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# The introduction of an environmental information system in Tanzania : a course and a dBase IV application as a first step, carried out at the National Enviremont Management Council, Dar es Salaam, Tanzania

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# The Introduction of an Environmental Information System in Tanzania

A course and a dBase IV application as a first step,
carried out at:
The National Environment Management Council,
Dar es Salaam, Tanzania

Joost Raaphorst, May 1996

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**Technology and Society**
**International Technological Development Sciences**

The knowledge and understanding of the process of system development and data structuring is extremely important for the management of the Environmental Information System. Furthermore, this knowledge and understanding will lead to more realistic expectations of the system, which will be important during the negotiations with concerning organizations. Hence, to increase this knowledge and understanding, two instruments have been developed. One is the 'dBase IV Application Writing' course and the other is the 'Tanzanian Wildlife Application', that has been developed to be used as an example.

The 'dBase IV Application Writing' course has been divided in the following six sections:
Section 1: General Information About Informatics and its Benefits
Section 2: Data Structuring
Section 3: The Construction of Databases in dBase IV
Section 4: Writing a Query
Section 5: The User Interface
Section 6: The Application

The 'Tanzanian Wildlife Application' is a dBase IV application, that is based on an existing dBase IV data file at the database department of NEMC. The application concerns with the administration of protected areas. All the specific characteristics of each protected area in Tanzania has been stored. Furthermore, all animal species, all plant species, all soil types and the visitor statistics of all the protected areas *can* be stored in the databases of the 'Tanzanian Wildlife Application'.

Both instruments have been carried out at the NEMC. The result of the course have not been evaluated, by using a test instrument. However, according to the observations during the course, an considerable increase of knowledge and understanding of the process of system development and data structuring, at the database department of NEMC may be assumed. The 'Tanzanian Wildlife Application' has been developed in cooperation with an employee of the database department and may be considered to be a major improvement of the former situation. However, still some bugs are presented in the application and the databases are not completely filled, so that the application does not operate optimal.

In general, this research contributes to a more successful introduction of an Environmental Information System in Tanzania.

# PREFACE

At the age of 12, I watched a television program about working in developing countries. I was fascinated by these images and I decided to start a career in the field of development cooperation. However, the years went on and the interest in developing countries diminished. In the final year of the B.Sc. course Higher Education in Informatics at the Eindhoven Polytechnic, the interest returned and I started the search for a follow-up study to meet the interest for working in developing countries.

This search resulted in the start of the study programme International Technological Development Sciences (ITDS) at the Eindhoven University of Technology. This study programme is focused on training engineers for a professional career related to international development problems. To obtain my M.Sc. degree a research assignment has to be carried out within a developing country. I got the opportunity to do my research at the National Environment Management Council (NEMC) in Dar es Salaam, Tanzania. The research was carried out at the directorate 'Environmental Education, Research and Documentation' of NEMC.

There are a lot of people who have made the period in Tanzania, to be an unforgettable experience. Besides those, a lot of people have supported me during the realization of the research assignment. It is impossible to mention all those people by name but in particular I would like to thank:

- Mrs. Maembe, my supervisor at the National Environment Management Council who offered me the research assignment and advised me on several aspects of my research.
- The employees of NEMC who were always very helpful and they made my stay in Tanzania pleasant. In particular I want to thank Miss Lilian for carrying out the 'dBase IV Application Writing' course and for helping me with all my questions, Miss Zafarani and Mrs. Malisa for being very nice colleagues.
- My supervisors dr. ir. A.M.C. Lemmens, dr. R.J. Kusters and P.E. Lapperre M.Sc., for their supportive remarks, recommendations and discussions during the fulfilment of my research period, as well as in Tanzania as in the Netherlands. Furthermore, I like to thank them for their willingness to spent extra time, during the last two months of my research period.
- My father, for the mental support during the complete research period and the financial support during the last six months of this period.
- Wim, for lending his computer, to make it possible for me to work during my favourite part of the day, the night.
- RAET IT-Services, for offering me a job and therefore, a deadline.
- My family, friends and house-mates, for the mental support during the complete research period.

# TABLE OF CONTENTS

# LIST OF FIGURES, TABLES AND BOXES

LIST OF FIGURES:


LIST OF TABLES:

LIST OF BOXES:

# INTRODUCTION

This M.Sc. thesis describes the research that has been executed as a result of the request of the National Environment Management Council (NEMC), to develop an Environmental Information System for Tanzania. NEMC has been established in 1983 and is active since 1986. The main function of NEMC is to advise the Tanzanian Government on all matters, related to the environment. To get a better understanding of the environmental processes in Tanzania, NEMC requested for the development of an Environment Information System. By means of such a system, NEMC will be more able to recommend environmental policy to the Tanzanian Government and therefore, NEMC will indirectly be more able to actually solve the environmental problems of Tanzania. This research considers the possibilities of an Environmental Information System for Tanzania, and in particular, the possibilities of NEMC to manage the system.

Chapter two describes the definition of the problem in detail. From this problem definition, the research questions will be derived, which will be answered in chapter four.

Chapter three deals with the background of the research. In chapter three, Tanzania will be described on the basis of some major figures. Furthermore, the major environmental problems of Tanzania will be discussed. Finally, chapter three will end with a consideration of the organisation structure and the main activities of NEMC.

In chapter four, the requirements of the Environmental Information System for Tanzania will be discussed. in this discussion, a distinction is made between the functional and the quality requirements of the system. The functional requirements determine the extent in which the Environmental Information System is able to support NEMC in recommending policy to the Tanzanian Government. The quality requirements environmental concern the use of the system. Chapter four will continue with an enumeration of the conditions for the management of the Environmental Information System. In this discussion, a distinction is made between the responsibilities and the skills of the manager of the Environmental Information System. Finally, chapter four will end with an analysis of NEMC, that will lead to an enumeration of the strong and weak points of NEMC for the management of the Environmental Information System.

As a result of chapter four, two instruments have been developed to increase the ability of NEMC to manage the Environmental Information System. The main objective of these instruments is to increase the knowledge and understanding of the process of system development and data structuring. One instrument is the 'dBase IV Application Writing' course and the other instruments is the 'Tanzanian Wildlife Application'. In chapter five, these instruments will be described in detail.

In chapter six, the two instruments will be evaluated. Since, no test instrument has been developed, the evaluation will be described according to the observations during the execution of the instruments.

Finally, this thesis will end with the overall conclusions and recommendations. The execution of the recommendations will increase a successful introduction of an Environmental Information System for Tanzania at the database department of the National Environment Management Council.

# RESEARCH PROPOSAL

## 2.1. Introduction

Tanzania is facing serious environmental problems. The Tanzanian Government and several international organizations have studied these problems. This has resulted in several reports on the environmental problems in Tanzania, appended with lists of actions that must be executed. The most important documents are the preliminary study of Tanzania, a result of the World Bank Environment Mission and the National Environment Action Plan (NEAP) written by the Tanzanian Government. In the institutional sphere, the Tanzanian Government established the National Environment Management Council (NEMC) in 1986 in order to advise the Government on all matters related to the environment. In chapter 3, the organization of NEMC and its main activities are described. In 1990 the Ministry of Tourism, Natural Resources and Environment (MTNRE) was founded.

The MTNRE and NEMC are both dealing with environmental issues. Since the foundation of the Ministry, its functions and responsibilities are overlapping those of NEMC. The Ministry is mainly concerned with the executive function, while NEMC has an advisory function to the Government, in particular, to the MTNRE.

This research is executed within NEMC and it concerns the role that information technology can play in tackling environmental problems. The next paragraph describes the problems that occur at NEMC in trying to write environmental policy for the Government. These problems are the basis of the call for an Environmental Information System (EIS). In paragraph 2.3., the research questions are described, which must be answered before we can actually develop an EIS and make it operational.

## 2.2. Problem Definition

Environment is one of the main issues within developing countries. The integration of environmental topics into economic development policies is essential to reach *sustainable development*. The overall goal of the Tanzanian environmental policy is "to achieve sustainable development that maximizes the long-term welfare of both present and future generations of Tanzanian people" [Ministry of Tourism, Natural Resources and Environment, 1994, p.23].

The concept of sustainable development was widely disseminated by the *World Conservation Strategy*. Sustainable development was seen as a way for conservation of the environment to play a part in improving human welfare. The three main aims stated in the World Conservation Strategy are as follows [Barrow, 1995, p.66-67]:

1 To maintain essential ecological processes and lifesupport systems (the latter being ecosystems natural and human-modified, necessary for food production and other aspects of human well-being).

2 To preserve genetic diversity (i.e. maintain wild and domesticated plants and animals to ensure as few as possible become extinct).

3 To ensure the sustainable utilization of species and ecosystems.

Figure 2.1. represents the concept of sustainable development. This representation consists of three systems. The intersection of these systems (part A) represents the area in which sustainable development plays a major role.

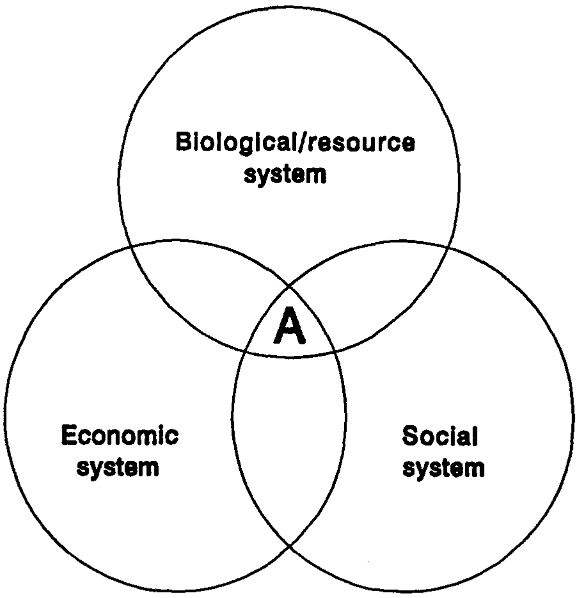


Figure 2.1: Representation of the concept of sustainable development

Since the introduction of the term, sustainable development has been defined in several ways [Barrow, 1995, p.67-68]. The definition used here is the one of the World Commission on Environment and Development:

Definition 1: *"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

The Tanzanian Government is conscious of the importance of sustainable development, which resulted in the formulation of the first National Environment Action Plan published in June 1994. This plan outlines six major problems for urgent national attention. These topics are: (a) land degradation; (b) water supply and quality; (c) pollution; (d) wildlife habitats; (e) aquatic systems; (f) deforestation. Each of these is important to the well-being of the country and the health of present and future generations of Tanzanians. Although exact data is not available, analysis shows:

(a) that land degradation is reducing the productivity of soils in many parts of Tanzania
(b) that despite considerable national effort, over half the people in towns and in the countryside do not have access to good quality water for washing, cooking, drinking and bathing.
(c) that the pollution in towns and the countryside is affecting the health of many people and is lowering the productivity of the environment.
(d) that the loss of habitats for wildlife is threatening the national heritage and is creating an uncertain future for tourist industry.
(e) that the productivity of lake, coastal and river waters is threatened by pollution and poor management.
(f) that Tanzania forest and woodland heritage is being reduced year by year through clearance for agriculture, for woodfuel and for other demands.

In chapter 3, the environmental problems of Tanzania are described in more detail.

Managing the environment is necessary to achieve sustainable development. In the case of Tanzania, the Tanzanian Government is the environmental manager. However, since NEMC is recommending policy on environment matters to the Government, NEMC is considered to be the environmental manager, in this research. According to Barrow [Barrow, 1995, p.32]:

Definition 2: *"The management of the environment can be described as the process of allocating natural and artificial resources in order to make optimum use of the environment in satisfying basic human needs at the minimum, and more if possible, for an indefinite future".*

Environmental management is based on the assumption that there is an optimum between conservation and the use of natural resources. The environmental manager needs to know the structure and function of the environment and how the human users act. Once the processes of change are known, it should be possible to control them better. Two inputs are crucial in achieving successful environmental management [Barrow, 1995, p.32-33]:

- access to consistent, reliable and comparable sets of data on environment and human activities
- enforceable rules and laws of environment and resource use.

In this research, the first input is of major concern. The environmental manager must have access to consistent, reliable and comparable sets of data on environment and human activities. At the moment, NEMC is collecting all kind of environmental data on a national level and is recommending policy on the basis of these data. These recommendations are based on incomplete, sometimes unreliable and incomparable data. The methods of measuring baseline data are different or in the worst case, unknown. Furthermore, a key characteristic of environmental problems is that they are cross-sectoral and their understanding requires information drawn from various sources.

Besides the problem of data collecting, an environmental manager must have the means and capability to store and to process these sets of data to environmental information. With this information the manager can make decisions on environmental matters. One of the means that can support the manager is an Environmental Information System. The advantage of such a system is the possibility to monitor the actual situation of the environment and to recognize problems for urgent attention. This is only the case when the EIS is functioning properly and used accordingly.

From the above, it is possible to give a description of the specific need of NEMC that can be considered as the basis of this research:

*"For the storage and processing of data, concerning environmental matters and human activities, the National Environmental Management Council requires an Environmental Information System to support the formulation of policy recommendations for the Tanzanian Government".*

The EIS can only come up to its expectations when it satisfies all functional and quality requirements and when it is used properly. Hence, it is essential to perform research on these aspects of the development and management of the EIS. In the next paragraph the research questions are outlined, which are related this problem.

## 2.3. Research Questions

In this paragraph the research questions are described that must be answered before the development of an Environmental Information System for NEMC. First, the questions are outlined for the development of the system in general. After that, the questions are specified for the case of Tanzania.

Main Research Questions:

1. What are the functional and quality requirements of an Environmental Information System for Tanzania?

2. Does the National Environmental Management Council meet the requirements of an organization that can manage an Environmental Information System for Tanzania?

Sub Research Questions:

1.1. What are the main functional requirements of an Environmental Information System?

1.2. What are the main quality requirements of an Environmental Information System?

1.3. What are the specific functional and quality requirements of an EIS in Tanzania?

2.1. What are the requirements of an organization that can manage an Environmental Information System?

2.2. What are the specific requirements of an organization that can manage an EIS in Tanzania?

2.3. If the answer of research question 2 is negative, what instruments are available to increase the ability of NEMC to manage an Environmental Information System for Tanzania?

## 2.4. Summary

- Tanzania is facing serious environmental problems. The Tanzanian Government is conscious of these problems, which resulted in the formulation of the National Environment Action Plan (NEAP), in which the concept of sustainable development is essential.

- To reach sustainable development, it is important to integrate environmental topics into economic development policies. For a solid integration, environmental management is essential. In the case of Tanzania, the Government is the environmental manager. Since NEMC is recommending policy to the Government, NEMC is considered as the environmental manager in this research.

- For the storage and processing of data, concerning environmental matters and human activities, NEMC requires an Environmental Information System to support policy recommendations for the Tanzanian Government.

- The main research questions are:
  - What are the functional and quality requirements of an Environmental Information System for Tanzania?
  - Does NEMC meet the requirements of an organization that can manage an Environmental Information System for Tanzania?

# RESEARCH BACKGROUND INFORMATION

## 3.1. Introduction

In this chapter some background information of the research will be given. In paragraph 3.2., Tanzania will be considered by means of some general figures of the country, its history and its economical activities. The main environmental problems of Tanzania that have been distinguished by the Tanzania Government will be discussed in paragraph 3.3. This chapter will finish with a detailed description of the organisation of NEMC and its activities.

## 3.2. Tanzania[1]

The United Republic of Tanzania is situated just south of the equator, bordered by the Indian Ocean and eight other countries: Kenya, Uganda, Rwanda, Burundi, Zaire, Zambia, Malawi and Mozambique. Tanzania was formed as a sovereign state in 1964 through the union of the separate states of Tanganyika and Zanzibar. The combined territories comprise 945,037 km$^2$, with mainland Tanganyika covering more than 99% of the total area. Dodoma, the designated official capital since 1974, is centrally located on the mainland and the legislative branch meets in here. Dar es Salaam, the largest city and port of the country remained the seat of most governmental institutions. Table 3.1. shows some demographical data of Tanzania.

| | 1988 | | 1990 | | 1991 | | 1992 | |
|---|---|---|---|---|---|---|---|---|
| Population | | 23,174,000 | | 24,403,000 | | 25,096,000 | | 25,809,000 |
| Density (pers./km$^2$) | | 26.2 | | 27.6 | | 28.4 | | 29.2 |
| Urban (%) Rural (%) | 26.5 | 73.5 | 32.8 | 67.2 | | | | |
| Sexe distribution: Male (%) Female (%) | 48.88 | 51.12 | 49.44 | 50.56 | | | | |
| Life expectancy: Male (%) Female (%) | | | 51.3 | 54.7 | 50.0 | 55.0 | | |

| | 1985-1990 | world avg. | 1991 | world avg. |
|---|---|---|---|---|
| Birth rate (p. 1,000) | 50.5 | 27.1 | 49.5 | 26.4 |
| Death rate (p. 1,000) | 14.0 | 9.9 | 15.2 | 9.2 |
| Natural increase rate (p. 1000) | 36.5 | 17.2 | 34.3 | 17.2 |
| Total fertility rate (per childbearing woman) | | 7.1 | | 7.0 |

Table 3.1: Demographical data of Tanzania

[1] *The description of Tanzania is based on the reports: Information Technology in Tanzania, Hardeveld, 1994; Tanzania and Tourism, ten Brinke, Daemen, Komen, Raaphorst, 1993; The National Environment Action Plan, MTNRE, 1994.*

### 3.2.1. The History of Tanzania

*The history of Tanganyika*
In the middle of the nineteenth century East Africa got involved in the European powercontest. In 1884 Germany conquered parts of East Africa under leadership of chancellor Bismarck. In 1890 Germany and England made an agreement about the division of East Africa. Tanganyika became a German protectorate. Tanganyika consisted of the now called Tanzania, Burundi en Rwanda. The British protectorate consisted of Kenya, Uganda and Zanzibar.
After WO I the German mastery ended. After the peace conference in 1919, Tanganyika became a part of the British mandate. Rwanda-Burundi came in Belgian hands. Unlike Germany Tanganyika was for Britain no important colony, because Britain was assured of raw material and markets in British-Indië. The consequence was that Britain made no investments in Tanganyika so that Tanganyika was totally neglected. This changed during the second world war, when the export of sisal and rubber was stimulated.
Between the two world wars, the national and political consciousness of the people of Tanganyika increased. This was because of the policy of the British government, which was called the 'indirect rule'.
The Tanganyika African Association (TAA) was founded in 1922 and was an association for the rich people. They started the process against colonialism in their country. In 1954 Julius Nyerere transformed the TAA into the first national political organization, the Tanganyika African National Union (TANU). In 1960 the TANU won the election with 70 seats against 1 and since then the British influence disappeared. On December the 9th 1961 Tanganyika became independent.

*The history of Zanzibar*
Until the eighteenth century Zanzibar was controlled by the Portuguese, but they had not enough naval forces to keep the island under their control. Together with the Arabs under the leadership of Seif Bin Sultan, the local people passed the Portuguese away. In 1890 Zanzibar became a British protectorate, with Arabian and Indian influences. On Zanzibar four associations were founded; the Zanzibar African Association, for the continental people, the Shirazi Association, for the original people, the Arab Association and the Indian Association. After the independency the Arab formed the government, but the African people began a rebellion because of their life circumstances and dispelled the Arabs. Then the Afro-Shirazi Party (ASP), a combination of original, continental and Arabian people, began to rule Zanzibar.

*The history of Tanzania*
The Afro-Shirazi Party had strong connections with China and the DDR. The United States of America were afraid that there would come a new Cuba before the East African coast, so they stimulated Julius Nyerere, president of Tanganyika at that time, to start a union with Zanzibar. Kamure, the president of Zanzibar, was also afraid of a taking over by the communist. On April the 22th 1964 Tanganyika and Zanzibar joined together in the United Republic of Tanzania.
Zanzibar retained in a large measure its autonomy. In 1984 a political crisis about separation between Zanzibar and the continent arose when a successor of Nyerere was discussed. In 1985 Nyerere retired as president of Tanzania and Ali Hassan Mwinyi became the new president. The cry for separation of Zanzibar is still not over, this is because of the speed of economical liberalisation and the differences between the Arabian and the African people.

### 3.2.2. The Economy of Tanzania

*General*
Agriculture is the mainstay of the Tanzanian economy. Agriculture constitutes over half of the Gross Domestic Product (GDP) and some 75% of export earnings, It provides a living for about 80% of the population work force. Industry accounts for only 10 percent of the GDP and mining less than one percent. Services, including government, produce approximately one-third of GDP. A

number of industries and public services were nationalized after the Arusha Declaration, when the intention to built a socialist state was announced. Many of these industries are now in the process of privatization, under reforms as imposed by the government, IMF and the World Bank.
From the early 1960s to 1970s, overall economic performance was favourable with a GDP annual growth of about 5% annually. The period between 1973-1984 registered economic decline and severe macro-economic imbalances mainly due to a series of external shocks (quadrupling oil prices, droughts, break up of the East African Community, the Kagera War with Uganda and expansion in dept-serving) combined with poor economic management policies. Encouraging signs of economic recovery started to set in during the course of the Economic Reform Programme period, with GDP annual growth ranging 4-5% since 1986.

*Agriculture*
The major food crops are corn, maize, rice, sorghum, millet, bananas, sweet potatoes, barley, potatoes and wheat. Corn and rice are the preferred cereals, whereas cassava and sweet potatoes are used as famine prevention crops. In some areas, food crops are being sold as cash crops. Peasants in Ruvuma and Rukwa regions, for example, have specialized in commercial corn production. Export cash crops provide the major source of foreign exchange. Coffee and cotton are most important in this respect, but export of tea, cashew nuts, tobacco and sisal are substantial. Cloves are the main export produce of Zanzibar.

*Industry*
Tanzania's industry is based on the processing of agricultural goods and on import substitution (based on imported parts and materials). Production of clothing, footwear, batteries and bottles takes place as well. There is also a hot-rolling steel mill. Three cement factories cover almost all domestic demand for cement for construction purposes. Due to infrastructural constraints (failing electrical power supply and transport problems), many of the enterprises produce on 30 percent of their capacity. A strategy to lay the foundation for the rapid growth of such basic industries as steel, chemicals, rubber and textiles was thwarted by the economical crisis of the eighties. Standby credit facilities from the IMF provided the capital investment needed to initiate a rehabilitation of existing industries.

*Natural resources*
In mainland Tanzania, about 50% of the total area is forest and woodland, of which only 3% is dense closed forest. Furthermore, 40% is grassland and scrub and 6 to 8% is cultivated. Grassland and scrub includes most of the rangeland area of the country and supports a total of 13 million cattle and 10 million sheep and goats. The cultivated area is largely worked by small holders. Shifting cultivation is still common particularly in the drier parts of the rainfed agriculture zone. About 1% of the total land area is held in large farms, which are concentrated in the northern parts of the country. While only 6 to 8% of the total land area is cultivated, it is estimated that up to 9% of soils are medium to high fertility and 23% are low to medium fertility. The rest are of low quality.

Aquatic resources are important for Tanzania. The country has the biggest lake and river systems of Africa, which includes large portions of Lake Victoria, Tanganyika and Nyasa and a variety of other small lakes, swamps and floodplains forming a major wetland resource. Several dams also provide irrigation, fishing and hydroelectricity: the latter are the major power source for urban areas. Marine resources include fish stocks, coral reefs, sandy beaches, mangroves, marine grasses, salt resources and great biological diversity. Marine fisheries are mainly coastal but there is great potential for game fishing and some commercial fishing potential in deep off-shore waters. There is potential for off-shore oil and gas.

Wildlife is an important part of Tanzania's resource endowment, as Tanzania is one of the world's richest and most diverse countries in terms of habitat and animal and plant species. As a recognition of this fact, some 25% of the total mainland area is set aside in protected areas, including forest reserves. The 13 National Parks, 16 game reserves and 50 game controlled areas are important global centres of biodiversity and four (Mt. Kilimanjaro, Selous Game Reserve, Serengeti National Park and Ngorongoro Crater) are World Heritage Sites. These protected areas form the major tourist base for the country.

Biodiversity is one of the country's greatest assets. Tanzania is among the five most diverse countries in Africa for mammals, birds and swallow tail butterflies. For plants, it is second in Africa. But the country is also important for endemic species; that is species which are found nowhere else. Important sites for endemic species include the great lakes for fish and the "Eastern Arc" mountains, where one quarter of the surveyed flora is endemic.

Energy and mineral resources are another important component of the resource base. The major energy resources are woodfuel (90%), hydropower and coal. There is also potential for natural gas, solar energy and wind energy. Petroleum imports supplement these national resources. Although minerals only make up a small part of GDP, mining of gold, diamonds, coal, tin, salt, gypsum, sand, lime, gemstones and exploration for gas all occur.

In appendix 4, a map of Tanzania has been included. Furthermore, maps are included of the major vegetation types, soil types and protected areas in Tanzania. In the next tables some important figures of the economy of Tanzania will be given.

| | 1989 | 1990 |
|---|---|---|
| Gross National Product (US $) | 3,079,000,000 | 2,779,000,000 |
| GNP per capita (US $) | 120 | 114 |

Table 3.2: Gross National Product

| | 1990 | 1991 | 1992 |
|---|---|---|---|
| 1 US $ = T Sh | 195.45 | 229.06 | 319.44 |

Table 3.3: Devaluation figures

| | | |
|---|---|---|
| Budget (1991-1992) | revenue | T Sh 215,162,000,000 |
| | expenditure | T Sh 227,973,000,000 |
| Public debt (1990): | | US $ 4,704,000,000 |
| Imports (1990): | | T Sh 169,439,000,000 |
| Exports (1990): | | T Sh 80,999,000,000 |

Table 3.4: General statements

## 3.3. Environmental Problems in Tanzania[2]

In chapter two, the main environmental problems have already been mentioned briefly. In this chapter, these problems will be discussed in more detail. The environmental problems that will be discussed are: land degradation, poor water supply and quality, environmental pollution, loss of wildlife habitats and biodiversity, conservation of aquatic systems and deforestation. Each of the main environmental problems in Tanzania will be described, succeeded by an indication of the extent of the problem, some causes of the problem and the legislative enactments.

[2] *The description of the environmental problems in Tanzania is based on the reports: National Environment Action Plan, MTNRE, 1994 and Tanzania, World Bank Environment Mission, World Bank, 1993.*

### 3.3.1. Land Degradation

The *fertility* of soil depends completely on one thin top layer, the humuslayer. This layer of 15 to 20 cm makes agriculture possible. Plants rely on water, warmth, oxygen and minerals coming from this humuslayer [IJken, 1988, p.25].

The problem of land degradation, also called erosion, can occur in different forms. If the soil remains on the same location, but it is losing fertility, it is called: *soil degradation.* If the soil has been removed from its location, this might have been caused by *wind* or *water erosion.* A continuation of the process of land degradation will lead to more and more desertification, which will endanger world's food production in the future.

In the case of soil degradation, the soil fertility can be recovered by not cultivating the land for a period of time, or by using organic or inorganic fertilizers. In the case of water or wind erosion the top layer is washed or blown away. Hence, the fertility of this land is decreased dramatically. No fertilizer or irrigation can bring back its fertility. In figure 3.1., the soil degradation in the world is shown.

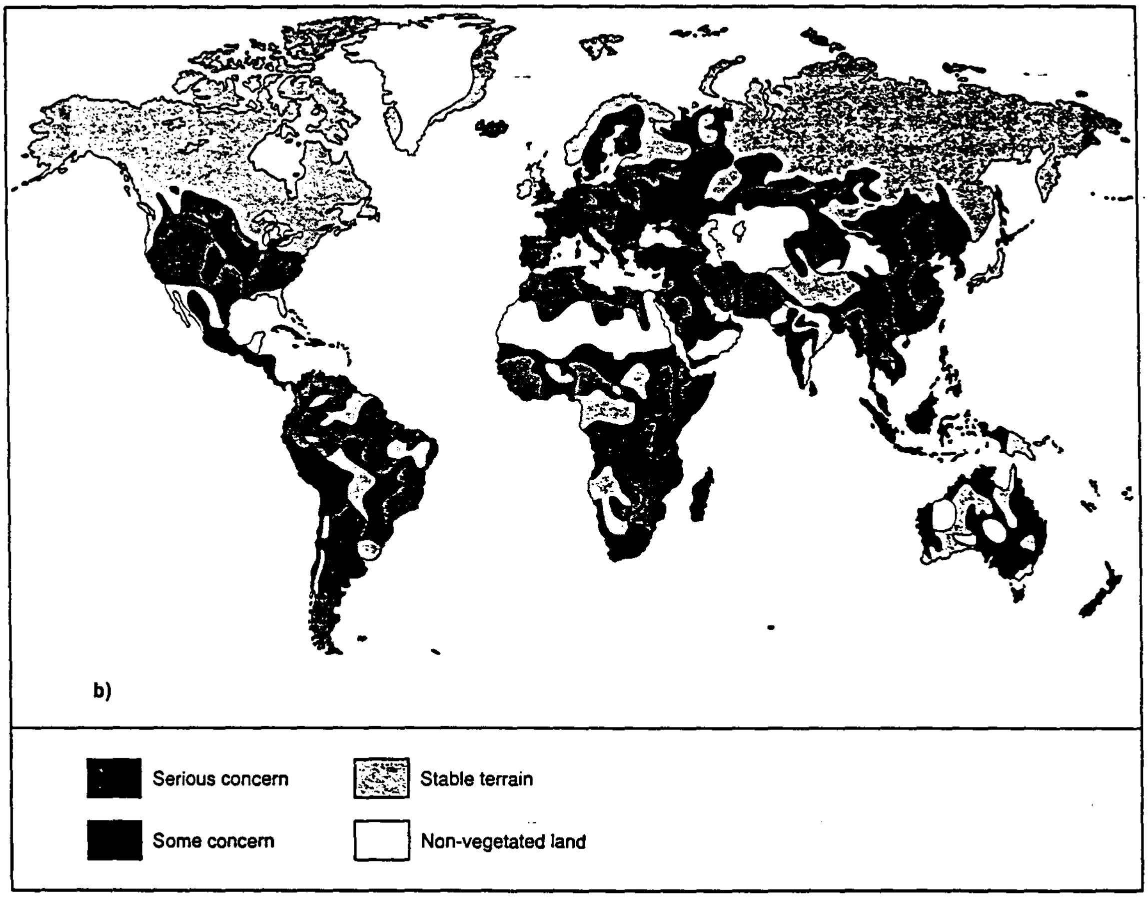


Figure 3.1: Areas of concern for soil degradation [Barrow, 1995, p.46].

An international example of water erosion is the Yellow River in China, where about 1.6 billion tons of soil a year is washed away in the ocean. Furthermore, 100 to 400 million tons of soil is yearly blown away from Northern Africa across the Atlantic Ocean [IJken, 1988, p.26].

### 3.3.1.1. Land Degradation in Tanzania

The problem of land degradation is the major environmental issue in Tanzania according to the National Environment Action Plan (NEAP). Documents on land degradation in Tanzania frequently quote two estimates of the overall situation. The first is an UNSO report from a mission in 1986, which assessed that about one third of the country is affected by desertification. The second is a 1987 FAO/Government of Tanzania report which claims that by 1980, 45 percent of the country suffered from desertification problems and that about one third of the rest was under threat [World Bank, 1993, p.1]. The original documents of these estimations cannot be located at the key institutions in Tanzania. Therefore, it is unknown what methods were used to determine these values, and how to meaningfully interpret assessments such as *affected* or *under threat*. Now, some of the causes of land degradation in Tanzania will be considered.

*Overcultivation*:

It is known that the fertility of soil decreases when the same plants are cultivated year over year. One common used solution in developing countries is shifting cultivation. The same plants are cultivated for a few years only and after that the land will not be used for some years. Now, the soil will recover its fertility. But land is not unlimited, so they use forest land to increase their land capacity or use land that is not yet recovered completely. Another solution is crop rotation. Some common used farming systems in Tanzania are: coffee/banana and maize/beans system. Most farmers know the benefits of crop rotation, but many do not practice it because of lack of land to answer consumer demand [International Centre for Development oriented Research in Agriculture (ICRA), 1992, p.71].

*Overgrazing*:

Overgrazing of rangelands leads to a degradation of vegetative cover and exposes the soil to wind and water erosion. Soil compaction may also occur, particularly along cattle routes. On a national scale, Tanzania has abundant rangelands: some 40 percent of the land area, or roughly 35 million hectares. The national herd is estimated to about 13 million heads, with a slow growth of less than 1 percent per year [World Bank, 1993, p.2].

*Deforestation*:

Deforestation is a problem on its own, because forest gives us oxygen to live. However, deforestation can also be considered a part of land degradation. Forest cover keeps the soil on the same location and makes it impossible to wash or blow away. There are several reasons of deforestation, which vary from locality to locality. In general, three main reasons can be distinguished: land increase for cultivation, land increase for rangeland, and the third reason is forest used as fuelwood. About 50% of the Tanzanian area is covered with woodland and it is declining dramatically. It is very difficult to get reliable information about these losses, but it is approximately 300,000 to 400,000 hectares a year, which is almost 1 percent of the total woodland [World Bank, 1993, p.3].

*Cultivation practices*:

The last cause that we are dealing with is poor crop cultivation practices. Good soil and water conservation is labour demanding and takes certain skills. In Tanzania, the use of fertilizers is low, because of lack of good fertilizers. Misuse may delay or cause a crop to be premature or damage soil or soil micro-organisms. Irrigation problems also occur. A lot of water is wasted. For some irrigation project it is known that about 20 percent of the waterflow ends up in the plants. The losses are due to design faults, construction or maintenance problems. Wastage of water means that less land can be properly irrigated.

In Tanzania several institutions are concerned with soil conservation. Before independence in 1961 bodies were created with the power to reserve land from use for conservation. For example, the National Resources Board, Range Development Commissions and later the empowerment of Local Governments to issue soil and water conservation by-laws. More recently recognition of the need to systematically plan land use, led to the creation of the National Land Use Planning Commission in 1984. The commission was given authority to recommend land use policy to the government and to prepare regional physical plans.

### 3.3.2. Poor Water Supply and Quality

Large parts of the world, periodically, seasonally or permanently, do not have enough water of the quality required. This may always have been the case or it may have become so, because population has increased and/or living standards have been improved raising demand for domestic supplies (drinking, cooking and washing needs), or it is due to development of industry or agriculture. Water supply problems may also arise because there has been alteration of available *rainfall, streamflow* or *groundwater.*

Streamflow is a potentially renewable resource but poor management may convert it to a temporary or permanent finite resource. The same holds for groundwater, that is sufficiently recharged to meet human demands. Poor management, particularly excessive use, can convert a renewable to a finite resource. Once polluted groundwater may take a very long time to recover and may be effectively ruined even if pollution stops.

#### 3.3.2.1. Poor Water Supply and Quality in Tanzania

Tanzania is a well-watered country with moderate to good rainfall and with many rivers and lakes. However, this broad statement hides the problem. In most part of the country, rainfall is seasonal and water is not readily available in the dry season. In many rural areas and on the unplanned settlements of all the main cities, people have to pay for water, either with scarce Tanzanian Shillings in the cities or with heavy labour in the rural areas. For many people, water is in short supply for *drinking, washing, cleaning, garden watering and small scale irrigation.* There is a clear relationship between the lack of household availability of water and the incidence of water related diseases.

Most urban water supply systems need rehabilitation and expansion. While 47% of the water demand is met in Dar es Salaam, only 29% is met in Lindi and only 11% in Kigoma. Tariffs are much to low and bill collections are poor. Actual collections are only about 8% of expenses in Dodoma, 20% in Tanga, and 40% in Dar es Salaam [World Bank, 1993, p.7]. Industry receives first priority for water in some cities leaving little to serve the poor. Barely 43% of rural residents have access to water sources within 400 meter, and laboratory analyses indicate that about 95% of groundwater is infected by disease causing organisms [World Bank, 1993, p.7]. Now, some of the causes of poor water supply and quality in Tanzania will be considered.

*Urban population*:

The rapid growth of the urban population goes beyond capacity. There is a lack of resources to exploit new water sources which are becoming increasingly costly. Water is priced very low, providing few incentives for efficient and no mechanism to allocate water between competing uses.

*Water pollution*:

Industrial and public water pollution leads to poor water quality. Lack of institutional capacity, resources, and political will to carry out water quality testing and to enforce anti-pollution laws. Furthermore, the poorly defined institutional responsibilities and lack of coordination between different governmental departments impedes effective management of water basin areas.

Legislative measures to water pollution have existed before independence. For example, prohibitions on discharge of certain substances into sewers ware contained in the Public Health Sewerage and Drainage Ordinance. More recently, prohibitions on water pollutions were included in several acts, and multiple bodies have been given the specific task of regulating pollution by proposing, issuing and enforcing standards or other regulatory controls. These bodies are: the National Urban Water Authority, the Central Water Board, the Tanzanian Bureau of Standards, the National Environment Management Council, the Radiation Protection Advisory Committee, Local Authorities and the Ministries responsible for fisheries and water. The Water Utilization and Control Act establishes standards for water quality and effluent emissions, as well as temporary domestic water quality standards.

### 3.3.3. Loss of Wildlife Habitat and Biodiversity

Biodiversity, including wildlife, is the totality of genes, species and ecosystems in a region [WRI, IUCN, UNEP, 1992, p.2]. The wealth of life on earth today is the product millions of years of evolutionary history. Over the course of time, human cultures have emerged and adapted to the local environment, discovering, using and altering local biotic resources. Many areas that now seem "natural" bear the marks of millennia of human habitation, crop cultivation, and resource harvesting.

Human beings have to act with respect for wildlife habitat and biodiversity. All human activities should serve the balance of the existing ecosystems. These ecosystems are disrupted by all kind of human activities, like: increase of land for agricultural production, hunting, bush fires, road construction and tourism.

#### 3.3.3.1. Loss of Wildlife Habitat and Biodiversity in Tanzania

Tanzania's wildlife resources are amongst the richest in the world. A full biodiversity profile of the country has not been worked out yet, but available statistics indicate that of the 10,000 plant species so far recorded, over a quarter are endemic. The forests of Tanzania also harbour 31 endemic amphibians, 18 endemic species of lizard, 9 species of snakes and 10 species of birds [Ministry of Tourism, Natural Resources and Environment]. Furthermore, the Selous Game Reserve has the largest concentration of elephants in East Africa. The tree climbing lions of Manyara National Park are unique throughout the world.

While Tanzania has been a leader in the designation of protected areas, Tanzanian wildlife resources and habitats are under threat. In some areas the threat is due to fragmentation and loss of critical ecosystem linkages, in some cases species are being overexploited. But in many areas the problem is the age-long conflict between the wild and the sown. In Eastern Acr mountains there is considerable local pressure to extend agriculture at the expense of forest often for very short term gain. Poaching is a concern where people hunt large mammals for horn and ivory. Furthermore, hunting for tourism is beginning to make an impact in some areas. Now, some of the causes of the loss wildlife habitat and biodiversity in Tanzania will be discussed.

*Population growth*:

The rapid population growth and increasing land conflicts as people and animals compete for increasingly scarce resources. This situation is intensified by changing lifestyles amongst rural people (cultivation displacing pastoralism).

*Bush fires*:

Intentional or accidental bush fires, are a significant cause of the disruption of wildlife habitat and biodiversity.

*Incentives for local communities*:

Local communities have no incentives to respect protected area boundaries, and frequently disturb habitat through land clearance and natural resources extraction, and take wildlife for their own uses, such as food, skins, or to sell for profit.

*Tourism*:

Tourist activities are becoming more and more a significant cause for the disruption of wildlife habitat and biodiversity. Moreover, hunting has become an interesting activity for the recreation business.

Tanzania has a well-defined system of national parks and protected areas. The Wildlife Conservation Act also restrict utilization of wildlife by limited users to those holding licenses. The Wildlife department of the Ministry of Tourism, Natural Resources and Environment is doing research on wildlife conservation and is formulating management plans for the protected areas.

### 3.3.4. Aquatic Systems Degradation

Aquatic resources include: Marine and freshwater ecosystems, mangrove forests, coral reefs, seaweeds and grasses, wetlands, lakes and rivers. The biological resources associated with aquatic systems are an important part of the biodiversity, they contribute to the livelihood of a significant number of people, they provide an important food source and they also contribute to the tourist industry. However, these resources are being polluted, depleted, and misused.

#### 3.3.4.1. Aquatic Systems Degradation in Tanzania

Marine pollution has been mentioned above and is important especially around urban areas. Beach erosion has become a major problem in the last two decades. Important tourist beaches are being affected and seagrass and mangrove forest ecosystems removed. Coral reefs are being damaged. In Tanga, up to 95% of coral reefs have been destroyed [World Bank, 1993, p.1].

About 80% of total Tanzanian fish production is fresh water fish, which is an important part of the food in many regions of the country [Ministry of Tourism, Natural Resources and Environment, 1994, p.16]. The most important environmental issues relate to the large lakes. Lake Victoria, Tanganyika and Nyasa are all currently threatened. As Lake Victoria is by far the largest production region, it is of greatest concern. Among the problems in the change in the ecological balance caused by the introduction of exotic flora and fauna. The Nile Perch, a large fish with carnivorous feeding habits, appears to have been a major factor in the reduction of several smaller species. Now some of the causes of the degradation of aquatic systems in Tanzania will be considered.

Wetlands, both coastal marine and inland freshwater, which consist of vast areas of freshwater streams and rivers, swamps, salt marches, flood plains and freshwater lakes are increasingly threatened by human interventions and expanded economic activities. Many wetlands are now in danger from reduction in water volume and flow, siltation, and pollution. This continued trend will undermine the direct economic productivity, ecological services, and biological diversity associated with wetland ecosystems.

*Fishing techniques*:

In Tanzania, fishing is carried out with different fishing techniques, some of which have proved to be environmentally destructive. The most common ones are dynamite fishing, trawling, poisoning and the use of nets with smaller mesh sizes. The consequences of these practices include destruction of coral reefs which are critical habitats for a variety of marine organisms, catching juvenile fish which may lead to depletion of species, loss of aquatic biodiversity and indiscriminate killing of aquatic organisms as a result of poisoning. Furthermore, coral reefs are being damaged by these fishing techniques.

*Tourism*:

Coral reefs are being damaged by coral and shell collection for the tourist industry.

Legislative enactments have attempted to address marine and freshwater fisheries issues. Limitations on fisheries offtake were established with the institution of a licensing system in the Fisheries Act of 1970. Furthermore, limitations were placed on methods of harvest by outlawing dynamiting and poisoning in the Fisheries Act regulations of 1973 and 1982. There is concern for the continued wide use of small mesh trawling and continuing damage to the coral reefs.

### 3.3.5. Increase of Environmental Pollution

Environmental pollution is affecting the health of human beings. All kinds of wastes are disposed in the environment and is polluting land and water resources. By polluted water, diseases will be spread easily. The most important environmental pollution problems are: urban pollution, industrial pollution outside urban areas, rural (mainly agricultural) pollution, mining pollution and coastal pollution.

#### 3.3.5.1. Increase of Environmental Pollution in Tanzania

Although different definitions of "urban" results in widely different estimates of the urban population, there is agreement that the urban population is growing very rapidly and that at least 3.5. million people now live in urban areas. Thus, urban pollution, poor sanitation and inadequate solid waste disposal are high priority environmental problems. About 60% of the urban housing is unplanned and is without services of either water delivery or waste disposal. While data is not generally available, it is estimated that less than 13% of the solid waste generated in Dar es Salaam is collected. The rest, estimated at around 400,000 tons a year, is disposed of within the city [Ministry of Tourism, Natural Resources and Environment, 1994, p.14]. The majority of industries in Tanzania do not pre-threat their waste prior to discharge into the water resources. The industries have not been subject to environment regulation and by most standards they are heavy polluters. Now, some of the causes of environmental pollution in Tanzania will be considered.

*Sanitation facilities*:
: Bad on-site sanitation facilities like, pit latrines or septic tanks, leads to a pollution of ground and surface water. In Tanzania many people rely on surface and groundwater supplies for drinking, bathing, washing clothes and irrigation.

*Waste water*:
: Waste water from cooking, bathing, etc. disposed in open drains, waterways or simply left to soak into the ground. This also contributes to groundwater pollution and poor environmental sanitation that will spread diseases.

*Solid waste collection*:
: Inadequate solid waste collection, also leads to pollution of land and water resources and has considerable health implications. Furthermore, dumpsites are not properly managed and children have access to these dumpsites.

*Industrial pollution*:
: Industrial waste contains heavy metals as mercury, chromium, lead, cadmium, salts and pesticides.

The creation of the Tanzanian Bureau of Standards as a standard-issuing body, related to product quality and production processes, was one recent legislative response to the problem. Local Governments have also been empowered to make by-laws regarding protection of public health and welfare and several local authorities have issued environmental sanitation by-laws.

### 3.3.6. Deforestation

Although is could be considered as a part of land degradation, uncontrolled deforestation is having serious social and economical costs as many people depend on this resource for basic food, energy and raw materials. There are also significant environmental consequences including loss of biological resources.

### 3.3.6.1. Deforestation in Tanzania

Forests and woodlands, that covers about 50% of the Tanzanian land area, are disappearing at an average annual rate of 300,000 to 400,000 hectares annually and the rate of reforestation remains exceedingly low. Total plantations now account for only 150,000 hectares [World Bank, 1993].

The demand for wood for fuel, charcoal and agricultural processing is localized and it is in specific areas that woodlands are being depleted, shortages occur, and prices are rising. An example of very visible quantifiable loss of woodland occur around Dar es Salaam, where wood and charcoal is now often brought from over 150 kilometres. Now, some of the causes of deforestation in Tanzania will be considered.

*Fuelwood*:
Fuelwood is mainly used for cooking. The sustainable supply of fuelwood is estimated at 19 million cubic meters per year, while consumption is estimated at 43 million cubic meters.

*Agricultural practices*:
Deforestation also occurs to increase the surface of land for agricultural practices. This increase of land is necessary to meet food demand.

*Bush fires*:
Intentional or accidental bush fires occur frequently in Tanzania.

Legislative responses of deforestation create legal limits on exploitation of the forestry resources by requiring licenses to harvest and/or sell any plant materials, from both public and private lands. Limits depends on the intended use of the materials. The revised Tanzanian Forest Action Plan (1993) has begun to address some of the issues involved. In general much remains to be done.

## 3.4. National Environment Management Council

In September 1983 the National Environment Management Council has been established by Act of Parliament No. 19. NEMC started to function in November 1986 in order to advise the Tanzanian Government on all matters, related to the environment. NEMC consists of a Chairman appointed by the President, 16 members technical staff, nominated by ministries and organisations involved in management or protection of the environment and appointed by the supervising Minister and finally, 25 members supporting staff.

The Director General of NEMC is responsible for the implementation of its decisions in day-to-day activities. He has autonomy, through the corporate status of NEMC, to enter into contract, deal directly with the press and generates sources of income from fines and fees. On policy mattes, he is responsible to the Minister responsible for the environment.

In the next paragraph the functions of NEMC, described in the Act of Parliament No. 19, will be considered. Paragraph 3.3.2. will show the organisation chart of NEMC and in paragraph 3.3.3., the main activities will be described.

### 3.4.1. Functions of the National Environment Management Council

The functions of the National Environment Management Council shall be to advise the Government on all matters relating to the environment, and in particular NEMC shall:

(a) formulate policy on environmental management and recommend its implementation by the Government;

(b) coordinate the activities of all bodies concerned with environmental matters and serve as a channel of communication between these bodies and the Government;

(c) evaluate existing and proposed policies and the activities of the Government directed to control of pollution and the enhancement of the environment and to the accomplishment of other objectives which affect the quality of the environment and, on the basis of that formulate policies and programmes which will achieve more effective management and enhance environmental quality;

(d) recommend measures to ensure that Government policies, including those for the development and conservation of natural resources, take adequate account of environmental effects;

(e) foster cooperation between the Government, local authorities and other bodies engaged in environmental programmes;

(f) stimulate public and private participation in programmes and activities for the national beneficial use of natural resources;

(g) seek advancement of scientific knowledge of changes in the environment and encourage the development of technology to prevent or minimize adverse effects that endanger man's health and well-being;

(h) specify standards, norms and criteria for the protection of beneficial uses and the maintenance of the quality of the environment;

(i) establish and operate a system of documentation and dissemination of information relating to the environment;

(j) formulate proposals for legislation in the area of environmental issues and recommend their implementation by the Government;

(k) establish and maintain liaison in other national and international organizations respect of issues and matters relating to environmental protection and management;

(l) undertake or promote general environmental educational programme for the purpose of creating an enlightening public opinion regarding the environment and the role of the public in its protection and improvement;

(m) perform such other functions as the Minster may assign to the Council, or as are incidental or conducive to the exercise by the Council of all or any of the preceding functions.

## 3.4.2. Organisation Chart of the National Environment Management Council

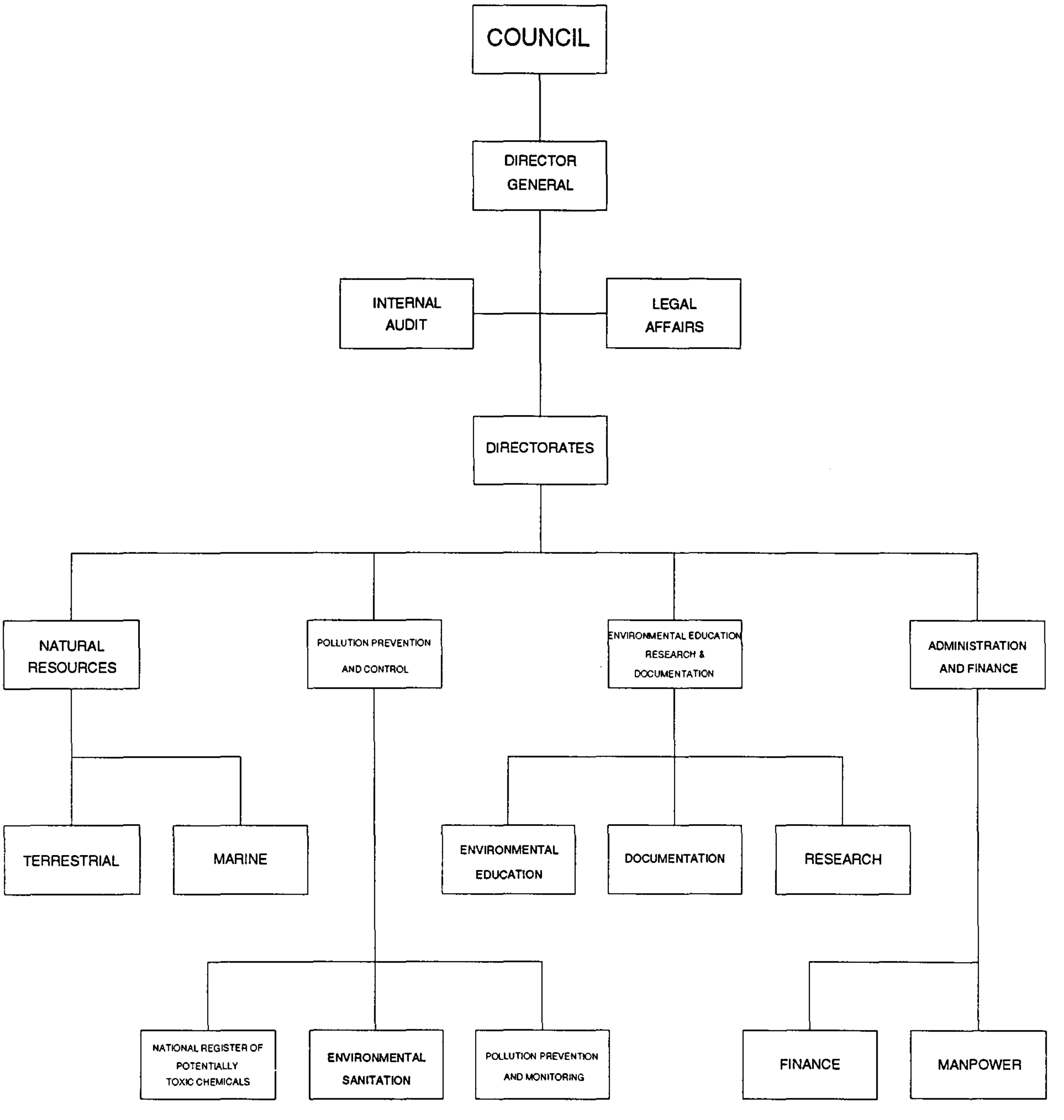


Figure 3.2: Organisation Chart of NEMC

### 3.4.3. Main Activities of the National Environment Management Council

The following activities have been undertaken and will continue at the National Environment Management Council.

Natural Resources department:
- Inventory of major wetlands of Tanzania;
- Survey of destructive activities to the aquatic environment;
- Inventory of natural resources and environment related projects;
- Support to the activities for environmental impact assessments;
- Preparation of marine contingency plan;
- Conservation of East African biodiversity project

Pollution Prevention and Control department:
- Environmental survey of mining operations;
- Industrial pollution follow-up activities;
- Inventory and monitoring of polluted water sources;
- Developing guidelines and development for environmental reporting;
- Monitoring of uses and the management of chemicals and hazardous wastes;
- Assessment of development projects;
- Pesticides management and storage;
- Possibility of recycling used lubricants;
- Inventorizing of hospital wastes and design of environmentally sound measures for solving them;

Environmental Education department:
- Training seminars for teachers;
- Production of learning/teaching materials;
- Monitoring and evaluation of previous activities;
- Public awareness and sensitization;

Environmental Information Centre department:
- establishment of a library to stock all available literature on the environment;
- development of a national environmental database to store information on national and regional parameters;

The above activities are executed with collaboration of other environment institution in Tanzania or expatriates.

## 3.5. Summary

Tanzania is a poor country in Eastern Africa. Its GNP per capita was US $ 114 in 1990. About 25 million people live on 945,037 $km^2$. The mainstay of Tanzania is agriculture, which contributes to the GDP for more than 50%, while it employs about 80% of the population work force. Furthermore, Tanzania is rich of natural resources.

Tanzania is facing serious environmental problems. According to the National Environment Action Plan, written by the Tanzanian Government, six major environmental problem can be distinguished:

Land Degradation
Poor Water Supply and Quality
Loss of Wildlife Habitat and Biodiversity
Aquatic System Degradation

Increase of Environment Pollution
Deforestation

The National Environment Management Council is established in 1983 and started to function in 1986 to advise the Government on all matters related to the environment. Staff of NEMC were divided in 1993, among four directorates: environmental education, research and documentation; pollution prevention and control; natural resources; and administration and finance.

# ANALYSIS OF THE RESEARCH QUESTIONS AND FURTHER ACTIONS

## 4.1. Introduction

In chapter 2, the problems of the National Environment Management Council in trying to recommend policy to the Tanzanian Government have been discussed. In the first place, the Council makes these recommendations on the basis of incomplete, sometimes unreliable and incomparable data. Secondly, the Council does not have the means to store data and to process these data to environmental information. With such information, the manager can make decisions on environmental matters. As we saw in chapter 2, one of the means that can support the environmental manager is an Environmental Information System (EIS). The advantage of such a system is the possibility to monitor the actual situation of the environment and to recognize problems for urgent attention. This is only the case when the EIS is functioning and used properly.

Two examples of operational Environmental Information Systems are GRID and CORINE. GRID (Global Resource Information Database) is a GIS (Geographical Information System) run by UNEP. It stores the data handled by the UN Global Environmental Monitoring System (GEMS). CORINE (*CoOR*dination of *IN*formation on the *E*nvironment) has been developed under the EEC auspices. It is a GIS-based program to gather, coordinate and ensure the consistency of information on the state of the environment, within the European Community.

In this chapter, the development and management of an EIS and in particular the development and management of such a system in Tanzania will be considered. First, a description is given of the functional and quality requirements of an EIS. After that, the description is specified for the case of Tanzania. Furthermore, the necessary specifications of an organization to manage and maintain the EIS will be discussed. And finally, the strong and weak points of the National Environment Management Council to manage the EIS for Tanzania will be identified.

## 4.2. Requirements for the Development of the Environmental Information System for Tanzania

An Environmental Information System must be developed as any other information system. Every information system must meet its functional and quality requirements. This paragraph describes the major functional and quality requirements of an EIS. In this research, all the global requirements of the EIS will be considered.

### 4.2.1. Functional Requirements

Before the description of the functional requirements, some major questions have to be answered:
Question: *What is the main goal of the Environmental Information System?*
Answer: The main goal is to support the process of decision making by the user.
Question: *Who is the user of the Environmental Information System?*
Answer: The user is the/an environmental manager.

The major question here is: "On what information can the environmental manager base his/her decisions?" This question is not easy to answer, but this paragraph will describe guidelines to answer this question.

In general, the decision maker must be conscious of the problem, the magnitude of the problem and the urgency of the problem. Furthermore, the decision maker must know the direct cause and the indirect causes of the problem, before he or she can actually formulate recommendations to solve the problem. In figure 4.1., the above is put into a model.

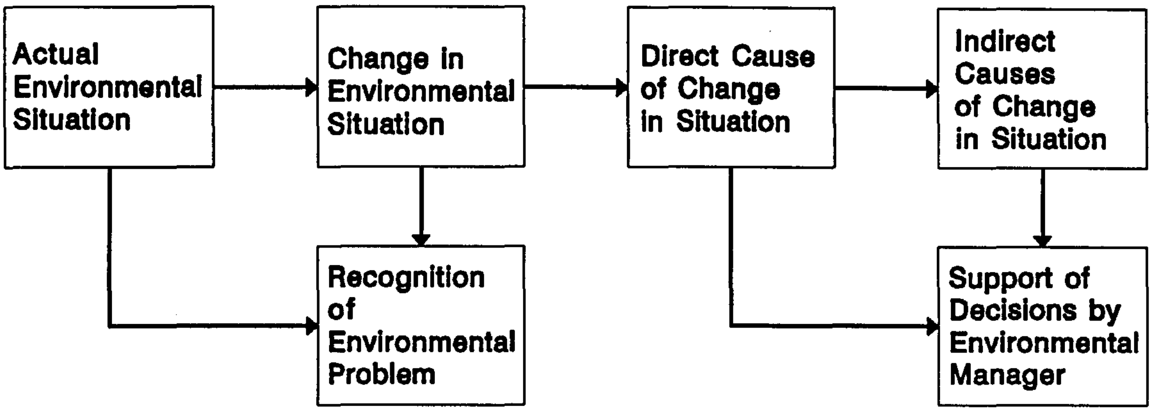


Figure 4.1: Functional requirements of an Environmental Information System

From figure 4.1., it is possible to derive the functional requirements of an Environmental Information System. The system must:

- show the actual situation of the environment,
- show the change in this situation,
- give the direct cause of the change and
- give the indirect causes of the change.

Each functional requirement will be explained in more detail in the paragraphs 4.2.1.1. up to 4.2.1.4.

In the foregoing, the environment has been considered as one undivided problem. This undivided problem can be divided into some sub-problems, according to the division that is made by the Tanzanian Government, which is represented in the National Environment Action Plan. In chapter three, the environmental sub-problems have been described. It might be advisable to divide some of the composite sub-problems to single sub-problems. For example, the problem of land degradation can be divided in the single problems: soil degradation, wind erosion and water erosion.

#### 4.2.1.1. Show the Actual Situation of the Environment

For each single environmental problem, the EIS has to show the actual situation . This is sooner said than done, because the actual situation can be represented in different ways and depends completely on the method of measurement. That these methods can lead to different results is shown by figure 4.2.

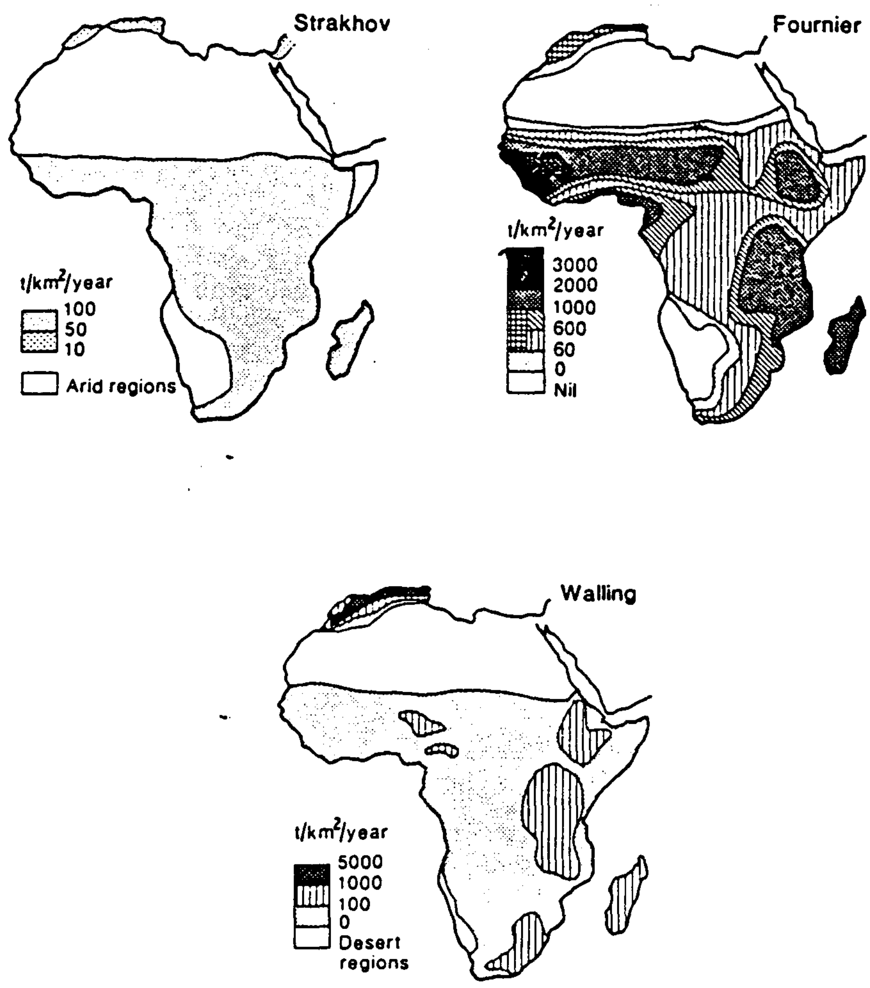


Figure 4.2. Using different methods of measurement of erosion by Strakhov 1967, Fournier 1960 and Walling 1984 [Blaikie and Brookfield, 1987, p.55][3]

To make a statement of the actual situation of the environmental problem, parameters[4] have to be determined. It is extremely important to choose parameters that can be used as an indication for the environmental problems. Moreover, for each environmental problem more than one parameter is possible. These parameters can be measured in various ways. The choice of the parameter and the method of measurement has to be made by the environmental manager and depends on the following aspects:

- costs of measurement
- correctness of measurement

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[3] *Strakhov's map gives sediment yields of 50 to 100 $t/km^2$/year for most of the inhabited part of Africa. Based on an extrapolation of sediment yields of sixty river basins, Strakhov distinguished primarily between a temperate moist belt in the northern hemisphere and the humid zones of the tropics and subtropics. Fournier used seventy-eight drainage basins up to 1,000,000 $km^2$ in size, of which none are in Africa, and by means of correlating sediment yield with a climatic parameter ($p^2/P$, where p is rainfall of the rainiest month; and P is mean annual rainfall), he came up with totally different sediment yields. Not only are they of an order greater than Strakhov's but, they also exhibit a different pattern. Wallings method is not discussed.*

[4] *A parameter is used in this context as an indication of a unmeasurable phenomenon. For example, the Gross National Product is an indication for welfare. Besides Gross National Product, welfare can be indicated by the Infant Mortality Rate or Life Expectancy [Lapperre, Winter 1992/1993, p.42-43].*

- ease of measurement
- time of measurement

After having chosen the parameter(s) and the method of measurement, these should be standardized, over the country and in time, to make comparison possible. This standardization is even more important than the correctness of the method of measurement itself, because comparison must be possible between the different situations in the country, to recognize the environmental problems with the highest priority. Furthermore, comparison must be possible in time, to recognise the change of the environmental situation. Box 4.1. gives an example for the problem of soil degradation. It suggests a parameter for soil degradation, and gives two methods of measurement.

The actual situation of the single problem of soil degradation is mapped if, for each piece of land in the country, the soil fertility is known. Hence, for each piece of land, the content of nutrients must be measured. Of course this is impossible to measure or at least extremely expensive. Therefore, we could measure the content of nutrients of the soil on some locations and then extrapolate it to surrounding locations.

Another method for the measuring of soil fertility is to examine the crop yield and to make a statement of the existence of nutrients. This method is much easier to perform, but mistakes can occur, because of the dependency of crop yield on weather conditions, for example.

Box 4.1: Parameters and methods of measurement related to the problem of soil degradation

### 4.2.1.2. Show the Change in this Situation

It is obvious that it is not sufficient to show the actual situation only, but that the change in this situation is more important. For example, when the soil fertility somewhere in the desert is measured to be almost zero, it is possible to notice this as a big problem for urgent national attention. However, it is more important to intervene in a case where soil fertility is declining slowly but constantly, because in this case, actions can lead to a stagnation of the soil degradation or even better, a recovery of the soil fertility.

Showing changes in the environmental situation is important, because with this information the environmental manager is able to:

- determine the problem, the magnitude and the urgency of the problem, and
- get an impression of the results of former executed actions.

Box 4.2. describes a change in soil degradation.

For the problem of soil degradation it is possible that the measurement of nitrogen of a piece of land shows a percentage of 0.16% in a particular year. Two years later, this percentage might be 0.11%. This means a decrease of soil fertility because of loss of nutrients.

Box 4.2: A change in soil degradation

### 4.2.1.3. Give the Direct Cause of the Change

The third functional requirement of an EIS is to give the environmental manager information about the direct cause of the change. Only with this information, it is possible to find out why the activity took place that caused the change of the environmental situation. In box 4.3. the causes are described, that have been responsible for the loss of nutrients, which has been described in box 4.2.

The decreased nitrogen content described in box 4.2. might be caused by poor agricultural practices. The farmer harvested for five successive years only maize and was not able to use a fertilizer to recover his land completely.

Box 4.3: Determine the direct cause of the change

### 4.2.1.4. Give the Indirect Causes of the Change

Finally, the last functional requirement is to give the indirect causes of the change. Maybe this is the most difficult requirement, because so many indirect causes could lead to a change of the environmental situation. A lot of research is necessary to give the indirect causes with a high degree of certainty.

It is difficult to give the indirect causes of an environmental problem. Therefore, it might be better to give characteristics of affecting factors. In this case, the task of the environmental manager is expanded with the assessment of the impact of these factors, on the environmental problem. Furthermore, the environmental manager has to indicate for which of the affecting factors he or she wants baseline data. In box 4.4., some possible indirect causes of the loss of nutrients are described.

Finding the affecting factors of the direct cause of the problem of soil degradation as described in box 4.3. is the goal of this functional requirement. We have to find an answer for the question: "Why did the farmer harvest maize for two successive years and why didn't he use a fertilizer to recover his land?"

Maybe it is just a matter of awareness. Maybe he couldn't buy any fertilizer because of lack of money. Maybe he just answered the demand for maize raised by an increase of population in the region.

These indirect causes are all possible but never universal. To determine the exact indirect causes requires a lot of research. However, if the environmental manager has access to baseline data about the affecting factors, he or she is able to make statements about the indirect causes.

Some of the affecting factors are fixed, for example: climate and soiltype. While, some of the factors are variable and can be influenced by measures. Some of these factors are: population, fertilizer production and distribution, knowledge and awareness of cultivation practices, infrastructure and industrial development.

Box 4.4: Indirect causes of the problem of soil degradation

All the functional requirements that have been described above, are necessary to support the environmental manager in the recognition of the environmental problems and the formulation of recommendations.

### 4.2.2. Quality Requirements

The functional requirements are those requirements that are needed to achieve the functional goals of an information system. Besides the functional requirements, there are quality requirements, which are dealing with the use of an information system. The idea of quality awareness started 40 years ago in the industrial sector and has reached software at last. In 1987 the international industry standard for quality systems, ISO 9001 standard, was defined by all the important industrial countries and was applied for software engineering as well as other disciplines. [Delen and Rijsenbrij, 1992].

Delen and Rijsenbrij have distinguished four dimensions. There are quality requirements for the process of the development (dimension I), for the information system considered as a static product (dimension II), for the information system considered as a dynamic product (dimension III) and for the value of the information for the company (dimension IV). In table 4.1. all the quality requirements have been ordered.

| DIMENSIONS | ASPECTS / ATTRIBUTES | | | |
|---|---|---|---|---|
| I PROCESS<br>development and control of information systems | 1 Quality conditions<br>a prof. skills<br>b account mgt<br>c project mgt<br>d system development | 2 Quality control | 3 Continuity | 4 Completeness of services |
| | | 5 Delegation to third parties | | |
| II PRODUCT STATIC<br>properties of the information system in maintenance & control | 1 Flexibility | 2 Maintainability | 3 Testability | 4 Portability |
| | 5 Connectivity<br>a external<br>b internal | 6 Reusability | 7 Fitness of the infrastructure | |
| III PRODUCT DYNAMIC<br>functioning of the system for the user | 1 Reliability<br>a correctness<br>b completeness<br>c authorizedness<br>d timeliness | 2 Continuity<br>a uninterrupted<br>b robustness<br>c restorability<br>d degradation possibility<br>e diversion possibility | 3 Efficiency<br>a speed<br>- internal<br>- total<br>b userfriendliness<br>c economy<br>d match with manual proc.<br>e workability manual proc. | 4 Effectiveness<br>a coverage of bus. processes<br>b availability<br>- in time<br>- on location<br>c usability<br>d decision support<br>e end user support |
| IV INFORMATION<br>importance for company | 1 Correctness | 2 Completeness | 3 Up-to-dateness | 4 Accuracy |
| | 5 Verifiability | | | |

Table 4.1: Quality Requirements

All the quality requirements, considered above are important. However, each quality requirement has a price tag. Therefore, it is essential to set priorities for each individual quality requirement. For the case of an Environmental Information System, some requirements with a high priority will be discussed now.

If we consider the environment as a system, this system is not limited by clear borders. This means that the EIS is never complete, so it must always be possible, to easily expand the system by new sub-systems dealing with other aspects of the environment. These that the quality requirement 'connectivity' of dimension II has a high priority.

The main goal of the EIS is to support the environmental manager, to formulate recommendations for the decision maker. This makes the requirement 'decision support' of dimension III important.

Since, main decisions will be based upon the information that is given by the EIS, the system must operate correct. So, correctness of dimension IV has a high priority.

Besides the important quality requirements, some requirements have a lesser priority. For instance, 'continuity' of dimension III. For an information system that has to process millions of transactions a day, which is not the case for the system under consideration, this requirement is much more important.

### 4.2.3. Functional and Quality Requirements Specified for the case of Tanzania

For the development of the Tanzanian Environmental Information System the same requirements are effective as described above. However, some recommendations can be made especially for the case of Tanzania. The EIS can be divided in some sub-systems that must be expanded by other sub-systems in the future. It is advisable to start with the sub-system that is dealing with the environmental problem with the highest priority. This might be land degradation. Before continuing with the development of other sub-systems, this sub-system should work properly. This means that:
- the system is provided with correct, reliable and comparable data,
- all the functions of the system are executed faultlessly,
- the users are able to work with the EIS, and that
- the system meets the needs of the users.

Another reason to start the development with one sub-system is that the data that is available at the moment is not standardized and not complete. To standardize the data for one environmental problem will be a time-consuming job. Furthermore, today's Tanzanian users are not familiar with computer technology, so some time will elapse before the users can work free from problems. Keeping the system small and clear will decrease the learning time.

The sub-system must be developed on a computer system, that is able to run the complete system. Micro computers are not suitable for this job. A mini computer with some workstations is more adequate to run the complete system. Further research is recommended on this issue before a hardware system can be chosen. The same idea holds for the software. The software should be able to run the complete information system without any problems. Besides standard software, like dBase IV and Oracle, it is possible to develop own software. Also, to advise on this issue, further research is required.

Finally, the quality requirement that should have special attention in Tanzania is maintainability. To increase the maintainability, the EIS should be developed clearly. Moreover, the system must be well documented.

## 4.3. Requirements for the Management of the Environmental Information System for Tanzania

The development of an Environmental Information System is only a little part of the total life cycle of the system. About 70% of the total costs of an information system is spent after its development [Genuchten, Bemelmans and Heemstra, 1993, p.258]. So, the management of an information system is even more important than its development. A bad management will make a good information system in no time worthless. Managing an information system has two aspects: responsibilities and skills [Mensching and Adams, 1991, p7-8].

### 4.3.1. Responsibilities of the Manager of an Environmental Information System

The manager must be able to control both the day-to-day operations and the long-term goals and objectives of the Environmental Information System. The balancing of these two concerns is critical to the continued successful operation of the system. According to Mensching and Adams, the manager must have at least a basic knowledge and understanding of each of the following functional areas:

- Operations: This includes scheduling of jobs, allocation of resources to specific jobs and supervision of the operations staff. Additionally, it is necessary to monitor the performance of the system to determine if service levels are adequate.
- Maintenance: The proper maintenance of both the hardware and software is important to assure smooth operations. Maintenance can be divided into perfective maintenance (new demands of the user) and corrective maintenance (restore of bugs).
- Data Management: This can be a critical area because of the volume of data and the variety of access needs of the users. Furthermore, the input of data has to be controlled. The system must continuously be provided with new and up-to-date baseline data.
- System Security and Integrity: This is a difficult but important area because of the risk of substantial loss. This would involve data and program backup and recovery, creation of audit trials, and control of access to the machine, data and programs.
- Strategic Planning: Long- and short-term planning and budgeting are key ingredients in any operation. Unfortunately, due to the dynamic nature of computing, these can be difficult to develop and implement.
- Acquisition of Computer Hardware and Software: This is a very time consuming but interesting area that demands that the manager and staff remain current as to existing and emerging technologies. Since application software can also be designed in-house, this will include the supervision of the application programming staff.

### 4.3.2. Skills of the Manager of an Environmental Information System

The manager of an information system has to be a person, who has knowledge of science to understand the functioning of the computer, knowledge of the environmental matters and also masters the art of managing and dealing with people. The selection of the Environmental Information System manager can be difficult. A pure technician is not desirable because of the lack of managerial and environmental knowledge and skills. Managers with little knowledge of computer technology are usually not successful since they do not have sufficient knowledge to assist and direct the technical staff. Hence, a well-rounded background is becoming more and more a necessity. Some of the skills of the manager include the following [Mensching and Adams, 1991, p.8-9][5]:

- Technical Computer Background: This would include exposure to both application and system programming with knowledge of hardware and software fundamentals.
- Environmental Background: The manager must be familiar with the environmental processes that are supported by the information system.
- Communication Skills: A majority of any manager's time is spent in communication with supervisors and subordinates. Ability to express one's ideas both in writing and speaking is critical. This includes the ability to explain technical concepts to noncomputer types without the use of incomprehensible jargon. At the same time, communication with the staff must be at the appropriate technical level.
- Managerial Skills: Many think that these skills are acquired only through actual experience. Some of the tasks performed include selection of personnel, delegation of authority and the assignment of responsibilities.

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[5] *The theory of Mensching and Adams is specified for the management of an Environmental Information System.*

### 4.3.3. Responsibilities and Skills of the Manager Specified for the Case of Tanzania

The above mentioned responsibilities and skills are not only required in developed countries, they are also required in Tanzania. The responsibility for data management is maybe the most difficult one, because this includes also the responsibility for data input. For years, data collection is a big problem in Tanzania. Data collection is a time-consuming activity and it can cost an enormous amount of money and manpower. In paragraph 4.2.1.1. has been described that this mainly depends on the method of measurement. Furthermore, the collected data should end up within the right institutions. This means that an infrastructure must be created in which environmental data becomes available for the right institutions, in the right format and quantity. NEMC can play an important part in the creation of such an infrastructure.

About the skills of the manager, the technical computer background should not be underestimated. However, in Tanzania there is a lack of qualified computer experts. Most of them are working for private companies, because they are to expensive for the governmental organisations. Since 1990, the University of Dar es Salaam has a course for Informatics. Besides this course, some private institutes give lessons in computer technology. These are mostly limited to simple introductions or specific applications [Hardeveld, 1994, p.70-71].

In Tanzania the communication skills are very important. A good understanding of the English language is an absolute necessity, because all computer related documentation is written in English and communication with manpower from donor countries is in English. In general the understanding of the English language at the database department of NEMC is good.

Finally, there is a lack of managerial skills in Tanzania. This skill can mainly be acquired through actual experience. So, managers in Tanzania have to experience the responsibility for an information system. They must have the possibility to make mistakes and to experience the consequences. Only than they can become good managers.

## 4.4. The National Environment Management Council as Manager of the Environmental Information System for Tanzania

In this paragraph we will make an analysis of the National Environment Management Council and in particular the database department of NEMC. The goal of this analysis is to find out if NEMC is able to manage the Environmental Information System for Tanzania. First, NEMC is considered in a national perspective. The relations with other environmental institutions will be studied and their coordinating role in dealing with environmental issues. Secondly, the database department will be described. In this description four aspects are distinguished: the hardware configuration, available software, their human resources and finally, the financial means.

### 4.4.1. The National Environment Management Council in a National Perspective

NEMC started to function in 1986. Its mandate included formulation of policy and legislation on environmental management, coordination of the activities of all bodies concerned with environmental matters, stimulation of public and private participation for beneficial use of natural resources, advancement of scientific knowledge of changes in environment, liaison with international organizations, and promotion of environmental education.

#### 4.4.1.1. Relation with the Ministry of Tourism, Natural Resources and Environment

Since November 1990, NEMC is part of the newly formed Ministry of Tourism, Natural Resources and Environment, a Ministry that was able to take on the environmental functions of the other governmental ministries. Several of the functions that originally belonged to NEMC are in process of being shared with or moved to the division of Environment [World Bank, 1993, p.7-8].

The above means that the responsibilities for environmental management are shared by NEMC and the Environment division of the MTNRE. The lines between the executive and advisory functions have not yet been clearly defined. A redefinition of the functions is necessary to avoid serious tension between the two institutions [World Bank, 1993, p.9].

#### 4.4.1.2. Relations with Other Environmental Institutions

The relations with other environmental institutions cannot be described in detail, The only thing, which is clear is that NEMC is aware of the existence of the institutions, since it holds databases with information about environmental institutions, their main activities and environmental experts. This is extremely important for the creation of an infrastructure for environmental data and the coordination of environmental activities.

### 4.4.2. The Database Department

One of the four divisions within NEMC is the directorate of research, environmental education & documentation (see chapter 3). This directorate has set up a database department, to store and process environmental data. The database department is combined with an environmental library and is responsible for the publication of NEMC NEWS, which reports the activities of NEMC. The database department will be described on the basis of four aspects: hardware configuration, available software, human resources and financial means.

#### 4.4.2.1. Hardware Configuration

| Present hardware: | | |
|---|---|---|
| Equipment: | Type: | Number: |
| Computer system: | IBM (or compatible), 80486, MS-DOS 5.0, MS-Windows 3.11, 200 Mb harddisk, VGA colour display | 2 (laptop)<br>4 (desktop) |
| Peripheral:<br>Printer<br>Printer<br>Plotter<br>Digitizer<br>Scanner | <br>Hewlett Packard Paintyet (colour)<br>Hewlett Packard Laseryet 4L<br>Hewlett Packard Plotter 7750 plus<br>Summergraphics<br>Hewlett Packard Scanyet IIc (colour) | <br>1<br>1<br>1<br>1<br>1 |
| Network: | - | - |
| Purposed Extension of hardware in the near future: | | |
| Equipment: | Type: | Number: |
| Computer system: | Apple Macintosh | 1 |
| Network: | Network, for library uses | 1 |
| Peripheral: | - | - |

Table 4.2: Present and future hardware

### 4.4.2.2. Available Software

| Present software: | |
|---|---|
| Standard software: | Used for: |
| Word Perfect 5.1<br>DBase IV 2.0<br>Lotus 123 for Windows<br>Q&A (question and analysis)<br>Micro CD ISIS<br>IDRISSI<br>ARC/INFO | Word Processing<br>Database Management<br>Spreadsheet<br>Library Management<br>Library Management<br>Mapping<br>Mapping |
| Own developed software: | - |
| Purposed Extension of software in the near future: | |
| Standard software: | Used for: |
| ORACLE<br>EXCEL<br>MAP/INFO<br>MAP/VIEW<br>Updates of existing software | Database Management<br>Database Management<br>Mapping<br>Mapping<br>Several |
| Own developed software: | DBase IV applications of existing databases |

Table 4.3: Present and future software

### 4.4.2.3. Human Resources

| Present human resources | | | |
|---|---|---|---|
| Function: | Formal education: | Additional courses: | Number: |
| Technical staff: | 1st degree of Higher education in Natural Resource Management | Unknown | 1 |
| Supporting staff:<br>Cartograph<br><br>Librarian<br>Data typist | <br>1st degree of Higher education in Cartography<br>Secondary school<br>Secondary school | <br>ARC/INFO, IDRISSI, WP 5.1<br><br>DBase IV, WP 5.1<br>DBase IV, WP 5.1 | <br>1<br><br>1<br>1 |

| Purposed Extension of human resources in the near future: | | | |
|---|---|---|---|
| New human resources: | | New courses: | |
| Function: | Formal education: | General: | Specific: |
| Librarian<br>Technician[6]<br>Data Analyst<br><br><br>Data Analystt | Secondary school<br>Unknown<br>1st degree + diploma of Higher education in Natural Resource Management<br>1st + 2nd degree of Higher education in Natural Resource Management | Data structuring course (1 person) | - |

Table 4.4: Present and future human resources

[6] *The technician has no affinity with Computer Science or Information Technology.*

### 4.4.2.4. Financial Means

| Present financial means: | | |
|---|---|---|
| Source: | Used for: | Amount: |
| Government | Running the office | - |
| Donor agencies | Equipment<br>- Hardware<br>- Software<br>Human resources (consultancy)<br>Cash for surveys and research | <br>US$ 150,000 for 3 years<br>US$ 5,000 for 3 years<br>-<br>- |
| Extension of financial means in the near future:[7] | | |
| No information | | |

Table 4.5: Present and future financial means

## 4.4.3. Strong and Weak Points of the National Environment Management Council for the Management of the Environmental Information System for Tanzania

This paragraph will describe the strong and weak points of NEMC with regard to the management of the Environmental Information System for Tanzania. These strong and weak points have been derived from the above description of NEMC and its database department.

*Weak points:*

- The lines between the executive functions of the Ministry of Tourism, Natural Resources and Environment and the advisory functions of the National Environment Management Council have not yet been clearly defined. A redefinition of these functions is necessary to avoid serious tension between the two institutions. Since the Ministry is responsible for the activities of NEMC, both institutions must agree with the location of the Environmental Information System for Tanzania.
- The National Environment Management Council has a lack of management capacity to manage the Environmental Information System. This lack of management capacity is not only a problem at NEMC, but this problem occurs on a national level. Management capacity can mainly be built by experience.
- The present hardware configuration is insufficient to run the complete Environmental Information System. A mini computer, instead of a micro computer might be more satisfying, but further research is necessary on this subject.
- The same holds for the present software, that is used at NEMC. DBase IV is not capable to run the complete system properly. For this case, ORACLE is more suitable, but further research is required on this issue.
- The knowledge and understanding of the process of software development and data structuring is insufficient for the management of the Environmental Information System. Recruiting of new personnel with a background in computer sciences and information technology would be required. However, these human resources are mainly settled in private organizations,

[7] *The donor community has provided, and continues to provide, valuable financial and technical input into the area of environment and natural resource management in Tanzania with primary support mainly in the areas of wildlife management, forestry and conservation. Without this support, the various sections of government most directly concerned with environmental issues would not be able to carry out some of their most basic functions. Although the scope and scale of these efforts vary, the principal body of assistance provides capacity building services to the various divisions under the Ministry of Tourism, Natural Resources and Environment and the National Environment Management Council [World Bank, 1993, p.32].*

because of their high wages. Hence, it is necessary to build up capacity at the database department by computer courses and in-house training.

*Strong points:*

- An Environmental Information System is extremely appropriate for the original activities of the National Environment Management Council. These activities included formulation of policy for the Government on all matters relating to the environment.
- The relations with other environmental institutions in Tanzania are good. NEMC is aware of the main activities of these institutions and knows the experts for each environmental issue. This is extremely important for the creation of the infrastructure to ease the collection and dissemination of environmental data.
- The knowledge on environmental issues and the understanding of environmental processes is good at NEMC. The formal education of the technical staff, consisting of 16 members, is at least 1st degree of Higher Education in Natural Resource Management.
- Since two or three years, the employees of NEMC are working with computers. This means that they have some affinity with computers and standard software packages. This is an enormous advantage, because it is easier to increase the knowledge on other computer related issues.
- Most of the donor countries are paying attention to the environmental problems of developing countries. Since NEMC and the MTNRE are the main environmental institutions in Tanzania, NEMC does not have to worry to much about the financial means in the future. Donor countries are and will be offering technical and financial support to NEMC, as long as good proposals for projects can be prepared by NEMC.

Considering the strong and weak points of NEMC for the management of the Environmental Information System, the conclusion is that, at the moment NEMC is not able to manage the Environmental Information System for Tanzania. To increase the ability of NEMC to manage the system, some actions have to be taken. These actions will be described in the next paragraph.

## 4.5. Further Actions for Reducing the Weak Points

In this paragraph, the weak points of NEMC for managing the Environmental Information System for Tanzania have been studied. This study must lead to the formulation of further actions that have to be taken, before NEMC is able to manage the system.

The first weak point, the unclear defined functions of NEMC and the MTNRE, can only be eliminated by a redefinition of the functions of both organizations. The execution of this action must be done by the Ministry in cooperation with the technical staff of NEMC.

The second weak point, the lack of management capacity can mainly be eliminated by managerial experience, according to the concept of learning by doing [Rosenberg, 1982, p.16].

The third and fourth weak point, the availability of appropriate hardware and software is a matter of further research and financial means. When donor countries and/or the Tanzanian Government have decided to develop and implement the Environmental Information System, it will become important to estimate the appropriate hardware and software.

Finally, there is a lack of knowledge and understanding of the process of system development and data structuring. Before the start of the development of the Environmental Information System, this weak point must be reduced enormously. Without the knowledge of the fundamentals of hard- and software, the introduction of the system would be unsuccessful. This knowledge is already important during the preparation of project proposals, because it will lead a better estimation of the expectations of the EIS. After the development of the EIS, the knowledge and understanding will lead to better maintenance, and therefore, to a more successful operation of the system.

Considering the above analysis of the weak points and the solutions, this research continues with the development of instruments to increase the knowledge and understanding of the process of system development and data structuring. So, chapter 5 will describe the development of these instruments, which will consist of the 'dBase IV Application Writing' course, concerning data structuring and the use of the standard software package dBase IV. Furthermore, an application will be developed in dBase IV, called the 'Tanzanian Wildlife Application', to experience the development of an application in practice.

## 4.6. Summary

*Summary with regard to the development of an Environmental Information System for Tanzania:*

- The main goal of an Environmental Information System is to support the process of decision making by the environmental manager.

- To achieve this goal, the Environmental Information System has to meet the following functional requirements:
  - show the actual situation of the environment,
  - show the change in this situation,
  - give the direct cause of the change,
  - give the indirect causes of the change.

- The most important quality requirement is connectivity, because the environment itself is an open system. Therefore, it must be able to expand an Environmental Information System by new sub-systems, dealing with other (new) environmental issues.

- The development of the Tanzania Environmental Information System should start with one small sub-system, including one environmental issue. For instance, land degradation. This sub-system should work properly, before this sub-system is expanded by other sub-systems. A full understanding of all of the processes of the sub-system is necessary. Furthermore, the data acquisition and processing must be well organized for this sub-system. This will lead to a better implementation and use of the sub-system that will be developed in the future.

*Summary with regard to the management of the Environmental Information System for Tanzania:*

- The manager of the Environmental Information System has responsibilities and requires skills. The responsibilities are related to the operations of the system, the maintenance of the system, the data management and the system security and integrity. Moreover, the manager has to have a technical computer background, an environmental background, communication and managerial skills.

- For the case of NEMC, the technical computer skills and the managerial skills are lacking or unpayable. Special attention to these two skills is required.

*Summary with regard to the ability of the National Environment Management Council to manage the Environmental Information System for Tanzania:*

- The weak points of the National Environment Management Council for managing the Tanzanian Environmental Information System are:
  - the lines between the executive functions of the MTNRE and the advisory functions of NEMC are not well defined,
  - the lack of management capacity is insufficient,
  - the present hardware configuration at the database department is not sufficient to run the complete system,

- the available software at the database department is not sufficient to run the complete system,
- the lack of knowledge and understanding of the process of system development and data structuring.

- The strong points of the National Environment Management Council for managing the Tanzanian Environmental Information System are:
  - the system would be extremely appropriate to support the original functions of NEMC,
  - NEMC is aware of the activities of other environmental organizations in Tanzania, which is necessary for the data acquisition,
  - the knowledge and understanding of environmental processes in Tanzania,
  - the present knowledge of computers and some standard software packages,
  - the financial means provided by donor organizations.

# INSTRUMENTS TO INCREASE THE ABILITY OF NEMC TO MANAGE THE TANZANIAN ENVIRONMENTAL INFORMATION SYSTEM

## 5.1. Introduction

A part of chapter 4 has described the weak points of the National Environment Management Council for the management of the Environmental Information System for Tanzania. The most essential weak point of NEMC to manage the EIS, is the lack of knowledge and understanding of the process of software development and data structuring. In this chapter, instruments will be developed to increase this knowledge and understanding. These instruments are the 'dBase IV Application Writing' course and the 'Tanzanian Wildlife Application'.

The 'dBase IV Application Writing' course, explains the most principles of data structuring. Furthermore, these principles are clarified by means of the standard software package dBase IV. DBase IV is chosen, because it is used at NEMC's database department for some years. So, the participants of the course are familiar with the basic operations of dBase IV. The course continues with more detailed information about the development of an user-interface and an application in dBase IV. In paragraph 5.2. the 'dBase IV Application Writing' course will be described in more detail. The final course is added in a separated appendix, appendix 1.

The 'Tanzanian Wildlife Application' will be useful dBase IV application, that must be considered as an example. This application was developed parallel with the course and it is based on an existing database at the database department of NEMC. The development of the application will be described in paragraph 5.3. The detail design of the application is added in appendix 2.

## 5.2. The 'Dbase IV Application Writing' Course

The 'dbase IV Application Writing' is an instrument to increase the knowledge and understanding of system development and data structuring. In paragraph 5.2.1., we start with the enumeration of the objectives of the course. The design and the execution of the course is discussed in paragraph 5.2.2.

### 5.2.1. Objectives of the Course

It is important to formulate the objectives in a structured way. Therefore, we have to make a distinction between *general* and *concrete* objectives [Gijsen, 1991, p.35]. The general objectives are described for the complete course, while the concrete objectives are described for each section of the course.

#### 5.2.1.1. General Objectives of the Course

At the end of the course, the participants should:
- have knowledge of the process of system development.
- have knowledge of the principles of relational data structuring.
- be able to construct databases in dBase IV.
- be able to describe the advantages of a query.
- be able to write a query in dBase IV.
- be able to describe the advantages of linking files.
- be able to link three files in dBase IV.

- be able to describe the advantages of input and output screens.
- be able to make input and output screens in dBase IV.
- be able to describe the advantages of an application.
- have knowledge of the development of an application in dBase IV.

### 5.2.1.2. Concrete Objectives for each Section of the Course

Section 1: General Information About Informatics and its Benefits
At the end of the course the participants should:

- know the difference between *technical information systems* and *administrative information systems.*
- know the four phases of system development.

Section 2: Data Structuring
At the end of the course the participants should:

- know the terms *entity, attribute* and *relation.*
- be able to find the *entities* and *attributes* for an easy problem description.
- understand the relation-types: *one-to-one* relation, *one-to-more* relation and *more-to-more* relation.
- be able to find the *relations* for an easy problem description.
- understand the difference between a *conceptual relational data model* and a *relational data model.*
- be able to design a *conceptual relational data model* and a *relational data model* for an easy problem description.
- know the terms *redundancy* and *inconsistent.*

Section 3: The Construction of Databases in dBase IV
At the end of the course the participants should:

- know the terms *record* and *field.*
- know the most important requirements of a database.
- know the term *key.*
- know the six columns of the *Control Center* of dBase IV: *DATA, QUERIES, FORMS, REPORTS, LABELS, APPLICATIONS.*
- know that each field of a database in dBase IV has a *field name, field type,* a *field width,* a *number of decimals* (if the field type is numeric) and that it can be *indexed.*
- know the six field types that can be used in dBase IV: *CHARACTER, NUMERIC, FLOAT, DATE, LOGICAL, MEMO.*
- understand the theory of *indexing.*
- be able to construct a *database file* in dBase IV.

Section 4: Writing a Query
At the end of the course the participants should:

- know the term *view.*
- know the terms *projection* and *selection.*
- be able to make a *projection on a database.*
- be able to make a *selection of records of a database* with two different methods.
- be able to make a *view query.*
- know six groups of *operators* that are used by dBase IV.
- know the most important *operators* that are used by dBase IV.
- understand the theory of *linking files.*
- be able to *link three files* in dBase IV.

- know the term *edit query*.
- know the edit queries *APPEND*, *REPLACE*, *MARK* and *UNMARK*.

Section 5: The User Interface
At the end of the course the participants should:

- know the difference between *input screens* and *output screens*.
- know the difference between a *.DBF file* and a *.QBE file*.
- know the terms *template*, *picture functions* and *edit options*.
- know the *symbols* that can be used in a template.
- know the most important picture functions for a *numeric field*.
- know the most important picture functions for a *character field*.
- know the most important *edit options*.
- be able to *design* an input screen and an output screen in dBase IV.
- be able to *place fields* in an input screen and output screen in dBase IV.
- be able to *give characteristics* to a field in dBase IV.

Section 6: The Application
At the end of the course the participants should:

- be able to use the *application generator*.
- be able to design *menu's*.
- know the actions that can be activated by menu items: *(TEXT NO ACTION)*, *OPEN A MENU*, *DISPLAY OR PRINT*, *PERFORM FILE OPERATION*, *RUN PROGRAM* and *QUIT*.
- be able to activate *menu items*.

### 5.2.2. The Design of the 'dBase IV Application Writing' Course

In paragraph 5.2.1., the objectives of the course have been formulated. This paragraph will describe the design of the course, in trying to achieve these objectives. The course has been divided in six sections. In each section the terms, that have been described in the objectives are explained.

In the course, two examples have been used, to support the principles of data structuring, field definition and queries, which has been described respectively in the sections 2, 3 and 4 of the course. The first example comprehends a simplified administration of a hotel, which has been used throughout the complete course. The second example is the present administration of the protected areas and has only been used for the relevant problems, that are faced when using this database. This example has been chosen, because it has been used as the environmental problem in the 'Tanzanian Wildlife Application'. In this way, the participants of the course will be conscious of the problems that presently occur, when using the database. In paragraph 5.3. these problems will be explained in detail.

To test the knowledge and understanding of the principles of data structuring, some exercises have been included in the course. These exercises concern the administration of a library. This subject has been chosen, because the employees of NEMC are familiar with the standard software package Q&A, that is used for the administration of NEMC's library.

Finally, the course has been illustrated by some drawings. These drawings will vary from (conceptual) relation data models to copies of the screens that are used by dBase IV, during the development of queries, input and output screens and applications.

### 5.2.3. The Execution of the 'dBase IV Application Writing' Course

The course will be done by at least one employee of the database department of NEMC. The time planning is as follows:
- each section will last one week.
- the discussion of each section will take four hours; during this time the section will be read and will be discussed in detail.
- the exercises will be made during the rest of the week.
- the discussion of the exercises will be before the start of the following section.
- the complete course will be finished within six weeks.

The development of the 'Tanzanian Wildlife Application' will be executed parallel to the course. One part of this application has to be developed by the participant(s) of the course. The development of the application will be described in the next paragraph.

## 5.3. The Development of the Tanzanian Wildlife Application

### 5.3.1. Introduction

Besides the course, another instrument has been developed to increase the knowledge and understanding of system development and data structuring. This is the 'Tanzanian Wildlife Application'. The main objective of this instrument is to experience the advantages of queries, input and output screens and an application. Another important objective is to perform some practical training in developing databases, queries, screens and applications.

This paragraph will describe the development of the 'Tanzanian Wildlife Application'. Before this description, the conditions of the application must be specified:
- the application has to support the activities of NEMC.
- one part of the application has to be developed by at least one employee of the database department of NEMC.
- the development of the application has to match the objectives of the course.
- it must be possible to develop the application within eight weeks.

With these conditions in mind, an environmental issue has to be chosen, to use in the application. This choice will be made in the next paragraph. Paragraph 5.3.3. will discuss the problems of the actual situation.

### 5.3.2. The Choice of an Appropriate Environmental Issue

The best way to experience the advantages of an application is by using databases that are presently used at the database department. In this way, the users will directly see the improvements, because they can compare the new situation with the old one. Hence, a study has been made of the presently available databases at NEMC's database department. These databases are represented in table 5.1. In appendix 3, the fields of these databases are given.

| File name | Description | Records |
|---|---|---|
| WETLAND.DBF | Location of wetlands of Tanzania | 402 |
| PESTICDE.DBF | Registrated approved pesticides in Tanzania (1992) | 144 |
| ENV.DBF | Sources of environmental information in Tanzania | 53 |
| DONORS.DBF | Donors helping in environmental development | 10 |
| SOURCES.DBF | Environmental information sources & contact persons | 218 |
| THREATS.DBF | Threats in Pugu. | 454 |
| PUGUVEG.DBF | Transect lines data in Pugu Forest Reserve | 79 |
| PUGUSTAT.DBF | Status of species in Pugu Forest Reserve | 0 |
| PUGUSPEC.DBF | Species data | 1 |
| ATLAS.DBF | Birds species | 7751 |
| CONTPRK.DBF | Protected areas of Tanzania: Conservation, Games, Parks, Forests, Marine | 100 |
| LIBRARY.DBF | Institutions holding environmental information in Tanzania | 568 |
| Several | Government notices pertaining to environment legislation in Tanzania | 800 |
| GLOSSAR2.DBF | Glossary of environmental terms and acronyms | 2361 |
| EXPERTS2.DBF | Environmental experts in Tanzania | 70 |
| COASTAL.DBF | Coastal Forest of Tanzania | 77 |

Table 5.1: Available databases at the database department of NEMC

Considering the above databases, we have chosen the data file CONTPRK.DBF to be the basis of the application. The reason for this choice is that there are some interesting problems with relation to this database. These problems are closely related to the objectives of the 'dBase IV Application Writing' course. In the next paragraph an explanation of these problems will be given.

### 5.3.3. The Use and Problems of the Database in the Actual Situation

This paragraph will describe the present use of the CONTPRK.DBF data file. Furthermore, some problems of this database will be mentioned.

File: CONTPRK.DBF
Description: Protected areas of Tanzania: Conservation, Games, Parks, Forests, Marine.
Number of records: 100.

Field specifications:
Areacode: protected area number.
Areaname: name of the area.
Status: conservation area, game reserve, national park, marine reserve or forest reserve.
Owner: owner of the area, normally the Tanzanian government.
Area_Hec: surface in hectares.
Year_Est: year of estimation of the protected area.
Region: name of region where the area is situated.
Coord_UTM: UTM coordinates.
Lat_Long: latitude and longitude coordinates.
Altitude: lowest and highest point of the area in comparison with sea-level.
Soil_Type: type of soil.
Vegn_Dom: dominant vegetation.
Plant_Sp: some different plant species.
Animal_Sp: some different animal species.
Services: delivered services (campsites, lodges, etc.).
Revenue: revenue of season 1991/1992 or 1992/1993.
Other_Info: memo fields, with visitors statistics and specific information about the area (threatened animals, etc.).

The data in the database can be used by employees of NEMC for different purposes. The database is used as some kind of word processor. If data is needed out of this database, an employee enters the database and moves the cursor to position of the required data. The database is not ordered and there are no operators used to decrease the search time. Moreover, when data is added, changed or deleted, it is possible to make typing errors. Furthermore, a lot of the data is missing. For instance soil_type and UTM_Coord are not filled in for any record. Most other fields are filled in for some of the records only. Besides these problems, there are some problems that can only be recovered by a restructuring of the database. These are:

- Animal and plant species administration:
  In the actual situation, there is one database with all data about protected areas. Some problems could arise when we want to expand the number of animal species or plant species. The field length might become too small to fill in more animal or plant species.

- Soil type administration:
  At the moment, there is a field 'Soil_type' but no soil types are recorded in the database. In one area it is possible that more than one soil type is present. This will lead to the same problem as the storage of the animal and plant species. The field length might become too small to store all different soil types.

- For the actual database, it is not easy to determine the protected areas, where one specific animal species is living. For example, we are not able to find the answer on the question: "In which protected areas lives the lion?" or "Which animal species are living in Arusha National Park?". The same problem is present for the administration of plant species and soil types.

- Indication of the number of species:
  Besides the above problem, there is no indication of the number of animals or plants that are respectively living or growing in the protected area.

- Indication of the surface of a soil type:
  There is no indication of the surface of a specific soil type.

- Visitors statistics:
  Another big problem is the storage of the visitors statistics. These statistics are stored in memo-fields, so no operations can be carried out on them.

### 5.3.4. Requirements of the Tanzanian Wildlife Application

In the previous paragraph, the problems of the data file CONTPRK.DBF in the actual situation have been described. This paragraph will describe the requirements of the Tanzanian Wildlife Application in trying to solve the above problems.

The application has to administrate the protected areas of Tanzania. These areas have some specific characteristics like: name, status, surface, region, etc. Besides these specific characteristics, information is desired of all the animals that are living and all the plants that are growing in these areas. Moveover, all the soil types that are present in the areas have to be administrated and, finally, the visitors statistics of these areas have to be stored and operations on these statistics have to be possible.

Now, the requirements of the application can be described in more detail. A division is made between the functional and the quality requirements. The next paragraph will describe the main functional requirements. In paragraph 5.3.4.2. the main quality requirements will be considered.

### 5.3.4.1. Main Functional Requirements

Functional requirements with regard to protected areas:
- The application has to show the user all protected areas in Tanzania with their specific characteristics.

Functional requirements with regard to animal species:
- The application has to show the user all animal species, that are living in one protected area, for each protected area.
- The application has to show the user all protected areas, where one specific animal species is living, for each animal species.
- The application has to indicate the number of each animal species in one specific protected area, for each protected area and the change of the number of these animal species in time.

Functional requirements with regard to plant species:
- The application has to show the user all plant species, that are growing in one protected area, for each protected area
- The application has to show the user all protected areas, where one specific plant species is growing, for each plant species.
- The application has to indicate the number of each plant species in one specific protected area, for each protected area and the change of the number of these plant species in time.

Functional requirements with regard to soil types:
- The application has to show the user all soil types, that are present in one protected area, for each protected area
- The application has to show the user all protected areas, where one specific soil type is present, for each soil type.
- The application has to indicate the surface of each soil type in one specific protected area, for each protected area and the change of the surface of these soil types in time.

Functional requirements with regard to visitor statistics:
- The application has to show the user the visitor statistics of each protected area and the change of these visitor statistics in time.

### 5.3.4.2. Main Quality Requirements

There are two important quality requirements for the application. The first one is the reliability of the data in the database. An important aspect of reliability is the correct input of data. The other important quality requirement is the maintainability of the application. An intensive participation of the users of the application during the development, will raise the maintainability. The other quality requirements like timeliness, effectiveness, efficiency, protection, user friendliness or connectivity (see paragraph 4.2.2.) are considered not important at this point in time.

### 5.3.5. System Concept

In this paragraph outline the application will be outlined. First, the conceptual relational data model will be developed according to the functional requirements. This conceptual relation data model will be translated to a relational data model. Therefore, the more-to-more relations have to be replaced by two one-to-more relations and a new entity[8].

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[8] *For the theory of data models is referred to the 'dBase IV Application Writing' course, section 2: Data Structuring.*

For the development of the conceptual relational data model, the entity-types have to be derived from the functional requirements. The entity-types that can be distinguished are: protected area, animal species, plant species, soil type and visitor. The names of these entity-types will be respectively: AREA, ANI_SPEC, PLA_SPEC, SOILTYPE and VISITOR. The relations between these entity-types are given in figure 5.1.

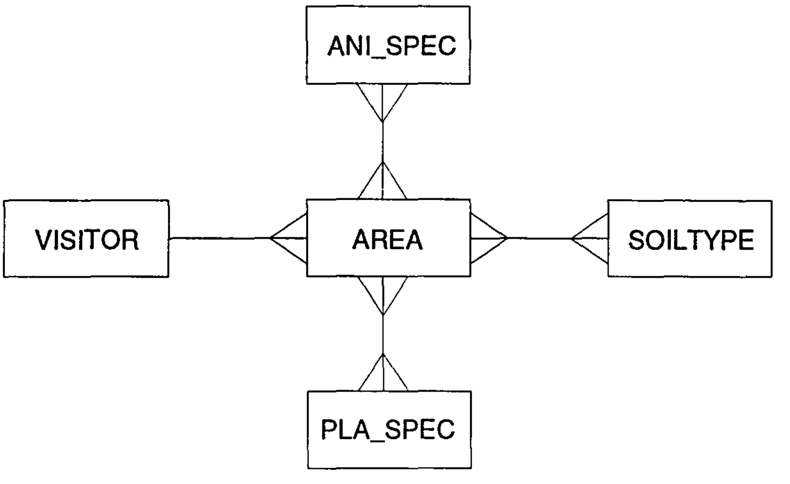


Figure 5.1: Conceptual relational data model of the Tanzanian Wildlife Application

The conceptual relational data model contains three more-to-more relations. Since more-to-more relations are not allowed in a database structure, we have to remove them and create the relational data model of figure 5.2.

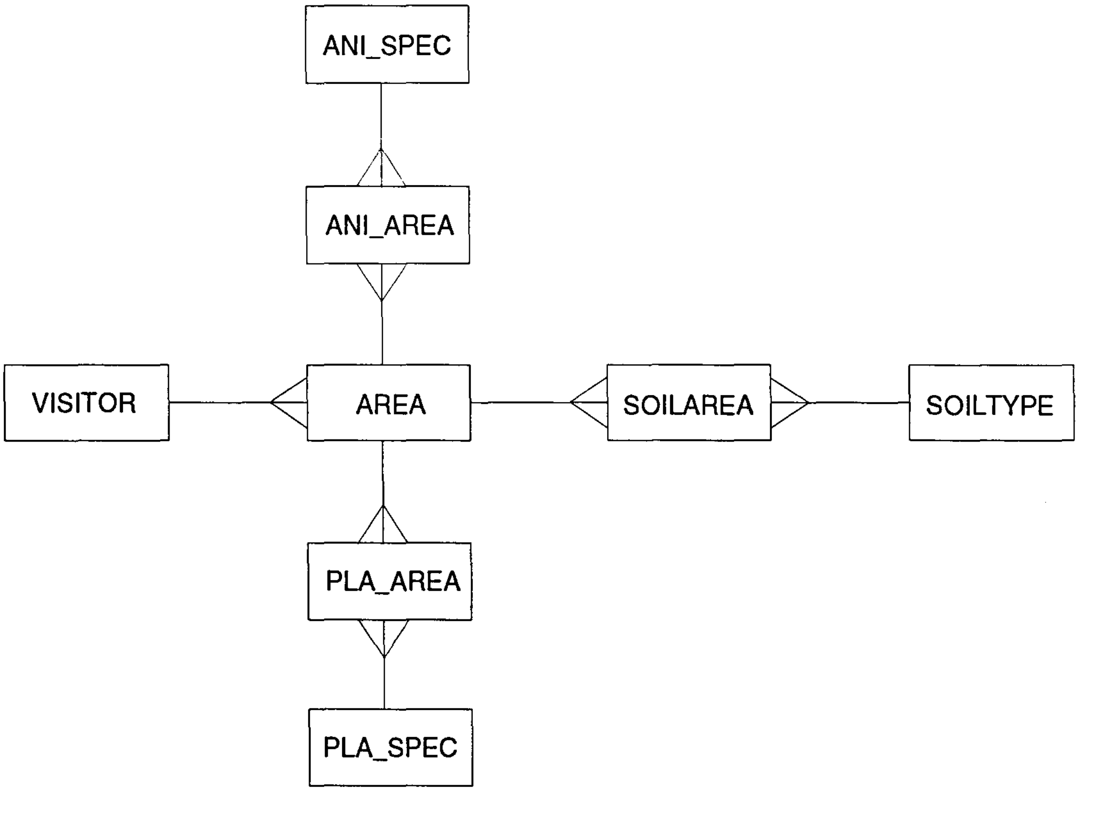


Figure 5.2: Relational data model of the Tanzanian Wildlife Application

According to the relational data model, eight databases have to be created. The name of each database will be the same as the name of the corresponding entity-type. Now, the content of each database has to be described. In the system concept, this description can be done in a natural language, while in the detail design, which is added in appendix 2, the description of the databases has to be unambiguous.

AREA: The database AREA contains data about all the protected areas in Tanzania. Of each protected area the following characteristics have to be recorded: their name, status (National Park, Game Reserve, etc.), the region in which most of the park is situated, size, coordinates, altitude, year of establishment, the provided services and some remaining remarks if necessary.

ANI_SPEC: The database ANI_SPEC contains data about all the animal species in Tanzania that have been observed. Of each animal species the following characteristics have to be recorded: their English name, scientific name, Swahili name, class (mammals, birds, etc.), order, family, if the animal is threatened and in which extent (extinct, endangered, vulnerable, rare, indeterminate), according to the IUCN Red List of Threatened Animals [The World Conservation Union, 1990].

ANI_AREA: The database ANI_AREA contains data about the animal species in a certain protected area. The following characteristics will be recorded: the animal number, which refers to an animal species in ANI_SPEC, area number, which refers to a protected area in the AREA database, the number of animals of that species, the year of estimation of that number, the season of estimation and the standard error.

PLA_SPEC: The database PLA_SPEC contains data about all the plant species in Tanzania that are observed. Of each plant species the following characteristics will be recorded: their English name, scientific name, Swahili name, class, subclass, order, family, according to Cronquist [Cronquist, 1981].

PLA_AREA: The database PLA_AREA contains data about the plant species in a certain protected area. For the moment this database contains 3 fields: plant species number, which refers to a plant species in PLA_SPEC, area number, which refers to a protected area in the AREA database and the year of estimation of that plant species. It is possible that this database will be expanded by other fields.

SOILTYPE: The database SOILTYPE contains data about soil characteristics. Of each soil type the following characteristics will be recorded: the texture class (clay, loam, sand, etc.), drainage class, soil order (entisol, vertisol, etc.) and land form [Baker, 1976].

SOILAREA: The database SOILAREA contains data about the soils in a protected area. At the moment, the database contains three fields: an area number, referring to a protected area, a soil type number, which refers to a soil type and the surface of that soil type.

VISITOR: The database VISITOR contains data about the visitors of the protected areas. The following characteristics will be recorded: the area number, the year, the number of residents, non-residents, residents_tx and the total number of visitors.

## 5.4. Summary

- To increase the knowledge and understanding of the process of system development and data structuring, two instruments are developed. These are:
  - the 'dBase IV Application Writing 'course, and
  - the 'Tanzanian Wildlife Application'.

*Summary with regard to the 'dBase IV Application Writing' course:*

- The main objective of the course is to increase the knowledge and understanding of the process of system development and data structuring. The theory of the course is clarified by means of the standard software package dBase IV. After finishing the course, the participant has to be able to construct databases, to write queries and to create input and output screens. Furthermore, the participant has some knowledge of the development of an application.

- The course contains six sections. These sections are:
  Section 1: General Information About Informatics and its Benefits
  Section 2: Data Structuring
  Section 3: The Construction of Databases in dBase IV
  Section 4: Writing a Query
  Section 5: The User Interface
  Section 6: The Application

*Summary with regard to the 'Tanzanian Wildlife Application':*

- The main objective of the development of an application is to experience the advantages of queries, input and output screens and an application. Furthermore, an employee of the database department of NEMC gains experience in developing databases, queries, screens and applications.

- The environmental issue that is used in the application concerns the administration of protected areas in Tanzania.

- The present database of the protected areas in Tanzania shows some problems. Some of these problems can only be solved by a restructuring of the database. For instance, the administration of animal species. In the present database, it is not possible to enter all the animal species that are living in a protected area.

- The new administration of protected areas is called the 'Tanzanian Wildlife Application'. The application makes use of eight databases, three view queries, eight input screens, three output screens and eight sub-applications.

# EVALUATION OF THE 'DBASE IV APPLICATION WRITING' COURSE AND THE 'TANZANIAN WILDLIFE APPLICATION'

## 6.1. Introduction

In chapter 5, two instruments have been developed that contribute to the increase of the knowledge and understanding of system development and data structuring. In this chapter, the two instruments will be evaluated in achieving the formulated objectives. The achievements of the 'dBase IV Application Writing' course has strongly been influenced by the development of the application, since both instruments are dealing with the same issues and have been executed parallel. For convenience, the achievement of the objectives of the course, will be evaluated as being the result of the course only. This evaluation will be described in paragraph 6.2. The evaluation of the 'Tanzanian Wildlife Application' concerns the execution and the extent to which the application meets the functional and quality requirements. The evaluation of the 'Tanzanian Wildlife Application' will be described in paragraph 6.3.

## 6.2. The 'dBase IV Application Writing' Course

### 6.2.1. The Execution of the Course

The course started on Monday the 10th of July 1995. During the execution of the course, the office of NEMC's database department moved to another location. This resulted in a delay of one week. So, the course was finished on Friday the 25th of August.

The database department of NEMC employss four people, which may be considered as the number of potential participants of the course. The course has intensively been taken by one employee. She has read the course and all the important subjects have been discussed in detail. Furthermore, she has done the exercises of section 2, 3 and 4. Two other employees have taken the course globally. They have read the course and have asked some questions about data structuring and queries, for which they had special interest. Other important activities and the absence as a result of illness, can be mentioned as reasons for taken the course globally, by these two employees. Finally, the head of the office has not been taken the course at all, because of other important activities.

The above holds that the knowledge and understanding of the process of system development and relational data structuring, that have been discussed in the course, is mainly embodied in one person. Hence, the results of the course depends on the ability of that person to absorb and to generate the knowledge and understanding, discussed in the course. Furthermore, the results of the course also depends on the opportunity, given to that person, to maintain and built up this technical capacity.

### 6.2.2. The Extent of Achieving the Objectives of the Course

To make a definite judgement of the results of the course, a test instrument should have been developed. However, this test instrument has not been developed, because of lack of time during the period in Tanzania. Therefore, the extent of achieving the objectives of the course are based on the observations, that were made during the execution of the 'dBase IV Application Writing' course. The achievements will be discussed on the basis of three aspects, that can be considered as a summary of the global objectives of the course.

These aspects are:

1. the knowledge of terms
2. the understanding of relational data structuring
3. the ability to use dBase IV

*ad 1) the knowledge of terms*

All the terms that have been described in the concrete objectives of the course, are discussed in detail. With none of the terms, the participant had insurmountable problems. The participant understands all the terms, but has some problems with the correct use of the terms in discussions.

*ad 2) the understanding of relational data structuring*

The participant of the course has made the exercise of section 2, which concerns the theory of relational data structuring. The participant needed some help to develop the relational data model. The participant was able to derive the entity-types from the problem description, but was not able to indicate all the relations between the entity-types. Concluding, the participant understood the process of relational data structuring, but was not able to practice this process completely by herself.

*ad 3) the ability to use dBase IV*

At the end of the course, the participant was extremely capable to use dBase IV. No problems occurred, with the construction of databases, queries and input and output screens by using the course. This became visible during the development of the 'Tanzanian Wildlife Application'.

A test instrument, that can measure the achievements of the course, have to include tests for the above summarized aspects of the course. When donor countries and/or the Tanzanian Government have decided to develop an Environmental Information System for Tanzania at the database department of NEMC, the knowledge and understanding of the process of system development and data structuring has to be studied again.

1. To test the knowledge of terms is obvious.
2. To test the understanding of data structuring, a simplified (environmental) problem has to be described. From this problem description, the participant of the course must be able to recognize the entity-types. Moreover, the participant has to design a conceptual relational data model and must be able to transform this model to a relational data model.
3. Finally, to test the ability to use dBase IV, the participant must be able to construct databases for this problem in dBase IV. The participant must be able to create fields, with field names, field types, etc. Furthermore, the participant must be able to link three files by using view queries and must be able to design queries by using projections and selections. At last, the participant must be able to design input and output screens by using respectively data files and view queries.

The results of this test instrument strongly depends on:

- the time elapsed between the end of the course and the execution of the test instrument,
- the experiences of the participants of the course with regard to data structuring and dBase IV during the time elapsed between the end of the course and the execution of the test instruments.

## 6.3. The 'Tanzanian Wildlife Application'

### 6.3.1. The Execution of the Development of the 'Tanzanian Wildlife Application'

The execution of the development of the application started on the 10th of July. The participant of the course started with the construction of the datafiles 'SOILTYPE.DBF' and 'SOILAREA.DBF' according to the specifications described in the detail design (see appendix 2). Moreover, the participant linked the datafiles 'SOILTYPE.DBF', 'SOILAREA.DBF' and 'AREA.DBF' by the creation of a view query, which resulted in the view 'SO_AR_VW.QBE. Finally, the participant created the input screens 'SOILTYPE.FMT' and 'SOILAREA.FMT' and the output screen 'SO_AR_VW.FMT'. For all the fields in these screens, the participant entered the *template*, *picture functions* and *edit options* according to the specifications described in the detail design. All the other datafiles, view queries, screens and the applications, that are mentioned in the detail design were realised by the system developer (i.e. J. Raaphorst).

### 6.3.2. The Extent of Meeting the Requirements of the Application

The application is developed within eight weeks and it contains:

- eight datafiles
- three view queries
- eight input screens for each datafile
- three output screens for each view query
- eight sub-applications
- one covering application

All the above parts of the application are described in the detail design, which is added in appendix 2. With the exception of the covering application, all the above parts are working properly. The covering application contains two bugs. These bugs concern the return from one menu to another. This return is not working properly for the 'Plant Species in Areas' menu to the 'Protected Areas' menu and for the 'Soil Types in Areas' menu to the 'Protected Areas' menu. The basis of the problem is the wrong indexing within the datafiles 'PLA_AREA.DBF' and 'SOILAREA.DBF'.

The 'Tanzanian Wildlife Application' meets all the functional requirements that are described in paragraph 5.3.4.1., if the bugs in the covering application are solved. Attention has also been paid to the quality requirements. By using the input screens with their specific field characteristics, the databases are convinced of correct data input. The maintainability of the application is increased by an intensive participation during its development and by the 'dBase IV Application Writing' course.

Finally, the databases that are used by the application are not filled completety. With the exception of the plant species data, most of the data is, in some extent available at the database department of NEMC. These data should be entered in the databases by the employees of the database department, by using the application.

## 6.4. Summary

*Summary with regard to the 'dBase IV Application Writing' course:*

- No test instrument has been developed to measure the achievements of the course, but according to the observations during the course, the following statements can be made:
  - the participant of the course understands the terms that have been described in the concrete objectives,
  - the participant of the course understands the process of relational data structuring, but is not able to define the relations between the entities exactly,
  - the participant of the course is extremely able to use dBase IV.

- Before the start of the development of the Environmental Information System for Tanzania, at the database department of NEMC, the achievements of the course have to be studied again. These test should include a test on the following aspects:
  - the knowledge of terms
  - the understanding of data structuring
  - the ability to use dBase IV

*Summary with regard to the 'Tanzanian Wildlife Application':*

- The application contains: eight datafiles; three view queries; eight input screens for each datafile; three output screens for each view query; eight sub applications and one covering application.

- Besides two bugs in the covering application, the 'Tanzanian Wildlife Application', meets all the functional and quality requirements. It may be considered as a major improvement of the former database, concerning the administration of protected areas.

# CONCLUSIONS AND RECOMMENDATIONS

In this final chapter, we will describe the conclusions and recommendations. Paragraph 7.1. describes the conclusions, while paragraph 7.2. describes the recommendations.

## 7.1. Conclusions

- The National Environment Management Council has been established in 1986 in order to advice the Government on all matters related to the environment. It is divided in the four directorates; 'natural resources', 'pollution prevention and control', 'environmental education, research and documentation' and 'administration and finance'. The directorate 'environmental education, research and documentation' is extremely active in the establishment of a library to stock all available literature on the environment. Furthermore, the directorate is responsible for publishing of the magazine 'NEMC NEWS' to increase the environmental awareness and finally, the directorate has done important work by the creation of databases concerning environmental organisations and experts and by collecting other environmental data.

- Tanzania is facing serious environmental problems. The environmental problems that have been distinguished by the Tanzanian Government concern:
  - Land Degradation
  - Poor Water Supply and Quality
  - Loss of Wildlife Habitat and Biodiversity
  - Aquatic System Degradation
  - Increase of Environment Pollution
  - Deforestation

- The Environmental Information System for Tanzania, that is described in this research can be an essential instrument for the environmental manager to recognize environmental problems. Furthermore, by use of the Environmental Information System, the environmental manager will be better informed of the direct and indirect causes that are the basis of the environmental problems. The Environmental Information System will only operate successful, if it will be developed and managed properly.

- At the moment the National Environment Management Council is not able to *develop* the Environmental Information System for Tanzania because of the lack of knowledge on information technology. The development of the Environmental Information System requires specialists on the field of information technology.

- At the moment the National Environment Management Council is not able to *manage* the Environmental Information System for Tanzania, because of lack of management capacity, available hard- and software and knowledge and understanding of the process of system development and data structuring.

- In this research two instruments are developed to increase the knowledge and understanding of the process of system development and data structuring. The instruments are: the 'dBase IV Application Writing' course and the 'Tanzanian Wildlife Application'. The course is intensively taken by one employee of the database department of the National Environment Management Council. Furthermore, the application is developed in collaboration with the same employee.

- In this research the results of the two instruments have not been evaluated by a test instrument. However, according to the observations during the execution of the course and the application, we may assume that the main objectives of the course and the application have been achieved. This means that there is a demonstrable increase of knowledge and understanding of the process of system development and data structuring, within the database department of NEMC. Furthermore, the employees of the database department have become more able to use the possibilities of the standard software package dBase IV.

- The 'Tanzanian Wildlife Application' has been developed, to function as an example of an application. It has showed to be a major improvement of the former database for the administration of protected areas. Unfortunately, too less data has been entered into the new databases to make the 'Tanzanian Wildlife Application' work optimal.

## 7.2. Recommendations

- The 'dBase IV Application Writing' course has been developed, to increase the knowledge and understanding of the process of system development and data structuring. The course functions as a basis. It is extremely important to keep in touch with the acquired knowledge and understanding by additional courses or in-house training.

- Before the development of the Environmental Information System, the lines between the functions of the National Environment Management Council and the Ministry of Tourism, Natural Resources and Environment have to be redefined. A logical definition would be; the National Environment Management Council as the advisory organisation and the Ministry of Tourism, Natural Resources and Environment as the executive organisation. The recommended functions of the organisations in this case would be:
  - The advisory organisation has to recommend policy on all environmental matters, without considering other development policies, like the economical or social policy. However, the environmental policy must include a cost and benefit analysis of the recommended measures, on which the executive organisation can base its decisions.
  - The executive organisation has to analyse the recommended environmental policy of the advisory organisation and has to implement the measures, while taking the other policies into account.

  According to the above definition of functions, the National Environment Management Council is the right organisation for the management of the Environmental Information System, because of its advisory function. The functional requirements of the Environmental Information System that are recommended in this research will support the advisory function, because it supports decision making on environmental matters, without considering the other development policies.

- Before the development of the Environmental Information System for Tanzania, the environmental manager has to determine, for each individual environmental problem, the parameters that indicate the actual situation of the problem. For example, the extent of the problem of land degradation can be represented by the parameter 'soil fertility' or 'thickness of the humuslayer'. Furthermore, the environmental manager has to standardized for each parameter the method of measurement. This standardisation is extremely important, because in this case it will be possible to compare the values of the parameters over the country and in time. This standardisation is even more important than the correctness of the value of the parameter itself.

- After the standardisation of the parameters and the methods of measurement, an infrastructure has to be created to collect the data that is required for the determination of the value of the parameter. For the creation of this infrastructure the relations with other environmental organisations is extremely important.

- Before the development of the Environmental Information System, the knowledge and understanding of the process of system development and data structuring at the database department of NEMC has to be studied again. This second study has to conclude that the formulated objectives of the 'dBase IV Application Writing' course are achieved.

- When all the above recommendations are executed, the development of the Environmental Information System for Tanzania can start. As a part of the system development process, a hard- and software configuration has to be selected that is able to run the Environmental Information System for Tanzania. The present hard- and software is not sufficient for running the complete system.

- The Environmental Information System for Tanzania should be developed by a Tanzanian software organisation, a donor organisation or by a collaboration of both organisations. During the development of the Environmental Information System, the National Environment Management Council has to operate as the environmental expert. It has to advise on the environmental data and the format of these data that must be stored and processed, to guarantee a successful implementation of the system. To increase the success of the negotiations with the system developers, the National Environment Management Council requires some knowledge of the fundamentals of hardware and software.

- The development of the Environmental Information System for Tanzania should start with one small sub-system, including one environmental issue. For instance, land degradation. Before this sub-system is expanded by other sub-systems, a full understanding of all the processes of the sub-system is necessary and the data acquisition for this sub-system must be well organised. This will lead to a better implementation and use of the sub-systems that will be developed in the future.

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# APPENDIX 1: THE 'DBASE IV APPLICATION WRITING' COURSE

Appendix 1 is the 'dBase IV Application Writing' course and is presented separatee from this report.

Appendix 1:

**'dBase IV Application Writing' course**

Carried out at:
The National Environment Management Council

Joost Raaphorst, may 1996

*Supervisors:*
dr. ir. A.M.C. Lemmens
dr. R.J. Kusters
P.E. Lapperre M.Sc.

## Preface

This course has been developed as a result of the research, that has been executed at the National Environment Management Council from march till september 1995. In the main report the objectives of this course have been described. The main objective of the course is to increase the knowledge and understanding of system development and data structuring. The course has been carried out at the database department of the National Environment Management Council from the $10^{th}$ of July till the $25^{th}$ of August.

The course has been divided in six parts. Section 1 starts with a global introduction of the field of **informatics** and the possible benefits of it. In section 2, the theory of **relational data structuring** will be explained. Furthermore, the terms 'entity', 'relation' and 'attribute' will be introduced.

The rest of the course will be concerned with dBase IV. Section 3 will explain quickly the **construction of databases**, because NEMC's employees are already familiar with the definition of fields. **Queries** will be discussed in more detail. In section 4, three databases will linked by means of a 'view query'. Also much attention will be given to **input/output screens**. In particular the protection of entry fields will be discussed in detail.

In the last part of the course, the development of an **application** will be discussed, by means of the application generator, which is a very convenient tool. The application will make use of the already developed databases, queries and input/output screens.

**Table of Contents**

## Section 1: General Information About Informatics and its Benefits

Informatics is a profession which is dealing with information. When we are processing data with a computer, we speak of a computerised information system (I.S.). There are two different types of information systems.

The first type is called **technical information systems.** These systems are normally found in production companies, where they are controlling the production process. Robots, for instance, are technical information systems. The second type is called **administrative information systems.** These systems are used in the office. Administrative information systems can perform several functions. They can processing all kind of data. For instance, financial data (salaries), sales data (how many products sold, price), suppliers data (addresses of suppliers), production data, customer data, etc. The processing of environmental data is also done by an administrative information systems.

Normally, an organisation which is working free from problems feels no need to invest in (new) information systems and/or computers. But after some time they will experience some problems. Maybe the company is not able to keep up with the competitors, because they are spending to much time on the administration of deliveries. The management of the company can now contract computer experts, who can map all the **information flows** in the organisation. These information flows can be computerised, so that the administration of deliveries will be less time consuming. Now, the company will be able again to compete with the competitors.

This is one example of the benefits of information technology. In this example the advantage of the I.S. is pure commercial. It is also possible to provide better services or to increase the conception of a certain problem to make better decisions.
For NEMC, the increase of the conception of certain problems is a reason to invest in information systems.

## The Phases of System Development

The development of an information system has to be done well considered, because else it can lead to big problems. A lot has been written about system development. In general the following steps have to be taken to decline the change of a failure. Besides these steps, the system developer has to think properly and structural.

Phase 1: The goals that must be achieved by the information system must be enumerated and accepted by all authorised parties. Examples of goals are: gain higher profits; deliver better service; double the sales of product A; etc.

Phase 2: Keeping the goals in mind, the problems of the organisation have to be detected. Examples of problems are: delivery administration takes too much time; the response time of the system is too low; the marketing activities have taken place in wrong order; etc. After the determination of the problems, a system concept has to be made. A system concept describes the functions of an information system, input data and output data.

Phase 3: In phase 2, we have described globally the functions of the system and the data that we want to use. Now, in phase 3, we have to describe the same. Only now it has to be described in a mathematical and unambiguous way, so that it can not be wrong interpreted.

Phase 4: In this phase the system is realised, tested and corrected. When everything is working properly, the information system can become operational and the goals will be achieved.

## Section 2: Data Structuring

Data structuring is an interesting and comprehensive subject according to all the books that are published. During the last three decades different approaches were made and three famous models were proposed: the **network** model, the **hierarchical** model and the **relational** model. In this course we will only look at the relational model, because dBase IV supports the relational model, in which the information is stored in tables. The relational model was introduced by E.F. Codd in 1970.

In this small course we will not go into all the theoretical details of relational models, but we will only discuss the practical side, which is needed to understand the development of the 'WILDLIFE APPLICATION'.

First we start with the description of an example, which we will use throughout the course. After that we will translate the text into a relational model and introduce the terms: **entity, attributes** and **relation.**

### An Example: Hotel Administration

We will illustrate the theory with an example. The example concerns a hotel, where people can rent a room. Each room has a number and contains one or more beds and can contain a bath. The room is situated at a certain floor. Furthermore, the hotel has visitors. The hotel records the name and address of each visitor. A visitor can make phone calls from his/her room via an operator. The phone bill has to be paid when the visitor checks out. Together with the phone bill, the visitor has to pay for the room.

### Translation to a Relational Data Model

When we look at the example, we have to find the things that we must put in the database. We have to think properly to distinguish these characteristics. The following things can be put into the computer of the hotel.

- what is the number of the room?
- how many beds are in the room?
- does the room contain a bath?
- on what floor is the room situated?
- what is the name of the visitor?
- what is the address of the visitor?
- how much money must the visitor pay, because of the phone calls?
- how much money must the visitor pay, because of the room?

Now, we know what we want to put into the computer, so we can develop the database by creating it's fields. We make one database and call it HOTEL_ADM. HOTEL_ADM contains the following fields:

- ROOMNUMBER (numeric[3])
- NUMBER_OF_BEDS (numeric[1])
- BATH? (logical)
- FLOOR (numeric[1])
- VIS_NAME (character[20])
- VIS_ADDRESS (character[50])
- PHONE_BILL (float[6])
- ROOM_BILL (float[6])

The hotel starts to work with the database HOTEL_ADM. The first visitor checks in and wants to stay for three days. The second visitor, who checks in wants to stay for two day. When the second visitor checks out the receptionist asks him: "Have you been here for two days or three days? I'm sorry, but I have forgotten it." There is a small problem, because we cannot record the number of days a visitor stays in the hotel. We have to add a new field to the database, called NUMBER_OF_DAYS (numeric[3]).

When the visitor wants to pay the room bill, the receptionist has to look for the rate of the room and multiply it with the number of days. Then she has to enter it the computer and collect the money. This is time consuming work and can lead easily to mistakes. Furthermore, the computer can also multiply, so why should you do it yourself? We have to add a new field, called RATE (numeric[3]).

After two months visitor one checks in for the second time. Now, he wants to stay for four days. The receptionist enters his name and the number of days. When he checks out, the receptionist looks in the database and find the old record, where the number of days was three instead of four. Now the visitor stayed in the hotel one day for free.

After a half year, the computer has not been very beneficial. The receptionist has even lesser time than before to answer the telephone and the administration of visitors has lead to some problems. The management of the hotel decides to quit working with the computer and return to the paper work again.

## What is Wrong with the Database HOTEL_ADM

The problem with the database is that we have tried to put all the data in one database. It is much better to divide the database according to the distinguished entities.

## Entity, Attribute and Relation

What is an **entity**? An entity is an important object about we want to record some information. An entity can be anything. For instance: a person, a room, a book, a computer, a student, etc.

An entity can be described by his characteristics. When we take the entity 'a person', it can be described by it's length, it's age, it's name, it's address, etc. These characteristics, we call **attributes**.

An **entity-type** is a collection entities with the same attributes. Examples of entity-types are very easy. These are: persons, rooms, computers, students, etc. Normally, we do not use the plural, but we use for the entity-type: person, room, book, computer, student, etc.

Between entities exist **relations**. A person can have a computer or a student can read a book. These are called relations. When we consider a class with students and a library with books, there will exist several relations, because many students are reading books. So, this means that there exist a relation between the entity-types 'student' and 'book'. We can represent this as in figure 1.

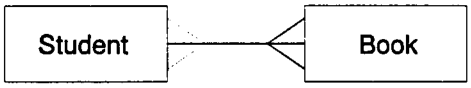



figure 1: A relation between the entity-types 'student' and 'book'

## Different Relation-types

There are different kinds of relations. In this course we will handle three main relation-types. The first relation-type is called the **one-to-one relation.** Every car has only one registration number and a registration number belongs only to one car. We denote a one-to-one relation as follows:

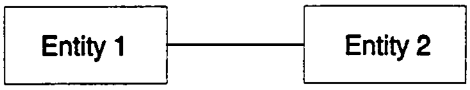



figure 2: A one-to-one relation

The second relation-type is the **one-to-more relation.** Every child has only one biological father, but the father can have more than one children. In this case the entity-types are: 'father' and 'child'. This is what we call a one-to-more relation and is denoted as follows:

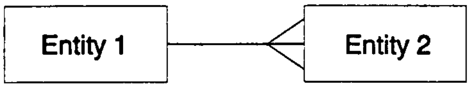



figure 3: A one-to-more relation

The third and last relation-type we will discuss is the **more-to-more relation.** A good example of a more-to-more relation is the problem of the database HOTEL_ADM. Every room can accommodate one or more visitors and a visitor can rent one or more rooms. Another good example of a more-to-more relation is the registration of animals in National Parks. In a National Park can live one or more different animal species. Animals of one animal specie can live in one or more National Parks. In figure 4, we see the notation of more-to-more relations.

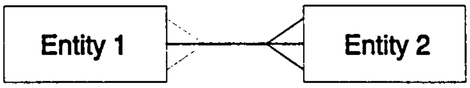



figure 4: A more-to-more relation

## Back to the HOTEL_ADM Database

It is very difficult to distinguish in a problem description the right entity-types. And when you have find the entity-types, it is even more difficult to be conscious of the exact relations that exist between the entity-types. You have to think mathematical and structural.

Now we want to develop the HOTEL_ADM database again. First we have to distinguish all the entity-types from the description. We can distinguish the following entity-types: room, visitor and phone-bill. Between these entity-types we have to find the relations. We can put these entity-types and relations in a **'conceptual relational data model'** as we see in figure 5.

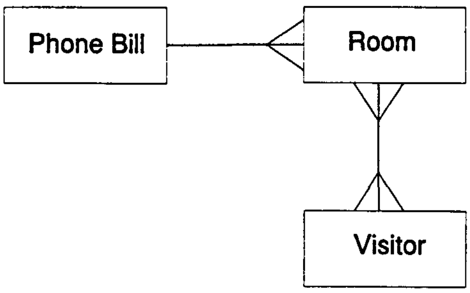



figure 5: A conceptual relational data model

This relational data model is conceptual, because it is not finished yet. In a conceptual relational data model may exist more-to-more relations. When we would translate a more-to-more relation to a database structure it would lead to problems. Which problems?

The actual WILDLIFE DATABASE (CONTPRK.DBF) contains three more-to-more relations. The 'AREANAME'-'ANIMAL_SP' relation, the 'AREANAME'-'PLANT_SP' relation and the 'AREANAME'-'SOIL_TYPE' relation. Some problems could arise when we want to expand the number of animal species or plant species. The field length might become too small to fill in more animal/plant species, see table 1. The same problem will arise with the storing of soil types. The field length will become too small to store all different soil types in one protected area. In table 1 we have left most of the fields for convenience.

| AREANAME | STATUS | ANIMAL_SP | PLANT_SP |
|---|---|---|---|
| NGORONGORO | CONSERV. AREA | UNGULATES, PREDATORS, LION | MONTANA FOREST, ACACIA WOODLAN |
| BURIGI | GAME RESERVE | GIRAFFE, IMPALA, ELAND, HIPPOPOT. | RIVERINE FOREST, PAPYRUS BEDS |
| SELOUS | GAME RESERVE | BUFFALO, ELEPHANT, IMPALA, ETC. | MIOMBO, THICKET, RIVERINE |
| ARUSHA | NATIONAL PARK | BLACK, WHITE COLOMBUS, LEOPARD | NUXIA CONGESTA, OLIVE, BAMBOO |
| MANYARA | NATIONAL PARK | HIPPO, ELEPHANT, BUFFALO, LIONS | YELLOW FEVER TREES, ALKALINE |
| SERENGETI | NATIONAL PARK | ZEBRA'S, THOMPSON'S GEZELLE, LION | GRASSLAND PLAINS WITH SAVANNA |

table 1: Some records of CONTPRK.DBF

There is a solution with one database possible. We can enter one animal and one plant specie per record, see table 2. The other fields like: 'AREANAME', 'STATUS', etc., have to be filled in for each animal specie. We see that this is not the right solution because we have to store so much data, that the disk space would be too less.

| AREANAME | STATUS | ANIMAL_SP | PLANT_SP |
|---|---|---|---|
| NGORONGORO | CONSERV. AREA | UNGULATES | MONTANA FOREST |
| NGORONGORO | CONSERV. AREA | PREDATORS | MONTANA FOREST |
| NGORONGORO | CONSERV. AREA | LION | MONTANA FOREST |
| NGORONGORO | CONSERV. AREA | UNGULATES | ACACIA WOODLAND |
| NGORONGORO | CONSERV. AREA | PREDATORS | ACACIA WOODLAND |
| NGORONGORO | CONSERV. AREA | LION | ACACIA WOODLAND |
| BURIGI | GAME RESERVE | GIRAFFE | RIVERINE FOREST |
| BURIGI | GAME RESERVE | IMPALA | RIVERINE FOREST |
| BURIGI | GAME RESERVE | ELAND | RIVERINE FOREST |
| BURIGI | GAME RESERVE | HIPPOPOT. | RIVERINE FOREST |
| BURIGI | GAME RESERVE | GIRAFFE | PAPYRUS BEDS |
| BURIGI | GAME RESERVE | IMPALA | PAPYRUS BEDS |
| BURIGI | GAME RESERVE | ELAND | PAPYRUS BEDS |
| BURIGI | GAME RESERVE | HIPPOPOT. | PAPYRUS BEDS |
| SELOUS | GAME RESERVE | BUFFALO | MIOMBO |
| SELOUS | GAME RESERVE | ELEPHANT | MIOMBO |
| SELOUS | GAME RESERVE | IMPALA | MIOMBO |
| SELOUS | GAME RESERVE | BUFFALO | THICKET |
| SELOUS | GAME RESERVE | ELEPHANT | THICKET |
| SELOUS | GAME RESERVE | IMPALA | THICKET |
| SELOUS | GAME RESERVE | BUFFALO | RIVERINE |
| SELOUS | GAME RESERVE | ELEPHANT | RIVERINE |
| SELOUS | GAME RESERVE | IMPALA | RIVERINE |
| ARUSHA | NATIONAL PARK | BLACK, WHITE COLOMBUS | NUXIA CONGESTA |
| ARUSHA | NATIONAL PARK | LEOPARD | NUXIA CONGESTA |
| ARUSHA | NATIONAL PARK | BLACK, WHITE COLOMBUS | OLIVE |
| ARUSHA | NATIONAL PARK | LEOPARD | OLIVE |
| ARUSHA | NATIONAL PARK | BLACK, WHITE COLOMBUS | BAMBOO |
| ARUSHA | NATIONAL PARK | LEOPARD | BAMBOO |
| MANYARA | NATIONAL PARK | HIPPO | YELLOW FEVER TREES |
| MANYARA | NATIONAL PARK | ELEPHANT | YELLOW FEVER TREES |
| MANYARA | NATIONAL PARK | BUFFALO | YELLOW FEVER TREES |
| MANYARA | NATIONAL PARK | LIONS | YELLOW FEVER TREES |
| MANYARA | NATIONAL PARK | HIPPO | ALKALINE |
| MANYARA | NATIONAL PARK | ELEPHANT | ALKALINE |
| MANYARA | NATIONAL PARK | BUFFALO | ALKALINE |
| MANYARA | NATIONAL PARK | LIONS | ALKALINE |
| SERENGETI | NATIONAL PARK | ZEBRA'S | GRASSLAND PLAINS WITH SAVANNA |
| SERENGETI | NATIONAL PARK | THOMPSON'S GEZELLE | GRASSLAND PLAINS WITH SAVANNA |
| SERENGETI | NATIONAL PARK | LION | GRASSLAND PLAINS WITH SAVANNA |

table 2: One database with one animal and one plant specie per record

Furthermore, we have to store a lot of data several times, which we have to avoid at all time. When data is stored several times, we call it **redundancy**. Suppose the name of a National Park would change, then you have to correct all the records in the database with that National Park. When we do not correct all the records, the database is **inconsistent**.

## A Relational Data Model

From a conceptual relational data model to the final relational data model is an easy step. We just remove all the more-to-more relations. In figure 6, we see how this can be done.

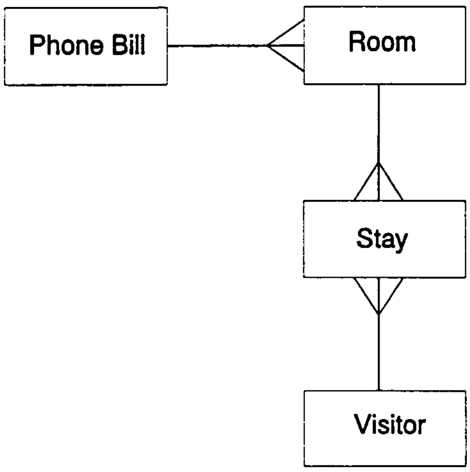



figure 6: A relational data model

By an additional entity-type and two additional relations, you can remove the more-to-more relation. Now we can translate the data model to a database structure without problems. When we make for each entity-type in the **relational data model** a database and link these databases by queries, we have developed an optimal database structure.

The development of databases means the creation of fields. These fields (attributes) represent the characteristics of the entity-type. The creation of database fields will be discussed in section 3.

## An Exercise: Library Administration

The exercise concerns a library, where people can lend books and periodicals. The library management want to develop a dBase IV application. They want to record the books, the periodicals and the members of the library. One book has an author, a title, etc. The periodicals have names and a week number or a month number. The members are also recorded in the database by name, address, birthday, etc. Once a year the members have to pay a contribution of Tsh 1000.

Questions:

What are the **entity-types** of the library administration?

..............................

..............................

..............................

..............................

What are the **relation-types** between these entity-types?

..............................

..............................

..............................

..............................

Can you draw the **conceptual relation data model** of the library administration?

Can you draw the **relation data model** of the library administration? Relation data model has no **more-to-more relations.**

How many databases must we make? .......

Give the databases names and can you mention the fields of the databases?

Database 1:................... Fields: ..............................
...............................
...............................
...............................
...............................

Database 2:................... Fields: ..............................
...............................
...............................
...............................
...............................

Database 3:................... Fields: ..............................
...............................
...............................
...............................
...............................

## Section 3: The Construction of Databases in dBase IV

In this section we will discuss globally the **construction of databases** in dBase IV. We start with some theory about databases and we introduce the terms **record** and **fields.** Furthermore, some requirements of a data file are mentioned. Then we will briefly explain the control center of dBase IV. We discuss globally the **control center** options; DATA, QUERIES, FORMS, REPORTS, LABELS and APPLICATIONS. After that, we discuss in more detail the construction of **data files** in dBase IV. The data files of the WILDLIFE APPLICATION will contain; protected area data, animal species data, plant species data and soil type data.

### Records and Fields

We can consider a data file as a table consisting of **rows** and **columns.** A row in a table, we call a **record** in a data file. The columns, we call **fields.** Table 3 has four columns. Each columns has a field name, for example AREANAME or ANIMAL_SP. Furthermore, table 3 contains 6 records, one record is for example; 'SELOUS', 'GAME RESERVE', 'BUFFALO, ELEPHANT, IMPALA, ETC.', 'MIOBO, THICKET, RIVERINE'.

| AREANAME | STATUS | ANIMAL_SP | PLANT_SP |
|---|---|---|---|
| NGORONGORO | CONSERV. AREA | UNGULATES, PREDATORS, LION | MONTANA FOREST, ACACIA WOODLAN |
| BURIGI | GAME RESERVE | GIRAFFE, IMPALA, ELAND, HIPPOPOT. | RIVERINE FOREST, PAPYRUS BEDS |
| SELOUS | GAME RESERVE | BUFFALO, ELEPHANT, IMPALA, ETC. | MIOMBO, THICKET, RIVERINE |
| ARUSHA | NATIONAL PARK | BLACK, WHITE COLOMBUS, LEOPARD | NUXIA CONGESTA, OLIVE, BAMBOO |
| MANYARA | NATIONAL PARK | HIPPO, ELEPHANT, BUFFALO, LIONS | YELLOW FEVER TREES, ALKALINE |
| SERENGETI | NATIONAL PARK | ZEBRA'S, THOMPSON'S GEZELLE, LION | GRASSLAND PLAINS WITH SAVANNA |

table 3: Records and fields

### The Most Important Requirements of a Data File

The development of data files can be very complex. For us it will be enough to know some requirements of a data file. The rules we have to comply with are the following:

1. Every record in a data file must contain the **same fields.** Not all the fields have to be filled in.
2. Every record must be **unique on the basis of one or more fields,** because we want to perform search operation on the records. The minimum group of fields for which a record is unique, we call the **key.** When we consider a book, it can be indicated uniquely by the author and the title of the book. Most of the time we add a special field to the record called **'number'** which indicate the record uniquely.
3. The **key fields** must always be filled in completely. Normally, this means that every record must have a unique number, because 'NUMBER' is the key field in most of cases.

4. Every **not-key field** must **be dependent on** the **key field**. For example: it is wrong to include the name of the protected area in the animal species database, because the AREANAME is not dependent on the animal specie. When the name of the area changes, we have change this name in all the records in the animal specie database, where that name is mentioned. In such a case we have to develop two databases and link them together.

## The Control Center of dBase IV

The Control Center of dBase IV presents six columns. These six columns can contain files. We can make six different kinds of files in accordance with the column.

**DATA:** In this column we can enter the data files, which we discuss in this section of the course.

**QUERIES:** In this column we can enter query files, which will be discussed in section 4. A **query** is a file from which we can select fields from data files. These fields can be presented in input or output screens. It is also possible to sort a data file for one or more fields. The result of a query is called **'view'**

**FORMS:** In this column we can enter form files, which will be discussed in section 5. A **form** is another name for a screen. This can be an input or an output screen. A screen makes it easy for a user to enter new data in a data file or to change the data. Fields can be presented in orderly way. Furthermore, it is possible to check the entered data on validity; is the data correct and possible.

**REPORTS:** In this column we can enter report files, which will not be discussed in this course. **Reports** can be printed on paper. For example; overviews, lists and letters. Reports are very useful for the WILDLIFE APPLICATION. It is advisable to develop reports later on.

**LABELS:** In this column we can enter **label** files, which will also not be discussed in this course. It is possible to print, for example, name and address data on a label or product data in a factory. For the WILDLIFE APPLICATION it is not useful.

**APPLICATIONS:** In this column we can enter application files, which will be discussed in last section. An **application** is a program, which can be started without entering dBase IV. In an application we can make menu's and perform different operations on data files and views. Some operations are; add new data, change existing data, delete data and browse data. It is also possible to execute queries, display screens, etc.

## Field Types

Every field in dBase IV data file has a number, a field name, field type, a width, a number of decimals (if the field type is numeric) and can be indexed. Indexing will be explained later. In dBase IV, we can choose six different field types.

**CHARACTER:** A **character field** can contain 254 characters. A character is a digit, letter or a symbol. If the character is a digit, it is not possible to perform calculation on the digit.

**NUMERIC:** A **numeric field** can contain 20 digits. With a numeric field it is possible to perform arithmetical operations. After a comma, we can put a maximum of 18 digits. Negative numbers are preceding by a minus character. Furthermore it is possible to precede the number by a currency symbol (Tsh or $).

**FLOAT:** A **float field** is almost the same as a numeric field. A float field is less exact, but the calculations are performed faster. Normally, we use float fields when we have to calculate a lot of statistical data. In the WILDLIFE APPLICATION we use no float fields.

**DATE:** A **date field** contains standard 8 characters. The layout of a date field can be changed when we run DBSETUP.EXE. It can be changed in 01-01-1995 or 01.01.1995 or 01/01/1995. The number of days between two date fields can be calculated by dBase IV.

**LOGICAL:** The width of a **logical field** is always 1 character. . We use a logical field when we want to record a statement. If the statement is true we enter t, T (true) or y, Y (yes), when the statement is false we enter f, F (false) or n, N (no).

**MEMO:** The last field is the **memo field.** A memo field must be used we want to enter data that is specific for that record and can not be entered in another field.

## Index Fields

Data is saved in files. These files contain records. The order of the records is the same as the order of entering. When we want to search in a large data file, it can take some time before dBase IV has found all the records corresponding the search operation. For example, when we want all the protected area names where the field 'STATUS' is 'GAME RESERVE', then dBase IV will look at all records in the data file. When we put an index on the field 'STATUS', the records will be sorted ascending from 'A' to 'Z'. Now, dBase IV can stop searching after the 'G', because no records will correspond the search operation any more.

When we put an index on a field, dBase IV makes a new file, called index file. This file takes some space on the hard disk, so we have to minimize the number of indexes.

## An Example: The Hotel Administration

Now, we will continue with the hotel administration. When we consider the relational data model of the hotel administration (figure 7), we see four entity-types; 'PHONE_BILL', 'ROOM', 'STAY' and 'VISITOR'. Each of these entity-types has it's own attributes. These attributes are the field names, we have to enter in dBase IV.

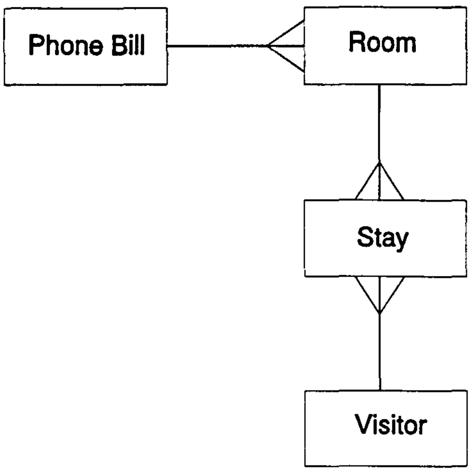



figure 7: Relational data model of the hotel administration

In total, we have to make four databases with the same names as the entity-types. The fields of the databases are as follows:

| Database ROOM | | | | |
|---|---|---|---|---|
| Field name | Type | Length | Index | Description |
| ROOM_NUMBER | numeric | 3 | yes | Number of the room |
| NUMBER_OF_BEDS | numeric | 1 | no | Number of beds in the room |
| BATH? | logical | 1 | no | Has the room a bath? |
| FLOOR | numeric | 2 | no | On which floor is room situated |
| RATE | numeric | 5 | no | The rate of the room |

table 4: Fields of ROOM database

| Database VISITOR | | | | |
|---|---|---|---|---|
| Field name | Type | Length | Index | Description |
| VIS_NUMBER | numeric | 5 | yes | Number of the visitor |
| VIS_NAME | character | 30 | no | Name of the visitor |
| VIS_STREET | character | 30 | no | Street name of the visitor |
| VIS_CITY | character | 30 | no | City name of the visitor |
| VIS_COUNTRY | character | 30 | no | Country name of the visitor |

table 5: Fields of the VISITOR database

| Database STAYS | | | | |
|---|---|---|---|---|
| Field name | Type | Length | Index | Description |
| VIS_NUMBER | numeric | 5 | yes | Number of the visitor |
| ARRIV_DATE | date | 8 | no | Date of arrival |
| LEAV_DATE | date | 8 | no | Date of leaving |
| ROOM_STAY | numeric | 3 | yes | Room number of the visitor |
| NUMBER_PERSONS | numeric | 2 | no | Number of accomp. persons |
| BILL | numeric | 7 | no | Bill the visitor (has to) pay/paid |

table 6: Fields of the STAYS database

| Database PHONE_BILL | | | | |
|---|---|---|---|---|
| Field name | Type | Length | Index | Description |
| ROOM_NB | numeric | 3 | yes | Number of the room |
| TIME | numeric | 5 | no | Duration of telephone call |
| DATE | date | 8 | no | Date of telephone call |
| DESTINATION | character | 30 | no | Destination of telephone call |
| PHBILL | numeric | 6 | no | Phone bill the visitor pays/paid |
| PAID? | logical | 1 | mo | Is the phone bill paid, yes or no |

table 7: Fields of the PHONE_BILL database

## Entering Fields in dBase IV

| Conditions | COMMAND | ACTION |
|---|---|---|
| From C:\> | C:\>cd dbase4<br>C:\DBASE4\>dbase | Starting dBase IV. |
| Control Center<br>CATALOG: C:\DBASE4\HOTEL.CAT<br>Column DATA, cursor on <create> | Press ENTER | Entering field design screen.<br>You are now able to enter field name, field type, width, number of decimals and index. |
| All fields are defined | Press CTRL-END | Accepting of the data file structure. |
| dBase IV asks:<br>**Save as:** | Type name of database, ROOM, STAYS, VISITOR, etc. | Saving of the data file structure. |
| dBase IV asks:<br>**Input data records now? (Y/N)** | Type 'Y' or 'N' | Y, entering data entry screen.<br>N, back to Control Center. |

table 8: dBase IV commands to define data fields

## An Exercise: Library Administration

The exercise concerns a library, where people can lend books and periodicals. The library management want to develop a dBase IV application. They want to record the books, the periodicals and the members of the library. One book has an author, a title, etc. The periodicals have names and a week number or a month number. The members are also recorded in the database by name, address, birthday, etc. Once a year the members have to pay a contribution of Tsh 1000.

According to the relational data model, we have to develop 4 data files with the following names: 'BOOK', 'PERIODICAL', 'MEMBER' and 'LEND'.

**Exercise:** Find for each Field Name in each database the field type, width and the number of decimals. Furthermore, consider for each field if it is useful to index or not.

| Database BOOK | | | | | |
|---|---|---|---|---|---|
| Number | Field Name | Field Type | Width | Decimals | Index |
| 1 | BOOK_NR | | | | |
| 2 | TITLE | | | | |
| 3 | AUTHOR | | | | |
| 4 | PUBLISHER | | | | |
| 5 | BOOK_LEND | | | | |

table 9: Fields of the BOOK database

| Database PERIODICAL | | | | | |
|---|---|---|---|---|---|
| Number | Field Name | Field Type | Width | Decimals | Index |
| 1 | NAME | | | | |
| 2 | PUBLISHER | | | | |
| 3 | DATE_OF_ISSUE | | | | |
| 4 | PERIODICAL_LEND | | | | |

table 10: Fields of the PERIODICAL database

| Database MEMBER | | | | | |
|---|---|---|---|---|---|
| Number | Field Name | Field Type | Width | Decimals | Index |
| 1 | MEMBER_NR | | | | |
| 2 | FIRST_NAME | | | | |
| 3 | SURNAME | | | | |
| 4 | ADDRESS | | | | |
| 5 | CITY | | | | |
| 6 | DATE_OF_BIRTH | | | | |
| 7 | PAID? | | | | |

table 11: Fields of the MEMBER database

| Database LEND | | | | | |
|---|---|---|---|---|---|
| Number | Field Name | Field Type | Width | Decimals | Index |
| 1 | BOOK_NR | | | | |
| 2 | MEMBER_NR | | | | |
| 3 | DATE_LEND | | | | |
| 4 | DATE_BACK | | | | |

table 12: Fields of the LEND database

## Section 4: Writing a Query

### Introduction

In this section we will learn how to write queries in dBase IV. There are two different types of queries; **'view queries'** and **'edit queries'**. In this course we will discuss the view query in detail and the edit query briefly, because the view query is more important for the 'WILDLIFE APPLICATION'.

With a **view query** it is possible to select records from a data file and arrange them in several orders. We will discuss **the making of view queries** in dBase IV and **two methods of the selection of records with a view query**. Furthermore, we describe the **operators** in dBase IV and the **linking of three data files** with a view query.

With an **edit query** it is possible to add, change, mark and unmark records, which comply with a condition. With a view query it is possible to perform **one of these** operation on **one** record at a time. With an edit query it is possible to perform **several** operations on **more than one** record at a time.

### The Making of a View Query

In the control center we can move the cursor to the colomn QUERIES on <create>. When we press ENTER, we see a screen where the **Layout Menu** is activated. The option **Add file to query** is high lighted. By pressing ENTER, we can choose from several data files. When we choose the option ROOM.DBF, we will see figure 8.

As we can see from figure 8, all the fields of the ROOM data file are shown (ROOM_NR, NUMBER_OF_BEDS, BATH?, FLOOR and RATE). This is presented on top of the screen. At the bottom we see 5 boxes, with in the first box **'View'**. In these boxes we can enter the fields we want to include in the view. The ↓-symbol before a field name, means that the field is included in the view. In figure 8 no fields are included in the view.

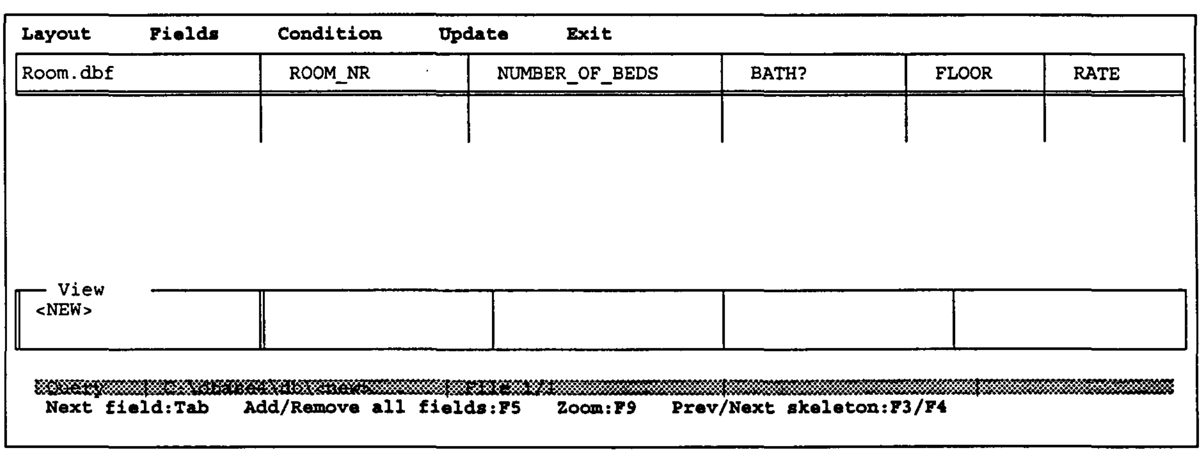



figure 8: The making of a view query

Pressing **TAB** moves the cursor to a field name. Pressing **F5** adds a field name to the view. When we move the cursor to the field name ROOM_NR and press F5, we will see figure 9.

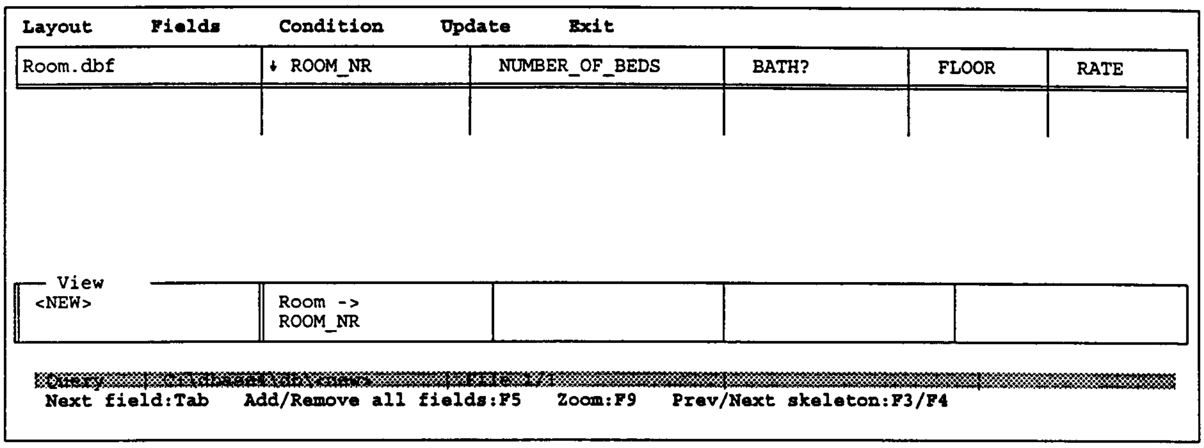



figure 9: Adding fields to a view

In figure 10, the view contains the the fields ROOM_NR, NUMBER_OF_BEDS and RATE. In the theory this activity is called **projection**. We say that the data file is **projected on** the fields ROOM_NR, NUMBER_OF_BEDS and RATE.

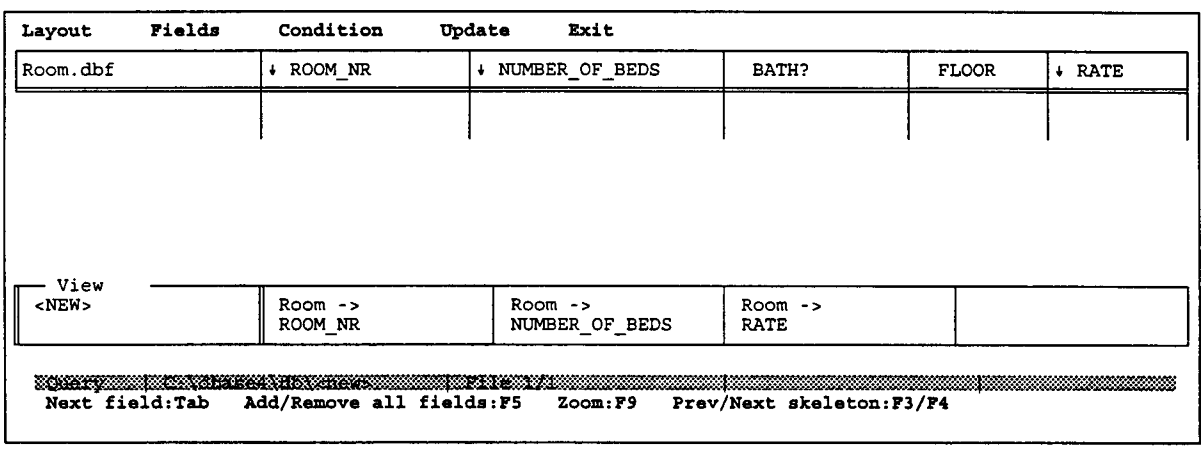



figure 10: 3 fields in the view

## Select with a View Query, Method 1

Besides **Projection** on a data file (including fields in the view), we can make a **selection** on a data file. With projection we exclude colomns of a data file. With selection we exclude rows (records) from a data file.

In figure 11, we select all the records from the ROOM data file, where the room number is greater than 100.

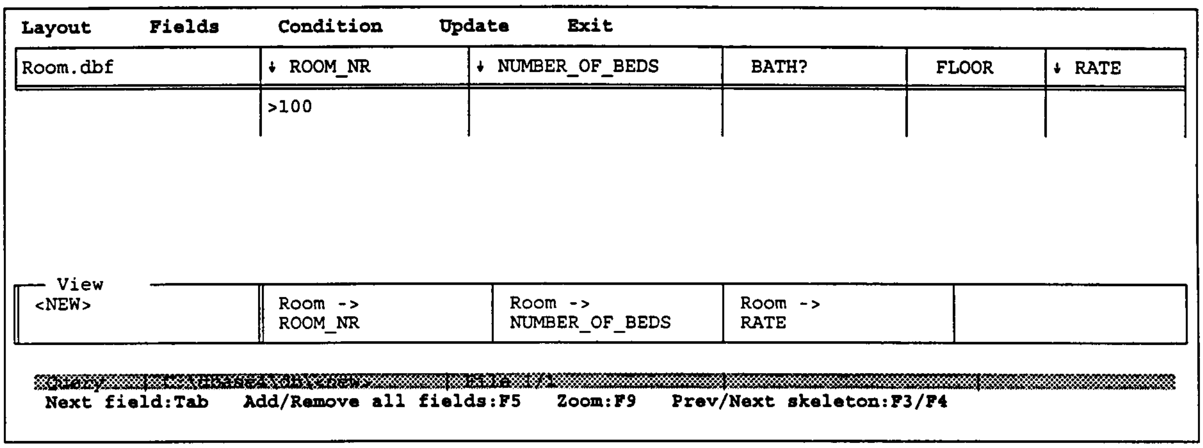



figure 11: Select rows (records) where ROOM_NR>100

In figure 12, we select all the records from the ROOM data file, where the room number is greater than 100 **AND** the number of beds is exactly 3.

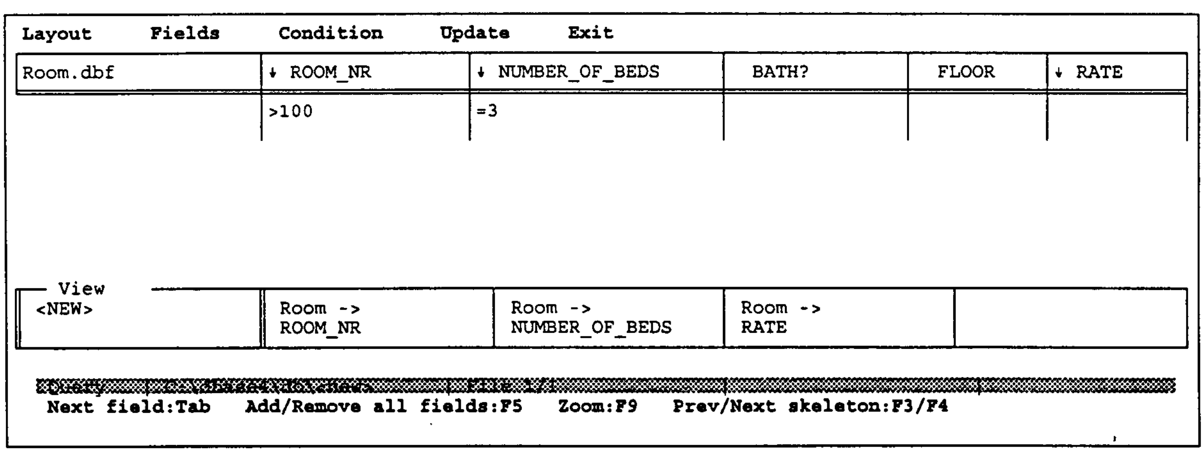



figure 12: Select rows (records) where ROOM_NR>100 and NUMBER_OF_BEDS=3

In figure 13 we select all the records from the ROOM data file, where the room number is greater than 100 **OR** the number of beds is exactly 3.

```
Layout    Fields    Condition    Update    Exit

| Room.dbf    | ↓ ROOM_NR | ↓ NUMBER_OF_BEDS | BATH? | FLOOR | ↓ RATE |
|             | >100      |                  |       |       |        |
|             |           | =3               |       |       |        |

View
| <NEW>  | Room ->  | Room ->         | Room -> |  |
|        | ROOM_NR  | NUMBER_OF_BEDS  | RATE    |  |

Query | C:\dbase4\db\<new> | File 1/1 |
Next field:Tab   Add/Remove all fields:F5   Zoom:F9   Prev/Next skeleton:F3/F4
```

figure 13 Select rows (records) where ROOM_NR>100 or NUMBER_OF_BEDS=3

### Select with a View Query, Method 2

Another method to select records from a data file will be described now. When we press **ALT-C**, we activate the option **Condition**. We can choose between '**Add condition box**', '**Delete condition box**' and '**Show condition box**'. We select 'Add condition box' and come to the figure below.

```
CONDITION BOX

```

In a **condition box** we can enter the selection criterion. The standard format of a selection criterion is:

**Field Name - Operator - Value**

When we want to select all the records where the field ROOM_NR is greater than 100, we have to enter in the condition box:

```
CONDITION BOX
ROOM_NR>100
```

| | | |
|---|---|---|
| where: | Field Name is: | **ROOM_NR** |
| | Operator is: | **>** |
| | Value is: | **100** |

When we want to enter **more than one** selection criterion in **one** condition box, we have to **separate** the selection criteria by a separation operator.

Suppose we want to select all the records where the field ROOM_NR is greater than 100 **AND** the field NUMBER_OF_BEDS is exactly 3, we have to enter in the condition box:

```
CONDITION BOX
ROOM_NR>100.and.NUMBER_OF_BEDS=3
```

| | | |
|---|---|---|
| where: | $1^{e}$ Field Name is: | **ROOM_NR** |
| | $1^{e}$ Operator is: | **>** |
| | $1^{e}$ Value is: | **100** |
| | Seperation Operator is: | **.and.** |
| | $2^{e}$ Field Name is: | **NUMBER_OF_BEDS** |
| | $2^{e}$ Operator is: | **=** |
| | $2^{e}$ Value is: | **3** |

## Operators in dBase IV

In dBase IV we can distinguish 6 groups of operators. These are:

- **Relational Operators**
- **Seperation Operators**
- **Ordering Operators**
- **Summary Operators**
- **The Unique Operator**
- **The Find Operator**

The most important operators are:

| Operator Group | Operator | Meaning |
|---|---|---|
| Relational | ><br>< <br>=<br>< > and #<br>> =<br>< =<br>$<br>like | greater than<br>less than<br>equal to<br>not equal<br>greater than or equal<br>less than or equal<br>contained in<br>pattern match |
| Seperation | .or.<br>.and. | or<br>and |
| Ordering | asc<br>dsc | ascending alphabetical<br>descending alphabetical |
| Summary | avg<br>sum<br>min<br>max<br>count | average<br>the sum<br>the minimum<br>the maximum<br>the number |
| Unique | unique | shows only one record when there exist more records with the same contents |
| Find | find | shows the record satisfying the condition accompanied by the preceding and succeeding record |

table 13: Operators in dBase IV

## Some Examples of Operators

```
CONDITION BOX
VIS_NAME="RAAPHORST"
```

After activating this **query**, the view will contain all the records where the field VIS_NAME = "RAAPHORST".

```
CONDITION BOX
VIS_NAME$"A?A"
```

Acivating this **query** returns all records where the name of the visitor contains the the character A, succeeded by any other character and than again succeeded by the character A. For example: the record where VIS_NAME = "**ZAF<u>ARA</u>NI**" will be present in the view.

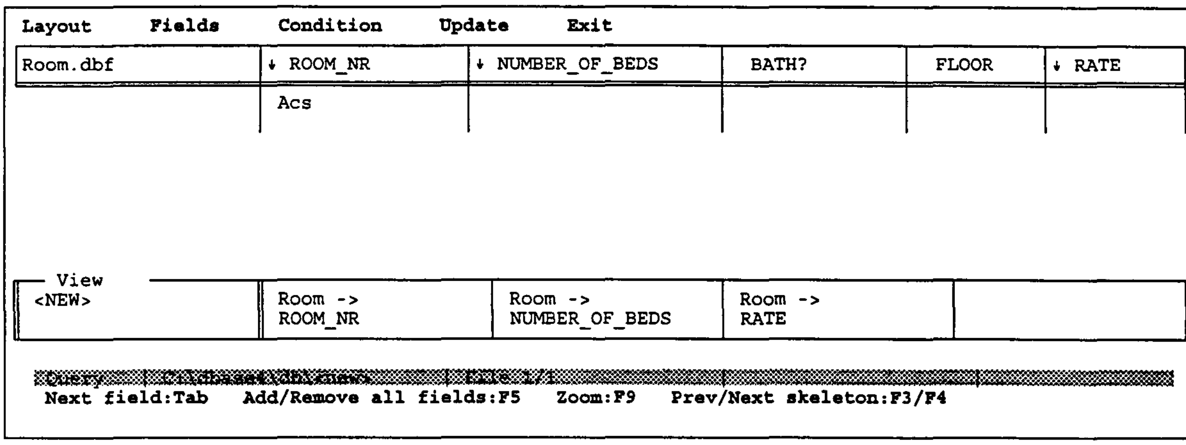



figure 14: Room numbers in ascending order

In the view, resulting from the query in figure 14, the room numbers will be in an ascending order.

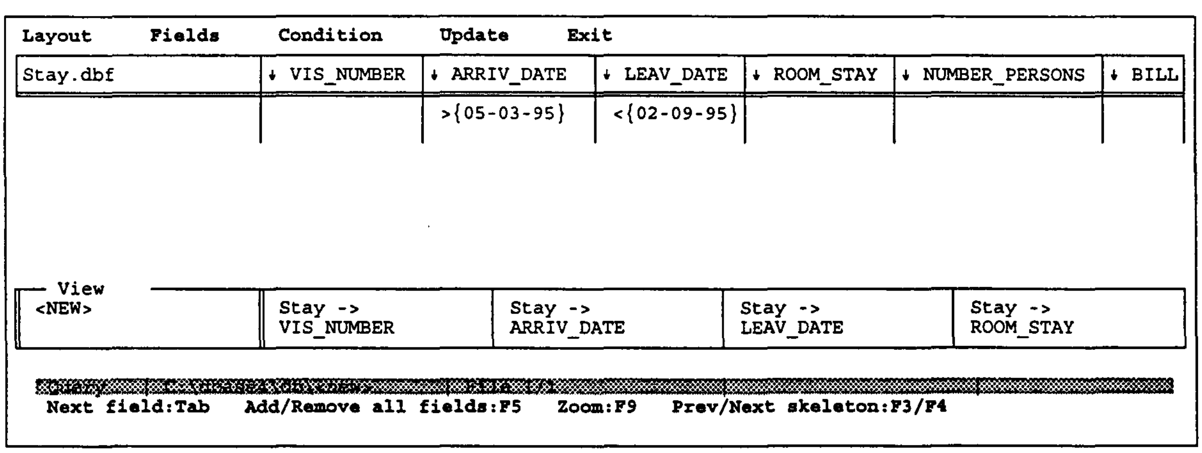



figure 15: Date fields used in the condition

In figure 15, we want all the records of STAY.DBF where the visitors arrived after 5 march 1995 **AND** left before 2 september 1995.

## Linking Three Files

In this course, we have often mentioned the term "**link**". We know that linking data files solves the problems of **more-to-more** relations. In this paragraph we will discuss in detail what happens when we link two or three files with each other. **Linking data files is only possible when they have corresponding fields**. This means that the fields must have the same **type**, **width** and **number of decimal** (if numeric). The field names **can** be different.

| data file Y | |
|---|---|
| A | B |
| a | 1 |
| b | 1 |
| c | 2 |

| data file Z | |
|---|---|
| A | C |
| a | * |
| b | ? |
| c | / |

| data file Y linked with Z | | |
|---|---|---|
| A | B | C |
| a | 1 | * |
| b | 1 | ? |
| c | 2 | / |

Suppose we want to link VISITOR.DBF and STAY.DBF from the hotel administration. They have one field in common. This is the field 'VIS_NUMBER'. Now we can link the two data files by means of this field. Suppose, the data files contain the following records:

| STAY.DBF | | | | | |
|---|---|---|---|---|---|
| VIS_NUMBER | ARRIV_DATE | LEAV_DATE | ROOM_STAY | NUMBER_OF_PERSONS | BILL |
| 233 | 04-06-1995 | 10-06-1995 | 101 | 0 | 24000 |
| 245 | 05-06-1995 | 14-06-1995 | 304 | 2 | 45000 |
| 260 | 03-06-1995 | 07-06-1995 | 207 | 1 | 16000 |
| 268 | 31-05-1995 | 08-06-1995 | 106 | 0 | 36000 |
| 275 | 04-06-1995 | 07-06-1995 | 301 | 3 | 24000 |

table 14: Some records of STAY.DBF

| VISITOR.DBF | | | | |
|---|---|---|---|---|
| VIS_NUMBER | VIS_NAME | VIS_STREET | VIS_CITY | VIS_COUNTRY |
| 233 | KITWARA | MANDELA ROAD | DAR ES SALAAM | TANZANIA |
| 245 | SEVERA | SAMORA AVENUE | DAR ES SALAAM | TANZANIA |
| 260 | NGONYANI | UN ROAD | DAR ES SALAAM | TANZANIA |
| 268 | RAAPHORST | BOSCHDIJK | EINDHOVEN | NETHERLANDS |
| 269 | CLINTON | WHITE HOUSE | WASHINGTON | AMERICA |

table 15: Some records of VISITOR.DBF

When we link the two databases, we create one new database (a view), with the following content:

| VISITOR.DBF and STAY.DBF linked with a **view query** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| VIS_ NUMBER | ARRIV_ DATE | LEAV_ DATE | ROOM_ STAY | NUMBER_ OF_ PERSONS | BILL | VIS_ NAME | VIS_ STREET | VIS_ CITY | VIS_ COUNTRY |
| 233 | 04-06-1995 | 10-06-1995 | 101 | 0 | 24000 | KITWARA | MANDELA ROAD | DAR ES SALAAM | TANZANIA |
| 245 | 05-06-1995 | 14-06-1995 | 304 | 2 | 45000 | SEVERA | SAMORA AVENUE | DAR ES SALAAM | TANZANIA |
| 260 | 03-06-1995 | 07-06-1995 | 207 | 1 | 16000 | NGONYANI | UN ROAD | DAR ES SALAAM | TANZANIA |
| 268 | 31-05-1995 | 08-06-1995 | 106 | 0 | 36000 | RAAPHORST | BOSCHDIJK | EINDHOVEN | NETHERLANDS |

table 16: VISITOR.DBF and STAY.DBF linked with a view query

When we consider table 16, we see that the view contains only 4 records, while table 14 and table 15 contain 5 records each. The reason for this is that the visitor numbers 275 and 269 are not equal.

## Linking Three Files in dBase IV

Now, we will discuss how we can implement a link in dBase IV. We will link the three data files from the hotel administration. When we add the data files ROOM.DBF, STAY.DBF and VISITOR.DBF into the view, from the Layout Menu, we can link them as follows.

**Layout    Fields    Condition    Update    Exit**

| Room.dbf | ↓ ROOM_NR | NUMBER_OF_BEDS | ↓ BATH? | FLOOR | RATE |
|---|---|---|---|---|---|
| | link2 | | | | |

| Stay.dbf | VIS_NUMBER | ARRIV_DATE | LEAV_DATE | ROOM_STAY | NUMBER_PERSONS | BILL |
|---|---|---|---|---|---|---|
| | link1 | | | link2 | | |

| Visitor.dbf | VIS_NUMBER | ↓ VIS_NAME | VIS_STREET | VIS_CITY | ↓ VIS_COUNTRY |
|---|---|---|---|---|---|
| | link1 | | | | |

| View <NEW> | Room -> ROOM_NR | Visitor -> VIS_NAME | Room -> BATH? | Visitor -> VIS_COUNTRY |
|---|---|---|---|---|

**Next field:Tab    Add/Remove all fields:F5    Zoom:F9    Prev/Next skeleton:F3/F4**

figure 16: Linking three fields with a view query

We can link the corresponding fields by typing corrosponding words in the fields. For example: ROOM_NR and ROOM_STAY are corrosponding fields. When we type link2 in both fields, dBase IV will link them when we activate the view query. Instead of link2, we can use every word as long as they are identical.

## The Edit Query

Besides the view query, we have the edit query. With an edit query we can change more than one record in a data file. DBase IV has four different edit queries.

**Append** A query to add records from other data files.

When we use **append**, the field types must be identical. Suppose we get a data file that contains animal species, which are not present in the current animal species data file. Now we can adjust the new data file, so that it has the same fields as the existing data file. When we make an append query we can add the records from the new data file to the old one. We don't have to type them again.

**Replace** A query which can change the field contents of a data file.

When we use **replace**, we must use a 'CONDITION BOX' to indicate which records have to be changed.

**Mark** A query to mark records which satisfy a specific condition.

Marked records will be deleted from the data file.

**Unmark** A query to cancel the marking of records.

For further information about edit queries, we refer to the **manual of dBase IV.**

## An Exercise: Library Administration

For the library administration we want to make a view. In this view we want to include the fields 'TITLE', 'AUTHOR' and 'BOOK_LEND'. Furthermore, we want all the records where the name of the author is Lilian and we want the titles in a ascended order. Fill in figure 17, so that we remain with a view that comply with the above restrictions.

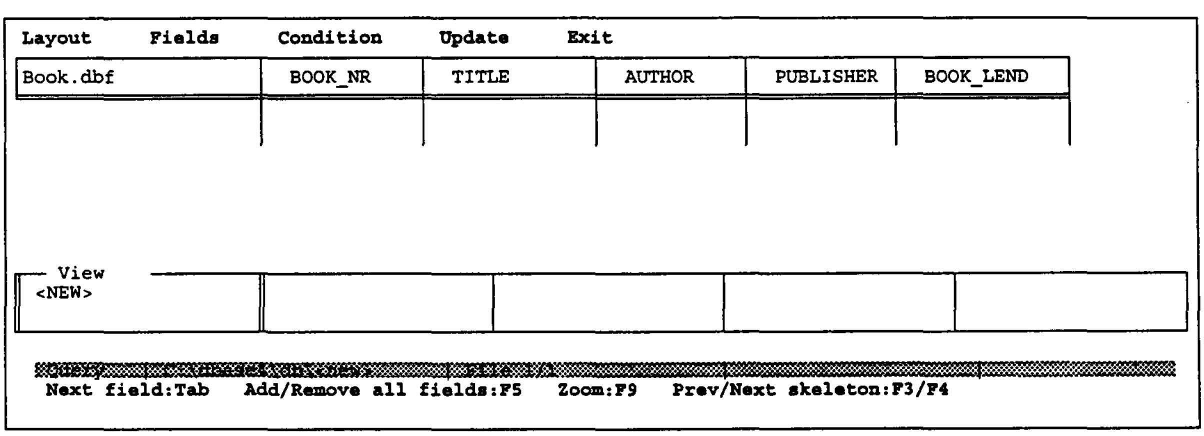



figure 17: Book.dbf in the view

In the next exercise we want to link the databases of the library administration with each other. In table 17 we see all the fields of the databases of the library administration.

| Database BOOK | Database PERIODICAL | Database MEMBER | Database LEND |
|---|---|---|---|
| BOOK_NR<br>TITLE<br>AUTHOR<br>PUBLISHER<br>BOOK_LEND | NAME<br>PUBLISHER<br>DATE_OF_ISSUE<br>PERIODICAL_LEND | MEMBER_NR<br>FIRST_NAME<br>SURNAME<br>ADDRESS<br>CITY<br>DATE_OF_BIRTH<br>PAID? | BOOK_NR<br>MEMBER_NR<br>DATE_LEND<br>DATE_BACK |

table 17: Fields of the library databases

Link the data files BOOK.DBF, MEMBERS and LEND with each other by completing figure 18.

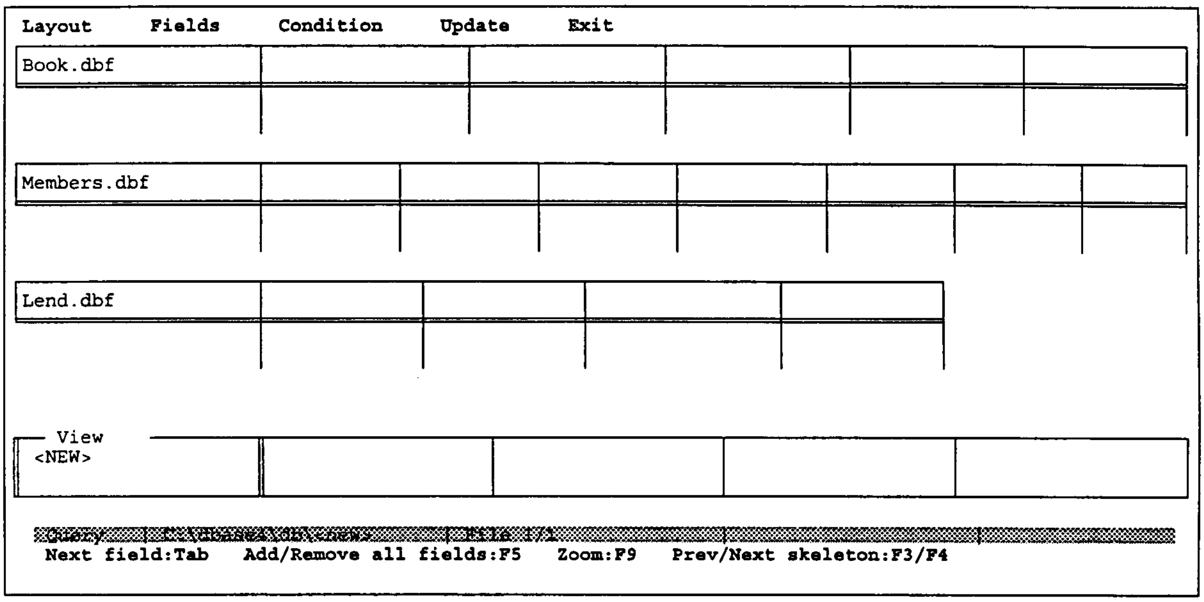



figure 18: Linking three fields of the library administration

# Section 5: The User Interface

In this section we will discuss the development of input and output screens. Input and output screens form the **User Interface** of an information system. A User Interface determines the **user friendliness** of an information system and therefore an important factor for the success of the application.

By means of an **input screen** we can enter data in a database. Hence, we have to include a .DBF file to an input screen. On the other hand, an **output screen** can present us data of a view (file with extension .QBE). In a view we can **combine** data from different data files. With an output screen it is possible to include only those fields that we want to show to the user.

In this section we will first discuss the menu options of the screen maker in dBase IV. In dBase IV we can choose from the **Control Center**, by moving the cursor, the option '**form**'. Pressing ENTER shows us figure 19.

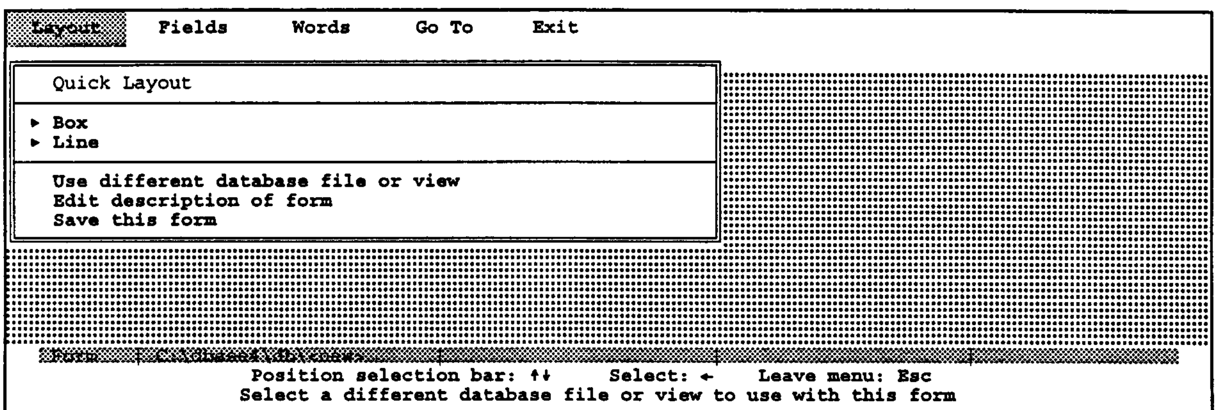


figure 19: opening screen

## The Layout Menu

We start from figure 19. We can only select options that are presented **bold**. When we choose the option '**Use different file or view**', dBase IV shows us a list of .DBF and .QBE files. We can select one of these files and include those fields in the screen. First, we select the ROOM.**DBF** data file to create an **input screen**. Later in this section we will use the STAYS.**QBE** to make an **output screen.**

After the selection of the data file ROOM.DBF, the option '**Quick Layout**' will be presented **bold**. Activating the option '**Quick Layout**' will lead to figure 20.

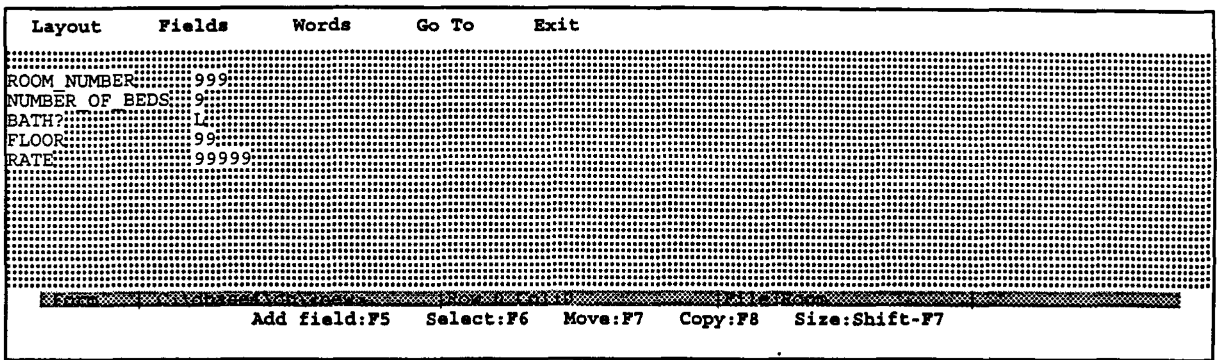



figure 20: Quick Layout

With the function key's we can bring the screen to perfection. Pressing **F5** activates table 18.

| VISITOR | CALCULATED |
|---|---|
| ROOM_NUMBER<br>NUMBER_OF_BEDS<br>BATH?<br>FLOOR<br>RATE | |

table 18: Pressing F5, Add field

By moving the cursor we can select one of the fields and **add** this field to the screen. With the function key **F6** we can **select** a block so we can move, copy or delete it. First move the cursor to the beginning of the block, then press **F6** and move the cursor to the end of the block. Press ENTER and we finish the block selection.

With **F7** we can **move** the block and **F8** will **copy** the block. . From the '**Layout Menu**' we can draw boxes and lines. When we select ▸ **Box** or ▸ **Line**, dBase IV shows us three options; '**Single line**', '**Double line**' and '**Using specified character {}**'. When we select one of these options we return to the screen maker. Now we have to press ENTER to indicate the beginning of the box or line, then move the cursor to the end point and press ENTER again. We can use **Shift-F7** to increase or decrease the size of the box.

## The Fields Menu

With the **'Field Menu'** we can **Add, Remove** or **Modify** a field. When we select **Add field** we come to table 18 again. After the selection of the field 'ROOM_NUMBER', dBase IV shows us figure 21.

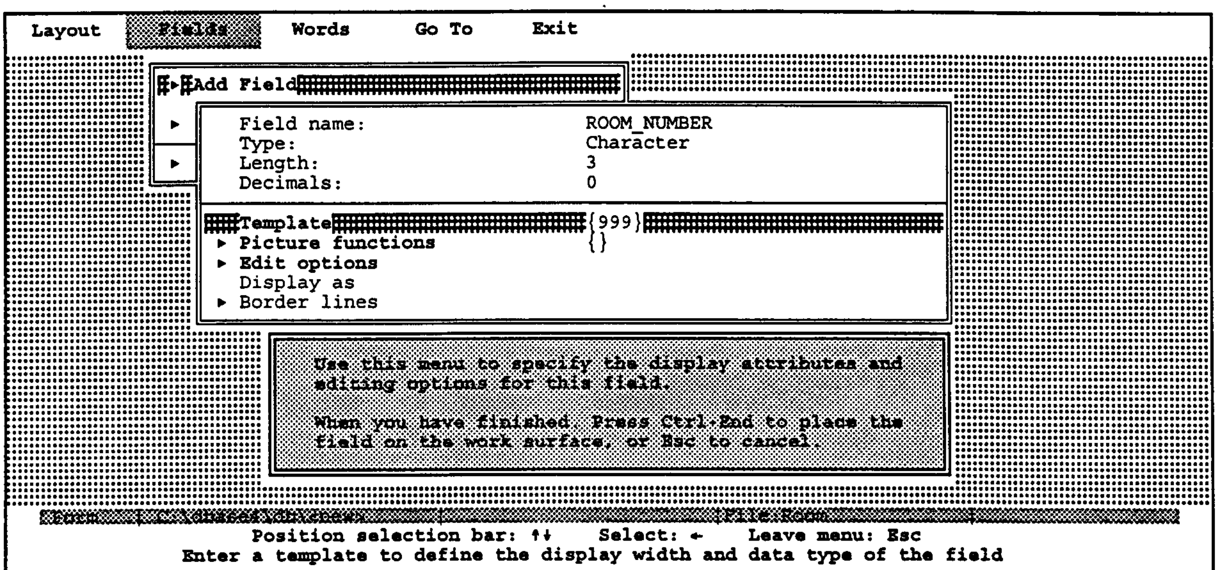



figure 21: Defining the field ROOM_NUMBER

We will now discuss all the options that are printed **bold**. We will start with the option **'Template'**, then **'Picture functions'** and we will end with **'Edit options'**.

### TEMPLATE:

This option can be used while we are making **input screens** and can protect us against input failures. Figure 21 shows us the template {999}, this means that we can only enter 3 digits in this field. So, the character **'9'** means that we can enter a digit only on the specified position. We can choose between 12 different symbols to place in the template, see table 19.

| Symbol | Description |
|---|---|
| Y | Y (yes) or N (no) allowed in alpha numeric or logical fields |
| L | Logical field, T (true), F (false), Y (yes), or N (no) allowed |
| 9 | Numeric field, digit or algebraical symbol allowed |
| # | Digit, space or algebraical symbol allowed |
| A | Only alpha characters allowed |
| N | Alpha characters and digits allowed |
| X | All characters allowed |
| ! | First alpha character turns to capital letter |
| * | Leading zeroes will be presented with * |
| $ | Leading zeroes will be presented with $ |
| . | Place decimal symbol |
| , | Division symbol between thousands |

table 19: Possible symbols in a template

Suppose we want to make an input field for the latitude and longitude values. Then the template can look like: **99°99'!/99°99'!**. Entering an alpha character in a '9'_position would be rejected accompanied by a sound signal.

**PICTURE FUNCTIONS:**

This option provides us the possibility to give a field very useful functions. ROOM_NUMBER has the field type '**Numeric**'. Later on we will deal with a '**Character**' field, because there are main differences between the two field types with regard to picture functions. Other field types are not discussed in this course. Pressing ENTER while '**picture functions**' is high lighted, will lead us to figure 21.

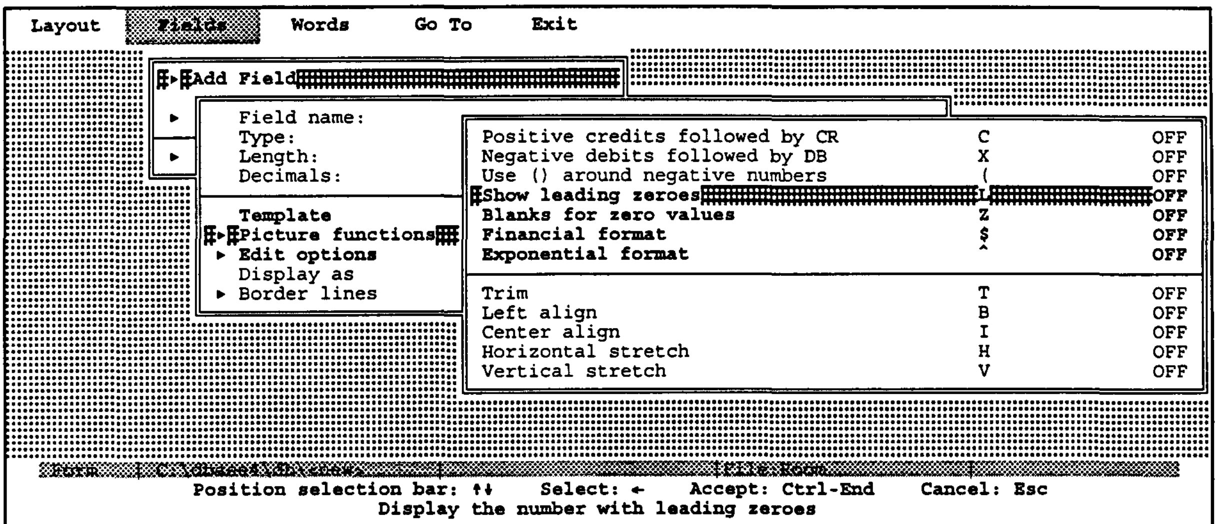


figure 21: Picture functions of a numeric field

We can activate an option by pressing ENTER. **OFF** will change in **ON**. We will only discuss he options that are printed **bold**.

The option '**Show leading zeroes**' makes it possible to put zeroes in front of every numeric field.

If the option '**Blanks for zero values**' is **ON**, the field will appear empty if the content of the numeric field is zero.

When we are dealing with financial data we can put a financial symbol in front of the field by activating the option '**Financial format**'. Standard the symbol is **$**, but by running DBSETUP we can select any financial symbol.

The last option, '**Exponential format**', will present the numeric value exponential. For example: **1,457,000**, will be presented as **1.457E6**.

When we are dealing with a 'character' field, pressing ENTER while '**Picture functions**' is high lighted, will lead to figure 22.

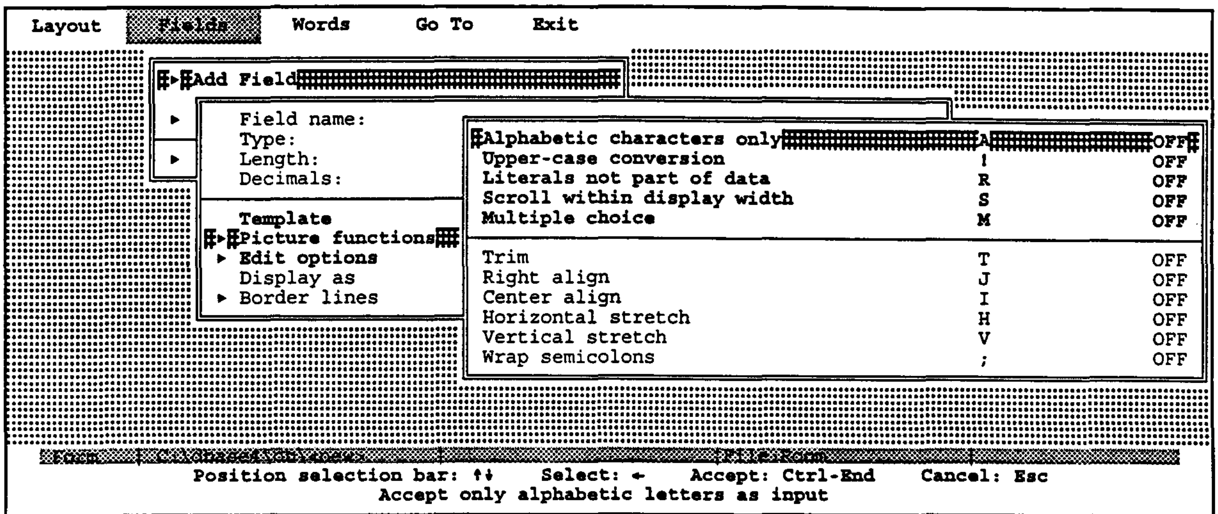


figure 22: Picture functions of a character field

We can activate an option by pressing ENTER. **OFF** will change in **ON**. Again, we will only discuss the options that are printed **bold**.

The option '**Alphabetical characters only**' is similar with a template filled with the symbol '**A**'.

The option '**Upper-case conversion**' is similar with a template filled with the symbol '**!**'.

The option '**Literals not part of data**' makes it possible to keep special format characters out of the database. This option can save us memory on the hard disk.

Activating '**Scroll within display width**' will provide us the possibility to decrease the field width on the screen. For example, when the field width is 30, we can decrease this field width to 20 and activate the '**Scroll within display width**'. In case the content of the field exceeds the 20 characters we can use the cursor to move within the field.

The last option is also very useful. The option '**Multiple choice**' makes it possible to enter all possible values. Pressing SPACE will present us all these possible values. This is very useful for the '**Soil type registration**' of the 'WILDLIFE APPLICATION', where we have for the field 'SOIL_ORDER', five possible values namely: ENTISOL, VERTISOL, INCEPTISOL, ULTISOL and OXISOL. This will decline the number of input failures enormously.

## EDIT OPTIONS:

Pressing ENTER while **'edit options'** is high lighted, will lead to figure 23.

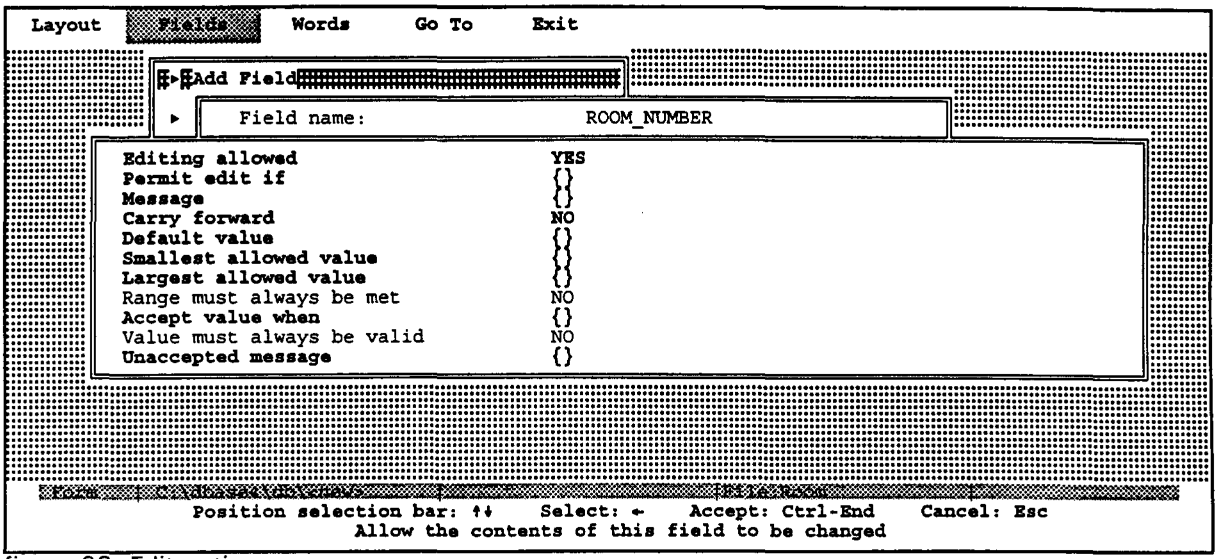


figure 23: Edit options

Edit options are the same for each field type, so here we don't discriminate between **'Numeric'** fields and **'Character'** fields.

When the option **'Editing allowed'** is put on **NO**, the other options will be omitted.

With the option **'Permit edit if'**, we can use any dBase expression to control the editing of records. For example, when we don't want to change the records in the ROOM data file, where the number of the room is greater than 100, we can enter after the **'Permit edit if'** option, the dBase expression **'ROOM_NUMBER< =100'**.

The option **'Message'** gives us the possibility to show the user a message when he or she enters this field. For the field ROOM_NUMBER, we can present the user the message :**'Enter the number of the room'**.

If **'Carry forward'** is put on **YES**, a new added record will contain for this field the same value as the last added record.

The **'Default value'** will always be presented to us, when we are adding records.

The **'Smallest allowed value'** and **'Largest allowed value'** makes it possible to specify a range for the field. For example: when we have a numeric field, in which we record the **year of establishment** of a protected area, we know that this value must be between 1900 and 2050.

When we have entered a smallest and largest allowed value, the option **'Range must always be met'** will be presented **bold.** When we set this option to **NO**, dBase IV will except all entered values. **YES**, will reject not allowed values.

We can place a dBase expression behind the option **'Accept value when'**, if we want to reject input values that cannot be rejected otherwise. Suppose that a room can only contain a bath when the room is on the first or second floor. The **'edit options'** of the field BATH? will contain, for the option **'Accept value when'**, the dBase expression: **'FLOOR=1.or.FLOOR=2'**.

When the option **'Accept value when'** is filled in, the option **'Value must always be valid'** will be presented **bold. NO** will accept all entered data. **YES,** will only accept input data that satisfies the dBase expression.

The last option, **'Unaccepted message'**, gives us the possibility to present a message to the user when the input data is rejected. For example: **'Entered data is not valid'**.

### The Words Menu

With **'the Words Menu'** it is possible to change the layout of the screen. From the Words Menu we will only discuss the option **'Display'**, because this option is used during the development of the 'WILDLIFE APPLICATION'.

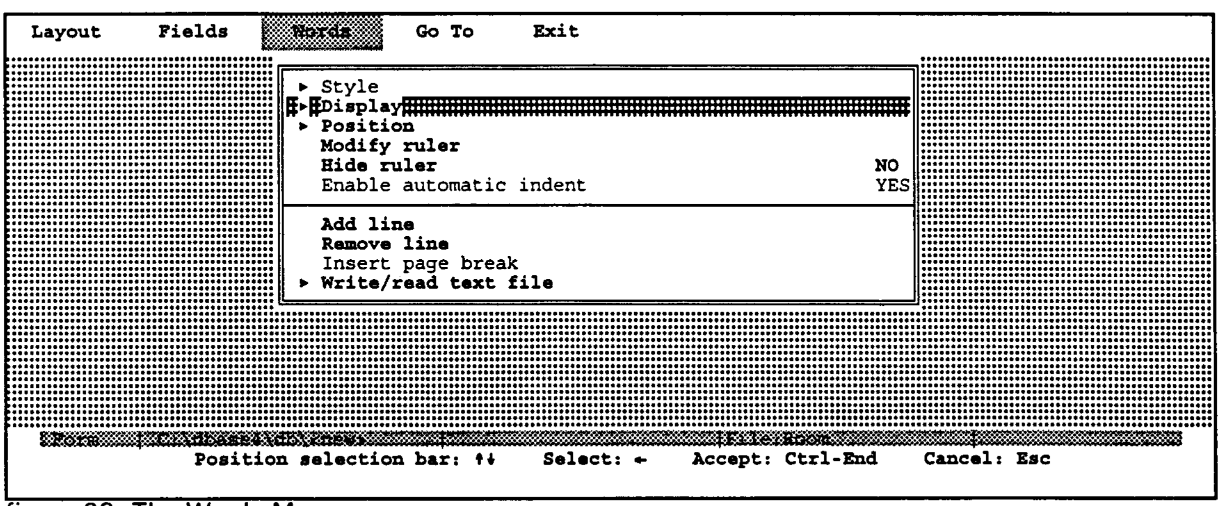


figure 23: The Words Menu

Pressing ENTER while the option **'Display'** is high lighted, will show us a template, where we can choose a foreground colour and a background colour by moving the cursor. This selection of colours will start from the cursor position and will be active every line until other colours are selected.

It is also possible to change the colours of a line, box or an area by selecting a line, box or an area by means of **F6**. Now we can activate the **'Display'** option and change the colours.

## The Go To and Exit Menu

The '**Go To Menu**' provide us some useful editing tools to, when we develop big screens, with more pages. Then we are able to search for lines by number, jump to a specified field and replace words or symbols.

The '**Exit Menu**' has only two options, namely '**Save changes and exit**' and '**Abandon changes and exit**'. This options are obvious.

## The Making of an Output Screen

**Output screens** can be made in the same way as input screens. Here we will discuss the differences between output and input screens. For Output screens we use **.QBE** files. We will discuss output screens by using the file STAY.QBE, which we made in section 4 and is shown in figure 24.

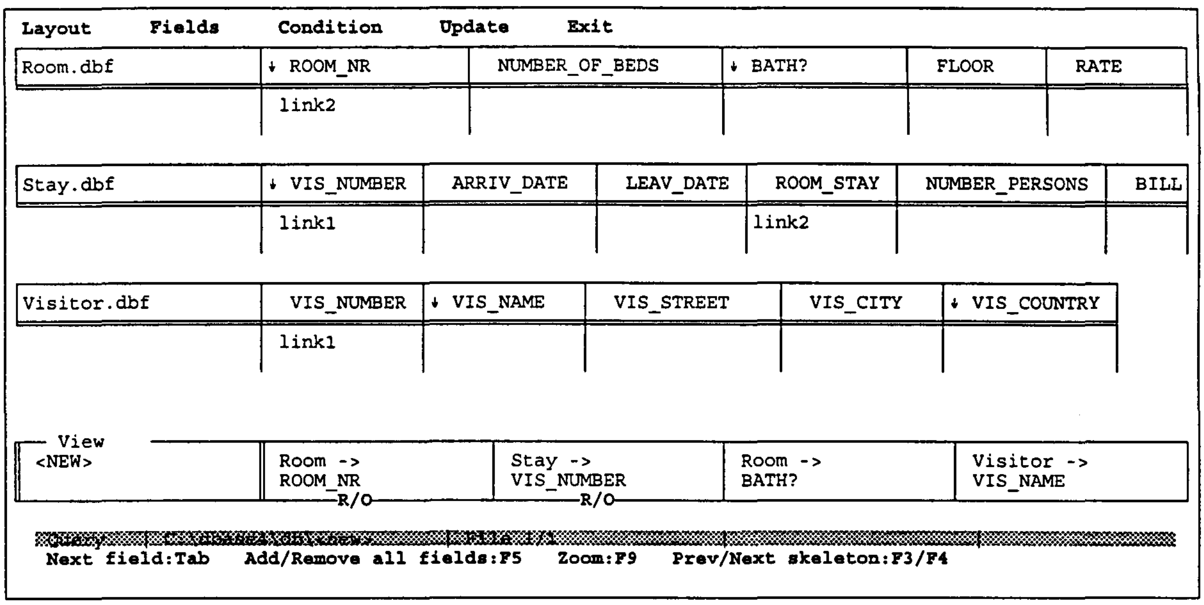



figure 24: The view query STAY.QBE

The **view** contains 5 fields; ROOM_NR, VIS_NUMBER, BATH?, VIS_NAME and VIS_COUNTRY. The linked fields ROOM_NR and VIS_NUMBER in the view are marked with **R/O**, which means **read only**. This means that we can not change the content of these fields by using this query.

Suppose we use the option '**Use different database file or view**' from the '**Layout Menu**' and select STAY.QBE. With '**Quick Layout**' all the fields of the view, will appear on the screen. When we use this screen we will see that dBase IV skips the **read only** fields ROOM_NR and VIS_NUMBER. This is why we call this screen an **output screen.**

## Section 6: The Application

In this last section we will learn, how to generate an **application**. An application is a list of commands, a **program**. In dBase IV it is possible to generate such a program and we can create menu's to make the program user friendly. The generation requires the created data files, queries and forms. It is possible to expand the application with reports and labels.

We start this section with the **creation of an application.** After that we will see how we can **create menu's** and how we can **activate menu items.** Not all the possibilities of applications in dBase IV will be discussed in this course. We will only discuss the options that are relevant for the 'WILDLIFE APPLICATION'

### The Creation of an Application

In the Control Center, we can select <**create**> in the column '**applications**'. We can choose between a '**dBase program**' and the '**Applications Generator**'. We choose the Application Generator, which will result in a screen where we can **define** the application. Defining an application implies that we have to enter the following data:

**Application name:** Here, we can enter the name of the application, which will have the extension .APP. After the generation of the application, DBase IV will create a file with extension .PRG.
**Description:** Enter the description of the application.
**Main menu type:** We can choose from five different menu types; BAR, POP-UP, FILES, STRUCTURE and VALUES.
**Main menu name:** Enter the name of the menu.
**Database/view:** Enter the database (.DBF) or view (.QBE), which must be included in the application.
**Set INDEX to:** Enter the index file (.MDX) which must be used in the application.
**ORDER:** Enter the field name on which we want to order the data file. This must be a field name, where INDEX is 'YES' in the data file definition.

After accepting the application definition, dBase IV will present us a screen with 5 option. We will discuss the options '**Design**', '**Application**', '**Generate**', '**Preset**' and '**Exit**'.

**Design:** With this option, we can design menu's. DBase IV shows us 5 different menu types and a batch process. The important menu types are '**Horizontal bar menu**' and '**Pop-up menu**'.
**Application:** In figure 26 we can see the options from this menu. With '**Display Sign-on banner**', we can present the user a welcome screen (sign-on banner) with information of about the application. The option '**Modify application environment**' makes it possible to change the colours during the application run-time. Furthermore, we can change the

settings and the application drive and path. We can use **'Generate Quick application definition'**, when we want to perform only standard operations on one data file. We will not use this option during the development of the 'WILDLIFE APPLICATION'

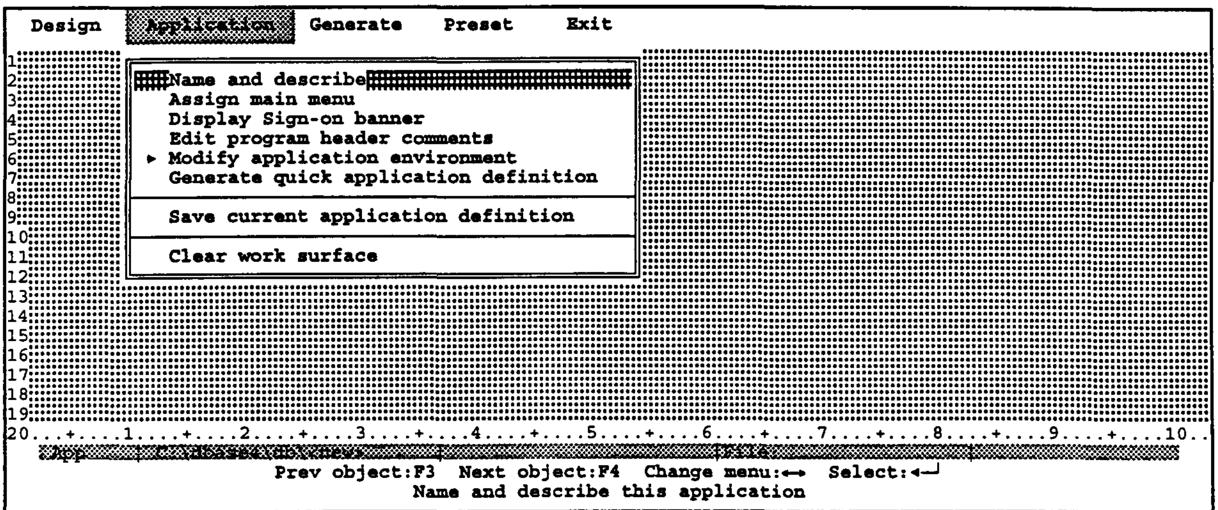


figure 26: The Applications Option

**Generate:** After defining the application we have to **generate** it to a dBase IV program (.PRG).

**Preset:** **'Preset'**, can change the settings and colours of the sign-on banner.

**Exit:** This option is obvious.

## Making Menu's

The 'WILDLIFE APPLICATION' will only exist of **POP-UP menu's**. When we select 'POP-UP menu' from the design option of figure 26, we will come to figure 27. With figure 27 we can design the **menu's**. We will now discuss the relevant options for making menu's.

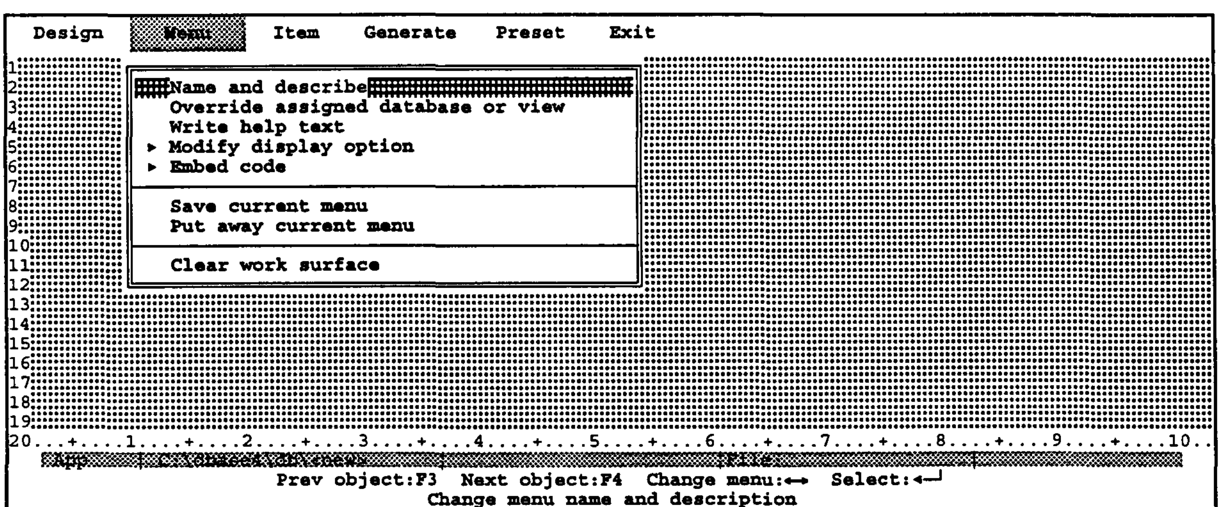


figure 27: The Menu Option

**Override assigned database or view:**
In the definition of the application, we have selected a data file to use in the application. This option makes it possible to change the data file (.DBF), the index file (.MDX) and the field name on which we want to order the data file for this menu.

**Write help text:** Pressing **F1** during run-time will show this text, to assist the user to perform an action.

**Modify display options:**
This can change the colours of this specific menu.

**Embed code:** Sometimes it might be necessary to add dBase commands **before** or **after** the presentation of a menu. With this option we can add dBase IV commands.

DBase IV shows us a box, where we can enter menu items. For example, '**Add Records**', '**Delete Records**' and '**Exit Menu**'. We can **move** the box and we can change the size of the box. After the creating of the menu, we have to assign actions and/or restrictions to the items.

## Activating Menu Items

Figure 28 shows us the '**Item Menu**'. The relevant options will be discussed now.

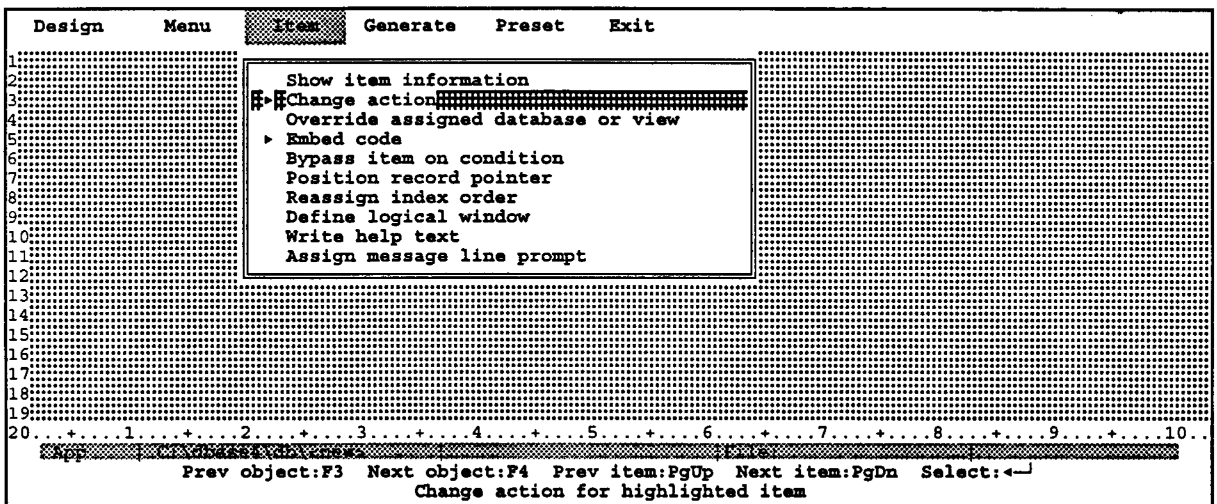


figure 28: The Item Option

**Show item information:**
This option will present us the selected database or view, the index file with the indexed field name. Furthermore, it presents the selected action.

**Change action:** This is the **most important option** of the application generator, because with this option we can perform all kinds of actions, which will be explained later.

**Override assigned database or view:**
In the definition of the application and menu, we have selected a data file to use in the application or menu. This option makes it possible to change the data file (.DBF), the index file (.MDX)

and the field name on which we want to order the data file for this item.

**Embed code:** Sometimes it might be necessary to add dBase commands **before** or **after** the execution of an action, assigned by the item. With this option we can add dBase IV commands.

**Bypass item on condition:**
There are cases where we want to skip a menu item. With this option we can enter a condition, which determines if the item is executable or not.

**Write help text:** Pressing **F1** during run-time will show this text, to assist the user to perform an action.

**Assign message line prompt:**
This option makes it possible to show the user a message when the cursor is put on the menu item.

The '**Change action**' option is the most important option and will be discussed here in detail. Figure 29 shows us the '**Change action**' menu. We can assign to one item, eight different actions.

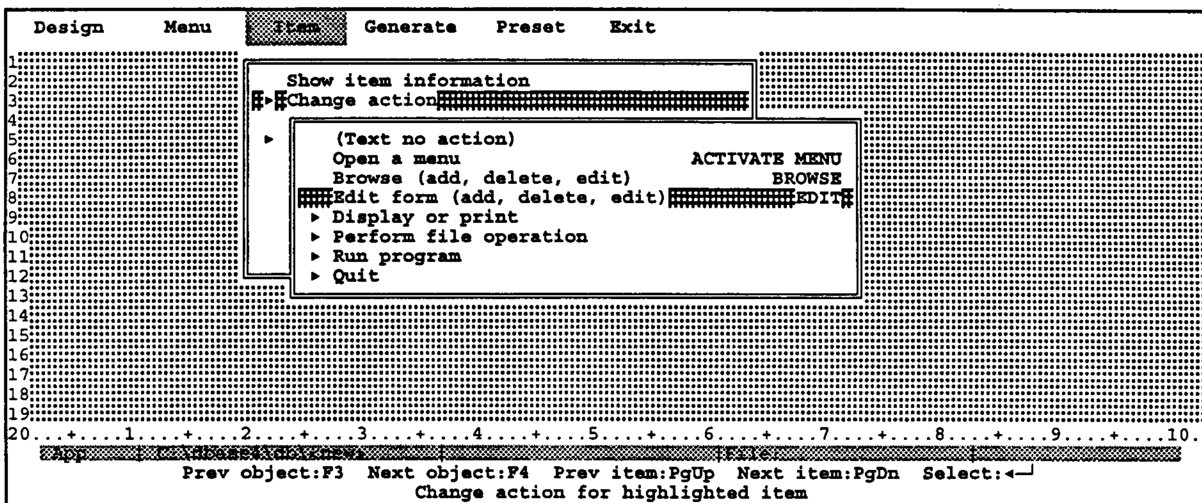



figure 29: The Change Action Option

**(Text no action):** When this action is executed, dBase IV shows the user only text, which can be entered by this option.

**Open a menu:** This action will open the menu, which can be entered by this option.

**Display or print:** With this action we can display or print records.

**Perform file operation:**
With this action we can add, delete or edit records immediately.

**Run program:** Every DOS or dBase IV program can be executed, when this action is executed.

**Quit:** There are two possibilities to quit. The first one is '**Quit to DOS**' and the second one is '**Return to calling program**'.

**Browse (add, delete, edit):**

When this action is executed, the database ordered by the indexed field name will be presented to the user in browse mode. We can choose the operations that are allowed on the database in the same way as the action **'Edit'**, which will be explained now.

**Edit (add, delete, edit):**

Executing this action will show the user the selected data file in a **form.** In figure 30, we see the **change action screen,** where we can enter some restrictions to the edit action.

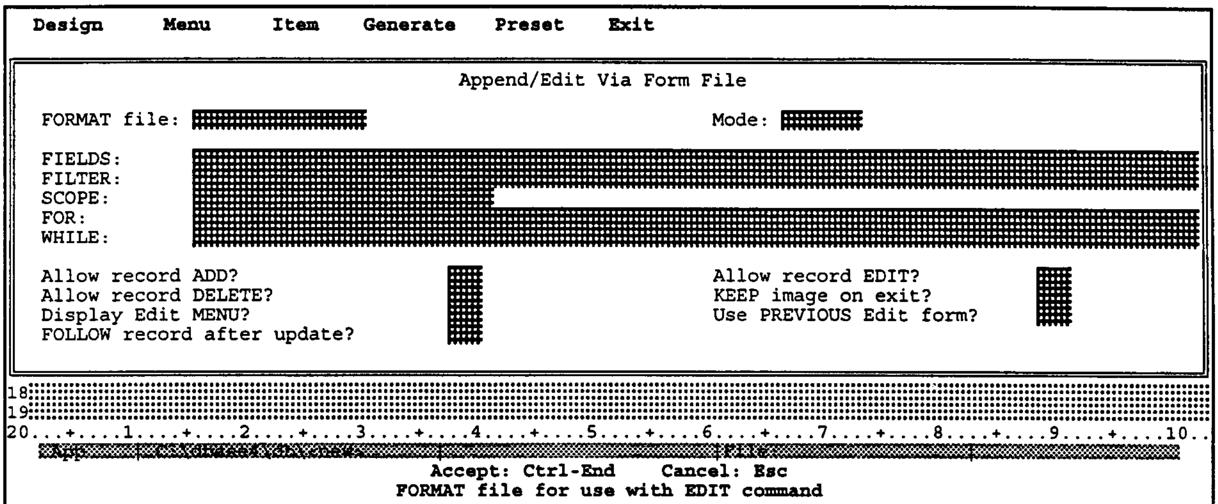



figure 30: The Change Action Screen

In the field **FORMAT file,** we must enter the name of the **form,** which we want to use of this action. The file name of a form has always the extension .FMT. The field **Mode** can be filled with APPEND or EDIT. In the case the field contains APPEND, we can perform all the operations on the data file. In the case the field contains EDIT, we can select the operations that are allowed **(add, delete** and **edit)** by entered YES (NO) after the question **'Allow record ADD (DELETE, EDIT)?'.**

# APPENDIX 2: THE DETAIL DESIGN OF THE 'TANZANIAN WILDLIFE APPLICATION'

This paragraph describes the detail design of the application. It has been divided in the parts: Data files; Fields in Databases; Views; Fields in Views; The Standard Layout of an Input Screen; Standard Layout of an Output Screen; The Templates and Picture Functions; Edit Options and Applications.

## Data files

| Entity | Database file |
|---|---|
| AREA | AREA.DBF |
| ANI_SPEC | ANI_SPEC.DBF |
| PLA_SPEC | PLA_SPEC.DBF |
| SOILTYPE | SOILTYPE.DBF |
| VISITOR | VISITOR.DBF |
| ANI_AREA | ANI_AREA.DBF |
| PLA_AREA | PLA_AREA.DBF |
| SOILAREA | SOILAREA.DBF |

Table 1: Data files

## Fields in Databases

| AREA.DBF | | | | | |
|---|---|---|---|---|---|
| Field Name | Field Type | Width | Dec | Index? | Description |
| AREA_NUM | Numeric | 3 | 0 | Y | Area Number |
| AREA_NAME | Character | 20 | | Y | Area Name |
| STATUS | Character | 20 | | N | Status |
| REGION | Character | 20 | | N | Region |
| SIZE_HEC | Numeric | 8 | 0 | N | Size in Hectares |
| LAT_LONG | Character | 15 | | N | Latitude/Longitude |
| ALTITUDE | Character | 9 | | N | Altitude |
| YEAR_EST | Numeric | 4 | 0 | N | Year of Establishment |
| SERVICES | Memo | 10 | | N | Services |
| REMARKS | Memo | 10 | | N | Remarks |

Table 2: Data file AREA.DBF

| ANI_AREA.DBF | | | | | |
|---|---|---|---|---|---|
| Field Name | Field Type | Width | Dec | Index? | Description |
| AREA_NR | Numeric | 3 | 0 | Y | Area Number |
| ANIMAL_NR | Numeric | 5 | 0 | Y | Animal Number |
| NUMBER | Numeric | 7 | 0 | N | Estimated Number of Animals |
| YEAR_EST | Numeric | 4 | 0 | N | Year of Estimation |
| SEASON_EST | Character | 3 | | N | Season of Estimation |
| AREA_EST | Numeric | 8 | 0 | N | Census Area (hec) |
| STAND_ERR | Numeric | 7 | 0 | N | Standard Error |

Table 7: Data file ANI_AREA.DBF

| PLA_AREA.DBF | | | | | |
|---|---|---|---|---|---|
| Field Name | Field Type | Width | Dec | Index? | Description |
| AREA_NR | Numeric | 3 | 0 | Y | Area Number |
| PLANT_NR | Numeric | 6 | 0 | Y | Plant Number |
| YEAR_EST | Numeric | 4 | 0 | N | Year of Estimation |
| SEASON_EST | Character | 3 | | N | Season of Estimation |

Table 8: Data file PLA_AREA.DBF

| SOILAREA.DBF | | | | | |
|---|---|---|---|---|---|
| Field Name | Field Type | Width | Dec | Index? | Description |
| AREA_NR | Numeric | 3 | 0 | Y | Area Number |
| SOIL_NR | Numeric | 5 | 0 | Y | Soil Type Number |
| SIZE_HEC | Numeric | 8 | 0 | N | Size of Soil in Hectares |

Table 9: Data file SOILAREA.DBF

## Views

| View Name | AN_AR_VW.QBE | PL_AR_VW.QBE | SO_AR_VW.QBE |
|---|---|---|---|
| Data file 1 | AREA.DBF | AREA.DBF | AREA.DBF |
| Data file 2 | ANI_SPEC.DBF | PLA_SPEC.DBF | SOILTYPE.DBF |
| Data file 3 | ANI_AREA.DBF | PLA_AREA.DBF | SOILAREA.DBF |

Table 10: View names and included data files

## Fields in Views

| View | AN_AR_VW.QBE | | |
|---|---|---|---|
| Data file | AREA.DBF | ANI_SPEC.DBF | ANI_AREA.DBF |
| Fields | AREA_NAME<br>STATUS<br>REGION | ANIMAL_NAME<br>CLASS | AREA_NR<br>ANIMAL_NR<br>NUMBER<br>YEAR_EST<br>SEASON_EST<br>AREA_EST<br>STAND_ERR |

Table 11: The fields of AN_AR_VW.QBE

| View | PL_AR_VW.QBE | | |
|---|---|---|---|
| Data file | AREA.DBF | PLA_SPEC.DBF | PLA_AREA.DBF |
| Fields | AREA_NAME<br>STATUS<br>REGION | PLANT_NAME<br>CLASS | AREA_NR<br>PLANT_NR<br>YEAR_EST<br>SEASON_EST |

Table 12: The fields of PL_AR_VW.QBE

| View | SO_AR_VW.QBE | | |
|---|---|---|---|
| Data file | AREA.DBF | SOILTYPE.DBF | SOILAREA.DBF |
| Fields | AREA_NAME<br>STATUS<br>REGION | TEXTURE<br>DRAINAGE<br>SOIL_ORDER<br>LAND_FORM | AREA_NR<br>SOIL_NR<br>SIZE_HEC |

Table 13: The fields of SO_AR_VW.QBE

## The Standard Layout of an Input Screen

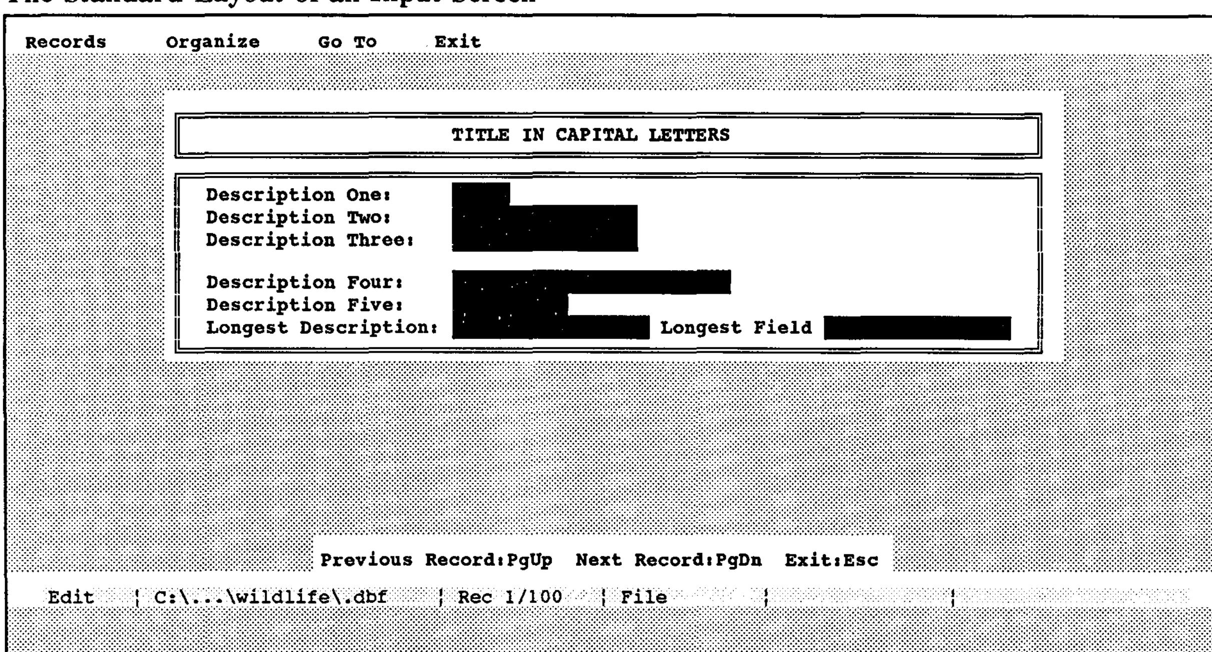



Figure 1: Standard layout of an input screen

Figure 1 contains two boxes. The first box shows the title of the screen in capital letters. The second box shows all the fields of the selected .DBF file. The width of the boxes is determined by the width of the longest description and the width of the longest field. Before each description we place two spaces, then the description followed by the ':'-symbol. Furthermore, we place spaces up to the field. The number of spaces after the longest description is only one, as we can see in figure 4. After the longest field we have to place two spaces up to the box.

The position of the boxes is in the centre of the screen. The position of the title is in the centre of the box. The position of the descriptions and the fields is determined by respectively the longest description and the longest field. At last the position of the sentence 'Previous Record:PgUp Next Record:PgDn Exit:Esc' is also in the centre of the screen. DBase IV put the messages and unaccepted messages, which can be entered as edit options, automatically at the bottom of the screen in the centre. Furthermore, we can group the field according to their meaning. In figure 1 we have grouped the first three fields and separatee the groups with a blank line.

The background colour of the screen is 'cyan' on every computer. This means that we have to fill the background of the screen with spaces, otherwise dBase IV selects the standard background colour, which can be different on every computer. The background colour of the boxes must be set on the colour 'blue'. The lines of the boxes have the colour 'bright white'. The same colour combination holds for the text inside and outside the box. At last the fields have a background colour of 'white' and a foreground colour of 'black'.

## Standard Layout of an Output Screen

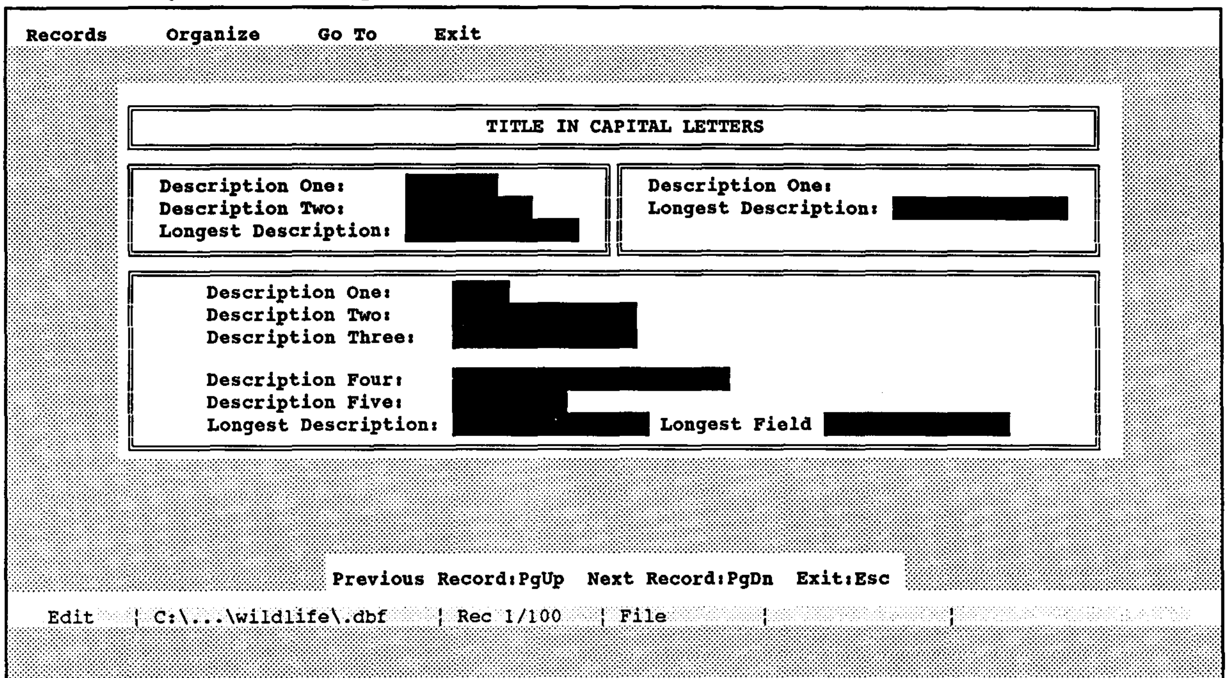


Figure 2: Standard layout of an output screen

Most characteristics are the same for an output screen and an input screen. The differences will be discussed here. The fields that belong to the same data file, are placed in one box. In the 'WILDLIFE APPLICATION' we have to develop an output screen for each .QBE file. In these files we have linked three files, so we create three boxes in an output screen according to figure 2. The file which links the two other files is placed below the other two boxes. The size of these boxes is determined by the width of the longest description and the width of the longest field. However, the field width may not exceed the 15 characters. In the case the field width exceeds the 15 characters the 'scroll option' of the 'picture functions' must be activated. The position of the descriptions and the fields in the box at the bottom is in the centre according to figure 2.

## The Templates and Picture Functions

| AREA.FMT | | |
|---|---|---|
| Field Name | Template | Picture Functions |
| AREA_NUM | 999 | {L} |
| AREA_NAME | AAAAAAAAAAAAAAAAAAAA | {!} |
| STATUS | AAAAAAAAAAAAAAAAAAAA | {!M} (M:CONSERVATION AREA, NATIONAL PARK, GAME RESERVE, FOREST RESERVE, MARINE RESERVE, ) |
| REGION | AAAAAAAAAAAAAAAAAAAA | {!} |
| SIZE_HEC | 99999999 | - |
| LAT_LONG | 99° 99'A/99° 99'A | - |
| ALTITUDE | AAAA-AAAA | - |
| YEAR_EST | 9999 | {Z} |
| SERVICES | MEMO | - |
| REMARKS | MEMO | - |

Table 14: Template and picture functions of AREA.FMT

| ANI_SPEC.FMT | | |
|---|---|---|
| Field Name | Template | Picture Functions |
| ANIMAL_NUM | 99999 | {L} |
| ANI_NAME | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| NAME_SCIEN | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| NAME_SWAHI | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| CLASS | AAAAAAAAAAAAAAA | {!M} (M:MAMMALS, BIRDS, REPTILES, AMPHIBIANS, FISHES, INVERTEBRATES, ) |
| ORDER | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| SUBORDER | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| FAMILY | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| SUBFAMILY | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| GENUS | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| THREATENED | L | - |
| THREAT_CAT | AAAAAAAAAAAAAAA | {!M} (M:EXTINCT, ENDANGERED, VULNERABLE, RARE, INDETERMINATE, ) |

Table 15: Template and picture functions of ANI_SPEC.FMT

| PLA_SPEC.FMT | | |
|---|---|---|
| Field Name | Template | Picture Functions |
| PLANT_NUM | 999999 | {L} |
| PLA_NAME | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| NAME_SCIEN | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| NAME_SWAHI | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| CLASS | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| SUBCLASS | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| ORDER | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| SUBORDER | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| FAMILY | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |
| SUBFAMILY | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {!} |

Table 16: Template and picture functions of PLA_SPEC.FMT

| SOILTYPE.FMT | | |
|---|---|---|
| **Field Name** | **Template** | **Picture Functions** |
| SOIL_NUM | 99999 | {L} |
| TEXTURE | AAAAAAAAAAAAAAA | {!M} (M:CLAY, LOAM, SAND, SANDY LOAM, LOAMY SAND, SANDY CLAY, CLAY LOAM, SANDY CLAY LOAM, ) |
| DRAINAGE | AAAAAAAAAAAAAAA | {!M} (M:EXCESSIVE, GOOD, MODERATELY GOOD, IMPERFECT, POOR, VERY POOR, ) |
| SOIL_ORDER | AAAAAAAAAA | {!M} (M:ENTISOL, VERTISOL, INCEPTISOL, ULTISOL, OXISOL, ) |
| LAND_FORM | AAAAAAAAAA | {!M} (M:FLAT, UNDULATING, DEPRESSION, SLOPE, ROLLING, HILLY, ) |

Table 17: Template and picture functions of SOILTYPE.FMT

| VISITOR.FMT | | |
|---|---|---|
| **Field Name** | **Template** | **Picture Functions** |
| AREA_NR | 999 | {L} |
| YEAR | 9999/9999 | - |
| RESIDENT | 9999999 | - |
| RESID_TX | 9999999 | - |
| NON_RESID | 9999999 | - |
| TOTAL | 999999999 | - |

Table 18: Template and picture functions of VISITOR.FMT

| ANI_AREA.FMT | | |
|---|---|---|
| **Field Name** | **Template** | **Picture Functions** |
| AREA_NR | 999 | {L} |
| ANIMAL_NR | 99999 | {L} |
| NUMBER | 9999999 | {Z} |
| YEAR_EST | 9999 | {Z} |
| SEASON_EST | AAA | {!M} (M:DRY, WET, ) |
| AREA_EST | 99999999 | {Z} |
| STAND_ERR | 9999999 | {Z} |

Table 19: Template and picture functions of ANI_AREA.FMT

| PLA_AREA.FMT | | |
|---|---|---|
| **Field Name** | **Template** | **Picture Functions** |
| AREA_NR | 999 | {L} |
| PLANT_NR | 999999 | {L} |
| YEAR_EST | 9999 | {Z} |
| SEASON_EST | AAA | {!M} (M:DRY, WET, ) |

Table 20: Template and picture functions of PLA_AREA.FMT

| SOILAREA.FMT | | |
|---|---|---|
| **Field Name** | **Template** | **Picture Functions** |
| AREA_NR | 999 | {L} |
| SOIL_NR | 99999 | {L} |
| SIZE_HEC | 99999999 | {Z} |

Table 21: Template and picture functions of SOILAREA.FMT

| AN_AR_VW.FMT | | |
|---|---|---|
| Field Name | Template | Picture Functions |
| AREA_NAME | AAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| STATUS | AAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| REGION | AAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| ANIMAL_NAME | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| CLASS | AAAAAAAAAAAAAAA | - |
| AREA_NR | 999 | {L} |
| ANIMAL_NR | 99999 | {L} |
| NUMBER | 9999999 | {Z} |
| YEAR_EST | 9999 | {Z} |
| SEASON_EST | AAA | - |
| AREA_EST | 99999999 | {Z} |
| STAND_ERR | 9999999 | {Z} |

Table 22: Template and picture functions of AN_AR_VW.FMT

| PL_AR_VW.FMT | | |
|---|---|---|
| Field Name | Template | Picture Functions |
| AREA_NAME | AAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| STATUS | AAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| REGION | AAAAAAAAAAAAAAAAAAAA | {S{ (S:15) |
| PLANT_NAME | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| CLASS | AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| AREA_NR | 999 | {L} |
| PLANT_NR | 999999 | {L} |
| YEAR_EST | 9999 | {Z} |
| SEASON_EST | AAA | - |

Table 23: Template and picture functions of PL_AR_VW.FMT

| SO_AR_VW.FMT | | |
|---|---|---|
| Field Name | Template | Picture Functions |
| AREA_NAME | AAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| STATUS | AAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| REGION | AAAAAAAAAAAAAAAAAAAA | {S} (S:15) |
| TEXTURE | AAAAAAAAAAAAAAA | - |
| DRAINAGE | AAAAAAAAAAAAAAA | - |
| SOIL_ORDER | AAAAAAAAAA | - |
| LAND_FORM | AAAAAAAAAA | - |
| AREA_NR | 999 | {L} |
| SOIL_NR | 99999 | {L} |
| SIZE_HEC | 99999999 | {Z} |

Table 24: Template and picture functions of SO_AR_VW.FMT

## Edit Options

| AREA.FMT | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Field Name** | **Editing allowed** | **Permit edit if** | **Message** | **Carry forward** | **Default value** | **Smallest allowed value** | **Largest allowed value** |
| AREA_NUM | YES | {} | Enter Area Number | NO | {} | {} | {} |
| AREA_NAME | YES | {} | Enter Name of Area | NO | {} | {} | {} |
| STATUS | YES | {} | Move Space to Select Status | NO | {} | {} | {} |
| REGION | YES | {} | Enter Region of Area | NO | {} | {} | {} |
| SIZE_HEC | YES | {} | Enter Size of Area in Hectares | NO | {} | {} | {} |
| LAT_LONG | YES | {} | Enter Latitude and Longitude | NO | 00° 00'S/00° 00'E | {} | {} |
| ALTITUDE | YES | {} | Enter Altitude of Area | NO | 0000-0000 | {} | {} |
| YEAR_EST | YES | {} | Enter Year of Establishment | NO | {} | 1900 | 2050 |
| SERVICES | YES | {} | Press F9 to Switch to Memo Field | NO | {} | {} | {} |
| REMARKS | YES | {} | Press F9 to Switch to Memo Field | NO | {} | {} | {} |

Table 25: Edit options of AREA.FMT

| ANI_SPEC.FMT | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Field Name** | **Edit all.** | **Permit edit if** | **Message** | **Car. for.** | **Default value** | **S** | **L** |
| ANIMAL_NUM | YES | {} | Enter Animal Number | NO | {} | {} | {} |
| ANI_NAME | YES | {} | Enter Name of Animal | NO | {} | {} | {} |
| NAME_SCIEN | YES | {} | Enter Scientific Name | NO | {} | {} | {} |
| NAME_SWAHI | YES | {} | Enter Swahili Name | NO | {} | {} | {} |
| CLASS | YES | {} | Enter Class of Animal | NO | "MAMMALS | {} | {} |
| ORDER | YES | {} | Enter Order of Animal | NO | {} | {} | {} |
| SUBORDER | YES | {} | Enter Suborder of Animal | NO | {} | {} | {} |
| FAMILY | YES | {} | Enter Family of Animal | NO | {} | {} | {} |
| SUBFAMILY | YES | {} | Enter Subfamily of Animal | NO | {} | {} | {} |
| GENUS | YES | {} | Enter Genus of Animal | NO | {} | {} | {} |
| THREATENED | YES | {} | Enter 'Y' if Animal is Threatened, 'N' otherwise | NO | N | {} | {} |
| THREAT_CAT | YES | THREATENED=Y | Press Space to Select Threat Category | NO | {} | {} | {} |

Table 26: Edit options of ANI_SPEC.FMT

| PLA_SPEC.FMT | | | | | | | |
|---|---|---|---|---|---|---|---|
| Field Name | Editing allowed | Permit edit if | Message | Carry for-ward | Default value | Smallest allowed value | Largest allowed value |
| PLANT_NUM | YES | {} | Enter Plant Number | NO | {} | {} | {} |
| PLA_NAME | YES | {} | Enter Name of Plant | NO | {} | {} | {} |
| NAME_SCIEN | YES | {} | Enter Scientific Name | NO | {} | {} | {} |
| NAME_SWAHI | YES | {} | Enter Swahili Name | NO | {} | {} | {} |
| CLASS | YES | {} | Enter Class of Plant | NO | {} | {} | {} |
| SUBCLASS | YES | {} | Enter Subclass of Plant | NO | {} | {} | {} |
| ORDER | YES | {} | Enter Order of Plant | NO | {} | {} | {} |
| SUBORDER | YES | {} | Enter Suborder of Plant | NO | {} | {} | {} |
| FAMILY | YES | {} | Enter Family of Plant | NO | {} | {} | {} |
| SUBFAMILY | YES | {} | Enter Subfamily of Plant | NO | {} | {} | {} |

Table 27: Edit options of PLA_SPEC.FMT

| SOILTYPE.FMT | | | | | | | |
|---|---|---|---|---|---|---|---|
| Field Name | Editing allow-ed | Permit edit if | Message | Carry for-ward | Default value | Smallest allowed value | Largest allowed value |
| SOIL_NUM | YES | {} | Enter Soil Type Number | NO | {} | {} | {} |
| TEXTURE | YES | {} | Press Space to Select Texture Class | NO | {} | {} | {} |
| DRAINAGE | YES | {} | Press Space to Select Drainage Class | NO | {} | {} | {} |
| SOIL_ORDER | YES | {} | Press Space to Select Soil Order | NO | {} | {} | {} |
| LAND_FORM | YES | {} | Press Space to Select Land Form | NO | {} | {} | {} |

Table 28: Edit options of SOILTYPE.FMT

| VISITOR.FMT | | | | | | | |
|---|---|---|---|---|---|---|---|
| Field Name | Editing allow-ed | Permit edit if | Message | Carry for-ward | Default value | Smallest allowed value | Largest allowed value |
| AREA_NR | YES | {} | Enter Area Number | NO | {} | {} | {} |
| YEAR | YES | {} | Enter Year of Visitor Statistics | NO | {} | 1900 | 2050 |
| RESIDENT | YES | {} | Enter Number of Resident Visitors | NO | {} | {} | {} |
| RESID_TX | YES | {} | Enter Number of Resident-TX Vis-itors | NO | {} | {} | {} |
| NON_RESID | YES | {} | Enter Number of Non-Resident Visitors | NO | {} | {} | {} |
| TOTAL | YES | {} | Enter Total Number of Visitors | NO | {} | {} | {} |

Table 29: Edit options of VISITOR.FMT

| ANI_AREA.FMT | | | | | | | |
|---|---|---|---|---|---|---|---|
| Field Name | Editing allowed | Permit edit if | Message | Carry forward | Default value | Smallest allowed value | Largest allowe d value |
| AREA_NR | YES | {} | Enter Area Number | NO | {} | {} | {} |
| ANIMAL_NR | YES | {} | Enter Animal Number | NO | {} | {} | {} |
| NUMBER | YES | {} | Enter Number of Animals Est-imated | NO | {} | {} | {} |
| YEAR_EST | YES | {} | Enter Year of Estimation | NO | {} | 1900 | 2050 |
| SEASON_EST | YES | {} | Press Space to Select Season of Estimation | NO | {} | {} | {} |
| AREA_EST | YES | {} | Enter Census Area in Hectares | NO | {} | {} | {} |
| STAND_ERR | YES | {} | Enter Standard Error (Number of Animals) | NO | {} | {} | {} |

Table 30: Edit options of ANI_AREA.FMT

| PLA_AREA.FMT | | | | | | | |
|---|---|---|---|---|---|---|---|
| Field Name | Editing allowed | Permit edit if | Message | Carry forward | Default value | Smallest allowed value | Largest allowed value |
| AREA_NR | YES | {} | Enter Area Number | NO | {} | {} | {} |
| PLANT_NR | YES | {} | Enter Plant Number | NO | {} | {} | {} |
| YEAR_EST | YES | {} | Enter Year of Estimation | NO | {} | {} | {} |
| SEASON_EST | YES | {} | Press Space to Select Season of Estimation | NO | {} | {} | {} |

Table 31: Edit options of PLA_AREA.FMT

| SOILAREA.FMT | | | | | | | |
|---|---|---|---|---|---|---|---|
| Field Name | Editing allowed | Permit edit if | Message | Carry for-ward | Default value | Smallest allowed value | Largest allowed value |
| AREA_NR | YES | {} | Enter Area Number | NO | {} | {} | {} |
| SOIL_NR | YES | {} | Enter Soil Number | NO | {} | {} | {} |
| SIZE_HEC | YES | {} | Enter Size of Soil in Hectares | NO | {} | {} | {} |

Table 32: Edit options of SOILAREA.FMT

## Applications

| | |
|---|---|
| Application name: | WILDLIFE.APP |
| Description: | Tanzanian WILDLIFE Database application |
| Main menu type: | POP-UP |
| Main menu name: | MAIN_MN |
| Database/view: | AREA.DBF |
| Set INDEX to: | AREA.MDX |
| ORDER: | AREA_NUM |

Menu Layout:

```
MAIN MENU
=========================
Protected Areas
Animal Species
Plant Species
Soil Types
Visitor Statistics

Exit to DOS
```

Figure 3: Menu layout of MAIN_MN

Menu item actions:

| Item name | Action | Parameters |
|---|---|---|
| Protected Areas | Run program | AREA.PRG |
| Animal Species | Run program | ANI_SPEC.PRG |
| Plant Species | Run program | PLA_SPEC.PRG |
| Soil Types | Run program | SOILTYPE.PRG |
| Visitor Statistics | Run program | VISITOR.PRG |
| Exit to DOS | Quit | |

Table 33: Item actions of MAIN_MN

Application name: AREA.APP
Description: Protected area registration
Main menu type: POP-UP
Main menu name: AREA_MN
Database/view: AREA.DBF
Set INDEX to: AREA.MDX
ORDER: AREA_NUM

Menu layout:

```
PROTECTED AREAS
==============================
Add Area Records
Change Area Records
Browse Area Records
Delete Area Records

Animal Species in Areas
Plant Species in Areas
Soil Types in Areas
Visitor Statistics

Exit Protected Areas
```

Figure 4: Menu layout of AREA_MN

Menu item actions:

| Item name | Action | Parameters | | | FORMAT file |
|---|---|---|---|---|---|
| | | allow ADD | allow EDIT | allow DELETE | |
| Add Area Records | Edit | YES | NO | NO | AREA.FMT |
| Change Area Records | Edit | NO | YES | NO | AREA.FMT |
| Browse Area Records | Browse | YES | YES | YES | |
| Delete Area Records | Edit | NO | NO | YES | AREA.FMT |
| Animal Species in Areas | Run program | ANI_AREA.PRG | | | |
| Plant Species in Areas | Run program | PLA_AREA.PRG | | | |
| Soil Types in Areas | Run program | SOILAREA.PRG | | | |
| Visitor Statistics | Run program | VISITOR.PRG | | | |
| Exit Protected Areas | RETURN | | | | |

Table 34: Item actions of AREA_MN

Application name: ANI_SPEC.APP
Description: Animal species registration
Main menu type: POP-UP
Main menu name: ANI_MN
Database/view: ANI_SPEC.DBF
Set INDEX to: ANI_SPEC.MDX
ORDER: ANIMAL_NUM

Menu layout:

```
          ANIMAL SPECIES
==================================
 Add Animal Specie Records
 Change Animal Specie Records
 Browse Animal Specie Records
 Delete Animal Specie Records

 Animal Species in Areas

 Exit Animal Species
```

Figure 5: Menu layout of ANI_MN

Menu item actions:

| Item name | Action | Parameters | | | FORMAT file |
|---|---|---|---|---|---|
| | | allow ADD | allow EDIT | allow DELETE | |
| Add Animal Specie Records | Edit | YES | NO | NO | ANI_SPEC.FMT |
| Change Animal Specie Records | Edit | NO | YES | NO | ANI_SPEC.FMT |
| Browse Animal Specie Records | Browse | YES | YES | YES | |
| Delete Animal Specie Records | Edit | NO | NO | YES | ANI_SPEC.FMT |
| Animal Species in Areas | Run Program | ANI_AREA.PRG | | | |
| Exit Animal Species | Return | | | | |

Table 35: Item actions of ANI_MN

Application name: PLA_SPEC.APP
Description: Plant species registration
Main menu type: POP-UP
Main menu name: PLA_MN
Database/view: PLA_SPEC.DBF
Set INDEX to: PLA_SPEC.MDX
ORDER: PLANT_NUM

Menu layout:

```
PLANT SPECIES

Add Plant Specie Records
Change Plant Specie Records
Browse Plant Specie Records
Delete Plant Specie Records

Plant Species in Areas

Exit Plant Species
```

Figure 6: Menu layout of PLA_MN

Menu item actions:

| Item name | Action | Parameters | | | FORMAT file |
|---|---|---|---|---|---|
| | | allow ADD | allow EDIT | allow DELETE | |
| Add Plant Specie Records | Edit | YES | NO | NO | PLA_SPEC.FMT |
| Change Plant Specie Records | Edit | NO | YES | NO | PLA_SPEC.FMT |
| Browse Plant Specie Records | Browse | YES | YES | YES | |
| Delete Plant Specie Records | Edit | NO | NO | YES | PLA_SPEC.FMT |
| Plant Species in Areas | Run program | PLA_AREA.PRG | | | |
| Exit Plant Species | Return | | | | |

Table 36: Item actions of PLA_MN

Application name: SOILTYPE.APP
Description: Soil types registration
Main menu type: POP-UP
Main menu name: SOIL_MN
Database/view: SOILTYPE.DBF
Set INDEX to: SOIL_NUM

Menu layout:

```
SOIL TYPES
=====================================
Add Soil Type Records
Change Soil Type Records
Browse Soil Type Records
Delete Soil Type Records

Soil Types in Areas

Exit Soil Types
```

Figure 7: Menu layout of SOIL_MN

Menu item actions:

| Item name | Action | Parameters | | | FORMAT file |
|---|---|---|---|---|---|
| | | allow ADD | allow EDIT | allow DELETE | |
| Add Soil Type Records | Edit | YES | NO | NO | SOILTYPE.FMT |
| Change Soil Type Records | Edit | NO | YES | NO | SOILTYPE.FMT |
| Browse Soil Type Records | Browse | YES | YES | YES | |
| Delete Soil Type Records | Edit | NO | NO | YES | SOILTYPE.FMT |
| Soil Types in Areas | Run program | SOILAREA.PRG | | | |
| Exit Soil Types | Return | | | | |

Table 37: Item options of SOIL_MN

| | |
|---|---|
| Application name: | VISITOR.APP |
| Description: | Visitor statistics |
| Main menu type: | POP-UP |
| Main menu name: | VIS_MN |
| Database/view: | VISITOR.DBF |
| Set INDEX to: | VISITOR.MDX |
| ORDER: | VISITOR_NUM |

Menu layout:

```
VISITOR STATISTICS
==================
Add Visitor Statistics Records
Change Visitor Statistics Records
Browse Visitor Statistics Records
Delete Visitor Statistics Records

Exit Visitor Statistics
```

Figure 8: Menu layout of VIS_MN

Menu item actions:

| Item name | Action | Parameters | | | FORMAT file |
|---|---|---|---|---|---|
| | | allow ADD | allow EDIT | allow DELETE | |
| Add Visitor Statistics Records | Edit | YES | NO | NO | VISITOR.FMT |
| Change Visitor Statistics Records | Edit | NO | YES | NO | VISITOR.FMT |
| Browse Visitor Statistics Records | Browse | YES | YES | YES | |
| Delete Visitor Statistics Records | Edit | NO | NO | YES | VISITOR.FMT |
| Exit Visitor Statistics | Return | | | | |

Table 38: Item actions of VIS_MN

Application name: ANI_AREA.APP
Description: Animal species in protected areas registration
Main menu type: POP-UP
Main menu name: AN_AR_MN
Database/view: ANI_AREA.DBF
Set INDEX to: ANI_AREA.MDX
ORDER: AREA_NR, ANIMAL_NR

Menu layout:

```
ANIMAL SPECIES IN AREAS

Animal Species in Area in Form
Browse Animal Species in Area
Areas Containing Animal Specie in Form
Browse Areas Containing Animal Specie

Add Animal Species in Areas Records
Change Animal Species in Areas Records
Browse Animal Species in Areas Records
Delete Animal Species in Areas Records

Exit Animal Species in Areas
```

Figure 9: Menu layout of AN_AR_MN

Menu item actions:

| Item name | Action | Parameters | | | FORMAT file |
|---|---|---|---|---|---|
| | | allow ADD | allow EDIT | allow DELETE | |
| Animal Species in Area in Form | Edit | NO | NO | NO | AN_AR_VW.FMT |
| Browse Animal Species in Area | Browse | NO | NO | NO | |
| Areas Containing Animal Specie in Form | Edit | NO | NO | NO | AN_AR_VW.FMT |
| Browse Areas Containing Animal Specie | Browse | NO | NO | NO | |
| Add Animal Species in Areas Records | Edit | YES | NO | NO | ANI_AREA.FMT |
| Change Animal Species in Areas Records | Edit | NO | YES | NO | ANI_AREA.FMT |
| Browse Animal Species in Areas Records | Browse | YES | YES | YES | |
| Delete Animal Species in Areas Records | Edit | NO | NO | YES | ANI_AREA.FMT |
| Exit Animal Species in Areas | Return | | | | |

Table 39: Item actions of AN_AR_MN

Application name: PLA_AREA.APP
Description: Plant species in protected areas registration
Main menu type: POP-UP
Main menu name: PL_AR_MN
Database/view: PLA_AREA.DBF
Set INDEX to: PLA_AREA.MDX
ORDER: AREA_NR, PLANT_NR

Menu layout:

```
PLANT SPECIES IN AREAS
==========================================
Plant Species in Area in Form
Browse Plant Species in Area
Areas Containing Plant Specie in Form
Browse Areas Containing Plant Specie

Add Plant Species in Areas Records
Change Plant Species in Areas Records
Browse Plant Species in Areas Records
Delete Plant Species in Areas Records

Exit Plant Species in Areas
```

Figure 10: Menu layout of PL_AR_MN

Menu item actions:

| Item name | Action | Parameters | | | FORMAT file |
|---|---|---|---|---|---|
| | | allow ADD | allow EDIT | allow DELETE | |
| Plant Species in Area in Form | Edit | NO | NO | NO | PL_AR_VW.FMT |
| Browse Plant Species in Area | Browse | NO | NO | NO | |
| Areas Containing Plant Specie in Form | Edit | NO | NO | NO | PL_AR_VW.FMT |
| Browse Areas Containing Plant Specie | Browse | NO | NO | NO | |
| Add Plant Species in Areas Records | Edit | YES | NO | NO | PLA_AREA.FMT |
| Change Plant Species in Areas Records | Edit | NO | YES | NO | PLA_AREA.FMT |
| Browse Plant Species in Areas Records | Browse | YES | YES | YES | |
| Delete Plant Species in Areas Records | Edit | NO | NO | YES | PLA_AREA.FMT |
| Exit Plant Species in Areas | Return | | | | |

Table 40: Item actions of PL_AR_MN

Application name: SOILAREA.APP
Description: Soil types in protected areas registration
Main menu type: POP-UP
Main menu name: SO_AR_MN
Database/view: SOILAREA.DBF
Set INDEX to: SOILAREA.MDX
ORDER: AREA_NR, SOIL_NR

Menu layout:

```
SOIL TYPES IN AREAS

Soil Types in Area in Form
Browse Soil Types in Area
Areas Containing Soil Types in Form
Browse Areas Containing Soil Types

Add Soil Types in Areas Records
Change Soil Types in Areas Records
Browse Soil Types in Areas Records
Delete Soil Types in Areas Records

Exit Soil Types in Areas
```

Figure 11: Menu layout of SO_AR_MN

Menu item actions:

| Item name | Action | Parameters | | | FORMAT file |
|---|---|---|---|---|---|
| | | allow ADD | allow EDIT | allow DELETE | |
| Soil Types in Area in Form | Edit | NO | NO | NO | SO_AR_VW.FMT |
| Browse Soil Types in Area | Browse | NO | NO | NO | |
| Areas Containing Soil Types in Form | Edit | NO | NO | NO | SO_AR_VW.FMT |
| Browse Areas Containing Soil Types | Browse | NO | NO | NO | |
| Add Soil Types in Areas Records | Edit | YES | NO | NO | SOILAREA.FMT |
| Change Soil Types in Areas Records | Edit | NO | YES | NO | SOILAREA.FMT |
| Browse Soil Types in Areas Records | Browse | YES | YES | YES | |
| Delete Soil Types in Areas Records | Edit | NO | NO | YES | SOILAREA.FMT |
| Exit Soil Types in Areas | Return | | | | |

Table 41: Item actions of SO_AR_MN

# APPENDIX 3: DATA FILES AT THE DATABASE DEPARTMENT OF NEMC

This appendix describes all data files, including the data file name, the description, the field names and the number of records. Related data files are combined in a catalog (.CAT). A term that is used by dBase IV.

**COASTAL.CAT**

| | |
|---|---|
| File: | COASTAL.DBF |
| Description: | Coastal Forest of Tanzania |
| Fields: | Region, Forest, Area, Protected, Species, District, Status, Soils, Coords, Altitude, Ownership, Population, Industry, Degradn, Rainfall |
| Number of records: | 77 |

**EXPERTS.CAT**

| | |
|---|---|
| File: | EXPERTS2.DBF |
| Description: | Environmental experts in Tanzania. |
| Fields: | Name, Title, Field, Address, Comments. |
| Number of records: | 70. |

**GLOSSARY.CAT**

| | |
|---|---|
| File: | GLOSSAR2.DBF |
| Description: | Glossary of environmental terms and acronyms. |
| Fields: | Term, Swahili. |
| Number of records: | 2361. |

**LEGISLAT.CAT**

| | |
|---|---|
| File: | LOCAL GOVERNMENT, LAND USE, ANTIQUITIES, TRANSPORTATION, HUMAN HEALTH, LAND MANAGEMENT, FISHERIES, WILDLIFE, PUBLIC LANDS/PRESERVED AREAS: NATIONAL PARKS, GAME PARKS AND NGORONGOR CRATER, FORESTRY, TOURISM, LIVESTOCK/GRAZING, INDUSTRY AND INVESTMENT, POLLUTION, WATER RESOURCES, ENVIRONMENTAL MANAGEMENT |
| Description: | Government notices pertaining to environment legislation in Tanzania. |
| Fields: | Title, Type, Year, Notice. |
| Number of records: | 800 (approximately). |

**LIBRARY.CAT**

| | |
|---|---|
| File: | LIBRARY.DBF |
| Description: | Institutions holding environmental information in Tanzania. |
| Fields: | Name, Address, Region, Telephone, Fax, Email, Contact, Mandate, Keywords, Remarks. |
| Number of records: | 568. |

**PROTECT.CAT**

File: CONTPRK.DBF
Description: Protected areas of Tanzania: Conservation, Games, Parks, Forests, Marine.
Fields: Areacode, Areaname, Status, Owner, Area_Hec, Year_Est, Region, Coord_UTM, Lat_Long, Altitude, Soil_Type, Vegn_Dom, Plant_Sp, Animal_Sp, Services, Revenue, Other_Info.
Number of records: 100.

File: ATLAS.DBF
Description: Birds species.
Fields: Cardno, Square, Locality, Month, Yr, Species, Bno, Status, AB, OBS, Remarks.
Number of records: 7751.

**PUGUDATA.CAT**

File: PUGUSPEC.DBF
Description: Species data.
Fields: Dno, Tranline, Plotno, Famname, Botname, Locname, DBH_Range, Frequency, Notes.
Number of records: 1.

File: PUGUSTAT.DBF
Description: Status of species in Pugu Forest Reserve.
Fields: Dno, Tranline, Plotno, Endemism, Rarity, Threatype, Endanged, Regener, Notes.
Number of records: 0.

File: PUGUVEG.DBF
Description: Transect lines data in Pugu Forest Reserve.
Fields: Dno, Tranline, Plotno, Plotrad, Invdate, Collector, Altitude, Slope, Aspect, VegDensity, Vegtype, Vegtype2, Regener, Soil, Soiltype, Threatype, Remarks.
Number of records: 79.

File: THREATS.DBF
Description: Threats in Pugu.
Fields: Tranline, Plotno, Plotrad, Sampplot_I, Altitude, Slope, Aspect, Vegdensity, Vegtype2, Reg_H_1M, Reg_H_G1M, Soiltype, Threatype, Remarks.
Number of records: 454

**SOURCES.CAT**

File: SOURCES.DBF
Description: Environmental information sources & contact persons.
Fields: Lastname, Firstname, Title, Orgn, Address, City, Country, Phone, Telex, Fax.
Number of records: 218.

File: DONORS.DBF
Description: Donors helping in environmental development.
Fields: Donorcode, Name, Address, Tel, Fax, Category, Project, Start_date, End_date, Prin_sect, Total_budg, Sub_sector, Imp_host, Dist_site, Outputs, Follow_up, Linkages.

Number of records: 10.

File: ENV.DBF
Description: Database of sources of environmental information in Tanzania.
Fields: Country, Region, Institutio, Type, Address, Tel, Email, Keywords, Dataqual, Contact.
Number of records: 53.

**TANZPEST.CAT**
File: PESTICDE.DBF
Description: Registrated approved pesticides in Tanzania (1992).
Fields: Dbno, Type, Trade_name, Reg_no, Com_name, Registrant, Regis_type, Usage.
Number of records: 144

**WETLAND.CAT**
File: WETLAND.DBF
Description: Location of wetlands of Tanzania.
Fields: Sheet_no, Type, Name, Degrees_1, Degrees_2, Grids_N, Grids_E, Length, Others.
Number of records: 402.

## APPENDIX 4: MAPS OF TANZANIA

This appendix gives the map of Tanzania, a map of the vegetation in Tanzania, a map of the soil types in Tanzania and a map of all the National Parks in Tanzania.

Figure 1: Map of Tanzania

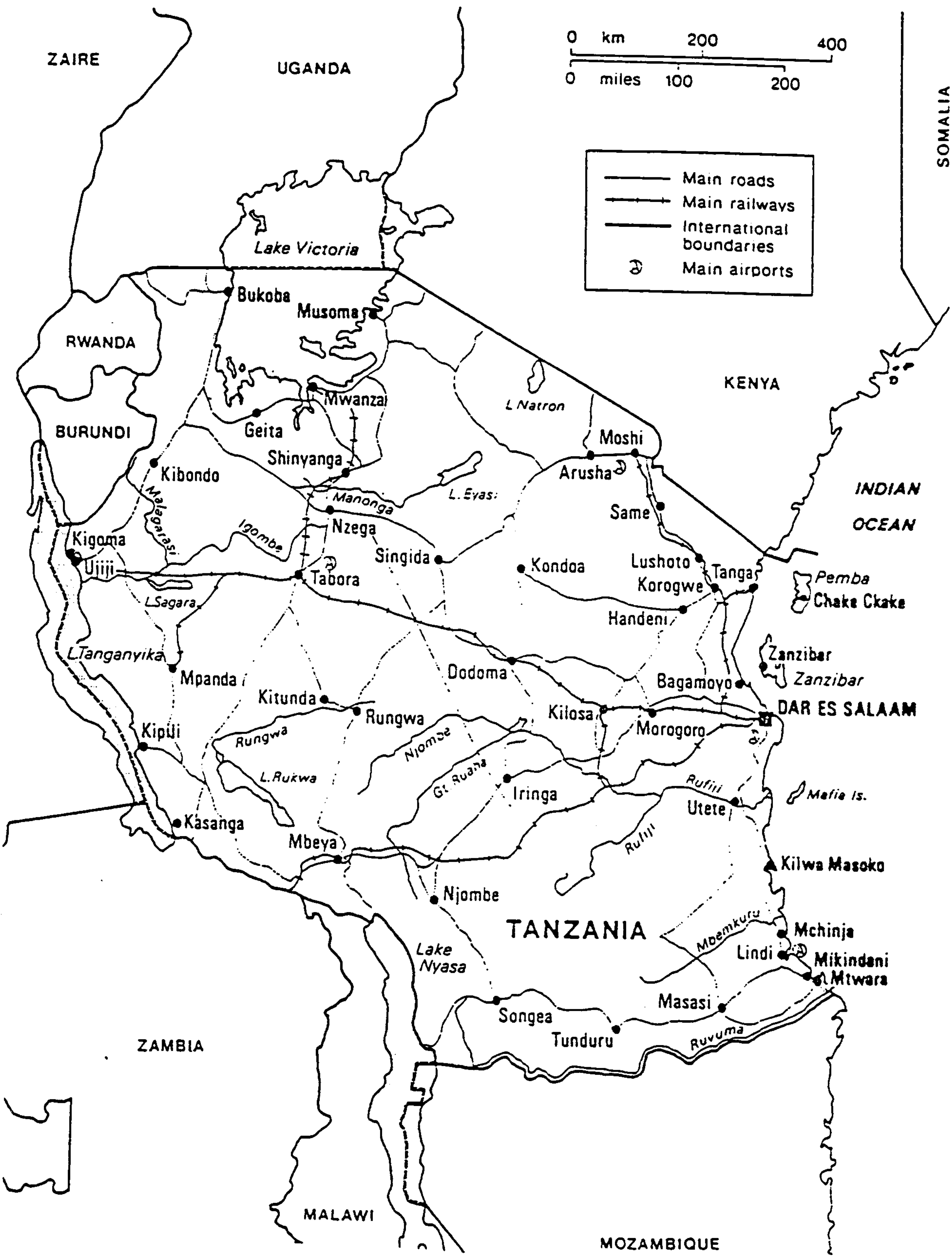
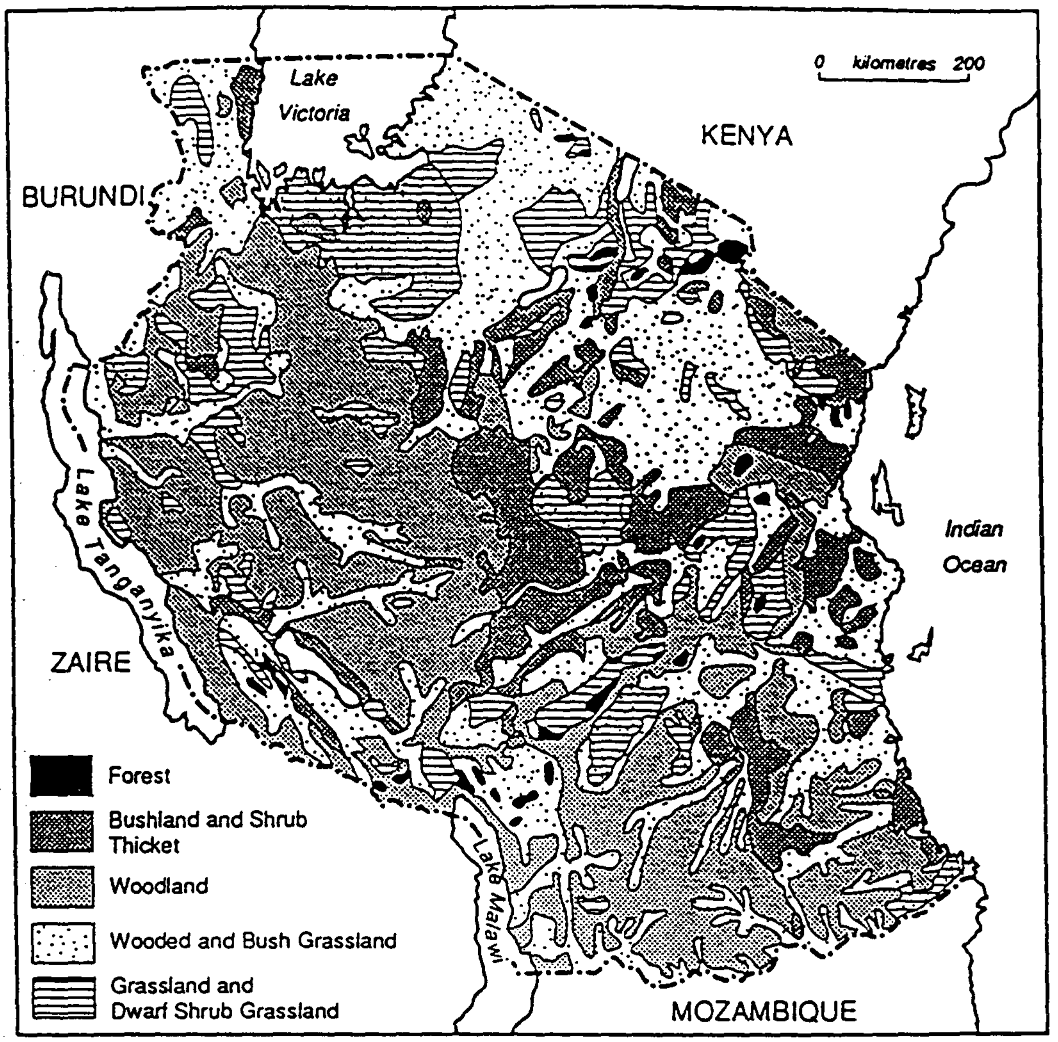
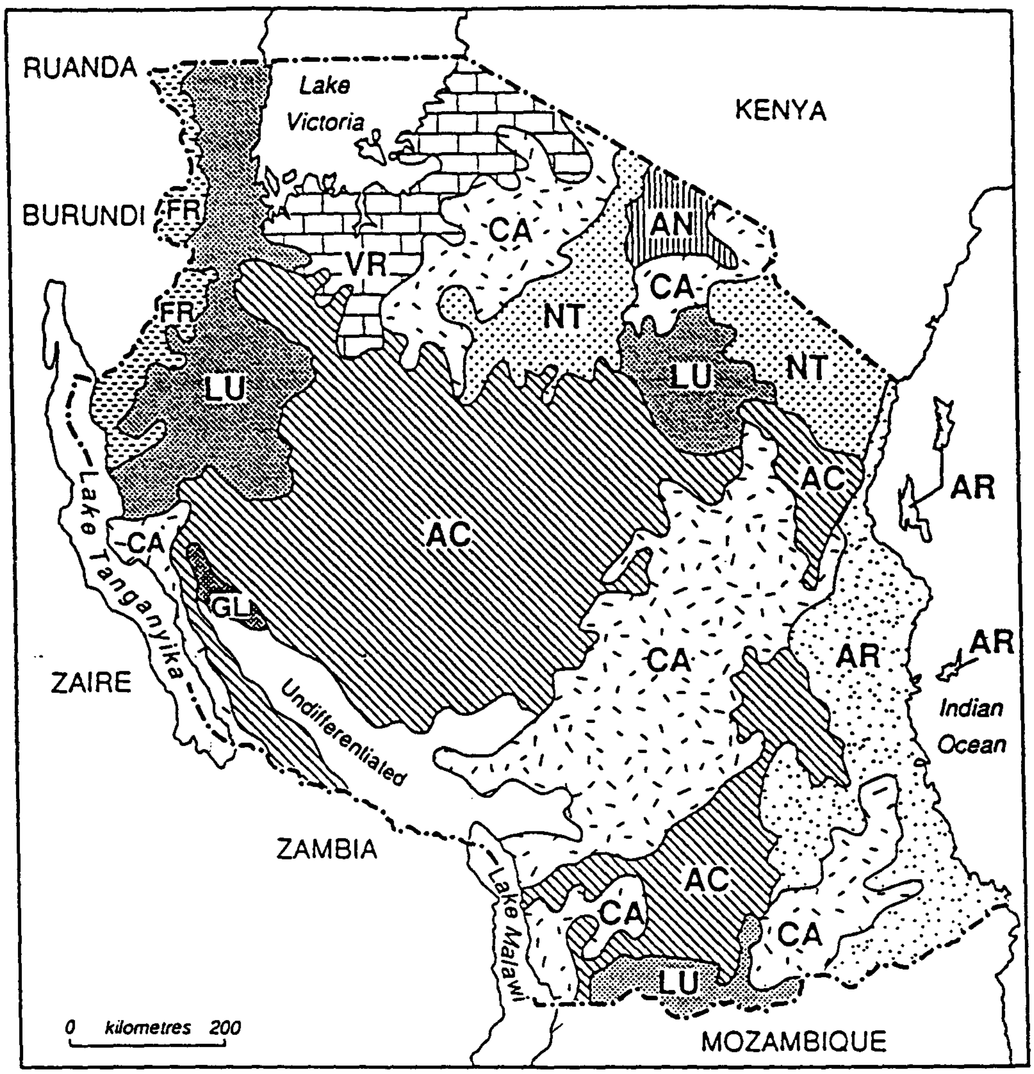


Figure 2: Map of Vegetation in Tanzania




Source: Adapted from Handbook of Natural Resources of East Africa, 1/4.0 million map of E. Africa, E. African Literature Bureau, Nairobi, 1976

Figure 3: Map of Soil Types in Tanzania

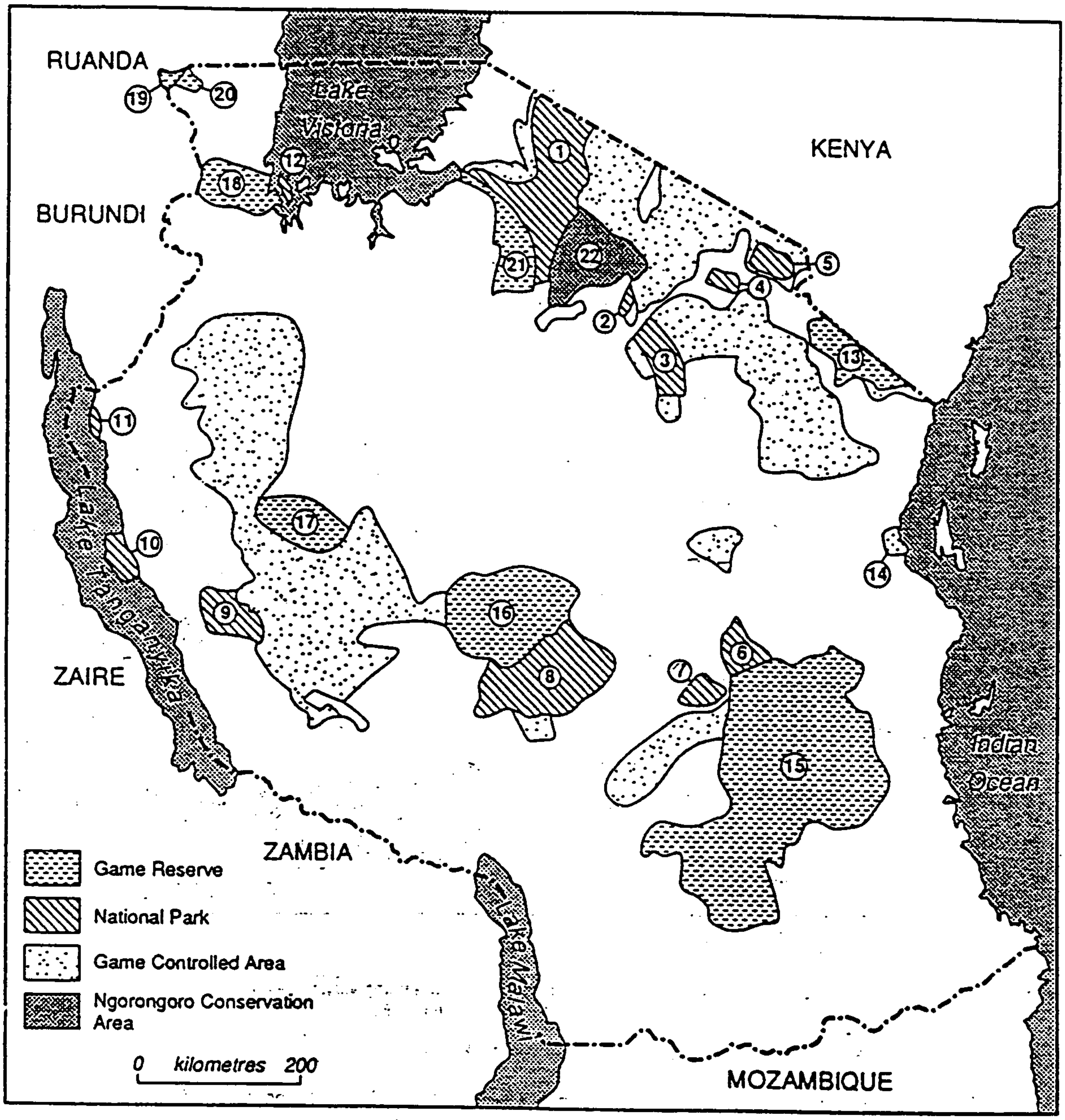



Legend

| | | |
|---|---|---|
| AC | Acrisols: | Soils with an argillic B horizon (containing illuvial clay and clay skins) with base saturation < 50% |
| AN | Andosols: | Soils developed from recent volcanic materials |
| AR | Arenosols: | Very sandy soils which have an identifiable B horizon; clay < 15% |
| CA | Cambisols: | Soils with a 'structural B horizon' but no argillic horizon |
| FR | Ferrasols: | Soils with an oxic horizon with a CEC < 16 m.e./100 g clay |
| GL | Gleysols: | Gleyed soils with hydromorphic properties dominating |
| LU | Luvisols: | Soils with an argillic B horizon with base saturation > 50% |
| NT | Nitosols: | Soils with a deep argillic B horizon and merging horizon boundaries, strongly structured with shiny ped faces |
| VR | Vertisols: | Dark cracking clay |

Source: Adapted from FAO-Unesco Soil Map of the World, 1977

Figure 4: Map of National Parks in Tanzania




Conservation Areas

1. Serengeti National Park
2. Manyara National Park
3. Tarangire National Park
4. Arusha National Park
5. Kilimanjaro National Park
6. Mikumi National Park
7. Udzungwa National Park
8. Ruaha National Park
9. Katavi National Park
10. Mahale National Park
11. Gombe National Park
12. Rubondo National Park
13. Mkomazi Game Reserve
14. Sadani Game Reserve
15. Selous Game Reserve
16. Rungwa/Kizigo Game Reserve
17. Ugala River Game Reserve
18. Biharamulo and Burigi Game Reserves
19. Ibanda Game Reserve
20. Rumanyika Game Reserve
21. Maswa Game Resereve
22. Ngorongoro Conservation Area