systems, or countries that have similar geographical features and a good record of flood management. The literature review identified Pakistan, the Netherlands, the UK and France but many participants offered other examples, or could not comment (see Figure 7.5)

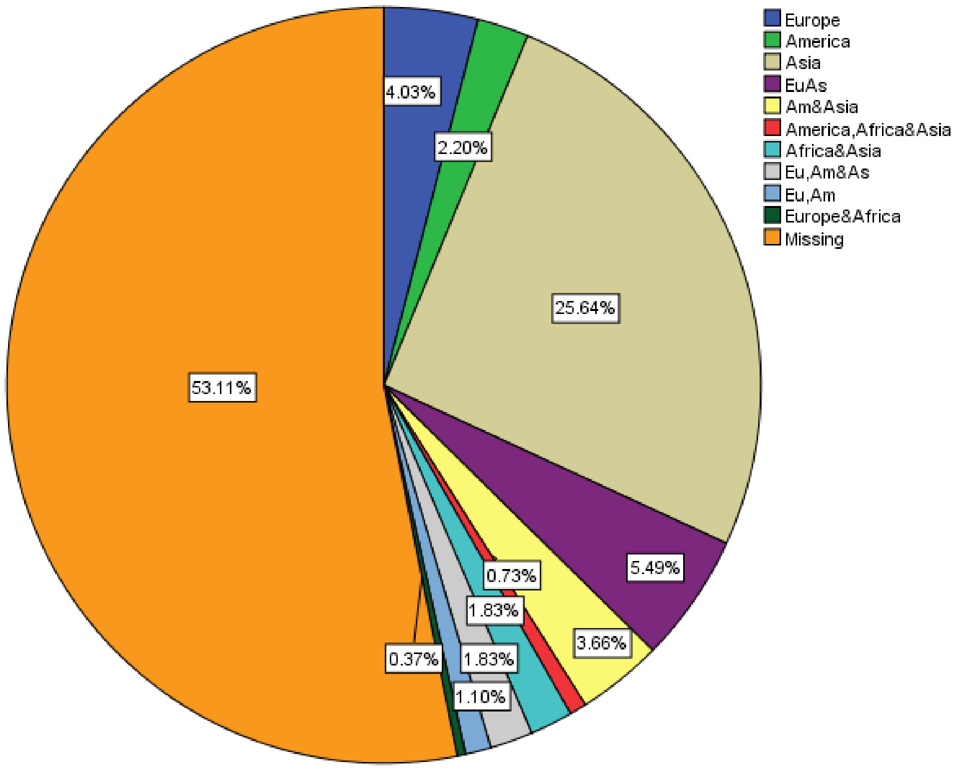

Figure 7.5: Participants examples of good flood management
Source: Author's own

SP2 believes that best practice from any country could be implemented in Oman, not only when pursuing technical approaches but also for tools such as control rooms and CCTV. These tools can be especially beneficial for monitoring local flooding, and sending signals to teams about specific areas where there are problems, to release water before it causes major flooding. In addition, systems can be implemented to observe the drainage network and identify damage to pipelines. Tools linked to GIS can be designed and implemented in conjunction with local drainage systems as part of subdivision plans, and grouped in a major passageways or common ducts allocated for all services.

Certainly, Oman is in a position to create its own flood management strategy, as it has a topographic diversity that does not exist anywhere else. Many interviewees, like P7, strongly upheld this view; in addition, they supported the idea of implementing a partnership between different agencies to blend experiences and skills to ensure successful management.

7.7.5. Partnership for Omani flood management

How can a partnership strategy achieve successful flood management in Oman?

Based on the information in Chapter 4, and the arguments mentioned earlier, cooperation in flood management should be encouraged, since individual efforts to pursue engineering approach projects in Oman have resulted in problems for both residents and areas. For example, P2 illustrated how, in Nizwa, a company constructed a road crossing the Falaj Dares leaving small culverts for the wadi. Residents objected, but the company refused to listen, arguing the implementation was based on a careful study. Unfortunately, about two years later the wadi demolished everything and broke the Falaj, causing unprecedented damage. In this case, ignoring the residents' demands and experience cost the government dearly, as it was necessary to re-build the culverts and conduct repair the Falaj.

Both experience and skills must be present in a new organisation, because the history of the wadis can be understood based on experience, whereas skills provide only the latest technology and the modern solutions and management knowledge for flood management. Therefore, W1 stated, participation by civil associations such as the Associations of Water, Environment, and Geologists is possible. In addition, a member of the Shura Council, and one member of the Municipal Council is advised to participate in the organisation of flood management, to contribute their views and convey the opinions of the citizens directly. However, Sheikhs and middle-aged/elderly people only participate in sub-committees in governorates that are well connected.

W4, W5, MU1 and CE observe that many middle-aged/elderly people have more experience than that held in the Regional Municipality data, which only dates to the 1980s. In the past the MRMWR benefited from these people's experiences in wadi surveys and when taking flood histories. His suggestion supports the intention of SCP. CE believes that benefitting from middle-aged/elderly people's experience and knowledge may be the first building block in the process of updating flood management. In fact, rain gauge stations are only recent innovations, and there is a scarcity of adequate information; even where records exist, they do not exceed 30 years for some wadis and 10 years for others. BMS observes that members of the Shura and Municipal councils could represent residents, but Sheikhs and middle-aged/elderly people have the necessary knowledge and techniques to deal with communities better than these bodies, although senior members of the community might be best employed as advisors rather than council members.

SP1 mentions that when planning at Duqm, one of the middle-aged/elderly people on site asked if there was any plan to allow a wadi in the area. The old man said he remembered sheltering from the flooding of the wadi under a tree, which they were all standing beside. While there are some benefits to considering such evidence, this author suggests, the involvement of middle-aged/elderly people in planning should be subject to additional research to verify accuracy.

On the other hand, W1 and W4 state that organisations require proper planning from the outset, with all government efforts directed toward sustaining communication. According to W4, a partnership organisation would require professionals, engineers, planners and experts who have worked in dry countries, because their experiences might suit the Omani situation. Therefore, water resource agencies must participate in flood management organisations, because, currently, they are responsible for the management of surface and groundwater. In addition, the MOH is responsible for city planning and must therefore be included, as should bodies responsible for roads projects, and electricity.

The organisation should have branches in all governorates but with power centralised in Muscat. According to MU1, and previous interviews, it should comprise specialists on water, planning, Shura and Municipal Councils and finance, and middle-aged/elderly locals as wells as experts in flood management and technical specialists, who are trained to observe satellite data and assess meteorological forecasts. This will make it possible to gauge the amount of water that will fall in a certain place and the anticipated impact.

According to W1, this committee must be technically proficient, and not for decision-making only. It should also oversee academics and professionals working in the field. Table 7.1 below shows the different opinions of the interviewees in terms of the stakeholders that should be involved in any new flood management organisation.

Agency Name	The interviewees																	
	P1	P4	P5	P6	P7	W1	W3	W4	W5	CE	SP1	SP2	M1	MU2	MM	AMS	BMS	M2
SCP& MOH	*	*	*	*	*	*	*	*		*		*	*	*		*	*	*
MM& MRMWR	*	*	*	*	*		*	*		*		*	*	*	*	*	*	*
Meteorology			*		*		*			*			*	*			*	*
ROP	*	*		*						*						*		
MD				*						*						*		
MTC			*	*				*		*					*			
NCRM&NCD																		
MECA		*	*									*		*			*	
NCCD	*		*	*		*	*						*					*
MF						*								*				
MH							*											*
MA				*														
Sohar Municipality										*		*						
Dhofar Municipality																		
SH&MU M			*			*	*					*	*				*	
Shaikh						*											*	
middle-aged/elderly people						*		*	*	*	*		*					
PAEW					*			*		*						*		*
Haya					*													

Table 7.1: Agencies and people proposed to form an Omani flood management partnership
Source: Author's own

From Table 7.1 it is evident that many stakeholders must cooperate for Omani flood management to succeed. Different categories of individuals are useful at different stages; for example, some can participate in city planning, some in water management and others in establishing a drainage system, since all agencies and individuals are significant and important. Rather than combining duties, it is better to divide tasks. This is clarified in the recommendations section in the final chapter of this thesis. Table 7.1 presents the views of all the interviewees, and their suggestions about parties to include in a unified flood management organization. Each of the interviewees indicated

Ministries and individuals they considered would add value to such an organisation (for details of the abbreviations in the table see Glossary of Abbreviations).

P6 suggests an ad hoc committee would be more appropriate than a permanent flood management organisation. In contrast, CE states that flood management is not only essential during or after floods, but as a permanent and unified option. According to P3, while flood management is presently managed by the NCRM any new body should be under the NCCD, so that it can build on NCCD experience, gained during previous floods. Additionally, M1 suggested the organisation should be led by, either the NCCD, MRMWR or the Metrological Agency. Whereas P1, MU1 and AMS suggested the SCP should lead the organisation, since this entity currently covers administration, planning and economic considerations. However, SP1 states that the SCP currently has many responsibilities and this might be not be a good time for the agency to take on additional work.

According to W4, any new organisation should comprise a group for planning, a group for supplying information, and a group for distributing services via an integrated system. One system, suggested by W3 could be comprehensive, involving cooperation between all previously mentioned stakeholders with the main goal of improving the planning system to avoid flood risk and improve planning in these areas to let water flow safely. For this reason, as shown in Table 7.1, experience and skills might be the target requirements for this level of management.

Importantly, any agencies involved must emphasise coordination and networking, to facilitate the exchange of information as an integrated system.

7.7.6. Skills and experience in flood management

How can skills and experience contribute to building a sustainable flood management system in Oman?

Political, economic and social factors are all significant in the success of the planning cycle, and neglecting any of these three might reduce the quality of flood management and the quantity of information available. In addition, each has a different role in creating a natural balance between planning and implementation. Therefore, focusing on this issue to ensure successful flood management and different views requires comprehension of the views held within various segments of society, to understand the public's opinions as well as the views of organisational participants.

M1 comments that community representation is valuable, and that these representatives can contribute to addressing social concerns, especially when the relevant issue is the construction of dams in a particular place, or the conversion of a bridge or street from one place to another, or even altering the path of a wadi. All these aspects need to involve interaction with the community or those who represent them, as mentioned above in reference to the middle-aged/elderly. All decisions could be linked to local interests, education, specialisms, or knowledge and experience in either flood management or planning and water management.

SPS, SP2, W1, CE, P1, P2, P5, and P7, all agree that both experience and specialisation are crucial, because experience enhances the ability to manage subsequent events. In addition, specialisation is of substantial importance, because specialists are continually updating information. Therefore, to create a good balance between skills and experience should minimise the challenges faced by the organisation. According to the literature presented in Chapter 4, capacity building between partners is essential, as explained further below.

7.7.7. Capacity building amongst partners in flood management partnership

The literature review in Chapter 6 established that capacity building between partners must be based on information exchange, honesty, effective relationships, and a good selection of members, according to their knowledge and speciality. In addition, efficient exchange of information, clarity of views, good communication and ongoing meetings are necessary to put forward views (see Chapter 4).

According to W5, capacity building relies on awareness, knowledge and media, Whereas, SP2, W1, and W3 state that the best option for capacity building in flood management is via specialised dialogues and discussions. This exchange of views is expected to offer a clearer picture and make it possible to agree on new ideas. The need to work as a team will counter contradictory views, and agreements should be effected after a clear and transparent discussion of opinions.

There may be differences in opinions between partners. For example, P2 noted a conflict in reference to the Wadi Goul subdivision plan. Many studies and suggestions were made to prevent the subdivision, such as building a defensive wall or road; however, at that time, Water Resources rejected the two projects as temporary solutions. Instead, Water Resources preferred to implement additional dams' projects. P2 stated that parties are now starting to review the area to determine a new and safer method for protecting the subdivision plans from the wadi. He states that implementation is the main dilemma facing the planning system in Oman, since studies can be carried out, but their findings not necessarily implemented (see Chapter 6 for more information about difficulties in implementation).

The author views this as a waste of time and effort; as in financial terms, studies cost the state huge amounts of money, and are frequently disregarded. P2 and SP2 advocate coordination throughout the process, as the most significant element informing success in a flood management partnership. P6 felt that by having one team responsible for maintaining continuity it would be possible to achieve capacity building amongst partners, although this should be within a good information sharing system, for example, GIS. Any partnership must reflect the values and traditions of Omani society.

SP2 believes that members of flood management organisations must be well educated and specialists. M1 and P4 emphasise communication between those working on similar projects based on openness within the community via the internet. A flood management partnership will be successful if there is effective cooperation, a good balance, an efficient schedule and respect for the views of others and teamwork. In addition, members should be educated and have experience in the field. Any decisions should be aligned with good city planning, water management policies and drainage systems to improve flood management.

7.8. Conclusion

The interviewees proposed the establishment of a good relationship and partnership between the various agencies for planning management and water management as the best approach to effective flood management and decision-making. It can be concluded, based on the arguments presented in this chapter, that water management is already effective in some areas, such as the refining of some wadis, the building of both protective and storage dams, and in coordination with residents, especially when creating dams in villages. However, it is not as effective when it comes to coordination with other agencies, like the planning department, or creating defences for wadi banks to protect people and property from flooding, except in critical areas like Alqurom. In addition, there is substantial weakness in flood risk maps limiting development in dangerous areas like Al-Hail.

The drainage system is unsustainable; planners are not looking toward future requirements, and not calculating the expectation of continuing construction, only concentrating on mending sewage pipes. There are failures in implementation, even here; such as the building of treatment stations inside wadis and urban areas, as well networked pipes with very small diameters under threat of the risk of wadi erosion. Any study of surface water drainage must start upstream, where dams are and move beyond, downstream to the sea.

According to the majority of the interview and questionnaire participants (see section 7.5), implementation of legislation and strategies is not very accurately observed, and needs more attention. Currently the integration between water management and spatial planning is poor, a comprehensive national strategy to regulate everything is planned but could be a long time in the forming. As mentioned by most interviewees, some of whom are area planners and others who are specialists in water management, and by questionnaire respondents; unification between planning systems and water management requires more attention to strengthen relationships to achieve authentic cooperation.

Effective relationships will assist spatial planning agencies to regulate changes in land use, which is the most significant cause of flooding, as evidenced in Al-Hail. Mistakes in land use planning contribute to Omani climate change, because emissions produced from new uses, such as industrial developments can contribute to GHG emissions, although the effect of this might contribute to general climate change, and not be concentrated in the Omani context only, since countries like China contribute more to emissions. Renewable energy is available in Oman, from the sun, wind and waves, but is not used.

A partnership for flood management is critically required in Oman, because currently it only consists of efforts made during flooding events but real flood management, as shown in the literature review, is more complicated. Thus, there must be good coordination to bring together experiences and skills through participation among specialists and professionals in both water management and planning management, to construct a sustainable flood management system in Oman. In this, the participation of community representatives from different fields, such as the Shura and municipal councils and middle-aged/elderly people, beside experts in planning management, water management, and flood management aim to strengthen flood management by sharing different views. These have to be offered under the umbrella of capacity building, resulting from a combination of mutual trust, dedication and honesty between members, and consisting of government agencies and other partners (see Table 7.1).

Improvements to the planning system are crucial, to build a future for Omani flood management, as was clarified in this chapter and the preceding one. The next chapter presents a case study, which will clarify the implementation of the planning system in practice and discuss practical flood management during previous floods events and related issues.

Chapter 8

Al-Hail Case Study

8.1. Introduction

This chapter focuses on the issue of *"Understanding the effect of the planning system on the ground and the improvements required to cope with flooding in Al-Hail"* and asks the key question, *"How can the planning system help improve the situation and reduce the effects of flooding in Al-Hail?"* This question is broken down into sub-questions and the responses discussed below.

Questionnaires and interviews for local people are very important to the main research question, as engaging with residents in areas that have already been affected by two periods of flooding, such as in Guno and Phet, clearly illuminates the reality of flooding. This questionnaire surveyed the opinions of locals regarding the shape of their immediate built-environment, and projects undertaken to protect them from flood risk. In addition, the aim was to gain an in-depth understanding of their collective work and ensure cooperation in procedures, so that planners could benefit from their experiences of past and current flooding events and assess the scale of flooding. It is crucial to understand their evaluation of their experiences of evacuation and flood management during flooding events, and the emergency care and compensation they received for affected property to clarify the situation with regard to flood management.

By using graphs and tables derived from the SPSS analysis and pictures from the site, the situation in Al-Hail regarding both flooding risk and flood management will be analysed. The experiences of middle-aged/elderly people and specialists from different agencies, and information from both city planning and flood management sources, will then be compared. This chapter uses a case study to understand the condition of the Omani planning system and flood management in practice. The evaluation of this case will refer to the findings concerning planning and flood management policies described in the two previous chapters. Further analyses of the Al-Hail case study data, in the form of pie charts and tables displaying the questionnaire findings appear Appendix 1.

As described in Chapters 6 and 7, the negative effects of the planning system in Oman became apparent following flooding in 2007, 2010 and in subsequent years. Flooding was attributed to poor city planning, changing land use, extensions permitting building in flood-prone areas, and encroachment into the wadi channels. Furthermore, the overlap between water management and city planning, poor coordination between the agencies responsible for planning and water, and shortcomings in information exchange between different agencies with responsibility for flooding exacerbated these problems. The interviewees, who included experts in both water management and city planning, in addition to community representatives, such as Shura and council members and specialists in various relevant subjects, all mentioned these factors.

This chapter describes planning and flood management systems with a view to obtaining greater knowledge of the situation on the ground. Information relating to both systems obtained from both experts and non-experts appeared in Chapters 6 and 7. Questionnaires were used to survey the opinions of the residents of Al-Hail, in addition to interviews with middle-aged/elderly people, who experienced the changing situation in Al-Hail before and after contemporary planning was introduced.

This chapter focuses on aspects related to Al-Hail's background, people's experiences of floods, city planning, the implementation of projects and their results as regards flooding, new drainage systems, the challenges faced and improvements required to protect Al-Hail from flood risk. Concluding remarks are made at the end of the chapter.

8.2. Background to Al-Hail

Al-Hail is one of the residential areas making up Muscat; it is administratively part of Alseeb (see Figures 8.1 and 8.2). The new planning system divides into southern and northern areas. Before the introduction of the new planning system, the area mainly consisted of farms and homes for fishermen, similar to most of the coastal areas in Muscat. What distinguishes this area from others in Alseeb is its use by Muscat residents as a summer destination, as its many farms are slightly cooler than Muscat town, Muttrah and other places in Muscat. Unfortunately, following new urbanisation, most of the farmland has been reallocated to residential and commercial use under the new planning system. According to many interviewees, including P2, W1, MU1, CE and W4, this change has failed to account for the wadi channels and sherjas that flow through these farms. Additionally, as noted in Chapter 6, planning confusion arose, due to changes in land use and encroachment into the wadi channels, the extension of which caused the areas to become dangerous, leading a large number of problems to arise. Such actions helped bring a more modern identity to the area, but resulted in new developments and projects causing some problems.

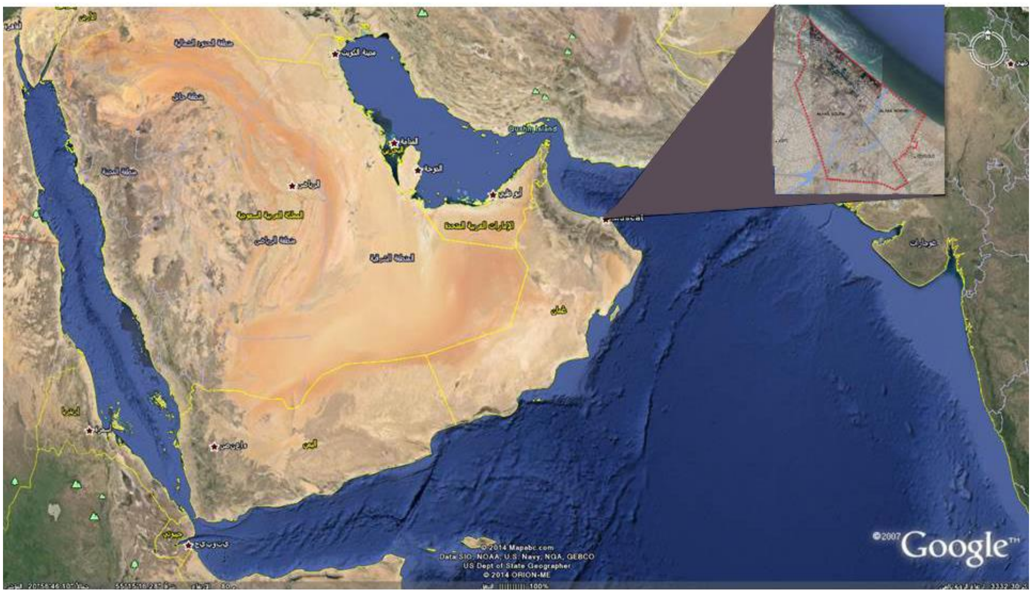

Figure 8.1: Al Hail's location as seen on Google Earth
Source: Adapted by the author from Google Earth

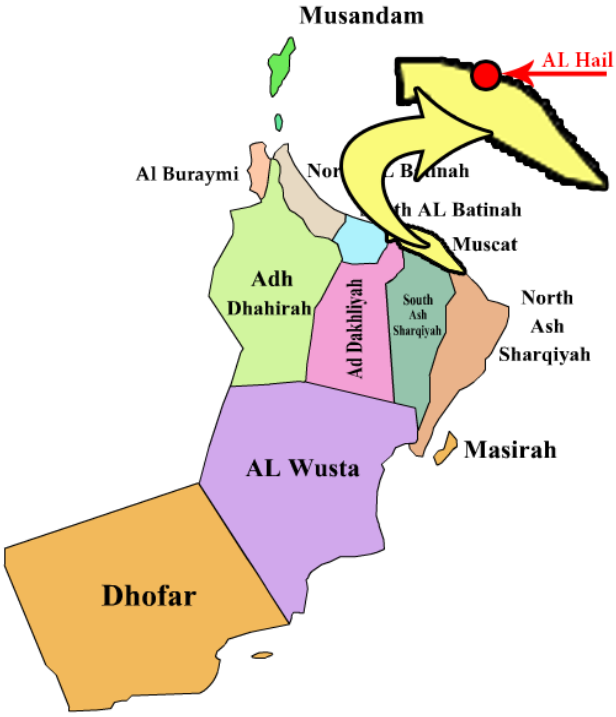

Figure 8.2: Al Hail's position in Muscat governorate
Source: Adapted by the author from MH

The planning department in the 1980s was involved in the reclamation and rehabilitation of this area for agriculture, designating the south of Al-Hail as new farmland ranging in size from 3000m^2 to 10000m^2. In addition, a small part of Al-Hail south was planned as residential plots; with farms and residential plots then distributed to beneficiaries. Changes were in response to population growth that helped change the identity of Al-Hail north. When interviewed, some of the Al-Hail south residents stated that before planning the area was flood-prone, acting as a watershed for all the wadis coming from Sumail. They argued that planning in this area was a bad decision, as the land naturally functions as a reservoir supplying all the Alseeb farms with groundwater. However, development of the area is already planned, and people are living there now; thus, new flood management projects, such as dams, have been initiated in some locations, as described in Chapters 6 and 7. However, this is still not an adequate strategy for flood management, and many improvements are required.

The Alkhoudh dam, created at the instigation of the government, may appear to be an alternative means of conserving water in the region. However, as described in Chapters 8 and 9, development threatens the dam, as the surrounding areas are being used for different purposes. However, some interviewees maintain that the new dam projects will help conserve water and protect the area from future flood risk (see Chapters 6 and 7).

In fact, it has become apparent in Al-Hail north that, despite the changing land use and encroachment into the wadi channels, planning professionals have largely failed to understand the huge problems that such areas face during flooding events. New farms planned in Al-Hail south were distributed to people on benefit contracts, and ownership was later assumed under the Semitic orders of His Majesty the Sultan. These plots have are now commercial and residential areas. The mistakes that occurred in Al-Hail north were then repeated in Al-Hail south.

Many houses and properties were damaged during the floods of 2007 and 2010, due to Al-Hail's location between the sea and the wadis. As described in Chapters 8 and 9, the previous floods came as a shock to stakeholders involved in flood management projects. As previously described, these studies and projects were individual efforts, and there had been a lack of coordination between water management and city planning management agencies. This had resulted in an overlap of responsibilities and led to flooding problems affecting bridges, culverts, roads and drainage systems.

Al-Hail was among the areas most severely impacted by flooding in 2007. This was due to water returning from the sea during Cyclone Guno, which, when combined with a huge amount of rain, flooded the area causing extensive damage to homes and properties. Some residents said this effect was a result of the encroachment of developments into flood plains and wadi channels, whereas some attributed it to the small dimensions of the culverts. Additionally, some experts in planning and water management stated that as the sea could not absorb the water from the wadi because of the cyclone, water re-entered the urban areas. As a resident of the area, the author had first-hand experience of the Guno flood of 2007. Culverts and cyclones increased the flooding, as after the cyclone, the culverts, which had themselves been blocked by trees and other obstacles, blocked the flow of water. In addition, planning mistakes and poor drainage systems also contributed to the problem. This situation is examined in greater depth in the next section. The different views of both specialists and local people, and the results of the questionnaire issued to Al-Hail residents, are presented and linked to the previous results and literature review chapters.

8.3. Al-Hail's experience of flooding and the main causes

Whilst the exact population of Al Hail is uncertain, according to the 2010 census entitled "Distribution of Population (Omani/Expatriate) in Muscat Governorate by Wilayat", the total number of residents of Alseeb was 302,292. These people were distributed in different areas of Wilayat and Al Hail. Table 8.1 lists people who participated in the case study survey. They were selected because they were local residents, and most had suffered damage to their homes due to the flooding in 2007 and 2010. In addition, middle-aged/elderly people (Sheikhs (see Glossary of Abbreviations for meaning)), and people with experience of gradual flooding during their lives were deliberately included (see Chapter 2 and Apendix 1 for more details).

Type of people	Age	Number
Middle-aged/elderly	40 to 80 years	10 people interviewed
Questionnaires	From 26 and above	120 people completed the questionnaire
Specialists views taken in this case study as well		

Table 8.1: Al-Hail people participated in the survey
Source: Author's own

As mentioned by the middle-aged/elderly residents of Al-Hail, flooding is not a new event; it occurred around 60 years previously, causing many date palm trees to fall. Flooding reoccurred 7 and 18 years later, followed by the two flood events of 2007 and 2010. However, the Guno flood was enormous, and the events of 2007 were completely different from those witnessed during previous floods (see Chapter 3). Many houses were affected by the flooding, some graves were eroded and properties damaged by the wadis and floodwaters. The middle-aged/elderly people interviewed stated that the main cause of the damage to the houses and other properties was their close proximity to the wadis; in some cases they were located inside the wadis (see Figures 8.3 and 8.4). This was due to the extension and creation of plots in wadi channels, some of which were under construction at the time. Culverts and bridges were also cited as a cause of flooding, as water flooded into residential and commercial areas (see the section on water management).

Figure 8.3: The two main wadis in Al-Hail overlapped with the urban area
Source: Adapted by the author from Google Earth

Figure 8.4: Land and buildings in the wadi
Source: Author's own

According to the middle-aged/elderly people interviewed, some of the lands offered by the MOH are located in the wadi itself, some of which have not yet been built upon. They maintain that these lands were given to people as compensation when their land was affected, or by titling decisions without consideration of their location in the wadi.

One of the middle-aged/elderly interviewees said he had some old land situated in this wadi, for which he received compensation. As described in Chapter 6, this reflects the confusion that occurs in planning and the effect of poor administrative decisions on planning. Middle-aged/elderly people stated that they had had no contact with the planning department during the allocation of lands in the wadis, and had reached a stage of desperation, as they felt that planning professionals were not listening to their suggestions. This contrasts with assertions made by planning professionals, such as P1, P3 and P6, concerning their good relationship with the community to support the planning process. In addition, the middle-aged/elderly people interviewed said that even the implementation agencies responsible for water management projects did not communicate with the community; a prime example of which is the creation of new culverts in front of commercial buildings (see the description of culvert problems below).

Both the middle-aged/elderly residents of Al-Hail and the questionnaire respondents stated that they were worried about flooding, due to their experiences in 2007 and 2010. This created bad feeling about planning and project mistakes that had led to damage to their homes and properties.

Evidence from local people suggests that poor planning has occurred during changes in land use, as well during the expansion of the wadi channels. In addition, coordination between the agencies responsible for water and city planning and drainage systems is lacking. These issues were clarified in Chapters 6 and 7 and are considered by local people to be a huge problem that could leader to a future disaster in Al-Hail.

The next section focuses on the practical aspects of the planning system and the relationship between the planning system and flooding. Whereas new projects have already given an indication of their effects on the ground, this chapter provides an overview of residents' experiences. This overview aims to measure the effectiveness of both the planning system and flood management from a practical perspective, to draw conclusions about the flood management situation from the field in reference to the information given in the previous chapters. It is hoped that this knowledge will help formulate recommendations for a sustainable flood management strategy in Oman. The next part covers the planning system in relation to city planning, water management, drainage management, cooperation between previous management and flood mitigation and adaptation.

8.4. City planning on the ground

How effective is the City planning on the ground to cope with flooding?

Middle-aged/elderly people and municipal council members (MM1) have stated that although the rain and wadis were previously a source of joy and pleasure, they now lead to a great deal of anxiety and fear of flood risk. The problem, as stated by the city planning authority itself, concerns the planning of the floodplain and wadi channels. This situation puts residents in a difficult situation in the event of flooding or heavy rainfall. Wadis can flow into homes at any time, since there is not enough space between the houses and the wadis. Around 47% of residents were worried about the wadis (see Figure 8.5). The figure shows that around 50% were not concerned, as they personally do not own houses situated near a wadi.

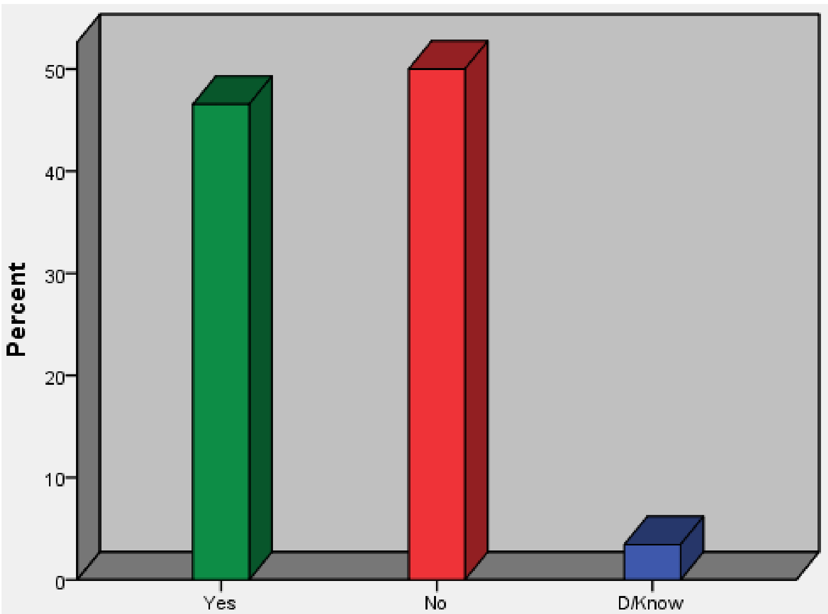

Figure 8.5: In the case of the re-planning of the area surrounding the wadi and its beautification would you desire to live next to the wadi?
Source: Author's own

Some interviewees, such as MMS, P1, CE, MU2, suggested re-planning in some areas near the wadis in Al-Hail, and offering compensation to owners. From the point of view of residents responding the questionnaire, 80% agreed with the principle of compensation, whilst 20% disagreed (see Figure 8.6).

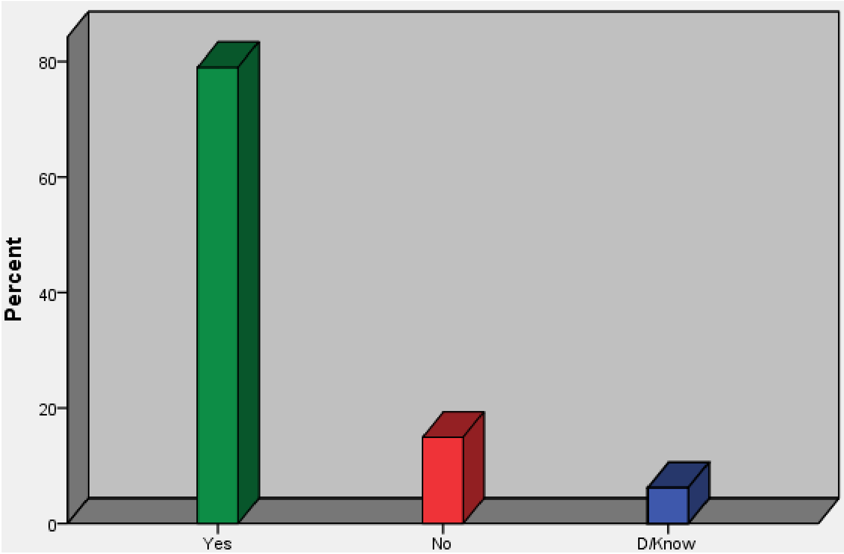

Figure 8.6: Residents in favour of compensation
Source: Author's own

Additionally, compensation could comprise financial compensation for both the houses and land affected. Figure 8.7 shows that around 55% of those surveyed agreed with this procedure, whilst around 45% preferred to receive land as compensation. However, respondent MU1 in the Al-Hail study stated that only around five to six houses would be affected if water channels were opened. This suggestion does not meet the demands of local people, who stated that re-planning of the wadi flood plain areas is the best approach, although it would be costly in terms of compensation. Most people agreed that there should be compensation. This is in line with the views of the questionnaire respondents (see Figure 8.6).

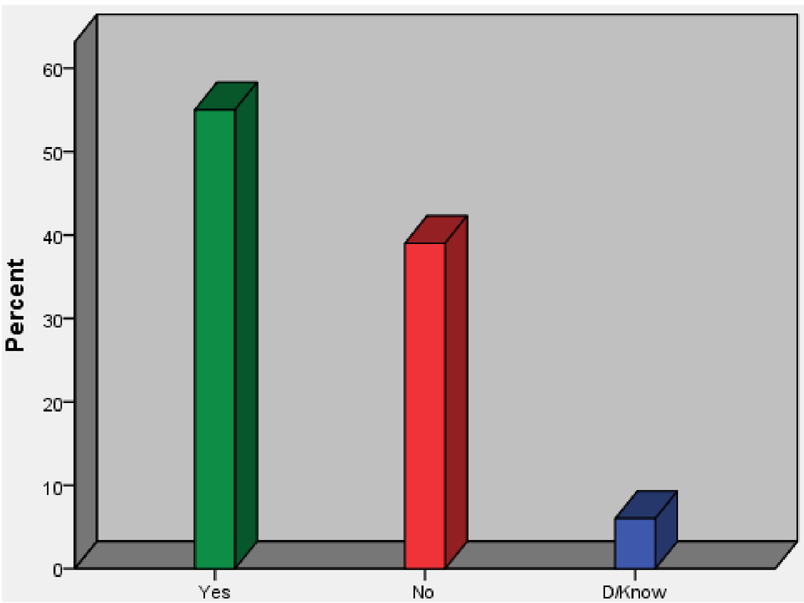

Figure 8.7: Would you prefer to be compensated financially for the building and given land as well?
Source: Author's own

A few of the Al-Hail residents interviewed need to live near the wadis for their livelihoods. In contrast, 69.2% of respondents to the questionnaires stated that they do not wish to live near wadis (see Table 8.2). As shown in Table 8.2, most of the residents (86.7%) suggested leaving space for the wadis to flow in their natural course. This might be because they preferred not to risk their lives, or resented the current infringement on the wadis by the planning system. As mentioned by both the representative of the Shura Council for Aseeb (MSS) and MM1, the wadis need to be directed to the sea without any obstacles, with good landscaping on their banks. In addition, the dams upstream and the other features that direct them into the main wadis should reduce the amount of water flowing into them. These solutions should enable local people to be confident about staying near these wadis as well as meeting the two theories of *"living with water"* and "*leaving space for the water to flow"*.

Leave space for wadi	Percentage		Live near wadi	Percentage
Yes	86.7%		Can live near wadi	24.2
No	3.3%		Cannot live near wadi	69.2
Don't know	10%		Don't know	6.6
Total	100%		Total	100%
Number of respondents	120		Number of respondents	120

Table 0.2: Leaving space for wadis to flow and living with wadis
Source: Author's own

As previously described, city planning has played a major role in the situation in Al-Hail, due to the changes in land use or building in the wadis. This situation, particularly after the floods described earlier, created consternation among the residents. The acceptance of compensation has been a major problem, and residents have not agreed on what form of compensation they prefer. In addition, residents who need to be compensated by both land and financial means might agree to wholly financial compensation, due to the shortage of land in Muscat described in Chapter 6. P1 preferred the option of offering financial compensation for lands affected in Al-Hail, due to the current huge shortage of in lands in the Muscat region. As the channels are supposed to be an average of 50m to 100m, relocating people would cost the Ministry a great deal in cases of land compensation, making compensation by money rather than land a preferred option.

The next section focuses on other areas of the planning system that must function in conjunction with city planning to achieve good flood management.

8.5. Water management on the ground

How effective is water management on the ground at coping with flooding?

As described in Chapter 6, many engineering and technical approaches to water management have either been built, are under construction, or are in the final stages of financial approval. Some of these projects might impact already protected flood-prone areas such as Alqurom. Some interviewees, such as P5 and MMS, have said that some buildings, such as culverts in Al-Hail, could encounter problems (see Figure 8.5).

8.5.1. Culverts facing buildings

Planning expert P1 argued that the culverts are a result of a comprehensive study and will not affect buildings, due to the integrated system of dams upstream and channelization of the wadis. This study involved SCP, MOH, MRMWR and MM. However, MU2 said that without building dams upstream the culverts are very dangerous during flood events. MU2 stated that the location of the culverts in the wadis does not extend to the outside of the wadis, although in reality this is not the case. W3 said that in Al-Hail, rehabilitation work has been carried out on the main road. A study from MRMWR was used to create four protection dams upstream of Wadi Aljufnan, which will help protect the area from flooding in the future. According to W3, these dams were designed to absorb the flooding on the level of Guno, and the remaining water should easily flow through the wadi channels to the sea. This flow of water is impossible to achieve without determining the wadi channels and affecting some buildings.

Planning expert SP1 stated, *"If the water comes into the culverts in the same volume, we can say goodbye to Al-Hail north and south"*. Most other interviewees share his view; such as W1, who said culverts exist only to protect users of the road without assessing the impacts for the residents of Al-Hail. In addition, W1 said this project has no need for specialists to assess the quantity of damage expected to arise from the culverts. BMS and AMS said that unfortunately culverts do address the problem of road congestion during rainy periods, but have created huge problems that might affect people and their property (see Figure 8.8).

Figure 8.8: Culverts adjacent to existing buildings
Source: Author's own

Some waterways or culverts have already been constructed directly opposite buildings in Al-Hail, without providing protection for those buildings, according to the MOH plan. Some interviewees likened this situation to a bomb designed to explode at any time. In addition, interviewees MU1, P1 and P2 said that although there has been talk of a project designed to oversee the completion stage, additional culverts, to determine the direction of the wadi, and to take action about buildings that act as obstacles, in reality there is no evidence of this. Furthermore, the owners of these buildings are not aware of any projects aimed at protecting their buildings. Conversely, MM has issued building permits for some new commercial buildings (see Figure 8.8.).

Decisions about affected buildings and compensation for owners must be directed to the MOH (MOH) to follow compensation procedures. However, as previously noted, MM originally undertook the project, which might lead to confusion amongst owners regarding who will provide compensation for land and buildings. This leads to two possibilities: either to only coordinate the work on culverts and ignore property owners or to ignore the MOH, as was the case in Alamerat (see Chapter 6). A further possibility is that compensation could be arranged later; although ignoring the possibility of buildings being affected in the event of any future flooding is not a good solution. It is assumed that if buildings are affected, this falls within the remit of the project for supplementing culverts and waterways, and determinations to leave open land. For example, in land next to the Al-Kindi Mosque (see Figure 8.8) mentioned by MSS and MM1, building created panic and inconvenience to residents living behind the site. However, a question arises concerning how this situation arose in the first place, and why the Municipality gave permission to build in such dangerous areas. This may provide evidence for the poor coordination and administrative and technical decisions made by the agencies responsible for implementation and development, such as MM.

8.5.2. Differences in the dimensions of culverts

A site visit by the author to Al-Hail revealed the existence of culverts of different dimensions in the same wadi. These differences, according to P1, resulted from encroachment by citizens onto land, which narrowed the wadi channels and therefore left only a limited amount of space for these projects. In addition, CE stated that the presence of culverts of two different sizes in the same wadi was due to both encroachment by people onto the wadi and the construction of buildings in the early stages of urbanisation. There has long been a lack of accurate data, as some of the floods only occurred at intervals of 500 or 1,000 years, meaning that people failed to anticipate the occurrence of hurricanes and floods like Guno and Phet. However, W1 stated that whilst the differences in the dimension of culverts are a result of estimates of risk before 2007, they are not a result of personal factors. Instead, he opined that the existence of different culverts in the Al-Hail wadis is a great mistake, and that the only way to protect people is to open up the wadi streams.

MU2 argued that the differences between culverts under building entrances and the roundabout culverts constitute a technical problem; the Municipality has received complaints from citizens, and these culverts are currently under investigation. MU2 said that whilst the culverts near the building are private, and the wadi is very narrow, residents have demanded removal of a building to open the wadi channel. This study argues that the culverts near the building, were created under the road, serving only that building (see Figure 8.9), and were approved by MM. It is therefore ultimately a municipality error as the owner received approval to create the bridge in the wrong place. Middle-aged/elderly people and some residents, such as MM1, expressed their resentment of the building, as previously stated, and attributed the large amount of floodwater experienced by their neighbours during the flooding in 2007 to both the building and its entrance.

Figure 8.9: The bridge depicted serves one building and caused flooding in 2007
Source: Author's own

There were four differently sized culverts noted in four different places in the same wadi (see Figure 8.16), meaning that the entire wadi should be examined to eradicate the obstacles to buildings and culverts. As mentioned by middle-aged/elderly people and most of the residents of Al-Hail, these obstacles were a source of dissatisfaction, leading to an increased fear of flood risk. AMS assumed that all the culverts from the beginning of the bridge in Sultan Qaboos Road to the sea must have the same capacity, as it is possible that the wadi could carry trees, animals and cars. This would lead to the closure of the culverts and inundation, therefore confronting local people with a disaster greater than that experienced in 2007. In contrast, BMS claimed that due to ill-conceived decisions, bridges have replaced many culverts. This lack of legislation and associated laws could cost the state a large amount of money, or even lead to loss of life, for which there may be legal consequences. Penalties must therefore be implemented, not only in response to financial and administrative corruption, but also to take into account the planning and design mistakes made by officials at all levels, from planning professionals to ministerial staff. This study argues that changing the culverts into bridges is a good decision, as in some places these changes helped release the water into the sea or into natural courses without any blockages, in contrast with the events of 2007 in Al-Hail.

Interviewee W1 stated that despite the organisation of wadis and bridges falling under the responsibility of MM, no action had been taken. In addition, the existence of this size of culverts should protect road users but could harm residents. Both residents and road users should be protected by bridges rather than by the huge culverts that direct the water toward existing buildings. In addition, CE argued that a hydrological study should precede the designing of any road or bridge project; the design of culverts must be commensurate with the size of the maximum expected flood. Culverts nevertheless exist at the site and residents have opposed both the poor management of the project and the encroachment into the wadi channels. An urgent solution involving compensation for all buildings situated in the wadis and the creation of good management for the wadis from their source to the sea involving dams and other technical approaches, such as landscaping, is therefore required.

Owners of any open land or buildings under construction in the wadis must receive compensation, as residents have the right to live without fear of flooding. From a more positive standpoint, floods can act as an incentive to change flood management policies and to improve the city planning. Greater improvements are likely to accompany any new drainage system, which, as described in the next section, is an essential aspect of sustainable flood management.

8.6. Drainage systems on the ground

How effective is the drainage system on the ground at coping with flooding?

Both the literature review and interviews described in Chapter 9 show that a sustainable drainage system in urban developments should operate in parallel with natural drainage. In Al-Hail, the Haya Company is constructing a new drainage system. However, as described in Chapter 6, this project is insufficient, as it is only for sewage and does not include rainwater drainage. Many interviewees, including PS1, W1, W4, P2, and P5, have argued that the work is currently incomplete. As described in Chapter 9, W1 maintained that any water management in Muscat, with the exception of dams, should be under MM management. However, this project is the responsibility of the Haya company, which, as mentioned by MMS in Chapter 7, has faced many challenges, such as funding issues and the location of vacuum stations and pipelines in wadis where they are at risk of being damaged.

Interviewee MU1 notes that the Haya Company has not received funding from MM for sewerage work in Al-Hail. However, the municipality is working with the company on the project, and it is under the direct supervision of the Ministry of Finance. The fragmentation of efforts is apparent, as the Haya Company is carrying out those projects that fall under the remit of the MM. Interviewee MU1 questioned whether the project is intended to generate profits, or to deal with the problem of sewage. He also asked whether the Haya Company or MM would be responsible for the future maintenance of the works. However, interviewee MMS stated that any profits will not exceed costs, and he observed that the budget for the project is continuously increasing and MMS.

Some interviewees recommended a combination of rainwater and sanitation in one main drainage system trench; for example MU1, whilst other interviewees and the author opined that the system could be created in a parallel with separate uses (see Chapter 7). The drainage system, as middle-aged/elderly people and other residents interviewed noted, is inadequate, as it currently only deals with sewage. Moreover, MM1, MU1 and SMS noted that the pipeline is only four to six inches in diameter, which is insufficient for sewage. MM1, SMS and the residents interviewed stated that the pipeline should be designed to drain away the floodwater that enters their homes during rainy periods, as well as sewage. Whilst this will prove costly for the government, more funding would be required to repair the damage from flooding.

It is apparent that the effectiveness of the planning system in practice is akin to that previously described in Chapters 6 and 7. There are evident shortcomings in the coordination of information exchange, as well city planning errors, such as the creation of new plots and extension in wadis. In addition, water management has created multiple problems, such as directing culverts into buildings. As previously noted, the variation in culvert size is one of the main reasons why floodwater entered houses in 2007. As already stated, the drainage system is inadequate, and the location of pumping stations in the wadis has raised questions about the future of the service. In this case, an in-depth understanding of the situation in Al-Hail would assist the planning system, as will be explained in the next section.

8.7. Flood management on the ground

How effective is flood management on the ground?

As noted in Chapters 8 and 9, the objective of this study was to examine the links between the different aspects of the planning system and their capacity to improve flood management procedures. The section below explores the experience of flooding in Al-Hail.

8.7.1. Reality of planning system partnerships

As mentioned in the literature review, in Chapters 4 and 7, which dealt with flood management, a good partnership between the agencies responsible for city planning, water and drainage is essential, as is integration between spatial planning management and water management. Such cooperation could strengthen or weaken the management of floods, depending on a number of aspects, e.g. the exchange of information and experience, as well as the avoidance of overlaps between projects. In addition, building a good relationship within the community among its representatives, to gain information and experience, must be at the forefront of any new flood management procedures.

Communication is an important component of future planning, and partnership is an approach that can facilitate this in multiple sectors. Any intended partnership must be based on a clear framework that guides appropriate partner selection. In addition, a partnership cannot be effective and meaningful if there is no cooperation between partners, or in the non-application of specific goals (see section 4.4.3 for more details). Appropriate planning partnerships must have strong underlying support, providing social, economic and political aspects. Therefore, the reinforcement of planning aspects that are commensurate with the requirements of the public is critical when planning the distribution of land use. The political concern to involve communities in planning, whilst also avoiding flood risk, reflects the relevant authorities' emphasis on the development of urban services and related infrastructure, as forming a key component of the partnership hierarchy. Consequently, the contribution of all actors begins with the preparation of subdivision plans. This continues into the formulation of building strategies, and overseeing implementation, to ensure that it is effective, practical and consistent with all societal, economic, political and environmental developments. Consensus creates a genuine partnership that represents all political, economic and social tendencies.

Efficient coordination should result in strong and sustainable flood management in Oman (see Chapters 6 and 7). As previously noted, interviewees BMS, SP1, W4, W5, MU1 and CE stated that communication between, and involvement of stakeholders from both the governmental side, namely the Ministries, and the community side, such as middle-aged/elderly people and Sheikhs, and flood management organisations, would constitute good practice. The sharing of experiences and skills to create a wide range of knowledge should decrease the amount of flood damage experienced by people and their property, as noted by P4.

As mentioned above, coordination between the government and the community is lacking. The residents of Al-Hail interviewed for this study are still awaiting evidence that the government is willing to utilise their knowledge and experience of their local area. According to the middle-aged/elderly people interviewed, only residents have a good understanding of their neighbourhood. This assertion was supported by W1 and SMS, who stated that people have the ability to manage floods in their local area. This knowledge is built on the accumulated experience gained from coping with flooding during their lifetime. In addition, as mentioned in Chapter 6, cooperation between the government and local community is also an essential aspect of good flood management.

8.7.2. Mitigation of the effects of flooding

During the flooding in 2007, Al-Hail residents suffered huge damage to their homes and property. These challenges and experiences provided lessons for the future avoidance and mitigation of any damage. Middle-aged/elderly people and other interviewees stated that whilst Al-Hail residents received compensation from the government, this did not fully recompense them for the damage caused to their homes and property. In addition, they argued that compensation was unfair, as some people received more than others did. Figure 8.10 shows that 16% of the questionnaire respondents believed the compensation was adequate, whilst around 64% described it as inadequate. This may be because it was the committee's first experience of compensation, or it may be due to an error in the survey data.

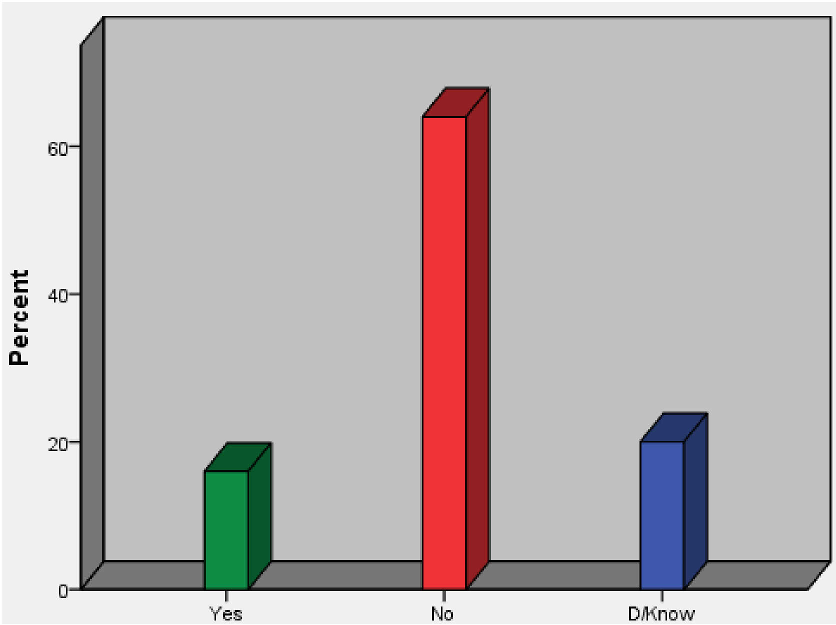

Figure 8.10: Residents who felt they received adequate compensation
Source: Author's own

Interviewee W1 stated that Al-Hail flash flooding was so strong, that 39.2% of questionnaire respondents left their homes in fear for their lives (see Figure 8.11). However, 56.9% of people chose to remain at home during the flooding (see Appendix 1). People may be reluctant to leave their homes for fear of losing them or of their own vulnerability. Prior to the floods, instructions to leave homes were given through various media, as Al-Hail was one of the areas expected to be affected by flooding. Of the respondents to the questionnaire, 33.7% were concerned for their lives, whilst 64.4% were not (see Figure 8.11). Many interviewees stated that the media started to inform people about the cyclone around one week before it occurred. Those participants who stated that they were uninformed might have missed media broadcasts. In total, 56.9% of residents stayed at home during the flood events (see Appendix-1), and 39.2% reported having not received notifications to leave their homes (see Figure 8.12).

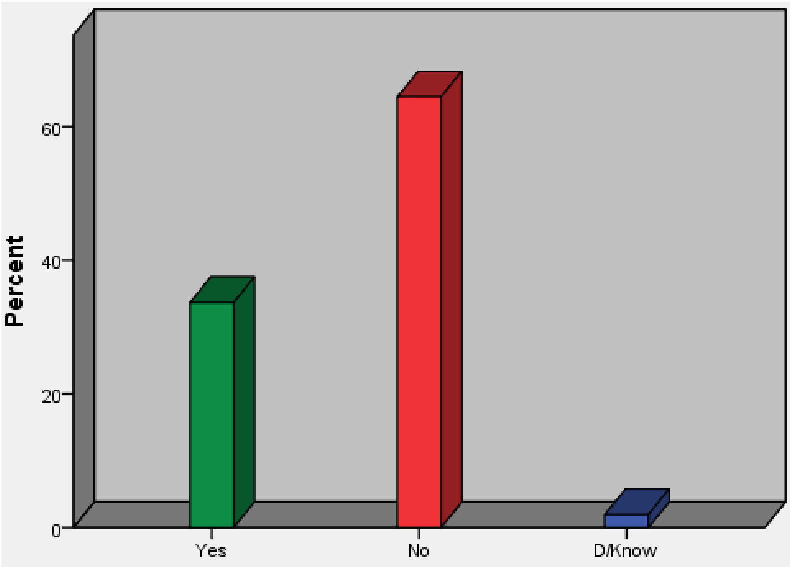

Figure 0.11: Residents who left their homes out of concern for their lives
Source: Author's own

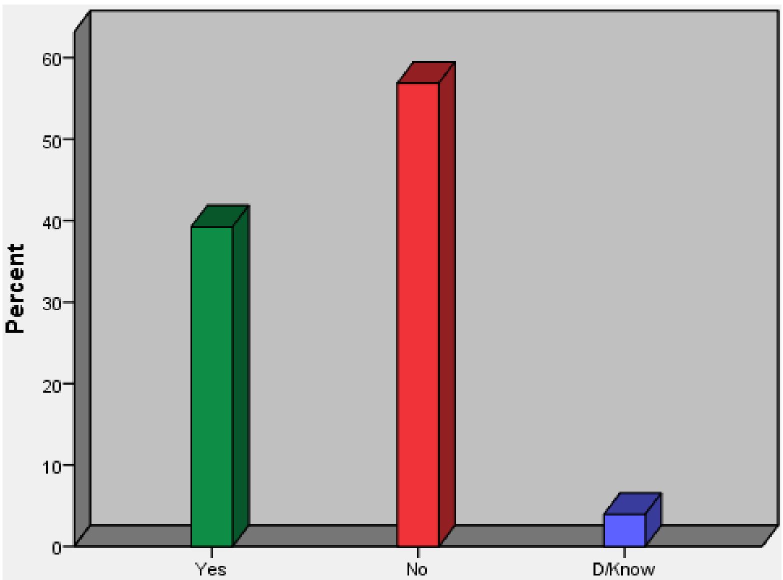

Figure 0.12: Residents who received notifications to leave home via various media
Source: Author's own

As stated in Chapter 4, property insurance covered the damage experienced by some individuals. However, the uptake of insurance is not widespread in Omani society. Figure 8.13 shows that 84.4% of questionnaire respondents stated they had not insured their homes. As shown in Figure 8.14, 88% stated the government had not explained to them how to insure their homes, even after flooding had occurred. This failure might be related to the low quality of the flood risk maps available showing areas vulnerable to the threat of flooding.

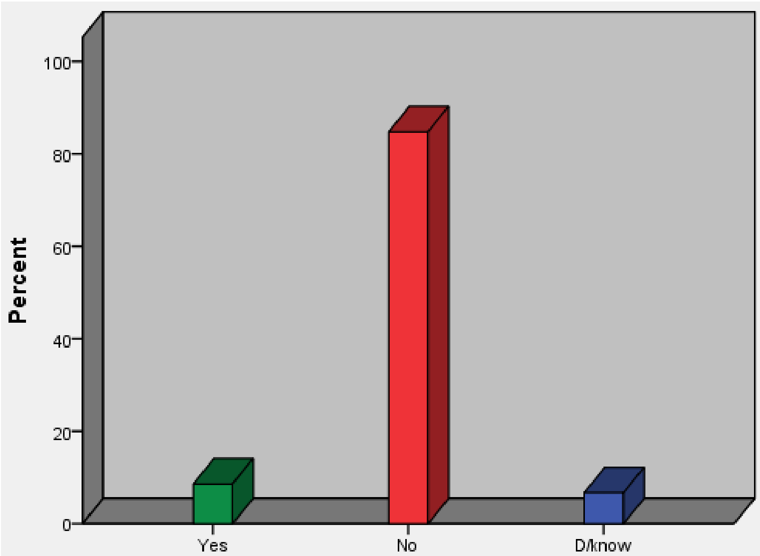

Figure 8.13: Did you take out insurance for your house after the floods?
Source: Author's own

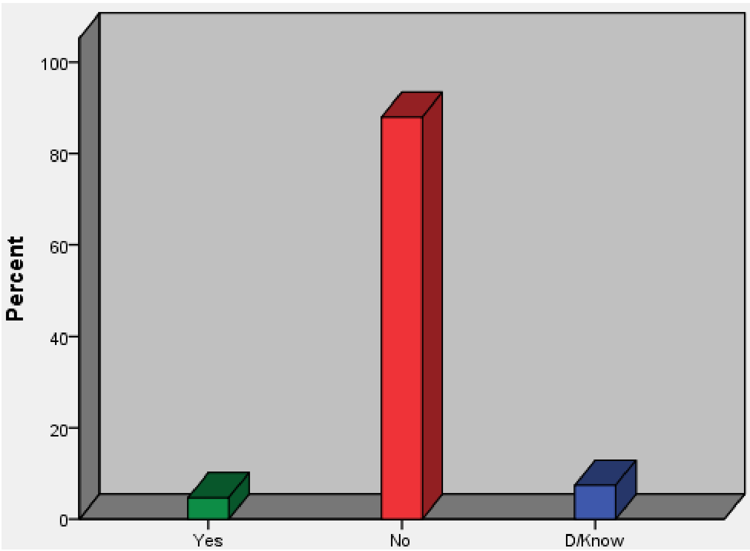

Figure 8.14: Residents receiving information about home insurance
Source: Author's own

8.7.3. Adaptation to flooding

Many interviewees stated that the government had made efforts to protect Al-Hail from flood risk when the water levels were rising, but that flooding had not yet occurred. Some of these efforts were successful, such as new dams. However, others were not, such as the majority of the culvert projects. As previously noted, many of the interviewees stated that the culverts had huge dimensions (see Figure 8.15) to enable cars to pass between Al-Hail north and south without regard for the existing buildings that might be affected by flooding (the culverts were directed towards buildings). Other culverts, which had not been constructed solely for water management purposes, were located in the middle of the Alkhurys Wadi under the entrances to buildings, or under connecting roundabouts.

Figure 8.15: The huge culverts oriented towards houses and commercial buildings and used as tunnels for cars
Source: Author's own

According to interviewee MU2, MM has undertaken some management and maintenance of the wadis in Al-Hail, and implemented other temporary solutions, such as dykes constructed in some of the wadis. These measures are temporary and are likely to be demolished by the wadi during heavy rainfall. Other projects include the three dams planned around Alseeb. Once final approval is secured, they will be linked to around 30km of channels, directed towards the sea. Whilst this project includes many areas in Alseeb, such as Almawalih and Al-Hail, many interviewees (including P2) have noted that the nature of these projects remains unclear.

Some culverts near to the sea have been widened extensively (see Figure 8.16), because they were found to be major obstacles to water flowing into the sea in 2007. As described earlier in the study, these culverts are still unlikely to serve the purpose for which they were originally intended, as the existing culverts in the middle of Wadi Alkhurys are too small.

Culverts between Al-Hail north and south in Sultan Qaboos Road

Culverts in the middle of Wadi Alkhurys

Culverts near the sea.

Figure 8.16: Three different sizes of culverts (Wadi Alkhurys)
Source: Author's own

The table below reports the opinions of Al-Hail's residents concerning the modifications they hoped to make to their homes following the Guno floods.

View	Percentage who had built their homes	Informed about the need for flood protection	Needed to add some protection to their homes	Instructed by the government to obtain home insurance
Yes	52.4%	8.3%	64.6%	4.6%
No	39.3%	80.2%	20.2%	88%
Don't know	8.3%	11.5%	15.2%	7.4%
Total	100%	100%	100%	100%

Table 8.3: Views of homeowners
Source: Author's own

Table 8.3 shows that whilst 52.2% of those surveyed had built their own homes, 80.2% received no information from MM about how to install flood protection during the building process. However, after the Guno experience, 64.6% agreed that adding some protection to their home was an important requirement, to reduce the risk from future damage. In total, 88% of questionnaire respondents stated that the government had not given them any information about how to obtain home insurance.

It would appear that flood management in Al-Hail has received little attention since the Guno incident, with the exception of some maintenance of the wadi channels. Nevertheless, in reality, the wadis require additional defences beside them, in the form of retaining walls to define the wadi's course. A number of interviewees, such as P2, P6 and SMS, and many Al-Hail residents, expressed this view. They also argued that it would be possible to reduce the strength and spread of the wadis by directing them along a single course. In addition, the interviewees observed that some of the new culverts did not incorporate flood protection concerns during the planning process. Therefore, improvement is required in the form of new studies for all wadis to determine current obstacles and suggest solutions. The participation of local people in the improvement of flood management should foster greater understanding of flood risks, and people should consider methods to protect their homes, including insurance. The following section examines these aspects in greater depth.

8.8. Possible improvements to protect Al-Hail from flooding

According to interviewee MU1, MM had the opportunity to design the culverts for floods that occur every 50 years and affect roads, or for floods that occur every 100 years and affect buildings. The Municipality chose the second option, and so is now working in coordination with the MOH to implement protective measures. However, MU1 stated that the Municipality principally focuses on protecting the roads. In addition, as noted in Chapter 6, there is a lack of coordination, in terms of individual efforts to inform other parties of the problem, which are detrimental to Al-Hail and its residents. Furthermore, encroachment into the wadis could also be due to individuals on the city planning side ignoring the needs of others, such as residents and service providers.

The contradictory views of planners regarding Al-Hail are very clear. The conflict between municipality staff and local people is apparent in the mistakes made by the planning department concerning the extension to the wadi channels. This study argues that planning staff may have had reasons for granting these extensions, such as pressure from local people and the administration. In addition, the absence of rain for long periods may have suggested to both local people and planning professionals that the wadis had dried up. This expectation corresponds with M1’s opinion regarding the causes of encroachment into wadi channels. There are two sides to this issue: on the one hand, the joy and pleasure for the whole family provided by an extension, and on the other, the ensuing environmental problems and damage to the wadi streams, which may cause flooding in the neighbourhood. Personal interest and the broader perspective of the general public interest should be balanced during the planning process. In an example of a specific problem, Al-Hail residents opined that a particular building and its bridge entrance had caused the flooding in the neighbourhood in 2007 and 2010.

Whilst the building of culverts and the channelization of wadis is a good solution in terms of directing water to the sea, these methods are less effective when storms and hurricanes occur, as water might return. Interviewee P4 therefore suggested re-planning the area from Aljufnan to the sea, and converting the wadi channels from the upper streams to the Alkhoudh dam to prevent the wadis becoming a hazard for residents. Interviewees W1, CE and W5 suggested building an integrated system, comprising damming, planting trees in upstream areas, and the construction of culverts and channels. In addition, the owners of affected buildings and land in the wadis should receive compensation. A further solution involves opening the wadi channels. Whilst these projects would be costly, due to the amount of compensation involved and the cost of channelization, dams, and landscaping, they should help achieve sustainable flood management and provide aesthetic improvements in the area.

According to PS1, the integrated system of water management described earlier is the only way to protect Al-Hail. This solution should be implemented in both Al-Hail north and south, but must originate in Almawaleih and Alkhoudh, passing Al-Hail and continuing to the sea. Interviewee P2 concurred, and both interviewees agreed that compensation would need to be awarded to facilitate this option. Al-Hail residents also accepted this solution, stating that the government should carry out remedial action as soon as possible to protect residents and their properties from flood risk; they were very upset about the delay. PS1 stated that whilst compensation is not an easy option to administer, the protection of people is primary, and requires the participation of all relevant stakeholders. Therefore, the re-planning of wadi banks must not only deliver protection, but should also make the area more aesthetically pleasing.

8.9. Conclusion

There is no easy solution to the problems in Al-Hail, given the involvement of different stakeholders and the various types of mistakes that occurred, and the need for extensive funding for the numerous improvements in the planning system as a whole. Mistakes in city planning procedures, extensions to wadi channels and changing land use have resulted in the closure of many small trenches and shergas. These findings draw on the statements made by residents, other interviewees from water management bodies, such as W1 and W5, and experts from other sectors, such as M1 and CE. Encroachment into the wadis was even noted by the planners themselves. However, water management cannot be viewed in isolation, due to the culvert problems; i.e. culverts directed towards existing buildings or differences in culvert dimensions, which were partially responsible for floodwater entering the neighbourhood in 2007. In addition, the area has become crowded with new buildings situated in the wadis. All of these contradictions are a result of poor coordination, individuals working in isolation and a lack of information exchange. As mentioned by both residents and specialists, such as P4, the infringements on the Al-Hail wadis and culvert problems are apparent, with residents understanding the huge damage they are likely to face during flooding.

The new drainage system in Al-Hail has only been designed to deal with sewage. There is no drainage provided for rainwater, except for small gutters along some new roads. In addition, the new system faces a number of challenges, such as the capacity of pipes, the location of the pumping stations and associated costs. Many residents are unfamiliar with insurance, and may need to be provided with information about the benefits they stand to gain from insurance if they lose property or are affected by flooding.

Middle-aged/elderly residents of Al-Hail stated that although before and during the flooding in 2007 the media issued a warning to leave the area, most people refused to do so. Whilst the government may not be able to change the attitudes of local people, they still need protection. This may involve forcing them to leave the area to seek refuge in the temporary shelters provided by the government (see Chapter 3). Furthermore, if the area is classified as at risk of flooding, the government needs to force people to take steps to protect their homes; the interviews and questionnaire respondents suggested that residents agree. Obtaining a building permit should be conditional on the inclusion of these types of protection, such as raising the ground floor and restricting its use for services such as parking (see Chapter 4).

It is also concluded that protecting Al-Hail from flooding risks involves building an integrated system of dams, planting trees upstream, channelization of the wadis, re-planning and improving the aesthetic nature of the wadi banks and creating a good drainage system for both sewage and rainwater. Numerous challenges are likely, due to the large gap between the authorities responsible for planning and implementation; these are two different organisations and each works independently. Other challenges concern providing suitable compensation for owners of affected plots and buildings. Protection of Al-Hail residents must be central to any future strategy for flood management.

Chapter 9, which follows, comprises a discussion, conclusion and recommendations for future work.

Chapter 9

Discussion, Conclusion and Recommendations

9.1. Introduction

This chapter answers the main question asked in the thesis: *How can the planning system in Oman enhance partnership working to reduce the damage from flood risk?* This question was broken down into sub-questions (see Table 1.1), and the answers have been presented and discussed in the preceding chapters.

The title of the research is: “Strategic work between agencies in the planning system for sustainable flood management: the case of Oman”, and the objective of the research was to understand the current situation and examine proposals to resolve it. The study was divided into four areas (the planning system in Oman, partnership working, damage limitation and flood risk). These four areas underpin the questions and sub-questions that posed in the study, and each relates to the sustainability of the planning and flood management systems.

This research aimed to investigate the causes of flood events, and to uncover solutions that could be implemented to resolve potential future problems. It found that flooding in Oman’s urban areas was a consequence of both inadequate water management and poor planning practices (see Chapter 6). Moreover, weak cooperation between the different agencies involved, and failures in water management were additional causes. The thesis also reported on issues related to the planning system, including the integration between spatial planning and water management, to provide an understanding of how to cope with flood management and instigate improvements. The literature review, fieldwork and data collection phases provided data to answer the research questions. Future research is indicated in relation to flood management in some areas. There is also an additional need highlighted, to improve flood management in Oman to bring it in line with global standards.

This research aims to add to the literature regarding the Omani planning system and flood management. In addition, effective strategic work between public sector departments and the private sector is observed to demand good collaboration and effective coordination and partnership between the different partners involved in the planning and flood management system, to achieve sustainable flood management to protect people and their properties from flood risk.

This Chapter includes a discussion of the issues raised by the study, and presents the main conclusion, recommendations, research limitations and proposals for future research.

9.2. Summary of findings and discussion

The literature reviewed in Chapter 3 demonstrated that flooding in Oman has caused considerable damage in urban areas, most of which resulted from mistakes made within the Omani planning system. Some authors, including Al-Farsi and Kiymi (2007) and Alwati (2011), identified the causes of problems in city planning as the encroachment of buildings into the wadis. Others, like Al-Shueili (2011) and Alwati (2011), illustrated that individual decision-making contributes to the quality of city planning in Oman. Meanwhile, authors such as Nuvel and Knaap (2010), Reeves (2005) and Foglesong (2012) explained that administrative pressures can affect planners' decisions, and Al-Shueili (2011) and Alwati (2011) added that such pressures might also influence practices in Oman. Additionally, Al-Farsi and Kiymi (2007) and Al-Barwani (2009) stated that the lack of maps identifying zones where flood risk exists, has led planners to build in flood prone areas. Based on the literature, fieldwork was planned to determine if the planning system bears the responsibility for flooding, and if so whether city planning or water management, including deficiencies in the drainage system, are most responsible.

Chapter 5 also elaborated on efforts by the NCCD both before and after flooding; in particular, regarding how it provided advice and information to people and created emergency plans to evacuate and shelter them outside dangerous areas.

Sub questions: *"How can the integration between spatial planning and water management improve the planning strategic work for sustainable flood management?"*

and *"How can the flooding plans and strategy deliver more effective flood management?"*

As detailed in Chapter 3, according to the IPCC (2007), The Met Office (2009), IPC (2011), Kumetat (2009), IMD (2006), Raouf (2007), Arnella et al. (2004), WHO (2002), David (2004), and McMichael et al. (2006), it is important to consider climate change as a cause of flooding. Land use and emissions of GHGs from different industrial and agricultural sectors are contributors to climate change (especially the huge quantities of emissions from countries like China and the US). This appears to be altering weather patterns, and as discussed in Chapter 4, better strategies are essential for managing land use and introducing sources of renewable energy to decrease the quantity of emissions.

Since flooding is a genuine threat in Oman, it is essential to prepare good management strategies to help reduce the damage to Omani cities. Many strategies exist that could be beneficial in mitigating the damage and reducing flood risk in urban areas. According to Brower and Van (2004), Saul et al. (2007), Nuvel and Knaap (2010), Tariq and Giesen (2011), Reeves (2005); Kitchen (2007) and Oosterberg et al. (2005), there are a variety of technical engineering approaches employed to manage flooding, such as dams and dikes. Other authors like Brower and Van (2004), Dicke (2008), McMinn et al. (2010), Reeves (2005) and Woltjer and AL (2007) have illustrated that creating space for water to flow into natural areas can reduce the damage that might result from flooding. In addition, Kitchen (2007), Nuvel and Knaap (2010), Reeves (2005), Woltjer and AL (2007) illustrated that integration between water management and spatial planning management is an ideal way to support flood management. Authors Brower and Van (2004), Nuvel and Knaap (2010), Piper (2005), and Woltjer and AL (2007) all mentioned that benefits are to be derived from observing the experiences of other countries in regard to flood management (see Chapter 4). According to Albrechts et al. (2001), Baeten (2001), Brinkerhoff (2002), Fincher and Iveson (2008), Forchner (2006), Piper (2005), Meijerink and Dicke (2008), SWFRAR 2 (2009), Talen (2000) and Wates (2008), partnership is the best strategy to manage water and flood risk management (see Chapter 4).

Many parties bear responsibility for the failures in Omani flood management; these include city planning authorities, water management agencies, and drainage companies.

Chapters 6, 7 and 8 observed mistakes made by each of these parties, but also reported a number of important improvements.

According to criteria derived from the literature review, questions were prepared as a basis for fieldwork. The author carried out the fieldwork in Oman in July 2013, and this included interviews with specialists in the planning system, water management, and other sectors of the government. In addition, local people, such as Al-Hail residents, the middle-aged/elderly and other residents and their representatives in the Shura council and the Municipal council were also interviewed. From these interviews, many opinions emerged, and by analysing these, the author was able to construct a large body of evidence for analysis. To clarify the results of these chapters, the sections below focus on the issues raised.

The key question raised was, *"How effective is the planning system in Oman in coping with flood management?"* This section examines, "the planning system in Oman" to evaluate the performance of the system in different areas, such as city planning and related aspects. In addition, it examines the water management strategy designed to deal with flooding from different areas, as well as drainage.

According to P6, Omani city planning was founded on the basis of modest requirements, supporting the provision of urban development and continued evolution, and the preparation of detailed plans supporting various uses (residential, commercial, industrial and agricultural (agricultural uses are now not included)). Interviewee P2 commented that the Sultanate has made considerable efforts in the field of planning and coordination with other partners, also benefitting from global expertise. Sometimes errors have arisen in planning; this has been for many reasons, such as population growth, and the increase in building heights.

As mentioned in Chapters 3 and 6, the Omani planning system passed through different stages to attain its current level. Therefore, modern planning, ac can be classified into two stages cording to some interviewees; i.e. before 2007 and after 2007. Before 2007 people was unaware of the dangers of wadis, because there had been no rain and many appeared to be extinct. Based on the author's experience in the field, urban planning in Oman can be classified broadly into three stages: before 2000, after 2000 and before 2007, and after 2007. Before 2000, the planning department was very strict about the extension of the wadis onto the flood plain; however, there was some encroachment into flood-prone areas. After 2000, there were many incursions onto the wadis and flood-prone areas, with the intention of meeting the demands for different land uses. However, after 2007, the plans were revised, and steps taken to avoid flood-prone areas and wadis, in coordination with others like MM, MRMWR, and SCP (for example Alamerat 7/1).

This city planning confusion and chaos, as well as the lack of clarity and vision was justified by planning experts (such as SP2), who emphasised that the officials and administrators overseeing administrative procedures were not planners. Therefore, as mentioned by many interviewees (such as P2 and AMS), individual decision-making by administrators affected planners' decisions. In addition, planning in Oman took place as an extension of already existing clusters of buildings, with the aim of encouraging people to remain in their regions. Therefore, extensions with subdivisions of less than 50 plots (according to P2), were not sent to the other Ministries for approval. This meant considerable encroachment into the wadi channels took place, with the consent of the planning department.

In addition, the planners approved individual cases for plot extensions and changes of land use. Interviewee P5 stated that the continuous pressures from citizens and other officials from outside the Ministry pushed planning in a dangerous direction. Furthermore, interviewee SP2 stated that around 80% of the planners' time was lost following up cases, instead of planning. The two different cases of plot extension and changing land use caused encroachment into the wadis and flood-prone areas. In addition, changes to land use caused problems with services provision, as it led to changes to the identity of places like Al-Hail (see Chapters 6 and 8). Moreover, it created an overlap between city planning and water management projects like dams, and subdivision plans, as explored in Chaper-6.

***Planning in flood-prone areas and wadis*:** Interviewee AMS and others stated that it was not logical that the new wadis would have been created by the floods, and P5 and P7 stated that in reality these wadis had existed before, but planning and development had diverted them. There is good evidence from planners that encroachment into the wadis happened; other evidence from P2 and P4 supported this, and they cited the planning of the area around Alkhoudh dam as a planning mistake.

Concerning this point, the planning department should aim to leave flood plain areas and wadis as natural areas without development, because after Guno, some small wadis had been converted to large wadis; thereby, increasing the risk present. The residents bore no responsibility for this, because the plots originally granted by the MOH were intended to last between 15 and 20 years according to new subdivision plans. P2 mentioned this in reference to Almowaleih, because the lack of natural channels and drainage systems caused water to circulate between houses and destroy some roads effecting many homes in the area, turning them into ruins during the 2007 flood.

Interviewee P5 stated that some subdivision plans had been planned for between ten and twenty years, but because of the expansion of land at the expense of roads and wadis, the subdivision plan completely changed. For this reason, CE stated that some land, designated as red areas already had buildings on it. The decisions by the planning department were identified by some interviewees, including W2, BMS and MMS, as a huge mistake with the potential to result in many disasters in the future (more details were then given about encroachments into wadis in Chapters 6 and 8).

Illegal land holding has also played a notable role in the encroachment into wadis, although the planning department continues to direct planning decisions. Therefore, planners could prevent encroachments, whether into the wadis or onto the flood-plain. This could be done in cooperation with the municipalities to clear all obstacles, because previous generations respected the wadis, according to the middle-aged/elderly people consulted. Interviewees, such as BMS also mentioned encroachment into wadis close to residential areas, as leading to further erosion, exacerbating the danger of deaths during floods.

Interestingly, although the wadis' paths are clear and well known locally, there has been no coordination between the departments responsible for water resources and the planning department, to allow the latter access to data on the channels. The lack of data about the wadis arises from three factors: First, the absence of such data originally; second, the lack of coordination between the MOH and others; and third, the lack of coordination between planners and administrators in the MOH, and the conflict of opinions between them. Some of planners (e.g. P1 and P2) said there is information available regarding all the wadis, but P3 claimed there is no such data. Another problem is that while satellite data may exist, it is incomplete and does not explore underground.

P3, in reference to the Alkhoudh dam, observed that data determining the areas prone to the three flooding types is limited. P3 and P4 observed no limitations on the wadis, according to the Urban Planning Guide issued by the Supreme Committee for Town Planning. This contradicts P1's assertion that restricted areas around the wadis appeared in the subdivision plans. He also explained that he could not determine what distance should be left between the wadis and reconstruction, and noted that planners are busy working on extensions, and so have no time to consider restrictions.

Land use and climate change: P1, MU1, P5 and W4 all agreed that climate change is a real problem, but stated that changing land use might have exacerbated problems. Land use changes can alter the nature of the built environment through actions such as creating new developments in the wadi channels, which results in flooding in urban areas.

In contrast, W5 claimed that changing land use, especially from agriculture to other uses, such as for industrial development, not only contributes to climate change but also to the pollution of water resources. For example, an industrial area planned by the MOH was cancelled because of claims by residents of a nearby village about the likely effect on the Falaj in their village. The effect of land use on climate depends on type of use: for example, in Oman many crushers are located near residential areas and have a huge effect on the environment, as they emit dust pollution. Another example, mentioned by P4, is the oil change workshops opened in the middle of commercial and residential neighbourhoods. This, in the author's view, might increase the level of greenhouse emissions, since the oil might cause chemical reactions.

Changes in land use have negative consequences, not only regarding flooding and climate change, but also, in terms of the mixing of communities, overlaps between uses, drainage problems and changes in the identity of a place (as explained in Chapter 4 and Appendix-2). Therefore, changes of land use must be subject to studies of all parameters related to either the human aspects or the location. For example, in Muscat, there is a huge shortage of land suitable for residential purposes and this is in high demand. In this case, change of land use or even increasing the height of the buildings might well be a solution for the future, but it must be subject to thorough studies, to avoid problems. It could increase the amount of vehicles and increase GHG emissions, because a huge population is gathered in a small area. Electric cars could offer a good solution, in addition to public transport, which is the main option for decreasing both emissions and congestion. Public transport is already successful in many places throughout the world, e.g. the underground in the UK and the metro in Dubai. Another solution to decrease the amount of emissions from fuel consumption is renewable energy; there are many sources of this in Oman.

Exchange of information: The rules state that the Planning Department should not plan an area prior to a review by the competent authority responsible for electricity, water, sewage, dams, or wadis. Other problems reported were the lack of information available to the concerned authorities, with the result that planners send surveyors to sites to retrieve data, and that the data that emerges does not match the information provided by specialists in that area. This might be the case with Alamerat 7/1. M1 stated that there is currently no exchange of information between the planning department and the meteorological department, which is in contrast with MRMWR. In addition, AMS stated that there is no connection between the different parties wishing to exchange information, and consequently, there is a lack of cooperation between them. Therefore, services connections, for example, require providers to break up road services to dig channels for their services. This represents a failure at the initial planning stage, and a lack of co-coordination between departments. This failure to exchange information is indicative of other problems affecting the planning department.

Expert SP2 stated that, because of the lack of coordination between the Ministries the SCP currently needs to achieve coordination between the various stakeholders for any project imposed by the technical committees and supervisory committees in the SCP. The technical committees, comprise the MOH, and the Municipalities and Environment, are now working together to draw a roadmap of the project, after attaining approval from the Supervisory Committee and the Supreme Council for Planning the project.

Challenges: city planning encounters multiple challenges, in particular, problems arise due to the thousands of requests for extensions to plots. The pressure for land extension, land-use change and increases in building height is ongoing. Many regions failed to plan properly when preparing subdivision plans; therefore, when requests are made for extensions it is advisable to re-plan, managing available options. The interviewees, including P2, AMS, and P5, mentioned the challenge presented by this; they opined that the main reason for the problem is the implementation of subdivision plans, which in some cases differ from their real use. In addition, development into dangerous areas such as wadis and flood-prone areas demonstrates the deficiency of city planners' views regarding the sustainability of developments. It also reflects a lack of efficient planning to deal with the built environment in a manner that ensures the protection of cities from the risk of flooding in future.

The responsibility for building in flood-prone areas, and for wadi encroachment, not only lies with the planning department; the other Ministries involved are implicated by their approval of developments. For example, in Muscat, if a building is situated in a wadi, why is the owner not moved and compensated? In addition, if the construction of a building represents a planning mistake, why did the MM issue a building permit? This statement also raises the much bigger issue of responsibility for dealing with flooding. What responsibility does the owner of a property have? It may be argued that there is a gap in flood management, which prevents the owner from dealing with these issues, due to the lack of any such organisation. In addition, the relationship between the state, private sector and individuals, as mentioned in Chapter 4, is very important to enable a city to cope with flooding. If the government makes a mistake by granting extensions to the private sector, or to individuals, then it is responsible for taking appropriate remedial action. However, the absence of a main flood management organisation and lack of cooperation between the community segments in the planning process is very clear. A new department responsible for monitoring and evaluating the progress of the planning system would help ensure all developments occur in safe areas and do not affect others. Arguably, the response is, as suggested by some interviewees, that the state prefers private interest to public interest. However, the state, as described by W1 is failing, because from the outset, officials should have visited sites to prevent the distribution of land situated in wadis. In addition, many interviewees, such as SSM, MM1 and others, have stated that the parties supervising implementation must protect anticipated future owners of buildings by refusing building permits, to save them from flood risk.

Planner P3 stated that the MRMWR is responsible for the wadis; therefore, it should oversee the relocation of those on effected plots. The effort made by the MOH in this regard to date has only concentrated on giving information to land owners regarding compensation. The confusion here concerns how the MOH shares information with the Municipalities about compensation. Building on land close to the wadis is assumed to be evidence that the MOH has failed to leave enough space for the expansion of services in the future, in view of the wadi's path. P2 commented that the MOH is supposed to play a key role in this area, such that when the flooding occurred in the areas along Dhayqa Dam and Alamerat 7/1, the MOH took on the burden of creating new spaces and compensation. There are also indications that problems arose due to lack of coordination and exchange of information between planning and water management departments. Projects appear to focus either exclusively on water management or land management, without referencing mutual interests. However, P6 stated the role of the MOH, has only emerged since flood events; specifically, in relation to the need to compensate the owners of effected lands.

According to interviewee W1, new settlements should be determined by the MOH, because it is the planning authority. This appears to be a contradiction of former practice; to some extent it reflects the aim of the involved parties to shift responsibility for decisions elsewhere. P4 stated that the former Supreme Committee for Town Planning created many subdivision plans, without consulting the MOH, especially in Albatenh; leading to subdivisions of existing private lands in the wadis.

P6 argued that, when involved in decision-making, the MOH now always leaves flood risk areas and does not plan developments in any areas where there is known risk (i.e. designated red, blue or yellow). However, developments during the 1980s took place in many red, blue and yellow areas, such as those in Algubra, Alothiba and Al-Hail. This development was rationalised by P1 and P6 in reference to changes in the degree of severity accorded to zones since that time, and expectations of the success of flood protection measures in flood-prone areas. However, W5 stated that lack of coordination was the primary reason for the encroachment of buildings on flood-prone areas. In addition, W5 stated that entire regions in Alamerat were planned without any reference to the presence of water although satellite images existed.

According to the interviewees and questionnaire respondents, there is at present no role for the community in planning. This is unhelpful, as representatives on the Shura and Municipal councils, and middle-aged/elderly citizens should have a right to provide input during the decision-making process. They are familiar with their localities and could usefully contribute their knowledge regarding the location of flood areas and dried up wadis.

On the other hand, SP1 stated that Guide SCTP's resolutions in 2000 (Numbers 5/85 - 31/93), were created in accordance with the elevation study but still not implemented (see Chapter 5). This demands a political decision, as many areas will be affected, although the strategy of intensification of the search alternative solutions, such as dams, may contribute to reducing flood plain areas. Conversely, P3 stated the majority of the subdivision plans after 2000 avoided the wadi channels, except for in Alamerat 7/1, where the wadi channels were unclear and no guidelines existed. As explained previously, this subdivision was effected during the Guno flooding.

A further problem, which led to some of the land subdivisions being affected, was the absence of protective dikes and dams in many areas. In addition, sediment in the wadis, and failure to clean and deepen them caused additional and extreme flooding. P2 commented that the majority of the new subdivision plans take into account the need to leave space between the wadis and plots, and that what happened in 7/1 was exceptional. Moreover, the situation arose because the consulting company who had re-planned the plots located them in sandy highlands about 9m above sea level, an area which is difficult to settle. When the author visited the site, it was clearly a plain containing many small and big wadis, as stated by the Shura council member, who described it as an area of confluence for the wadis. It is noteworthy that the Ministry faced difficulties when removing the sand and insuring settlement of the ground. Any citizen receiving land in the future will encounter great difficulty receiving funding to build on it, as those on a low income might receive a smaller loan from the bank. This would not be sufficient to cover the cost of the building, which is increasing daily, or to ensure that any buildings constructed would be flood-proof. Buildings might require investment and insurance as this area is classified as a floodplain and homeowners might in future be forced to insure their property.

Water management: Water management departments employ good strategies, such as studying the location of dams and their significance for maintaining natural reservoirs of water and offering protection from the risk of flooding. The MRMWR currently takes major responsibility for dam building, managing existing ones and planning future dams. Therefore, dams upstream are the most important, because they can reduce the amount of water flowing into urban areas. An example of this is the dam already completed in Alamerat, which helped reduce the amount of water flowing during the previous rains. Dams, in addition to offering protection and a reservoir, can also function as tourist attractions and offer neighbouring areas the opportunity to store water. Dams like the Dhayqa dam, which is huge, are managed in such a way that they have water year round. This dam attracts many tourists to the area, boosting the national economy and the private sector.

Technical engineering approach: W1 stated that technical approaches to flood management (e.g. dams) could reserve around 80% of a wadi's water. For this reason, the municipalities are enthusiastic about employing the technique widely. Dams in Oman do not only offer protection but can also act as feed dams; for example, Alkhoudh and Alansab dams feed the farms in Aseeb and Baushar. However, it is important to note that dams can create problems by their location, making it essential to consult local people regarding the history of wadis in their area before constructing them. In addition, SP1 stated that building dams can create environmental problems, since without dams, sediments in the water reach the sea, providing a food source for corals, as noted by environmental specialists. Nevertheless, there are ways to resolve this issue; the first being practical transportation, via land and sediments to the sea, and the second being hydrological, i.e. releasing the water accumulated in the dams over sustained periods when there is no danger of flooding. The hydrological option could be beneficial for both coral and marine life and for recharging sources of groundwater.

***Drainage system*:** Some efforts were made following Guno and Phet to improve water drainage from new roads. These included proposing a design with an integrated system to avoid a huge amount of water flowing downstream. This water, according to many experts, such as CE, SP1 and P2, poses many challenges for people during times of rain and flooding. Water flowed into urban areas, covering many areas because of the lack of drainage systems to discharge the water into Omani cities; of these, Muscat is a good example. As mentioned in Chapters 7 and 8, the Haya company in Muscat undertook modest efforts to drain sewage, but without aiming to drain other types of water such as rainwater.

The current drainage system project, according to the interviewees and based on the author's site visit, resulted in many errors of judgment. These mistakes included, among others, the location of the plumbing stations and the diameter of the pipes (see Chapters 7 and 8). During the Guno event, many pipelines were affected in Algubra and Alothiba, because of their location and technical issues. This danger should have resulted in modifications to existing projects, but according to the interviewees, this has not happened and inadequate pipe diameters remain a particular concern. Therefore, a comprehensive drainage system must be created to cover all types of drainage, including for rainwater and sewage. This will demand cross party support, and the granting of road building permits in the municipalities and areas responsible for water management. In addition, city planners must create adequate drainage systems. Many interviewees suggested this could be done by offering a main trench for all services (see Chapters 6 and 7).

Sub question: How effective is flood management in Oman at safeguarding people and property from flood risks? This sub-question examines other important aspects of the main question; namely "partnership working, reduce the damage, and flood risk", and areas that could be improved to ensure sustainable flood management.

Sustainability for flood management in Oman**:** Flood management in Oman, as mentioned in Chapter 7, is most effective, when preparing for flooding or during flood events, and when working to evacuating people and shelters from flood risk, through efforts provided by the National Committee for Civil Defence (NCCD). Thus, there is a need for considerable effort and cooperation in terms of building strategies and practical efforts to support technical engineering approaches longer term. The majority of the interviewees and questionnaire participants mentioned the poor coordination between the different partners involved in the planning system in Oman, i.e. city planning management and water management. Attempts to resolve the lack of cooperation between parties were begun by the planning department, who sought to protect cities from flood risk. The majority of interviewees agreed that city planning had resulted in many mistakes, which contributed to the flooding in 2007 and 2010. Middle-aged/elderly people and other residents of Al-Hail confirmed that city planning is the main cause of flooding in Al-Hail.

Other interviewees, like P2, stated that city planners were not the only partners in the flood management team to have a negative influence on planning and strategic work with regard to Omani flood management. Water management, in addition, has some effect on the flooding in urban areas in many different places in Oman, such as Al-Hail. These refer to deficiencies in building technical engineering approaches and mistakes in creating diverse types of management. Therefore, integration between spatial planning management and water management must be sought; because any integrated system between the two aspects supports approaches that permit both *"living with water"* and *"leaving space for water to flow"*, which are both accepted by Omani society. However, the second option is preferred, because it develops both nature reserves to attract tourists and builds confidence in those who have had previous bad experiences living close to the wadis or in flood-prone regions during the Guno and Phet flooding. Therefore, most participants expressed a preference to live away from the wadis. However, this unwillingness to stay in close proximity to the wadis or in flood-prone areas may change if participants can be convinced that re-planning of the areas around wadis and good management through flood wall defences and recreational and reserves, such as has been achieved in the Netherlands, is possible (see Chapter 4).

Expert CE stated that the absence of flood management presents enormous danger, especially in dry or semi-dry climates like Oman, which are exposed to torrential rains over a short period. The region is steep, and most areas are hilly and mountainous and lack vegetation, which hastens the speed of the flow of the flood requiring greater control of wadi water in cities. Therefore, the presence of vegetation in mountainous areas and in the high watershed could help reduce the speed with which water flows downstream. It is also helpful to insure the wadis are kept clear, to allow water to flow, by removing obstacles and waste, also trimming trees and cleaning bushes to improve the soil and reduce the drift. Additionally, Chapters 6 and 7 showed that good city planning, and a comprehensive drainage system must be combined to protect urban areas from flood risk.

Expert SP1 points out that after Guno, consultants emphasised the need to avoid flooding altogether by reserving rainwater in reservoirs and protecting the cities by creating a good integrated system of dams and protection. According to interviewees P7 and AMS the insurance offered for buildings situated along the flood-plain and close to the wadi represented an increase in the integrated system of bridges connected to major channels extending into the sea. It would be beneficial to build on this by improving water services, including sanitation throughout Muscat and the provinces, however, not on this scale as the system barely accommodate what exists on the ground. Additionally, other countries, which have been successful in planning, as representatives of the community and government parties must cooperate to achieve successful Omani flood management (for more details about this see Chapters 6, 7 and 8).

The key question here is, *"How can the planning system help improve the situation and reduce the effects of flooding in Al-Hail?"* As mentioned in Chapter 8, the responsibility for the problems in Al-Hail is shared by all the planning system's components. City planners have made many mistakes, in particular water management itself causes problems, as flooding in Al-Hail is partly a result of deficiencies in the drainage system. According to interviewees W1, P2, CE and some middle-aged/elderly residents, city planning is the root cause of the problems in Al-Hail, as planners did not respect the wadi channels. In addition, there are problems arising from culverts not being created in ideal locations, and being orientated towards existing buildings (see Chapter 8). All of these issues created significant problems for the area during the floods of 2007 and 2010. The drainage system, which is under construction, has encountered many obstacles, such as determining the dimensions of pipes, the location of pumping stations and the fact that it is designed principally for the disposal of sewage water.

Building in wadi channels is evidence of planning failure; for example, the planning department created many plots in Al-Hail's wadis on the north side, which are downstream of the wadis, leaving safer upstream areas, in Al-Hail south, open. On the other hand, as mentioned in Chapter 7 the implementation body, the MM, created culverts directed towards the existing buildings. These culverts offer good protection for the road but create a huge problem for the residents and users of the commercial buildings located at their mouths (see Figure 8.8). Thus, this an emergency effort to make improvements, by creating wadi channels stretching out to the sea to offer reassurance to people in the region regarding the culverts is required. This may lead to the need for considerable compensation, although people's lives are more valuable, and it is not applicable to leave them in areas subject to risk of flooding.

According to interviewees like P3, the MOH is not responsible for compensation in the event of damage to buildings and property, but the party that created the culverts is responsible for compensation. This links to P2's comment that buildings inside the wadis must be removed to open the wadi channels; although he noted that some such buildings currently remain under construction. The owners of some buildings found culverts directed toward their buildings and received compensation in accordance with a royal decree, covering owners of affected lands. However, whether residents choose to accept compensation, and which entity is responsible for compensating them (whether the MM or the MOH) is unclear. There is continuing concern that there is still building along the wadis, which will cost the government additional money in compensation in the future, and will cost the owners of the new buildings both time and money.

Expert P2 stated that, unfortunately there are multiple locations; for example, in Al-Hail, where extensions were granted in places that were already very crowded, leading to building in the wadis. This created confusion in planning and for residents. The interviewee agreed that the planner sometimes acts merely as an administrator, and is therefore unable to defend planning decisions. In addition, P6 stated that older properties, damaged in Al-Hail in 2007 and 2010, existed before planning practices were centralised. This might be true, but the planning department should have deducted the wadi channels from the percentage of available land, and should have bought out owners, designating the land for non-agricultural use and subdividing it into small plots of around 600 square metres.

Distribution of lands in the wadis, and lack of coordination between the MOH, MM and MRMWR, in addition to culvert design problems, and the non-existence of an adequate drainage system, are the main causes of the problems identified in Al-Hail. Therefore, creating a clear path for the wadis must be prioritised, to allow water to flow easily. This might require removal of all the buildings and culverts that stand in the way of these routes, as a preferred option. In addition, the dams, which the municipalities intend to build upstream, may reduce the amount of the water flowing down to Al-Hail, depending on the quantity and the location of any rainfall. If the rain is very heavy, over a long period this will cause dams to overflow, and water to flow to low-lying areas at high speed. In addition, after heavy rainfall the dams might also threaten the area. In this case, CE stated that culverts along the main road will impact longer-term on Al-Hail as a whole; therefore, re-planning the paths of the wadis and the protection of their banks to provide protection for residences and existing buildings is very important. In addition, creating a comprehensive drainage system must be prioritised in Al-Hail, to decrease flooding risk.

9.3. Thesis main conclusion (concluding statements)

Flooding is a global phenomenon, and many countries in Europe, Asia and Africa have suffered for years from the huge damage it brings about. Flooding kills people and livestock, damages property and alters the entire ecosystem. As mentioned by the IPPC (2007) and the IMD (2006), rapid industrialisation and urbanisation, resulting in the loss of natural environmental resources, and climate change, affecting temperature and rain fall, led to drought in many countries worldwide between 2000 and 2006, i.e. India and Pakistan. Extreme weather demands that people protect themselves and their properties. In the case of flooding, measures include building embankments, spurs, dikes, floodwalls, dispersions, structural diversions, delayed action dams, bypass-structures and means to canalise floodwaters, and better land use management. Since climate change, according to many authors (WHO, 2002; Arnella et al., 2004; David, 2004; Al-Zakwani, 2009), is contributing to flooding, decreasing the amount of GHGs, reducing the burning of fossil fuels, and adapting industrial processes is urgently required, and demands cooperation from all countries.

The GHG emissions generated by Omani industries are small compared which those produced by other countries like India and China; nevertheless, a reduction in the level of emissions is imperative. Changing land use in Oman has not been a major contributor to climate change, as was clarified by many experts such as M1. However, according to interviewees such as P2, W1, and the evidence from the case study, changing land use has resulted in problems affecting the built environment issues; such as the closing of shergas, which led to flooding in urban areas like Al-Hail in 2007 and 2010 (see

Chapter 8). In addition, based on the literature review and according to many of the interviewees, Oman is not an enthusiastic supporter of renewable energy. This requires attention, as it has access to abundant renewable energy sources, such as solar power, wave power and wind energy.

Flooding is not new to the Omani people; it has happened before, leading to considerable damage to properties and human life. However, there is now encroachment into the wadi channels and flood plain areas that has been permitted by the planning department, which (according to the study participants) has led to more damage from flooding. According to the literature review, and both the interviews and questionnaire responses, flooding in Oman is a genuine concern, following flooding during Guno and Phet and later in 2011. These floods resulted from hurricanes and storms, which came from the Bay of Bengal, through the Indian Ocean, and then into the Arabian Sea, leaving behind them considerable destruction in many coastal areas of Oman (Tariq and Giesen, 2011). Specialists in meteorological data, M1 and M2, explained that the floods occurred because of winter depressions, which came from Iran during the period from November to March, and depressions, storms and hurricanes from the Arabian Sea, during the period May to June and October to November (see Chapter 8). The most recent storm was Nanauk, which passed on 15 June 2014, creating a lot of fear among the population located in the coastal areas of Oman along the Arabian Sea.

Absence of a clear strategy for flood management in Oman has created confusion between the different agencies involved, each of which has planned and implemented projects independently. However, after the latest floods unification between all government parties has grown, since the costs of repairing the losses were huge. As seen in the analysis sections of the thesis, Chapters 6, 7 and 8, and in the previous discussion, city planning faces multiple problems, including an urgent need for solutions. Contradictions have emerged between administrators wishing to intervene in planning work, but unwilling to communicate with others.

Existing failures in former planning have increased the load on the planning department, and so they are failing to address current planning issues, such as improvements in the planning and improvement of planners' skills and education. Therefore, the planning system continues to revolve around the same group, the SCP. However, according to many interviewees, such as MMS, it has been unclear if the SCP's role is one of implementation, planning or monitoring. As mentioned in Chapter 8, experienced decision-makers are available in Oman, and would be best exploited by working together within a single organisation. Oman currently experiences planning and development problems concerning both water and planning management (Al-Farsi and Al-Kiymi, 2007). Therefore, integration between spatial planning and water management must be adopted to create sustainable flood management.

Chapter 6 reported that the lack of flood risk maps had resulted in poor coordination in city planning, deficiencies in exchanging information with others, poor unification matching experiences and skills, and overlaps in individuals' responsibilities within the decision-making process. Additionally, there is encroachment into the wadis, either by local people, through illegal land holding, or by the planning department through new lands and extension of old lands. All of these aspects combined have been major causes of the flooding in Oman. Additionally, such behaviours and actions have contributed to the quality of city planning in Oman, resulting in mistakes due to poor planning in flood prone areas (see Chapter 6). Therefore, the present planning system in Oman has played a major role in previous flood events, such as Guno.

As mentioned by many interviewees (e.g. M1, M2, SP1 and W5), the wadis have in many areas remained dry, due to the long-term scarcity of rain. However, the flooded wadis were not new, as suggested by P1, P3 and P6. Rather, the wadis paths were very clearly marked and well known; the issue was a lack of coordination between the departments responsible for water resources and the community, who understood the area. This lack of knowledge in the planning department underpinned their subdivision plans, as mentioned by W5 and ASM, in accordance with the satellite imagery, and without reference to the concerned authorities. P4 observed that the old areas were unaffected by flooding, but that many of the newly planned areas are affected. This not only means that the MOH must take responsibility, but that others might also share responsibility, because other bodies oversaw the majority of the subdivision plans before their implementation.

Interviewees, including P4, stated that planning should include a good space for water to flow along its original channels. This may require compensation and abandonment of some projects in the public interest. Since water projects work towards the protection of water, which is a valuable resource, as well as to reduce risk from flooding, measures mentioned in Chapters 4 and 8 regarding *"leaving a space for the water to flow"* are applicable.

W1 and others stated that drainage systems demand a lot of money and a long timeframe to implement, and so must be appropriate. For example, the trenches of drainage systems should be in the wadi channels. This comment was unsupported by many other interviewees, who argued that the existence of a drainage network was subject to damage.

According to many interviewees, there is a need to strengthen cooperation between the different agencies responsible for water and land use planning and flood protection. In addition, partnerships for flood management are essential; because there are overlaps between responsibilities (see Chapters 6, 7 and 8). For this reason, the author suggests creating a major organisation as the main body for flood management. To date there has been useful work done by the NCCD, but this has limits. Its efforts were largely exercised during flood events; whereas, flood management, according to many countries, such as France, Netherlands and the UK, requires continuous work. For example, in the UK, according to the Flood Risk Management (Scotland) Act 2009, work is divided between different agencies and groups. Each group works in different fields, although ultimately all agencies are linked under the supervision of the Scottish Parliament.

In Oman, work varies between parties tasked with separate planning projects, which ultimately result in the repetition of projects, as mentioned by M1 under overlapping responsibilities. Here the author notes that agencies receiving subdivision plans directed their focus toward determining private land uses, rather than considering environmental factors. Organisations must now consider including services and leaving space for water to flow, as mentioned by the majority of researchers investigating strategies in European countries, as detailed in Chapter 4. Therefore, cooperation between different agencies must be granted from the outset, and planning departments must listen to the suggestions received from these agencies.

The huge amount of damage to infrastructure and property, and the deaths resulting from flooding during Guno and Phet were a clear warning to correct any previous mistakes and to build a good future planning system in Oman. This might be achievable by implementing a good partnership between the agencies responsible for city planning and water management and the representatives of the Omani's society and public sector. All stakeholders must to work together to help the SCP or other parties take responsibility for managing flood risk, using systems like GIS to deliver information to a central authority (see recommendation 11).

Hence, the principle of true partnership informs success, by taking into account economic and social dimensions, as well as the urban planning environment. This principle should guide any operating framework and partner selection strategy. Partnerships enable cohesion, uniting all segments of society to ensure mutual benefit from services (see section 7.7.5). A partnership for flood management is essential to Oman, as long-term cooperation is central to successful flood management (see literature review, Chapter 4). Thus, there must be good coordination bringing together experience and skills through partnerships involving specialists and professionals in both water management and planning management, to construct a sustainable flood management system in Oman. In addition, involving community representatives from different fields, such as the Shura and Municipal councils and the middle-aged/elderly members of the population, and experts in planning management and water management, would strengthen future Omani flood management strategies through knowledge sharing (see Table 7.1).

9.4. Recommendations

1- To reduce the damage from flood risk, Omani city planners should consider locating entertainment and open spaces in residential areas, and those already devoted to those uses, while also observing original natural features and the existing built-environment. When planning, it is necessary to determine the degree of flood risk to make it easy for people to understand which areas are under threat, and the attendant level of risk.

Flood management officials in Oman need to create good partnerships, with their counterparts in other countries to benefit from their knowledge (e.g. officials from the Netherlands, the UK, and France). Flood management should not only focus on Muscat, but should be extended to all governorates. This could initially be achieved by creating a new comprehensive structural planning mechanism for each governorate. This would relate to jobs and good quality education and healthcare, and encourage immigrants from these governorates to reverse migration from Muscat home, to limit migration to the capital.

2- An Egyptian project cited by planner (P5), "Build Your Own House", requires the MOH to provide a house rather than land. This then reduces the amount of land used, and provides an opportunity for people who have married recently to remain in a good home whilst paying minimal or no rent. Furthermore, when offering plots or houses, planners must mention the level of flood risk, and special conditions must be implemented during development and attempts made to clarify to owners from the outset how to avoid problems in the future.

3- The building of comprehensive and integrated water management systems will determine the future of flood management in Oman. Such schemes might involve offering compensation to the owners of buildings and the land located in the wadis. This is the best way to work toward achieving sustainable flood management systems, and can be realised through devising a comprehensive strategic plan for urban development.

As noted in Chapters 4, 6, and 7, flood management requires concerted action between all sectors of the state, with effective town planning stemming from spatial planning and water management within an urban or wider catchment area. Increasing the effectiveness of Omani flood management must be a cumulative task, based on cooperation between the different parties responsible for water management and city planning. Certainly, city planners and water engineers should be required to establish adequate integration between spatial planning management and water management agencies. Partnership between different agencies is the best strategy for ensuring the future success of drainage management, water management and city planning management, which will then result in good strategic flood management. This will address the conflict that appears to exist between planning strategies or processes.

Without cooperation, each Ministry will work independently, creating an overlap between projects and interests, resulting in a repetition of earlier studies.

4- Training people to accept the implementation of experiences from other countries with regard to planning and habitat renewal, could positively affect planning regulations, such as development of the flood plains and wadis, and addressing encroachment onto land at risk from flood when services are planned by the planning department. This can be done by meeting people in their own communities and providing them with courses, or requesting community groups to come to the planning department. For example, middle-aged/elderly people should be invited to consult on city planning, because they have experience and knowledge about the history of wadis and floods, and the experience to deal with flood management. Middle-aged/elderly people also provide a source of knowledge about the history of flooding, making their presence in such a partnership very important. In addition, other members, who represent the community, should be selected based on an interest in and knowledge of flooding.

5- Creation of a public body for disaster management, which is financially and administratively independent, comprising employees from related parties, should be instituted and named: the “Public Authority for Planning and Flooding management”. This organisation would have to be divided into two; one for planning and the other for implementation. The person responsible for overseeing the Authority should be well educated and understand the diverse aspects of the subject, be knowledgeable about future plans, and have the ability to lead strategic government thinking and take on a futuristic outlook to bring together all the necessary data in a single unified system. It is also important to set up a network program for this public body, like a GIS plan to insure delivery of all services without overlap or damage to infrastructure. In addition, insurance should be considered for properties located in flood-prone areas, or very close to the wadis.

6 - Infrastructure plans are dependent on establishing a good system, such as GIS, and on positioning all services together in different layers in a single main trench. In addition, this would improve time spent on maintenance and facilitate early identification of problems such as the drainage network. The new public body could be

funded by a loan from a local or international bank, to develop/provide services in and to create channels, infrastructure and build entertainment venues. Subsequently, the loans could be paid off by the profits raised from delivering these services

7- To create an appropriate strategy to manage the wadis in Al-Hail a viable approach would be to begin by simulating wadi flooding. Planners must consider that the wadi may flood during heavy rainfall, cyclones, or both, because sometimes the sea floods the wadis running into urban areas. Therefore, every eventuality should be simulated to insure an effective planning approach is available to manage the wadi channels. A simulation can be the basis of a good plan, and deliver a good result. However, more work is needed to study the geography of the area and to input data collected from previous flooding and rainfall events. After the simulation is complete, implementation of comprehensive integrated systems should be undertaken, including modelling of effective obstacles and compensation.

This might involve creating a main trench around Muscat and connecting all the wadis to it, to enable water to flow to the sea, and to stop flooding from the sea by creating a barrier that can be used to close off the water, but which can be opened at any time like (like the Thames Barrier in the UK). This will protect the area from floodwaters coming from the mountains, and facilitate the release of water after flooding or cyclones. Additionally, the trench will restrict the flow of water to areas that are appropriate for water management purposes, such as dams and outlet channels. The main aim is to reserve a good amount of water to re-use for drinking, agriculture and other general human needs, in addition to decrease its effects downstream.

8- To address climate change, different types of renewable energy sources might be used to decrease emissions when generating electricity. Solar, wind and wave technologies could be used in the production of electricity, instead of fuelling a cycle of pollution.

9.5. Thesis limitations and suggestions for future research

A number of limitations affect this work. There were some practical limitations that are worthy of mention. First, despite the author's promise to the interviewees that their details would remain confidential, some of them were not very clear about how their anonymity could be protected; especially those in important posts. This created problems for the author when seeking to convince them to contribute information. Second, some of the planners consulted had not worked in the planning department, although they had access to planning strategies and were aware of issues related to urban planning, such as flood management strategies (see Section 2.7.6). Third, the time limitations placed on the study meant that it was only possible to study Muscat (Al-Hail); however, extensive studies of all the areas affected by previous recent flood events in Oman would be valuable. Thus, the author proposes the following future studies as part of his ongoing work:

- ***First study***: A comprehensive study of villages and people living downstream of the Wadi Dayqah dam. P7 stated that any collapse of the dam would result in the destruction of the urban areas downstream of the wadis associated with the dam. Therefore, it is crucial to manage the wadi channels downstream to avert any risk in the event of a collapse. According to W3, residents in the villages situated below the dam have already requested protection for their farms in case the dam floods, or in case of any emergency; however, the estimated cost of this protection is very high and so it has not been implemented. AMS fears the dam could explode in the event of an earthquake, or even due to water pressure, creating a major disaster. Thus, building defences for villages such as "Al Seih" below the dam is essential, as is creating subsidiary dams below the main dam, to ease the amount of water flowing in emergencies.
- ***Second study:*** A comprehensive study of people living in the areas downstream of Wadi Alkhoudh. An examination of the differences between planning in old villages, according to local people who have not been affected by flooding, and new planning undertaken by the planning department. P2 mentioned Alkhoud as an example; this is a reservation area, which is naturally flooded; but which was used for residential and commercial purposes. He argued that although this is primarily a planning mistake, this does not excuse actors continuing

infringement on wadis and places classified as prohibited zones. The conclusion is that the planning department is still apportioning land for development without a strategic plan, thereby repeating the problems characteristic of the earlier subdivision plans. It is evident that the planning department has failed to abide by the Urban Planning Guide published by the Supreme Committee for Town Planning (this was meant to be an obligation after 2000, according to Decisions 5/85 and 31/93).

Finally, an important limitation to raise, is that when this study was undertaken the Supreme Council for Planning was new (established in 2012), and so throughout most of the period in which this research was being undertaken its strategies remained in development. Therefore, information related to future urban planning, as it relates to local plans, structural plans and strategic plans has not yet emerged. This was a limitation on this study; however, it also represents an opportunity, as it is anticipated that the new body is in a position to adopt some of the recommendations made herein, and so the author plans to engage in future efforts in terms of publication to pursue this possibility. This is critical, as the fragmentation of efforts, problems relocating residents in areas at high risk of flooding, poor communication, fractured information exchange, and enduring planning errors, will otherwise continue to threaten the future of Omani flood management. These issues must be addressed, as the frequency of flood events appears to be increasing, and the growth in Oman’s urban population is continually putting pressure on the available land.

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Appendix 1

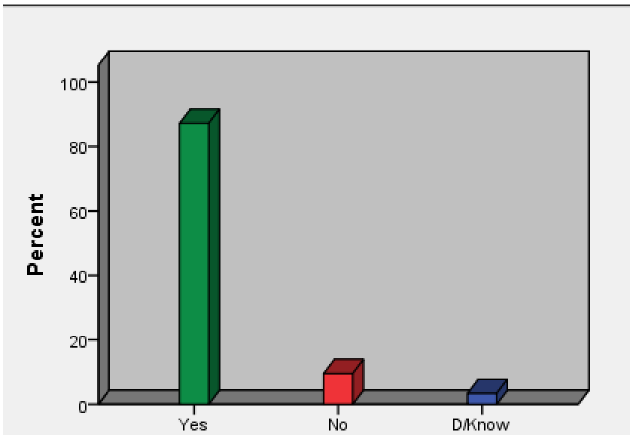
Fieldwork Questions and questionnaire's analysis

Questionnaire for different people from Omani society (Dead-ended questions)

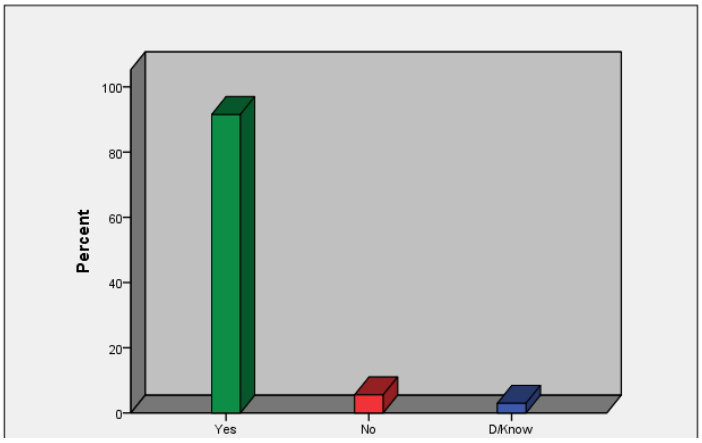
No	Questions	Yes	No	Don't know
	1- Affected and Compensation			
1	Is the phenomenon of floods causing concern to Omani society?			
2	During the floods in 2007 and 2010, did these floods cause any flooding in homes and land near wadis?			
3	Was your home affected by the floods that occurred between 2007 and 2010?			
4	Have you been compensated for the damage to your home and your property?			
5	Is this compensation equivalent to the losses you have suffered?			
6	Does your home and your property insurance guard against the risk of flooding?			
7	Was there a force from Muscat Municipality ready to secure your home during the initiation of reconstruction, or when did you add any supplements to the home?			
	2- Implementation of legislation and strategies:			
8	Do you think implementation of legislation and strategies in terms of planning and flood management working sufficient in Oman?			
	3- Current situation of planning system and flood management:			
9	Is the planning system the main cause of flooding?			
10	Is the creation of new lands and the plots extension done by the Ministry of Housing the main reason for the creation of flooding related problems in developed areas?			
11	Are projects such as bridges, water drainage tunnels, excavations and other projects one of the main causes of flooding in developed areas?			
12	What are projects that caused flooding in development areas?			
	4- Climate change cause floods events:			
13	Is flooding in Oman due to the climate change issues?			
	5- Spatial planning and decentralisation:			
14	Are the deficiencies in the management of water the main causes of flooding?			
15	Are inadequate sewage systems the main causes of flooding?			
16	Is flooding due to the encroachment of citizens to the wadi's channels?			
17	Are the citizens themselves infringing on the valley streams?			
18	Is deficiencies planning system the main causes of flooding (due to the planning for flood-prone areas and valley channels)?			
19	Is there any conflict at the moment between change of land use, extensions and creation of new plots with water management?			
	6- Integration between water management and spatial planning:			
20	From your own perspective is the cooperation between the planning and management of water in Oman is sufficient /adequate?			
21	Do the planning or water management issues require more attention?			
22	Is the integration between planning management and water management must be in order to avoid flooding?			
23	From your own point of view, is integration between the planning and management of water management the solution to reducing the flooding risk?			
	7- partnership: intervention of political, economic and social:			
24	Is the selection of the stakeholder for flood management related to the planning and water management background?			
25	Is the selection of the stakeholder related to the political, economic and social?			
26	Is partnership between the planning and management of water from your point of view useful?			
	8- Skills and experience for planning and flood management partnership:			
27	When creating a partnership in planning to avoid flooding problems, should the society be a partner in this partnership?			
28	Is the stakeholder's selection depends to their: Skills ( ) Experience ( ) could be by their effectiveness in social aspects ( ) Skills and Experience ( ) Experience and Effectiveness in social aspects ( )	•	•	•
29	Are concerted efforts among the various stakeholders contributing to the sustainability of contemporary subdivision plans in the Sultanate of Oman to avoid flood-affected areas?			
30	Will the flood management in Oman be better if a partnership is created between the different stakeholders?			
	9- Technical engineering approach and flood management:			
31	Do you think technical engineering approach (such as dams, wall defences) is a good vision for the future management of flood and water in Oman?			
32	Does the flood management experience of other countries work in Oman?			

Analysis of the questionnaire issued to different people from Omani society:

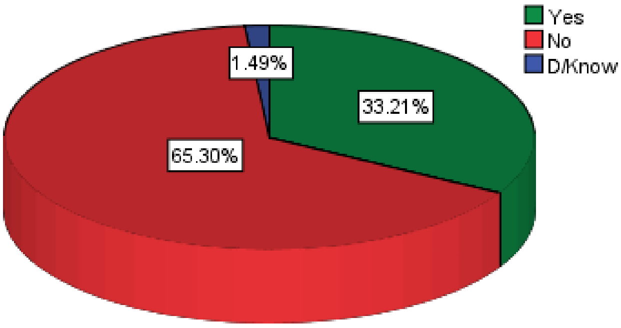
Is the phenomenon of flooding causing concern to Omani society?



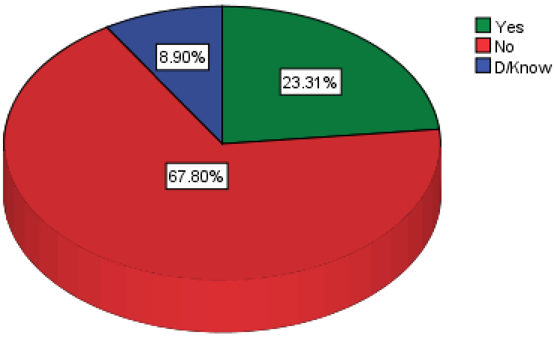
During the floods in 2007 and 2010, did these floods cause any flooding in homes and land near wadi?



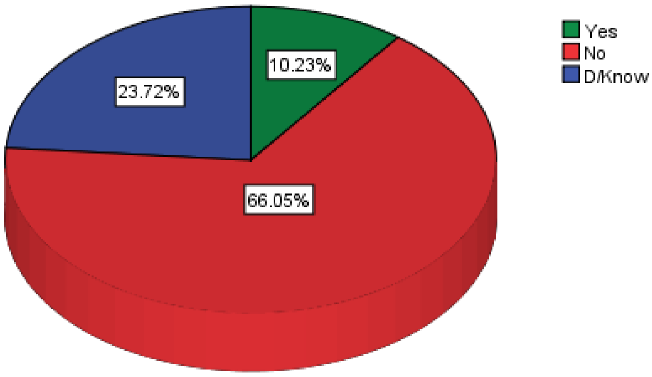
Was your home affected by the floods that occurred between 2007 and 2010?



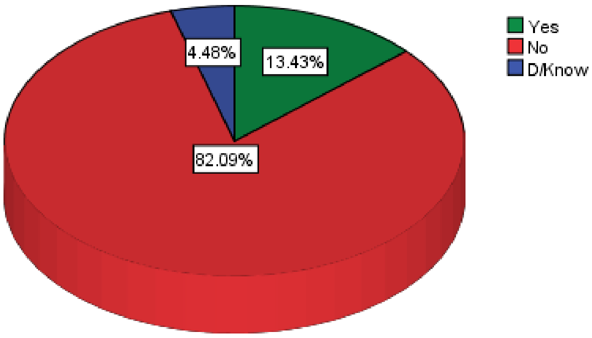
Have you been compensated for the damage to your home and your property?



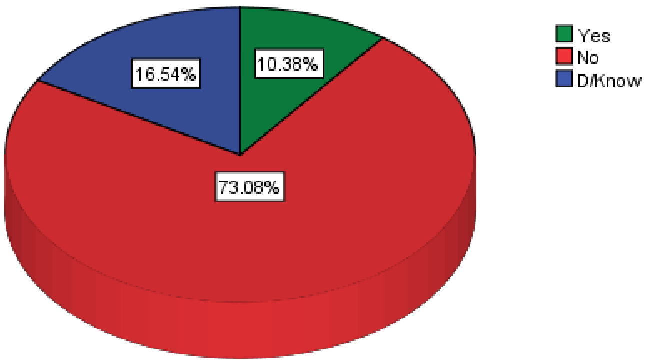
Is this compensation equivalent to the losses you have suffered?



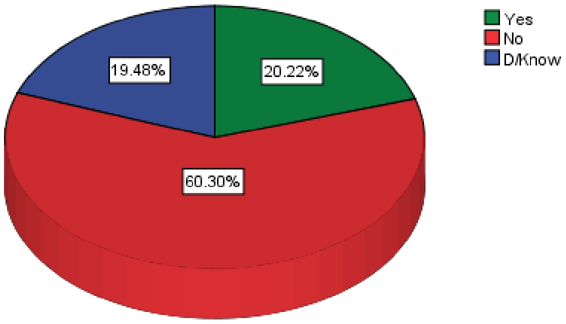
Does your home and your property insurance guard against the risk of flooding?



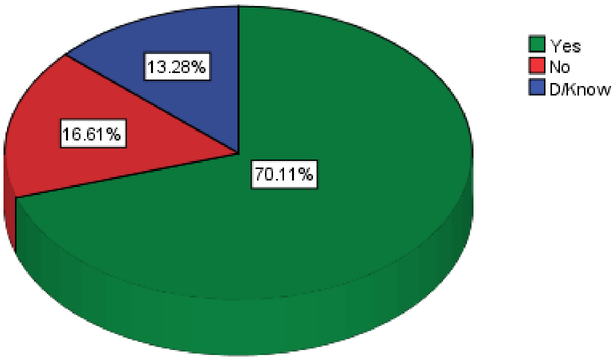
Was there a force from Muscat Municipality ready to secure your home during the initiation of reconstruction, or when did you add any supplements to the home?



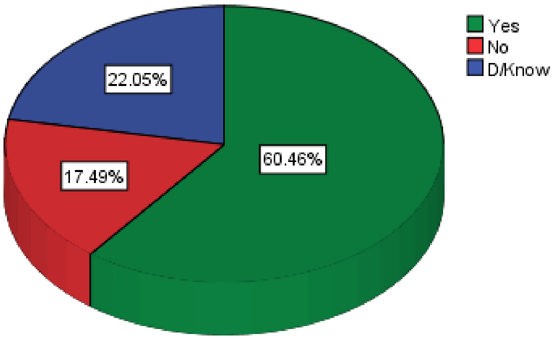
Do you think implementation of legislation and strategies in terms of planning and flood management working sufficient in Oman?



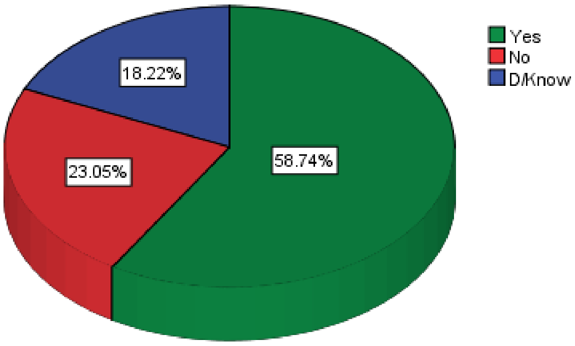
Is the planning system the main cause of flooding?

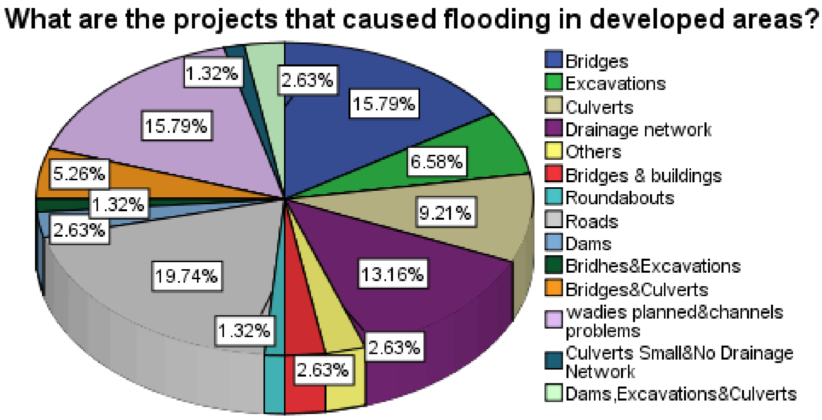


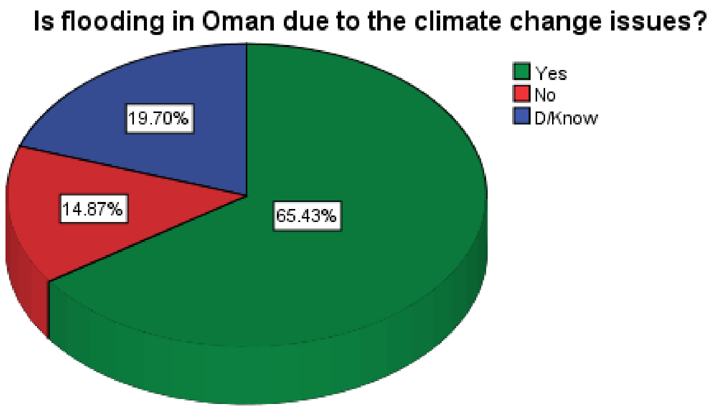
Is the creation of new lands and the plots extension done by the Ministry of Housing the main reason for the creation of flooding related problems in developed areas?

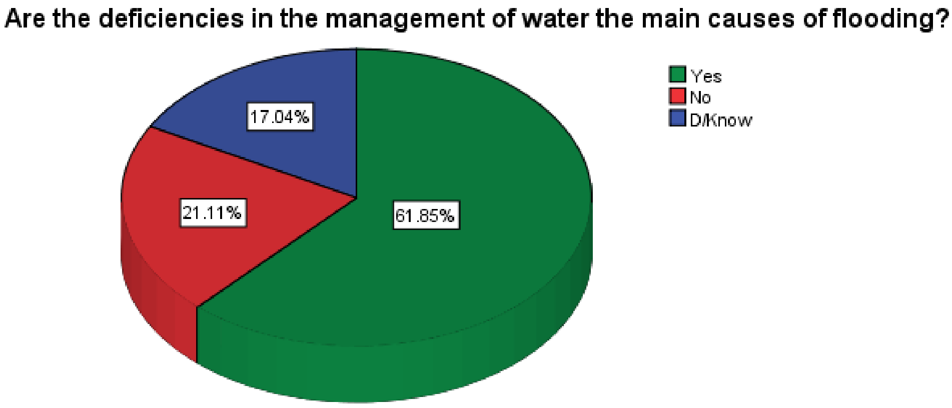


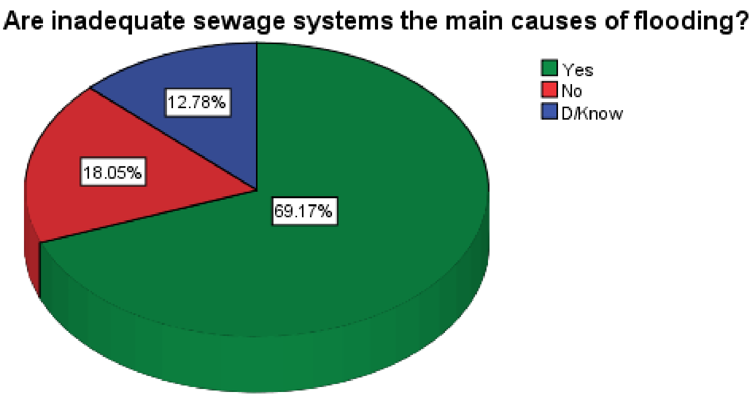
Are projects such as bridges, water drainage tunnels, excavations and other projects one of the main causes of flooding in developed areas



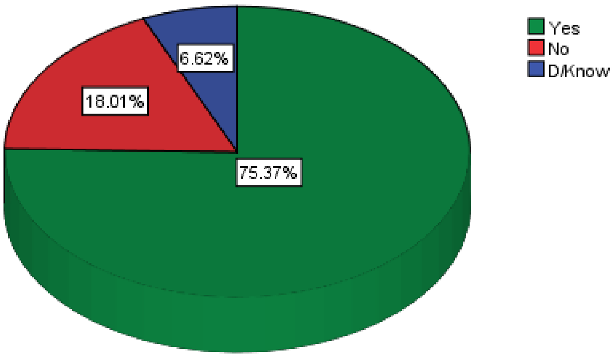

What are the projects that caused flooding in developed areas?
Bridges
Excavations
Culverts
Drainage network
Others
Bridges & buildings
Roundabouts
Roads
Dams
Bridhes&Excavations
Bridges&Culverts
wadies planned&channels problems
Culverts Small&No Drainage Network
Dams,Excavations&Culverts
1.32%
2.63%
15.79%
15.79%
6.58%
5.26%
9.21%
1.32%
2.63%
19.74%
13.16%
1.32%
2.63%
2.63%


Is flooding in Oman due to the climate change issues?
Yes
No
D/Know
19.70%
14.87%
65.43%

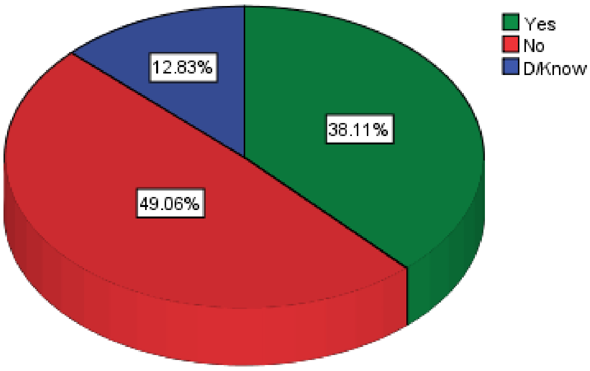

Are the deficiencies in the management of water the main causes of flooding?
Yes
No
D/Know
17.04%
21.11%
61.85%


Are inadequate sewage systems the main causes of flooding?
Yes
No
D/Know
12.78%
18.05%
69.17%

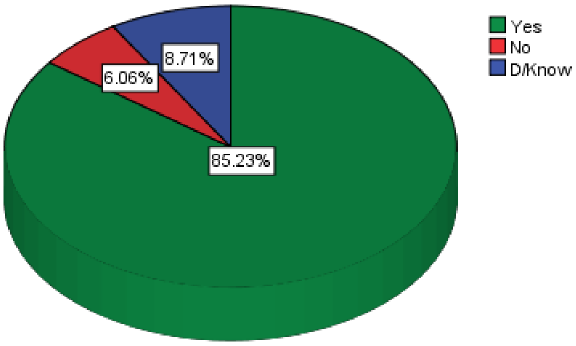
Is flooding due to the encroachment of citizens to the valley's channels?



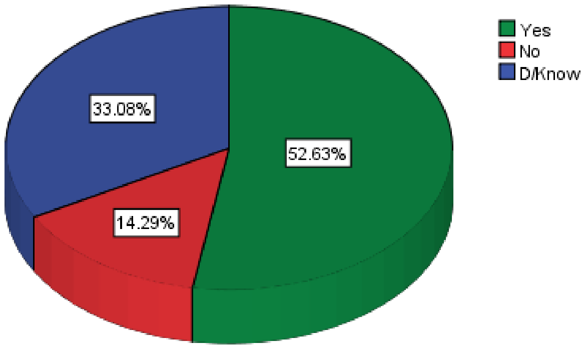
Are the citizens themselves infringing on the valley streams?



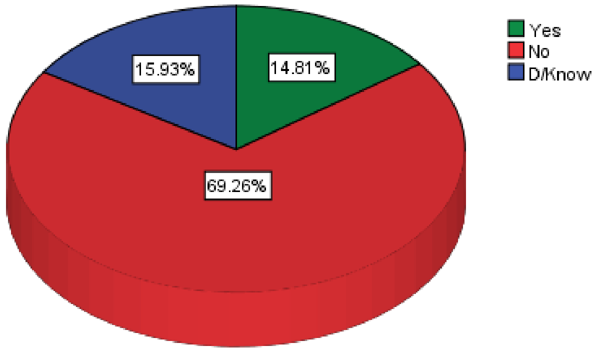
Is deficiencies planning system the main causes of flooding (due to the planning for flood-prone areas and valley channels



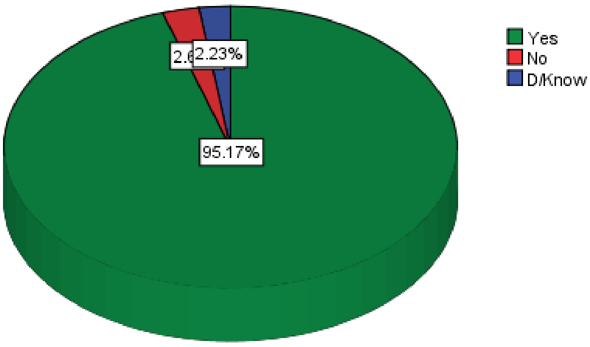
Is there any conflict at the moment between change of land use, extensions and creation of new plots with water management



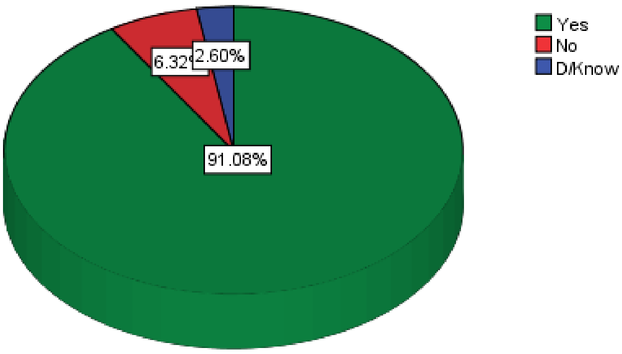
From your own perspective is the cooperation between the planning and management of water in Oman is sufficient /adequate?



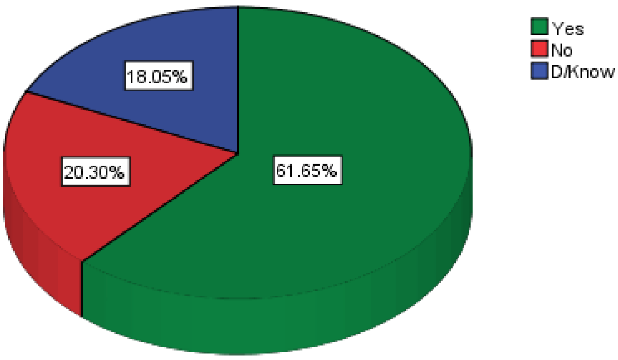
Do the planning or water management issues require more attention?

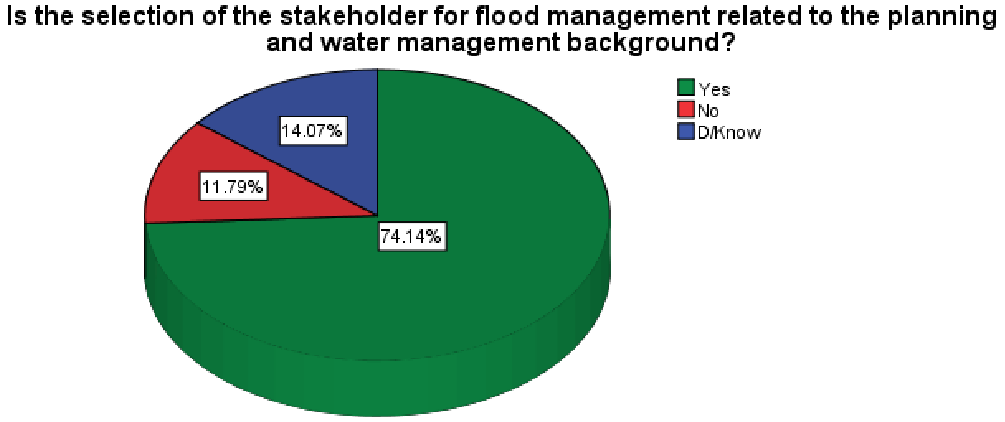


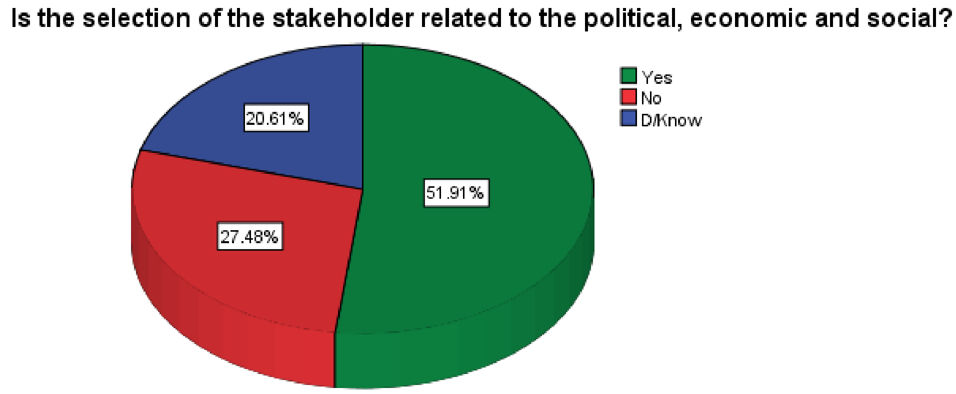
Is the integration between planning management and water management must be in order to avoid flooding?

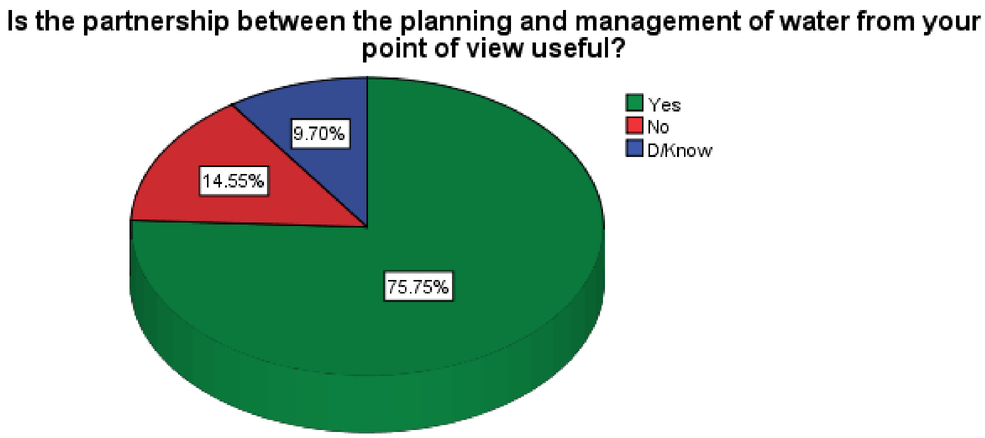


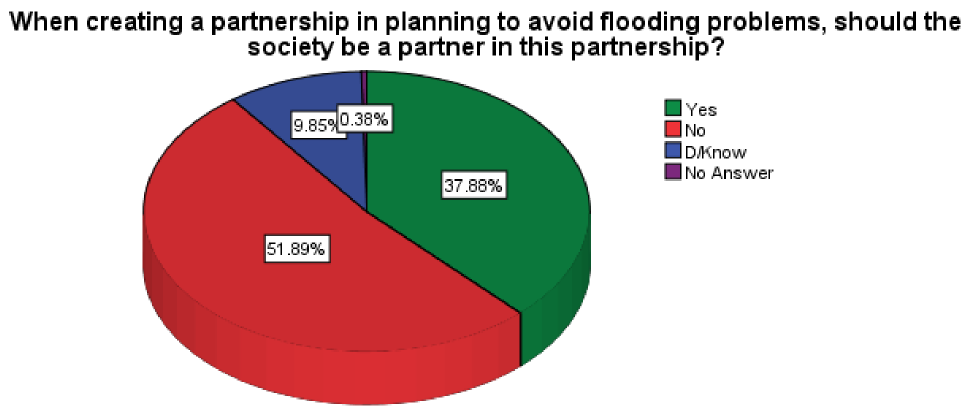
From your own point of view, is integration between the planning and management of water management the solution to reducing the flooding risk?



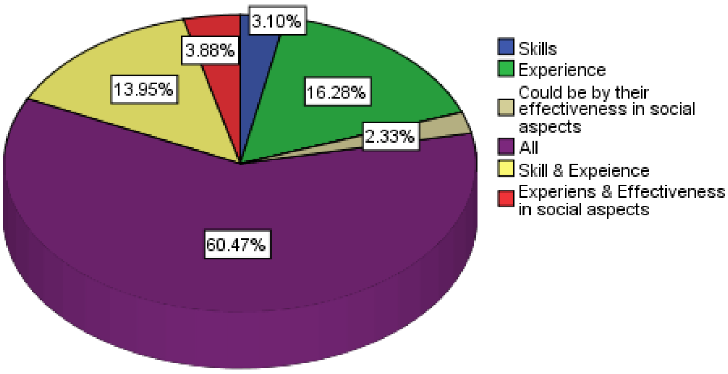

Is the selection of the stakeholder for flood management related to the planning and water management background?
Yes
No
D/Know
14.07%
11.79%
74.14%


Is the selection of the stakeholder related to the political, economic and social?
Yes
No
D/Know
20.61%
51.91%
27.48%

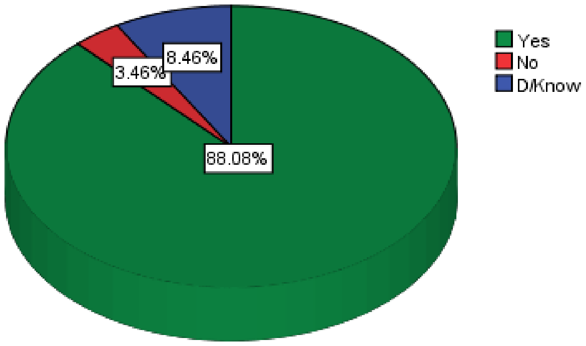

Is the partnership between the planning and management of water from your point of view useful?
Yes
No
D/Know
9.70%
14.55%
75.75%


When creating a partnership in planning to avoid flooding problems, should the society be a partner in this partnership?
Yes
No
D/Know
No Answer
9.85%
0.38%
37.88%
51.89%

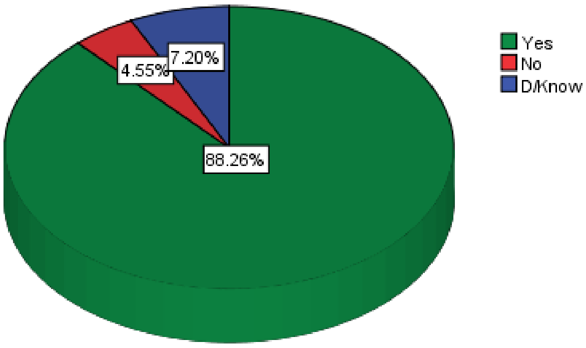
Is the stakeholder's selection depending to their?



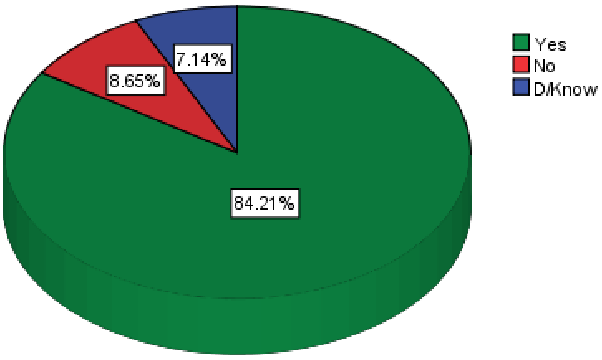
Are concerted efforts among the various stakeholders contributing to the sustainability of contemporary subdivision plans in the Sultanate of Oman to avoid flood-affected areas?

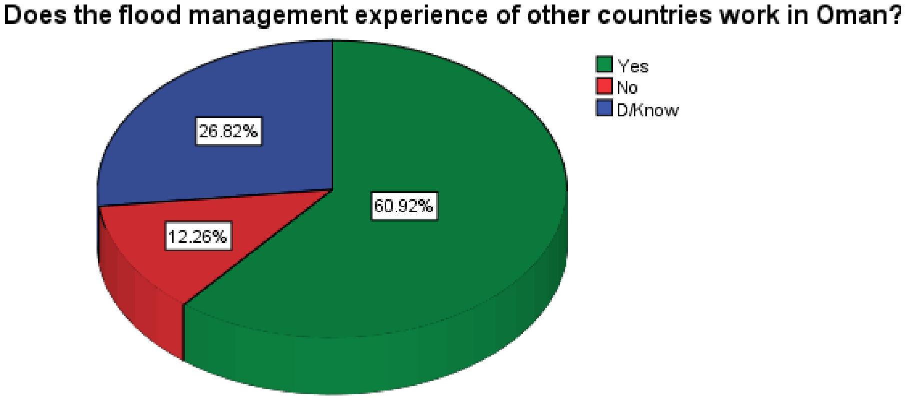


Will the flood management in Oman be better if a partnership is created between the different stakeholders?



Do you think technical engineering approach (such as dams, wall defences) is a good vision for the future management of flood and water in Oman?




Does the flood management experience of other countries work in Oman?
Yes
No
D/Know
26.82%
12.26%
60.92%

Questionnaire Al Hail people (The Case Study)

Part-1 About the property (optional)

Full Name: --

Age: from 25 – 35 ( ) or 35 – 45 ( ) or 45 – 60 ( ) or more than 60 years ( )

Affiliation Optional: ---------------------------------

Monthly income: from 350 – 700 ( ) or 700 – 1500 ( ) or from 1500 and order ( )

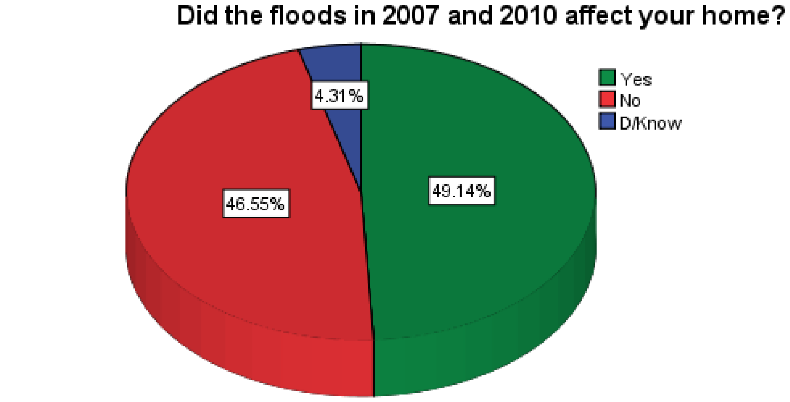
Tenant ( ) Owner of the house ( )

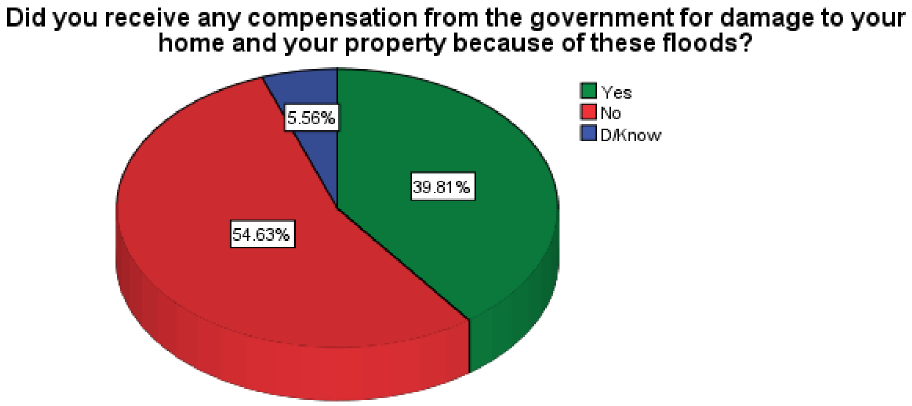
Number of years of residence in this home (-----------)

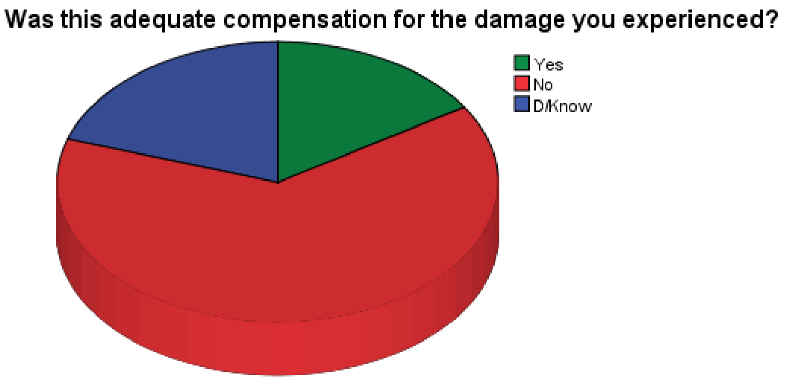
Information about the home: Plot no (----------) Square (----------) Area (----------)

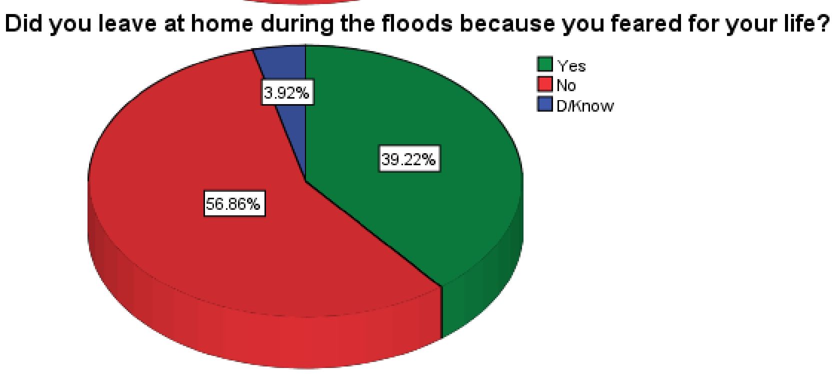
No	Questions	Yes	No	Don't know
Part -2 About the flooding and protection				
1	Did the floods in 2007 and 2010 affect your home?			
2	Did you receive any compensation from the government for damage to your home and your property because of these floods?			
3	Was this adequate compensation for the damage you experienced?			
4	Did you leave home during the floods because you feared for your life?			
5	Did you take out insurance for your house after the floods?			
6	Have the government or insurance companies informed you regarding the kind of protection that you will need for your home in order to preserve it from being affected by floods in the future?			
7	Did you build your home?			
8	If you built your own house, have you been notified by the municipality or any other parties to work on certain requirements concerning the floods?			
9	If you had the opportunity to re-build your home would you wish to add any kind of protection to protect it from flooding?			
10	Has the government told or obliged you to insure your home?			
11	Were there any instructions provided to you by the government or privet sector like insurance company before the floods?			
12	Were there any directives from the government regarding the insurance on your property being affected by these floods in future?			
Part -3 About the compensation and planning				
13	Are you worried about the wadi near your house?			
14	Would you recommend your friends to build their housing next to the wadi?			
15	If you were told that your home was located in a wadi that is a restricted area, would you accept compensation to move?			
16	Would you prefer to be compensated financially for the building or for the land?			
17	Would you prefer to be compensated financially for the building and land as well?			
18	If you prefer the second option how much money would you hope to obtain for your building and land?			
19	In the case of re-planning of the area surrounding the wadi would you recommend that there was sufficient space between the wadi and the houses?			
20	What is the distance which you would propose to leave between the houses and the wadi?			
21	In the case of the re-planning of the area surrounding the valley and its beautification would you desire to live next to the wadi?			
22	From your own perspective, is there any cooperation between the Ministry of Housing and the community in the planning process?			
23	If summoned by the planning authorities to participate in the planning of any area would you participate in the planning process?			
24	Do you prefer your representatives to participate in the planning process?			

Analysis of the Questionnaire of Al Hail people (the Case Study):

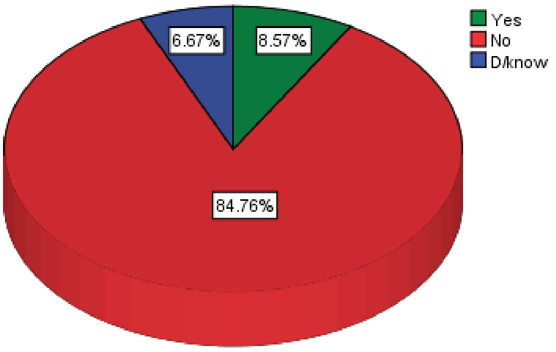




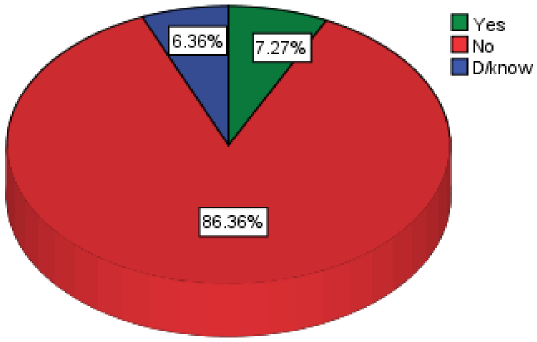




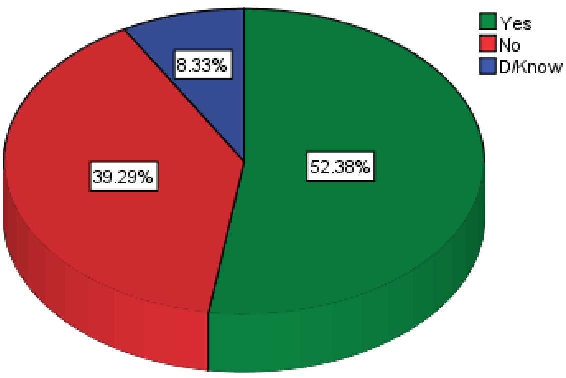
Did you take out insurance for your house after the floods?



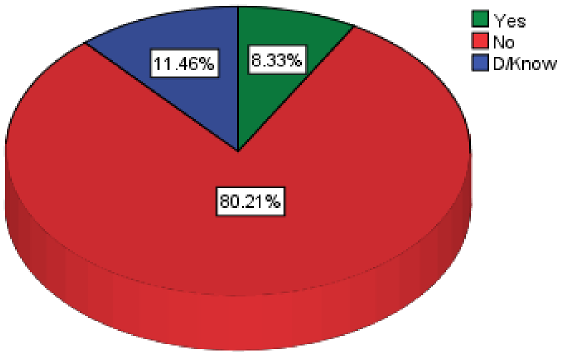
Have the government or insurance companies informed you regarding the kind of protection that you will need for your home in order to preserve it from being affected by floods in the future?



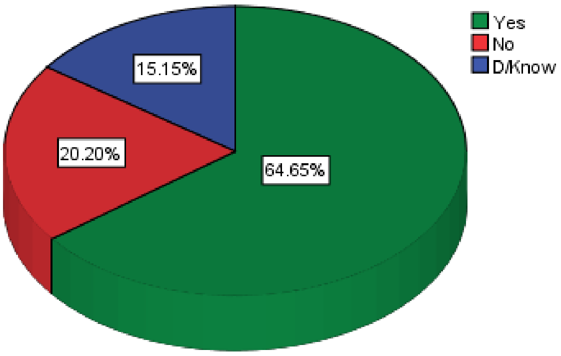
Did you build your home?



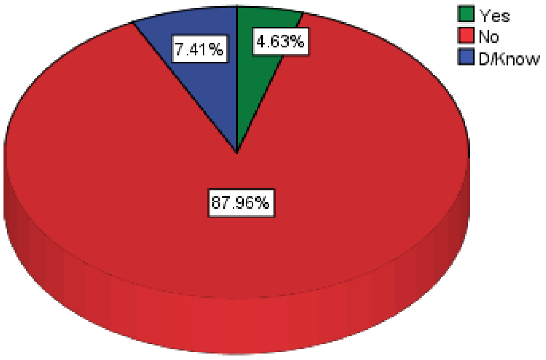
If you built your own house, have you been notified by the municipality or any other parties to work on certain requirements concerning the floods?



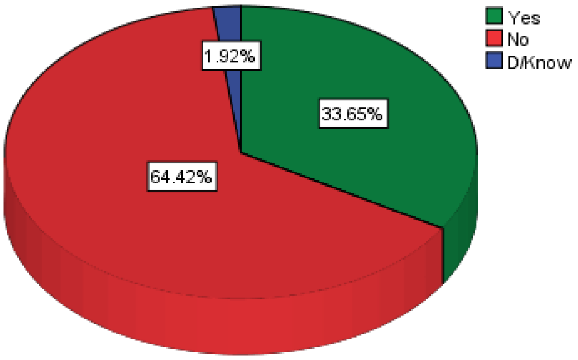
If you had the opportunity to re-build your home would you wish to add any kind of protection to protect it from flooding?



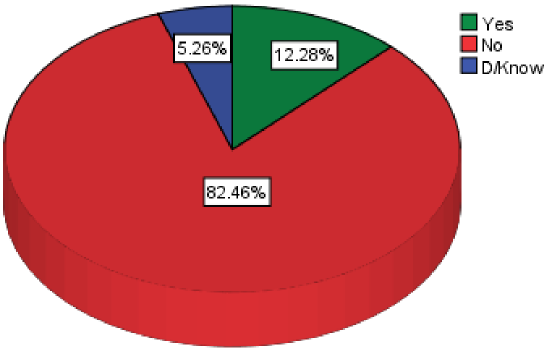
Has the government told or obliged you to insure your home?

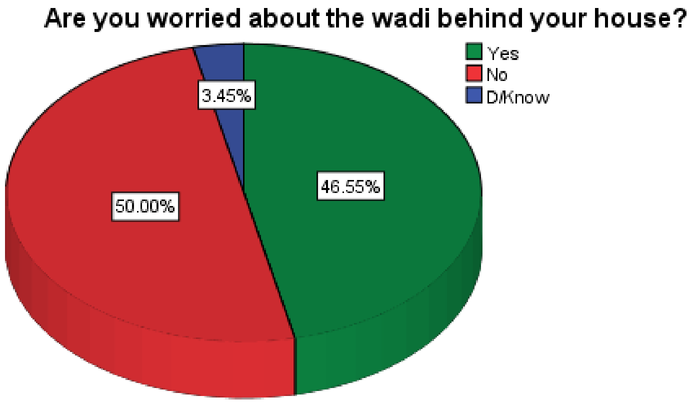


Were there any instructions provided to you by the government or privet sector like insurance company before the floods?

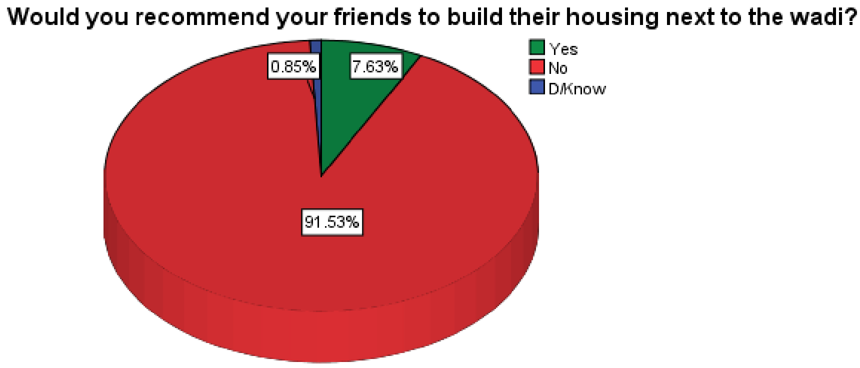


Were there any directives from the government regarding the insurance on your property being affected by these floods in future?

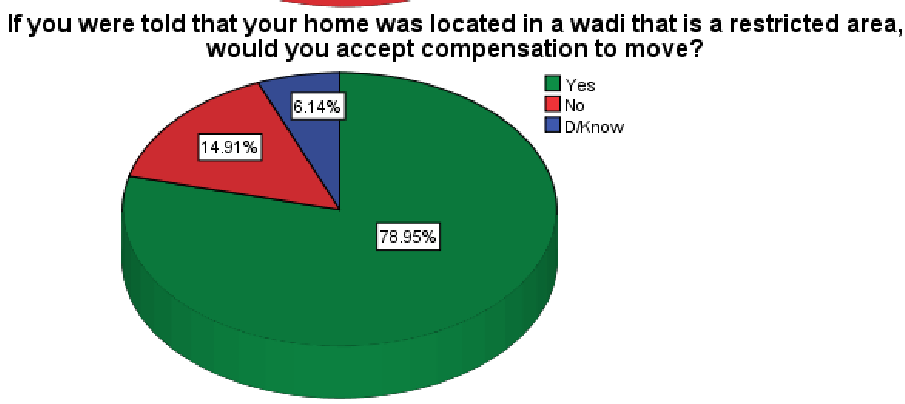




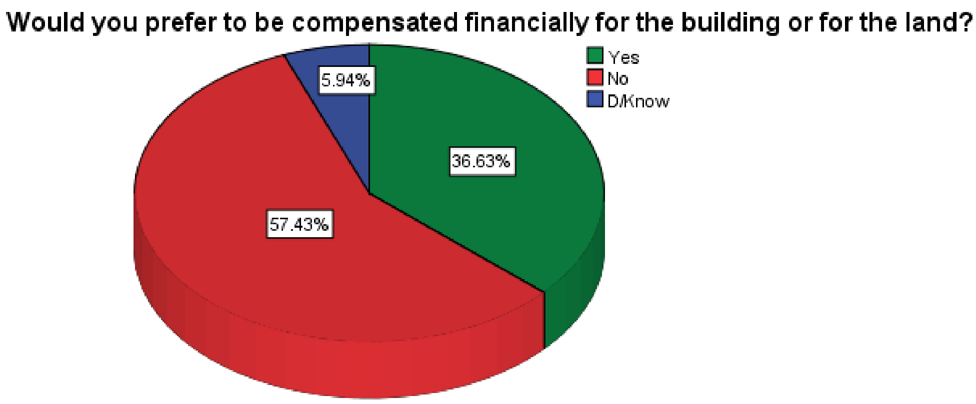
Are you worried about the wadi behind your house?
Yes
No
D/Know
3.45%
46.55%
50.00%



Would you recommend your friends to build their housing next to the wadi?
Yes
No
D/Know
0.85%
7.63%
91.53%

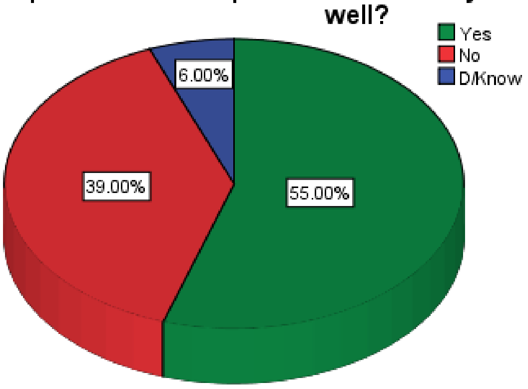


If you were told that your home was located in a wadi that is a restricted area, would you accept compensation to move?
Yes
No
D/Know
6.14%
14.91%
78.95%

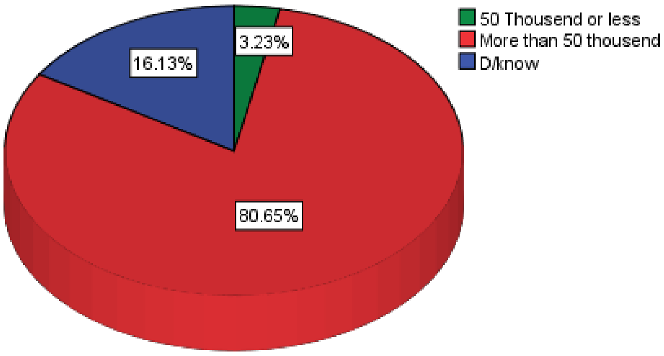


Would you prefer to be compensated financially for the building or for the land?
Yes
No
D/Know
5.94%
36.63%
57.43%

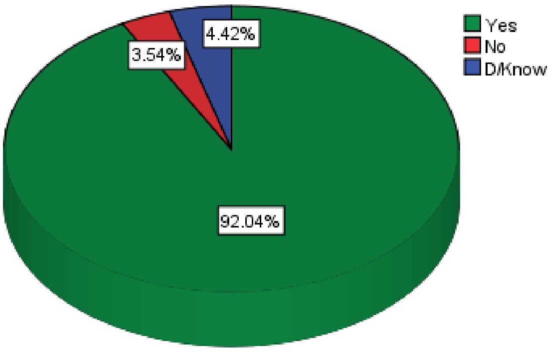
Would you prefer to be compensated financially for the building and land as well?



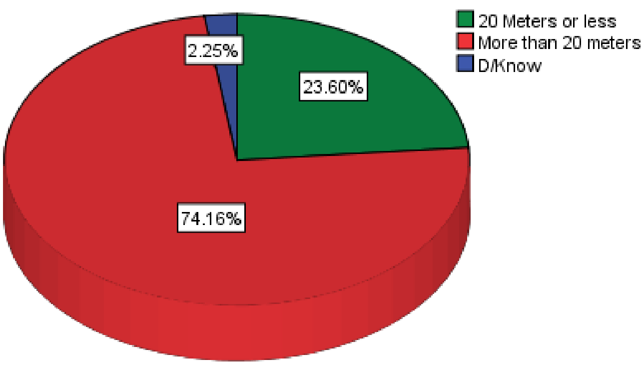
If you prefer the second option how much money would you hope to obtain for your building and land?

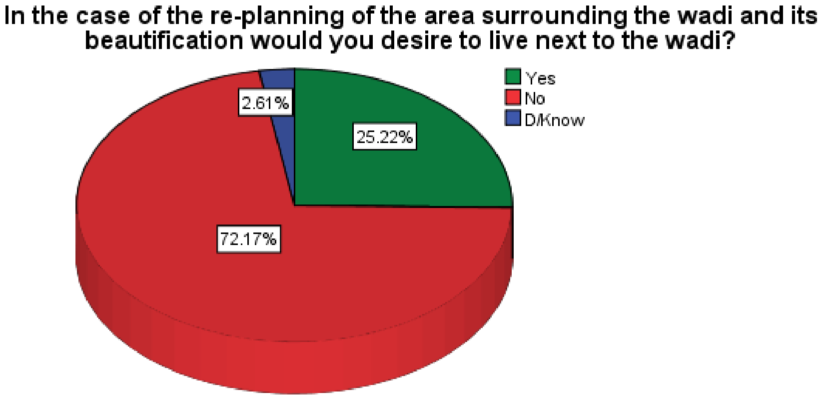


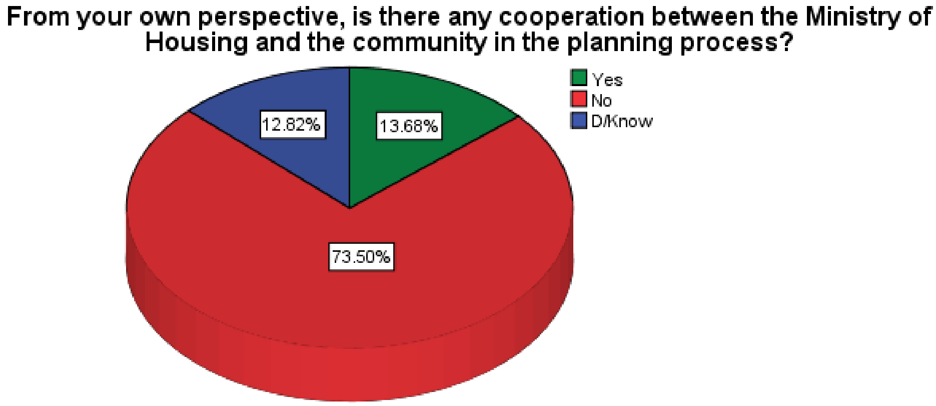
In the case of re-planning of the area surrounding the wadi would you recommend that there was sufficient space between the valley and the houses?

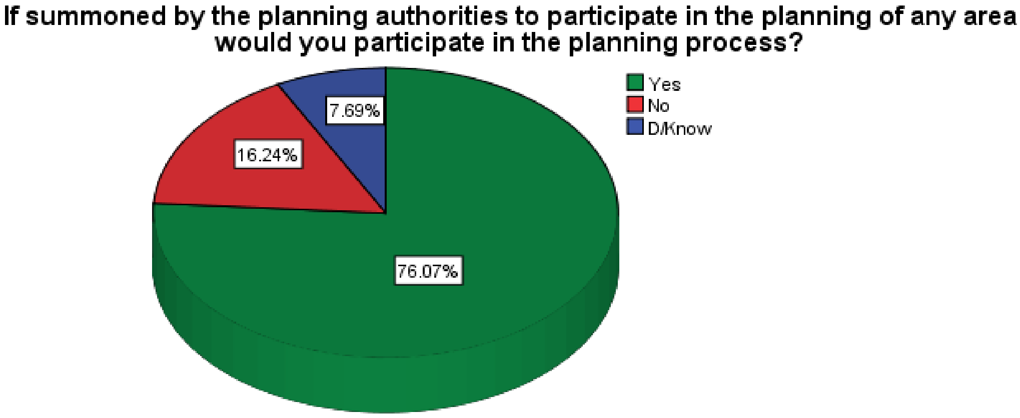


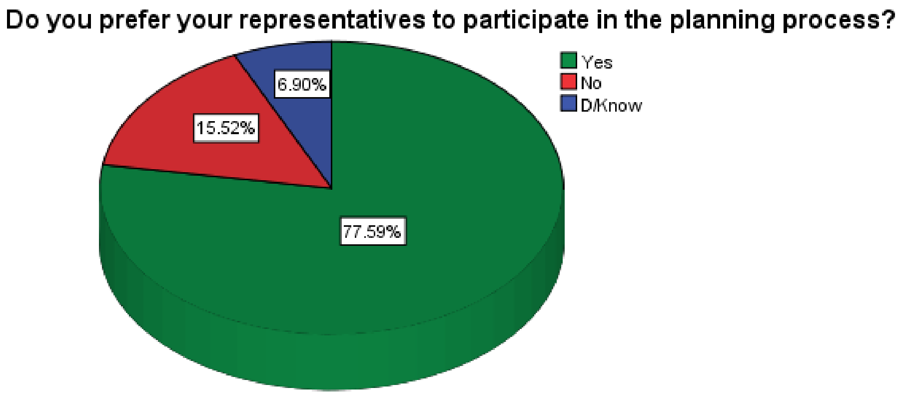
What is the distance which you would propose to leave between the houses and the wadi?




In the case of the re-planning of the area surrounding the wadi and its beautification would you desire to live next to the wadi?
Yes
No
D/Know
2.61%
25.22%
72.17%


From your own perspective, is there any cooperation between the Ministry of Housing and the community in the planning process?
Yes
No
D/Know
12.82%
13.68%
73.50%


If summoned by the planning authorities to participate in the planning of any area would you participate in the planning process?
Yes
No
D/Know
7.69%
16.24%
76.07%


Do you prefer your representatives to participate in the planning process?
Yes
No
D/Know
6.90%
15.52%
77.59%

Interviews with different people, specialists, and those from different cultures (open-ended questions)

Num.	Subject area and Questions
	1- The responsibility and partnership of Omani flood management:
1	What is your assessment of the current planning system in Oman? - To what extent is the Omani planning system the central cause for creating environmental problems? - Where is the problem, is it the ministry level or is it a local level? Can you tell me more about this? What about planning system? - What evidence have you got that the planning system is causing problems? Why they causing problems? - Are there any specific examples of this? - Have certain individuals within the decision-making process caused this?
2	What is your assessment of the current water management system in Oman? - What aspects in terms of water management must be improved?
3	What is your assessment of the current drainage system in Oman? How can the quality of drainage system in Oman be improved?
4	To what extent are you satisfied with the current flood management in Oman? - You think if we had easy correlation between the spatial planning and water management will that improve the situation?
5	What are the shortcomings in the performance of each of the current planning and water management systems? - What is the most important basis that can be required for the creation of an improvement in both of them?
	2- Climate change cause floods events:
6	To what extent has the increase in temperature as a result of the rise in the sea level or the occurrence of cyclones and storms and therefore as sequences of flooding? - Do you think the flooding caused by sewage system or it is flash flood or it is wadis flood? - Are there any other external factors? If so what are they?
7	To what extent do you see the relationship between land use management and the occurrence of flooding in Oman in terms of the carbon dioxide emissions? - What are the other damages related to the management of land use?
8	What kind of relationship should be created between the planning system and meteorology to avoid the planning of floodplains?
	3- Implementation of legislation and strategies:
9	To what extent is the management of strategies of spatial planning and water would be beneficial it they work together? And what way? - do you consider at the moment that the strategy of the planning and water management are connected or interconnected? - is the ministry of housing and water authority do work together currently? Would they any negative consequence if they working closer together?
	4- Integration between water management and spatial planning:
10	To what extent incorporation between water management and spatial planning management will help create the kind of coherence in the unification efforts for the success of flood management?
	5- Spatial planning and decentralisation:
11	To what extent is the conflict now between the changes in land use, extensions and the creation of new plots with water management? - Are there wary of any conflict with water management? - How this conflict is resolved? - What is the most popular approach for resolving conflicts in the policy-making process and planning issues?
	6- Intervention of political, economic and social:
12	How do you think the ordinary citizen can be involved in planning for flood management? (Or is it sufficient for them to choose their representative) - Who are these Representatives? - Who should be in flood management team? - What are the parties you think should be combined to improve the management of flooding in contemporary plans?
	7- Effectiveness and successful partnership in urban planning and flood management (Skills and experience):
13	How do you think we can achieve good cooperation in planning to manage flooding in Oman? - How should a part of the team for planning to reduce floods can be work? - Who do you think should be members of a flood management team? - Who is has the right skills and experience to plan for flood management? - Who ills has skills and experience should be involved in the collaboration to reduce flooding?
	8- Capacity building amongst partners and partnership challenges:
14	How could the capacity between stakeholders be build up when creating flood management collaboration in Oman? - What are the most significant parameters which should be assessed in this relationship? - What is the role of values and traditions in this regards?
	9- Technical engineering approach for flood management:
15	To what extent does the engineering technical approach like dams participate in Omani flood management? - Is a heavy technical approach for flood management appropriate in the future?
16	Do you think there are good flood management practices of other countries is might work in Oman? - How could this to be adapted to Oman? - Which countries are these?

Interviews with municipalities people (Open-ended questions - related to the Case study)

No	Subject title	No	Questions
10	Implementation of legislation and strategies according to Urban Planning Guide (SCTP, 2000)	1	How do Muscat municipality and Ministry of Regional Municipalities and Water Resources coordinating to achieve appropriate methods for water projects in Muscat?
		2	What is the situation regarding main road culverts, which are directed towards subdivision plans and dwellings In AL-Hail? - Why are the culverts in Al-Hail North wadis not facing the same dimension?
		3-A	What type of Future strategies that Muscat Municipality provided for drainage system specifically in Al-Hail and in Muscat in general?
		3-B	What type of Future strategies that Regional Municipalities and Water Resources provided for drainage system to all of Omani governance?

Planning people (Open-ended questions- part-1)

Number	Questions
	1- Current situation of planning system (Implementation of legislation and strategies):
1	What is your assessment of the current planning system in Oman? - To what extent is the planning system in Oman in line with the actual developments and variables? - What are the current challenges being encountered by the Omani planning system, which could potentially affects the implementation of the legislation and strategies?
2	What is the role of the community in terms of planning? - What is the extent of their participation in the planning process in Oman?
3	To what extent are you satisfied with the current flood management in Oman?
4	To what extent will the Omani National Spatial Strategy (ONSS) play a role in Omani planning and, therefore, participate in future flood management?
	2- Climate change causes for floods events:
5	To what extent do you see the relationship between land use management and occurrence of flooding in Oman in terms of the carbon dioxide emission?
	4- Integration between water management and spatial planning:
6	To what extent are the management strategies of planning and water interconnected and parallel?
7	What is the actual addition that will be generated by incorporating the water management effort with spatial planning to minimise the risk of flooding?
	5- Spatial planning and decentralisation:
8	To what extent is the existing coordination and utilisation between the Ministry of Housing and agencies responsible for water management and the environment as well as those responsible for the climate? - What kind of relationship should be between planning system and these different stakeholders to avoid planning of floodplains? - What is the technique that is being used by the planning authorities to protect the plans from the flooding risk?
9	To what extent do you think such development has forced the acceleration of the planning system and therefore resulted to planning in flood plain areas? - Are there any examples of this?
	6- Intervention of political, economic and social in planning system:
10	What are skills and experiences be needed if we wants to improve the approach of planning system and flood management in Oman?
	7- Effectiveness and successful partnership in urban planning and flood management:
11	To what extent the cooperation in Omani planning system is important? - How could the city planning be improved to reduce the flood risk through the cooperation strategy? - What are the reasons that have prevent the incorporation of some stakeholders in the city planning process since the beginning of the subdivision plans?
	8- Skills and experience for planning and flood management partnership:
12	According to you - How can the coordination for flood management be effective in Oman? - Who are the stakeholders who would be involved in the Omani planning system management if a strong organization in flood management were to be created? - What are the most significant aspects should be existed in those stakeholders?
	9- Capacity building amongst partners and partnership challenges:
13	What are those aspects that might help in successes or failed the cooperation in planning and flood management in Oman? - Does the Omani culture have a different situation to deal with when cooperating between the stakeholders? - What is that?
	10- Technical engineering approach for flood management:
14	To what extent does the engineering technical approach like dams participate in Omani flood management? - Is a heavy technical approach for flood management appropriate in the future?
15	Do you think there are good flood management practices of other countries is might work in Oman? - How could this to be adapted to Oman? - Which countries are these?

Interviews with planning people (Open-ended questions - part-2 related to the Case study)

Subject title	No	Questions
Implementation of legislation and strategies according to Urban Planning Guide (SCTP, 2000)	1	The Supreme Committee for Town Planning, decisions (5/88) and average number (31/93) adopted some guidelines, including reporting property owners located in places prone to flooding, and assigned responsibility to the Muscat Municipality and Ministry of Regional Municipality and Water Resources. What role are you playing in this area?
	2	Among the standards that have been adopted by the Supreme Committee for Town Planning Resolution No. (5/85) and average number (31/93) is to identify areas that are exposed to floods nuances, the three areas of High severity (red), with medium risk (blue) and gravity low (yellow). To what extent is the existing coordination between planning system and other stakeholders in terms of determining of the flood-prone areas? - What do you think about the Supreme Committee resolution her in this kind of categorization in these three areas? - Is this helping the coordination between the planning system and the other stakeholders practically in flood prone areas? - Who originally is expected to implement these guide lines? - Are you do in this or other people might using the guide lines?
	3	From the fact that areas are exposed to flooding valleys from year1 to 5 years, and high water, more than half a meter and speed of half a meter per second, Is this a standard regulation for this flood prone areas is to be implemented in Al-Hail has been taken in to account? - Is the planning system able to do with these conflicts? -What conflicts could be counted with? - Can the planning system do with these conflicts basically? - How do you think the Omani system deal with flooding?
	4	Among the proposals interim certified by the Supreme Committee for Town Planning, by resolutions Numeric (5/85 - 31/93), in the risk of floods and including the Ministry of Housing, is the implementing agency for planning in Muscat by the urban planning policy in the Sultanate, and to take control of reconstruction and planning, to minimize the flood risk, and not allow reconstruction in flood-prone areas, as stated in the resolution, How does this taken into account the new subdivision plans in Muscat after 2000? What are these procedures? - Do you think this rest of changing of land use, extensions and new housing plots creating more problems? How?

Life-history interview (Open-ended questions) related to the Case study

Number	Questions
	1-Time line experience of flooding:
1	In your lifetime is the flooding in Al-Hail changed at all?
2	Do you think we doubt about flooding any better 20 years ago then we do now?
3	Do you think flooding getting worse now?
4	Do you think climate change causing this?
	2- Al-Hail situation after planning : under (Current situation of planning system):
5	To what extent is the phenomenon of flooding causing concern to you?
6	How effective is the current planning system of reducing floods risk in Al-Hail?
7	What conflicts could be countered with Omani planning system by improving planning quality for the implementation of planning strategies in Al-Hail?
8	What is the current conflict between change of land use, extensions and creation of new plots with water management?
	3- Flooding experience in Al-Hail Under: (Integration between water management and spatial planning):
9	To what extent are you satisfied with the current flood management in Oman in wide? and Al-Hail in particular?
10	What aspects in terms of the cooperation between spatial planning and water management could be appropriate and successful about the cooperation for flood management?
11	Do the planning or water management issues require more attention? Or do they both have the same level of importance and therefore, incorporation must be between them in order to avoid flooding?
	4- Evaluations of current projects in Al-Hail Under: (Implementation of legislation and strategies:
12	To what extent the management strategies of the planning and water are interconnected and parallel?
	5- Drainage situation Under: (Implementation of legislation and strategies according to Urban Planning Guide (SCTP, 2000):
13	To what extent is that the drainage system in Al-Hail is sufficient to cope with flooding? - does cause of damages as a result of planning problems or deficiencies in sanitation issues or other various issues? What are those?
	6- Future hoping for Al-Hail in terms of flood management Under: (Effectiveness and successful partnership in urban planning and flood management):
14	How the cooperation between different agencies in terms of flood management can be sustainable?

Appendix 2

Further research related to the thesis: Notes from the Fieldwork

The role of climate change in causing flood events: *To what extent is there a relationship between land use management and the occurrence of flooding in Oman in terms of the carbon dioxide emissions?*

According to the literature review and Chapter 7, climate change is one of the elements implicated in the occurrence of floods. Climate change results from different factors, most of which humans are largely responsible for; such as changing land use from agricultural to industrial uses and CO_2 emissions from the transportation (IPCC, 2007; The Met Office 2009; IPC, 2011). Decreasing these emissions can be achieved in different ways, such as shifting to public transport and using renewable energy sources. Therefore the next section will focus on investigating how all segments of the planning system in Oman, such as city planning, water management, developments or even drainage system, can manage the local emissions of the GHGs.

As mentioned in Chapter 2, the climate change phenomenon is occurring on a global scale, not by the small amount of emissions from only one country. Clearly, countries like the US, India and China emit huge amounts of GHGs from their industrial sectors. On the other hand, Rauf (2007) notes that the Gulf countries (GCC) have a poor record in terms of fuel emissions. If such emissions are measured per-capita these countries have a larger amount of emissions than other countries with much larger populations (see Chapter 3).

P2 points out that determination of land use is subject to multiple criteria; for example, the actual needs of the region to avoid environmental problems in the future, which might contribute to the climatic problems. According to P3, P6 and MU1, change in land use is one of the main factors effecting the climate, because industrial emissions are not like residential or agriculture emissions. This consideration was illustrated by P6's example of the cement factory in Muscat, which was studied by a group of Ministry members. This partnership consisted of the MH, MTI and MRMWR, who agreed to leave a space between the houses and the factory and compensated the people who had land in this zone.

P6 believed that dust and thermal emissions from Omani factories might be contributing to climate change, since the increase in temperature in the last three years is unprecedented. This has been noticed in many countries over the world; among them the GCC and the Sultanate (see Chapter 3). M1 mentioned the *"Committee for Co-operation Council for Meteorology and Climate was established only two years ago"* to address global warming issues. According to M1, this committee aims to link key projects between the GCC in subjects related to meteorology, including the climate: for example, linking Gulf radar systems to predict floods. Bahrain and the United Arab Emirates have already been involved in such projects, but they are of interest to many other Gulf States. These types of projects will involve the exchange of experiences and knowledge between the GCC countries and will contribute to shared collective solutions, which will be used to reduce the impact of flooding in these countries.

As mentioned previously, arguments over land use change in Oman concern installations such as the cement factory, but to clarify, the following section elaborates on these issues.

Renewable energy: According to the literature review, there is no doubt about the impact of various forms of energy on the environment and climate both in Oman and globally. Energy-related emissions from Oman cannot be separated from those of the rest of the world. However the atmosphere is being affected by emissions from all the countries of the world, and we do not know where the impact will be, as it is distributed worldwide.

Machinery, equipment and vehicles that move on the ground, and air conditioning and power generating technologies all increase thermal emissions and gases. There is also a change in sea levels caused by temperature and humidity and the concentration of some of the elements and increase of carbon dioxide in the atmosphere, which affect the ozone layer. All this will impact the ecological balance of the climate; therefore, the only solution is to create international cooperation to share the information and generate solutions to avoid damaging the earth.

According to CE, Oman and the Arab region, and the Gulf region in particular have natural and renewable energy resources, but due to the presence of petroleum products, gas products, and petrochemicals resulting in cheap expendable energy there is a lack of interest in renewable energy. Alternative energy sources in the Gulf countries are diverse, and take the form of solar, wind and tidal energy. CE stated that there is a possible benefit from these energies, as they are environmentally cleaner, although recent accidents and disasters have caused a great decline in some countries, such as Japan. In Europe, for example, CE pointed out that Germany was one of the biggest users of nuclear power, but after the recent events during the Japanese tsunami, many countries have begun to rethink their nuclear policies. Photovoltaic cells are still a high-cost option, requiring further study. It is not easy to install solar power plants, as they must be planned meticulously to avoid the risk of thermal radiation, and data is needed on effects like moisture and wind. According to CE, the Sultanate has embarked on solar energy research, and there is a pilot project managed by the Public Authority for Electricity and Water.

In contrast MU2 stated that renewable energy is virtually ignored by Oman, although it is very good alternative and much safer for the environment. In Oman, tidal energy, solar energy and wind power, waste from building materials (like concrete and glass) could be used in the production of electricity, instead of landfilling and entering into a cycle of pollution. These might be safer than nuclear energy and are naturally abundant in Oman. Because of the country's location, these types of energy were strongly recommended by many interviewees, but experts, as mentioned earlier, warn that the installation of these stations is very expensive; even if they will be useful in future.