SWALIM

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Background

General

An oasis (plural: oases) or cienega (southwestern United States) is an isolated area of vegetation in a desert, typically surrounding a spring or similar water source. The irrigated agricultural forms when the ground water lies close to the surface to form a spring or to be reached by wells. Oases also provide habitat for animals and even humans if the area is big enough. In this study, the oasis farming areas are referred to as irrigated agricultural farms.

The Irrigated agricultural farms are an important livelihood on which several agro-pastoral families in Puntland depend. They constitute small scale farms that continue to receive increased humanitarian attention in form of development aid. Frequent droughts and land degradation due to human influence are processes that have reduced the production potential of these irrigated agricultural farms. Quick-fix solutions are therefore urgent. Consequently and subsequently, information on these irrigated agricultural farms is important and imperative for informed decision making initiatives that are geared towards productive resource planning and management concerns.

Irrigated agricultural farming in Puntland usually occurs along *toggas* and around springs which provide water for the production of date palms, papaya, citrus and vegetables (European Union 2010). Date palm production is unable to meet demand and significant quantities are imported. Date palms are used for shade, and the by-products are used fences, baskets and mats while part of the trunk is an ingredient of local paint. Methods of date palm farming are well known in Somalia.

Much of the irrigation infrastructure has been destroyed over the several years due to catastrophic storm events or abandonment. Many farms are poorly managed and exhibit low production, poor quality tree crops and inadequate water supply. The techniques applied for farming are also outdated and many of the farms are in

coastal areas where the water is brackish. Post harvest losses are common through insect and mould infestation. Consequently, large volumes of dates are imported to meet the local market. Genetically improved material for the crop is lacking.

The traditional date farming is being replaced by high value vegetable production, which contributes to loss in quality of Somali dates. Vegetable farming in irrigated agricultural area is expanding into land susceptible to flooding, including *toggas*. Lastly, there is increased surface run-off due to reduced water infiltration in watershed and general soil erosion leading to increased flooding within *toggas* and adjacent agricultural plots.

Nevertheless, there exist good markets in the urban areas. The prevailing opportunities include removing and planting out off-shoots, pruning and replacement of unproductive palms with improved cultivars (cloned material), better spacing, planting vegetable gardens between palms and improving water supply systems. It is also important to explore options for inter-cropping citrus and vegetables to reduce soil erosion, to use dwarf palms for fencing and erosion barriers, and sustainable handicraft materials and value added opportunities from palm products.

In view of the foregoing, information on the irrigated agricultural farms is important for sustained planning and management of these agro-pastoral systems. The fragility of the ecosystems in which these irrigated agricultural regimes are found and the fact that Puntland agricultural potential development has been neglected for a long time makes it even more urgent to generate such data.

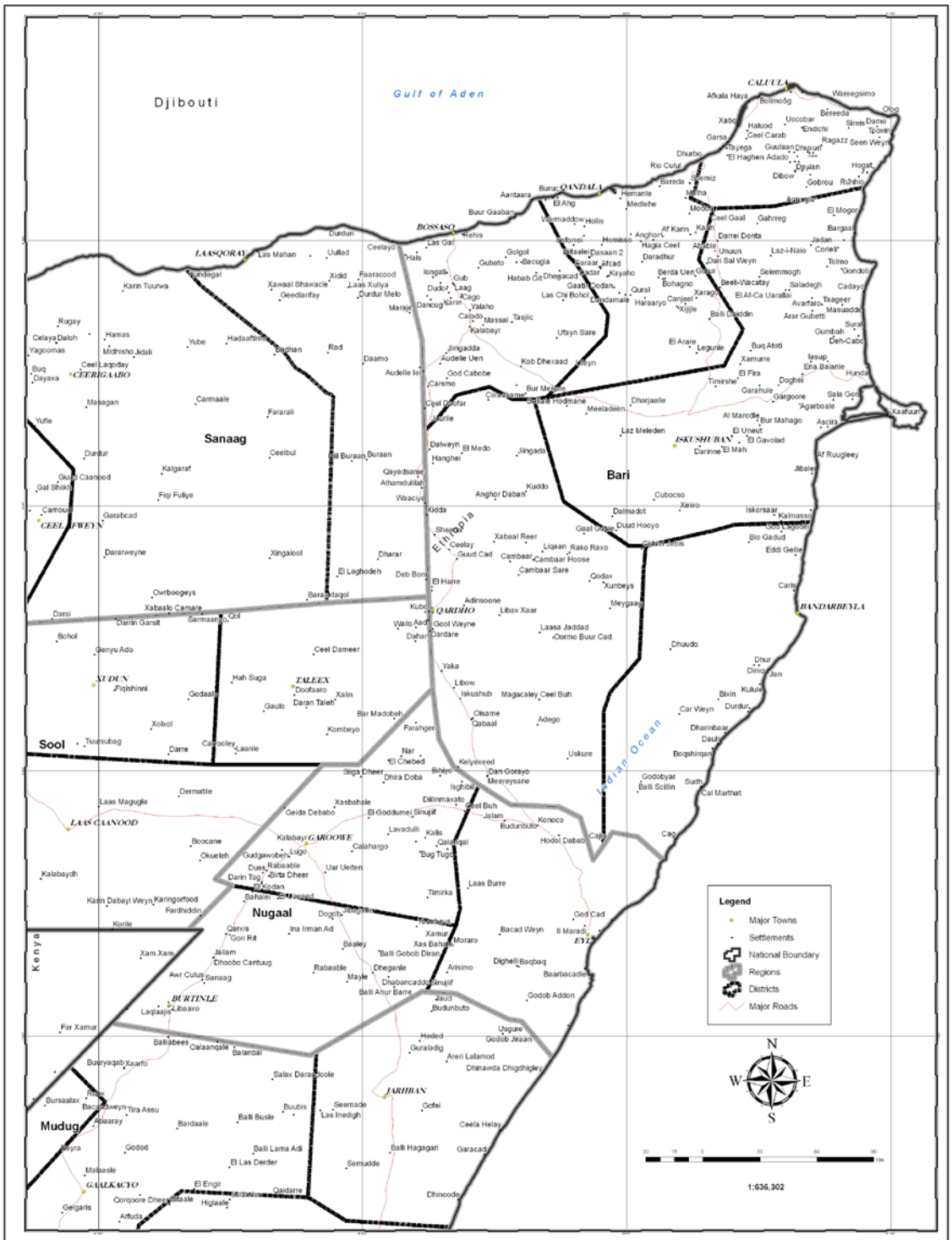
Objectives

The overall objective of the project is to provide the information needed to obtain a comprehensive understanding of the status, dimension and management of the Irrigated Agricultural production systems.

Specific objectives will be to:

1) produce land cover map showing the Irrigated agricultural farms in Puntland.
2) produce data on (production systems - crops and livestock) type of crops planted, type of livestock, strengths in irrigated agricultural farming, weaknesses in irrigated agricultural farming, and opportunities in irrigated agricultural farming in Puntland.
3) identify irrigation water sources and their yield estimation

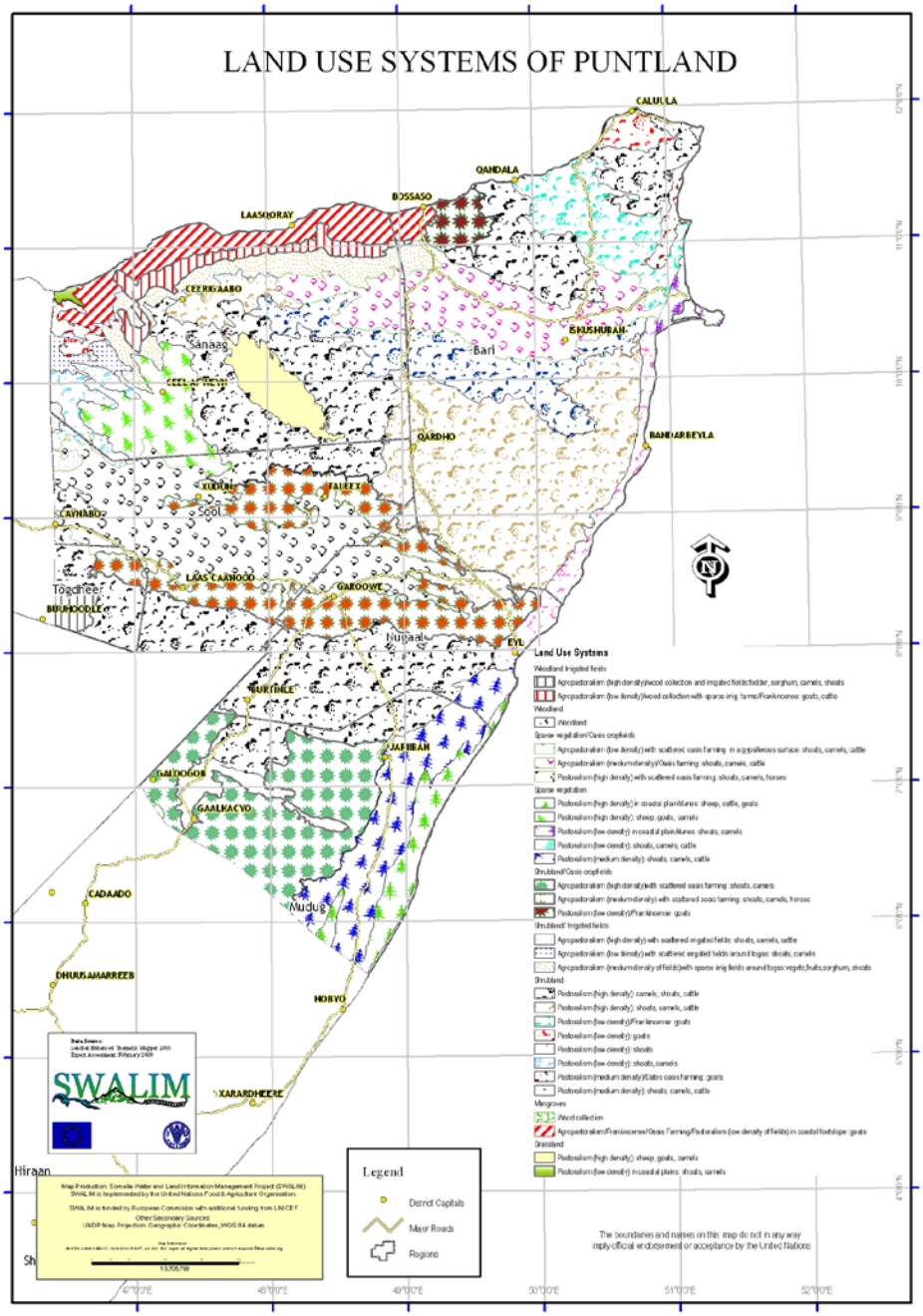
The Study Area



The study area covered the whole of Puntland. Puntland state falls within the north-eastern parts of Somalia and comprises of the eastern Sanaag, Sool, northern part of Mudug, Nugaal and Bari regions. Garowe is the capital city while Boosaaso is the most important sea port. There is an important road that connects the north from Boosaasoto Gaalkacyoin the south (see figure 1).

The land use systems map for Puntland

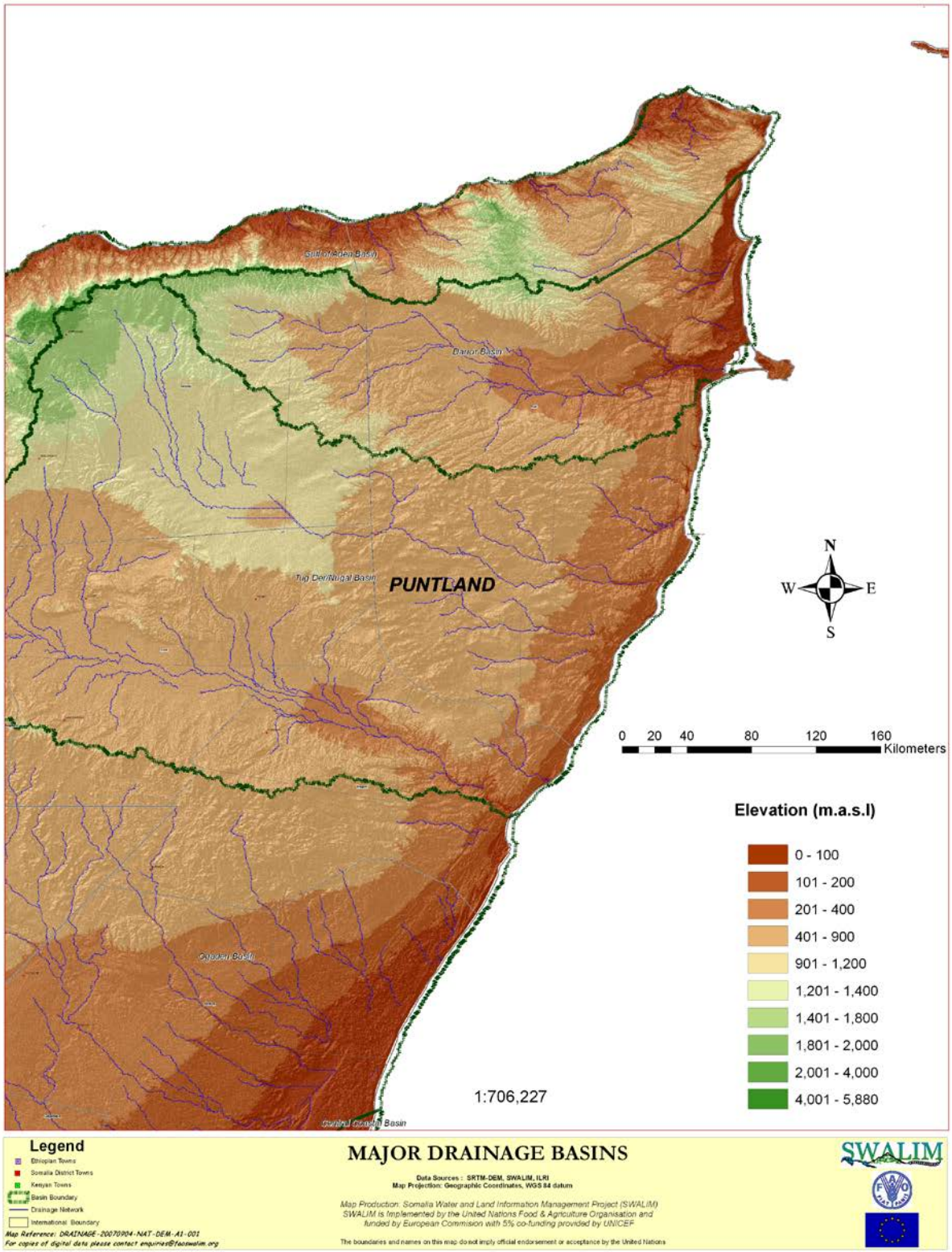
Figure 2: land use systems of Puntland



The land use system in Puntland is mainly pastoralism with the land cover being mainly savanna (see figure 2). The animals kept include goats, sheep, cattle and camels. Other land use includes irrigated agricultural farming along the streams where water is either channelled directly from the springs and/or from shallow wells which are constructed close to the streams, in the valley bottoms. Up on the Golis Mountains the land cover is different and the land use also varies. Pockets of crop fields can be found up the Golis Mountains and the vegetation includes *Juniperus spp.* and among others. Frankincense extraction is a practiced activity in some of drier areas in the north-eastern part of Golis Mountain (Cal Madow) in Puntland.

Woodlands of *Acacia bussei* (Galool) are characterized by intense charcoal burning activity that threatens the entire fragile ecosystem. The charcoal produced is for both local and export destination.

Figure 3 shows Puntland and the associated basins and their drainage.



Puntland comprises of 4 main drainage basins namely, Gulf of Aden basin, Daroor basin, Togdheer/Nugaal basin and the Ogaden basin. Within each of these 4 basins traverses several seasonal streams. The elevation above sea level rises from 0 - 100 meters along the coast to 4001 - 5880 meters in the Golis Mountains. Except for the Gulf of Aden basins streams which drain into the Gulf of Aden, all the other streams drain into the Indian ocean. Figure 3 shows Puntland and the associated basins and their drainage.

Methods

The methods used in this study are the ones elaborated in the land use study report for the SWALIM phase II Northern Area of Study in Somaliland, SWALIM Project Report N^{o} L-04 of February 2007. The methods used with their modifications are given below here.

Bibliographic research

This study involved an initial bibliographic research in order to obtain insights about irrigated igricultural iarming in Puntland. Research involved the Internet, literature, within and outside SWALIM and (importantly) visits to projects and institutions whose activities are concentrated on Puntland. The SWALIM digital library was very helpful in this bibliographic research.

Field survey preparations

After obtaining a very general overview of irrigated agricultural farming in Puntland, preparations were made for the implementation of the actual land use survey itself. As current standard procedure, two aspects were initially considered; firstly, the technical aspects and then a review of the socio-political situation of the country which could limit carrying out a standard field survey. The field survey was focused on two principal activities: (1) mapping of the irrigated agricultural farming areas and (2) characterisation of the irrigated agricultural farming activities in Puntland.

Mapping of the irrigated agricultural farms in Puntland required fieldwork in order to generate data that would subsequently help in characterization of the activities in these areas. Consequently, and with the help of semi structured interviews through

questionnaire (Annex 2), a participatory and technical field assessment was designed. This questionnaire was designed to facilitate semi-structured interviews that were subsequently aimed at gathering both purely technical data by the surveyor, and indigenous knowledge from the different land users. Data to be collected using this form was semi-quantitative and with no focus on socio-economics. In addition to the semi-structured data collection form, a FAO LCCS land cover data collection form (annex 1) was also prepared for use during the field survey activity.

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

The sampling scheme was based on the preliminary mapping of irrigated agricultural farms in Puntland using Google Earth. The high resolution Google Earth images were for 2003. It was hoped that all the irrigated agricultural farms shown in the preliminary map would be visited for activity characterization.

Irrigated agricultural farming activity characterisation field survey

At the time of the field survey the international staff members of SWALIM were not allowed to conduct the field survey due to security reasons. As a result, Somali experts , from Puntland, were contracted to perform the field data collection. However, and given that the SWALIM approaches may be new to these experts, a training stage was planned. The Somali field survey experts were trained in for one week in mid-July 2010.

The training involved descriptions of how to obtain data on the irrigated agricultural farming activities in Puntland. The training also dwelt on how to work with the existing activity characterization form in the field and how to elicit information from land users. The FAO land cover classification data form and procedure of collecting the data was also explained to the trainees.

A 15 day field data collection phase was planned to collect data from all anticipated irrigated agricultural farms in the preliminary map. The preliminary irrigated agricultural farms map was reviewed together with the Somali experts and staff members of the SWALIM liaison office in Garowe for completeness and feasibility of visits to the various areas. Subsequently, new irrigated agricultural farming areas were added while areas that were too insecure to visit were omitted in the field survey plan. Three Somali field survey experts were contracted to perform the field exercise. These field surveyors were trained in the use of the field data collection from for irrigated agricultural farming data collection, rapid rural appraisal techniques, use of a GPS, map reading and interpretation of the proposed sampling scheme in order to guarantee proper collection of data. General land cover concepts and data collection procedures and techniques were also explained to the field surveyors.

Data input and analysis

The completed irrigated agricultural farms characterization forms were sent to Nairobi. A Microsoft Excel worksheet was designed for data entry as a first assessment for form correctness and completeness. This was also useful in helping map interviews as point maps (i.e. with X, Y GPS coordinates) using ArcView 3.2 software to monitor areas covered and to better understand spatial irrigated agricultural farming activity patterns. A Microsoft Access database template was also created in which to enter the irrigated agricultural farms characterization forms.

All data contained in each form were entered into the Excel spreadsheet. These were then grouped according to their preliminary irrigated agricultural farming map and checked to see whether the Somali field surveyors had discovered new farming areas and or if they had visited all the planned areas. Preliminary analysis was made on the different irrigated agricultural farms visited for characterization and their location on the satellite imagery and any specific productive variables of each system. Data was crosschecked against key data collected for different land use systems during the fieldwork reconnaissance period.

All the land cover data collection forms were also analysed and mapped as points using the X and Y coordinates provided in the form. These land cover data forms with their resulting descriptive spatial point data were also used to cross check the irrigated agricultural farms map.

Irrigated agricultural farming activity characterisation

With data now in digital format and following preliminary analysis, the final irrigated agricultural farming activity characterizations present in Puntland were defined. For the activity characterisation semi-qualitative variables were analysed according to individual irrigated agricultural farms. This characterisation involved the utilisation of the activity point map to better understand distribution of the different irrigated agricultural farms. As an example, the system of irrigated agriculture does not have the same components and characteristics in Nugaal valley and the Sool plateau. Using the point map and the interview data, comparisons were made for the different landscape regimes.

The irrigated agricultural farms were characterised from a technical point of view that included agronomic aspects, constraints/threats and opportunities/strengths. The livestock production systems within the irrigated agricultural farming areas were also characterised, though not in a detailed way. Lastly, the charcoal burning activity was also characterised, by tree species type and the areas where it is most common.

Irrigated agricultural farms mapping

The field survey was guided by the preliminary irrigated agricultural farms map that was produced using Google Earth prior to the field survey activity. Google Earth version 5.0.11733.9347 with a Build date of May, 2009 was used in this exercise. Field sample sites were selected, randomly, within these irrigated agricultural farming areas. These field sample sites were digitized as point maps, with the field survey results being used to validate the preliminary map. The field survey activity together with input from the SWALIM liaison office , in Garoowe, on the location of the irrigated agricultural farms was used to produce the final irrigated agricultural

farms map, from the Google Earth images in Puntland. This map covers all the irrigated agricultural farms seen on the images.

The mapping methodology involved using Google Earth for verification of presence of oases farms in an area. Compared to other sensors like Landsat TM or SPOT MSS, Google Earth offers a series of historical free images at a much higher resolution. Its user interface also allows for data capture in the form of Keyhole Mark-up Language (KML) format that can be exported and used in different applications. The ability to take a virtual walk on Google Earth with a seamless image cover provides an opportunity to identify different features on the Earth's surface. Application of Google Earth for mapping in Puntland is also made possible by the fact that there is a countrywide coverage by images of high resolution and cloud-free. The interpretation of Google Earth images for mapping followed a known principle that oases are usually found along most river valleys (see figure 5).

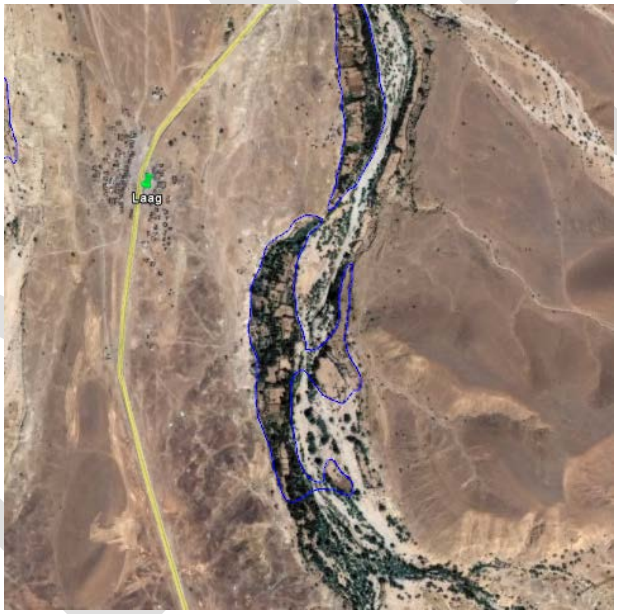


Figure 5: Location of Irrigated agricultural farm near Laag Village, Bossasso District Bari Region.

Oases farms exist as distinct features that can easily be discriminated by visual image interpretation. Some of the factors considered in deciding whether a feature was an irrigated agricultural farm or not were the fact that farms could easily be identified by their blocky pattern on the high resolution satellite image. Other areas

had presence of common irrigated agricultural plantation of date palms. Consequently, using the image characteristics of shape, size, geographic location, associated features, among others, and given the clarity of image features in the Google high resolution images, it was possible to discern the different irrigated agricultural farms in Puntland.

Data on settlements and district boundaries were converted to KML format and overlaid on Google Earth Images. Using the district boundaries as control areas, a virtual tour of the mage was made through the districts of interest and all possible oases farms digitized as polygons using the Google Earth's Add Polygon tool at an eye altitude of 527 meters. The eye altitude in Google Earth refers to a point, which GE flys to as you zoom in and out of the image. You would need data for the size of the area concerned to zoom to the correct altitude, and this wouldn't always be the same altitude, as a city would require a lower camera position to a country, for example, to zoom to a position where the area filled the screen nicely. Therefore this isn't something you could do at your end, it is something that GE servers have included in the data returned. In brief, it is the approximate altitude at which your eyeball must be, in order for your eye (when looking straight down) to see the same view as is shown by the camera. The irrigated agricultural farms were marked as single polygons. This was repeated until all the farms had been digitized. Data and maps of known locations of irrigated agricultural farms obtained from the field was also corroborated in the mapping process. While in the process of mapping, the oases farms were given names of settlements where they fall as identifiers.
The end result was a KML thematic layer of irrigated agricultural farms. These layers were then converted to shapefiles to conform to other data format using XTools Pro Tool extension in ArcGIS 9x.

Results

Maps of the irrigated agricultural areas in Puntland

Figure 6a: Irrigated farms in Northern Puntland

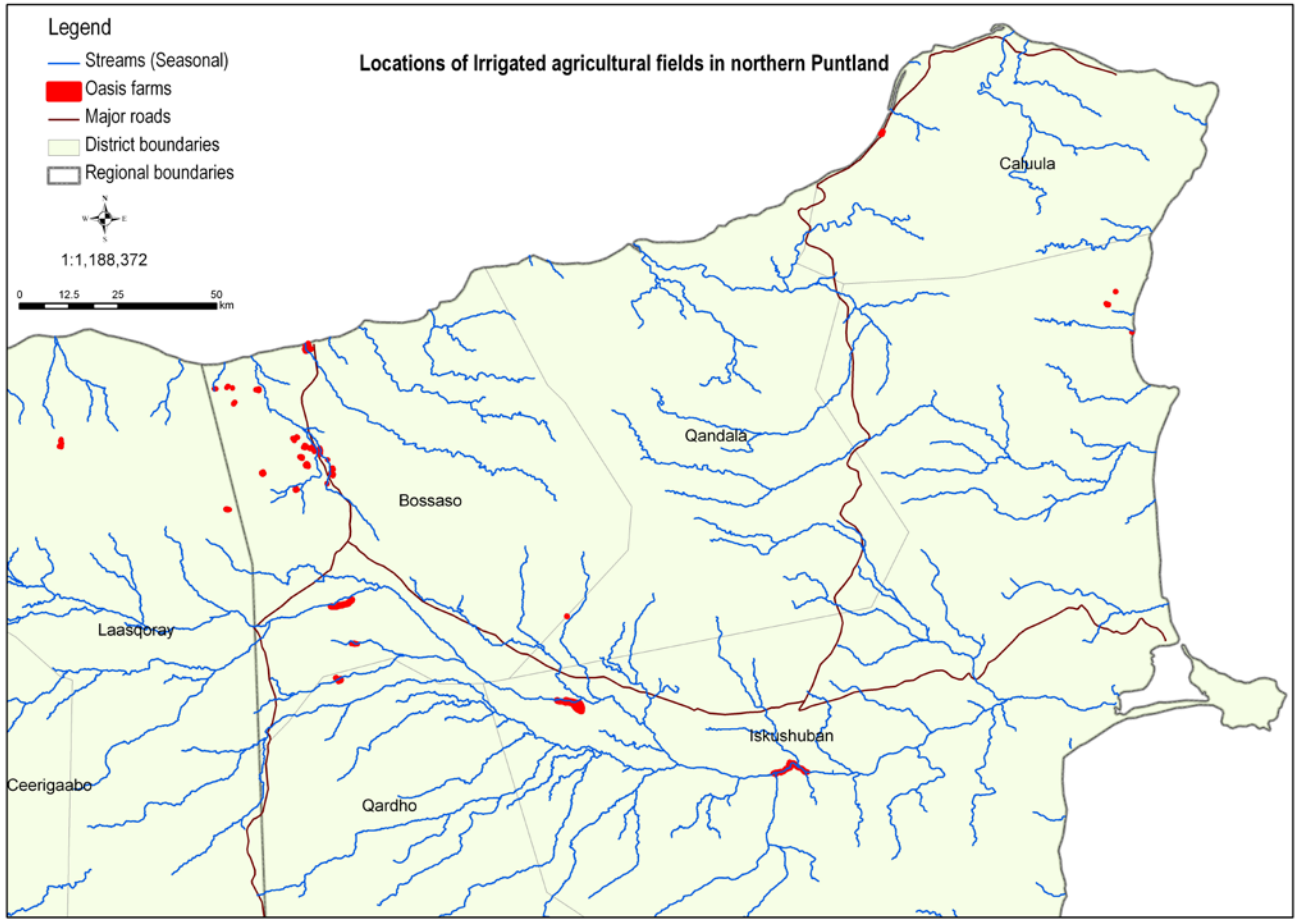
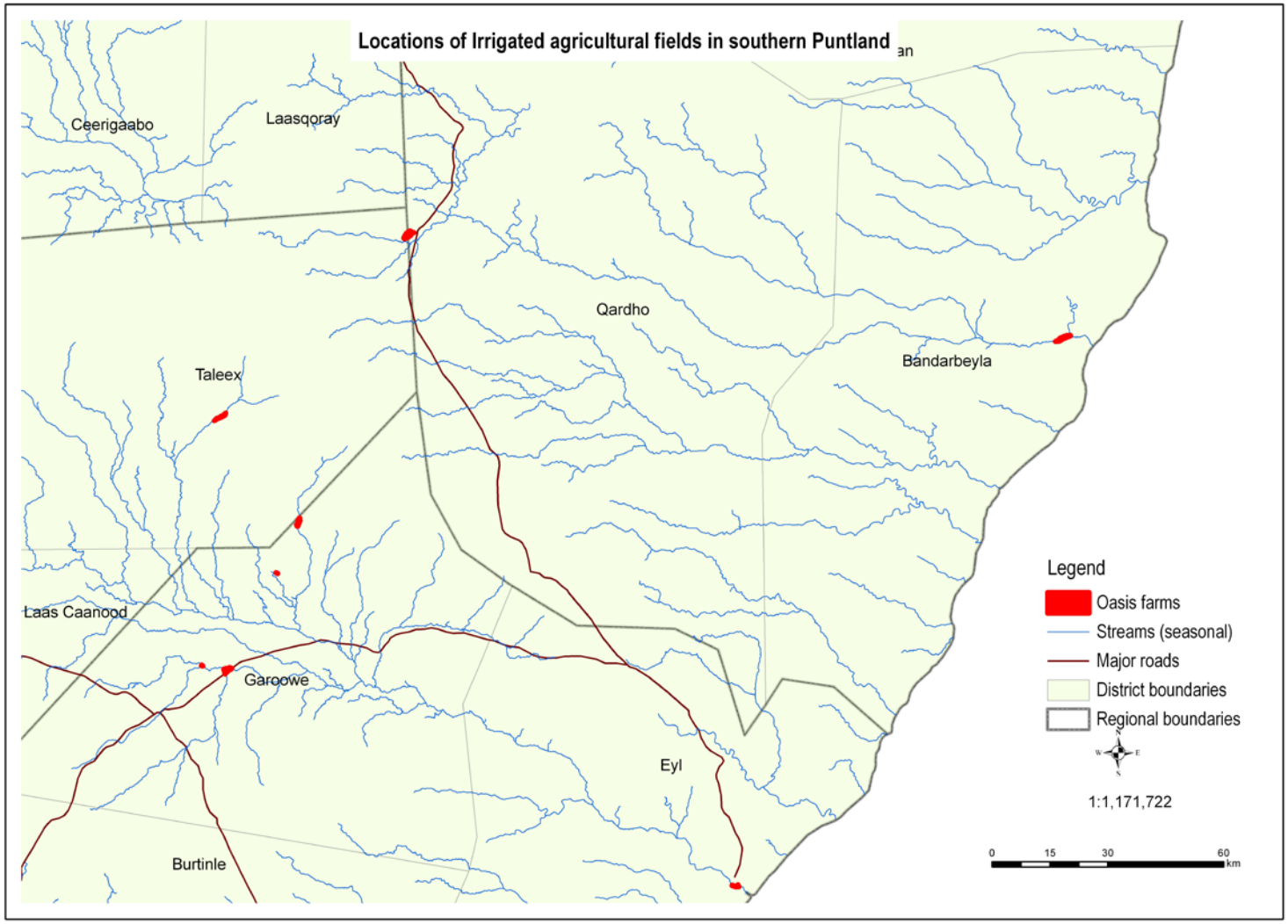


Figure 6b: Irrigated farms in Southern Puntland



The irrigated farms size by district

Table 1: The irrigated farms size by district

District	Irrigated area (ha)
Bandarbeyla	204.66
Boosaaso	661.20
Ceerigaabo	140.13
Eyl	29.26
Garoowe	221.05
Iskushuban	1,000.48
Laas Caanood	196.37
Laasqoray	42.51
Qardho	61.44
Taleex	290.67
Total	**2848**

Table 1 shows the area covered by irrigated agricultural areas by district. Iskushuban has the largest area covered by irrigated agricultural farms while Eyl has the least area covered by these farms.

Map 1 shows the location of the irrigated agricultural farms in Puntland as mapped from the high resolution Google Earth images of 2003. Note that all the irrigated agricultural farms are found along the streams. It is also important to note that there are numerous irrigated agricultural farms close toBoosaaso. The Daroor basin also has a considerable number of irrigated agricultural farming areas, all along the numerous streams. Some of the irrigated agricultural farms are found along the coastal strip. The irrigated farms in Puntland occupy an area of about 2850 hectares.

The following are results emanating from the field questionnaire surveys conducted in July-August 2010 in several irrigated agricultural farms in Puntland. The results have been summarized by the irrigated agricultural farms that were visited. Only 8 irrigated agricultural farming areas were visited. The results are given in tables that are explained by a text below them.

Source of water, land improvement, type of input and level of input

Table 2: Source of water, land improvement, type of input and level of input, mechanization and farm management.

ID	Irrigated agricultural Location	Land Improvement	Input	Other Inputs	Mechanisation	Farm management
1	Balley	Wells	Low	Manure	None	Spacing
2	Eyl	Drainage	Low	_	None	_
3	Eyl	Spring	Low	Manure	None	Fencing
4	Daroor/Kalmaian	Wells	Low	Manure, Pesticides	_	Nursery
5	Iskushuban	Drainage	Low	_	_	Irrigation Canals
6	Xalin - Kal-Cad	Wells	Low	Pesticides	None	None
7	Xalin - Mizo ma qarshe	Wells	Low	Pesticides	Yes	_
8	Boocame	Wells	Low	Pesticides	Yes	None

Wells (see photograph 1) and springs are the major sources of water for irrigation in the irrigated agricultural farming areas and 100% of the irrigated agricultural farms visited indicated that they have done some land improvement by constructing wells and spring improvement (see table 2). The use of animal manure and pesticides is common while mechanized farming is limited with most farmers using hand held tools to till the land. Farming input levels remain low as 100% of those interviewed indicated that their farm input levels are low (Table3).

Table 3: Agronomic aspects

Agronomic aspect	% response
Improvement on the farm	100%
Low level farm Input	100%
Farm Inputs application	75%
Mechanization on farm	25%
Farm management	50%
Crops Fruits, vegetables	90%
Intercropping	25%
Field Size (<2Ha)	97%
Crop Production for market	50%
Good crop health condition	75%

Photo 1: Shallow well in irrigated agricultural farm close to Garowe

Crops grown, pattern of cropping, field size, destination of crop products, condition of crops and limitations to agricultural production

Table 4: Crops grown, pattern of cropping, field size, destination of crop products, condition of crops and limitations to agricultural production

ID	Irrigated agricultural Location	Crops	Intercropping	Field Size	Purpose for Crop Production	Crop Condition	Limitations
1	Balley	Fruit trees, vegetables	Yes	<2Ha	Market, Food	Good	_
2	Eyl	Date palm, Banana	_	<2Ha	_	Poor	Infertile soils, Poor farming techniques
3	Eyl	Vegetables, Potato	Yes	<2Ha		Good	
4	Daroor/Kalmaian	_	None	<2Ha	Food, Market	Poor	Poor seed
5	Iskushuban	Fruit tress	_	<2Ha	Market, Food	Good	_
6	Xalin - Kal-Cad	Fruit trees, vegetables	None	<2Ha		Good	Salinity, Pests
7	Xalin - Mizo ma qarshe	Fruit trees, vegetables	None	<2Ha	Market	Good	Salinity
8	Boocame	Fruit trees, vegetables	None	2-5Ha	_	Good	Salinity, pests

The crops grown are mostly fruit trees (see photographs 2, 3 and 4) and vegetables, with some of the farmers practicing intercropping (see table 4). The crop condition was found to be good (75% of the irrigated agricultural farms visited) with the field size being mostly less than 2 hectares and the crop products destination being manly the market for cash. Limitations to farm production included mainly saline soils, poor seed and generally low fertility soils.

Photo 2: Tamarind and citrus fruit trees in irrigated agricultural farm in Puntland

Photo 3: Date Palm tree in Irrigated agricultural farm in Puntland - close to Garowe

Photo 4: Date Palm tree in irrigated agricultural farm in Puntland - Eyl (notice the poor plant condition)

Photo 5: Crop fields in Irrigated agricultural farm in Puntland - Balley (notice the just ploughed fields

Photo 6: Agro-pastoralism in irrigated agricultural farm in Puntland - Balley (notice the crop fields in the foreground and goats in the background

Photo 7: Date palms in Irrigated agricultural farm in Puntland - Iskushuban

Photo 8: *Prosopis* encroachment threat in irrigated agricultural farms in Puntland - Xalin

Agronomic practices, farm training, constraints/threats and opportunities to agricultural production

Table 5: Agronomic practices, farm training, constraints/threats and opportunities to agricultural production

Id	Irrigated agricultural Location	Agronomic Aspects	Farm Training	Constraints/threats	Opportunities
1	Balley	Manure	_	No cash, Poor seed, Pests,	Shallow Wells, Soil Conservation, Ready market
2	Eyl	_	_	Poor seed, pests, No cash/ Poor knowledge	Water and land is available
3	Eyl	Manure	No	Poor seed, pests, No cash	Good soil, Water available
4	Daroor/Kalmaian	Manure, pesticides	No	Poor seed, pests, No cash, Poor Technical Knowledge, Poor equipment	Land, Water, Manpower available,
5	Iskushuban	_	Yes	Poor seed, pests, No cash, poor agricultural equipment	Good soil, Water available, available land
6	Xalin - Kal-Cad	Pesticides	_	_	_
7	Xalin - Mizo ma qarshe	Pesticides	_	_	_
8	Boocame	Pesticides	_	_	_

The agronomic practices in these irrigated agricultural farms include mainly the use of pesticides and manure (see table 5). Farm training is limited with only about

10% of those interviewed indicating that they had received some form of farm training. The constraints/threats to agricultural production included poor seed for planting, incidence of pests and general lack of cash for sustained production. Poor farming technical knowledge accompanied by poor farm equipment also pose as major threats to agricultural production in the irrigated agricultural farming areas. Lastly, the opportunities to irrigated agricultural farm production include majorly the availability of water in form of shallow wells and springs, ready market for the farm produce and good fertile soils in most part of the country.

Livestock type, number and health, enclosures, forage, water source, constraints and opportunities to livestock production

Table 6: Livestock type, number and health, enclosures, forage, water source, constraints and opportunities to livestock production

Irrigated agricultural Location	Livestock type	Livestock number	Livestock Health	Forage Condition	Enclosures	Water Source	Constraints/threats	Opportunities
Garowe/Balley - 02								
Eyl 04			_	_	_	_	_	_
Balley 01			_	_	_	_	_	_
Garowe/Balley - 04	Camel, Goat, Sheep	C12, G200, S100	Good	Good	__	_	Water shortage, Poor quality pasture	_
Eyl - 05	_	_	_	_	_	_	_	_
Eyl - 05	Goat		Good	Good	_	Spring	Animal diseases, Lack of veterinary drugs	Adequate forage,
Eyl - 01	_	_	_	_	_	_	_	_
Eyl - 02								
Dharoor	_	_	_	_	_	_	_	_
Dharoor/Kalmaian	_	_	_	_	_	_	_	_
Iskushuban - 04	_	_	_	_	_	_	_	_
Iskushuban - 03	_	_	_	_	_	_	_	_
Iskushuban - 01	_	_	_	_	_	_	_	_
Xalin 01 Kal-Cad	Goat, Sheep	Goat 30, Sheep 23	Good	Good		Shallow well	Forage shortage during dry period	
Iskushuban - 02	_	_	_	_	_	_	_	_
Xalin - Mizo ma qarshe 02	Goat	35	Good	Good	_	_	_	_
Boocame 02	_	_	_	_	_	_	_	_
Boocame 01	_	_	_	_	_	_	_	_
Boocame 04	Goat	25	Good	Good	_	Shallow well	Forage shortage during dry period	_
	_	_	_	_	_	_	_	_

Land use in the irrigated agricultural farming areas is agro-pastoralism. Livestock includes camel, goats and sheep that are mainly of good health (table 6). The forage condition in the irrigated agricultural farming areas is generally good with the springs and shallow wells being the main source of water for the animal (see photograph 4). Main constraints/threats include shortage of forage during the dry season and animal diseases that are accompanied by wanting veterinary services.

Photo 4: Livestock watering point in Oasis farm in Puntland. Notice the broken wind mill in the background

Table 7: Charcoal production

Irrigated agricultural Location	Charcoal Burning	Charcoal & Land Degradation	Preferred Charcoal Species	Type of Kiln	Dead or Live Trees	Current Situation
Garowe/Balley - 02	_	_	_	_	_	_
Eyl 04	_	_	_	_	_	_
Balley 01						
Garoowe/Balley - 04						
Eyl - 05	_	_	_	_	_	_
Eyl - 05	_	_	_	_	_	_
Eyl - 01	_	_	_	_	_	_
Eyl - 02	_	_	_	_	_	_
Daroor	_	_	_	_	_	_
Daroor/Kalmaian	_	_	_	_	_	_
Iskushuban - 04	_	_	_	_	_	_
Iskushuban - 03	Charcoal Burning	_	Prosopis juliflora	Mound	Dead or Live Trees	Charcoal burning is around wadis
Iskushuban - 01	Charcoal Burning	_	Prosopis juliflora	Mound	Dead or Live Trees	Charcoal burning is around wadis
Xalin 01 Kal-Cad	_	_	_	_	_	_
Iskushuban - 02	Charcoal Burning	_	Prosopis juliflora	Mound	Dead or Live Trees	Charcoal burning is around wadis
Xalin - Mizo ma qarshe 02	_	_	_	_	_	_
Boocame 02	_	_	_	_	_	_
Boocame 01	_	_	_	_	_	_
Boocame 04	_	_	_	_	_	_
	_	_	_	_	_	_

Burning of trees for charcoal production (see table 7) was found to be rampant in the irrigated agricultural areas, with *Prosopis julliflora* tree species being the most

preferred tree species. The charcoal production by burning of felled trees occurs around the river channels, also called *wadis*.

Table 8: Water source and yield (1 meter cubed = 1000 litres)

S No.	X-Coordinates	Y-Coordinates	Location of water source	Type of water source	Time taken to harvest (hr)	Volume of collected water (lts)	Remarks
1	0369932	882157	Eyl	Shallow well	1	2000	Source is permanent
2	0368614	0882424	Eyl	Spring	1	11232	Spring is permanent
3	0363922	1156135	Daroor	Shallow well	1	12000	Source is permanent
4	0239506	940177	Garoowe-Balley	Shallow well	1	12000	Source is permanent
5	04756936	0822947	Boocame	Shallow well	1	8000	Source is permanent
6	0370704	0882091	Eyl	Spring	1	2000	Spring is permanent

All the oases visited were found to have permanent water sources. These water sources included springs and shallow wells. The yields of these water sources, according to actual sampling, ranged from 48000 litres to about 270000 litres of water per day for the springs and 48000 litres to 290000 litres of water each day for the shallow wells (see table 8). Diesel pumps are commonly used (see photograph 8).

Photo 8: Shallow well with water in Irrigated agricultural near Garoowe. (notice the diesel pump for irrigation)

Annex 4 illustrates how the flow of water from springs and wells is measured while annex 3 shows the data collection form used.

Discussions and conclusions

The irrigated agricultural farms in Puntland are associated with the distribution of the shallow wells and springs as the main source of irrigation water. However, these farms fall far bellow the irrigation potential of the land in Puntland.

There are claims of infertile soils, use of poor crop seed, incidences of crop pests, increased soil salinity due to continued irrigation with slightly saline water and poor technical farming knowledge among others. These compounded constraints lead to reduced crop production. Besides crop production practices the communities in these irrigated agricultural farming areas are essentially agro-pastoralists. Animal diseases are rampant in these areas, and veterinary services are wanting. Quick fix solutions need to be sought. There is, consequently and subsequently, need to carry out research that is aimed at alleviating these problems.

As regards the environment of these irrigated agricultural farming areas, it was established from the surveys that charcoal burning activity is common wherever there are trees. These tree growing areas need to be identified and monitored to facilitate environmental conservation measures. These trees provide forage to the animals in the dry period and also help to conserve the soil. Cutting down the trees will expose the soil and eventually lead to land degradation.

Lastly, the irrigated agricultural farming areas are important crop producing baskets in Puntland. The study observed that there is great potential in increasing the area under irrigation in the oases of Puntland.

Challenges

The security situation in Puntland remained a problem during the field survey period in this study. There are locations (for example areas close to Golis Mountain) where the survey team could not visit due to the insecurity problem.

Secondly, in some areas where the survey team could access, the local people were not very welcoming. The survey team had to spend a lot of time negotiating with the local community elders so that they could be allowed to administer the questionnaire. The overall result was that, the ultimate number of questionnaires administered was very small. Many irrigated agricultural farming areas were not visited. Consequently, there is need to increase the number of samples by administering more questionnaires.

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Annexes

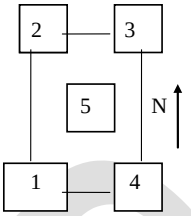
Annex1: FAO-SWALIM LAND COVER FIELD VERIFICATION FORM (LCCS)

A. GENRAL INFORMATION

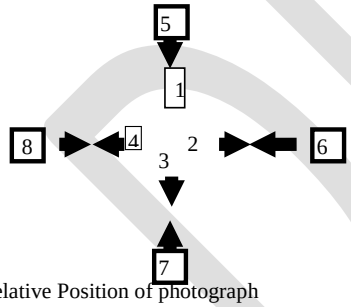
RELEVEE N^0		ACCESSIBILITY	☐	Very Good
AREA NAME			☐	Good
LOCATION			☐	Medium
OBSERVER			☐	Bad
DATE				
TIME				
RELEVEE SIZE		(in m $^{3 \text{ or}}$ ha)		

COORDINATES

N or S	East

On the spot	Observing the spot from a distance
Indicate relative position of Coordinate 	Distance from viewpoint to observed point ☐ (m) The bearing of the observed point ☐ (^{0})

FIELD PHOTOGRAPHS



Relative Position of photograph

GENERAL LANDFORM

Slope

- ☐ Flat to Gently Sloping Terrain (0-7%)
- ☐ Gently Sloping to Moderately Sloping (8-3%)
- ☐ Sloping to Moderately Steep, Undulating to Rolling terrain (14 - 20%)
- ☐ Steep to Very Steep, Rolling to Hilly terrain (21-55%)
- ☐ Extremely Steep Terrain, Steeply Dissected Hilly and Mountainous Terrain (56 - 140%)

B. GENERAL LAND COVER INFORMATION

LAND COVER

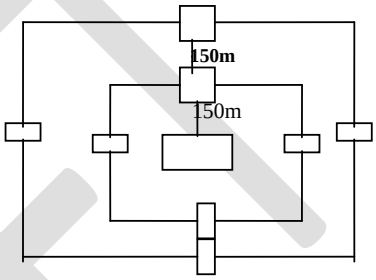
- General land cover Type	A.	☐	Vegetated	☐ Non - Vegetated
Relevee Site	B.	☐	Terrestrial	☐ Aquatic or Regularly Flooded Land (including WADY Areas)

- Specific Land Cover Type	Single major Land Cover Aspect	Two Mixed major land Cover Aspects	
		Most Important	Second
Cultivated	☐	☐	☐
Natural/Semi-Natural	☐	☐	☐
Built Up	☐	☐	☐
Bare	☐	☐	☐
Artificial water Body	☐	☐	☐
Inland Water	☐	☐	☐

AREA LANDCOVER HOMOGENITY (Applicable if on spot)

Land cover Homogeneous for more than 300 m ☐ Yes

Around the sample area: ☐ No



LAND COVER SEASONAL ASPECTS

	Natural/Semi-Natural vegetation				Cultivated Fields			
	dry	green	flowering	fruits	ploughed	initial stage	full mat stage	harvested
TREES	☐	☐	☐	☐	☐	☐	☐	☐
SHRUBS	☐	☐	☐	☐	☐	☐	☐	☐
HERBS	☐	☐	☐	☐	☐	☐	☐	☐

C SPECIFIC LAND COVER INFORMATION

NATURAL & SEMI-NATURAL VEGETATION

	Level	Cover	Height	Leaf Type			Leaf Phenology	
				Broad	Needle	Aphyllous	Evergreen	Deciduous
WOODY				☐	☐	☐	☐	☐
Trees	1			☐	☐	☐	☐	☐
	2			☐	☐	☐	☐	☐
	3			☐	☐	☐	☐	☐
Shrubs	1			☐	☐	☐	☐	☐
	2			☐	☐	☐	☐	☐
HERBACEOUS								
Graminoids								
Forbs								

Cover Estimation of vegetation Visual ☐ Instrumental ☐ Other ☐

CULTIVATED TERRESTRIAL AREA AND MANAGED LAND

-Life Form of **MAIN** CROP	Leaf Type		Leaf Phenology			
	Broad	Needle	Evergreen	Deciduous	Fruit Trees	Plantation
☐ Trees	☐	☐	☐	☐	☐	☐
☐ Shrubs	☐	☐	☐	☐		
☐ Herbaceous						
☐ Graminoids						
☐ Other						

. Crop Name ☐

-Life Form of SECOND CROP	Leaf Type		Leaf Phenology			
	Broad	Needle	Evergreen	Deciduous	Fruit trees	Plantation
☐ Trees	☐	☐	☐	☐	☐	☐
☐ Shrubs	☐	☐	☐	☐		
☐ Herbaceous						
☐ Graminoids						
☐ Other						

Crop Name ☐

-Average Field Size ☐ (m^2 or ha)

-Field Distribution

- ☐ Bordering Fields
- Distance between fields
  - ☐ < average field size
  - ☐ = 1 to 3 X average field size
  - ☐ = 3 to 9 x average field size
  - ☐ > 9 x average field size

- Cultivation period
  - ☐ main crop, during two or more different periods within same year
  - ☐ second crop in same period as main crop
  - ☐ second crop in different period as main crop
  - ☐ second crop starts during active period main crop

- Cultivation Time Factor

Time lap between two consecutive active periods
- ☐ =< 1 year
- ☐ 1 to 4 years
- ☐ > 4 years

-Water Supply/Irrigation
- ☐ Not Irrigated
- ☐ Supplementary Irrigation
  - ☐ Post flooding
  - ☐ Surface
  - ☐ Sprinkler
  - ☐ Drip
  - ☐ Other ☐

-Life Form MANAGED LAND

Urban Vegetated Area

Area covered by trees is
- ☐ > 40%
- ☐ between 20% and 40%
- ☐ < 20 %

BARE AREAS

- ☐ Consolidated
  - ☐ Bare Rock
  - ☐ Gravel, Stones and Boulders
  - ☐ Hardpans
- ☐ Unconsolidated
  - ☐ Bare Soil
    - ☐ Stony (5 - 40%)
    - ☐ Very Stony (40 - 80%)
  - ☐ Loose and shifting sands
- ☐ Dunes
  - ☐ Barchans
  - ☐ Parabolic
  - ☐ Longitudinal

    - ☐ Saturated
    - ☐ Unsaturated

Annex 2: LAND USE FORM FOR THE OASIS FARMS IN PUNTLAND

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
	Oasis farming
	Irrigated Farming
	Rainfed Agriculture
	Flood Recession Cultivation in Desheks
	Agropastoralism (semi-sedentary grazing)
	Urban Centres and Rural Settlements
	Currently without use
	Dunes and Bare Lands

Farming System

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

Check	Land Improvement
	Drainage
	Berkad
	Borehole
	Wells
	Terracing
	Soil bunding
	Water harvesting
	War (Dams/Reservoirs)
	Other…

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

	Input Level
	Low input
	Medium input
	High input

3. Mechanization: ( ) Yes ( ) No

Type……
……

4. Is there any form of Farm management and/or protection observed?

Yes ( ) No ( )

If Yes, give the type:……

Crops

1. Can you indicate the Current crop/s? (you can select and describe more than one)

	Crop Type
	Date palm
	Maize
	Sorghum
	Millet
	Rice
	Sesame
	Groundnuts
	Cowpeas
	Mung Bean
	Vegetables
	Banana
	Fruits Trees
	Other

2. Is there any intercropping activity? Yes ( ) No ( )

If yes, which crops? ……, ……, …… ……..

3. Can you indicate an average of the Field size corresponding to this unit?

	Average Farm Size
	<2 ha
	2-5 ha
	>5 ha

4. Which is the Purpose of the crop production?

Crop Type	**Crop Use**			
	market	consumption	fodder	Other
Date palm				
Maize				
Sorghum				
Millet				
Rice				
Sesame				
Groundnuts				
Cowpeas				
Mung Bean				
Vegetables				
Bananas				
Fruits Trees				
Other				

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

Crop Type	Crop Phenological Stage				
	start	growing	flowering	fruiting	fallow
Date palm					
Maize					
Sorghum					
Millet					
Sesame					
Groundnuts					
Cowpeas					
Mung Bean					
Vegetables					
Bananas					
Fruits Trees					
Other					

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

Crop Type	Crop Condition		
	Crop Failure	Poor Crop	Good Crop
Date palm			
Maize			
Sorghum			
Millet			
Sesame			
Groundnuts			
Cowpeas			
Mung Bean			
Vegetables			
Bananas			
Fruits Trees			
Other			

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

Climate conditions……
……
……
Water availability……..
……
……
Soil related factors
……...
……
……
Agronomic cultural aspects…….
……
……
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
Date palm									
Maize									
Sorghum									
Millet									
Sesame									
Groundnuts									
Cowpeas									
Mung Bean									
Vegetables									
Bananas									
Fruits Trees									
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
Date palm												
Maize												
Sorghum												
Millet												
Sesame												
Groundnuts												
Cowpeas												
Mung Bean												
Vegetables												
Bananas												
Fruits Trees												
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?

1. 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

Strengths	Weaknesses

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

Strengths	Weaknesses

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			

1. 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	
	War (Dams/Reservoir)	
	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).

Threats	Weaknessess

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
	Pit/trench kiln
	Mound kiln
	Other

i. **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 3: SWALIM Water Source Yield Data Collection Form

Date	Time	District Name	Area (Location)	Water Source Type	Observer Name	Coordinates		Collected volume (litres)	Time taken (minutes)	Yield	Remarks
						x	y				

Annex 4: Measuring flow from springs and shallow wells

Springs

The flow of water from a spring is usually termed the yield. The yield is determined by the amount of water which percolates into the aquifer, and how much water is stored in the aquifer. The yield may vary with season, depending on the type of spring. The flow from springs is almost always difficult to measure because flows tend to be dispersed and rarely concentrate into well-defined channels amenable to discharge measurement.

Types of springs

There are two types of springs, gravity and artesian springs.

i. Gravity springs occur where ground water emerges on the surface because an impermeable layer prevents it from seeping downwards, or the water table is at the same height as the land.
ii. Artesian springs occur where ground water emerges at the surface after confinement between two impervious layers of rock.

The yield of gravity springs is likely to vary with the season. Measurement of yield should therefore always be done when the flow is least, usually at the start of the wet season. Artesian springs tend to have constant yield, as the aquifer is confined under pressure and so produces a constant amount of water.

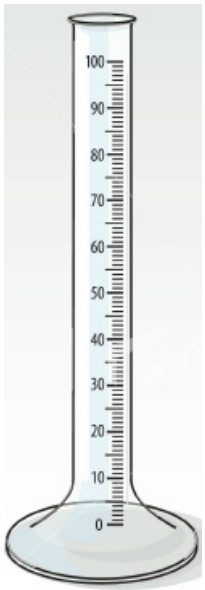
Measuring flow from springs

The most accurate method of measuring spring yield is by observing the time required filling a container of known volume, or the time required to partly fill a calibrated container. The basic equipment is a stopwatch and a calibrated container (Figure). The time taken for the container to fill is measured and the yield in litres per second easily calculated. It is good to take several measurements of the yield and average the result.

A simple way to calibrate a container is to add known volumes of water by increments and measure the depth of water in the container. Calibration can also be accomplished by weighing the container with varying amounts of water in it, noting the depth in the container, and using the formula:

$$V = (W_2 - W_1) / w$$

Where: V = volume of water in the container, W_2 = weight of container with water, W_1 = weight of empty container, and w = unit weight of water. Simpler yet, purchase a calibrated container such as a graduated cylinder or graduated beaker of sufficient size.



The basic field procedure consists of interrupting the flow and collecting the water. The main problem in spring yield measurement is to ensure all the flow of the spring is collected. The best way is to build a small earth dams around the spring to create a pool. A length of pipe is laid through the dam and leads to the container. Whilst pool is filling, no water should run into the container but should be diverted. Use cloths, clay, or other materials to temporarily seal cracks and force the water to go into the pool. Once the pool has reached a level when it is no longer filling up, the water should be allowed to run into the container and the yield measured. When the pool has reached a steady level, the water flowing out of the pipe is equal to the water flowing into the pool from the spring.

In some situations, soft plastic pails, containers, or beakers can be placed directly in contact with the spring to directly capture the outflow. Where flows come out of the ground in a number of distinct sources or if they are scattered over a broad area, you may need to add up the results of several different measurements.

Use the stopwatch and allow a sufficient period of time so any error in measuring time is negligible. If water is ponded or otherwise diverted, allow the flow to stabilize before beginning. Repeat each measurement three or four times to be certain no errors have been made and to achieve consistent results.

Other useful methods that require extra resources

Sometimes springs are large enough to concentrate discharge into a defined channel but still too small to allow measurement with a pygmy current meter. Under these conditions, a portable weir plate or a portable Parshall flume may be useful.

One suitable device is a 90º V-notch weir fabricated out of 10- to 16-gage

galvanized sheet iron. The weir can measure flows from 6.0 to 650litre/day within 3% accuracy.

A portable Parshall measuring flume is another device that can be used to measure flows when the depths are shallow and velocities low. A modified Parshall flume is recommenced because of its simplicity, relatively light weight, and ease of installation. The flume is installed by placing it in a hole dug in the channel and by filling in around it to prevent any water from bypassing it and levelling it with a carpenter's level. Discharge is determined by staff gage readings and a flume rating table.

Example of Parshall measuring flume

Shallow Wells

A shallow well, as we use the term is, hand dug water well, 4.0 to 20.0 m deep and about 2.0m diameter. It is lined with locally made bricks/stones and sealed with a concrete top slab. A simple hand powered pump is installed in the top slab to allow pumping the water. Sometimes the concrete slab does not exist. The amount of water that comes from a shallow well is termed its yield.

Measurement of yield should be taken when the water table is at its lowest level. Usually this is at the start of the wet season, as there is a time lag between the onset of the rains and water table rising. Artesian wells, like artesian springs, will maintain a steady level all year.

The procedure is simple: all the water in the well, or as much as possible, should be pumped out. The rise of the water back to the well, to the point where it regains its former level, is timed. The yield can then be roughly calculated from the diameter of the well, the height of water column and the time taken for the water to rise.

This can be compared with the irrigation requirements of the farms and a decision made on whether the shallow ell needs any deepening.

Estimation of irrigation water requirements

Estimation of crop water requirements and irrigation requirements are based on soil, climate and crop data. Irrigation water requirement is normally estimated using FAO crop model (CROPWAT). In addition, the program allows the development of irrigation schedules for different management conditions and the calculation of scheme water supply for varying crop patterns. All calculation procedures used in CROPWAT are based on the two FAO publications of the Irrigation and Drainage Series, namely, No. 56 "**Crop Evapotranspiration - Guidelines for computing crop water requirements**" and No. 33 titled "**Yield response to water**".

As long as the part of the source yield measured exceeds the irrigation water requirement, then the source can be used.

N.B: please include the report: 1) the list of the irrigated agricultural farms in each district with the respective geographic coordinates and size of the farming areas. 2) Again include the map showing the water sources and water suitability for irrigation. 3) Change the drainage map in the report with another one written the drainage basin names.