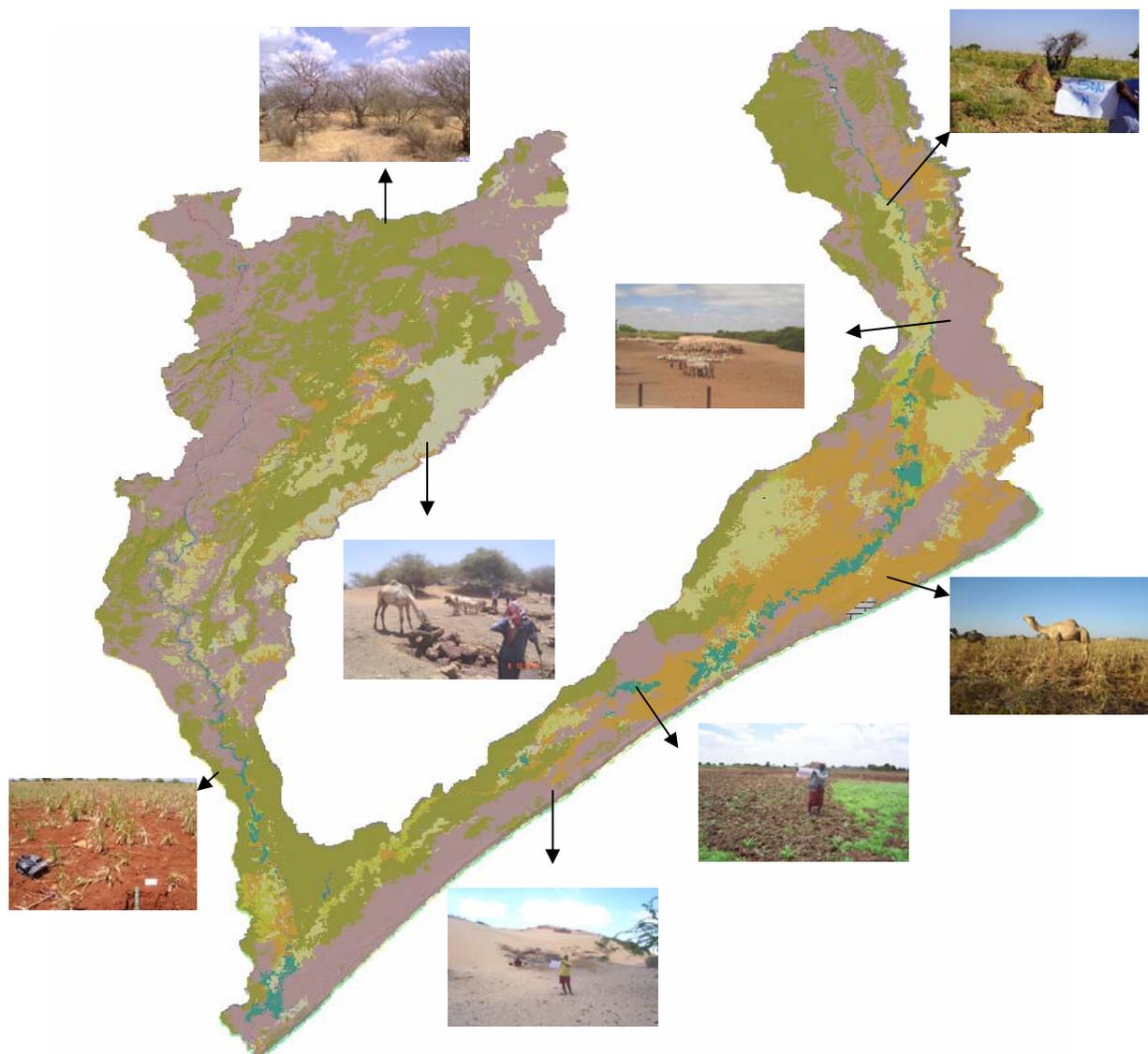


Land Use Characterization of the Juba and Shabelle Riverine Areas in Southern Somalia



Project Report N°L-07
May 2007



Somalia Water and Land Information Management
Ngecha Road, Lake View. P.O Box 30470-00100, Nairobi, Kenya.
Tel +254 020 4000300 - Fax +254 020 4000333,
Email: enquiries@faoswalim.org Website: <http://www.faoswalim.org>.



The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations and the SWALIM Project concerning the legal status of any country, territory, city or area of its authorities, or concerning the delimitation of its frontiers or boundaries..

This document should be cited as follows:

Oduori, S., Vargas, R. and Alim, M. 2007b. Land Use Characterisation of the Juba and Shabelle riverine areas in Southern Somalia. FAO-SWALIM. Project Report No. L-07. Nairobi, Kenya.

ACKNOWLEDGMENTS

The authors wish to acknowledge the considerable support given by the Project Task Force during the preparation of this report. Special thanks go to Dr. Hubert George for his overall contribution.

First of all, many thanks to all the Somali experts (especially to Ahmed Farah Roble, Mohamed Sheikh Abdi Ahmed, Hassan Farah Hashi, Ibrahim Dagane Ali, Abdinasir Osman Elmi, and Mohamed Muhiyadin Mohamoud) who endured the difficult conditions in Southern Somalia to collect data without which the entire study would have been incomplete.

Many thanks go to the Food Security Analysis Unit (FSAU) of FAO for their logistic contributions during the field survey and for providing access to their library and documents.

SWALIM staff both in Nairobi and in Mogadishu are acknowledged for their support.

Last but not least, the Chief Technical Advisor of FAO-SWALIM, Dr. Zoltan Balint, is thanked for his tireless encouragement and support in all fields. Without his support this study would not have been accomplished.

TABLE OF CONTENTS

Acknowledgment

List of Acronyms

1 INTRODUCTION	1
1.1 Objectives.....	2
2 MATERIALS AND METHODS	1
2.1 Study area.....	1
2.1.1 Location and delineation.....	1
2.1.2 Climate.....	2
2.1.3 Geology.....	4
2.1.4 Landform/Soils.....	4
2.1.5 Land Cover.....	4
2.1.6 Land Use.....	5
3 METHODS	1
3.1 Bibliographic research.....	1
3.2 Field Survey preparation.....	1
3.3 Land use field survey.....	2
3.4 Data input and analysis.....	2
3.5 Land use characterization.....	2
3.6 Land use mapping.....	3
4 RESULTS	1
4.1 Preliminary land use classes.....	1
4.2 Land Use Survey.....	2
4.3 Final Land Use Classes.....	2
4.3.1 Rainfed Agriculture.....	4
4.3.2 Irrigated Agriculture.....	7
4.3.3 Transhumance Pastoralism.....	10
4.3.4 Wood Collection for Charcoal Burning.....	13
4.3.5 Rural Settlement.....	14
4.3.6 Built-Up Areas - Urban Area and Airport Services.....	14
4.3.7 Dunes and Bare Lands.....	15
4.3.8 Water Bodies.....	16
4.3.9 Crop Calendars.....	16
5 CONCLUSIONS AND RECOMMENDATIONS	21
6 BIBLIOGRAPHY	22
7 ANNEXES	24
7.1 Annex 1: Land use data collection form.....	24
7.2 Annex 2: Coordinates of the visited sampling sites and its land use class.....	24

List of Tables

Table 1: the Land Use Classes and their Hectarage.....	4
Table 2: Crop Calendar for Rainfed Agriculture.....	17
Table 3: Crop Calendar for Irrigated Fields.....	18

List of Figures

Figure 1: Study Area.....	1
Figure 2: Mean monthly rainfall patterns in the study area (1963-2001).....	3
Figure 3: Mean annual rainfall distribution map and climate of study area.....	5
Figure 4: Land Use Survey Samples.....	3

List of Plates

Plate 1: Rainfed sorghum. Notice moisture stress	5
Plate 2: Grazing of standing crop residue.....	6
Plate 3: Rainfed Agriculture - sorghum and maize intercropped.....	6
Plate 4: Rainfed Agriculture sorghum, harvested sesame and maize intercropped	7
Plate 5: Irrigated Fields. Notice fruit trees and herbaceous crops.....	9
Plate 6: Silted and damaged irrigation canal.....	9
Plate 7: Pastoralism (cattle).....	11
Plate 8: Pastoralism (watering camels)	11
Plate 9: Pastoralism (camels).....	12
Plate10: Pastoralism (goats)	12
Plate11: Watering livestock	13
Plate 12: Tree cuttings ready for firing to produce charcoal	14
Plate 14: Rural Settlement with Pond for water (human and livestock).....	14
Plate 15: Urban Area	15
Plate 16: Bare Areas.....	15
Plate 17: Water pond (domestic and livestock use)	16

LIST OF ACRONYMS

EC	European Commission
FAO	Food and Agriculture Organization of the United Nations
FSAU	Food Security and Assessment Unit
GIS	Geographic Information Systems
GPS	Global Positioning System
LADA	Land Degradation Assessment in Drylands
SWALIM	Somalia Water and Land Information Management
UNDP	United Nations Development Programme

1 INTRODUCTION

Land use is characterised by the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it. This definition of land use establishes a direct link between land cover and the actions of people in their environment (Di Gregorio and Jansen, 2005). Land Use information provides spatially defined information for management of land at national and global levels, usually in the framework of climate change, land degradation, poverty reduction, food security, natural resources management, etc.

There is growing concern over the degradation of natural and agro-ecosystems. In this case, land use studies form the basis for analyzing and assessing the human activities that can lead to land degradation.

A prerequisite for better use of land, is information on existing land use patterns and land use through time (Anderson *et al*, 1976). Such information is required by legislators, planners, and state and local government officials to determine better land use policy, project transportation and utility demand, identify future development pressure points and areas, and implement effective plans for regional development.

Land policy is clearly of importance to many countries. It is important for a nation and government to know the following: which are the types of human activities in the territory?, how much land is currently utilized?, which crops or other plants or trees are grown on different kinds of land in different places?, are they irrigated or rainfed?, how do potential yields vary from place to place and from season to season, and how many people are settled in an area with different levels of production cost and with different management techniques?

This information can be used to make wise choices between alternative ways of using land, determine where best to locate new developments in settlement, cropping, drainage, irrigation or the use of new technical methods, to explain variations in output between locations and years, and to search for methods to decrease their impact, to respond to many other questions about the management and use, including conservation, of the natural environment (FAO, 1990).

Datasets of sufficient scope on land use (i.e. information covering multiple attributes of land use such as land use purposes, associated land management and socio-economic factors) are generally scarce or outdated, particularly in developing countries (George & Nachtergaele, 2002). This applies to Somalia, where data and information related to land use is scarce and outdated. Land use data for the Jubba and Shabelle riverine areas are scarce. The most prominent land use study covering part of the present study area is one produced by the Land Resources Development Centre (LRDC, 1985). Since that time, human activities in the study area have changed due to the ongoing socio-political situation and there is a need for an updated and integrated study of land use activities.

A variety of models or schemes of land use characterization appropriate to a range of planning objectives are possible, although each has its limitations (George & Petri, 2006). However, in the case of Somalia the scheme should suit the current challenging situation. Field observations are not easy to carry out, and socio-economic data is difficult to record according to globally accepted standards.

Considering the socio-political situation of the country this study aimed at employing a practical approach. The study combined scientific research techniques of GIS and Remote Sensing as mapping tools, accompanied by ground observations involving site-specific semi-structured interviews with local land users and contact with organizations in the survey area (Oduori *et al*, 2007). Interviews and discussions with local farmers and

herdsmen were not only necessary for collection of socioeconomic land use data, but were also fruitful in land use characterization from a technical and ecological perspective.

This report presents the land use characterization (thematic and spatial) of the Jubba and Shabelle riverine areas and is intended to be used by different users involved in sustainable development.

1.1 Objectives

The overall objective of this study was to characterize and map the current land use in the Jubba and Shabelle riverine areas. The specific objectives were:

- a. To inventory, classify and map present use of the land.
- b. To analyse causes and reasons underlying the present land use situation by means of technical assessment and the use of rural appraisal techniques.

2 MATERIALS AND METHODS

2.1 Study area

2.1.1 Location and delineation

The study area lies between 41°53' and 46°09' east of the Prime Meridian; and between 0°16' south and 5°04' north of the Equator. It covers almost 88 000 square kilometres (8 793 596 hectares) covering the whole of the Jubba River and the greater part of the Shabelle River watersheds within Somalia (see Map 1).

The most important towns found in the area are: Luuq, Garbahaarrey, Baardheere, Bu'aale, Jilib, Jamaame and Kismaayo, in the Jubba valley; and Beledweyne, Buulobarde, Mahadday Weyn, Jawhar, Balcad, Mogadishu, Afgooye, Marka, Baraawe, and Haaway in the Shabelle valley.

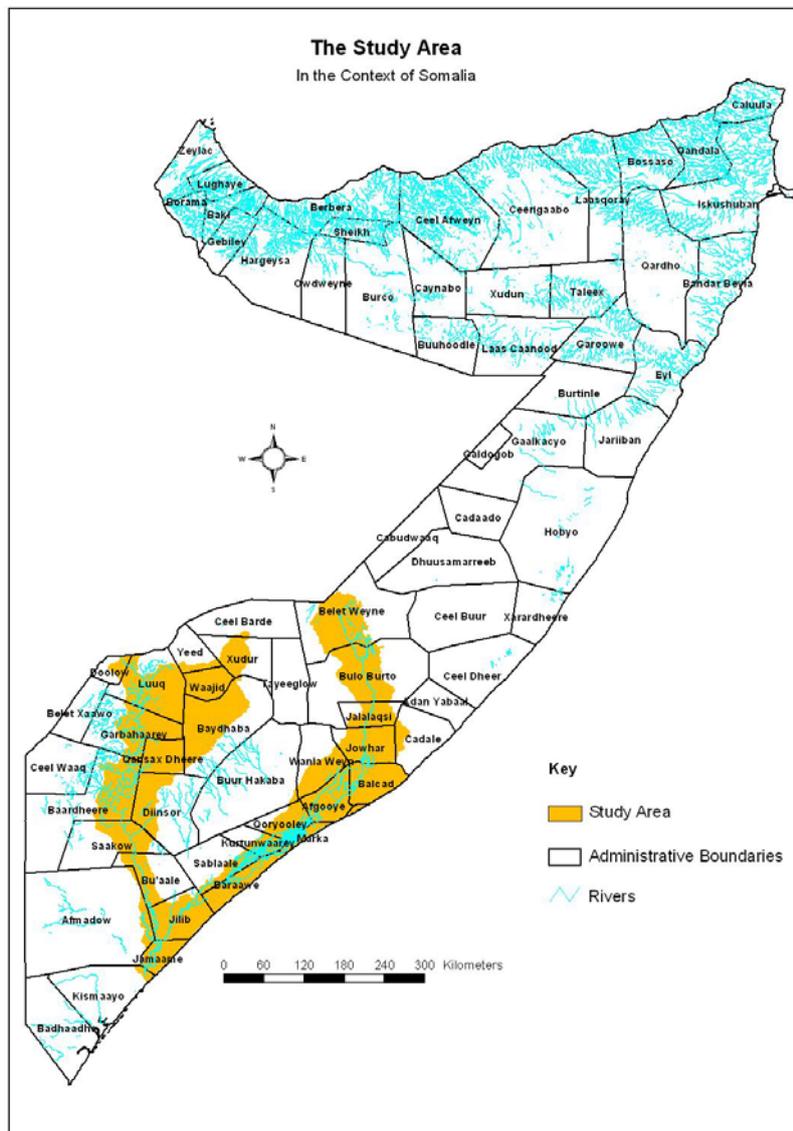


Figure 1: Study Area

2.1.2 Climate

The climate of the river basin areas of southern Somalia is tropical arid to dry and sub-humid, and is influenced by the north-easterly and south-easterly air flows of the Intertropical Convergence Zone (ITCZ). North-easterly and south-easterly air masses meet in the Intertropical Front (ITF) and raise air upwards to produce rain. The annual movements of the ITCZ from north to south across Africa and back again, give rise to four different seasons in Somalia, comprising two distinguishable rainy seasons alternating with two marked dry seasons, as follows:

- *Gu*: April to June, the main rainy season for all over the country
- *Xagaa*: July to September, littoral showers, but dry and cool in the hinterland
- *Deyr*: October to December, second rainy season for all over the country
- *Jilaal*: January to March, longer dry season for all over the country

Rainfall in the study area is erratic, with a bimodal pattern except in the southern riverine areas close to the coast where some showers may occur even during the *Xagaa*. (see Figure 1 and Figure 2). Rainfall varies considerably over the study area, with the *Gu* delivering about 60% of total mean annual rainfall. Total mean annual rainfall ranges from 200 - 400 mm in areas bordering Ethiopia in Hiiraan, Gedo and Bakool regions and 400 - 500 mm in the central Bay and northern part of Middle and Lower Shabelle Regions. Higher rainfall areas receiving more than 600 mm occur in the Middle Jubba region, around Jilib in the southern riverine areas. Rainfall is characterised by intense, short rainstorms. The study area has a high inter-annual rainfall variation and is subject to recurrent drought every 3-4 years, and more severe dry periods every 7-9 years.

Air temperatures are influenced by altitude and by the strength of seasonal winds. In the first dry season (*Xagaa*) days are often cool and cloudy all over the region, with light showers in areas close to the coast. In the second dry season (*Jilaal*) days are hot, or very hot and dry. However, the hottest period coincides with the months of March and April.

Temperatures vary with the seasons, with the mean annual temperature ranging from 23°-30°C, with a maximum temperature of 41°C in March (Baardheere) and a minimum temperature of 24°C in July. In areas near the major rivers the relative humidity is high, ranging from about 70-80%, but further inland away from the rivers the air is much drier. Relative humidity is higher in the coastal areas, where it usually exceeds 87%. Normally, the high relative humidity is compounded by higher temperatures.

The major winds are in response to the north and south seasonal movement of the Intertropical Convergence Zone, and in particular the Intertropical front. In the study area the winds persistently blow from the northeast during *Jilaal* (December to February), when the weather is hot or very hot, and from the southwest during *Xagaa*, (June to August), when the weather is cool and cloudy.

The weather is hot and calm between the monsoons (part or whole of April and part or whole of September). In the *Jilaal* periods, prevailing winds are strong and blow in heavy dust storms from the Arabian Peninsula. Weaker winds generally occur during the inter-monsoonal periods of April/May and October/November. Average wind speed varies between 2-6m per second.

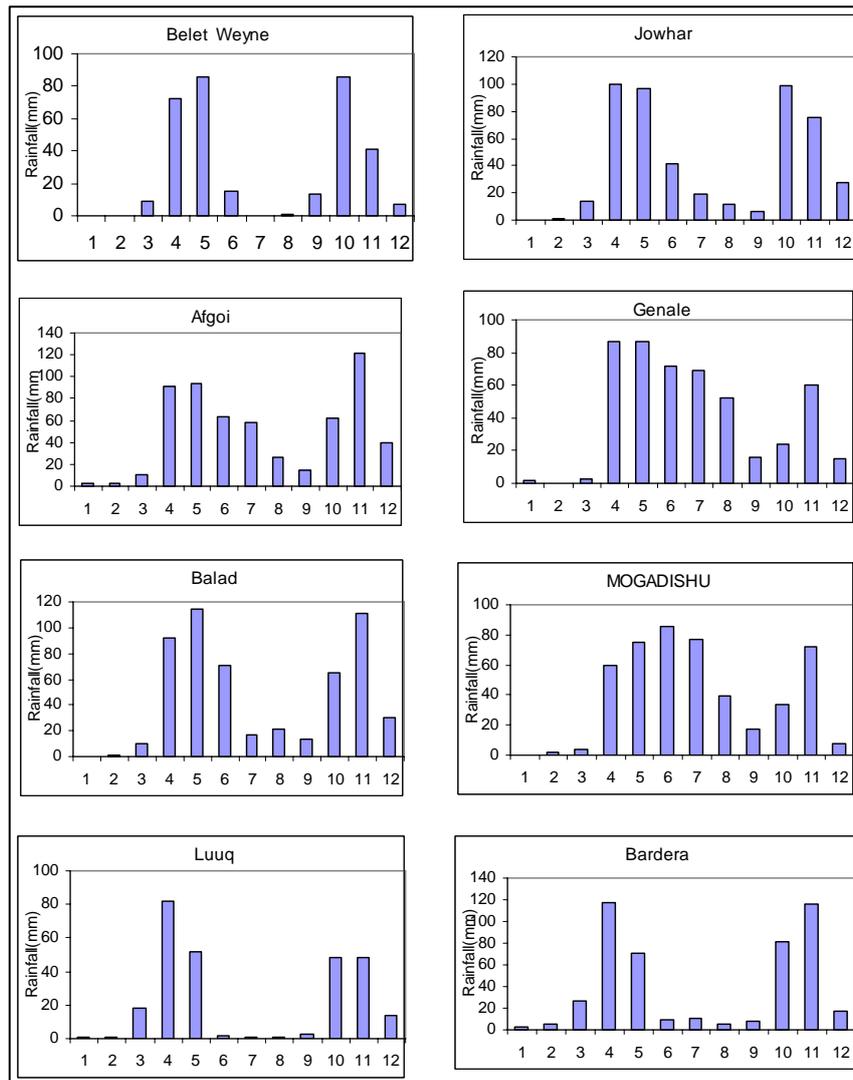


Figure 2: Mean monthly rainfall patterns in the study area (1963-2001)

Evapotranspiration is consistently high throughout the study area. The highest potential evapotranspiration occurs in the northern areas of Gedo, Bakool and Hiraan regions, where it exceeds $> 2\,000$ mm/yr; in the rest of the area it is between $1\,500 - 2\,000$ mm/yr. Annual rainfall (P) is everywhere far below potential evapotranspiration (PET) and there is a significant moisture deficit for most of the year.

Three broad climatic zones may be recognized, characterized by differences in patterns of rainfall:

- The coastal zone - with significant amount of rain occurring from July -August (*Hagi* rains) that lengthen the *Gu* season.
- The semi-arid zone – with two strongly defined rainy seasons and an additional light rainy season that may occur during July-August.
- The arid zone – with a lower annual rainfall and a dry period between July-August. The monsoon winds are the most important factor affecting the climate and the timing of the rainy periods. The south-west monsoon winds prevail during June, July and August. The north-east monsoon winds prevail during December, January and February.

2.1.3 Geology

The Study Area is characterized by the outcropping of the metamorphic basement complex, made up of migmatites and granites. Sedimentary rocks such as limestones, sandstones, gypsiferous limestones and sandstone are present and an extensive, wide system of coastal sand dunes. Basaltic flows are present in the northwestern part of the study area. From a tectonic point of view, the study area is characterized by a fault system lying parallel to the coast in the alluvial part of the AOI, and by a system of northwest-southeast oriented faults in the metamorphic basement complex.

Some late Tertiary fluvio-lagunal deposits occur on the Lower Jubba plain and part of the southern Shabelle, consisting of clay, sandy clay, sand, silt and gravel. Recent fluvial deposits are common alongside the two major rivers, the Jubba and Shabelle, consisting of sand, gravel, clay and sandy clay. Other Recent alluvial deposits occur in small valleys in Gedo and Bakool Regions and in the Buur area, consisting of gravelly sand or red sandy loam materials. A wide coastal dune system occurs along the coast.

2.1.4 Landform/Soils

According to the bibliography, the study area is characterized by the following land features:

1. The two main river valleys (Jubba and Shabelle Rivers) that traverse the generally level, undulating morphology of the area;
2. hilly topography in the middle of the study area cut by wadis, and gently undulating wide plains toward the coast; and
3. a coastal dune complex known as the Merka red dunes, which fringes the coast from beyond the Kenyan border, separating the narrow coastal belt from the Webi Shebeli alluvial plain (Carbone & Accordi, 2000).

The study area is dominated by the presence of the distal portion of the two main perennial rivers of the Horn of Africa, flowing from the highlands of Ethiopia towards the Indian Ocean: the Jubba River (700 km of which are within Somalia, out of its 2 000 km total length) and the Shabelle River (1 560 km of which are within Somalia, out of its almost 1 800 km total length). The Jubba flows into the Indian Ocean close to Kismaayo city, while the Shabelle impounds itself a few kilometres before reaching the lower tract of the Jubba.

Because of the predominance of alluvium, many soils comprise layers of deposited materials which, because of the semi-arid climate, have been little-affected by normal soil-forming processes. Despite their variability, most soils share the characteristics of heavy texture and low permeability, with a tendency to poor drainage.

2.1.5 Land Cover

Land cover in the study area consists mainly of natural vegetation. Other cover types include Crop fields (both rainfed and irrigated), Urban and Associated Areas (Settlement/Towns and Airport), Dunes and Bare lands and Natural Water bodies. The natural vegetation consists of riparian forest, bush lands and grasslands. Woody and herbaceous species include *Acacia bussei*, *A. seyal*, *A. nilotica*, *A. tortilis*, *A. senegal*, *Chrysopogon auchieri* var. *quinqueplumis*, *Suaeda fruticosa* and *Salsola foetida*.

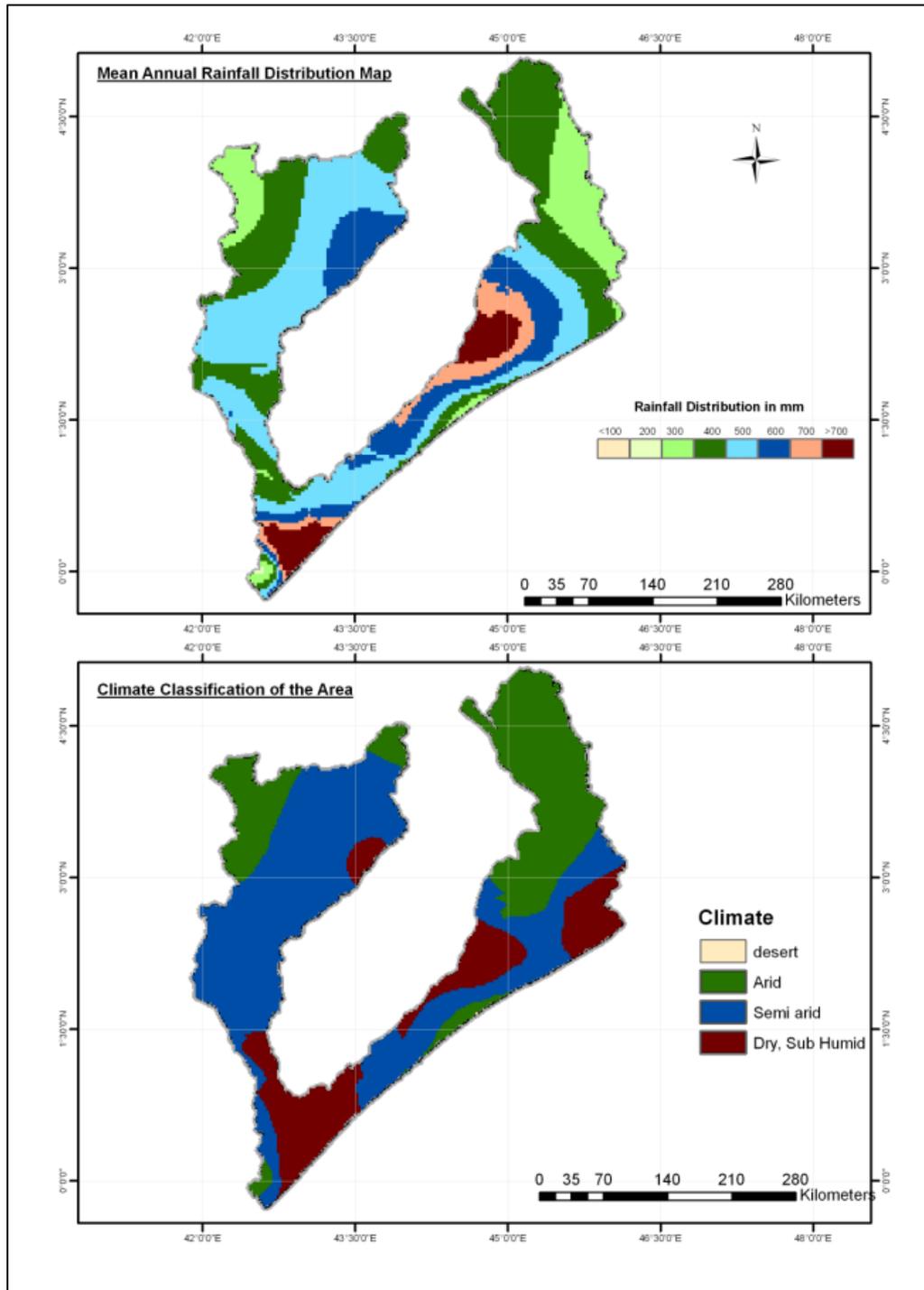


Figure 3: Mean annual rainfall distribution map and climate of study area

2.1.6 Land Use

Land use in the study area consists mainly of grazing and wood collection for fuel and building material. Rangelands in the Jubba and Shabelle catchments support livestock such as goats, sheep, cattle and camels. Livestock ownership is private, but grazing lands are communal, making it very difficult to regulate range use. Rangelands are utilised by herders using transhumance strategies (Shaie, 1977). Land cover associated with this land use includes forest, bushlands and grasslands (GTZ, 1990).

Farmers in these two river valleys are sedentary, practicing animal husbandry in conjunction with crop production. They tend to keep lactating cattle, a few sheep and goats near their homes, while non-lactating animals are herded further away, in the manner of herding nomadic stock. However, rainfed and irrigation farmers keep relatively small numbers of livestock, mainly cattle and small ruminants.

Animal feed is primarily from natural vegetation and crop residues, while dry season watering of animals is from rivers. Crop residues provide forage for non-browsers such as cattle and sheep. Numerous water reservoirs in the area between the two rivers provide water in the wet season and also serve as alternative water sources to the rivers. Groundwater is also an important source of water for livestock, other sources including hand-dug wells, swamps, creeks and boreholes.

Other land uses include rainfed agriculture, which includes agriculture that is entirely dependent upon rainfall. Crops under this category of land use include sorghum, millet, maize, groundnuts, cowpeas, mung beans, cassava and other minor crops, and are grown twice a year in the *Gu* and *Deyr* seasons.

Small-scale irrigated fields are also found along the Shabelle and Jubba river valleys, growing maize, sesame, fruit trees and vegetables while large-scale plantations include sugar cane, bananas, guava, lemon, mango and papaya.

Flood recession cultivation in *desheks* (natural depressions) on the Jubba River floodplain is common, crops including sesame, maize and vegetables. Major crops in the *desheks* are maize, sesame, tobacco, beans, peas and vegetables, watermelon and (rarely) groundnuts. Cropping is either single or mixed.

3 METHODS

3.1 Bibliographic research

The study initially involved a bibliographic review of land uses in the study area. Research was focused on internet searches, grey literature and – importantly - a visit to projects and institutions with activities concentrated in Somalia. Examples of such institutions and organizations are FSAU, UNDP and the EC. Numerous libraries were visited where many reports were collected. All documents were assessed for information regarding land resources, and land use specifically. The different land use classes and their characterisations were outlined from the reports, following which a land use survey plan was established from the results of the bibliographic research activity.

3.2 Field Survey preparation

After building a very general idea of land use characteristics in the study area, preparations were made for the implementation of the actual land use survey itself. The land use inventory is an intermediate product in the SWALIM framework aimed at assessing physical land suitability of the study area. Before planning for the field, certain aspects had to be reviewed and considered - first the technical aspects, and then a review of the national socio-political situation which might limit performance of a standard land use survey.

With these considerations in mind, a survey consisting of two principal activities was designed: land use mapping and the characterization of the different land use classes.

Land use mapping requires a fieldwork stage to determine the different land use spatial patterns in the study area. The only way to characterize land use is through technical field assessment and participatory approaches. A land use data collection form was designed, to help map and characterise land use (see Annex 1). This data collection form was designed to facilitate semi-structured interviews subsequently aimed at gathering both purely technical data by the surveyor and indigenous knowledge through the different land users. Data to be collected with this form was semi-quantitative and mostly related to the bio-physical components of each land use system. There was not much focus on collecting socio-economic data due to the socio-political situation and the relevance of that data to the current situation.

The preliminary land use classes generated in the bibliographic research were included in the form, grouped into three principal land use systems: agriculture, livestock production and wood collection.

A rigid sampling scheme was not used due to the prevailing constraints, including lack of information regarding accessibility and landmines, and considering that the surveyors were Somali nationals that were to receive training for these purposes. Other prevailing constraints included insecurity due to war ongoing at the time of the survey, and social acceptance problems with communities. Instead, the sampling scheme was based on the land cover survey and a sampling scheme using the box concept. This box concept involved stratified random sampling of different land cover classes produced in the preliminary land cover map. Boxes were ideally distributed according to thematic aspects and accessibility. However, visits to each point were not compulsory and were dictated by field realities. The size of sample boxes varied with the size of the polygon being sampled, the general rule being that the bigger the polygon the bigger the box. The details of this concept are outlined in FAO-SWALIM Report No L-03 (Monaci *et al*, 2007). The box concept was applied to the land use survey because the land cover map formed the basis for mapping land use.

3.3 Land use field survey

Given that the international staff members of SWALIM were not allowed to conduct the field survey on their own for security reasons, besides a language barrier and confidence with the land users, the project decided to contract Somali experts to perform the field data collection.

A training period for the Somali team was carried out from 23rd to 28th February 2007 in Hargeisa. A field data collection manual prepared by SWALIM (Vargas *et al*, 2007) was used as the basis for this training because it contains a description of how to get data for all the land resources, including land use. The objective of this training stage was to help test the different forms and to facilitate practically oriented training to the Somali team. The land use surveyors were trained in land use data collection, rapid rural appraisal techniques, the use of a GPS, reading maps and interpreting the proposed box sampling scheme to guarantee proper land use data collection.

Immediately after training, a one month field data collection phase was conducted to collect land use data. However, as an integrated land resources survey other resources such as landform, land cover and soils were also collected. Six land use surveyors were distributed through the study area which, for logistical reasons, was subdivided into three sections. Land use data collection forms were used for collecting technical data using direct observation techniques and, in most of the cases, through a semi-structured interview.

3.4 Data input and analysis

While field data collection was underway, batches of completed land use forms were sent to Nairobi. An Excel data entry worksheet was designed as the first assessment for correctness and completeness of the forms. This worksheet was also useful in helping map the visited sites (with X, Y GPS coordinates) using ArcView 3.3 software. This map assisted us periodically in monitoring areas that were covered by the surveyors, and also our preliminary understanding of spatial land use patterns.

All data contained in each form was entered into the Excel spreadsheet. Entries were then grouped depending on the preliminary land use class they belonged to, while checking whether the land use surveyors had discovered new land use classes in the study area. A preliminary analysis was done regarding the different land use classes described in the forms, their location/s on satellite image backgrounds and the specific productive variables of each system.

This process was sequential till the final batch of land use forms reached the office in Nairobi.

3.5 Land use characterization

With data stored in a digital format and after the preliminary analysis, the final land use classes present in the study area were defined. The preliminary land use classes changed based on variables collected in the field, principally because the form was focused on individual land use classes whereas the fieldwork data showed that there were no single classes. However, for land use characterization, the semi-qualitative variables were analysed according to individual land use classes. This characterization involved the utilization of the land use point map to understand where the different land use classes occur. Based on the point map and the data per interview, groupings were made into different land use classes. Finally, each point data form was reclassified according to the final land use classes. This whole process offered tremendous support to the final stage of actual land use mapping.

As the final classes were defined, they were characterised from a technical point of view including agronomic aspects, constraints and opportunities. The positive and negative aspects of each system and how to improve them from land user perspectives were highlighted. These land users perspectives were crosschecked against technical aspects described by the surveyors.

3.6 Land use mapping

It may be recalled that the land use survey was guided by the preliminary land cover map produced by FAO-SWALIM (Monaci *et al*, 2007). This preliminary land cover map and the land use point map formed the cartographic and thematic basis for mapping land use. Furthermore, available Landsat ETM and ASTER satellite images were used to clarify some specific patterns in complex areas.

The procedure involved the reclassification of each land cover polygon according to its relation with the defined land use classes supported by the land use point map, and the land use characteristics of each class. This was done by an on-screen computer process using ArcView 3.2 GIS software.

Validation was done using expert knowledge from Somali experts familiar with land use patterns in the study area.

4 RESULTS

4.1 Preliminary land use classes

Bibliographic research outlined the following six major land use classes:

Irrigated Farming

Irrigated farming comprises large scale irrigated farming schemes larger than 20 000 ha, including sugarcane, rice and bananas.

Irrigation along the Shabelle River is by gravity, downstream of Genale and in a small area around Jowhar where water barrages were constructed during the 1920s. Along the remaining zones of the Shabelle River and all along the Jubba River, diesel pumps are used to extract water. Land is irrigated under controlled and flooding conditions.

In small-scale irrigation, crops grown include maize, sesame, fruit trees and vegetables, while large scale plantations include sugarcane, bananas and fruit trees such as guavas, lemons, mangos, papaya, etc.

Flood Recession Cultivation in Desheks

Desheks are natural depressions in the flood plain of the Jubba River, seasonally flooded by river water and in addition may be flooded by underground flow from the river or by runoff from adjacent areas. Soils in these desheks retain enough moisture to support one crop. The main crops cultivated are sesame, maize and vegetables. Major crops are maize, sesame, tobacco, beans, peas and vegetables, water melon and rarely ground nuts. The crops are either single or mixed crops.

Rainfed Cultivated Area

This land use class includes agriculture entirely dependent on rainfall. Crop growing under this category of land use is done twice a year, in the *Gu* and *Dur* seasons. Crops include sorghum, millet, maize, groundnuts, cowpeas, mung beans, cassava and other minor crops.

Grazing and Wood Collection for Fuel and Building wood

Rangelands in the Jubba and Shabelle catchments are used as grazing areas by pastoralists, mostly by goat, sheep, cattle and camels. Livestock ownership is private but grazing lands are communal, making it very difficult to regulate range use. Rangelands are used for transhumance strategies by herders (Shaie, 1977). Land cover associated with this land use includes forest, bush lands and grasslands (GTZ, 1990).

Farmers in these two river valleys are settled, and practice animal husbandry in conjunction with crop production. They tend to keep lactating cattle, a few sheep and goats near their homes, while non-lactating animals are herded further away in a manner similar to the herding of nomadic stock. However, rainfed and irrigation-dependent farmers keep relatively small numbers of livestock, mainly cattle and small ruminants.

Animal feed is obtained from natural vegetation and crop residues, while watering of animals is from rivers during the the dry season. Crop residues are used to provide forage to non browsers, such as cattle and sheep. Numerous reservoirs provide water in the wet season and also serve as alternative water sources to rivers. Groundwater is also an important source of water for livestock, other sources including hand-dug wells, swamps and creeks and boreholes.

Urban Centres and Settlements

This category of land use comprises urban centres, villages and satellite settlements having housing structures of two types: immobile or fixed houses, and mobile houses.

Dunes and Bare Lands

These are areas without use as they are sandy and barren. In the dunes, soils are very sandy, lack structure and cannot not hold plant life.

These six classes formed the basis for the preliminary map and its legend.

4.2 Land Use Survey

Map 2 shows points visited for land use characterization through semi-structured interviews with farmers and pastoralists, to help in subsequent characterization of land use. Notice that the Lower Jubba and part of the Lower Shabelle were not accessed during the surveys, due to flooding and also insecurity problems at the time. Land use characterization of areas that were not accessed was based on results from similar areas that were visited where interviews carried out.

4.3 Final Land Use Classes

The final mapping resulted in 12 verified classes of land use (see Table 1):

- i) Transhumance Pastoralism/Wood Collection
- ii) Transhumance Pastoralism
- iii) Transhumance Pastoralism/Rainfed Agriculture
- iv) Rainfed Agriculture
- v) Rainfed Agriculture/Transhumance Pastoralism
- vi) Dunes and Bare Land
- vii) Irrigated Agriculture
- viii) Transhumance Pastoralism/Wood Collection/Rainfed Agriculture
- ix) Transhumance Pastoralism/Irrigated Agriculture
- x) Water Body
- xi) Built Up Area
- xii) Rural Settlement

Figure 4: Land Use Survey Samples

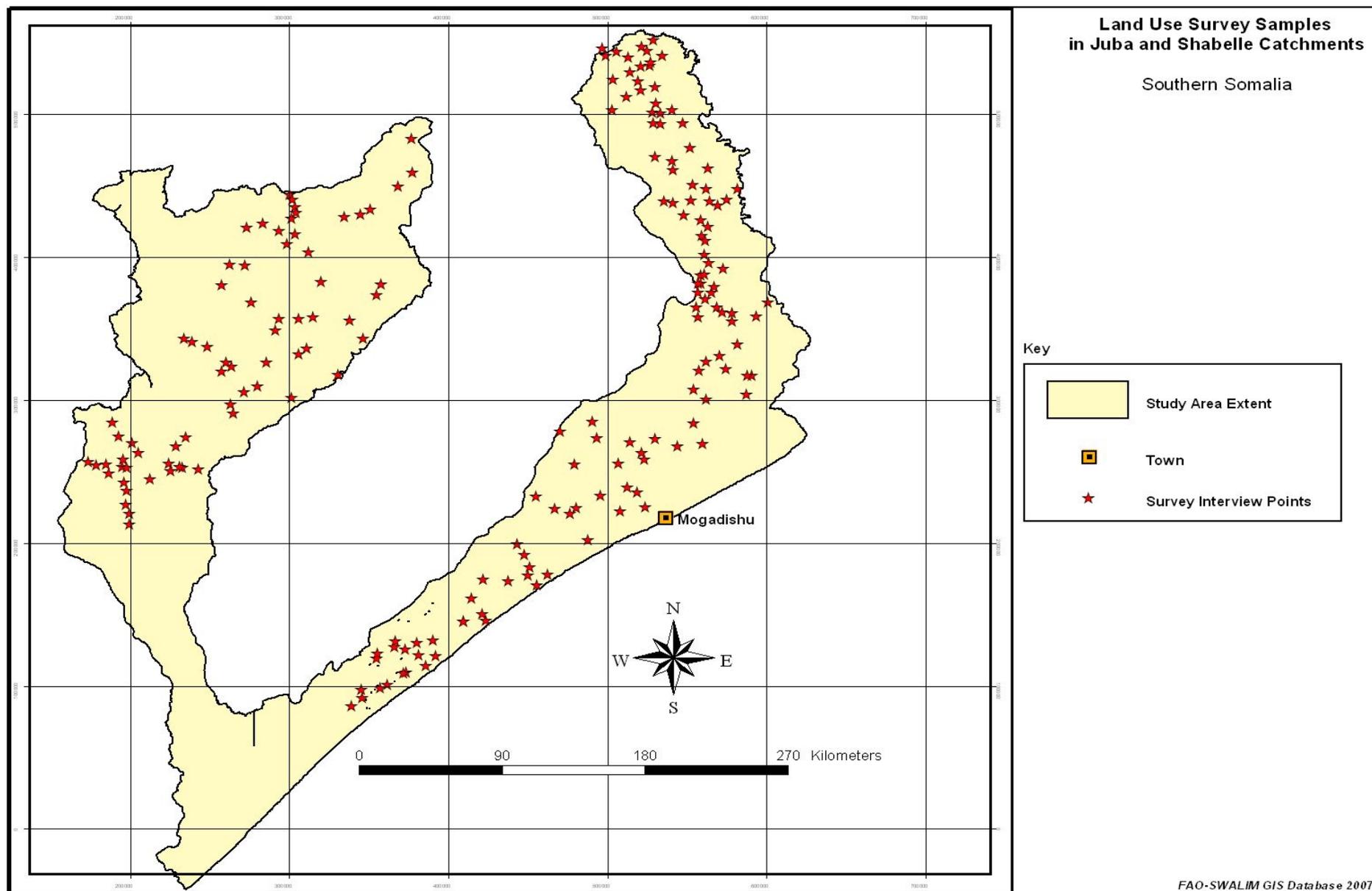


Table 1: Land Use Classes and area

Code	Land Use Class	Km ²
TW	Transhumance Pastoralism /Wood Collection	43 372
TP	Transhumance Pastoralism	36 841
TR	Transhumance Pastoralism/Rainfed Agriculture	11 868
R	Rainfed Agriculture	8 326
RT	Rainfed Agriculture /Transhumance Pastoralism	2 568
BL	Dunes and Bare Land	1 933
I	Irrigated Agriculture	1 873
TWR	Transhumance Pastoralism /Wood Collection/Rainfed Agriculture	1 399
TI	Transhumance Pastoralism/Irrigated Agriculture	234
W	Water Body	140
U	Built Up Area	99
RS	Rural Settlement	3
Total		108 656.0

Land Use Classes have been arranged in their order of dominance. Transhumance Pastoralism/Wood Collection is the most dominant land use, while Rural Settlements are the least dominant in coverage within the two catchments, covering 43 372 km² and 3 km², respectively.

4.3.1 Rainfed Agriculture

Rainfed Agriculture involves crop production entirely reliant on rainfall, practiced all along the river catchments. Given that the climate of the river basin areas is tropical arid to dry, sub-humid, Rainfed Agriculture is characterized by water harvesting and soil and water conservation measures (soil bunding, terracing, drainage, dams, and other water reservoirs) as improvement systems associated with it. The most common crops in this category are sorghum, cowpeas, sesame, mung beans, maize and vegetables.

- **Land improvement** – consists of soil water harvesting, (soil bunding, wells, dam/reservoir, ponds and terracing). Water is a limited resource in this area and therefore farmers try to devise ways of conserving the little available water. Drought is a common phenomenon.
- **Input levels** – agricultural production input levels are generally low. Local seeds are widely used.
- **Mechanization** –40% of interviewees indicated that they use machinery, with tractor use being common. In rare cases, oxen are also used to provide plough power.
- **Farm management** – a few people are fencing their farms, but for most there is no form of farm management.
- **Types of crops** –crops grown are mainly sorghum, cowpeas, sesame, mung beans, maize and vegetables.
- **Intercropping** – intercropping is common, with combinations including maize and sesame, sorghum and sesame and cowpeas and sesame (see Plate 4).
- **Purposes of crop production** – crops are produced for food, marketing and animal fodder. In most cases, animals are grazed on harvested field residues (see Plate 2). Crops that have failed to mature due to moisture stress are sold to pastoralists as animal feed.

- **Crop condition and limitations to agricultural production** – crop performance in the area ranges mostly from poor to total failure (see Plates 1 and 3). Good crops are rare. Limitations to agricultural production include low rainfall, pests, floods, low soil fertility, poor farming technology and erratic rainfall. Plate 1 shows a failure of a sorghum crop.
- **Agronomic aspects** – yields fall far below potential levels, which may reach 3 000 kg/acre for maize. In some cases, maize yield may be as low as 200 kg/ha.
- **Farm training** – The majority of farmers have not received any farm training, with the result that most farming techniques applied are inadequate.
- **Constraints to agricultural production** – constraints include lack of tillage capacity, poor soil fertility, pests, drought, floods, lack of technical knowledge and - above all - lack of credit.
- **Opportunities** – opportunities for farmers include provision of farm training, improved extension services, use of pesticides and fertilizer, improved security, rehabilitation of water reservoirs, improved markets, improved seed, credit, facilities, construction of shallow wells and water reservoirs.



Plate 1: Rainfed sorghum. Notice moisture stress



Plate 2: Grazing of standing crop residue



Plate 3: Rainfed Agriculture - sorghum and maize intercropped



Plate 4: Rainfed Agriculture sorghum, harvested sesame and maize intercropped

4.3.2 Irrigated Agriculture

Irrigated Agriculture is practiced along alluvial plains close to the Jubba and Shabelle rivers. Irrigation along the Shabelle River is by gravity downstream of Awdegle and a small area around Jowhar, where water barrages were constructed during the 1920s. Along the remaining zones of the Shabelle River and all along the Jubba River, diesel pumps are used to extract water. Lands are irrigated under controlled and flooding conditions.

In small-scale irrigation, crops grown include maize, sesame, fruit trees and vegetables, while the few large-scale plantations include bananas and fruit trees such as guava, lemon, mango and papaya.

Irrigation is also practiced by flood recession cultivation in desheks. Desheks are natural depressions in the floodplain of the Jubba River, seasonally flooded by river water and in addition may be flooded by underground flow from the river or by runoff from adjacent areas. Soils in these desheks retain enough moisture to support one crop. The main crops cultivated are sesame, maize, beans, peas, watermelons, vegetables and - rarely - ground nuts. Crops are either single or mixed.

- **Land improvement** – consists of soil bunding, irrigation and drainage canals, terracing, dams and wells. Input levels for agricultural production are generally low to medium, with local seed being widely used.
- **Inputs and their levels of application** – Input levels for agricultural production are mostly low to medium, and include fertilizer and pesticides.
- **Mechanization** –tractor use is common but oxen are also used to provide farm power, mainly during preparatory stages of ploughing and construction of irrigation infrastructure. However, due to high costs of machinery purchase and hire most farmers cannot afford their use, with the result that few farmers have been able to

invest in irrigated farming. Other machinery includes water pumps used to pump water from rivers into fields.

- **Farm management** – the majority of farmers practicing irrigation agriculture do not apply any form of farm management, and few farmers have fenced their farms. Other farm management forms include river bank embankments to check flooding. In some cases crops have been separated by type, so that one may have citrus crops on one side of a field and papaya on the other.
- **Types of crops** – crops grown include maize, sesame, cowpeas, mung beans, groundnuts, sorghum, rice, vegetables and fruit trees (see Plate 5).
- **Intercropping** – intercropping is a common practice, with fields comprising a mixture of crops; for e.g. maize with sesame, sesame with cowpea and vegetables with fruit.
- **Purposes of crop production** –crops are produced for sale at markets, human consumption at home and/or fodder for animals.
- **Crop condition** – crop condition within irrigated fields may be characterized by poor crop condition and even crop failure attributed to waterlogging following floods, poor or infertile soils, pests, unimproved seeds, droughts and limited cash resources necessary for improved farming activities.
- **Agronomic aspects** –yields were found to be much higher than in rainfed fields, with maize yields reaching 1 000 kg/ha. Fertilizer and pesticides are used. Farm labour is drawn primarily from family members, but hired labour has been recorded on irrigated farms. Seed varieties are mostly local.
- **Farm training** – farm training is wanting, resulting in most farmers not being able to apply adequate, appropriate farming techniques. Fields are flood-irrigated, a wasteful method when rated against water scarcity and high evapotranspiration processes.
- **Constraints to agricultural production** –constraints include lack of tillage capacity (shortages of labour, ox-plough implements and tractors), market inaccessibility, flooding, water scarcity, loss of irrigation infrastructure (siltation, etc.) (see Plate 6), poor roads, pests, drought, lack of capital, lack of technical knowledge, and lack of security. Lost irrigation infrastructure will require reconstruction, which is expensive. Together with the limited purchasing power of farmers, it may become impossible to revive irrigation projects. Market inaccessibility demoralizes farmers as they are unable to sell produce. Farmers have little incentive to work in the fields as they do not see any tangible benefits.
- **Opportunities** – opportunities for farmers include canal rehabilitation, borrowing cash from relatives, restoration of security, use of pesticides, use of fertilizer, improved markets for farm produce, farm training and land demarcation to facilitate permanent farm parcels.

Table 3 shows the crop calendar for various irrigated crops in the study area.



Plate 5: Irrigated Fields. Notice fruit trees and herbaceous crops.



Plate 6: Silted and damaged irrigation canal.

4.3.3 Transhumance Pastoralism

Transhumance Pastoralism is the most common type of grazing system in this area (see Plates 7-11). In this system, animals are moved in a well-designed pattern associated with the availability of water and forage. Little land improvement is associated with the land use, except for boreholes and wells plus other water sources associated with settlements and crop fields.

- **Animals kept** –animals are mostly sheep and goats, cattle, camels and donkeys (see Plates 7-11).
- **Livestock products and use** - products obtained include milk, meat, skin and ghee, both for domestic and commercial use. Products are sold in markets, which are not always easily accessible. Roads leading to markets are often in bad condition and in certain cases markets are situated long distances away.
- **Livestock health** – this was found to range from average to good in the surveyed area. In some cases livestock health was found to be poor due to fodder scarcity, such as where shrubs dry up in drought years.
- **Forage condition** - forage quality was found to be moderate for all animal types. In some cases, forage was good. However, in drier years livestock suffers greatly and may die.
- **Presence of enclosures** – enclosures refer to fenced off grazing lands, in which grasses are sometimes harvested for sale and dry season animal fodder. Enclosures were found to be a rare feature during the survey.
- **Water sources** - shallow wells are important sources of water for livestock, especially in the dry season. Other livestock water sources include rivers, boreholes and ponds.
- **Constraints** - constraints associated with livestock production include disease, water shortage, poor quality dry season pasture, drought, low market prices for livestock products, poor livestock management systems, long distances to watering points, high water costs and poor road networks.
- **Opportunities** – according to interviewees, feasible opportunities for livestock production include provision of veterinary services, improved security, construction of shallow wells, provision of markets for livestock and livestock products, rehabilitation of damaged water reservoirs, rehabilitation of water canals, sinking more boreholes, training in proper livestock husbandry, establishment of sustainable rangeland management strategies.

Transhumance pastoralism may occur as a single land use class, or may occur as a mixed unit with Agriculture and Wood Collection for charcoal burning.



Plate 7: Pastoralism (cattle)



Plate 8: Pastoralism (watering camels)



Plate 9: Pastoralism (camels)



Plate10: Pastoralism (goats)



Plate11: Watering livestock

4.3.4 Wood Collection for Charcoal Burning

Charcoal burning is common wherever there are trees, especially *Acacia bussei*, *A. nilotica* and *A. seyal*. Other tree species cut for charcoal include *Acacia tortilis*, *Terminalia prunoides* and *Prosopis juniflora*. Charcoal burning is practiced as an alternative livelihood, its negative effects to the environment notwithstanding. Charcoal production has led to increased soil erosion, reduced grazing land and reduction in biodiversity. The practice is illegal and is conducted against the wishes of pastoralist



Plate 12: Tree cuttings ready for firing to produce charcoal

communities and government. Charcoal burning sites are located far from settlements, and those involved do all they can to remain undetected. The activity is rampant, occurring in areas of high tree density (See Plate 12). Charcoal burning has promoted a decline in range quality and caused land degradation, especially as a result of water erosion. Trees are cut live and kilns are mostly of the mound type, with rare cases of pit and trench types.

The highest demand for charcoal comes from urban dwellers in major towns such as Mogadisho, Baidoa, Berbera, Kisimayo, Belet Weyne and others. Some charcoal is re-exported to Arab countries.

4.3.5 Rural Settlement

Rural settlements are characterized by the presence of several houses together, as well as animal sheds. Notable features include heaps of manure, ponds and other associated features (see Plate 14). Charcoal burning sites may be found nearby, wherever there are trees suitable for charcoal burning. Rural settlements are also close to water sources.



Plate 14: Rural Settlement with Pond for water (human and livestock)

4.3.6 Built-Up Areas - Urban Area and Airport Services

Built-Up Areas are essentially areas with high concentrations of buildings and people, such as towns or urban settlements. Notable features include shops, schools, hospitals, roads, offices and other social amenities (see Plate 14). Built-Up Areas offer ready markets for charcoal and farm produce such as milk, fruits, vegetables, ghee and grains. Trucks loaded with charcoal are a common sight. Towns offer consumer supplies to rural settlements, including cooking oil, soap, drinks, flour, medicines and sugar.



Plate 15: Urban Area

4.3.7 Dunes and Bare Lands

These are areas without use, as they are sandy and barren. In the dunes, soil is very sandy and lacks structure, and can therefore not anchor plant life (see Plate 16).



Plate 16: Bare Areas

4.3.8 Water Bodies

This category incorporates all water bodies, including dams, ponds and other reservoirs.



Plate 17: Water pond (domestic and livestock use)

4.3.9 Crop Calendars

As part of the land use characterization, crop calendars for rainfed and irrigated agriculture were produced to give a general overview of production systems in relation to seasonality and productive activities. These calendars are shown in Tables 2 and 3.

Table 2: Crop Calendar for Rainfed Agriculture

CROP TYPE	JILAL (Dry Season)			GU (Long Rains)			HAGAA (Short Rains)			DEYR (Short Rains)		
	January	February	March	April	May	June	July	August	September	October	November	December
1 st Maize												
2 nd Maize												
Sorghum												
1 st Sesame												
2 nd Sesame												
Cowpea												

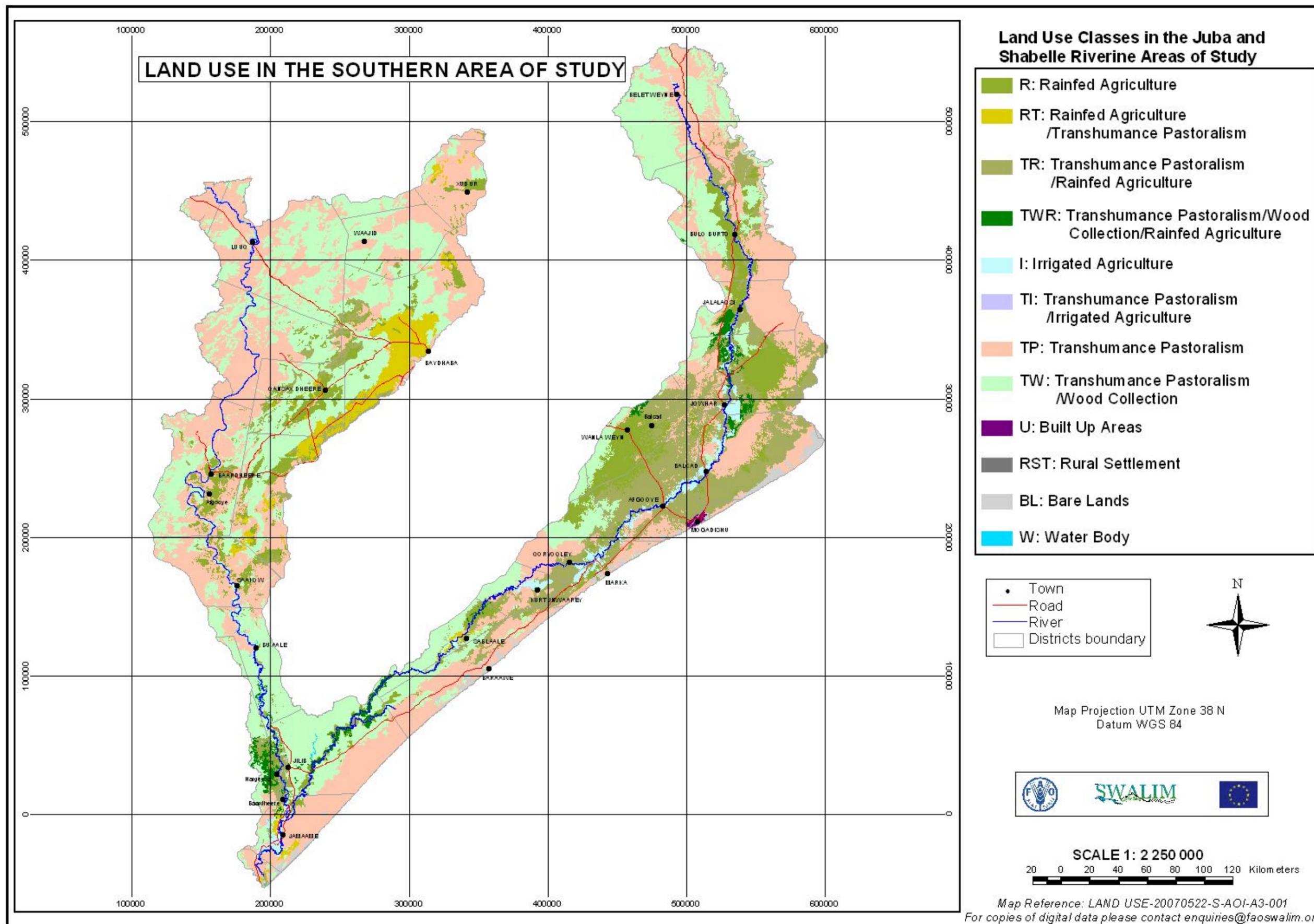
Table 2 above shows the crop calendars for some selected rainfed crops. Rainfed crops are grown during the long rains of *Gu* and a second crop may be planted immediately thereafter to take advantage of the short rains of *Hagaa* (see Table 2). The third crop may be planted during the short rains of *Deyr*. No crops are grown in the dry *Jilaal* season.

Table 3: Crop Calendar for Irrigated Fields

CROP TYPE	JILAL (Dry Season)			GU (Long Rains)			HAGAA (Short Rains)			DEYR (Short Rains)		
	January	February	March	April	May	June	July	August	September	October	November	December
Fruit Trees												
Tomato												
Maize												
Sesame												
Groundnuts												
Rice												
Cowpea												
Vegetables												

Irrigated crops may be grown all year round so long as water is available, as shown in Table 3 above. Fruit trees, which are permanent crops, remain in fields throughout the year with fruits being harvested whenever they mature. However, each tree crop has a period when fruits are ready to pick. Table 3 also indicates that, in irrigated fields, crops can be grown even during the *Jilal* dry season. Floods in the *Gu* season of 2006 prevented growing of crops during that season.

Map 3: Land Use of the Jubba and Shabelle Riverine areas



5 CONCLUSIONS AND RECOMMENDATIONS

A complete inventory of human activities expressed in terms of land use was performed, including classification of different land use classes and generation of a 1:100 000 map showing patterns of those activities.

Descriptions of land use classes included a technical assessment of their components, including assessments of each activity in terms of the current situation and trends.

A semi-structured questionnaire was instrumental in establishing information about land use in the area under investigation. However, due to time constraints coupled with the current socio-political situation in Somalia, information emanating from this questionnaire was qualitative rather than quantitative. In addition, the socio economic dimension was incompletely emphasised in interviews. It is therefore important that these aspects of land use should be addressed in future.

Crop calendars were not exhaustively established. The results give a very general indication of cropping patterns without explaining underlying reasons behind some of the characteristic timing of crop farming activities. For example, crop calendars indicate that it is not common to grow crops in the *Gu* season under irrigated systems. However, it may be easier and more logical to say that growing of crops during the *Jilaal* season under rainfed agriculture is not practical due to lack of soil moisture. Soils become too dry in *Jilaal* to allow plant growth.

6 BIBLIOGRAPHY

- Besteman, C & Cassanelli, L V. 2000. *The Struggle for land in Southern Somalia. The War Behind the War*. HAAN P O Box 607, London SW16 1EB.
- Bronsveld K., van Gils H., Groten S., Huizing, H. & van Wijngaarden W. 1992. *Land Ecology and Land Use Survey*. ITC Lecture Series LS. ITC Enschede, The Netherlands.
- de Leeuw P. 1984. Pastoral production Systems and Land Utilization Types. **In:** Siderius, W. (ed). *Proceedings on Land Evaluation for Extensive Grazing*. ILRI, Wageningen. pp. 113-119.
- Dent D. & Young A. 1980. *Soil Survey and Land Evaluation*. Cambridge University Press. Longmans.
- Di Gregorio A. & Jansen L.J.M. 2005. *Land Cover Classification System. Classification Concepts and User Manual. Software Version 2*. FAO, Rome
- Dixon J., Gulliver A. & Gibbon D. 2001. *Farming Systems and Poverty. Improving Farmer's Livelihoods in a Changing World*. FAO and World Bank. Rome and Washington DC.
- European Commission. 2003. *Banana Sector Study for Somalia Strategy for Agricultural Development and Diversification in Lower Shabelle. 2002/34474 Version 1*. European Union Rural and Agriculture Temporary Association.
- FAO. 1983. Guidelines: land evaluation for rainfed agriculture. *FAO Soils Bulletin 52*. Food and Agriculture Organization of the United Nations, Rome.
- FAO. 1991. Guidelines: land evaluation for extensive grazing. *FAO Soils Bulletin 58*. Food and Agriculture Organization of the United Nations, Rome.
- FAO. 1985. Guidelines: land evaluation for irrigated agriculture. *FAO Soils Bulletin 55*. Food and Agriculture Organization of the United Nations, Rome.
- George, H. & Nachtergaele, F. 2002. Global land use databases. Chapter 16 **in:** *Global Environmental Databases – Present Situation; Future Directions*, Vol. 2. Tateishi & Hastings (Eds.), ISPRS, Geocarto International, pp. 55-67.
- George, H. & Petri, M. 2006. *The rapid characterization and mapping of agricultural land use: A methodological framework approach for the LADA project*. Unpublished MS. Rome, Italy.
- GTZ. 1990. *Masterplan for Jubba Valley Development. Main Report*. Somali Democratic Republic.
- Faillace, C. and Faillace E. R. 1986. Hydrology and Water Quality of Southern Somalia Volume I: Text. GTZ-WDA.
- Hack, H., McKilligan, Fino D. & Ouko. 2002. *Banana Sector Study for Somalia Strategy for Agricultural Development and Diversification in Lower Shabelle*. European Commission
- Huizing, H. 1992. *Land Evaluation*. Lecture Notes for the LE Specialization. ITC, Enschede, The Netherlands.
- Kannegieter Ir. A. 1987. *Land Ecology and Land Use Survey*. ITC Lecture Series N9. Part A. remote Sensing for Land Ecology and land Use Survey. ITC Enschede, The Netherlands.
- Land Resources Development Centre. 1985. *Land Use in Tsetse-Affected Areas of Southern Somalia*. Somali Democratic Republic. National Tsetse and Trypanosomiasis Control Project. Land Use Survey. Surbiton, UK-Mogadishu, Somalia. Pp 289
- Ministry of Agriculture. 1990. Food Early Warning Department, , Somali Democratic Republic,. *The Agro-climatology of Somalia, Technical Report No 12*.
- Ministry of Agriculture. 1983. North-West Region Agricultural Development Project. Feasibility Study and Technical Assistance. *Agricultural Development Programme B-Irrigated Agriculture. Main Report and Annexes*. SOGREAH Consulting Engineers, Grenoble, France.

- Monaci, L., Downie, M. & Oduori, S. 2007. *Land Cover of Selected Study Areas in Somaliland and Southern Somalia*. FAO-SWALIM. Project Report No L-03. , Nairobi, Kenya.
- Mott MacDonald. 1996. *Middle Shabelle Flood Control Study*. Mott MacDonald Group, Cambridge, England.
- Oduori, S., Vargas, R. & Alim, M. 2007. *Land Use Characterisation of a Selected Study Area in Somaliland*. FAO-SWALIM. Project Report No. L-04. Nairobi, Kenya.
- Shaie, A.M. 1997. *Inventory Report Somalia*. FAO Report. Rome, Italy.
- Vargas, R., Paron, P., Monaci, L., Shaie, M. Oduori, S. Downie, M. and Nduby, A. 2007. *Field Survey Manual*. Project Report L-01. FAO-SWALIM. Nairobi, Kenya.

ANNEXES

6.1 Annex 1: Land use data collection form

6.2 Annex 2: Coordinates of the visited sampling sites and its land use class



LAND USE FORM

1. Date.....

2. GPS coordinates:
 N.....E.....

3. Name of the observer.....

4. Local name of the village or any location.....

5. Select the Actual Land Use:

Check	Type of land Use
<input type="checkbox"/>	Irrigated Agriculture
<input type="checkbox"/>	Rainfed Agriculture
<input type="checkbox"/>	Rainfed Fallow Agriculture
<input type="checkbox"/>	Nomadic Pastoralism
<input type="checkbox"/>	Transhumance Pastoralism
<input type="checkbox"/>	Agropastoralism (semi-sedentary grazing)
<input type="checkbox"/>	Grazing and Wood collection for charcoal and firewood
<input type="checkbox"/>	Urban area
<input type="checkbox"/>	Sedentary Pastoralism
<input type="checkbox"/>	Currently without use
<input type="checkbox"/>	

Farming System

1. Land improvement systems, please check the ones present in the unit

Check	Land Improvement
<input type="checkbox"/>	Drainage
<input type="checkbox"/>	Berkade
<input type="checkbox"/>	Borehole
<input type="checkbox"/>	Wells
<input type="checkbox"/>	Terracing
<input type="checkbox"/>	Soil bunding
<input type="checkbox"/>	Water harvesting
<input type="checkbox"/>	Other...

2. Can you determine the level of input in the present land use system?

	Input Level
<input type="checkbox"/>	Low input
<input type="checkbox"/>	Medium input
<input type="checkbox"/>	High input

3. Mechanization: () Yes () No

Type.....
 ...



5. Can you indicate the actual Phenological stage of the crop?

Crop Type	Crop Phenological Stage				
	start	growing	flowering	fruiting	fallow
Maize					
Sorghum					
Sesame					
Cowpeas					
Barley					
Other					

6. What is the general crop condition at this time?

Crop Type	Crop Condition		
	Crop Failure	Poor Crop	Good Crop
Maize			
Sorghum			
Sesame			
Cowpeas			
Barley			
Other			

7. In case of crop failure or poor crop, which is the principal limitation?

Climate conditions.....

Water availability.....

Soil factors..... related

Agronomic aspects..... cultural

Other.....



8. Can you explain some principal agronomic aspects?

Actual crop	Hectarage Under Crop	Type of seed	Type of cropping	Use of fertilizers	Manure	Use of pesticides	Labour	Machinery	Aprox.Yield per ha
Maize									
Sorghum									
Sesame									
Cowpeas									
Barley									
Vegetable									
Fruits									
Other									

9. Can you make a general Crop Calendar for this land use system? Give a complete yearly Crop Calendar.

CROP	JILAL			GU			HAGAA			DEYR		
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Maize												
Sorghum												
Sesame												
Cowpeas												
Barley												
Vegetables												
Fruits												
Other												

1	Land preparation
2	Planting
3	Mid-season
4	Harvesting

10. Have you received any Farm Training in the last 5 years? Are there any rural extension services?

11. What are the Major constraints and opportunities from a farmer's perspective (semi structured interview? Analyse the crop history by trying to get information from the land users regarding a historical perspective of the lands in terms of production. How is the current situation and what future improvements are possible). What according to you is the best alternative land use in this area?

Constraints	Opportunities

12. Major constraints and opportunities from a technical point of view (your opinion as technician regarding the negative issues regarding all the aspects and also some feasible solutions).

Constraints	Opportunities

Livestock

1. Which is the type of grazing?

	Type of Grazing
	Nomadic Pastoralism Transhumance Pastoralism Semi-sedentary (Agropastoralism) Other.....

2. Which are the species present in the system?

	Type of animal
	Camel Goat Sheep Cattle



3. Can you estimate the number of animals per species?

Species	Aprox. Number
Camel	
Goat	
Sheep	
Cattle	
Other	

4. Can you List the Livestock Products and their use?

Livestock Product	Camel	Goat	Sheep	Cattle	Other	Use for Livestock Product
Meat						
Milk						
Skin						
Ghee						
Cheese						
Other						

5. Can you indicate the general health condition from a physical appearance?

Species	Condition		
	bad	average	good
Camel			
Goat			
Sheep			
Cattle			
Other			

6. If the general condition is down from average to bad, can you explain the principal reasons for it?

7 What, in your opinion, is the quality of the forage for the various animals as listed below? (Tick)

Animal Type	Forage Quality		
	Good	moderate	bad
Camel			
Goat			
Sheep			
Cattle			
Other			

8. Enclosures in the rangeland area.

Presence of enclosures	Purpose of Enclosures (list)	Destination of Produce from enclosures (list)	Do they cause problems? (yes or no) list problems

9. Which is the water source for the livestock?

	Water Source	Season
	Rivers	
	Boreholes	
	Shallow well	
	Other:	

10. What is the distance to the nearest watering point for the animals (in kilometres)?

- In the rainy season?.....
- In the dry season?.....

11. What are the Major constraints and opportunities from a pastoralist’s perspective (semi structured interview? Analyse the grazing history by trying to get information from the land users regarding a historical perspective of the lands in terms of livestock production. How is the current situation and what future improvements are possible). What according to you is the best alternative land use in this area?

Constraints	Opportunities

12. Major constraints and opportunities from a technical point of view in regard to livestock production (your opinion as technician regarding the negative issues regarding all the aspects and also some feasible solutions).

Constraints	Opportunities



Wood Collection (firewood and charcoal production)

1. Is the charcoal production a common activity in the area?

Yes.....

No.....

2. Is charcoal production leading to rangeland degradation in this area? List the environmental problems associated with charcoal production

a).....

b).....

c).....

3. Is the charcoal production activity selective in species?

Yes / No

If yes, list preferred tree species, starting with most preferred tree species

4. Which type of production method they use?

	Type of Kiln
<input type="checkbox"/>	Pit/trench kiln
<input type="checkbox"/>	Mound kiln
<input type="checkbox"/>	Other

5. Do they use live or dead trees? (tick)

Yes / No

6. Can you explain the current situation in terms of land use? (This is a related to a general overview of the influences of this land use in the landscape. Specifically if the charcoal is only in some part of the area or is in the all surroundings. (Stimulate the pastoralists to sketch the extent of the charcoal burning activity)

Annex 2: Coordinates of the visited sampling sites and its land use class

Id	Date	X	Y	Land Use
1	19.03.2007	262427	224078	Nomadic Pastoralism
2	20.03.2007	251895	212551	Nomadic Pastoralism
3	20.03.2007	243844	198098	Rainfed Agriculture
4	21.03.2007	249588	196218	Nomadic Pastoralism
5	21.03.2007	255480	186403	Nomadic Pastoralism
6	18.03.2007	259803	232802	Nomadic Pastoralism
7	18.03.2007	258619	243001	Rainfed Agriculture
8	18.03.2007	257082	225599	Rainfed Agriculture
9	19.03.2007	280266	234761	Nomadic Pastoralism
10	19.03.2007	273991	228599	Nomadic Pastoralism
11	22.03.2007	260252	194996	Rainfed Agriculture
12	25.03.2007	345896	239102	Nomadic Pastoralism
13	26.03.2007	372960	276373	Nomadic Pastoralism
14	27.03.2007	398872	262351	Nomadic Pastoralism
15	18.03.2007	260415	230892	Nomadic Pastoralism
16	20.03.2007	233990	197084	Rainfed Agriculture
17	21.03.2007	261655	185125	Nomadic Pastoralism
18	21.03.2007	261478	178502	Nomadic Pastoralism
19	21.03.2007	263446	173464	X
20	22.03.2007	259808	197989	Irrigated Agriculture
21	19.03.2007	276513	201082	Rainfed Agriculture
22	19.03.2007	269559	205080	Nomadic Pastoralism
23	19.03.2007	265087	195829	Rainfed Agriculture
24	19.03.2007	220807	199503	Irrigated Agriculture
25	20.03.2007	227771	199391	Nomadic Pastoralism
26	22.03.2007	281183	192993	Nomadic Pastoralism
27	22.03.2007	290303	188771	Nomadic Pastoralism
28	25.03.2007	347970	233747	Nomadic Pastoralism
29	25.03.2007	342412	248813	Nomadic Pastoralism
30	27.03.2007	384831	257336	Nomadic Pastoralism
31	27.03.2007	398271	271931	Nomadic Pastoralism
32	24.03.2007	540679	512964	Nomadic Pastoralism
33	21.03.2007	545318	525140	Nomadic Pastoralism
34	21.03.2007	552281	529213	Nomadic Pastoralism
35	21.03.2007	548166	521697	Nomadic Pastoralism
36	20.03.2007	541856	499124	Nomadic Pastoralism
37	17.03.20007	525395	503898	Nomadic Pastoralism
38	15.03.2007	472642	529902	Nomadic Pastoralism
39	18.03.2007	494826	533579	Nomadic Pastoralism
40	26.03.2007	495779	547597	Nomadic Pastoralism
41	16.03.2007	495509	529252	Nomadic Pastoralism
42	16.03.2007	502866	528570	Nomadic Pastoralism
43	20.03.2007	546574	496941	Nomadic Pastoralism
44	24.03.2007	534341	521244	Flood Recession Cultivation in Desheks
45	24.03.2007	544270	505962	Rainfed Agriculture
46	18.03.2007	504488	503330	Nomadic Pastoralism
47	18.03.2007	524018	519304	Rainfed Agriculture, Agropastoralism
48	17.03.20007	517847	521055	Nomadic Pastoralism

49	17.03.2007	513594	511965	Nomadic Pastoralism
50	15.03.2007	469787	540621	Rainfed Agriculture, Agropastoralism
51	21.03.2007	534724	526450	Rainfed Agriculture, Agropastoralism
52	21.03.2007	541604	534645	Nomadic Pastoralism
53	21.03.2007	537277	527553	X
54	20.03.2007	530572	514187	Nomadic Pastoralism
55	20.03.2007	X	X	Rainfed Agriculture, Agropastoralism
56	28.03.2007	478491	552304	Nomadic Pastoralism
57	24.03.2007	504563	541035	Nomadic Pastoralism
58	24.03.2007	502431	533342	Agropastoralism & Irrigated Agriculture
59	22.03.2007	520502	530006	Nomadic Pastoralism
60	22.03.2007	508757	530645	Rainfed Agriculture, Agropastoralism
61	04.03.2007	312815	554389	Irrigated Agriculture
62	07.03.2007	331968	562333	Grazing & Wood Collection
63	05.02.2007	325960	557830	Irrigated Agriculture
64	05.03.2007	336304	570422	Rainfed Agriculture/Agropastoralism
65	06.03.2007	309553	587381	Rainfed Agriculture
66	07.03.2007	326880	574455	Rainfed Agriculture
67	09.03.2007	275911	559931	Irrigated Agriculture
68	09.03.2007	274256	544031	Nomadic Pastoralism
69	11.03.2007	269674	521472	Nomadic Pastoralism
70	10.03.2007	242430	518820	Irrigated Agriculture
71	11.03.2007	265211	523475	Nomadic Pastoralism
72	11.03.2007	262419	506878	Grazing & Wood Collection
73	12.03.2007	227799	476607	Nomadic Pastoralism
74	12.03.2007	232148	480777	Nomadic Pastoralism
75	12.03.2007	232775	523803	Agropastoralism (semi-sedentary grazing)
76	14.03.2007	284090	470246	Nomadic Pastoralism
77	13.03.2007	291347	490492	Rainfed Agriculture
78	16.06.2007	119549	373833	Nomadic Pastoralism
79	16.03.2007	119024	371620	Nomadic Pastoralism
80	17.03.2007	131199	381208	Nomadic Pastoralism
81	17.03.2007	107588	345239	Nomadic Pastoralism
82	17.03.2007	111164	361930	Nomadic Pastoralism
83	18.03.2007	139676	380573	Grazing and Wood Collection
84	18.03.2007	134945	373073	Grazing and Wood Collection
85	19.03.2007	128799	355177	Grazing and Wood Collection
86	19.03.2007	132531	355389	Grazing and Wood Collection
87	21.03.2007	154735	423488	Nomadic Pastoralism
88	21.03.2007	159585	421388	Nomadic Pastoralism
89	22.03.2007	182739	421901	X
90	22.03.2007	170100	414806	X
91	23.03.2007	186047	450175	Agropastoralism (semi-sedentary grazing)
92	24.03.2007	239799	454940	Rainfed Agriculture/Agropastoralism
93	24.03.2007	231635	467268	Nomadic Pastoralism/Grazing and Wood collection
94	26.03.2007	178788	455835	Nomadic Pastoralism
95	04.03.2007	362497	557361	Nomadic Pastoralism
96	04.03.2007	374750	561916	Rural Settlements
97	04.03.2007	369245	555746	Agropastoralism (semi-sedentary grazing)
98	04.03.2007	484853	377184	Nomadic Pastoralism
99	04.03.2007	433036	345096	Nomadic Pastoralism

100	04.03.2007	431286	334842	Nomadic Pastoralism
101	04.03.2007	436330	351043	Nomadic Pastoralism
102	05.03.2007	365700	578348	Nomadic Pastoralism
103	05.03.2007	363245	593782	Nomadic Pastoralism
104	05.03.2007	373004	601022	Nomadic Pastoralism
105	05.03.2007	461849	377388	Rainfed Agriculture, Agropastoralism
106	05.03.2007	451957	368754	Nomadic Pastoralism
107	05.03.2007	430074	301466	Nomadic Pastoralism
108	05.03.2007	419278	303653	Nomadic Pastoralism
109	06.03.2007	359535	578306	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
110	06.03.2007	369661	569171	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
111	06.03.2007	365741	572508	Agropastoralism (semi-sedentary grazing)
112	06.03.2007	379440	565834	Rainfed Agriculture
113	06.03.2007	383645	567111	Rainfed Agriculture
114	06.03.2007	446797	300235	Nomadic Pastoralism
115	06.03.2007	443426	302267	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
116	06.03.2007	437962	303653	Nomadic Pastoralism
117	06.03.2007	412512	298481	Nomadic Pastoralism
118	06.03.2007	421785	293560	Nomadic Pastoralism
119	06.03.2007	407332	312026	Nomadic Pastoralism
120	07.03.2007	379668	557164	Nomadic Pastoralism
121	07.03.2007	385689	558965	Nomadic Pastoralism
122	07.03.2007	391086	559088	Nomadic Pastoralism
123	07.03.2007	385841	557404	Nomadic Pastoralism
124	07.03.2007	434156	304275	Nomadic Pastoralism
125	07.03.2007	426784	283378	Nomadic Pastoralism
126	07.03.2007	424123	273138	Agropastoralism (semi-sedentary grazing)
127	08.03.2007	391757	561248	Agropastoralism (semi-sedentary grazing)
128	08.03.2007	399834	564133	Nomadic Pastoralism
129	08.03.2007	395673	572742	Agropastoralism (semi-sedentary grazing)
130	09.03.2007	418194	559498	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
131	09.03.2007	4055199	569748	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
132	10.03.2007	415171	561904	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
133	10.03.2007	424517	563557	Irrigation Farming, Agropastoralism (semi-sedentary grazing)
134	10.03.2007	405185	561083	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
135	10.03.2007	450404	581755	Nomadic Pastoralism
136	10.03.2007	439099	569399	Nomadic Pastoralism
137	10.03.2007	443022	575204	Urban Centres and Rural Settlements
138	10.03.2007	377603	355210	Nomadic Pastoralism
139	10.03.2007	385141	357983	Nomadic Pastoralism
140	10.03.2007	442294	535565	Nomadic Pastoralism
141	11.03.2007	432570	548018	Transhumance Pastoralism
142	11.03.2007	441961	564406	Nomadic Pastoralism
143	11.03.2007	450407	562130	Nomadic Pastoralism
144	11.03.2007	464649	563575	Rainfed Agriculture
145	11.07.2007	386816	320254	Nomadic Pastoralism
146	11.03.2007	360554	338344	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
147	11.03.2007	348224	346514	Rainfed Agriculture
148	11.03.2007	323202	330602	Nomadic Pastoralism
149	12.03.2007	440966	541344	Nomadic Pastoralism
150	13.03.2007	429286	558764	Irrigation Farming, Agropastoralism (semi-sedentary grazing)

151	12.03.2007	453048	554015	Nomadic Pastoralism
152	12.03.2007	442644	552363	Nomadic Pastoralism
153	12.03.2007	361568	305970	Nomadic Pastoralism
154	12.03.2007	362560	315141	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
155	12.03.2007	340966	310978	Nomadic Pastoralism
156	12.03.2007	337141	305989	Rainfed Agriculture
157	13.03.2007	331625	285954	X
158	13.03.2007	X	X	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
159	13.03.2007	361575	293563	Nomadic Pastoralism
160	13.03.2007	353527	291100	Nomadic Pastoralism
161	14.03.2007	325225	257770	Nomadic Pastoralism
162	14.03.2007	329049	263789	Nomadic Pastoralism
163	14.03.2007	331838	260600	Nomadic Pastoralism
164	15.03.2007	311487	271380	Nomadic Pastoralism
165	15.03.2007	303031	262959	Rainfed Agriculture
166	15.03.2007	296711	264752	X
167	15.03.2007	463243	541504	Irrigation Farming, Agropastoralism (semi-sedentary grazing)
168	15.03.2007	307461	301377	Rainfed Agriculture
169	15.03.2007	315542	279898	Rainfed Agriculture
170	17.03.2007	108409	357251	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
171	05.03.2007	553463	330521	Rainfed Agriculture
172	10.03.2007	246305	512720	Rainfed Agriculture
173	16.03.2007	124080	386181	Nomadic Pastoralism
174	16.03.2007	141177	390469	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
175	13.03.2007	280002	493452	Agropastoralism (semi-sedentary grazing)
176	16.03.2007	130773	391915	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
177	14.03.2007	261699	479599	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
178	12.03.2007	276858	514364	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
179	07.03.2007	343831	582058	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
180	06.03.2007	322518	591114	War (Dams/Reservoirs), Other(rivers in wet season)
181	07.03.2007	580179	348896	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
182	23.03.2007	191334	450997	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
183	22.03.2007	182058	438009	Nomadic Pastoralism
184	21.03.2007	154011	409394	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
185	21.03.2007	154011	409394	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
186	11.03.2007	229813	508213	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
187	11.03.2007	240526	495469	Nomadic Pastoralism
188	25.03.2007	186522	462665	Rainfed Agriculture
189	24.03.2007	200124	448042	Irrigation Farming
190	24.03.2007	207107	443379	Nomadic Pastoralism. Grazing and wood collection for charcoal and firewood
191	26.03.2007	209871	487668	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
192	17.03.2007	96138	339160	Nomadic Pastoralism
193	18.03.2007	136670	365962	Nomadic Pastoralism
194	17.03.2007	101934	345798	Rainfed Agriculture, Agropastoralism (semi-sedentary grazing)
195	18.03.2007	140845	366794	Irrigation Farming, Flood recession cultivation in Desheks, Agropastoralism
196	12.03.2007	279515	529978	Nomadic Pastoralism
197	05.03.2007	306210	562366	Rainfed Agriculture
198	09.03.2007	289756	554568	Irrigation Agriculture
199	06.03.2007	322638	587927	Rained Agriculture