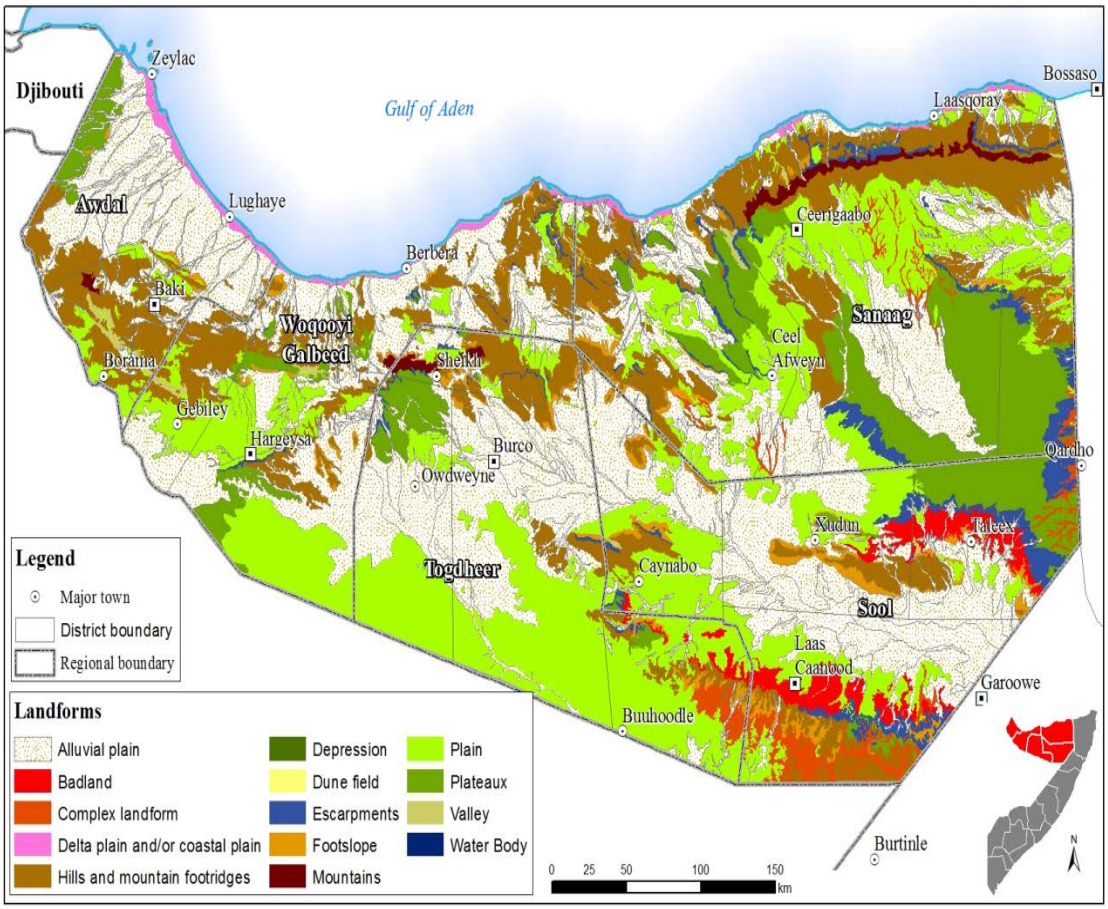
Territorial diagnostic report of the land resources of Somaliland



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List of Acronyms

AEZ	Agro-ecological Zones
AfDB	African Development Bank
ALES	Automated Land Evaluation System
AOI	Area of Interest
ASAL	Arid and Semi-Arid Lands
AUC	African Union Commission
DEM	Digital Elevation Model
DTA	Digital Terrain Analysis
EC	Electric Conductivity
ECA	Economic Commission for Africa
EU	European Union
FAO	Food and Agriculture Organization
FSNAU	Food Security and Nutrition Analysis Unit
ICPAC	Inter-Governmental Climate Predictions and Assessment Centre
ISRIC	International Soil Reference and Information Centre
ITCZ	Inter-Tropical Convergence Zone
LADA	Land Degradation Assessment in Dry Lands
LCCS	Land Cover Classification System
LCML	Land Cover Meta Language
LGP	Length of Growth Period
LUT	Land Use Types
MASL	Meters above sea level
MONP&D	Ministry of National Planning and Development of Somaliland
NAPA	National Adaptation Programmes of Action
NDVI	Normalized Difference Vegetation Index
PET	Potential Evapo-transpiration
RBU	Resource Based Units
RH	Relative Humidity

SLM	Sustainable Land Management
SOMALES	Somalia Automated Land Evaluation System
SRTM	Shuttle Radar Topography Mission Digital Elevation Model
SWALIM	Somalia Water and Land Information Management
TAS	Terrain Analysis Software
TPI	Topographic Position Index
WHO	World Health Organization
WOCAT	World Overview of Conservation Approaches and Technologies

Acknowledgments

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Executive Summary

This territorial diagnostic report focuses on the land resources of Somaliland and is based primarily on the SWALIM project's work related to land over the past decade. The report predominantly examines the bio-physical characteristics, as the major determinants of the production potential of land, and synthesizes information related to climate, landform, soil, land cover/land use and ground water resources. The study has contextualized the land issues within the socio-economic, politico-institutional and demographic realities of Somaliland.

In the presence of rather sparse population, coupled with less intensive land management practices, the pressure on land resources should have stayed within reasonable limits. From a demographic point of view, the nomadic and rural population, which depend directly on land resources, count for less than 45% of the total population of Somaliland. However, the contribution of land resources to Somaliland's economy is much higher by virtue of its livestock and agriculture sectors, as well as through Ecosystem Goods and Services (EGS).

With around 90% of land under nomadic and transhumance pastoralism, and some 2% under agro-pastoralism activities, the economic picture depicts extensive land utilization with rather inadequate economic return and, unfortunately, adverse environmental effects. With 60% contribution to the national economy and occupying the lion's share of land resources, the livestock sector is characterized by free-grazing, poor per-animal productivity and an almost total absence of value chain management. Agriculture is mainly subsistence in nature; it covers around 2% of land and is faced with dwindling water resources, climate shocks, invasive species and accelerated soil erosion. Nevertheless, it is calculated that the limited land resource potential can be reasonably expanded through improved land management.

The politico-institutional context combines the traditional clan system and the newer, more formal democratic structures of the Houses of Representatives and Elders. This provides the opportunity to develop policies through consensus and with a greater understanding of grass-roots concerns and scenarios. The constitution includes two distinct clauses (articles 12 and 18) covering the sustainable management of the land resources; however, their effective enactment requires elaborate institutional arrangements, which are yet to be put in place.

At the institutional level, the challenges include limited skills and understanding of integrated land resource management among the lower tier of the relevant staff at central level, and very limited human capacity on the ground. Staff at the ministry level is reasonably educated and can be considered strong although lean. When it comes to field staff, the situation is far more precarious. The missing elements also include adequate research and extension activity, investment towards enhanced returns, value-chain arrangements, appropriate marketing, access to benefits and sharing of obligations.

The bio-physical analysis of the land resources is elaborated along the four major landforms: 1.) coastal and piedmont, 2.) mountains and highlands, 3.) plateaus and, 4.) valleys. The productive potential in these four landforms is analysed in terms of climate and climate effects, including ground water, soils, land cover and land use.

1. Coastal plain and Piedmont:

The most arid landform in Somaliland with uni-modal rain of 100 mm per annum and a temperature of 28-35 ^{0}C, the potential evapo-transpiration exceeds the rainfall by thirty times. With mixed quality 18 boreholes were found with 105 m average depth. The soils of the landform (represented by Arenosols and Regosols) are poor in texture, structure and fertility. Due to aridity and the absence of adequate land cover, sheet and gully erosions prevail and the eastern two-third part of this landform undergoes continuous land degradation. 4% of the landcover is woody vegetation scattered between Zeylac and Berbera, and only 0.02% is irrigated agriculture near Berbera. With 95% of either bare land or covered with herbaceous vegetation, the landform is associated with nomadic and transhumance pastoralism.

2. Mountain and Highlands:

Comprising Golis Mountains, the landform receives 300 - 600 mm of bi-modal rainfall, with 20 – 24^{0}C with the potential evapotranspiration equals the rainfall, the ratio is most balanced in the entire Somaliland. 79 boreholes were found with 111 m average depth, with fair quality along the mountains and saline in the valleys. The major soil class is Leptosols (59%) i.e. predominantly rocky and shallow, followed by Cambisols (22%) which are deeper and loamy. The soils generally lack nitrogen, however well in potassium and micro-nutrients, and the soils in the less sloping lower reaches are adequately developed. 63% and 14% of the landcover comprises of herbaceous vegetation and woody vegetation respectively.. The woody vegetation is concentrated in the Golis Mountains but also in the areas surrounding Borama and Hargeisa. With larger part under nomadic pastoralism, 16% landcover is under transhumance pastoralism with timber collection and charcoal production and 2% (1000 Km^2) under irrigated agriculture.

3. Plateaus:

With largest area in Somaliland the plateau landform receives 300 - 600 mm of bi-modal rainfall. The temperature ranges between 20 and 24 ^{0}C and the ratio between rainfall and potential evapo-transpiration is one to one and a half, giving a manageable climatic situation. 162 boreholes were found with 111 m average depth, with rather saline quality. The soils in

general are deep, low in nitrogen and phosphorus, high in potassium and other micro nutrients, thus the soils can be reasonably productive by replenishing the fertility through supplying nitrogen and phosphorus. 81.3% (58459 Km^2) area is covered by herbaceous or sparse woody vegetation, 2.6% (1936 Km^2) area under rainfed agriculture and 0.2% (174 Km^2) under irrigated agriculture. Around 23% area is bare lying in the east of Ceel Afweyn. About 70 million hectares (90%) of plateaus is under nomadic and transhumance pastoralism with timber collection and charcoal production, and 256,000 hectares under agro-pastoralism (3.4%).

4. Valley

The landform receives less than 200 mm bi-modal rainfall per annum, with temperature of 28-32 ^{0}C and potential evapotranspiration exceeding the rainfall by seven times. The landform is characterised by high aridity. 48 boreholes were found with 119 m average depth and varying saline quality. The soils of the valleys comprise clayey Calcisols 35%, silty or sandy and saline Solonchak 24%, sandy loam Regosols 20% and stony or rocky Leptosols 19%. These soils are low in nitrogen, adequate in Phosphorous and high to average in potassium. The land-cover in this landform consists of about 57.3 % (16,738 ha) by sparse or herbaceous natural woody vegetation and 16.8% (4925 Km2) by closed to open natural woody vegetation. Less than 0.26% (78 Km^2) is irrigated agriculture southeast of Burco. Around 94% (2.8 million ha) is under nomadic and transhumance pastoralism and 0.1% (2165 ha) under agro-pastoralism. This landform is also characterised by timber collection and charcoal production activities.

Challenges and Gaps

The land resources of Somaliland pose series of challenges and gaps related to biophysical shortcomings, management limitations, and institutional and capacity gaps. The major bio-physical limitations include aridity, ground water insufficiency, climate shocks, poor soils, accelerated erosion, low biomass production and degradation of existing vegetation cover and spreading of invasive species (e.g. Prosopis, Opuntia, Parthenium species, etc.) in productive lands.

Recommendations

The replenishment and sustainable use of the land resources of Somaliland demands the following measures:

Formulation of policy vision and road map for the sustainable governance of the land-resource of Somaliland and capacity enhancement to plan and implement the sustainable land resource management.

Shifting from Business as Usual to Proactive scenarios - challenging the present paradigm, looking at land in totality rather than pieces on the basis of use potential; identifying the interface of one use with the other – looking at land as ecosystem with potential for production of goods and services.

A thorough cost-benefit analysis with focus on the cost and benefits of the business as usual with the more proactive and holistic scenario based on the recommendations listed in this report. The use of modern technologies and input intensive management, the mainstreaming of land resource base small and medium enterprise development, including micro-finance facilitation needs to be examined.

Integrated land-use planning and management to be carried out in an informed, integrated and participatory manner at various levels starting from the smallest unit of land resource i.e. village and subsequently going to the larger unit, ultimately ending at the landform level.

Addressing the issue of aridity by managing land in congruence with the natural capability of the land, thus the potential of plateau and mountain/highlands landforms needs to be optimally used in a cost effective manner. Nevertheless the landform with extreme aridity needs to be managed for other uses such as forestry, through conservation measures. This is essential to check the expanding desertification of these regions, which ultimately spreads to the more promising land resources.

Although the ground water has been mapped in Somaliland, a working level mapping of test pumping is needed. The land use planning process should integrate ground water assessment, including test pumping mapping at micro-level (village/settlement) as well. The recharge requirements should be assessed and measures including water harvesting and

integrated watershed management should be carried out. Awareness and capacity building in the subject of ground water and its replenishment should be tailored and imparted and made part of the land use planning process.

Managing the climate shocks should be done through climate change adaptation measures, its mainstreaming in the government planning process and demonstrations through donors assistance. Climate change shocks preparedness and resilience should be done together with disaster management authority. Awareness and Training packages need to be developed and imparted. Climate smart agriculture and livestock management should be demonstrated with the help of UN agencies and donors.

Limited soil fertility should be managed through a holistic approach including nutrients adding, conservation measures, crop rotation and shifting, encouraging Leguminosae plant species and encouraging cost effective subsidies.

The issue of invasive plant species should be addressed through national level efforts and the formulation of a cohesive national strategy based on awareness, eradication and promoting the use of Prosopis for charcoal production as well as substitute to threatened acacia species.

Addressing the ecosystem fragmentation and degradation through integrated approach including assessing land degradation through LADA / WOCAT methodology and land restoration opportunity identified through use of WOCAT SLM measures. This shall also include creating alternative livelihoods and income generation activities through skills training and development of innovative entrepreneurship arising from the ecosystem goods and services. The charcoal issue should be addressed through enforcement as well as replenishing the deforested areas and providing alternative energy sources and livelihoods options for the local communities. Comprehensive and cohesive grazing land management strategy and its demonstration is also included.

The issues of ecosystem degradation & fragmentation, droughts and floods and desertification should be addressed through mainstreaming of the biodiversity, climate change

and combating desertification through the trust funds such as GEF, Adaptation Funds, Green climate fund, Special Climate Change Fund, etc.

Holding of an international conference on the land-resources of Somaliland in general as well as assessing/exploring the indigenous knowledge related to land and its uses and integrating this with the contemporary knowledge of the government and research organizations.

1. Introduction

The territorial diagnostic report prepared by SWALIM is under project GCP/SOM/054/EC "Rebuilding Confidence on Land Issues in Somalia" funded by the European Union. The work by SWALIM focused on developing inventory of the natural resource base and on the land resources of Somaliland. The report is based on the following four inter-connected inputs:

- Desk assessment of the land resources using existing data (climate, soil, , land use, satellite)
- Soil survey and soil data analysis to increase understanding of soil characteristics including soil fertility and other soil production variables;
- Livelihood and land use surveys to verify production systems (Land Use Systems) previously defined by SWALIM;
- Analysis of soils, land use and production limitation and potential and compilation of an expanded land resources database.

As a first step to accomplish this diagnostic report, the desk assessment of the land resources using existing data is done through taking stock of the various land related studies conducted by SWALIM. This stock taking was supplemented with relevant GIS maps. Although in generic terms SWALIM analysed the land resources of overall Somaliland, nevertheless the land resources of the Northern Area of Interest comprise 12,939 Km^2 and were examined exhaustively with reference to landforms, soils, climate and land-use and/land cover. Based on an articulated analysis of these parameters the land suitability was assessed for this area. Studies are also conducted to assess the land degradation process and developing monitoring framework for land degradation. In all these studies the established methodologies of FAO are used together with SWALIM remote sensing & GIS expertise, and the methodological niche of FAO/SWALIM was complimented with field observations, structured interviews, focused group discussions, etc. GIS and Remote Sensing based simulation has been extensively used

for the analysis and based on the ensued knowledge guidelines are developed for monitoring land degradation, assessing land resources/cover and conducting land use planning.

SWALIM assessed the land resources of Somaliland through a three track approach of, firstly, improvement and tailoring the methodological aspect of conducting the assessment; secondly, development of a cadre of skilled practitioners to use the SWALIM methodologies of conducting surveys to evaluate land resources; and thirdly, articulating the reports related to various aspects of land resource assessment. These reports, together with GIS maps, effectively described the various bio-physical aspects of the land resources of Somaliland.

1.1 Background

The overall question of understanding the land is subject to dissecting its various aspects in a cohesive manner. Creation of this multi-dimensional understanding is essential to inform development of a comprehensive land policy for effective governance of land as well as various options leading towards sustainable land management. The Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security (VGGT) sets out guiding principles for responsible governance of tenure as follows:

1. **Improve Tenure Governance** by providing guidance & information on internationally accepted practices.
2. **Contribute to the improvement and development of the policy, legal and organizational frameworks** regulating the range of tenure rights.
3. **Enhance the transparency** and improve the functioning of tenure systems.
4. **Strengthen the capacities & operations of implementing agencies,** judicial authorities, local governments, farmers' organizations, civil society, academia, private sector, etc.

Better governance of tenure contributes to achieve improved food security as well as contributing to poverty eradication, sustainable livelihoods, social stability, rural development, environmental protection and sustainable social and economic development.

FAO has played a remarkable role in relation to land evaluation by setting the principles of land evaluation and developing the broader methodological framework to conduct this evaluation in 1976. Based on this framework FAO further developed approaches to evaluate specific land uses such as rain-fed agriculture, irrigated agriculture, livestock and forestry production (FAO 1983; 1984; 1985; 1991 respectively). FAO also developed technical guidelines on these approaches (FAO 1996). In February 1997, the department of Soil, Crop and Atmospheric Sciences of Cornel University published the Automated Land Evaluation System (ALES). ALES helped evaluators to build expert systems according to the FAO Framework of Land Evaluation (Cornel University 1997).

A more holistic picture of land evaluation and governance is presented in the Guidelines of Land Policy in Africa (AUC-ECA-AfDB Consortium, 2010) that conceptualize the land question with the following aspects:

- The Geographical and Ecological Context: comprise of climate, soil, land cover, land use, landforms, etc. This context is of paramount importance as this shapes the succeeding four contexts of land. Yet adequate management of these four contexts can offset the geographic and ecological limitations to a reasonable extent and that is why several of the less productive areas around the world are converted in reasonable productive lands. This bio-physical aspect of land shapes the ecosystems, watershed functions, biodiversity, etc.
- The Politico-institutional Context: this covers the aspects of statutory control, regulation, legislation, policy, strategy and plans to manage the land. This aspect also includes the issue of capacity and state institutions responsible for political and administrative steering of the land.
- The Economic Context: this covers the role of land in agriculture and other green sectors economies as well as the role of land in other sectors of economies. In Africa in general and Somalia in particular, land plays a very dominant role in the overall economic spectrum through land-based sectors such as agriculture, livestock, forestry, etc. However tapping the land productive potential is also subject to the health of the

overall economy – the healthy economy leads to the effective provision of agriculture inputs and thus perpetuates positive relation between land and economy, subject to adopting the social and ecological principles of sustainable land management. This makes the multi-dimensional cost-benefit analysis as important as the bio-physical analysis while planning for realizing optimum production of the land.

- The Social and Cultural Context: land plays a dominant role in shaping the power structure in agro-pastoral societies, thus the issue of ownership, tenure, marginalisation, gender, conflicts, spirituality, etc. becomes very important. The socio-cultural aspects have strong nexus with tapping the productive potential of the land.
- The Demographic Context: the issue of population increase is affecting land in terms of land fragmentation due to land division and in-cohesive land use change. The issue of urbanization and desertification can also find its root in the demographic context.

Somalia Water and Land Information Management (SWALIM) built on the policy guidelines, evaluation frameworks and tools developed by FAO and others, nevertheless tended to tailor and improvise these methods to the Somali context, whilst refining them incrementally as well.

1.2. Introduction to the land resources of Somaliland

Situated in the horn of Africa, Somaliland has a total area 137, 600 Km2 with a coastline of 850 Km along the Gulf of Aden (MONP&D Somaliland, 2015). For the analysis of the associated land resources, we refer to FAO that define Land and Land Resources as a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface climate, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near-surface sedimentary layers and associated groundwater and geo-hydrological reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.) (FAO/UNEP, 1997). Under the overall context of this

formulation and together with FAO land resource framework, the SWALIM knowledge base of land resource is incremental in nature. While building on the overall FAO knowledge, SWALIM incrementally generated literature related to the Somaliland land resource through field surveys and extensive use of remote sensing and GIS techniques. SWALIM's review of these land resources in snapshot is as follows:

1.2.1. Climate:

Arid and Semi-Arid Lands (ASALs) make up most of the landmass of Somaliland, and these are characteristically prone to extreme weather conditions including high mean surface temperatures, periods of extended drought, highly erratic rainfall and strong winds (UNDP/ICPAC, 2013).

The main synoptic scale systems affecting rainfall in Somaliland include the Inter-Tropical Convergence Zone (ITCZ), monsoonal winds and ocean currents, jet-streams including the 'Somali Jetstream', easterly waves, tropical cyclones, neighbouring Indian Ocean and Red Sea conditions, as well as tele-connections with various regional and global scale climate systems. The large-scale systems include the Quasi- biennial Oscillation (QBO), El-Niño/Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), and intra-seasonal waves (UNDP/NAPA, 2013).

SWALIM has not only accessed and analysed substantial information on the climate but based on potential evapotranspiration (PET) and rainfall variability has developed the length of growth period (LGP) map and legend for the whole of Somalia which can be conveniently delineated for Somaliland. Nevertheless the detail LGP for the Northern AOI is effectively derived. By combining LGP with aggregated soil groups agro-ecological zoning of Somaliland generated with 29 main zones and 3 inter-zonal regions defined by landforms.

1.2.2. Landforms:

The landform of Somaliland was mapped while using integrated landform mapping approach at semi-detailed scale using Remote Sensing and GIS techniques. Methodologically the study on the landform of Somaliland succeeded in achieving a legend system. This system takes into account the integrated use of satellite images, topographic and other thematic maps,

DEM and their derived products, and 3D visualization, for identifying and mapping the landforms of Somaliland with the greatest precision. This legend is also suitable for soil mapping and identification of the hazards such as erosion and flooding. A full list of the Landform automatic classification and an explanation of the conceptual background is provided. These efforts led to the formulation of 14 landform types together with its coding, extent and description with a limited reflection on its relation with the productive potential of the land resource associated with the respective landform type.

1.2.3. Soils:

Although the first regional soil reconnaissance survey was conducted in the Juba and Shebelle region by FAO-Lockwood in 1967, the first systematic soil survey of Somaliland was conducted by Sogreah in 1981 (Vargas, R. R., Alim, M. 2007). In the period 1987-88 ISRIC carried out the soil inventory on 1:1 million scale soil map on the basis of information that existed at that time. The map and associated data were digitized by FAO in 1998 in the shape of Land and Water Digital Media Series 2. This map was later simplified by SWALIM for land evaluation and the demarcation of Agro-ecological zones (AEZ). The various soil groups were aggregated in seven classes based on physical limitations to crop production as well as in conformation to the World Reference Base for Soil Resource 2006.

In producing soil data SWALIM used multi-scale and multi-user approach so as to be effectively and readily used by the natural resource managers. Most soils found in the study area (covering parts of Borama, Gebiley, Hargeisa, south of Lughaye) belong to the class with very limited soil development, with 45% of the soils being rocky/stony with limited potential for agriculture. This nature of the soil is mainly due to peculiar geography of the area as arid and hilly terrain on one hand and the less adequate human activities on the other. Soil fertility is low as these are continuously degraded due to agro-pastoral activities with almost no application of fertilizers (Vargas, R. R., Alim, M. 2007).

1.2.4. Land use/land cover:

The landuse and landcover were assessed for Somaliland through sampling techniques with USGS methodology using grid spacing of 500 m and with the help of 15 m resolution ASTER

satellite images of 2013. The work was supplemented by very high resolution images and interpreted through NDVI images. Landcover maps were developed for the whole of Somaliland as well as for individual districts. The landuse classes were created using the FAO standardized LCCS v.3 methodology (http://www.glcn.org/ont_2_en.jsp).

In general seven land-cover classes comprising natural woody vegetation (sparse trees & herbaceous canopy together with closed to open canopy) covering 75 % of the area followed by bare area covering 23% of Somaliland. The rain-fed crops cover around 1.71%, whereas irrigated crops cover only 51 ha area giving about 0.01% of Somaliland. These land-cover classes together with the soils, landform and climate determine the nature of the land use.

In the Northern AOI (Somaliland) around 60% area is used purely for grazing including transhumance pastoralism and about 40% for crop production where rain-fed agriculture is practiced in combination with pastoralism and wood collection. Goats and sheep are grazed mainly on sloping areas, whereas cattle and camels are grazed on flatter areas. This land use class is the economic basis of households in the study area. Sedentary pastoralism around homesteads is a common practice. Hay harvesting supports this land use, as harvested hay can be used during the dry season. The Sorghum belt of Somaliland typically represents rain-fed agriculture, where a variety of water harvesting techniques intended at water retention was found. However, these structures are inadequately constructed and in some cases lead to severe gully erosion. Irrigated agriculture is mostly confined to orchards and vegetable crops growing as cash crops. These crops are irrigated through wells, dams and other water bodies, which are generally poorly constructed, leading to water losses and erosion. Uncontrolled grazing together with deforestation for charcoal production has led to degradation of areas under woody vegetation (Oduori, S., Vargas, R., Alim, M. 2007).

Thus on the face of resource scarcity on one hand and the poor management practices on the other a bleak situation is presented in most of the available literature. Nevertheless, options are available which can help in bringing conducive changes that requires an informed, shared and robust management based on the analysis of reliable and sufficient data.

1.2.5. Land evaluation of Somaliland (Northern Area of Interest)

SWALIM developed Somali Automated Land Evaluation System (SOMALES) by adapting FAO Automated Land Evaluation System (ALES) to the Somali context. SWALIM developed resource based units (RBU) by superimposing the multi-temporal and multi-spatial land resources (soils, land use, land cover and landform) together with agro-climate on a scale of 1:100,000. RBU formed the basic unit of land evaluation. The generic land uses of Somaliland comprise of rainfed agriculture, irrigated agriculture, extensive grazing (pastoralism) and forestry (tree plantation). SOMALES provided four suitability levels: highly suitable, moderately suitable, marginally suitable and not suitable. Thus the evaluation reveals the various levels of suitability for each of the four land uses in every RBU for the Northern AOI. Due to the absence of cost/benefit analysis for various LUTs a comparative analysis couldn't be developed. Nevertheless, some qualitative assessments with details available in FAO-SWALIM Report No: L -12, 2007.

1.3. Conclusion

Together with FAO land evaluation framework and UN guideline for land policy formulation, SWALIM has developed substantial information in the form of reports and maps that can effectively support the overall bio-physical assessment of the land resources of Somaliland. Nevertheless the following issues were identified:

- The Geographical and Ecological Context (Bio-physical data): as mentioned before substantial data is already available. Nevertheless information on the feasibility of small scale irrigated agriculture needs to be available specifically on the sources and its distribution, its current status and proposed improvement measures with associated investments would be needed. This context also shapes the ecosystems, watershed functions, biodiversity, etc. notwithstanding SWALIM lack of information on this aspect will be compensated through the recently completed NBSAP Somalia in general and Local Biodiversity Strategy and Action Plan of Somaliland in particular.
- The Politico-institutional Context: This refers to statutory control, regulation, legislation, policy, strategy and plans to manage the land. This aspect also includes the

issue of capacity and state institutions responsible for political and administrative steering of the land. This will be collected through the semi-structured interviews and focussed group discussion with experts and government officials of Somaliland.

- The Economic Context: this covers the role of land in agriculture and other green sectors economy as well as the role of economy in land resource management. Not substantial analysis is available and data is sketchy. Due to the very important role of land and its very intricate and vulnerable nature the multi-dimensional cost-benefit analysis is as important as the bio-physical analysis while planning for realizing optimum production of the land.
- The Social and Cultural Context: land plays a dominant role in shaping the power structure in agro-pastoral societies. Therefore, the issue of ownership, tenure, marginalisation, gender, conflicts, spirituality, etc. becomes very important. Data about the socio-cultural aspect of land will need to be obtained.
- The Demographic Context: the issue of population increase is affecting land in terms of land fragmentation due to land division and in-cohesive land use change. The issue of urbanization and desertification can also find its root in the demographic context. SWALIM GIS facility may be of help to arrive at the urbanization vis a vis its impact on the land. Along with the land use, the land use change would also need to be assessed.

2. Methodology

For the purpose of this territorial diagnostic report the literature related to the two districts (Burco & Oodweyne) and Northern Area of Interest are intensively used, however other relevant literature produced by SWALIM and other sources is also consulted. Together with the resources that focus on Somaliland, the knowledge emanated from the two districts and the SWALIM's Northern AOI is used to extrapolate assessment of the land resources for the whole of Somaliland. The overall SWALIM land related literature in general and reports and maps focussed on the Northern AOI and lately the two districts helped in arriving at common understanding of land resources and its various factors (Landform, Soils, Land use & Land cover, Climate and land degradation). In nutshell the methodology chapter of this report consists of; a. the methodological approach for developing this report; and b. methodologies used for studying the land-resources (soil, landcover, landform, landuse, etc.) of Somaliland.

2.1. The Approach

This report is developed on the basis of the analysis of the five interconnected dimensions that shapes the overall productivity of the land. These comprise; a. Geographical and Ecological Context of Somaliland; b. the Politico-institutional Context; c. the Economic Context; d. the Social and Cultural Context and e. the Demographic context. Keeping in view the foundational significance of the geographical and ecological context, the bulk of analysis is focussed here and thus with a central role in determining the overall land evaluation. Nevertheless the succeeding four contexts (politico-institutional, economic, socio-cultural and demographic) are touched upon as principle influencing factors in managing the natural potential of the land.

The report is furnished on the basis of a four pronged input consolidation and analysis: a. analysis and consolidation of the existing knowledge developed by SWALIM and other relevant sources; b. field surveys to substantiate and update the existing knowledge; c. meetings with key stakeholders to augment and validate the initial draft; and d. input integration and conclusion.

a. Analysis and consolidation of the existing knowledge: this is considerably touched upon in the literature review, and provides basis for this incremental analysis and conclusion. SWALIM has developed over 20 reports on land resources, together with GIS based maps. These are extensively used in addition with the material developed by FAO and other relevant actors are also considered.

b. Field Surveys: field surveys were focussed on the soils, land-cover and land-use and livelihoods. The SWALIM team imparted one-week training to the surveyors and detailed questionnaires were provided to these surveyors. The questionnaires were fed in the cell phones of the field surveyors showing them how to use the field data collection forms and questionnaires. Field data was then collected using the mobile phones and transmitted immediately after to SWALIM for compiling and analysis. For the soil analysis the samples were tested and results processed in the laboratory. The results are incorporated in the report.

c. A systematic consultative process was followed comprise focussed group discussion in a theme-specific manner (such as meeting with agronomists, soil scientists, economists, etc.) and augmenting the available information and analysis made so far. These focused group sessions were followed by a two-day event to validate the gathered information and present the overall conclusion with the intent to substantially refine and validate it.

d. While integrating and furnishing the conclusion, the bio-physical elements of soil, landform, land-cover and land use and climate were synthesised for all the administrative regions of Somaliland in general and Oodweyne and Burco in particular. The four bio-physical parameters are superimposed on the administrative map of the respective district, that gave a holistic picture of the bio-physical characteristics of the respective administrative region vis a vis its potential for various management interventions. Based on the bio-physical potential of the respective administrative unit, the management recommendations were devised for two scenarios; a. Business as Usual and b. Action/intensive management.

2.2. Integrated Methodologies Used for the Studies of Land Resources of Somaliland

The integrated methodologies for assessing the land resources of Somaliland comprise the following three stages:

1. Stage one (pre-field survey): this refers to literature reviews, preparation of a Field Survey Manual and then a preliminary preparation of data and software and of unverified maps for the North selected study area of interest (AoI) in Somaliland produced by interpretation of satellite images
2. Stage two: refers to the proper field survey including verification of preliminary Landform and Land Cover mapping, field data collection of soils and land uses. This was jointly conducted by SWALIM team and experts belonging to relevant Ministries of Somaliland
3. Stage three: refers to consolidation of the unverified maps of landform and land cover using field verified data to finalize terrain analysis and improve the land cover maps. The landuse maps were developed on the basis of landcover together with field verification. Considering the landform as the basis, the soil maps were prepared through field verification and lab analysis of the soils. The process also included the description, interpretation and classification of soil profiles.

Details of general methodology followed during the three stages of the land resource survey:

The materials and methods utilized for landforms and land cover of selected study area in Somaliland include three integrated methodologies: (1) Digital Terrain Analysis (DTA), (2) Visual Image Interpretation (VImI), (3), and Field Survey.

Stage 1:

1.1 Pre-Field Survey

Ia. Data collection for landforms of selected study area:

- ***Analysis of the objectives:*** the aim of production of the new datasets on the physical environment of the study area was part of a Natural Resource Inventory and to contribute layers for a land evaluation exercise.
- ***Literature review***
- ***Ancillary data and image collection***: existing previous datasets about landforms of Somalia include [FAO SOTER (Global and national soils and terrain digital database, 1995, at scale of 1:1000 000), and FAO Africover (1:350 000)].

  Remote sensing data acquisition: The main datasets used for the visual image interpretation are satellite images of Landsat7 ETM, Aster, Ikonos and QuickBird, existing maps (topographic maps 1:100 000 of 1970s; semi-detailed geological maps of 1:200 000 and1:250 000 scale; one at national scale 1:1 500 000); datasets on landform from SOTER (scale 1: 1000 000); Africover (1:300 000) and grey literature.
- ***Software***: obtained three software packages for DTA analysis, apart from ArcGIS, all freely available through the internet: (a) LandSerf for landform classification, (b) TAS, Terrain Analysis Software, for landform classification, and (C) TPI, Topographic Position Index, for landform and slope position index.
- Shuttle Radar Topography Mission Digital Elevation Model (SRTM-DEM

Ib. Data collections for land cover study of the selected area:

1. Literature review (land cover)
   - Ancillary data for land cover (topographic maps, Africover land cover map, LCCS classification system),
2. Remote sensing data acquisition for land cover: Landsat 7 enhanced Thematic Mapper 2000-2001-2002; Landsat 5 Thematic Mapper 1985- 1986; MSS 1972-1873 -1976; IKONOS (5x5 and 7x7 km) 2001 – 2003; Aster VNIR and SVNIR – 2005
3. Software used for Digital Terrain Analysis:

- Digital Elevation Model (DTM)
- ESRI GIS package and Geovis (Terranova);
- Imagework (PCI);

4. FAO Land Cover Classification System (LCCS)

Ic. Data collections for Soil survey of the selected study area:

- Literature review: reports (SOGREAH soil report without maps), internet, grey literature, scientific articles, etc.
- Remote sensing application: used integrated Landform maps at 1:100 00 and 1:50 000 scales produced with visual interpretation of the Digital Terrain Analysis of the satellite imagery
- Software: Soil-Land Inference Model (SoLIM 4.0)

Id. Data collections for land use study of the selected area:

1. Literature review: bibliography, internet, grey literature, reports outlining the different land use classes in the area
2. Used the preliminary land cover map produced by FAO-SWALIM (Land Cover of Selected Study Areas in Somaliland and Southern Somalia Project No: L-03, February, 2006)
3. Software: Arc View 3.2

II. Model study: Setting up the methodology; First explorative analysis of the morphology and geology (bibliography); analysis of land cover; Creation of the legend scheme

III. Legend formulation and verification:

Data analysis of landforms included Satellite images, DEM derived products (slope, hillshade, etc.), Topographic maps and existing maps, Geological maps, and 3D draping models; and map legend.

Data analysis of land cover comprised image processing, adding panchromatic, stretching, and filtering, and use of NDVI and Thermal Capacity Index and finally setting up the preliminary legend FAO Land Cover Classification System (LCCS)

Other activities included detailed literature analysis; Software development; Trial and implementation

Field survey preparation: included unverified maps production; Setting the methodology and materials and Setting the field work methodology and materials

Stage 2: Field Survey

The materials prepared for the field survey included:

- Preliminary maps with legends (geology, landform) ,land cover map with legend and selected sites for field investigation, printed in color on A0 format paper;
- Field forms complimented with data collected through mobile phones for landform, land cover, soils, and land use;
- Laminated tables with legends for the codes adopted for the maps;
- Field tools
- Maps with selected Field Investigation sites for landform, land cover, land use and soils (for site and profile description and soil samples collection from representative sites using the produced landscape map through a transect sampling scheme (Map1)
- Glossaries and bibliography

Other activities included (1) Training of Somaliland National Experts (4 groups included geolGolists, ecolGolists, agriculturalists and soil scientists); (2) Reconnaissance field survey; (3) Starting of the Somaliland national expert Field survey

A complete land resources survey was performed on landforms, land cover, land use and soils of the selected study area by investigating 185 field sites.

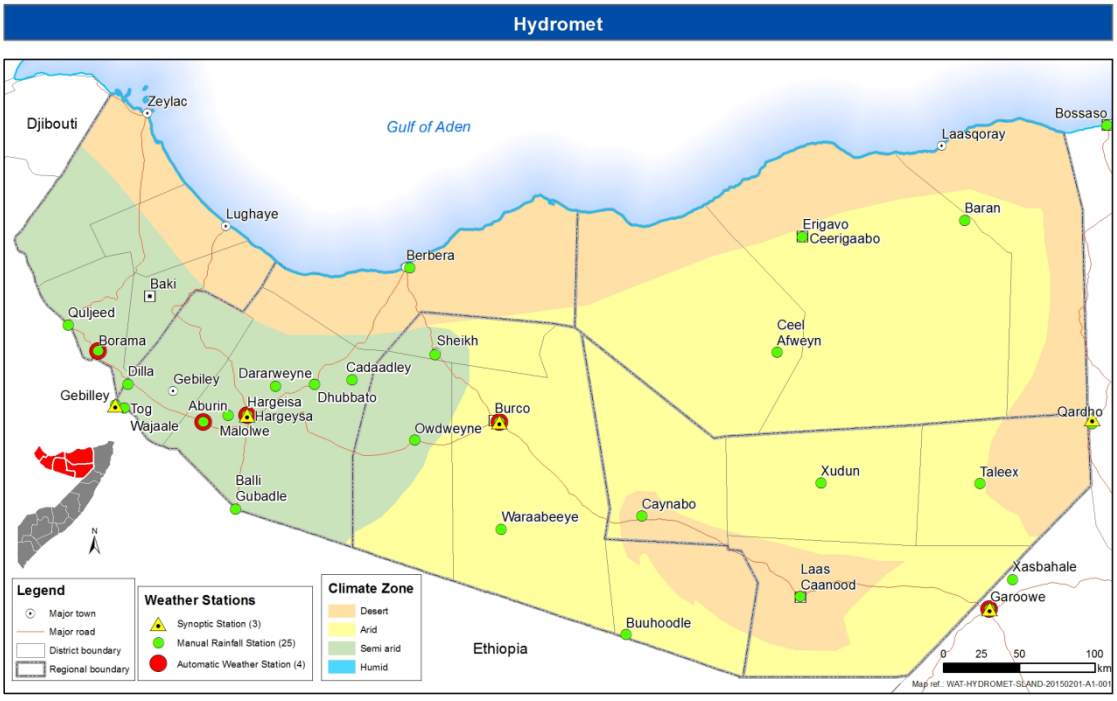
Stage 3: Field survey data input and analysis:

- Classification and input of the field data and pictures;
- Implementation of the Digital Terrain Analysis
- Validation of the landform data and land cover based on the field results;
- Defining the final land use classes
- Analysis of soil samples in the laboratory (Nairobi) and interpretation of the data and final classification using WRB 98 soil classification system and entry of soil profile data into database software SBDmPlus 2.1 for storing soil profile data.
- Finishing of the mapping procedures
- Final editing of the verified Landform Map, Land Cover Map, Land Use Map and Soils Map.
- Verified maps finalization
- Report writing

NB: Details of the Integrated Methodologies Used for the Studies of Land Resources of Somaliland are contained in the FAO- SWALIM Reports: No. _Field Survey Manual project Report No: L-01; Landform of Selected Areas in Somaliland and Southern Somalia Project Report NO: L-02, May 2007; Land Cover of Selected Study Areas in Somaliland and Southern Somalia Project No: L-03, February 2007; Land Characterization of a selected Study Area Project Report No: L-04, February 2007; and Soil Survey of a Selected Study Area Project No: L-05, February 2007.

3. Climate and Ground Water of Somaliland

This chapter is intended to cover the climate and water resources as critical input for the productive potential of the land. The climate section of this chapter covers both the precipitation and temperature, whereas the ground water is covered as separate section in this chapter. Both the climate and ground water of Somaliland have been extensively studied by SWALIM. The climate is studied through the establishment of an extensive weather monitoring network that includes both manual and automatic observations stations. A total of 32 weather observation stations are installed at strategic locations throughout Somaliland that include the pre-war stations to facilitate the use of the long series of historical data in weather analysis, for details read Map 1. The information present here highlights key climate factors that relate to land resources development. For a detailed analysis of Somaliland climate, see SWALIM Technical Report W-01.



Map 1: Type and Location of Weather Observation Stations in Somaliland

3.1. Climate of Somaliland

Somaliland has three major climate zones; desert, arid and semi arid. Generally, the climate is a result of the north and south movement of the Inter-Tropical Convergence Zone (ITCZ) that results in a bimodal rainfall pattern with two rain and two dry seasons.

Temperatures are generally high throughout the year, with an annual average maximum temperature of 36 to 38 °C in the coastal areas and becoming slightly lower inland. The highest temperatures are experienced in the months of June through September, becoming cooler in January and February when temperatures decrease substantially to as low as 15 °C. The temperature decrease with altitude is about 6.5°C per 1000m.

Potential Evaporation Transpiration (PET) varies between 1000 to 3000 mm/year with mean annual values for the region being greater than 2000 mm/year. PET exceeds rainfall across the region and is highest in dry seasons with values between 280 mm/month inland and 440 mm/month in the coastal areas. In the driest areas, e.g. Berbera, annual PET values exceed 3000mm/year.

Relative Humidity (RH) is relatively low reaching average values around 40% in the lower parts of Togdheer. Generally, RH is influenced by the permanent strong dry wind from the Arabian Peninsula, in particular the Kharif winds, which contain very low moisture content. RH is however higher in the coast areas where it reaches 70%.

3.1.1. Climatic Zones

Detailed analysis of Somaliland weather data reveals three main climatic zones across the regions. These include; (a) desert zone mainly along the coastal belt, (b) very arid zone in the central and western areas and (c) semi arid zone in the lower parts of Awdal and Waqooyi Galbeed (Figure 1). The three zones are further elaborated below:

- **Desert zone**: This zone receives less than 100 mm of annual rainfall and the rain seasons lasts for one month only. The coastal belt of Somaliland and a small portion in southern Sool region falls under this kind of climate. Major towns in this zone include Zeylac, Lughaye, Berbera, Lasqooray and Laas Caanood. Rainfall is unreliable while

daily average temperatures are above 30^0C. The desert zone is unsuitable for cropping and pastoralism is the common land use.

- **Arid zone**: This zone receives less than 400 mm of annual rainfall and the rain season lasts for a maximum of three months. Rainfall usually comes in heavy showers and a large proportion is lost through runoff. Although cropping is possible, irrigation is absolutely essential for success. High temperatures are experienced throughout the year. This zone covers the central and eastern parts of Somaliland and includes town such as Ceerigabo, Ceel Afweyne, Burco and Xudun.
- **Semi-arid zone**: This zone receives 400 to 600 mm of annual with the rainfall seasons slightly exceeding three months. Rainfed cropping is possible but irrigation is indispensable for reliable and good crop harvests. Some drought-resistant crops such as sorghum and millet may give reasonable yields without irrigation, but there is still a risk of unreliable rainfall and subsequent crop failure. The zone includes inland areas of Awdal and Waqooyi Galbeed regions in the western parts of Somaliland which plays a major role in production of most important food crops for the whole of Somaliland.

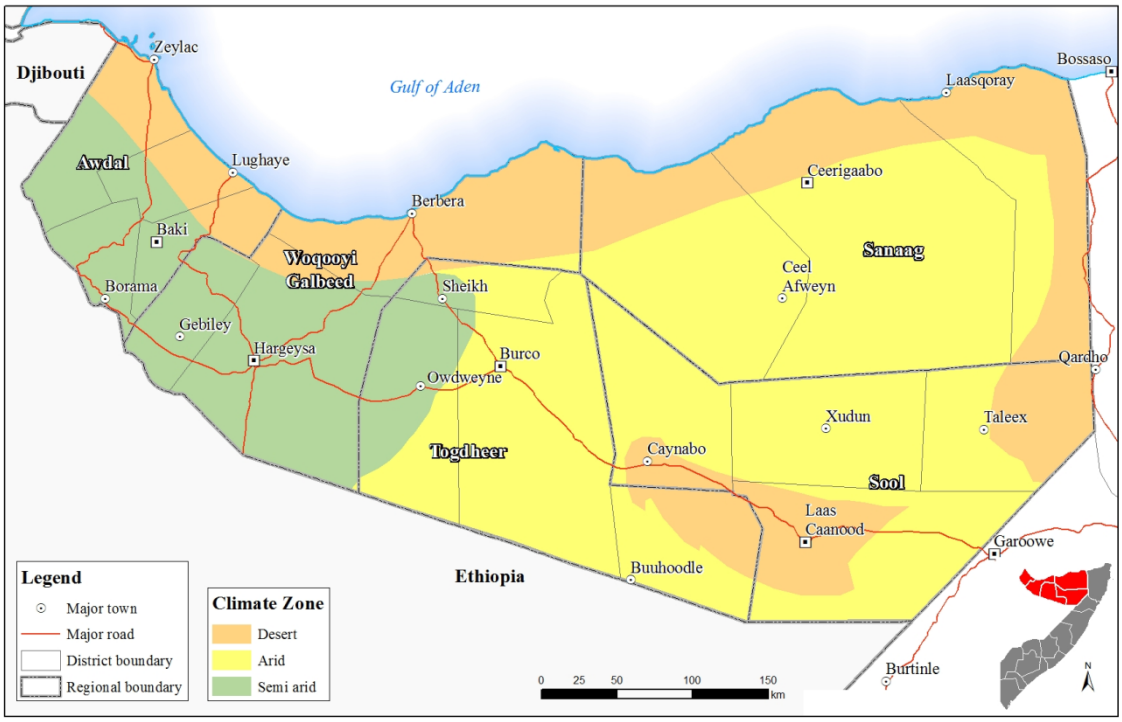


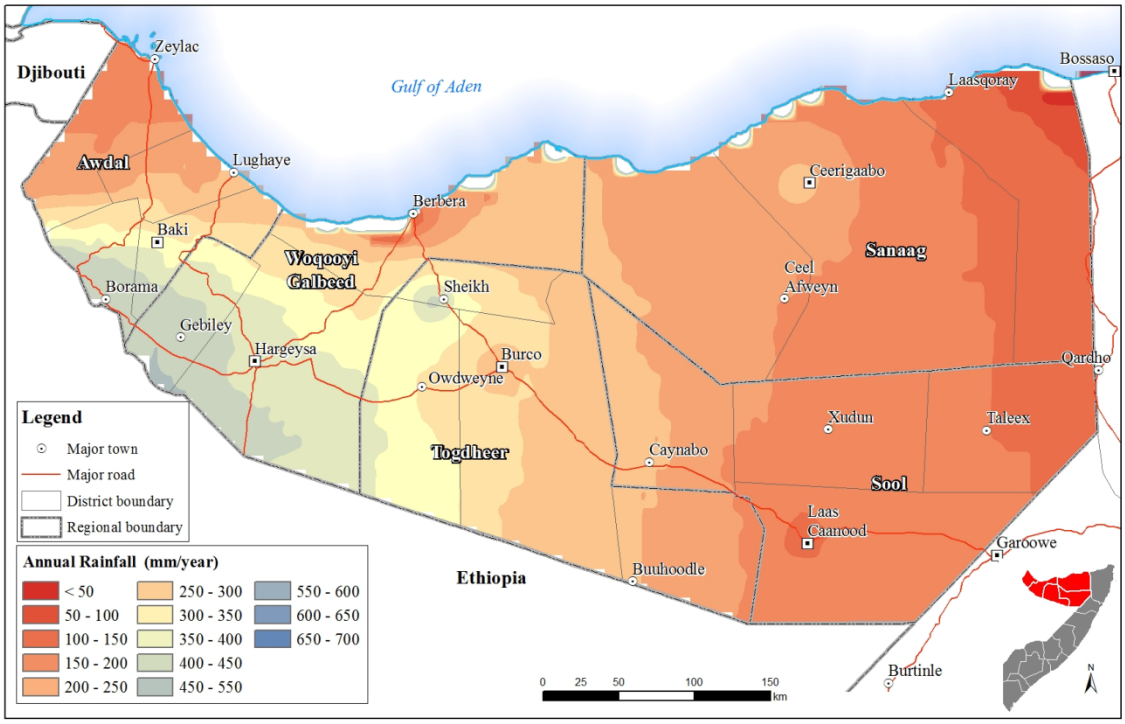
Figure 1 Somaliland climate zones

From this analysis, it is evident that Somaliland is predominately dry with 75% of the region being either Desert or Arid. Only a small portion of Somaliland to the South West is semi-arid. Somaliland is therefore prone to harsh weather conditions which present a major land resource development challenge.

3.1.2. Rainfall spatial and temporal distribution

This distribution is computed by interpolating the long term mean annual rainfall observed at the different rainfall monitoring stations. From Figure 2, a modest rainfall situation is evident across Somaliland. The lower parts of Awdal and Waqooyi Galbeed regions receive the best rainfall with values between 500 to 600 mm per year. The Central and Eastern parts of Somaliland including Togdheer, Sool and Sanaag regions come next with rainfall values of 100 to 400 mm per year. The rest of the country, particularly the coastal belt and a small pocket of the area south of Sool region are characterized by very low rainfall with values less than 100 mm per year. This modest rainfall is distributed across two rain seasons that are

interspaced by two dry seasons. The temporal distribution of the rainfall in Somaliland, like in any other dry environment, further limits and constrains the productivity of the land.



Map 2: Somaliland mean annual rainfall spatial distribution

The four seasons experienced in Somaliland are summarized below:

- ***Jiilaal*** **-** This is a dry season occurring from December to mid March. During this season the region experiences cool and dry air. January and February are actually the coolest months of the year in Somaliland. Relative humidity is relatively high with low wind speeds during this season.

- ***Gu*** **–** This is the long rainy season, lasting from late march to mid June and with relatively wet and hot conditions. During this season, there is plenty of water in most areas and is a breeding period for the livestock. Rainfall increases from west to east of the region with the coastal belt receiving minimal rains.

- ***Xagaa –*** This is a dry season occurring from late June to September. Though generally a dry season, there are areas that receive scattered showers including Baki, Borama, part of Oodweyne and Hargeisa. Other parts remain very windy and dry.
- ***Deyr –*** This is the short rainy season lasting form October to November. The rainfall received is less than that of the *Gu* rainy season.

3.1.3. Climate of the main landscapes of Somaliland

For the purpose of assessing land productivity, the climate of four major landscapes of Somaliland is presented in the following section. The climatic characteristics of the four landscapes are presented on Annex 1.

Coastal landscape:

The climatic characteristic of the coastal landscape is summarized on Figure 2 below.

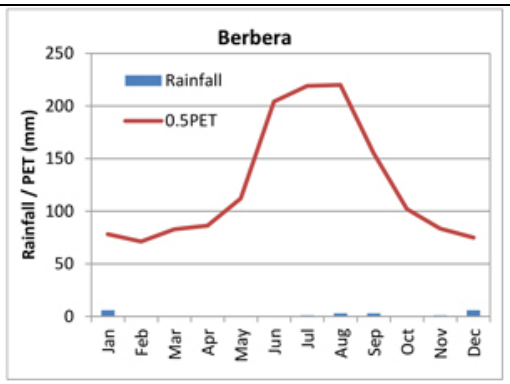
Climatic Characteristics		**Rainfall and Evapotranspiration**
Areas Covered	Berbera, Lughaya, Zeylac	
Climate zone	Desert (Hot dry)	
Rainfall Pattern	Unimodal	
Annual Rainfall Range (mm)	< 100	
Temperature (o C)	28 - 35	
Relative Humidity (%)	> 70	

Figure 2: Climatic characteristics of the coastal landscape

The Coastal Plain and Piedmont is a strip that runs parallel to the Northern boundary of Somaliland. This landscape includes the areas of Berbera, Lughaya and Zeylac. It has an altitude of less than 500 meters above sea level (masl). The area has a desert climate and is

extremely hot and dry with total annual rainfall below 100 mm and very high temperatures of between 28 and 35oC on average.

The Potential Evapotranspiration exceeds rainfall by more than 30 times and therefore greatly limiting land productivity except for desert vegetation. Rainfall is extremely low and occurs in trace amounts. This landscape does not provide opportunity for crop production. The climatic water demand s extremely high throughout the year but mostly so between June and September.

Mountains and Highlands (Moist) landscape

The climatic characteristics of the Mountains and Highland (Moist) landscape are summarized in Figure 4 and 5 below.

The Mountain and Highlight (Moist) landscape is South of the Coastal landscape and to the West. This landscape includes the areas around Borama. It has an altitude of between 1200 and 1900 MASL. The area has a relatively moist climate with moderate temperature (20 – 24 ^{o}C) and total annual rainfall of between 500 and 600 mm. This is one of the best production areas of Somaliland.

This landscape has a good rainfall distribution with the two rain seasons almost merging to provide a conducive production condition as compared to the rest of Somaliland. The Potential Evapotranspiration is almost equal to the rainfall and therefore good opportunity for production of crops, pasture and other vegetation. This landscape has the highest opportunity for crop production within Somaliland. The months between April and September provides the best period for crop production.

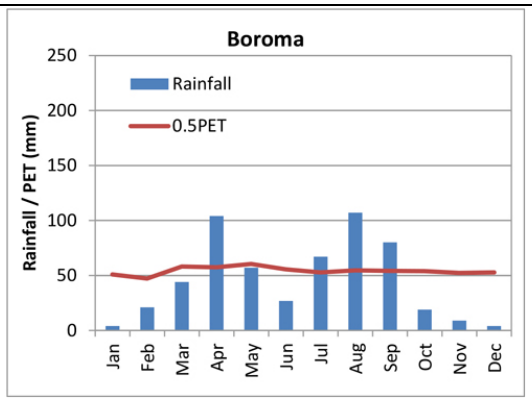
		Rainfall and Evapotranspiration
Areas Covered	Borama	
Climate zone	Semi-arid (Dry and Moist)	
Rainfall Pattern	Bimodal	
Annual Rainfall Range (mm)	500 – 600	
Temperature (^{0}C)	20 – 24	
Relative Humidity (RH)	< 50% (in rainy period > 80%)	

Figure 3: Climatic characteristics of the Mountain and Highlands (Moist)

Mountains and Highlands (Arid) landscape

The climatic characteristics of the Mountains and Highland (Arid) landscape are summarized in Figure 4 below.

The Mountain and High (Arid) landscape is South of the Coastal landscape and to the East. This landscape includes the areas around Sheikh and Ceerigaabo. It has an altitude of between 1200 and 1900 MASL. This landscape is similar to the moist Mountain and Highland landscape presented in Fig. 3 above but has a drier climate although the average temperature remains between 20 – 24 ^{0}C.

The landscape has two rain seasons with total annual rainfall of between 300 and 500 mm but the Potential Evapotranspiration is almost three times the rainfall and therefore limited

potential for crop production. The moderate rainfall however provides good opportunity for production of pasture and other vegetation. The months between May and October experience very high climate water demand and therefore more limited growing condition.

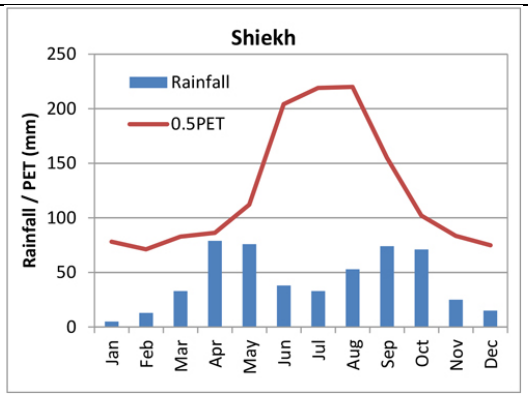
Climatic Characteristics		**Rainfall and Evapotranspiration**
Areas Covered	Sheikh, Ceerigaabo	
Climate zone	Semi-arid (Dry)	
Rainfall Pattern	Bimodal	
Annual Rainfall Range (mm)	300 - 500	
Temperature (o C)	20 - 24	
Relative Humidity (RH)	< 50% (in rainy period > 80%)	

Figure 4: Climatic characteristics of the Mountain and Highlands (Arid) landscape

Plateau (Semi-Arid) landscape

The climatic characteristics of the Plateau (Semi Arid) landscape are summarized in Figure 5 & 6 below.

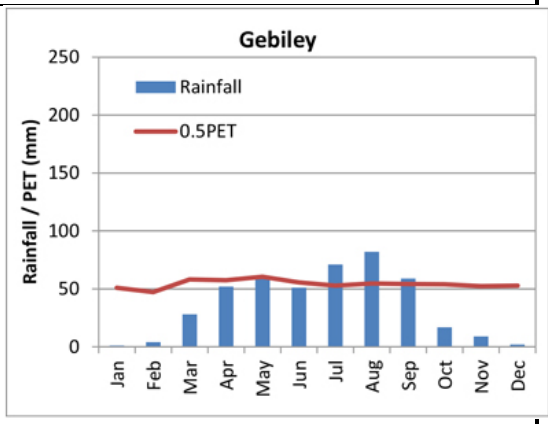
Climatic Characteristics		Rainfall and Evapotranspiration
Areas Covered	Wajaale, Gebiley, South of Hargeisa	
Climate zone	Semi-arid (Moist)	
Rainfall Pattern	Bimodal	
Annual Rainfall Range (mm)	500 - 600	
Temperature (o C)	20 - 24	
Relative Humidity	< 50% (in rainy periods > 80%)	

Figure 5: Climatic characteristics of Plateau (Semi-arid) landscape

The Plateau (Semi-arid) landscape is south of the Mountain and Highland (Moist) landscape and to the West by Valley landform. This landscape includes the areas around Wajaale, Gebiley and Hargeisa. It has an altitude of between 1200 and 1500 MASL. This landscape is similar to the Semi Arid Mountain and Highland landscape presented in Fig. 4 above but has a slightly drier climate although the average temperature remains between 20 – 24 ^{o}C. The landscape has a total annual rainfall of between 500 and 600 mm which is distributed across two rain seasons which almost join together to provide a conducive crop and vegetation growing condition. The landscape Potential Evapotranspiration is one and half times the

rainfall and therefore good potential for crop and vegetation growth. The landscape comes second to the Semi Arid Mountain landscape in terms of the land production potential.

Plateau (Arid) landscape

The climatic characteristics of the Plateau (Arid) landscape are presented in Figure 6 below. The Plateau (Arid) landscape is in the South of Somaliland and includes the areas around Burco, Oodweyne, Caynabo, Ceel-Afweyn, Dhahar and Badhan. It has an altitude of between 500 and 1200 MASL. This landscape is similar to the moist Plateau landscape presented in Figure 5 above but has a drier climate. The average temperature is around 27 ^{o}C.

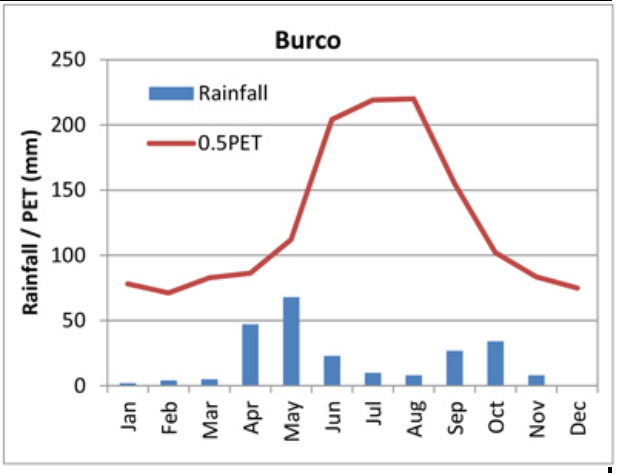
Climatic Characteristics		**Rainfall and Evapotranspiration**
Areas Covered	Burco, Oodweyne, Caynabo, Ceel-Afweyn, Dhahar, Badhan	
Climate zone	Arid	
Rainfall Pattern	Bimodal	
Annual Rainfall	200 - 300	
Temperature ^{0}C	27	
Relative Humidity (RH)	< 50% (in rainy periods > 80%)	

Figure 6: Climatic characteristics of Plateau (Arid) landscape

The landscape has a total annual rainfall of between only 200 and 300 mm which is distributed across two rain seasons. The landscape Potential Evapotranspiration is more than six times the rainfall and therefore very limited potential for crop and vegetation growth. The months between June and September experience very high climatic water demand. The potential for crop and vegetables can be substantially improved with small scale irrigation.

Valley landscape

The climatic characteristics of the Valley landscape are summarized on Figure 7 below.

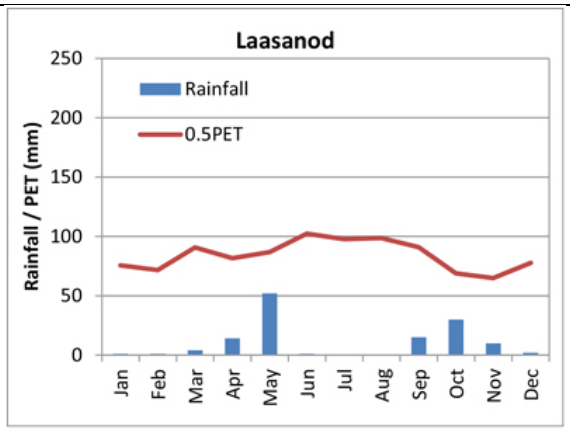
Climatic Characteristics		
Areas Covered	Laascaanood, Taleex, Xudun	
Climate zone	Desert (Hot dry)	
Rainfall Pattern	Bimodal	
Annual Rainfall Range (mm)	< 200	
Temperature (o C)	28 – 32 ^{0}C	
Relative Humidity (%)	< 50% (except in rainy periods RH > 80%)	

Figure 7: Climatic characteristics of Valley landscape.

The Valley landscape includes the areas around Laascaanood, Taleex and Xudun. It has an altitude of between 500 and 1000 MASL. This landscape has both Arid and Desert climate with average mean temperature of between 28 and 32 ^{0}C. The landscape receives less than 200 mm of annual rainfall which is spread across two rain seasons with a very distinct dry season between the two seasons. The landscape Potential Evapotranspiration is more than seven times the rainfall and therefore very limited potential for crop and vegetation growth within this landscape.

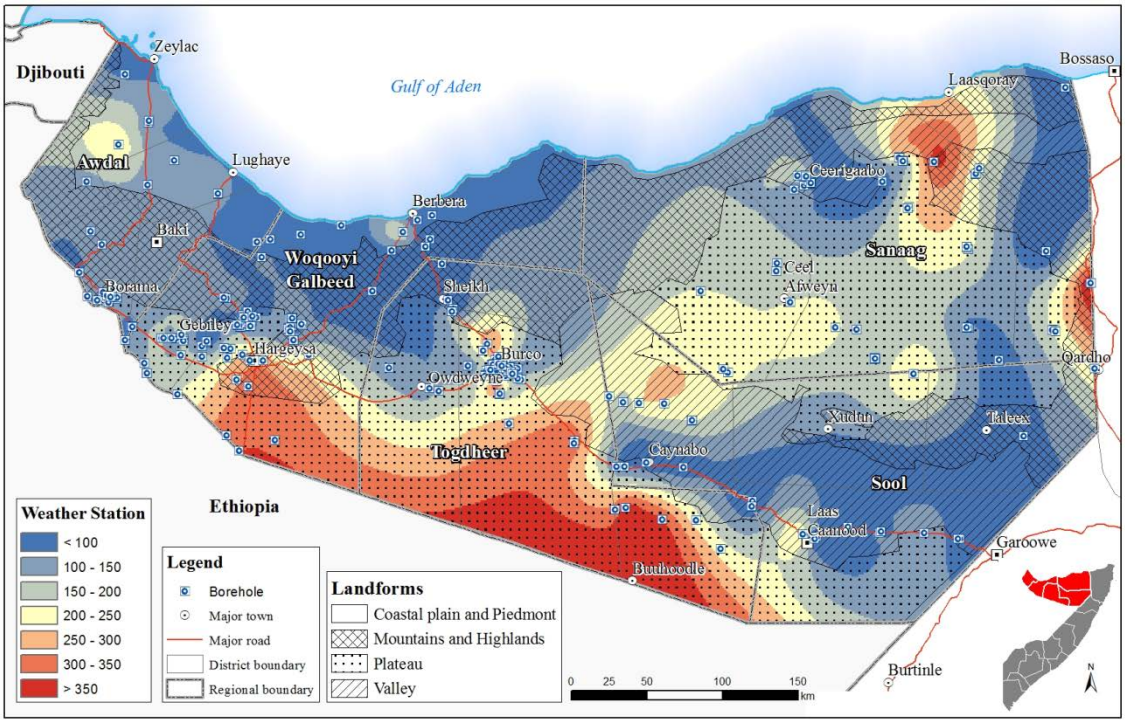
3.2. Groundwater Resources of Somaliland

Groundwater is the primary source of water supply in Somaliland, mainly from boreholes, springs and dug wells. Surface water resources in the region are limited to seasonal rivers (togga) and small water catchments which hold water only during rainy season. Potential groundwater aquifers occur extensively throughout Somaliland with varying characteristics regarding depths, yields and quality aspects. Recharge to the aquifers is limited by limited rainfall, high evaporation and short runoff events. A study by SWALIM (Hydrogeological Assessment of Somaliland and Puntland, 2012) classified areas with groundwater potential in Somaliland into two categories, considering the water quality and aquifer depth:

- Areas of shallow to moderate deep well and fair to good water quality located along the coastal belt, along streams in the mountainous areas and sloping escarpment of Somaliland.
- Areas of very deep wells with poor quality water along the plateaus and valleys in Togdheer and Sool regions.

Within the dry river beds there are often shallow perched aquifers of 2 – 20m depth found in the alluvial sediments and within the flood plains.

The depth of boreholes in Somaliland varies from less than 30m up to almost 400m, with yield from as low as 0.5l/s to over 17l/s. Very deep low yielding aquifers compounded by high salinity are the major challenges facing development of groundwater resources in Somaliland. Map 1 shows the spatial distribution and variation of borehole depths across the four major landforms in Somaliland.



Map 3: Borehole distribution and variation of depths in different landforms

Somaliland has a vast area of land under plateau. Accordingly, there are many boreholes established along the plateaus, with varying depths. According to the water sources database in SWALIM, the borehole depths along the plateau range from 37 – 370m. Majority of these boreholes are very deep, 61% over 150m deep. Only 14% of the 164 boreholes are less than 100m deep (Table 1). The water quality of majority of boreholes drilled in the plateau is poor, mainly due to elevated levels of salinity.

In the mountains and highlands areas of Somaliland boreholes are generally shallow compared to other landforms. There are 41 boreholes (52%) with depths less than 100m, and only 17% are more than 150m deep. Along the valleys 42% of boreholes are within 100m depth; 33% are between 100 – 149m deep while 26% are deeper than 150m. Water quality along the mountains is generally fair but gets poor in the valleys, again due to high salinity levels.

The area classified under coastal plain in Somaliland is small compared to the other three classes. Only 18 boreholes fall under this landform, out of which 8 (44%) are shallow with

depths less than 100m, and 17% deeper than 150m. Water coming out of the boreholes established along the coastal plain is of mixed quality.

	Coastal Plain & Pediment		**Mountains & Highlands**		**Plateau**		**Valley**	
Max depth (m)	240		394		370		291	
Min depth (m)	40		28		37		42	
Average depth (m)	105		111		162		119	
Total No. of Boreholes	**18**		**79**		**164**		**48**	
< 100m deep	8	44%	41	52%	23	14%	20	42%
100 - 149m deep	7	39%	25	32%	42	26%	16	33%
150 - 199m deep	2	11%	6	8%	73	45%	6	13%
>200m deep	1	6%	7	9%	26	16%	6	13%

Table 1: Summary of boreholes in Somaliland

High salt concentrations in the groundwater of many wells across the different landforms in Somaliland render them marginally suitable or unsuitable for humans and/or livestock. The groundwater quality is related to the chemical composition of geological formations through which the water has passed, as well as to the balance between recharge and discharge. Concentrations of chemical components vary widely depending on the location and type of water source. In general, very few groundwater sources in Somaliland conform to international standards as the salt content commonly exceeds 1 g/l, which under normal circumstances is the upper limit for human consumption. However, acceptance of water with relatively high ion concentrations is a necessity, as there is usually no alternative (Milanovic, 2012). Shallow aquifers contain less salt content, but are often bacteriologically contaminated.

3.3. Run-off and Surface Water Resources of Somaliland

The ground water at the moment is the only major water resource for irrigation in Somaliland, which by no mean is sufficient, and with increasing climatic shocks this is further endangered. On the other hand it is quite common that Somaliland receives huge volumes of runoff within

a very short period of time as a result of torrential rains. The generated run-off triggers massive erosion and also floods. In this situation the Somaliland authorities have contemplated to come up with ways of not only containing the run-off but to harvest this water for replenishing ground water resources as well as irrigation. The major challenge in this case is to quantify the generated runoff from various catchments, as this requires a systematic monitoring network for a longer period of time. SWALIM conducted a study in collaboration with Somaliland Ministry of Agriculture and Water Resources at Tog Waheen Basin to develop a methodology for estimating generated surface runoff. The study however could not provide sufficient information that can guide systematic water harvesting at the catchment level. The study concluded that much more data on rainfall and river flow need to be collected for sound analysis of the rainfall – runoff relationship in the basin, and development of methodology for estimation of surface runoff for a period of 10 – 15 years before analysis is done. The long term data collection ensures that rain and river flow data for almost all possible scenarios in terms of magnitude and intensity are captured making the results obtained a good representative of the basin under investigation.

5. Landforms and Soils of Somaliland

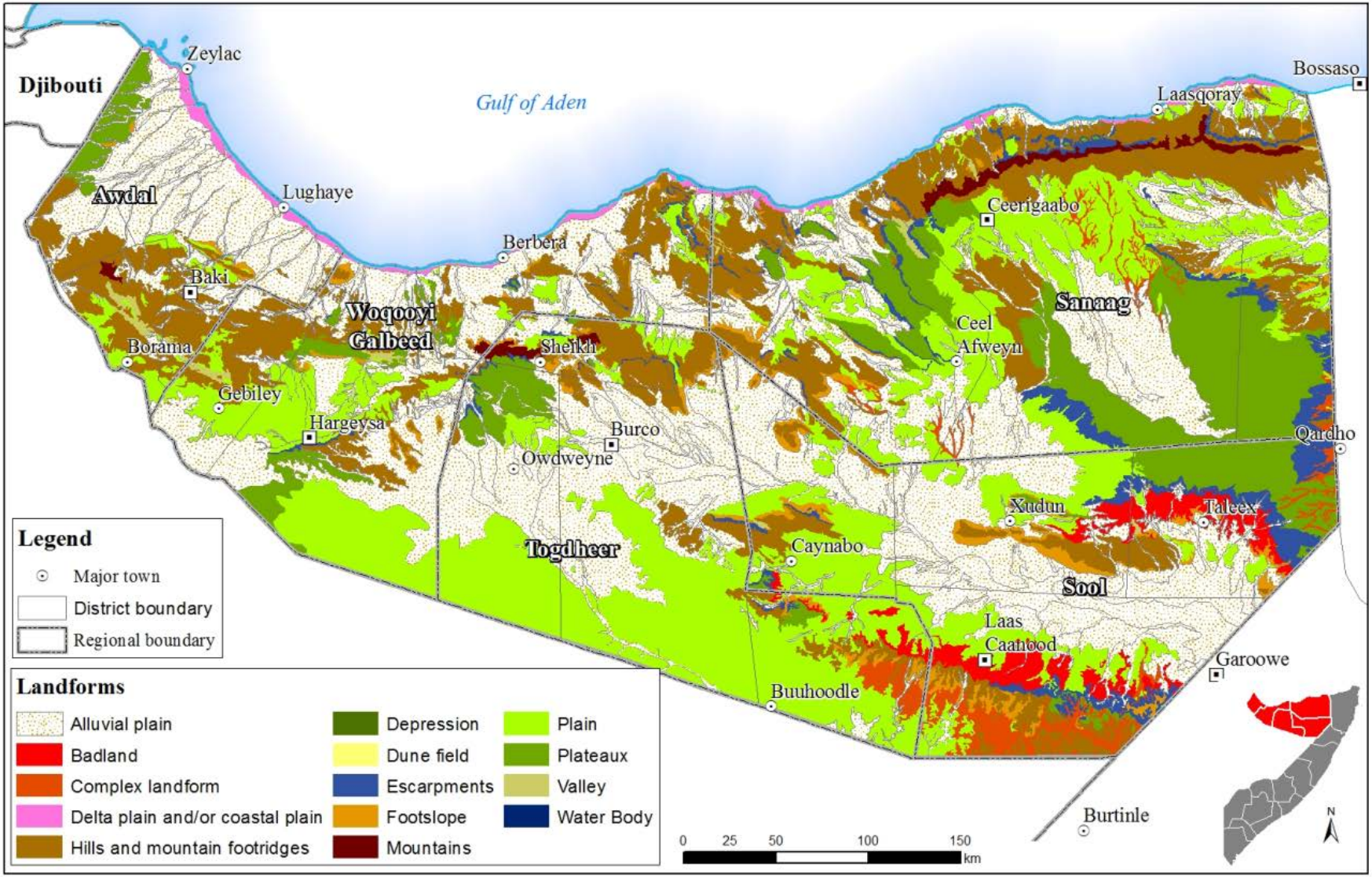
5.1. Landforms

The physical terrain, that substantially influences the productive potential of land, is explained in terms of hierarchical order of landscape, relief and landform. SWALIM has adopted landform to analyse the morphology of physical terrain mainly through two sources; a. Landform of selected study area (Northern Area of Interest) in Somaliland (FAO SWALIM Project Report L-02, 2007) and b. the Landform map of Somaliland. The report is produced while using integrated landform mapping approach at semi-detailed scale using Remote Sensing and GIS techniques. The different terrain classes are distinguished on the basis of topography, slope angles, size & shape, drainage pattern & density, surface geological conditions and colour, tone, pattern and texture. Various types of landscapes, reliefs and landforms were explained, coded and subsequently recorded in the survey process.

A legend system for the landforms of Somaliland is developed through the integrated use of satellite images, topographic and other thematic maps, DEM and their derived products, and 3D visualization. Beside precise, this legend is also suitable for soil mapping and identification of the hazards such as erosion and flooding. To prevent erroneous entering of codes of landscape/relief/lithology/landform and increases reliability and quality of entered data, a GIS based system using ESRI and ArcGIS was developed and used. A full list of the Landforms together with their explanation and conceptual background is provided. These efforts led to the formulation of 14 landform types together with its coding, extent and description with a limited reflection on its relation with the productive potential of the land resource associated with the respective landform type.

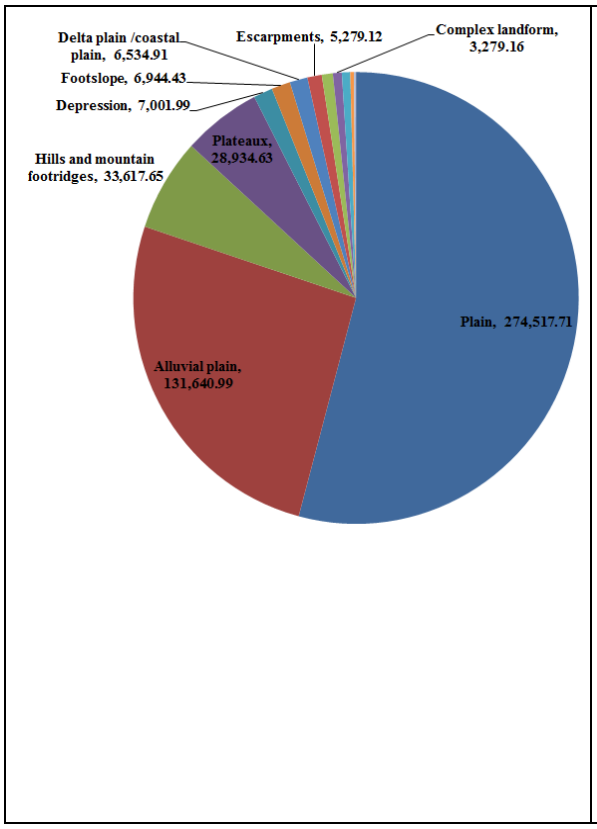
Lithologicaly, Somaliland is characterised by the presence of igneous, sedimentary and metamorphic rocks. Morphologically Somaliland is characterised predominantly by a flat coastal plain in the north, that joins extended alluvial plain and culminates into steeper mountains. The hills and mountains occupy most of the central and north-eastern Somaliland. These mountains run SW-NE alignment. South of the mountains and hills is the plateau and extended plain, however with spread over escarpments and bad-land in the southeast.

According to the slope pattern the morphology can be grouped in four sectors: a. coastal sector with modest slope towards the south; b. mountain-hill sector with slope frequently higher than 50% and occupy a considerable (over 6%) area of Somaliland; c. an expanded alluvial plain runs north-west to central-east with low slope (below 16%), occupying an area around 26%; d. the plain forms the central eastern part, however predominantly forms the southern part and covers around 50% of Somaliland, this is almost flat with slope seldom above 4%.



Map 4: Landform Map of Somaliland

The prevalence of various landforms in relation to the overall area of Somaliland is given in figure 8 as follows:



Landform Type	Area (Km^2)	% area	
Plain	274,517	54.15	
Alluvial plain	131,640	25.97	
Hills/mountain footridge	33,617	6.63	
Plateaux	28,934	5.71	
Depression	7,001	1.38	
Footslope	6,944	1.37	
Delta/coastal plain	6,534	1.29	
Escarpments	5,279	1.04	
Dune field	4,053	0.80	
Complex landform	3,279	0.65	
Badland	3,082	0.61	
Mountains	1,328	0.26	
Valley	663	0.13	
Water Body	102	0.02	

Figure 8: Landform distribution in Somaliland

The constraints and potential of these landforms greatly varies as well as their potential in relation to soil formation, moisture retention and response to biological, climatic, demographic, etc. pressures. Certainly the use options and management requirements greatly varies with the varying landscape. This needs a detailed description; however this shall be catered for in this overall territorial diagnostic report.

Based on the similarity and the dominance, various landforms are merged together into four landforms as follows:

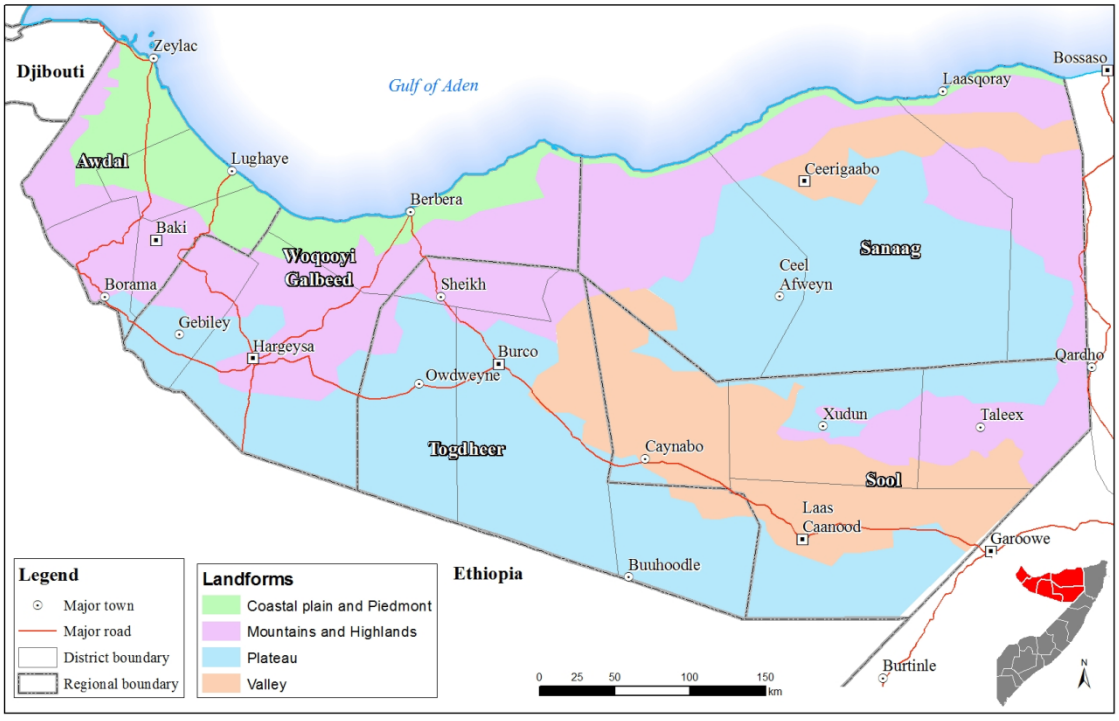
a. Coastal plain and Piedmont

b. Mountains and highlands

c. Plateaus

d. Valleys

These landforms are used in the analysis of all the land resources and the overall conclusion and recommendations of this report are devised, while taking these four landforms as the distinctive yardsticks for the land resources of Somaliland. The following map provides the delineation of these four classes of the landforms.



Map 5: The representative landforms of Somaliland

5.2. Soils of Somaliland

The first study on Soils of Somaliland was conducted by North-West Region Agriculture Development Project in 1983. This survey covered an area of 33500 Km^2 at a scale of 1:500,000, and established that the parent material of the soil belongs to metamorphic, Jurassic, cretaceous, volcanic, alluvial and calcareous formations. Based on these origins, together with type of deposit and degree of weathering the soils were classified into four orders (Aridisols, Entisols, Mollisols and Vertisols), rock-land form. In the period 1987-88 ISRIC carried out the soil inventory on 1:1 million scale soil map on the basis of information that existed at that time. The map and associated data were digitized by FAO in 1998 under

the Land and Water Digital Media Series 2. This map was later simplified by SWALIM for land evaluation and the demarcation of Agro-ecological zones (AEZ). The various soil groups are aggregated in seven classes based on physical limitations to crop production as well as in conformation to the World Reference Base for Soil Resource 2006. Most of Somaliland is characterized by an association of shallow and/or stony soils and somewhat deeper calcareous soils. A small area with deep, clayey soils is found south of Gebiley in south-western Somaliland.

Because of the peculiar geography of the area and prevailing aridity most of the soils of Somaliland are less developed with 45% soils were found to be rocky/stony with limited potential for agriculture. Soil fertility in general is low due to continuous depletion and almost no application of fertilizers.

5.2.1. Occurrence and location of the soils of Somaliland:

As described in the methodology section of this report the soils of Somaliland were assessed and mapped resulting in nine soil classes: **Vertisols, Calcisols, Fluvisols, Regosols, Cambisols, Arenosols, Gypsisols, Leptosols** and **Solonchak**. The prevalence of the nine classes of soils of Somaliland is depicted in the pie chart: on Figure 10.

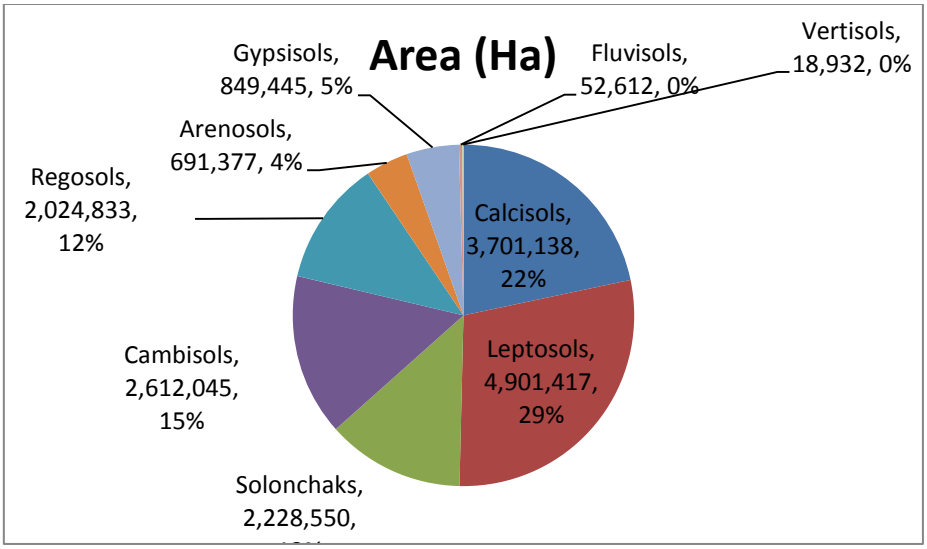
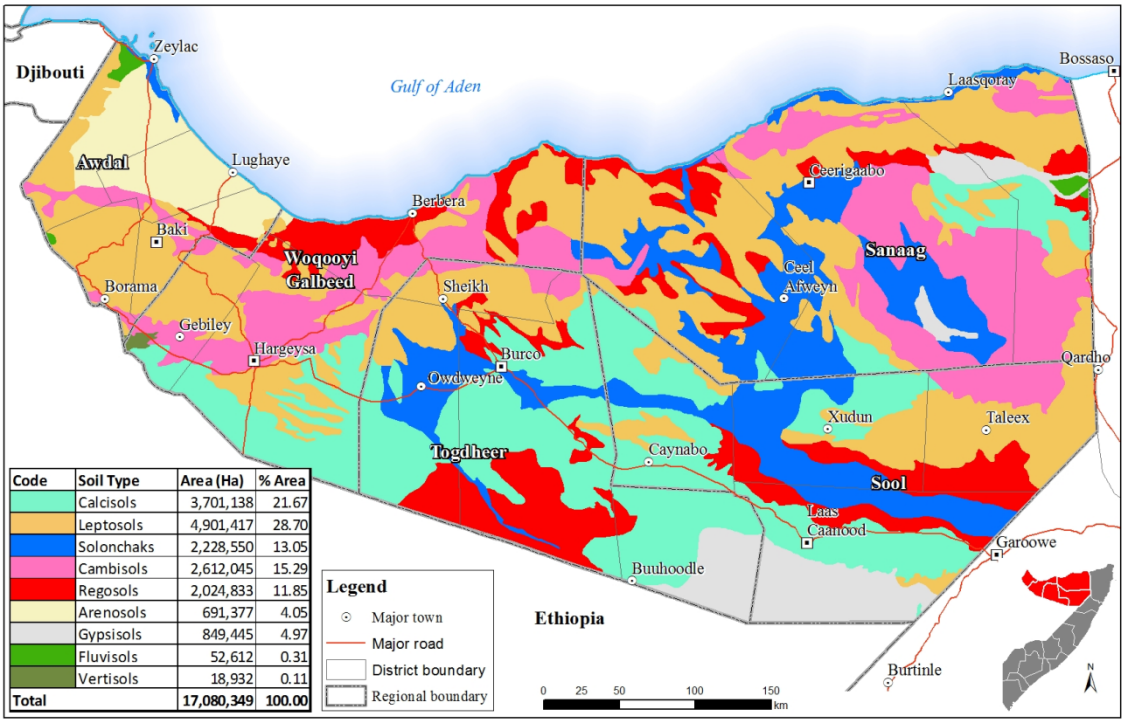


Figure 9: Distribution of Soil types

Five classes of soil namely Leptosols, Calcisols, Cambisols, Solonchak and Regosols dominantly prevail in Somaliland. The other four classes (Gypsisols, Arenosols, Fluvisols and Vertisols) also occupy considerable extent of area; the distribution of these soils is shown in the following map:



Code	Soil Type	Area (Ha)	% Area
	Calcisols	3,701,138	21.67
	Leptosols	4,901,417	28.70
	Solonchaks	2,228,550	13.05
	Cambisols	2,612,045	15.29
	Regosols	2,024,833	11.85
	Arenosols	691,377	4.05
	Gypsisols	849,445	4.97
	Fluvisols	52,612	0.31
	Vertisols	18,932	0.11
Total		17,080,349	100.00

Map 6: Soil map of Somaliland

5.2.2. The productive potential of the soils

The parameters that determine the productive potential of soil are mainly texture, structure, pH value, Electric Conductivity. The texture is the proportion of sand, clay and silt in the soils and this determines the moisture holding capacity of the soil. The fertility is referred mainly to nitrogen, phosphorus and potassium, as in Somaliland the micro-nutrients is not a big issue, even potassium value is appropriately found in most of the lands otherwise fit for agriculture. Given the vast array of the soil structure in Somaliland, generic description is made. Due to the higher pH value, the soils are predominantly alkaline and don't have the issue of micro-nutrients as well as potassium deficiency. The Electric Conductivity (EC), that determines the salinity of the soil, however doesn't pose a major challenge in Somaliland as

the EC value is within the desirable limits and the salinity is not a major issue. Table 2 briefly explains the soil physical and chemical properties as follows:

Table 2: Physical and chemical properties of the soils of Somaliland

Soils		DEPTH	SAND %	SILT %	CLAY %	TEXTURE	Bulk_density (g/cm)	C-%	N-%	P-ppm	pH (H2O	EC mS/cm	CECm-meq/100g	Ca++	Mg++	K+	Na+	PSB %	CaCO3 %
Vertisols	Average values	150	27	14.5	58	C	1.4	0.62	0.07	9.48	8.2	1.1	21.8	21.8	4.8	0.87	1.94	100	25.7
	Range values		6-64	4-38	12-80		1.16-1.55	0.01	0.02	2.1	7.81	0.14	7.28	5.02	0.3	0.1	0.2		14.85
								1.76	0.19	35.5	8.8	4	45.32	86.29	10.93	1.76	8.55		34.15
Calcisols	Average values	99	40.65	16	43.5	SCL	1.48	0.54	0.06	10.04	8.2	0.76	17.29	27.05	3.86	0.62	1.2	100	22.2
	Range values							0.18	0.02	2.2	7.87	0.15	8.68	9.61	0.47	0.16	0.45		6.65
								1.16	0.14	39.4	8.42	4	33.4	112.74	37	1.37	3.95		37.35
Fluvisols	Average values	14	54.3	27	18.5	SL	1.51	0.38	0.03	8.28	8.34.	1.68	12.87	15.87	1.66	0.36	1.83	100	12.25
	Range values	0-200	10	10-92	4-74	2-62	1.30-1.67	0.09	0	6	7.7	0.07	5.4	5.3	0.3	0.1	0.1		1
								0.85	0.11	14.2	9	10.6	23.86	28.1	7.85	0.67	7		30
Regosols	Average values	160	68.8	18	12.5	SL	1.65	0.46	0.05	9.71	8.26	0.69	15.11	13.59	1.23	0.3	0.47	100	7.58
	Range values						1.61-1.7	0.19	0.03	0.5	8.1	0.12	6.6	10.47	1.06	0.09	0.1		4.65
								0.64	0.12	15.3	8.76	2.3	32.58	17.7	1.47	0.3	1		11.15
Cambisols	Average values	70	50	26	24	SCL		0.39	0.04	7.4	8.1	1.3	29.9	23.4	5.2	0.2	2	100	10
	Range values						1.39	0.45	0.04	7.65	8.025	1.96	27.55	21.675	4.525	0.225	1.75	100	13.5
		140	36 - 52	20 - 38	24 - 34		1.39	0.38 - 0.57	0.03- 0.05	7.4 - 7.8	7.9 - 8.2	1.24 - 3	24 - 30.8	19.4 - 23.4	2.8 - 5.2	0.2 - 0.3	1 - 2	100	10 - 16
Arenosols	Average values		79.6	14.8	5.6	SL	1.6	0.12	0.002	9.02	9.32	0.22	1.28	10.72	0.4	0.26	0.48	100	4.2
	Range values							0.1	0	1.6	8.8	0.07	0.6	6.6	0.3		0		4
		120	92	28	8		1.6	0.12	0.002	34.6	10	0.4	2.7	12.9	0.7	0.5	1	100	5

5.2.3. Description of soil classes

Based on the chemical and physical analysis of the soils classes, the soils of Somaliland are described as follows:

Leptosols: This is the dominant class of the soils of Somaliland covering around 29% of area (49014 Km2) and are commonly found on the mountains (Golis and Karkaar) and also in the plateaus and dissected plateaus. From the surface to the depth, these soils are made up of stony and rocky formations without soil development. These soils are very shallow over continuous rocks; on the other hand these are also extremely gravelly or stony. These characteristics make these soils of limited suitability for agriculture.

Landuse significance: This soil type has limited potential for any specific intensive use such as agriculture or agroforestry. Nevertheless the soil type has some potential for wet season grazing and as forest land. The vegetation cover consists of general open shrubs, open trees with shrubs and open herbaceous with shrubs. Due to Excessive internal drainage and shallowness that can cause drought, the soils mainly need conservation and therefore natural vegetation cover should be maintained.

Calcisols covers around 22% of area (37011 km2) and commonly occurs in the dissected plateaus and some piedmonts. They are developed in calcareous parent material. The lower parts of the landscape is mostly alluvial and colluvial consisting of base-rich weathered deposits consisting mainly of highly calcareous sands and gravel of colluvial and alluvial soil deposits. The majority of the Calcisols have a clayey texture which slightly changes with soil depth. These soils are strongly calcareous, moderately to strongly alkaline, not saline, have adequate to high cation exchangeable capacity, high to adequately or rarely excessive content of phosphorus and deficient in organic matter and total nitrogen.

Landuse significance: Although low in surface organic matter, have good amount of soil nutrients and also good in water holding capacity. Most of these soils are under shrubs, grasses, herbs and sparse trees and used as grazing lands. These soils are good for rainfed agriculture with sorghum and maize where farming is not hindered by surface stoniness, shallow petro-calcic horizon or aridity.

Cambisols cover around 15% of area (26120 Km^2) of Somaliland and occur from flat to gently sloping surfaces of alluvial deposits. The soil texture is within the loamy classes. These soils are moderately alkaline in soil reaction, non saline to moderately saline, high to moderate cation exchangeable capacity and high base saturation and strongly calcareous. They are deficient in nutrients, specially nitrogen and phosphorus.

Landuse significance: These soils are medium to deficient in fertility especially nitrogen and phosphorus with high degree of erosion in mountain areas, these soils are commonly used for grazing and wood harvesting. In the presence of water sources small irrigated fields of fruit trees and herbaceous crops (pulses and vegetables) are practiced. The soils require soil and water conservation measures to be in place.

Solonchaks found in 13% of Somaliland (22285 Km^2) are soils with high concentration of soluble salts at certain times of the year. They are located in playas (a desert basin with no outlet which periodically fills with water to form a temporary lake).

Landuse significance: These soils support mostly scattered vegetation (halophytic plants), allowing very marginal levels of grazing activity. Soil and water conservation activities are required, along with controlled grazing and avoiding clearing the land for agriculture.

Regosols occurs in around 12% of Somaliland (20248 Km^2) and comprise all the soils that cannot be referred to any other reference soil group. These soils occur in the arid and semiarid environments in variable relief types in the landscape. These soils are shallow and have a uniform sandy loam texture, strongly to moderately alkaline reaction, are not saline, have high cation exchange capacity, high base saturation, are strongly calcareous and deficient in phosphorous and nitrogen.

Landuse significance: Poor in fertility, these are delicate soils with low moisture holding capacity and susceptible to severe erosion that make these soils of minimal significance for agriculture. These soils are used extensively for communal grazing and wood collection.

Gypsisols occupies around 5% of the area of Somaliland (8,494 Km^2) Gypsisols are developed in mostly unconsolidated alluvial, colluvial and aeolian deposits of base rich

material. In Somaliland, Gypsisols are found in Gebi/Dharoor Valley south the Golis mountain and east of Badhan town. These soils are formed in an arid zone, where Evapotranspiration exceeds the rainfall and the soils have secondary accumulation of gypsum forms on gypsiferous parent material. The soil texture has high silt content which result in surface crusting that dramatically reduces the infiltration rate and consequently have low water holding–capacity. Also the surface has stoniness and uneven subsidence of the land surface and widened cracks and holes due to dissolution of gypsum in percolating water into the sub-surface, the components of calcium sulphate enter solution in the parent material and are transported upward in solution.

Landuse significance: These soils have low availability of major plant nutrients such as nitrogen, phosphorous, potassium and magnesium. The natural vegetation is sparse and dominated by ephemeral grass and/or trees and xerophytic shrubs. In Somaliland these soils are used only for extensive grazing.

Arenosols occurs in 4% of Somaliland (6914 Km^2) are soils in the coastal plains that consist of deposits with finer material of loamy sand texture of recent alluvial deposits. These are highly permeable and have low water storage capacity. They are strongly alkaline in reaction and are not saline. These soils are deficient in soil nutrients, particularly organic matter, nitrogen and phosphorus.

Land use significance: The vegetation cover on these soils varies from bare soil with scattered vegetation (open herbaceous and closed strips of Prosopis species along the streams). The soils are not favouring cultivation of crops and transhumance grazing and sedentary pastoralism prevails where most common grazing animals are goats and camels.

Fluvisols occurs in 0.3% of Somaliland (526 Km^2) and are young soils developed on parent material of recent alluvial plains, river fans and tidal marshes which are periodically flooded by seasonal rivers within Golis and Karkaar Mountains or Al Mountains, highlands and dissected plateaus. Topography is flat to gently undulating surface.

The major physical and chemical factors limiting crop production usually relate to soil texture, alkalinity, and high levels of salinity. The majorities of these soils have good water

drainage and water holding capacities, and are periodically flooded. The soil texture is sandy loam. The pH ranges from moderately alkaline to strongly alkaline, varying with depth or spatially. All Fluvisols are deficient in organic matter and nitrogen and phosphorus is low.

Landuse significance: with the application of fertilizers, the soils are usually suitable for all uses. These soils are commonly used for irrigated crops or grazing and woodcutting for fuel wood in the absence of irrigation.

Vertisols occurring in 0.1% of Somaliland (189 Km^2) are churning, deep heavy clay soils with high proportion of alternately swelling and shrinking clays during wet and dry seasons respectively. In these soils, clay content increases with depth. In dry season the soils develop grumic and granular structure in the upper horizon, deep vertical cracks. In the subsoil there are prismatic, angular and sub-angular structures. The Vertisols have relatively high water storage due to the high clay content. The stored water is very important for the survival of crops and plants during the cropping season.

The chemical factors limiting crop production are usually related to the increase of soluble salts in the soil, these soils are moderately alkaline in reaction and moderately base saturated. Salinity is uniformly low throughout the soil profile. The levels of exchangeable sodium are generally very low. The organic matter and total nitrogen in the topsoil are lower than deficient. Therefore nitrogen fertilizer or manure will be necessary to maintain or increase crop yields under present farming systems. Phosphorus content is often low, so application of phosphorus fertilizer is required and is likely to improve crop production in intensive cultivation systems.

Landuse significance: These are considered productive soils where most agricultural land of Somaliland is found. Good results require water harvesting and soil conservation that increases moisture retention in the sloping areas, therefore good potential production exists under specific soil management practices. Small scale agriculture with sorghum, maize, millet, cowpeas and oat is practiced after rainy season. The area is also used for extensive grazing and wood collection.

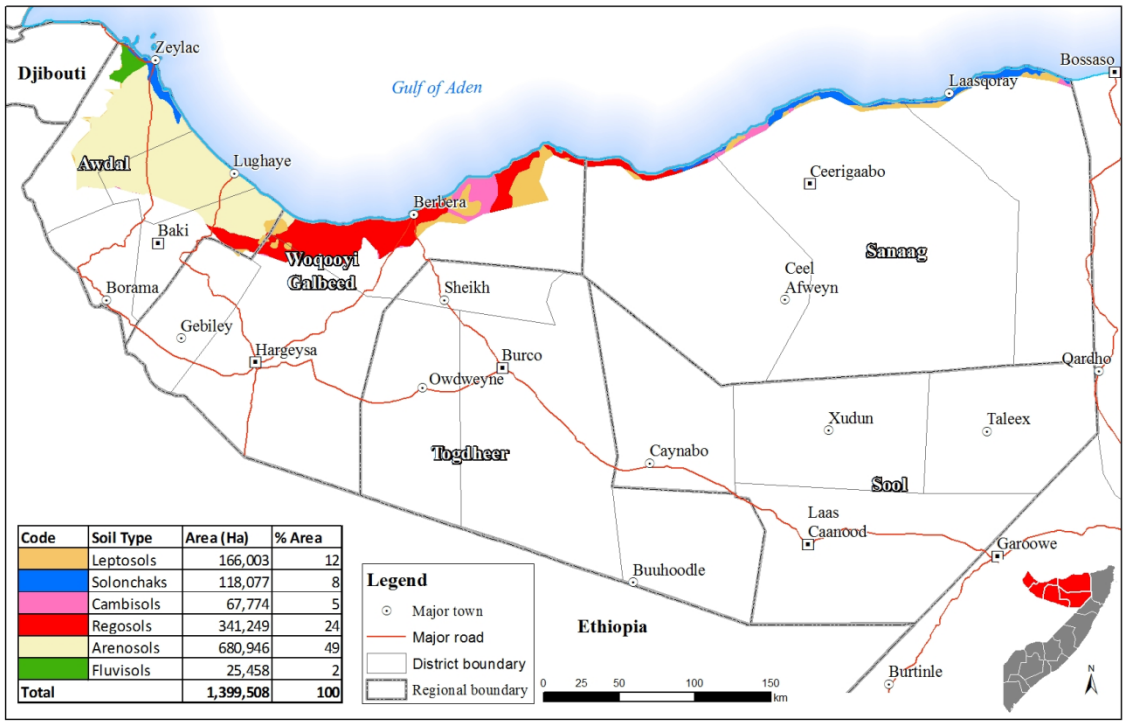
5.2.4. Soils by Land forms of Somaliland

As part of the generic plan for developing this report, the soils are further elaborated with respect to four landforms as follows:

1. Soils of the coastal plain
2. Soil of the mountains and highlands
3. Soils of plateaus
4. Soils of valleys

Soils of the coastal plain

The landform of the coastal plain stretching from the border of Puntland in the east to the border of Djibouti in the west presents six soil types elaborated as follows:



Code	Soil Type	Area (Ha)	% Area
	Leptosols	166,003	12
	Solonchaks	118,077	8
	Cambisols	67,774	5
	Regosols	341,249	24
	Arenosols	680,946	49
	Fluvisols	25,458	2
Total		1,399,508	100

Map 7: Soils of the Coastal Plains

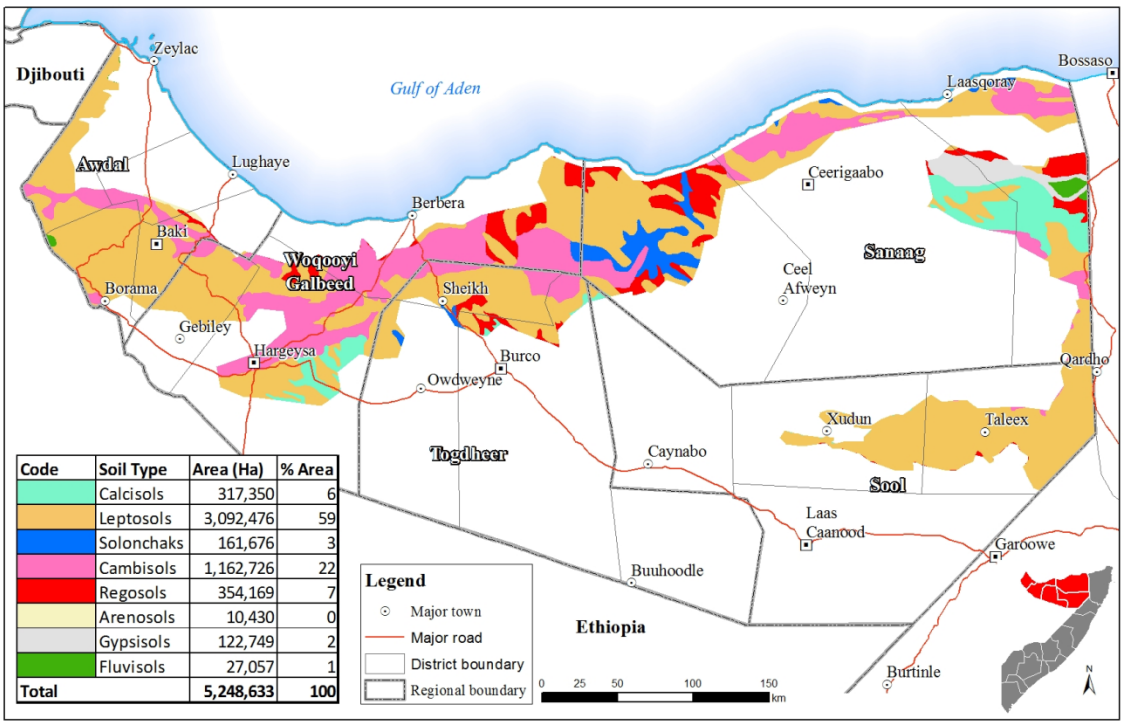
The soils of the coastal plain are predominantly Arenosols (49%), followed by Regosols (24%) and Leptosols (12%). All these major soils of the coastal belt are not promising for

agriculture or other intensive uses due to their chemical and physical properties. The aridity together with the parent material makes these soils deficient in soil nutrients, particularly organic matter, nitrogen and phosphorus. The solonchak (8%) are saline in nature with herbaceous vegetation and are not fit for intensive use. The only promising soils are Fluvisols (2%) and Cambisols (5%) where agriculture can be practiced if other inputs are available. These soils, that make a total of 103,271 hectares in the coastal belt, need water and soil conservation to enable them to be used for extensive grazing and forestry.

Soils of the mountains and highlands

The landform has eight soil types dominated by Leptosols and Cambisols. 58.9% of the landform is under Leptosols soils, which are very shallow soils, highly stony and poor in fertility. These characteristics make these soils of limited suitability for agriculture. The vegetation cover is also variable, consisting of general open shrubs and trees with shrubs and general open herbaceous with shrubs. The soils are not suitable for any specific intensive use and demands soil and water conservation before applying alternative management regimes. 6.7% of the landform is under Regosols soils with fragile land surface, low moisture holding capacity and poor fertility. The soils have minimal agriculture significance. They are used as extensive communal grazing lands and for wood collection and demands adequate water and soil conservation measures to ensure sustainable land management.

22% of the landform comprises Cambisols soils that occur in slopes, denudation surfaces and some alluvial plains. These soils, with medium fertility and loamy textures, offer favourable conditions for grazing and wood harvesting, and also for small scale irrigated agriculture for fruit trees and herbaceous crops (pulses and vegetables). They occurs on severe eroding lands in the mountain areas thus needs to be very carefully handled, with conservation practices and controlled utilization of forest products. 6% of the landform comprise of Calcisols which are well drained with good water holding capacity and reasonable amount of soil nutrients. Most of these soils are under shrubs, grasses, herbs and sparse trees and used as grazing lands. The Soils are good for agriculture use due to their physical properties. These soils are also used for rain-fed agriculture with sorghum and maize where farming is not hindered by surface stoniness or a shallow petro-calcic horizon or aridity.



Code	Soil Type	Area (Ha)	% Area
	Calcisols	317,350	6
	Leptosols	3,092,476	59
	Solonchaks	161,676	3
	Cambisols	1,162,726	22
	Regosols	354,169	7
	Arenosols	10,430	0
	Gypsisols	122,749	2
	Fluvisols	27,057	1
Total		5,248,633	100

Map 8: Soils of Mountains and Highlands

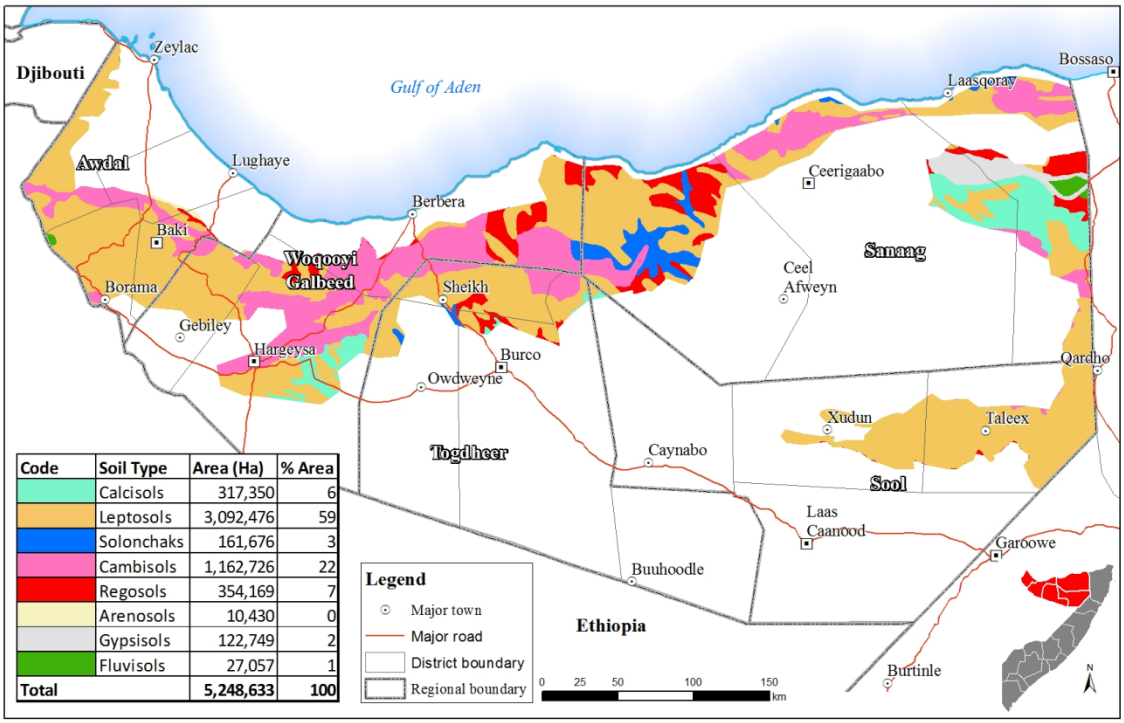
Soils of the Plateaus

31.5% of landform contains Calcisols which are well drained with good water holding capacity. Due to insufficient rainfall or moist conditions the soils support small scale irrigated agriculture only. These soils are mainly used for grazing and wood harvesting.

18% of the landform comprises Cambisols which have medium fertility and loamy textures. These soils provide reasonable conditions for grazing and wood harvesting, and also for irrigated agriculture for fruit trees and other crops. They occur on severely eroded lands in the plateau areas thus needs to be very carefully handled, with conservation practices and controlled utilization of forest products.

A very small portion (0.3%) of the Plateaus is under Vertisols, deep soils which are good in water holding capacity and are located on flat or gentle slopes.

Beside the above three soil types, others comprise Solonchak, Regosols, Gypsisols and Leptosols which do not offer opportunity for intensive use including agriculture.



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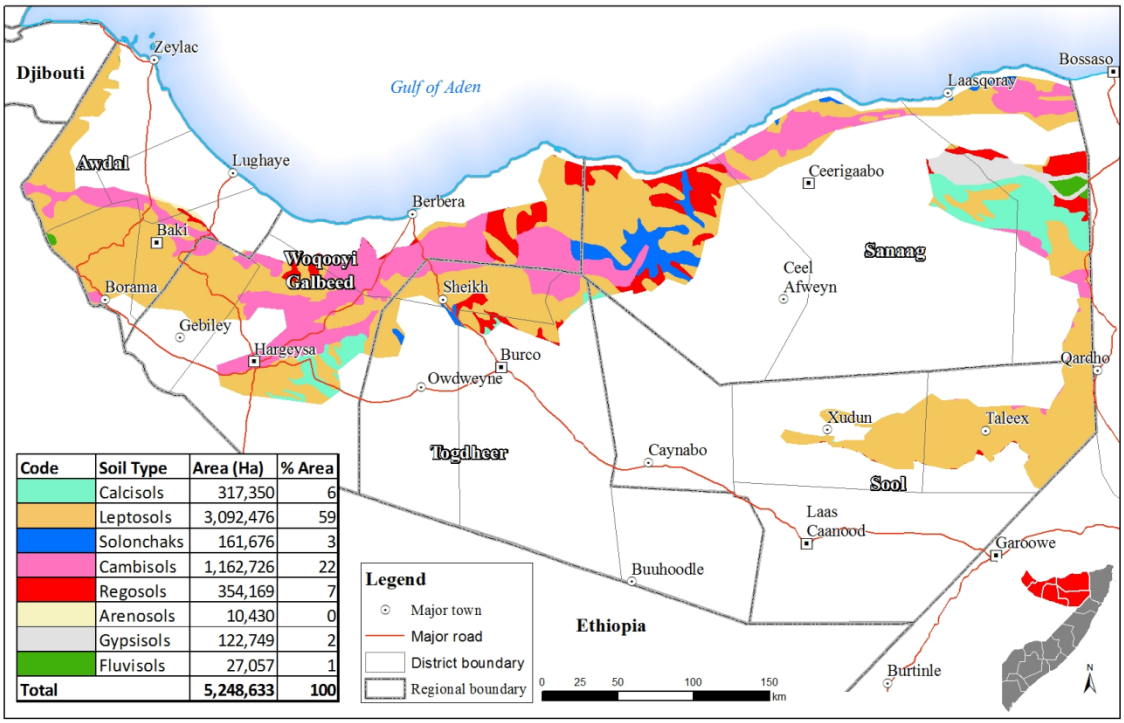
	Regosols	354,169	7
	Arenosols	10,430	0
	Gypsisols	122,749	2
	Fluvisols	27,057	1
Total		**5,248,633**	**100**

Map 9: Soils of Plateaus

Soils of the Valleys

Almost 35% of landform contains Calcisols which are well drained soils with good water holding capacity. Due to insufficient rainfall and moist conditions these soils can support small scale irrigated agriculture only. These soils are mainly used for grazing and wood harvesting.

All the other soil types, beside the above, don't offer favourable conditions for intensive use including agriculture.



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	Regosols	354,169	7
	Arenosols	10,430	0
	Gypsisols	122,749	2
	Fluvisols	27,057	1
Total		**5,248,633**	**100**

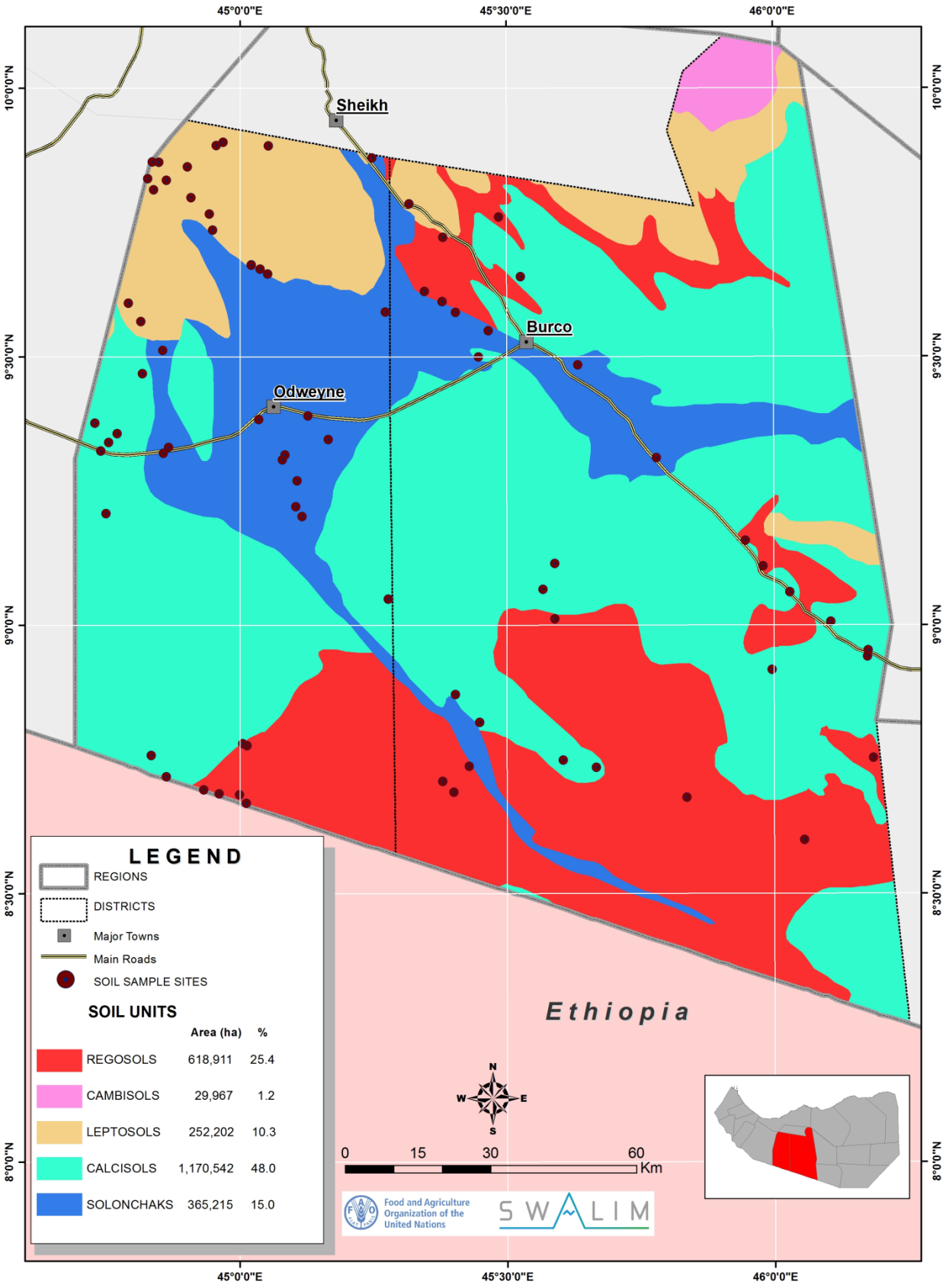
Map 10: Soils of the Valleys

5.2.5 Soils of Burco and Owdweyne

In August 2015, SWALIM carried out soil survey in selected agricultural areas in Oodweyne and Burco districts to provide updated information on the productive potential of soil for the most common soils to local farmers and stakeholders. Accessible sites were selected and stratified random sampling was done from the preliminary land cover map. A total of 79 soil samples were collected in the field. The soil sampling was done in the four major soil classes namely Calcisols, Leptosols, Regosols and Solonchaks of the two districts. This resulted in sampling of more than 18 samples per soil class. Cambisols was left out as this covers a small portion (1 %). The location of sampling together with the soil class and its extent is depicted in map 11.

The chemical properties such as soil pH, macronutrients (total nitrogen, total organic carbon, phosphorus, potassium and magnesium), micronutrients (manganese, copper, iron, zinc and sodium), and Electrical Conductivity (EC) was carried out in laboratory and the summary of the result for the chemical analysis of the four classes is summarized in the following table 3.

The result shows that the soils in general have moderately alkaline pH, and low in nitrogen, phosphorus and organic matter. The calcium and magnesium content in these soils varies from medium to high. The micronutrients are all normal. The soil electrical conductivity of all the soil types is low meaning that there is no problem of soil salinity in the study area. The moderately high pH values reduce the availability of phosphorus due to its precipitation in the soil solution as phosphate salts. Soil micro nutrients including iron, zinc, copper, and manganese are available to plants as shown by the above results. Fertilizers can be added to soil to increase concentrations of plant nutrients.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8°30'0"N
8°0'0"N
Sheikh
Burco
Odweyne
Ethiopia
LEGEND
REGIONS
DISTRICTS
Major Towns
Main Roads
SOIL SAMPLE SITES
SOIL UNITS
Area (ha) %
REGOSOLS 618,911 25.4
CAMBISOLS 29,967 1.2
LEPTOSOLS 252,202 10.3
CALCISOLS 1,170,542 48.0
SOLONCHAKS 365,215 15.0
N
W
E
S
0 15 30 60
Km
Food and Agriculture Organization of the United Nations
SWALIM

Map 11: Soils of Burco and Owdweyne

Soil type	* Soil pH	* Total N %	* Total Org. Carbon %	* P (Olsen) ppm	K me%	Ca me%	Mg me%	Mn me%	Cu ppm	Fe ppm	Zn ppm	Na me%	Elect. Cond. mS/cm
Calcisols	8.31	0.08	0.61	8.41	0.55	56.20	2.92	0.11	3.00	12.22	2.01	0.39	0.21
Leptosols	8.28	0.10	0.78	6.83	0.24	66.84	3.72	0.02	2.10	7.28	1.83	0.33	0.44
Regosols	8.24	0.08	0.59	7.76	0.68	53.49	3.06	0.14	2.66	15.71	2.00	0.43	0.45
Solonchaks	8.17	0.09	0.73	9.33	0.49	70.34	3.47	0.02	2.87	4.56	1.57	0.44	0.53
Cambisols	-	-	-	-	-	-	-	-	-	-	-	-	-
Remarks	Moderately alkaline	Low	Low	Low	Low	High	Adequate in Calcisols, High in rest	Low	Adequate	Adequate in Calcisols and Regosols. Low in rest	Low	Adequate	None

Table 3: Chemical analysis of the soils of Burco and Owdweyne

Recommendations for major crops of the two districts:

Soil fertility refers to, among other properties, the presence of rich nutrients necessary for basic plant nutrition, including nitrogen, phosphorus and potassium (primary nutrients) and a tolerable soil pH (range 6.0 to 6.8) for most plants and large amounts of top soil. The soils of Burco and Owdweyne are less fertile, therefore for the major crops of the area following inputs are recommended:

Sorghum:

At land preparation apply 5 tons/acre of well decomposed manure or compost. At planting time apply 25 kg/acre of urea. Three weeks after sowing top dress with 50 kg/acre of urea.

Cowpea:

At land preparation apply 5 tons/acre of well decomposed manure or compost and 25 kg/acre of urea. Mix well with the soil.

Pawpaw:

At transplanting apply 20 kg of well decomposed manure or compost and 50 gm of urea mixed with top soil per planting hole. 2-3 months after transplanting apply 25 gm/plant of urea and thereafter apply 50 gm/plant/year of urea 1-2 weeks after the onset of the rains. To determine the right amount of fertilizers, the soil should be tested annually.

5.2.6. Current use and recommendation for adequate management

In general the nine classes of the soils of Somaliland can be categorised into two groups: a. Fluvisols, Calcisols, Cambisols and Vertisols; these soils offer opportunities for intensive use including agriculture and b. Solonchaks, Arenosols, Leptosols, Gypsisols and Regosols are soils with low water holding capacity and poor fertility which do not offer opportunity to be managed for any intensive use.

The following table outlines the soil context of Somaliland including its physical and chemical properties, limitations, location of occurrence, existing management and recommendations for appropriate use.

Table 4: Overall analysis of the soils of Somaliland

SOIL	PHYSICAL	CHEMICAL	LIMITATIONS	OCCURANCE	MANAGEMENT AND USE	Recommendations
Vertisols With 18,932 ha area and 0.11% coverage.	• Located on flat to slightly sloping surfaces. • Low bulk density, dark colours & clayey texture • Grumic/Granular surface structure • Angular/subangular, prismatic subsurface horizons. • Deep soils • Deep and wide vertical cracking structure. • Wedge-shaped structures and slickensides development in lower layers, • Churning and	• Low organic matter content • Low in nitrogen and phosphorus • pH: tends to alkaline • EC: Negligible or slightly saline. • Low Exchangeable sodium. • CEC: Moderate • High base saturation • High accumulation of lime • Dominant cations calcium and magnesium	• Very susceptible to erosion: sheet, rill and gully • Frequent soil crusting at the surface • Hard pan formation in the sub-surface layers due to use of heavy machinery • Severely waterlogged during high rainfall periods. • Difficult to plough with oxen implements • Difficult to cultivate with heavy machinery • Poor traficability when wet	• Occur south of the Al Mountains in the Plateaus and dissected plateaus, mostly flat plateau and some areas sloping towards streams in rolling surfaces. • Semi-arid with alternating wet and dry seasons with comparatively higher rainfall of 500 mm that positively influences soil formation processes. • The soils are commonly located in the “sorghum belt”. • Located mostly in Borama and Wajaale districts	• Considered fertile soil where most agricultural land is found. • Good potential production under specific soil management practices. • Smallholder agriculture in post-rainy season with sorghum, maize, millet, cowpeas and Qat, and extensive grazing and wood collection. • Good results require water harvesting and soil conservation that increases moisture retention in the sloping.	• Soil pH is too alkaline for some crops • Organic matter content is low • To add Nitrogen fertilizer in the ammonium sulphate form or urea, Phosphorus and Potassium • Zero or minimum till to minimize compaction and induce natural structure formation • Deep ploughing sometimes needed to avoid formation of a hard pan below the plough layer that restrict s root penetration and downward movement of water • Mulching to prevent excessive soil cracking and root shearing, controlling weed growth, preventing excessive loss of fertilizer N and ameliorating high soil temperatures and run-off and
Calcisols With 3,701,138 ha area and 21.67% coverage.	• Medium or fine texture • Well drained • Good water holding capacity. • Surface run-off over the bare soil causes sheet, rill and gully erosion	• Low organic content on the surface • The surface has crumb or granular structure or platy structure as well • Blocky structure at the sub-surface • Good amount of soil nutrients.	• Stoniness of the surface in some parts hinder arable farming • Aridity; • Salinity in lower horizons. • High pH and/or high calcium content limit the availability of some nutrients.	• Principally occur in dissected plateaux and some piedmonts in arid and semi-arid areas • Deep fluvial incisions form areas of bare rock at the upper surface that causes high and intense degradation. • Falls in Woqoyi galabeed	• Most of these soils are under shrubs, grasses, herbs and sparse trees and used as grazing lands. • Good for rainfed agriculture with sorghum and maize where farming is not hindered by surface stoniness or a shallow petro-calcic horizon.	• Suitable for extensive grazing and drought tolerant crops under rainfed • Furrow irrigation practices is more suitable than basin irrigation • Add nitrogen, phosphorus, and trace elements fertilizers

Fluvisols With 52,612 ha area and 0.31% coverage.	• Located on flat to gently undulating surface. • Young soils along rivers • Good water conductivity • Mainly light soil texture classes. • Soil profiles show stratification and a weak	• Near-neutral or high pH values • Accumulate fertile soil material • Irregular organic content with depth. • Salinity in lower layers locally.	• Periodical flooding • No major soil development • Susceptible to build up salinity after long term of irrigation	• Young soils developed on parent material of recent alluvial plains, river fans and tidal marshes which are periodically flooded Common within the Al Mountains, Highlands and Dissected Plateaus • Parts of Zeylac, part of	• . Usually suitable for all uses, however are commonly used for irrigated crops or grazing and woodcutting for fuel wood.	• Use well decomposed manure or compost. • Fertilize with Ammonium sulphate or urea, and Phosphorus and Potassium
Leptosols With 4,901,417 ha area and 28.70% coverage.	• Very shallow soils over continuous rock • Extremely gravelly or stony • Excessive internal drainage.	• Very poor fertility	• Shallow depth. • Soil stoniness and gravel content. • Potential for wet season grazing and as forest land • Excessive internal drainage and shallowness can cause	• Occur mainly in the Al Mountains, in isolated mountain blocks or rugged hilly areas and in the Plateau and dissected plateaus • Fairly distributed, parts of Awdal and Waqoyee Galabeed (Gabiley,	• Vegetation cover consisting of general open shrubs, open trees with shrubs and open herbaceous with shrubs. • Not suitable for any specific intensive use. • Mainly conservation.	• • Natural vegetation cover should be maintained
Cambisols With 2,612,045 ha area and 15.29% coverage.	• Loamy textures and bulk density	• Moderately alkaline • Medium or deficient fertility specifically nitrogen and phosphorus	• Severe eroding land in mountain areas. • Poor soil fertility	• Common in arid and semi-arid areas and coastal areas as well • Occur in slopes, denudational surfaces and in some alluvial deposits. • Topography varies from flat to gently sloping surfaces of alluvial deposits.	• Due to insufficient rainfall moisture conditions, these soils are commonly used for grazing and wood harvesting. • Small irrigated fields of fruit trees and herbaceous crops (pulses and vegetables) are practiced beside the water sources.	• Soil and water conservation efforts to be enhanced • Control wood collection • Use of ammonium sulphate, urea and phosphorus fertilizer
Regosols With 2,024,833 ha area and 11.85% coverage.	• Weakly developed mineral soil in unconsolidated material. • Shallow or stony soil • Sandy loam texture and moderately high bulk density	• Strongly to moderately alkaline reaction • Non saline • Deficient in nitrogen and phosphorus	• Delicate and severely eroding soils. • Low moisture holding capacity • Poor fertility	• Occur in variable relief types in planation surfaces, denudational surfaces, and pediments of dissected plateaus; • Occurs in Southern Togdhere (parts of Burco	• Minimal agriculture significance due to fragile land surface and low moisture holding capacity that require frequent application of irrigation • Used as extensive communal grazing lands and for wood	• Soil and water conservation efforts to be enhanced • Control wood collection • Regosols in mountainous areas are delicate and best left under natural vegetation

Arenosols With 691,377 ha area and 4.05% coverage.	• Sandy soils developed in active sand dunes. • Moderately high bulk density • Extremely drained • Coarse texture	• Very poor fertility • Saline soils	• Wind erosion • Salinity • Soil texture (sandy) • With sandy texture • High permeability and low water holding capacity • Low nutrient storage,	• Occur in the coastal plain, • Commonly flat with small, slightly sloping surfaces towards the Gulf of Aden • The soil profile shows no sign of development or horizon differentiation.	• Vegetation cover varies from bare soil with scattered vegetation, to general open herbaceous and closed strips of Prosopis species along the streams. • Not favouring cultivation of crops. • Transhumance grazing and	• Practice controlled grazing • Avoid clearing for cultivation • Appropriate soil conservation measures • Recommend sustainable economic Prosopis utilization
Solonchaks With 2,228,550 ha area and 13.05% coverage.	• Heavy texture soils • Low water conductivity	• Very saline soils	• Soils with a high concentration of soluble salts at certain times of the Year • Salinity • Heavy Texture	• Located in the playas areas • Land cover in the area is mainly bare soil with scattered vegetation, Very marginal for grazing activity. • Occurs in Odweyne, central plateau near	• Land cover in the area is mainly bare soil with scattered halophyte vegetation, • Very marginally used for f grazing activity. • Soil Conservation activities are needed.	• Soil and water conservation efforts to be enhanced • Practice controlled grazing • Avoid clearing for agriculture

6. Land cover and land use

6.1. Land cover of Somaliland

Various methodologies are used for assessing the land cover of Somaliland, nonetheless keeping in view the scope of this report, mapping done by SWALIM on the dot grid basis is adopted. The entire area of Somaliland has been consistently mapped with a standardized description of the classes present in the legend (LCCS3) and the agricultural areas are precisely estimated. The mapping can also be used as baseline for further studies for assessing ecosystems of Somaliland or for a change assessment. Although the seven land cover classes in the legend are not enough to describe the land cover features in detail, the land-cover assessed through this approach is suitable for estimating intensive uses such as agriculture. Scattered/small sized classes are not consistently detected. Notwithstanding, with the assessment of agriculture as well as the landcover under other extensive uses, this limitation insignificantly hinders efforts at prospective systematic landuse.

The soils, climate and landform of Somaliland have shaped a variety of land cover that is categorized into seven land-cover classes. These classes comprise natural woody vegetation (sparse trees & herbaceous canopy together with closed to open canopy) covering 73.72% of the area followed by bare area covering 24.44% of Somaliland. The rain-fed crops cover around 1.34%, whereas irrigated crops covers only 0.37% (620 Km^2) of Somaliland. These land-cover classes together with the soils, landform and climate determine the nature of the land use. The seven classes of the land cover are detailed in the following figure 10.

The landscape with natural or semi-natural vegetation having 15 to 100% density of shrubs and/or trees are classified as natural woody vegetation closed to open covers. The area with woody vegetation having density of 3 to 15%, or 3 to 80% of density with herbaceous (non-woody) vegetation are classed as natural woody vegetation sparse or herbaceous. This class has the highest (57.27%) area coverage in Somaliland, followed by bare areas (24.44%) and then natural woody vegetation closed to open (16.45%). Less than 2% area is under agriculture, both irrigated and rain-fed. Map 5 shows the overall landcover of Somaliland.

Landcover by landforms: Table 5 shows the consolidated landcover of Somaliland in each landform.

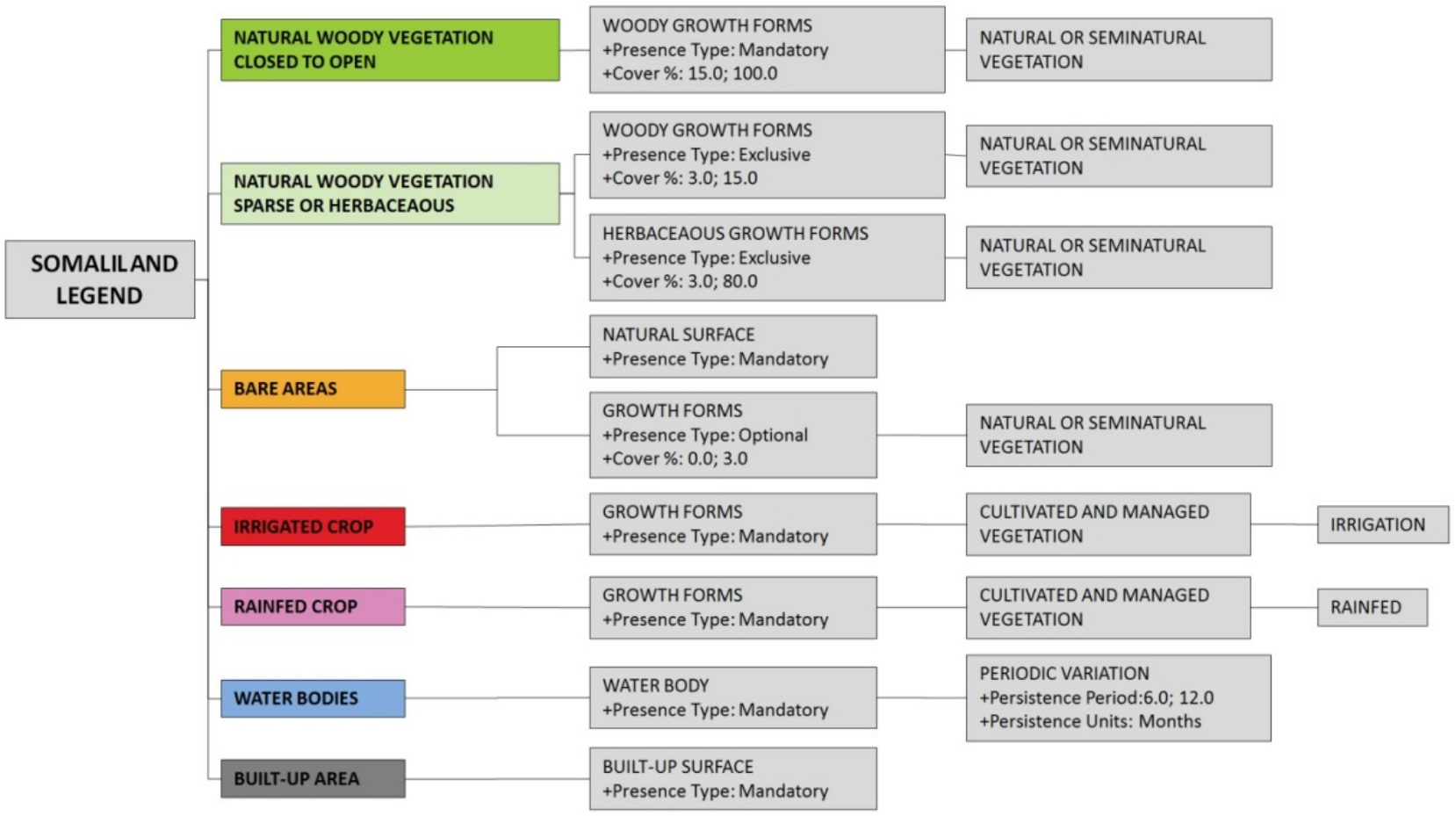
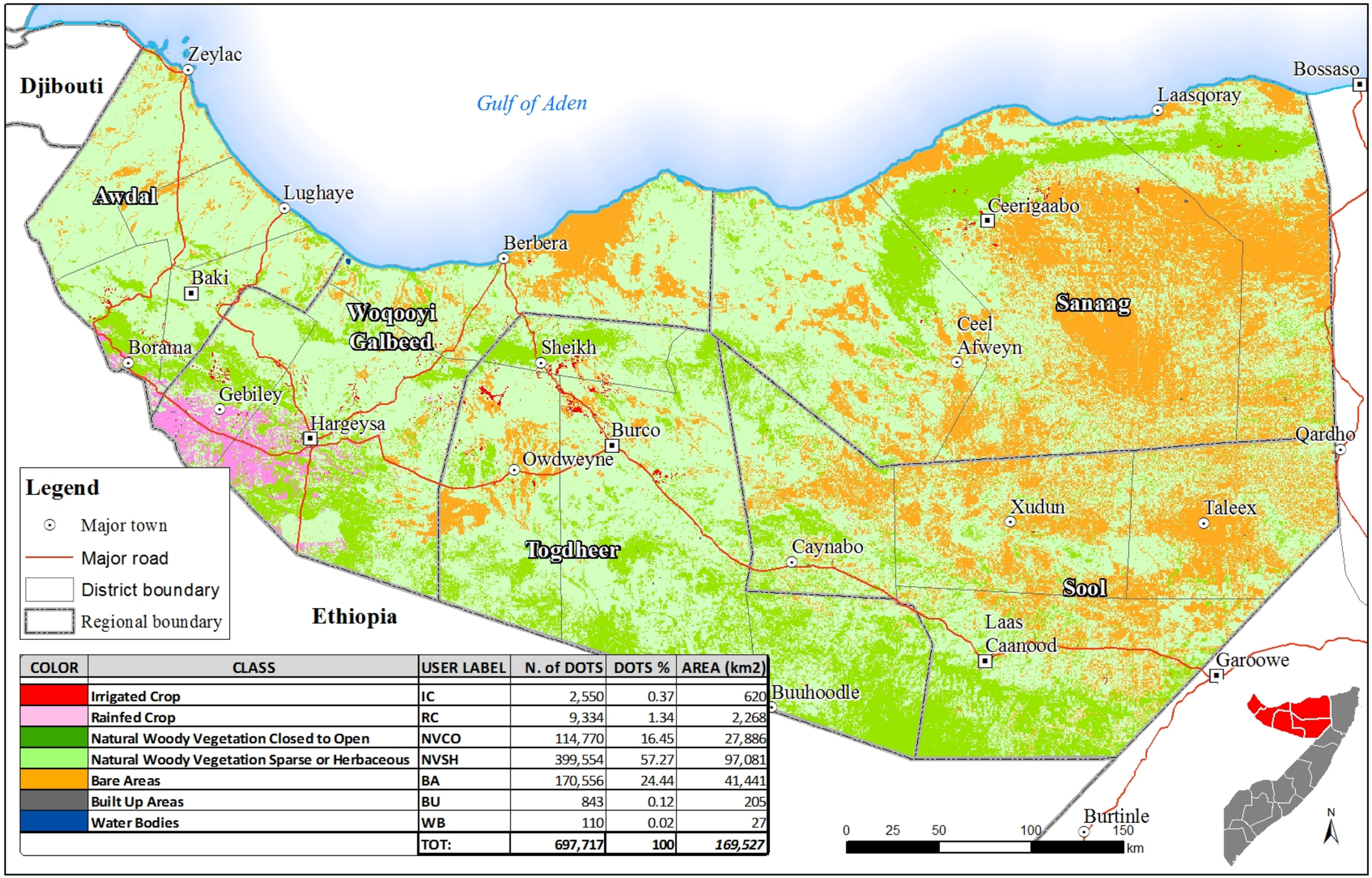


Figure 10: Landcover Classification of Somaliland

Landforms of Somaliland	Irrigated		Rainfed		Closed to Open NWV		Sparse/Herbaceous NWV		Bare Areas		Built Areas		Water bodies		Total area
	%	Km^2	%	Km^2	%	Km^2	%	Km^2	%	Km^2	%	Km^2	%	Km^2	Km^2
Coastal plains	**0.02**	**2.9**			**4.21**	**588.8**	**71.38**	**9992**	**24.2**	**3391**	**0.09**	**12.6**	**.08**	**11.2**	**13999.4**
Mountain/ Highlands	**0.54**	**283**	**0.90**	**471**	**14.04**	**7372.2**	**62.82**	**32985**	**21.5**	**11315**	**0.15**	**76.2**	**.00**	**0.7**	**52503.2**
Plateaus	**0.20**	**147**	**2.59**	**1936**	**21.79**	**16303**	**52.33**	**39156**	**23**	**17186**	**0.13**	**99.2**	**.00**	**3.7**	**74831.4**
Valleys	**0.26**	**75**	**0.01**	**3.7**	**16.87**	**4925.2**	**57.33**	**16739**	**25.5**	**7438**	**0.06**	**16.3**			**29196.6**
Total															**170530.7**

Table 5: Consolidated landcover of Somaliland in each landform



COLOR	CLASS	USER LABEL	N. of DOTS	DOTS %	AREA (km2)
	Irrigated Crop	IC	2,550	0.37	620
	Rainfed Crop	RC	9,334	1.34	2,268
	Natural Woody Vegetation Closed to Open	NVCO	114,770	16.45	27,886
	Natural Woody Vegetation Sparse or Herbaceous	NVSH	399,554	57.27	97,081
	Bare Areas	BA	170,556	24.44	41,441
	Built Up Areas	BU	843	0.12	205
	Water Bodies	WB	110	0.02	27
		TOT:	**697,717**	**100**	***169,527***

Map 12: Landcover/Landuse Map of Somaliland 2013

The legend of the land cover map of Somaliland is summarized in Table 4 as follows:

CLASS	Km^2	%
Irrigated Crop	**508**	**0.30**
Rainfed Crop	**2406**	**1.42**
Natural Woody Vegetation Closed to Open	**28950**	**17.08**
Natural Woody Vegetation Sparse or Herbaceous	**98331**	**58.00**
Bare Areas	**39111**	**23.07**
Built Up Areas	**204**	**0.12**
Water Bodies	**18**	**0.01**

Table 6: Land cover by landforms of Somaliland

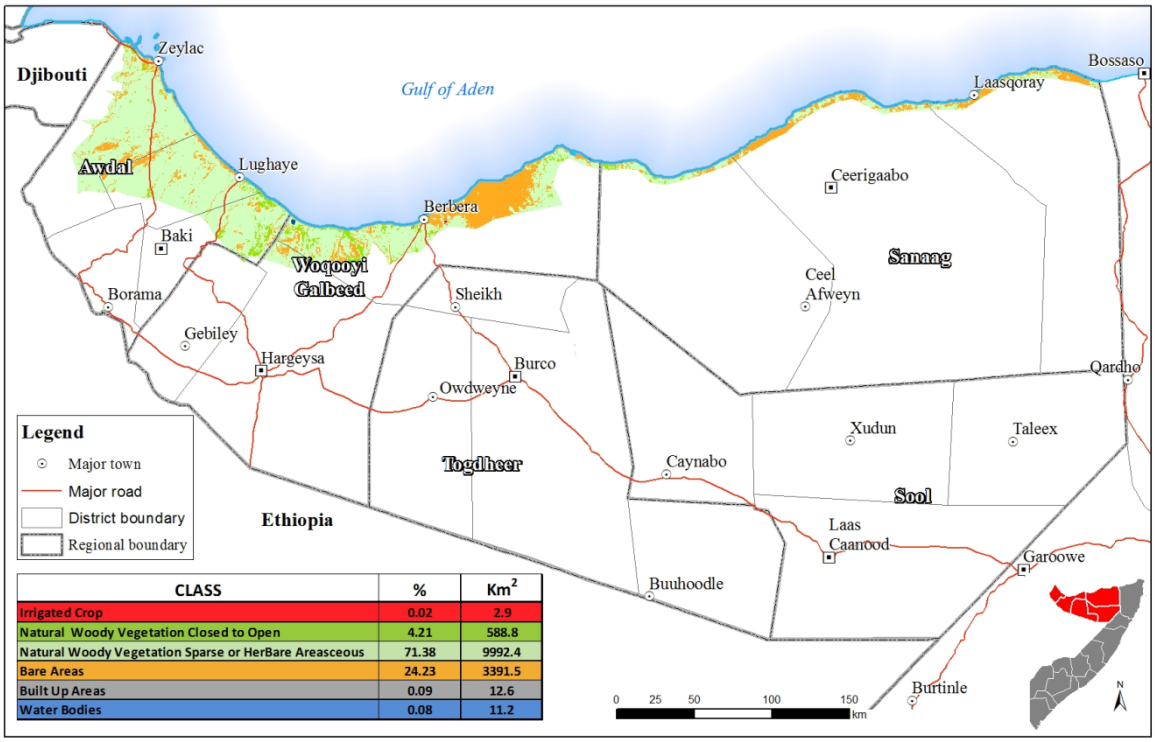
As part of the generic plan for developing this report, the land resources including land covers are further elaborated with respect to four landforms as follows:

- Landcover of the coastal plain and piedmont
- Landcover of the mountains and highlands
- Landcover of plateaus
- Landcover of valleys

6.1.1 Landcover of the coastal plain and piedmont:

Characterised by the very high aridity and poor formation of soils, this landform is predominant (71.4%) covered by natural wood vegetation sparse to herbaceous comprise of scanty trees and grass lands with varying density. 4.2% of area is covered with wood vegetation closed to open found mainly in the area between Berbera and Lughaye. Bare areas cover 23% of Somaliland and lies mainly east of Berbera and along the border of Puntland in most of the Sanaag and the northeast of Sool regions. These areas are mostly bare with natural vegetation of less than 3% density. 2.9 Km^2 (0.02%) area is under irrigated agriculture in the south of Berbera, whereas 11.2 Km2 (0.08%) area comprise of water bodies situated in the east of Lughaye. The landcover of this zone is stunted and due to the progressive land degradation in the form of water and wind erosion, the cover

is threatened; replenishment will be a huge challenge due to the aridity and erosion. Thus conservation soil and land cover conservation is of immense importance in this landform.

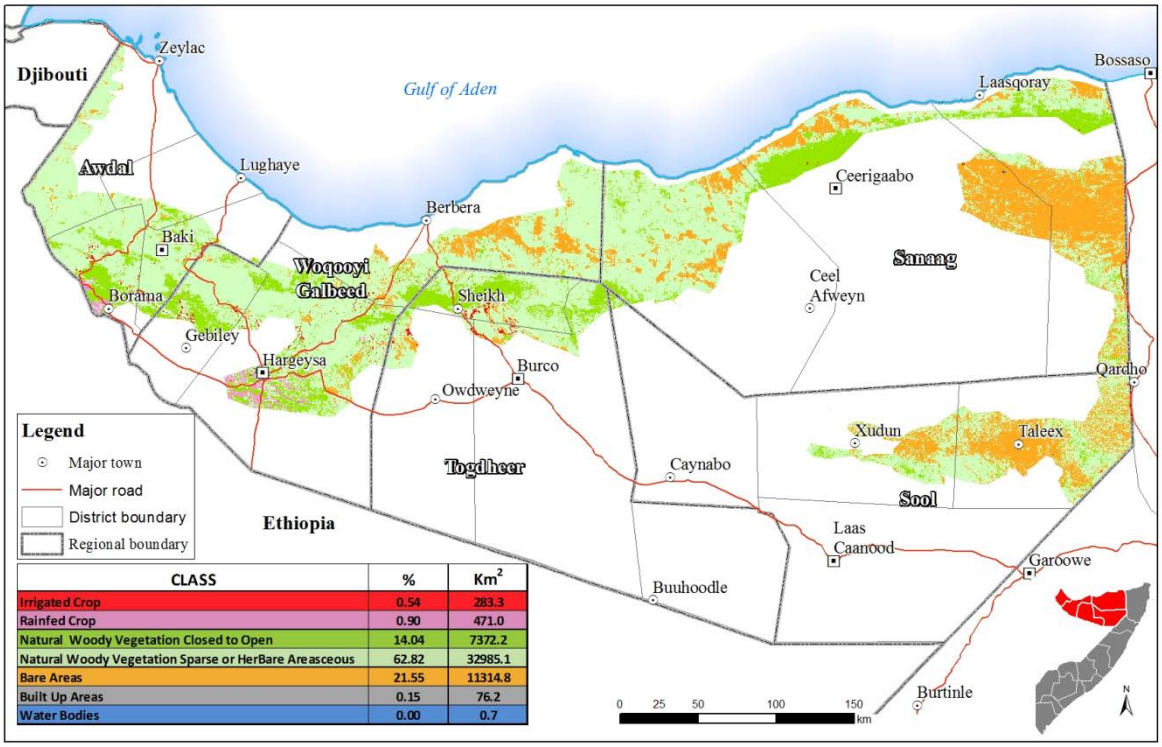


CLASS	%	Km^2
Irrigated Crop	0.02	2.9
Natural Woody Vegetation Closed to Open	4.21	588.8
Natural Woody Vegetation Sparse or HerBare Areasceous	71.38	9992.4
Bare Areas	24.23	3391.5
Built Up Areas	0.09	12.6
Water Bodies	0.08	11.2

Map 13: Landcover of Coastal Plain and Piedmont

6.1.2. Landcover of the mountains and highlands:

Although considerable area (62.82%) is occupied by natural woody vegetation sparse or herbaceous, followed by bare areas (21.55%), the landform has the highest area under irrigated agriculture (0.54% and 283 Km^2). These fields are located south of Sheikh, and scattered around Hargeisa, Gebiley and Borama. The rainfed agriculture (0.9% with 471 Km^2) is scattered around Hargeisa and east of Borama. The natural woody vegetation closed to open category covers 14% of the landform with relatively dense patches in the Golis, North of Ceerigaabo and around Sheikh. Woody vegetation with varying density is also found around Gebiley and Borama.

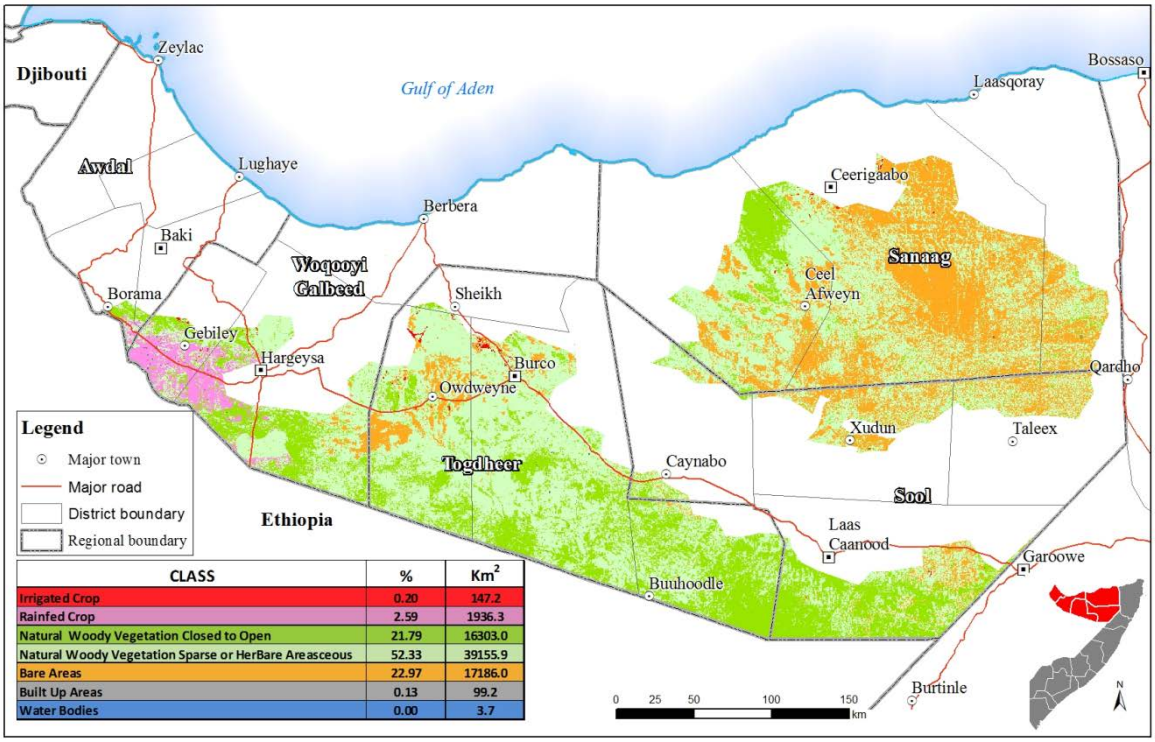


CLASS	%	Km²
Irrigated Crop	0.54	283.3
Rainfed Crop	0.90	471.0
Natural Woody Vegetation Closed to Open	14.04	7372.2
Natural Woody Vegetation Sparse or HerBare Areasceous	62.82	32985.1
Bare Areas	21.55	11314.8
Built Up Areas	0.15	76.2
Water Bodies	0.00	0.7

Map 14: Landcover of Mountains and Highlands

6.1.3. Landcover of plateaus

The plateau landform covers the largest (around 44%) part of Somaliland, the landform harbours the largest (around 3000 km2 and 3 %) area under rainfed agriculture in Somaliland. Rainfed agriculture is cluttered south of Gebiley and west of Hargeisa. The two landcover classes of natural woody vegetation (closed to open and sparse to herbaceous) cover 74% of the land area of this landform. This vegetation occurs mostly in the south along the Ethiopian border as well as south of Ceerigaabo. Thus in terms of the extent this overall landcover is very important. A considerable part (23%) of the plateau is bare area, situated mostly in Sanaag and northern Sool.

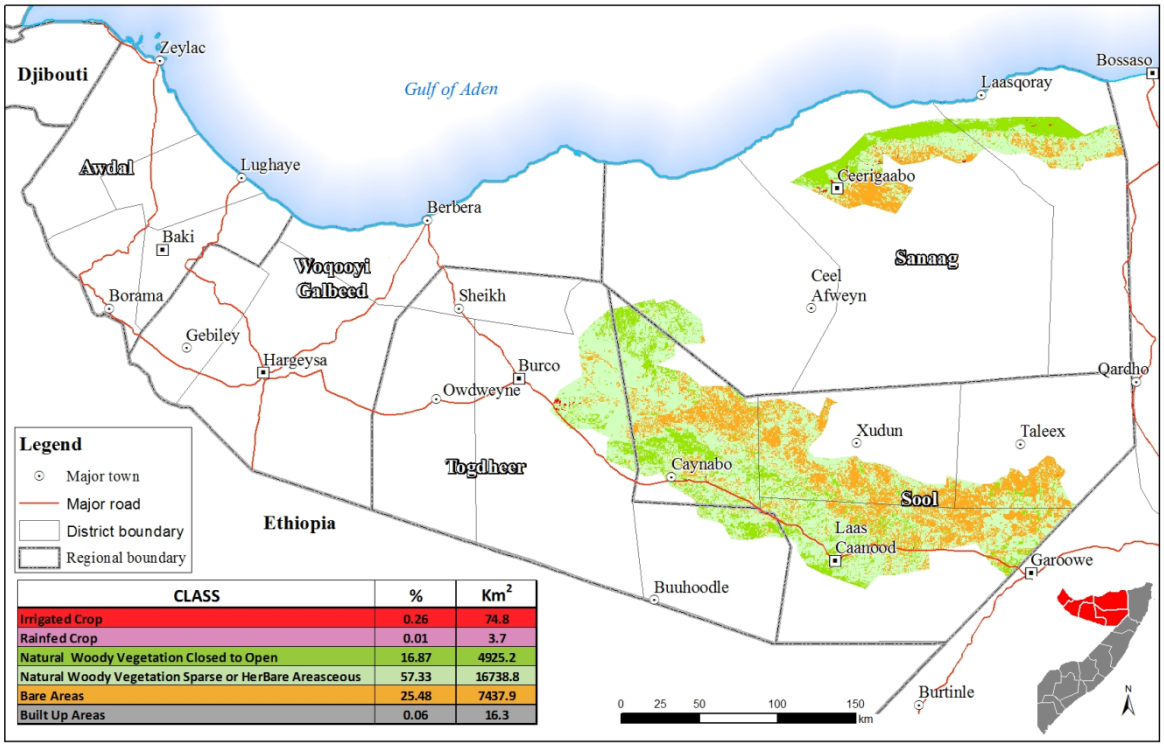


CLASS	%	Km^2
Irrigated Crop	0.20	147.2
Rainfed Crop	2.59	1936.3
Natural Woody Vegetation Closed to Open	21.79	16303.0
Natural Woody Vegetation Sparse or HerBare Areasceous	52.33	39155.9
Bare Areas	22.97	17186.0
Built Up Areas	0.13	99.2
Water Bodies	0.00	3.7

Map 15: Map of land cover of Plateau in Somaliland

6.1.4. Landcover of valleys

Together with bare area, the woody vegetation covers almost the entire (99.64%) valley landform of Somaliland. Although considerable area (74.22%) is occupied by natural woody vegetation sparse or herbaceous, followed by bare areas (25.48%), the landform has the least area under rainfed agriculture, but has 74.8 Km^2 (0.26%) area under irrigated agriculture near Ceerigaabo and southeast of Burco. The natural woody vegetation closed to open occupies area south of Golis mountains and some area under Laas Caanood and Caynabo.



CLASS	%	Km²
Irrigated Crop	0.26	74.8
Rainfed Crop	0.01	3.7
Natural Woody Vegetation Closed to Open	16.87	4925.2
Natural Woody Vegetation Sparse or HerBare Areasceous	57.33	16738.8
Bare Areas	25.48	7437.9
Built Up Areas	0.06	16.3

Map 16: Map of land cover of Valley in Somaliland

6.2. Land uses of Somaliland

SWALIM has categorized the landuse of Somaliland in nine classes. Nomadic pastoralism is the most extensive landuse with 11.5 million hectares covering 67.7% of the total area of Somaliland. This is followed by Transhumance Pastoralism with 3.79 million ha covering 22.23% of Somaliland. Bare area comprises 3.87%, whereas transhumance pastoralism with charcoal production and timber collection together forms 4% of the landuse in Somaliland. Built up area, river bank and water bodies are, though very small land-uses, however quite important in terms of influencing the management of the land resources of Somaliland. The following table provides an overall picture of the landuse of Somaliland:

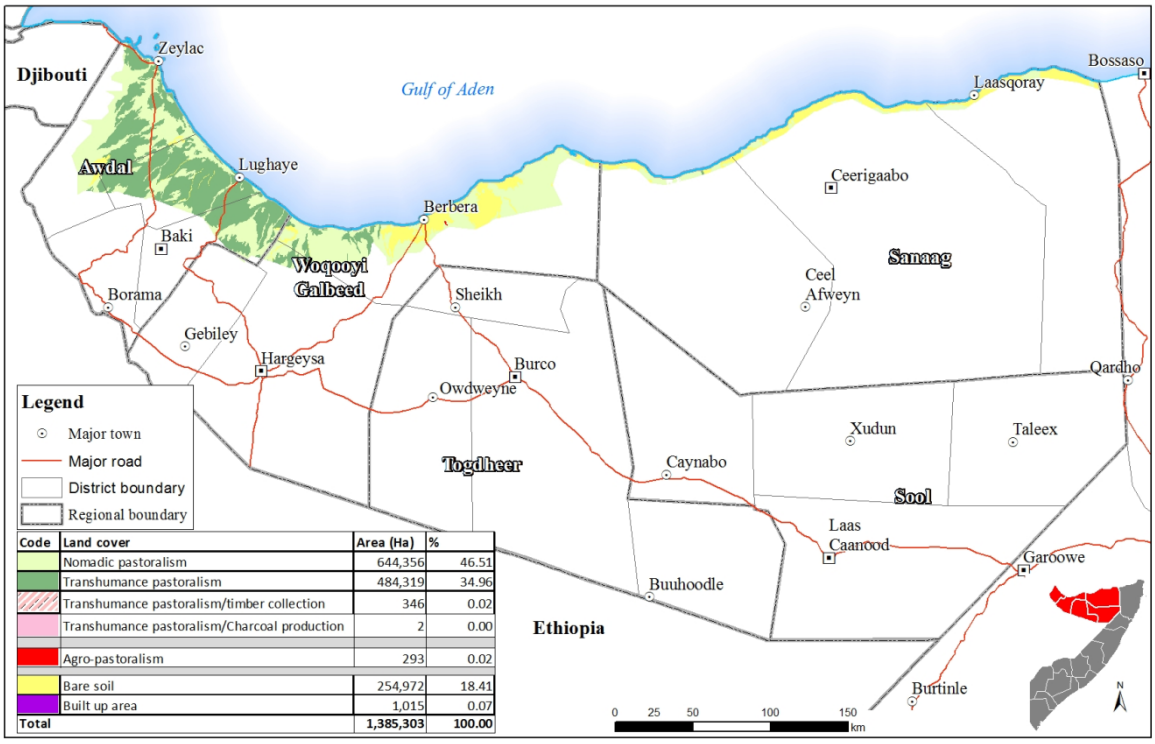
Landuse	Area (Km^2)	% area
Nomadic pastoralism	115327	67.69
Transhumance Pastoralism	37869	22.23
Transhumance Pastoralism/Charcoal production	5379	3.16
Transhumance Pastoralism/Timber collection	1437	0.84
Agro-pastoralism	3645	2.14
Bare soil	6594	3.87
Built up area	36	0.02
River Bank	78	0.05
Water body	4	0.00
	170369	100

Table 7: Land-uses of Somaliland

The land-uses are further elaborated along the four landforms as follows:

6.2.1. Land use in the Coastal plains of Somaliland

The coastal belt is dominantly under Nomadic Pastoralism (46.5%) and the Transhumance Pastoralism also forms considerable (34.96%) land use, followed by bare area (18.41%) with no economically significant land use.

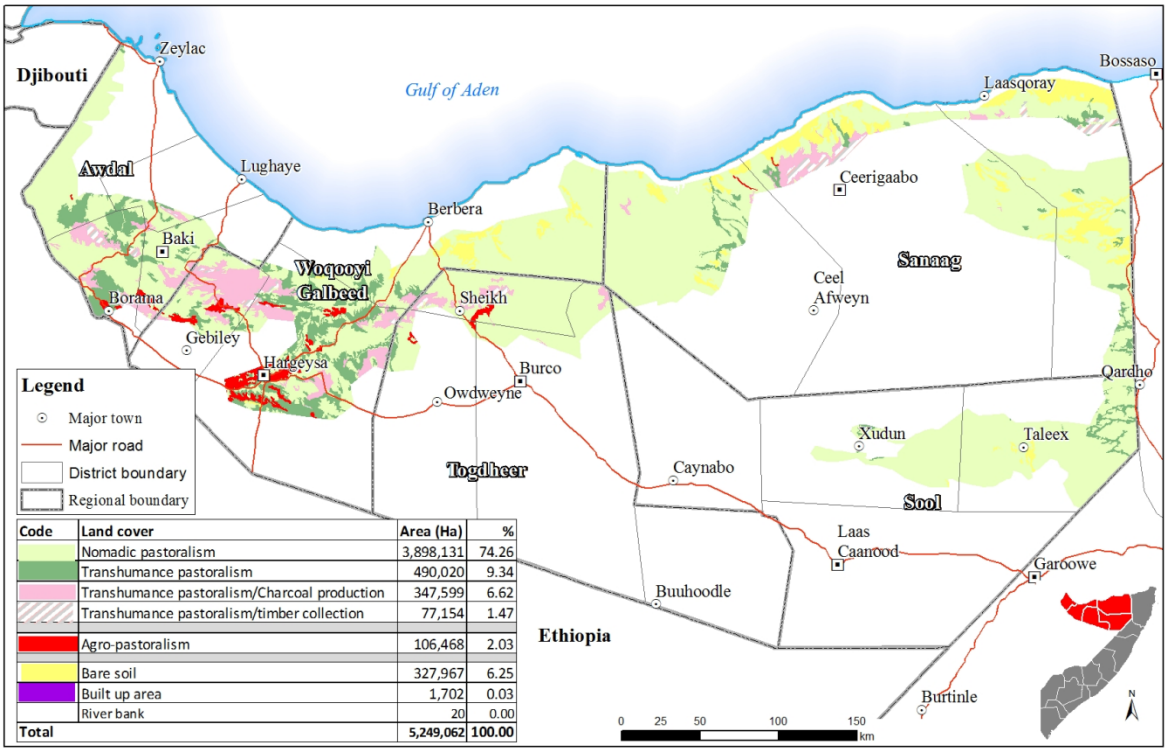


Code	Land cover	Area (Ha)	%
	Nomadic pastoralism	644,356	46.51
	Transhumance pastoralism	484,319	34.96
	Transhumance pastoralism/timber collection	346	0.02
	Transhumance pastoralism/Charcoal production	2	0.00
	Agro-pastoralism	293	0.02
	Bare soil	254,972	18.41
	Built up area	1,015	0.07
Total		1,385,303	100.00

Map 17: Land use in the Coastal Plain

6.2.2. Land use in the Mountains and highlands of Somaliland

The Nomadic Pastoralism is the dominant landuse with 74% area of this landform together with other land-uses occupying the remaining area of Somaliland. Agro-pastoralism and Transhumance Pastoralism land-uses have a substantial area, This provides an opportunity for improved management, nonetheless with challenges of conserving the potential through integrated and cost effective landuse management regimes.

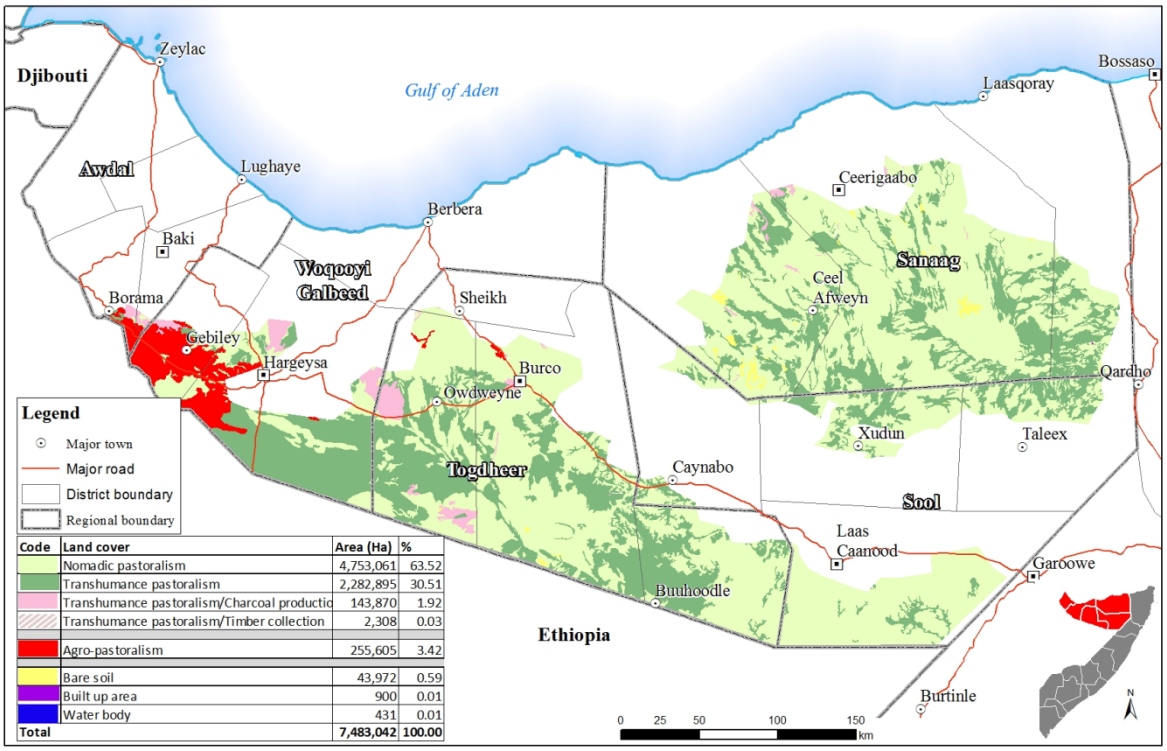


Code	Land cover	Area (Ha)	%
	Nomadic pastoralism	3,898,131	74.26
	Transhumance pastoralism	490,020	9.34
	Transhumance pastoralism/Charcoal production	347,599	6.62
	Transhumance pastoralism/timber collection	77,154	1.47
	Agro-pastoralism	106,468	2.03
	Bare soil	327,967	6.25
	Built up area	1,702	0.03
	River bank	20	0.00
Total		**5,249,062**	**100.00**

Map 18: Land use in the Mountains and highlands of Somaliland

6.2.3. Land use in the Plateaus of Somaliland

Both from the extent of the land and the land use, this land form is of immense importance with substantial development potential on one hand and posing the challenges emanating from over-use and degradation of the land resources on the other. This zone has the highest area under Agro-pastoralism standing at 3.42% (255,605 hectares). Beside Nomadic Pastoralism, the transhumance pastoralism with charcoal collection is also a significant land-use. Agro-pastoralism together with Transhumance Pastoralism provides opportunity for socio-economic uplift but has multiple challenges including appropriate landuse planning and soil and water conservation as well.

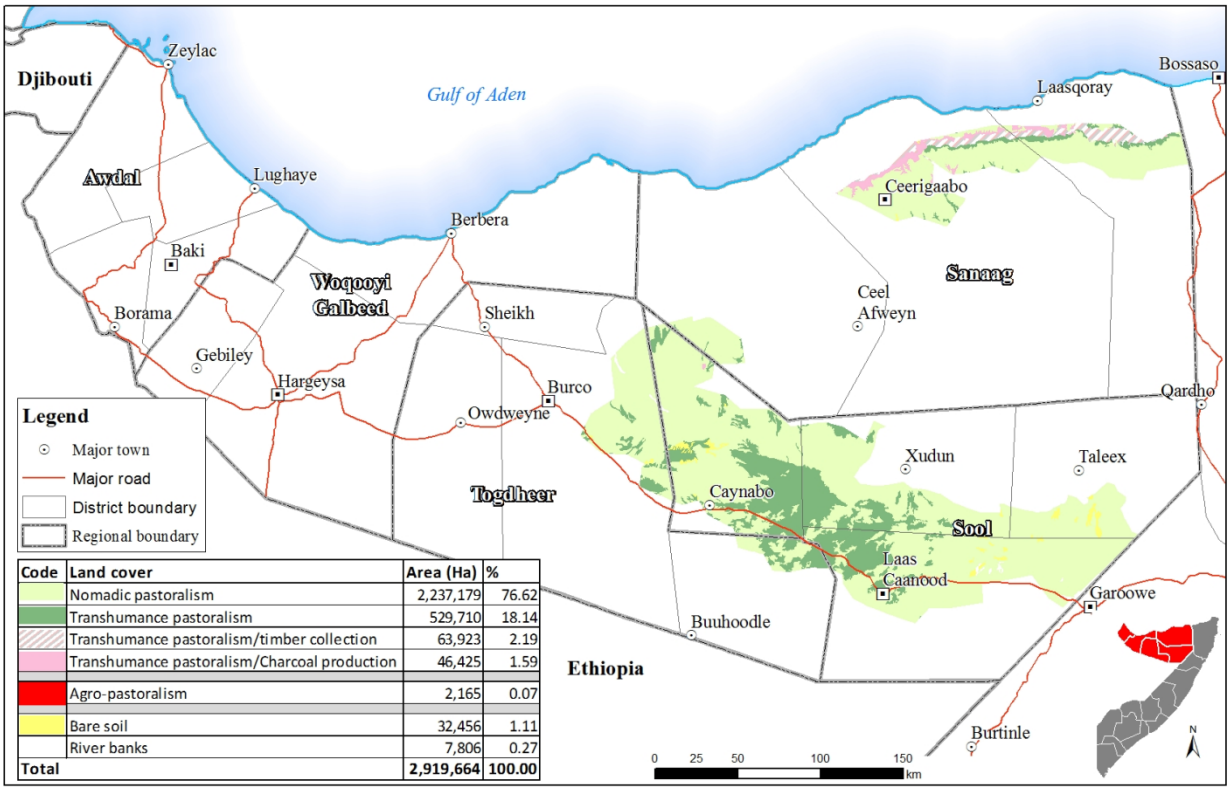


Code	Land cover	Area (Ha)	%
	Nomadic pastoralism	4,753,061	63.52
	Transhumance pastoralism	2,282,895	30.51
	Transhumance pastoralism/Charcoal productic	143,870	1.92
	Transhumance pastoralism/Timber collection	2,308	0.03
	Agro-pastoralism	255,605	3.42
	Bare soil	43,972	0.59
	Built up area	900	0.01
	Water body	431	0.01
Total		7,483,042	100.00

Map 19: Land use in the Plateaus of Somaliland

6.2.4. Land use in the Valleys of Somaliland

This landform is mainly under Nomadic Pastoralism landuse, followed by transhumance pastoralism and some timber and charcoals production. The landuse poses conservation related challenges. Agro-pastoralism is limited to the valleys south of Golis Mountains.



Code	Land cover	Area (Ha)	%
	Nomadic pastoralism	2,237,179	76.62
	Transhumance pastoralism	529,710	18.14
	Transhumance pastoralism/timber collection	63,923	2.19
	Transhumance pastoralism/Charcoal production	46,425	1.59
	Agro-pastoralism	2,165	0.07
	Bare soil	32,456	1.11
	River banks	7,806	0.27
Total		**2,919,664**	**100.00**

Map 20: Land use in the Valleys of Somaliland

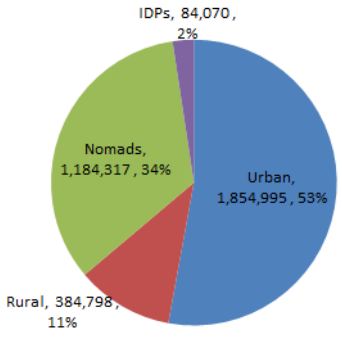
7. Production systems, livelihoods, Socio-economic and institutional factors

Somaliland is situated in the Horn of Africa. It borders the Red sea and the Gulf of Aden to the North, Somalia in the East, the Federal Republic of Ethiopia to the Southwest and the Republic of Djibouti to the Northwest. It lies between Latitudes 8 and 11 North and Longitudes 42 and 49 East. The total area of the Republic of Somaliland is 137,600 square kilometres and has a coastline which is about 850kms long. Although the land resource is central to the lives and livelihoods of the people of Somaliland, nevertheless these resources are highly affected by broader socio-economic factors, thus the context for this report is set while elaborating these influencing factors as follows:

7.1. Demographic context

Although Somaliland is still not overpopulated, nevertheless keeping in view the fragile nature of the land resource on one hand and the rather higher rate of increase (through birth rate and in-migration) on the other, the situation is worrisome situation. The population of Somaliland was estimated at 3.5 million in 2014 with a population density estimated at 25 persons per square km (Somaliland Figures, 2014). The population consists of nomads (33.8%), urban dwellers (52.9%), rural dwellers (11%) and internally displaced people (2.4%). The annual population growth rate is estimated at 2.7%.

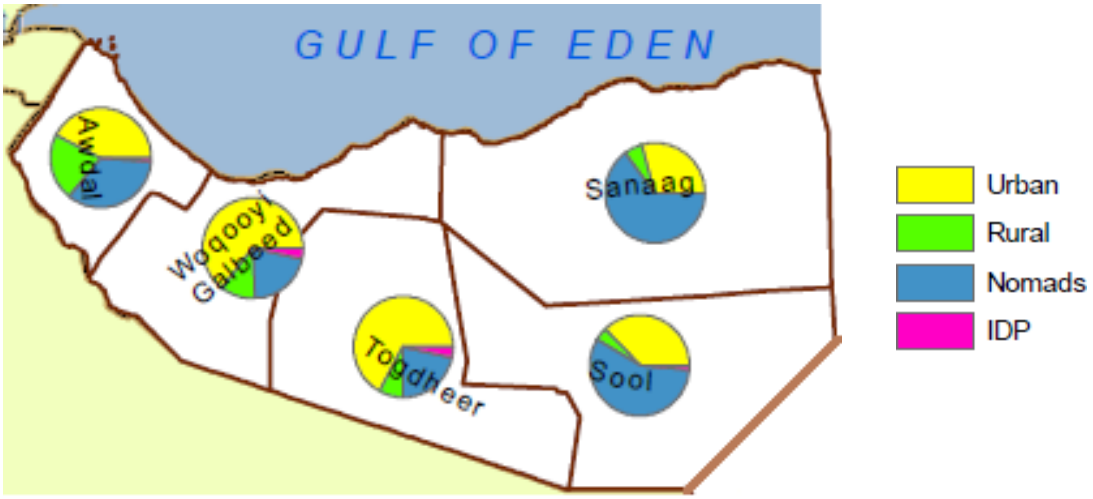
The pie chart and table below shows the population distribution by occupation regionally. With increase in urban population, lateral expansion, productive lands are converted into urban settlement. On the other hand the rural and nomadic segments that together constitute 45% of Somaliland population, further burden these already fragile land resources.



Population, 2014					
REGION	**Urban**	**Rural**	**Nomads**	**IDPs**	**Total**
Awdal	287,821	143,743	233,709	7,990	673,263
Waqooyi Galbeed	802,740	138,912	255,761	44,590	1,242,003
Togdheer	483,724	57,356	154,523	25,760	721,363
Sanaag	159,717	30,804	352,692	910	544,123
Sool	120,993	13,983	187,632	4,820	327,428
Total	1,854,995	384,798	1,184,317	84,070	3,508,180

Table 8: Population comparison rural and urban by regions

Source: UNFPA, 2014



Urbanization:

The GIS based observation of three cities (Hargeisa, Borama and Burco) in Somaliland shows a phenomenal expansion over a period ten to thirteen years. Particularly the city of Hargeisa is almost doubled from 2002 to 2015, see table 8, which shows urban expansion in Somaliland. This expansion has direct and indirect implication on the land resources as on one the built up area is engulfing the productive surrounding whereas the urbanization also enhances overall environmental footprint of the people, including pressure on the land resources.

Name	No. of Points	Area Km2	Perimeter/ Length (Meters)	Centroid/Mid -Point (Degrees Minutes)	Bounding Box Maximum (Degrees Minutes)	Bounding Box Minimum (Degrees Minutes)
Hargeisa 2002	242	29.80	45,247	09.5625996°, 044.0623295°	09.5944091°, 044.1018795°	09.5263693°, 044.0198002°
Hargeisa 2015	267	59.72	58,461	09.5598735°, 044.0641637°	09.5981672°, 044.1191395°	09.5018396°, 044.0070065°
Borama 2004	1404	5.40	20,912	09°56.19241', 043°11.16500'	09°57.19592', 043°11.87514'	09°55.01523', 043°10.54620'
Borama 2014	2,086	8.85	17,869	09°56.30151', 043°11.23711'	09°57.72600', 043°12.18071'	09°54.97622', 043°10.50922'
Burco Feb 2004	211	11.22	23,384	09.5207819°, 045.5381896°	09.5394711°, 045.5604317°	09.4996421°, 045.5194090°
Burco June 2015	143	19.43	25,647	09.5199674°, 045.5400882°	09.5434934°, 045.5675424°	09.4953474°, 045.5150942°

Table 9: Urban expansion in Somaliland

7.2. Socio-economic context

The country is divided into thirteen regions, namely, Awdal, Maroodi-jeeh, Saahil, Togdheer, Sanaag, Sool, Gabiilay, Salal, Oodweine, Saraar, Buhoodle, Hawd, and Badhan. These are sub-divided into 81districts. Hargeisa is the capital of Somaliland with the estimated population of 680,000. Other cities include Borama, Berbera, Burco, Ceerigaabo, and Laascaanood (Somaliland Ministry of Planning and Development, 2010).

7.3. Political situation

Somaliland declared its independence from Somalia after the total collapse of Somali Government on 18 May 1991 as a result of the civil war of the late eighties and early nineties. The decision was made by the Congress of Council of Clan Elders held in Burco from 27 April to 15 May, 1991. According to its constitution, the Republic of Somaliland is a democratic country

with a multi-party system. Nevertheless Somaliland is still awaiting UN's recognition as an independent country.

The politics of Somaliland take place within a hybrid system of governance, which, under the Somaliland's constitution, combines traditional and western institutions. The constitution separates government into an executive branch, a legislative branch, and a judicial branch, each one functions independently from the others. The Parliament has two chambers. The House of Representatives has 82 members, elected for a five-year term while the House of Elders (Guurti) has 82 members, representing traditional leaders. Somaliland has a multiparty political governance system consisting of only 3 elected parties (one-man-one vote) as per the constitution. Somaliland has held two local municipal elections (2002 and 2012), a parliamentary election (2005) and two presidential elections in 2003 and 2010 respectively.

Education:

The current educational system consists of a primary education level with eight grades followed by secondary level education with four grades and university of 4 years. Overall, the number of students enrolled in primary schools, secondary schools and universities in Somaliland continues to grow rapidly. Primary schools have increased students enrolment from 35,997 in 1998 to 206,544 in 2014. The gender enrolment estimates in 2012/13 indicate that there are 3 girls for nearly 4 boys. Most of the schools were constructed with the help of aid assistance from the international community. The total number of students enrolled in secondary schools grew during 2007/08 from 19,146 to 20,489, which translates to an annual growth rate of 7%, but gender disparity in enrolment stands at 1 girl for 2.4 boys in the 2009/2010 school year. 63% of the secondary schools in Somaliland are public while 37% are private (Somaliland figures, 2014). There are also about seventeen universities with 2000 students graduating every year.

Health: The population of Somaliland which stands at 3.5 million is served by 25 hospitals, 91 health centres and 164 health posts. The health sector receives large amounts of assistance from international organizations (Somaliland figures, 2014).

Water: There are no perennial rivers in Somaliland. People from urban town get water from the underground water sources particularly boreholes. The water supply for rural communities

mostly comes from shallow wells, surface run off collected into the underground cemented cistern which is locally known as *''Berkad''* and other water sources including earth dams and springs. Somaliland has established the ministry of water resources which has developed water regulatory frameworks including policies, water regulations, strategies and acts. This ministry is responsible for water related issues in Somaliland.

Economy: The backbone and mainstay of Somaliland's economy is livestock, that contributes 60-65% of the GDP and 80-85% of foreign trade (exports) earning. About 65% of the population depends either directly or indirectly on livestock and livestock products for their livelihood. Crop husbandry provides subsistence for about 20% of the country's population. Foreign aid and remittances from the Somaliland Diaspora also play a major role in the economy of the country. The contribution of livestock to the national economy is estimated at close to 28%. Thus, a large share of Somaliland's people relies mainly on livestock products and by-products for their livelihood (Ministry of Planning and Development, 2010).

7.4. Natural Resources Context

Soils: Soil types closely follow the geomorphology of Somaliland. Soils are characterized by poor structure, high permeability, low moisture retention capability and inadequate internal drainage. Soil erosion is a major problem. This is a result of torrential rainfall on sloping terrain, heavy wind storms, overgrazing of livestock and vegetation clearing for farming purposes, fencing wood and charcoal production. Soil erosion has led to reduced water infiltration and a corresponding increase in runoff. Both gulley erosion and stream bank erosion is prevalent. Gully erosion is a threat to both farming and livestock production. It has already made large areas of land unproductive and is spreading at an alarming rate.

Vegetation: The vegetation of Somaliland consists mostly of grass, shrubs, and woodland. Grass and shrubs are mainly in the coastal plains. Shrubs and grass with scattered trees are dominant in the sub-coastal areas (north of the Golis Mountains). Evergreen trees and scattered shrubs, which are sometimes in clusters, can be found on the Golis Mountain. Open trees (woodland) are mainly in the plateau southeast and southwest of Hargeisa. The most common trees are Acacia and Commiphora species.

Land tenure and use: The land is a public property commonly owned by the nation, and the state is responsible for it (Somaliland National Constitution, Art. 12). In the past the rangelands were held either under a system based on customary water rights in the traditional clan-based land ownership system in which land was considered to 'belong' to families although there was no formal title deed. Land is mainly used for livestock production or mix crop and livestock production.

The use of different zones at different seasons is greatly influenced by fodder, pasture and water availability and by the seasonal activity of biting insects and ticks. The coastal grasslands are used for extensive livestock grazing especially in the dry season as water is more available in these areas than in the wood land. The bushy grassland areas provide a good source of wet season grazing and are favoured for camel and goats because of their browsing habits.

Farming practises: Somaliland agriculture sector contributes to 25% of the country's livelihoods and is dominated by subsistence farmers, who practice rain-fed farming. Dry land farming accounts for nearly 90% of all agricultural activities with irrigated agriculture accounting for 10% of agriculture activities (Master plan for Somaliland agriculture sector, 2007 and Somaliland in figures, 2011). The main crops grown in Somaliland are maize, sorghum, millet and cowpea. Typically local varieties, including Elmi Jama, a late maturing sorghum variety is grown. Intercropping of different plants in the same field is common. Water melons and vegetables are also cultivated in some developed watersheds using rainfall runoff harvested in reservoirs along seasonal river banks. The geophysical characteristics of the shallow and stony soils in the mountains and piedmont areas and lack of adequate soil moisture in the coastal zone means that there is limited agricultural activities in these zones. Other limitations for crop production include soil erosion and low soil fertility due to the increasing trends of land degradation that further limits the suitability of agriculture in the marginal lands.

Land degradation: The SWALIM's study has shown that land degradation is moderate to strong in Somaliland. About 37% of Somaliland is degraded and the most common degradation types are loss of topsoil due to wind and water erosion, loss of soil nutrient in agriculture productive areas (mainly western part of Somaliland), loss of vegetation cover (in eastern part, parts of north-western and south-eastern). Soil loss by water erosion and loss of vegetation were the most

widespread types of land degradation in Somaliland. Although the degradation is moderate to strong, its trend is increasing. Therefore sustained and strategic measures are needed to control the degradation (FA0-SWALIM Technical Report L-10).

On the other hand, large concentrations of livestock together with the felling of trees for charcoal and firewood have had a profound impact on species composition, ground cover and the structure of vegetation. Grazing pressure and soil erosion are now a serious problem and, together with periodic droughts, have had a devastating effect on the vegetation and soils (Sommerlatte and Umar, 2000).

Land Policy and Legislations: There had been attempts in the past to develop national land policy but it has not been developed. The Somaliland Government has established a Land Policy Review Committee (LPRC) with task to develop a comprehensive land policy. The process of developing a land policy is one and this report will contribute towards this process through providing evidence based information on land and natural resources situation in Somaliland.

Rain fed agriculture is the main agricultural production system, and is practiced in the Baki and Borama districts (Awdal region) and in Gabiley region and the Faraweyne and Hargeisa districts (Maaroodi-Jeex region). A smaller portion of the country has irrigated agriculture along the river valleys. The Somaliland authorities recognize the need for land use planning and zoning and consultations have been going on between relevant Government ministries and traditional leaders aimed at resolving the emerging conflicts caused by spontaneous settlement and enclosure of rangelands. The major land policy areas of concern are:

1. Demarcation of pastoral rangelands and farmlands,
2. Abolition of all enclosures illegally held by communities and return to common property status,
3. Restoration of all previous governmental range reserves to the relevant agencies
4. Promotion of land management among concerned governments institutions, traditional leaders and communities.
5. Expansion of urban areas into rural territories (specifically grazing land)

Land is governed under plural legal system, namely Sharia, Statutory and Customary laws. Existing statutory laws related to land governance are as in the table below.

Land policy, laws and acts	**Institution**
Agricultural Land Registration Act, 2008, draft	Ministry of Agriculture
Somaliland Agricultural Policy, 2008, draft	
Somaliland land tenure policy, 2008, draft	
Prevention of Deforestation and Desertification Law (Environment Conservation Act and Proclamation)- Law No. 04/1998, approved	Ministry of Environment and Rural Development
Somaliland Rangeland Policy, 1999, Draft	
Law on Forests Conservation and Fauna Law No. 69/2014	
Presidential Decree No. JSL/M/WM/222-2689/092014	
Urban Land Management Law No.17/2001Law on Fauna (Hunting) and Forest Conservation Law No. 15/1969	Ministry of Public Works and Housing
Prevention of Degradation and Deforestation law No. 04/1998	
Ministerial Regulation on Land Dispute Law. No. 01/2014	
Coordinating the development of the Somaliland Land Policy Development (on-going)	Ministry of National Planning & Development
Presidential Decree No. JSL/M/MG/081/1-3495/082015	
National Water Law No. 49/2011	Ministry of Water Resources
Law of livestock No. 34/2006	Ministry of Livestock
Somaliland Fishery law(N0:24/1995)	Ministry of Fisheries and Marine Resources
Mining code Draft(N0:---/2000)	Ministry of Mines

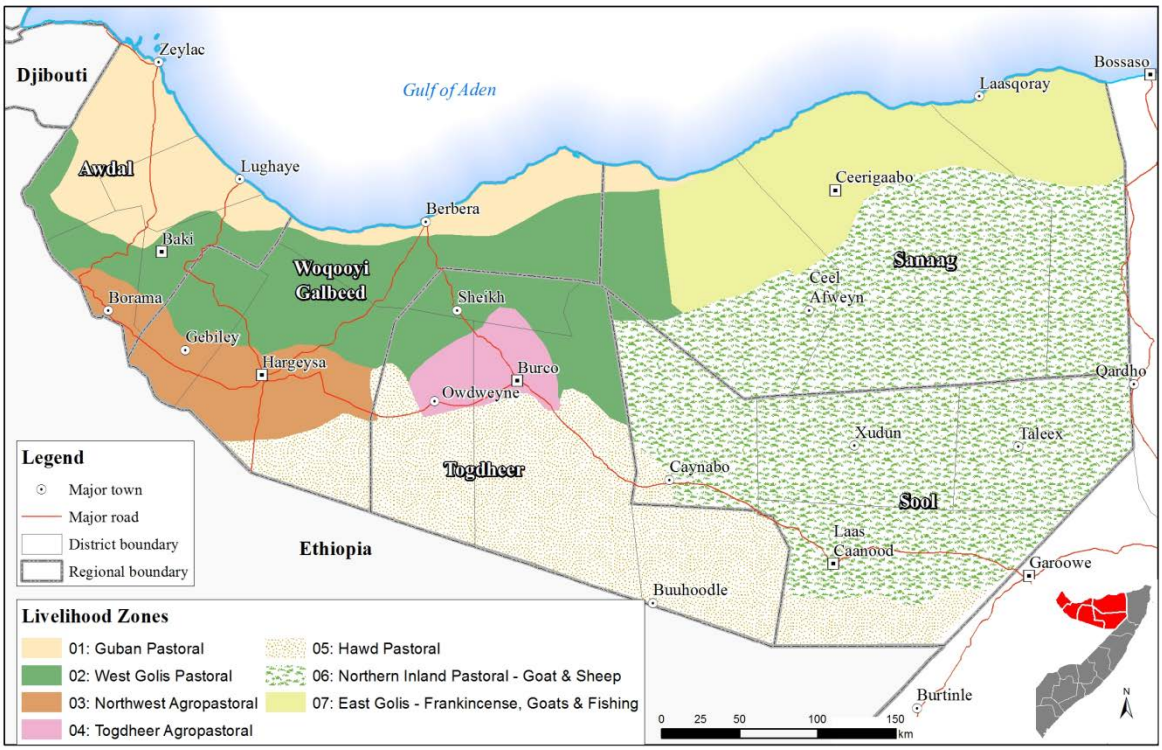
Table 10: Key land related policies, laws and acts in Somaliland

7.5. Public Service Delivery and Information Management Context

With an economy dependant on natural resources, the absence of reliable information to facilitate allocation and re-distribution of resources and planning presents major challenges. Yet, good-quality water and land information is widely recognised as crucial to relief, rehabilitation and development initiatives for Somaliland. Somali Water and Land Information Management project (SWALIM), has been in operation since 2003 to provide critical water and land resources related information. SWALIM does this by retrieving lost data and building upon them to create and make available a wealth of information for sustainable water and land resource management. However, if the capacity required to manage such a system is not developed, this service will continue to be sourced externally. To meet this need, SWALIM aims at building the capacity of the Somali institutions and individuals to enable them continue with the generation, communication and use of water and land information by Somalia's public sector.

7.5. The Livelihood context: a zonal perspective

In Somaliland the major livelihoods from the land resource comes from pastoral, agro-pastoral and Silva-pastoral activities. The rural economy is based predominantly on these activities in the form of livestock, agriculture, forestry and their associated trade. Although Somaliland has growing urban centres that consumes large quantitates of food items, nevertheless the practice of value chain is almost non-existent and the local products from the livestock and agriculture is marketed without adding any value. On the other hand imported dairy products, poultry and other agriculture products is a common scene in these urban centres. From the land resource perspective, Somaliland is divided in seven livelihoods zones (with considerable overlaps) as follows:



Map 21: Livelihood zones of Somaliland (FSNAU 2015)

1. Guban Pastoral and Mountain Livelihood Zone

The Guban pastoral livelihood zone covers the northwest, along the coast, and is known to have strong connections with the Middle East. Many of the Somalis in this area are of the diaspora origin, thus substantial remittances are received from abroad in this zone. This zone also supports good livestock conditions due to reasonable water sources available in the mountains and camel, cattle and goats/sheep is the common livestock, owned by pastoralists. In general animal and human population have increased over the last few years with high numbers of returnees from southern and central Somalia. Due to the stable security situation since 1996 and favourable natural environment for livestock this is relatively wealthy area with diversified livestock holdings and a more guaranteed mountainous water supply as cattle are predominantly found in the mountainous areas. 70% of the total livestock population are sheep, 25% goats, 4% camel and 1% cattle. 80% of herd composition in mountainous zones is goats, whilst in the Hawd plains 75% are sheep.

2. **West Golis Pastoral Livelihood Zones**

The West Golis livelihoods zone comprise of highlands that crosses Togdheer, Waqooyi-Galbeed and Awdal regions of Somaliland. With highest peaks located around Sheikh the altitude of the zone reaches to over 2000 meter a.s.l and intercepted with valleys. Together with palatable grass species, the vegetation cover is dominated by shrubs and trees, mainly Acacia species. This vegetation cover adequately supports the livestock and thus the livelihoods predominantly comprise livestock rearing – sheep, camel and mainly goats. Together with sporadic springs, the main water source is shallow wells in the valleys and during dry seasons water scarcity is experienced in the zone. Based on these resources irrigated agriculture is practiced sporadically and mainly on subsistence basis.

3. **North West Agro-Pastoral (NWAP)**

North West Agro-Pastoral (NWAP) livelihood zone extends west of Togdheer agro-pastoral livelihood and is bordered by West Golis Pastoral to the North and Hawd Pastoral to the south and Zone 5 of Ethiopia to the west. With topography ranges from 1000 to 1700 altitude, this zone is a prime crop (sorghum and maize) and cattle production area. Parts of the area have been under sorghum and maize cultivation since the 1930s and in the 1990s it was the only significant area of sedentary cultivation in Somaliland. Most of the zone is composed of scattered acacia trees, but in the arid areas of the northeast, grasslands give way to a combination of low brushes and grass clumps. The main water sources are Ballis (rainwater catchment) in the slopes of the Golis Mountains and shallow wells in the northern part. Crops growing, livestock production and trade are the major livelihood related activities.

4. **Togdheer agro-pastoral livelihood zone**

The zone is closely linked with the urban and Hawd pastoral communities through livestock/products trade, sale of charcoal, access to labour and kinship support. The population of Togdheer Region is estimated at 402,295 persons (30% urban, 65% nomadic pastoralists, & 5% agro-pastoralist). The area has traditionally been used as a grazing area with small pockets of rain-fed cultivated land. The Main crops of the zone are sorghum, maize, cowpea, water melon and vegetables. Grass production and sale is a vital income source for the middle & better-off and

provides labour opportunities (grass cutting) for the poor. Wealth determinants are mixed livestock and cultivated land. Both assets have reduced in recent years due to limited farm inputs and recurrent droughts. Income sources include livestock and its product sales, petty trade, fodder sales and labour. Burco market is a dynamic and rapidly expanding centre, the zone also benefits from its proximity to Berbera port and Burco/Yaroowe markets with access to livestock trade and opportunities for fodder sales and employment. Nevertheless, recurrent shocks (drought & disease) have affected livestock herd sizes, forcing some pastoralists to shift in to farming around streams or moving to urban centres looking for jobs.

5. **Hawd pastoral:**

The Hawd Pastoral livelihood zone extends from the North West in West Galbeed to the highlands of Togdheer and Galbeed in the North, traverses the foothills of the Golis range in the East, eventually merging with the wider Hawd plateau in the Somali region of Ethiopia. The region benefits from bimodal rainfall: Gu (April-June) and Deyr season (October- November). Some Western parts of Togdheer and the South of Waqooyi Galbeed region experience short cycle karan rains (mid-August-September). The dominant species reared include sheep/Goat and camel.

6. **Northern inland pastoral – Goat and sheep**

This sheep and goat (shoat) pastoral livelihood zone is among the largest pastoral livelihood zones in Somaliland. Soil and vegetation varies, but have common resemblances. The rangeland conditions are under continuous degradation due to persistent droughts, overgrazing and proliferation of berkads/boreholes. The Annual Rainfall (100-200 mm) is erratic with very high evapotranspiration rates. Berkads and Boreholes are the main water sources in Sool area. Main socio-economic activity is pastoralism, as livestock is the key livelihood asset (Shoat/camel etc.). Sale of livestock and livestock products is the main source of income. Purchase of imported food commodities complimented by some portion from livestock products and food aid are commonly accessible. In general there is heavy reliance on livestock export and food supply through Bossaso port.

7. East Golis Livelihoods Zone

East Golis pastoral livelihood zone is characterised by the frankincense, goat, sheep & camel and artisanal fishing related livelihoods activities. The zone covers an area of approximately 41,380 square kilometres, with rugged terrain and mountain ranges that are incised by dry seasonal rivers and ravines. The slope in this livelihood zone is steep in the area around Ceerigaabo and the Golis Mountains; and slightly flatter towards the Gulf of Aden. The zone receives two seasonal rainfalls separated by two dry seasons. Livestock reproduction and productivity peaked at water and pasture availability in the Gu and Deyr seasons. These periods coincide with increased milk availability, which contributes to improved household dietary needs and income from livestock products. Livestock sales usually peak in May and October, due to improved livestock body conditions, good water and pasture availability and high demand due to the Eid and Hajj festivities. Low milk availability occurs in Jiilaal and mid-Hagaa seasons, due to low water and pastures production and out migration of livestock away from pastoral catchments.

In this zone tapping and selling frankincense is a key livelihood activity, its production is negatively affected by droughts, storms and winds which sometimes lead to trees falling, termites, plant borers and overexploitation of trees. Seeking of social support and credit is a key coping strategy perfected by poor households in the livelihood zone. For instance, most poor and lower middle households seek credit during the onset of the Frankincense production period and repay the debts during the peak harvest periods around August, the period when the price of frankincense is high.

8. Integration, Conclusion and Recommendations

This territorial diagnostic report of the land resources of Somaliland focusses predominantly on bio-physical characteristics as the major determinants of the productive potential of land. The synthesis of the SWALIM information on climate, landform, soil and landcover/landuse provide us with systematic insight on the status of the biological aspects of the land resources. It is important to note that the other influencing factors, such as socio-economic, demographic and institutional dimensions in Somaliland, play an important role in the utilization, replenishment and/or degradation of the land resource.

With a population density of some 25 persons per Km^2 and the rather low intensity land management practices, the ecological footprint in general and the pressure on the land resource in particular should be within reasonable limits. The nomadic and rural dwellers that directly depend on the land resources together count for less than 45% of the population of Somaliland.

With its 65% dependence on livestock and 25% on agriculture, the land resource feeds this population directly through products and services arising from livestock, agriculture and forestry sectors; and indirectly through Ecosystem Goods and Services (EGS). With around 90% of land under nomadic and transhumance pastoralism and above 2% under agro-pastoralism activities the economic picture shows extensive land utilization with rather inadequate economic return. With 28% contribution to the national economy and fed by the lion's share of land resource, the livestock sector is posed with three sets of challenges: a. the un-regulated and excessive use of the rangelands in the form of free grazing, b. rather than productivity, the number of livestock is the prevailing value, and c. the inadequate efforts of value chain management in this sector. Thus a win-win situation for the rangeland and livestock needs to be ushered in through cost-effective and sustainable management of livestock and the pastures.

With the very small portion of land under agriculture, and in the form of subsistence farming, achieving food security for Somaliland is a challenging proposition. This situation is exacerbated by other elements, such as dwindling water resources, climate shocks, the spread

of invasive species into productive lands (specifically the Prosopis tree species), and accelerated land degradation through water and wind erosion.

The politico-institutional context of Somalia now presents a reasonable scenario - specifically by integrating contemporary democratic structures with the traditional clan system in the form of legislative houses of representatives and elders. This provides the potential to shape policies through consensus on one hand and integrate the national and grass-root scenarios on the other. The constitution of Somaliland stipulates remarkable environmental conservation clauses through its articles 12 and 18 for the sustainable management of the land resources. These clauses entrust the state with enormous responsibility and require elaborate institutional infrastructure to implement on the ground. Somaliland authorities are aware of these challenges and are consistently exhibiting their willingness to cope with this capacity gap through strategic planning and policy measures. Nevertheless the task is uphill in nature and cohesive and collaborative efforts are required.

At the institutional level, all the sectors which depend directly on land resources, such as agriculture, livestock , and forestry, are facing a dichotomy of two streams of knowledge – contemporary scientific and indigenous. The differences are quite sizable in nature, but the two approaches can work in parallel. The government institutions go by the former stream whereas the nomadic and transhumance communities manage the land resource through the latter. Any systematic effort to integrate these efforts, although very important, however is missing.

At the institutional level the challenges are manifold, including limited skills and understanding of integrated land resource management among the lower tier of the relevant staff, with very limited capacity (in staff numbers, skills, systems, equipment, finances, networking, etc.) on the ground. The strength of the staff at the ministries' level is still lean. However the staff is much better compared to field staff, who are too few on the face of the tasks shouldered to them. At the management level, three essential issues must be addressed: adequate research and extension, intensifying investment towards short-term and long term returns, and putting in place value-chains, appropriate marketing and access to benefits and obligation sharing.

At the bio-physical level, the report is based on an analysis of the land resources of Somaliland along the four major landforms: coastal and piedmont, mountains and highlands, plateaus and valleys. The productive potential in these four landforms is analysed on the basis of climate, soils, land cover and land use. The relevant details are condensed in the following table:

Table 11: Synthesis of the bio-physical aspects of the land resource of Somaliland

Landform	Climate					Ground Water			Land-cover					Land-use				Soil				
	Total rainfall	Distribution	PET	Temp ^{0}C	Rainfall/PET	# of borehole	Depth	Water Quality	Herbaceous vegetation	Wooded vegetation	Rainfed crop	Irrigated crop	Bare area	Nomadic Pastoralism	Trans-human Pastoralism	Agro-Pastoralism	Bare soil	Type	Depth	Texture	Fertility	Salinity
Coastal plain and Piedmont (comprise of coastal belt, however wider in west and covers most of Zylec and Lughaya)	< 100	Uni-modol	2977	28-35	PET exceeds rainfall by more than 30 times	18	Max 240 M Min 40 M Average 105 Meter (8) 44% shallow	Water along the coastal plain is of mixed quality	9992 Km2 (71.4%)	589 Km2 (4.2%)	NA	2.9 Km2 (0.02%)	3391.5 24.23 %	46.5% of the area	34.96%	0.02%	18.40 %	Arenosols (48%) Regosols (24%) Leptosols (12%) Solonchak Cambisols Fluvisols	Deep Shallow Very Shallow Deep Deep Deep	Loamy Sandy Rocky / stony Silty, sandy loamy	Low N, P & good in K	none to low salinity medium to high
Mountain and Highlands (comprise of Al Mountain/Gol is (Oogo) Boorama, Gabiley and Hargeisa)	500 - 600 around Borama 300 - 500 around Sheikh & Ceerigaabo	Bi-modal	1300	20 -24	PET is almost equal to the rainfall	79	Max 394 M Min 28 M Average 111 M 41(52%) shallow	Water quality along the mountains is generally fair	32985 Km2 (63 %)	7372 Km2 (14%)	471 Km2 (0.90%)	283 Km2 (0.54%)	11315 Km2 21.5%	74%	16%	2%	6.20%	Leptosols 59% Cambisols 22% Regosols 6% Calcisols 6% Solonchak 3%	Very Shallow Deep Shallow Deep	Rocky loamy Sandy loam Clayey	Low NPK Low NP, K is good	Low High Not saline High
Plateaus (comprise of Burco, Oodweyne, Caynabo, Ceel-Afweyn, Dhahar, Badhan,	500 - 600 in the south and southwest 200-300 near Burco and Oodweyn	Bimodal	1300	20 - 24	PET is 1.5 times to the rainfall	164	Max 379 M Min 37 M Average 162 M	Majority of boreholes is poor, due salinity.	39156 Km2 (52.3 %)	19303 Km2 (21.8%)	1936 Km2 (2.6%)	174 Km2 (0.2 %)	17186 23 %	63.50%	32%	3.40%	0.60%	Calcisols 31% Cambisols 18% Solonchak 17% Leptosol	Deep Deep V.shallow do	Clay Loamy Rocky	Low N, High PK Low N & P, K tends to high	Not saline High Absent or low in the rest

Wajaale, Gebiley, Borama and Hargeisa)	e.						Only 23 (14%) shallow										s 10% Gypsisols 9%				
Valley (comprise of Laascaanood, Taleex,Xudun)	<200	Bi-modal	2014	28 - 32	PET is 7 times to the rainfall	48	Max 291 M Min 42 M Average 111 M 20 (42%) shallow	Water quality gets poor in the valleys	16739 Km2 (57%)	4925 Km2 (16.9 %)	4 Km2 (0.01%)	75 Km2 (0.26 %)	7438 25.5%	94.70%	3.80%		1.10%	Calcisols 35% Solonchak 24% Regosols 20% Leptosols 19%	Deep Deep Shallow V.shallow	Clay Silty or sandy Sandy loam Rocky / stony	Low N, adequate in P and high to average in K	Low, except solonchak

Coastal plain and Piedmont: (comprised of the coastal belt, including the towns of Laasqoray and Berbera, and is wider in the west covering most of Zeylac and Lughaye).

Climate: with a total rainfall (uni-modal) of less than 100 mm per annum and a temperature range of 28-35 ^{0}C, (e.g. where potential evapotranspiration exceeds rainfall by thirty times), the landform is characterised by extreme aridity.

Soils: The soils of the region are comprised predominantly Arenosols (48%) and Regosols (24%). The highly arid climate affects the soil formation process and the soils are poor in texture, structure and fertility. The aridity, together with the absence of adequate land cover, facilitates erosion and sheet and gully erosion is a common phenomenon in the landform. This process is leading to perpetual soil impoverishment in most of the landform. Nevertheless the soil diversity and status improves in the north-western part of the landscape.

Land cover: the predominant land cover (over 95%) is comprised of herbaceous vegetation and bare area, with 4% woody vegetation scattered between Lughaye and Berbera. Only some 3 Km2 (0.02%) near Berbera supports irrigated agriculture.

Land use: the land use of this landform is mainly nomadism and transhumance pastoralism.

Mountain and Highlands: This comprises the Al and Golis Mountains and lies to the south of Laasqoray, north of Ceerigaabo and around Sheikh, South of Hargeisa and Borama.

Climate: The landform receives 500 - 600 mm of rain around Borama and 300 – 500 mm around Sheikh and Ceerigaabo: the rainfall is distributed in two seasons. The temperature ranges from 20 to 24 degrees Centigrade and the ratio between rainfall and potential evapotranspiration is almost equal, the most balanced in all of Somaliland.

Soils: The major soil class is Leptosols (59%) which are predominantly rocky and shallow, followed by Cambisols (22%) which are deeper and loamy. The soils generally lack fertility despite being well stocked in potassium and micro-nutrients. Adequate rainfall and lower aridity means the soils in the less sloping lower reaches are better developed.

Landcover: the landcover comprise herbaceous vegetation over 32,985 Km2 (63 %) and woody vegetation over 7,372 Km2 (14%), with more than 21% bare area. The vegetation is concentrated in the Golis Mountains but also in the areas surrounding Borama and Hargeisa.

Land use: a considerable part of this landform is still under nomadic pastoralism, with 16% in transhumance pastoralism and 2% under agriculture. Given the large extent of the landform, this comprises around 1,000 Km^2.

Plateaus: (comprised of Burco, Oodweyne, Caynabo, Ceel-Afweyn, Dhahar, Badhan, Wajaale, Gebiley, Borama and Hargeisa)

Climate: The landform receives 500 - 600 mm of rainfall south of Borama and Gebiley, and 300 – 500 mm around Burco and Oodweyne; the rainfall is distributed in two seasons. The temperature ranges from 20 to24 degrees Centigrade and the ratio between rainfall and potential evapotranspiration is one to one and a half, therefore a manageable climatic situation.

Soils: The soils in general are deep, low in nitrogen and phosphorus, high in potassium and other micro nutrients. Salinity is found in cambisols, but absent in other soil types. Generally the soils are productive and the fertility can be replenished by adding nutrients.

Landcover: This landform represents the largest portion of Somaliland and 39,156 Km2 (52.3 %) is covered by sparse or herbaceous natural woody vegetation, 19,303 Km2 (21.8%) is covered by closed to open natural woody vegetation, with 1,936 Km2 (2.6%) area under rainfed agriculture and 174 Km2 (0.2 %) under irrigated agriculture. Around 23% of the area lying in the east of Ceel Afweyn is bare.

Land use: around 70 million hectares (over 90% of the area) of this landform together is under nomadic pastoralism (60%) and transhumance pastoralism (30%), with 256,000 hectares under agro-pastoralism (3.4% of the area of this landform). This implies that most of this landform is dedicated to pastoralism.

Valley (comprised of Laascaanood, Caynabo, Taleex and Xudun)

Climate: With total rainfall of less than 200 mm per annum (distributed in two season) and a temperature range of 28-32 ^{0}C, the potential evapotranspiration exceeds the rainfall by seven times, meaning the landform is characterised by high aridity.

Soils: The soils of the valleys comprise clayey Calcisols 35%, silty or sandy Solonchak 24%, sandy loam Regosols 20% and stony or rocky Leptosols 19%. Where the calcisols and solonchaks are deep, however, the other two types are shallow. Except for the solonchaks, salinity is absent in the soil types of this landform. The soils are low in nitrogen, adequate in phosphorous and high to average in potassium.

Landcover: In this landform 57.3 % (16,738 ha) is covered by sparse or herbaceous natural woody vegetation, 16.8% (4925 Km2) is covered by closed to open natural woody vegetation, and only less than 0.26% (78 Km^2) southeast of Burco has irrigated agriculture. The rainfed agriculture is nominal in this landform. Over 25% of the area is bare, stretching east to west of this landform, south of Xudun and Taleex.

Land use: around 2.8 million hectares (over 94% of the area) of this landform together is used for nomadic pastoralism (77%) and transhumance pastoralism (18%), with only 2,165 hectares under agro-pastoralism (0.1% of the area of Somaliland). This landform is also characterised by timber collection and charcoal production activities.

Challenges and Gaps in the sustainable management of the land resources of Somaliland:

Based on the overall analysis, the land resource of Somaliland poses the following challenges and gaps that need to be addressed to ensure the sustained supply of its products and services:

Bio-physical challenges:

Aridity: Due to high temperatures and low availability of rainfall, the evapotranspiration in most cases far exceeds the rainfall, except in areas within the mountain and highlands and a small proportion of the plateau. Areas along the coast and in valleys face extreme aridity.

Ground water challenges: the ground water availability presents challenges of quantity, quality, distribution and high development cost. Besides limitations in quantity, the

distribution is skewed and the underground reservoirs pose disjointed distribution. The quality is marred by salinity in many cases.

Surface water challenges: Somaliland is receiving substantial amount of rains in the wet seasons, however the rains rather than replenish the ground water and/or become a source of irrigation, turn into perilous source of run-off and thus leads to accelerated erosion both sheet and gullies. Reliable information is not available on the extent, timing and location of the surface water availability, SWALIM conducted a study at Tog Waheen and its recommendations are reflected in this report.

Climate shocks: Changing climatic patterns shift from protracted droughts (especially in the eastern part of Somaliland) to floods in the seasonal rivers. The situation is exacerbated by the poor land cover on one hand and the inadequate preparedness for these hazards. The hazards of drought and flood trigger livelihood crises and that in turn lead to further degradation of the land, as the need for survival compels local people to exhaust any left-over vegetation through over grazing and deforestation.

The fertility of the soils: Evidence of declining fertility cannot be established definitively. Although the soils have adequate Potassium and micro-nutrients, they are generally poor in phosphorus and, in particular, nitrogen. Surface salinity in uncommon, but the soils are alkaline and crops requiring neutral soils have less prospect of.

The soil texture also presents major challenges, as loamy and deep soils are found only in some parts of the highlands and plateau landforms. Beyond these areas, most of the soils are either excessively stony or sandy, with limited prospects for crops.

Accelerated erosion: Erosion by wind and water is common and leads to further degradation of the soil and vegetation. In dryer areas along the coast, and also in parts of eastern Somaliland, sand dune formation is a common phenomenon. The formation of ever-expanding gullies is seen in sloping areas.

Low biomass production: due to the bio-physical constraints in general, and the aridity and inadequate ground water specifically, Somaliland is faced with low biomass production that

perpetuates other issues related to soil fertility and the production of ecosystem goods and services.

Invasive species: Several invasive species (such as Prosopis, Opuntia, Parthenium species, etc.) threaten the land resources of Somaliland. Among these species Prosopis poses the major threat as this is encroaching mainly productive areas under agriculture or forestry. *Prosopis* is widely spread across Somaliland with a particularly high concentration in the Woqooyi Galbeed region. The pattern of invasion confirms that it invades first lowlands next to rivers and Wadis as well as peri-urban areas both inland and along the coast.

Management Challenges:

Absence of holistic planning and management of land resources: land resources in general and the various land uses in particular toned to be managed in a cohesive manner. This is imperative in a complex conglomeration of land uses that depend on each other. These ecosystems also require a holistic approach that brings together the social, ecological and economic realities. However, in Somaliland integrated planning and management is absent.

Absence of value-added sustainable use of land resources: the resources are not processed and used in a value-added manner. As a result, while the land resources are over-exploited, the socio-economic returns are much less relative to the corresponding resource use.

Lack of the use of modern technologies and input intensive management: input intensive management and the use of modern techniques and technologies is the exception rather than the prevailing practice.

Ecosystem fragmentation and degradation: Shaped particularly by deforestation, erosion, gully formation, encroachment for agriculture and infrastructure, the degradation of the ecosystem adversely affects the productive potential of land in Somaliland in general and the drier parts of the Sool and Sanag areas in particular. The deforestation for charcoal, mostly for commercial purposes, is another leading factor in deforestation and ecosystem degradation.

Free and extensive grazing of large concentrations of livestock, together with the felling of trees for charcoal and firewood, have had a profound impact on species composition, ground cover and the structure of vegetation. Grazing pressure and soil erosion are now a serious

problem and, together with periodic droughts, have had a devastating effect on the vegetation and soils.

The free/over grazing has led to habitat degradation in multiple ways, such as the stunted growth of vegetation due to browsing pressure. Over-grazing has also marred the natural regeneration of the woody vegetation. The “hoeing” phenomenon, together with the removal of the vegetation cover, has facilitated gully and sheet erosion. Thus the process of land degradation is perpetuated by the mutually reinforcing factors of soil erosion and the suppression of the regenerative capacity of the natural vegetation – the protective cover of the soil and habitat in general.

Selective deforestation: Acacia species are the most favoured trees for making charcoal, as well as for timber and other uses. These species, belonging to the **Leguminosae** family, uses atmospheric nitrogen, thus allowing it to survive in nitrogen poor soils while enriching the soils naturally. The removal of these trees deprives the otherwise nitrogen poor soils of Somaliland of their only source of natural enrichment.

Unsuitable or unproductive land for farming: cost-ineffective agricultural practices are widely practiced, specifically in areas which are otherwise not fit for agriculture. Farmers soon abandon these lands for another patch of (unfit) land to see the same fate repeated again and again. . This renders a substantial amount of land completely unproductive.

Infrastructure deficit: essential infrastructure, in the shape of farm-market roads, marketing infrastructure, storage facilities, etc. are largely not available.

Increase of unpalatable plant species in plains: overgrazing is leading to the depletion of palatable species and the infestation of less-palatable species. This increases food insecurity for livestock in a place where the economy depends greatly on livestock.

Institutional & Capacity gaps:

Divergent Vision, Power dynamics and Resource use: Various actors and ministries are involved in the management of land resources; however the vision, power dynamics and ultimate resource use are not coherent and not driven by consensus.

Given the evolving and promising constitutional, policy and legislative framework, the institutional and human capacity is rather limited. The ministries are considerably structured, but are understaffed; the situation further deteriorates at the level of region or districts. Thus policies formulated even in a participatory manner have less prospect of effective implementation on the ground.

Research and Extension: Despite the presence of a staff position for research at the Ministry level, the actual capacity to conduct research work is very limited. The research cycle is non-existent in the regions and districts, as there is no extension and feedback mechanism from the research services of the ministry to the ground and vice versa. In addition to understaffing, the ministries and regional hubs are poorly endowed with essential equipment, materials and infrastructure necessary for effective operation. The fiscal allocation is small and the available essential equipment are few compared to what is required.

The knowledge aspects: Although the organizational structures are elaborate, and have within their mandate integrating indigenous elements of management (such as the clan system and traditional practices), the overall multi-dimensional human resource requirement is nevertheless barely touched. The challenges are manifold, including limited skills and scarce understanding of sustainable land management among the lower tier of the relevant staff, and the very limited human capacity (in number, skills, systems, equipment, finances, networking, etc.) on the ground. The staff at the ministry level is reasonably educated and, while few in number, still comparatively much better than the field staff.

Absence of coordinated management by institutions: Sustainable land management entails coordinated planning and management of all the institutions involved in land use. Beside the public sector institutions, civil society/NGOs and grass-root communities are either not effectively engaged or otherwise work in a patchy and non- synergistic manner.

Lack of capacity for negotiation and engagement: the skills, knowledge, structure and associated human resource are not available to engage and negotiate win-win situations among conflicting stakeholders at the local level.

Overlapping traditional/statutory systems: in many cases, two sets of rules exist and are applied in an overlapping manner. At the same time adequate understanding and recognition of customary systems and rights among the statutory legal institutions is lacking.

The issue of tenure: land resources in Somaliland present a variety of tenurial arrangements. Traditionally, these were predominantly communal. However the land tenure system has evolved over the years categorized as follows: communal land (predominantly controlled by clans in rural areas), (i) public land (government controlled land including wildlife reserves, etc.), (iii) private land (majority in urban areas and in rural areas as well especially farmland). This fragmentation of de-facto ownership is plagued with opposing claims and thus rife with conflicts that have led to a "tragedy of the commons" and thus over-exploitation of the resource base.

Recommendations:

In response to the above challenges, the following measures are recommended to manage the land resources of Somaliland on sustainable basis:

Vision and road map formulation for the sustainable governance of the land-resource of Somaliland: Preferably in an event/conference where all the key actors and stakeholders are present, the vision and broad road map for governance and sustainable management of the land resources of Somaliland should be developed.

Capacity to plan and implement the sustainable land resource management: SWALIM has already carried out a gap assessment on capacity and has devised recommendations related to various aspects of the requisite capacity for sustainable land management. The plan should be implemented through SDF resources, preferably on a smaller scale to start. For full roll out, resource mobilization should be carried out. SWALIM can help in reviewing the plan and mobilizing resources for its implementation.

Challenging the present paradigm and Shifting to more Proactive scenarios: looking at land in its totality rather than in pieces based on potential use; identifying the interfaces of one land use with another – looking at the land as an ecosystem with the potential for the production of goods and services.

Cost benefit analysis: A thorough cost-benefit analysis is also recommended, focussing on the costs and benefits of "business as usual" compared with the more proactive and holistic scenarios suggested by the recommendation listed in this report. The cost benefit analysis should also examine the use of modern technologies and input intensive land management. This should also include the feasibility and demonstration of small and medium enterprise development, including micro-finance facilitation.

Integrated land-use planning and management: It is recommended that this be carried out in an informed, integrated and participatory manner at various levels, starting from the smallest unit of land resource (i.e. the village) and subsequently moving to larger units, ultimately arriving at the landform level. This needs to be done by a multi-disciplinary team that combines various expertise (technical, related to the bio-physical aspect of land, legal, experts in negotiation and engagement, experts in resource economics, etc.) as well as involving community representatives and civil society experts. The process should be led by a focal point in the ministry who has the mandate and capacity to coordinate and convene various stakeholders. The process should commence with the resource assessment at the micro level, preferably using a physical assessment together with GIS and remote sensing estimations. It must be done in an inclusive manner, without compromising on the rights of marginal segments of the community. The process needs to be flexible in nature to cope with the varying realities on the ground. However, it must be steered in a centred and principled manner and include the following elements:

- Meaningful engagement on the basis of inclusivity and transparency
- Systematic situation assessment, including analysis of opportunities and challenges
- Holistic/integrated approach facilitated by multi-disciplinary team
- Agreement on the fair distribution of benefits and investments/obligations
- Realistic system of implementation and appraisal

Addressing the issue of aridity: The generic proposition on addressing the issue of aridity is to choose the land-use in congruence with the natural capacity of the land. Thus the potential

of landforms 2 and 3 (plateau and mountain and highlands) needs to be optimally used, as these landforms offer areas where agriculture can be practiced in a cost effective manner within the given precipitation range. However, the landforms with extreme aridity need to be managed for other uses, such as forestry, through conservation measures. This is essential to check the expanding desertification of these regions, which could ultimately spread to more promising land resources.

Addressing the challenges of the ground water: these may be approached through the following steps:

- Although the ground water is mapped in Somaliland, however a working level mapping of test pumping is needed. The land use planning process should integrate ground water assessment, including test pumping mapping at micro-level (village/settlement) as well.

- The water recharge requirements should be assessed and additional measures, including water harvesting and integrated water shed management, should be carried out. These actions should be part and parcel of land use planning.

- Awareness raising and capacity building on the subject of ground water and its replenishment should be specifically tailored for and imparted to those working on the ground.

Addressing the challenge of surface water:

- Substantial data on rainfall and river flow need to be collected for a sound analysis of the rainfall – runoff relationship in the basins for a period of 10 – 15 years prior making the analysis.

- The monitoring network, preferably automatic stations, in the various basins of Somaliland needs to be intensified from the existing stations. By increasing the number of monitoring stations the localised rains would be measured and used to establish a good relationship between a rainfall event and resulting surface runoff.

Managing climate shocks through:

- Climate change adaptation measures should be mainstreamed in the government planning process;
- Demonstration project sponsored through donors' assistance in general and Green Climate Fund in particular should be mobilized. FAO may play a proactive role in this regard.
- Climate change preparedness and resilience should be managed together with disaster preparedness and management institutions. Awareness and training packages need to be developed and imparted.
- "Climate smart" agriculture and livestock management should be demonstrated with the help of UN agencies and donors.

The fertility of the soils: A two-track approach should be adopted as follows:

a. In case other critical inputs such as water are available, nitrogen and in some cases phosphorus should be added in accordance to the requirements of the crop.

b. In relatively less fertile areas fruit crops with long root systems should be adopted.

c. Ecosystem approach to land-use should be adopted that helps in conserving and enhancing the soil fertility

d. Wherever possible, crops and tree species belonging to the Leguminosae family should be promoted and encouraged

e. Crop rotation should be stressed and crops with lesser nitrogen requirements should be favoured.

f. The subsidy for fertilizers and other green sector inputs may be assessed in terms of its cost effectiveness in the longer term.

Spread of Invasive Species: Has become a major challenge and needs national-level efforts. The formulation of a national strategy is proposed with the following elements:

- The root causes of the expansion of invasive species should be clearly understood and measures for arresting their further expansion should be carried out.

- Eradication should be promoted only in high productive lands, replacement with Acacia species should be promoted in other land use areas.
- In relatively less productive areas, the use of Prosopis may be promoted for charcoal burning and other value added utilizations.
- Intensive community/local level mobilization and education on successful technologies should be carried out.
- Linking entrepreneurs with the local communities for possible partnerships on processing, utilization, and commercialization of products should be explored.

Addressing ecosystem fragmentation and degradation: The degradation and fragmentation is shaped by a combination of deforestation, erosion, gully formation, and human encroachment for agriculture and infrastructure. This will therefore need an integrated approach with the following elements:

- Baseline assessments of potential demonstration hotspots should be carried out that include biological, physical, economic and demographic aspects;
- Participatory and ecosystem-based land-use plans should be developed for potential hot spots and to address the drivers of degradation together with enforcement;
- Create alternative livelihoods and income generation activities through skills training and development of innovative entrepreneurship built around ecosystem goods and services;
- The charcoal issue should be addressed through enforcement as well as replenishing deforested areas and providing alternative energy sources and livelihood options for local communities;
- Land degradation should be assessed using the LADA/WOCAT methodology and land restoration opportunities identified through use of WOCAT SLM measures.
- Comprehensive and coherent grazing and land management strategies should be developed in a participatory manner and demonstrated on a pilot basis in selective grazing hotspots.

Mainstreaming of the UN Conventions on Biodiversity, Climate Change and Combating Desertification in the land resources debates and policies: this is essential as it provides opportunities to address the issues of ecosystem degradation and fragmentation, droughts, floods and desertification, through available trust funds such as GEF, Adaptation Funds, Green Climate Fund, Special Climate Change Fund, etc. The government of Somaliland is already on board through the Ministry of Environment and other relevant ministries in this regard.

Holding an international conference on land resources of Somaliland

Assessing/exploring indigenous knowledge related to the land and its uses and integrating this knowledge with the contemporary work of government and research organizations.

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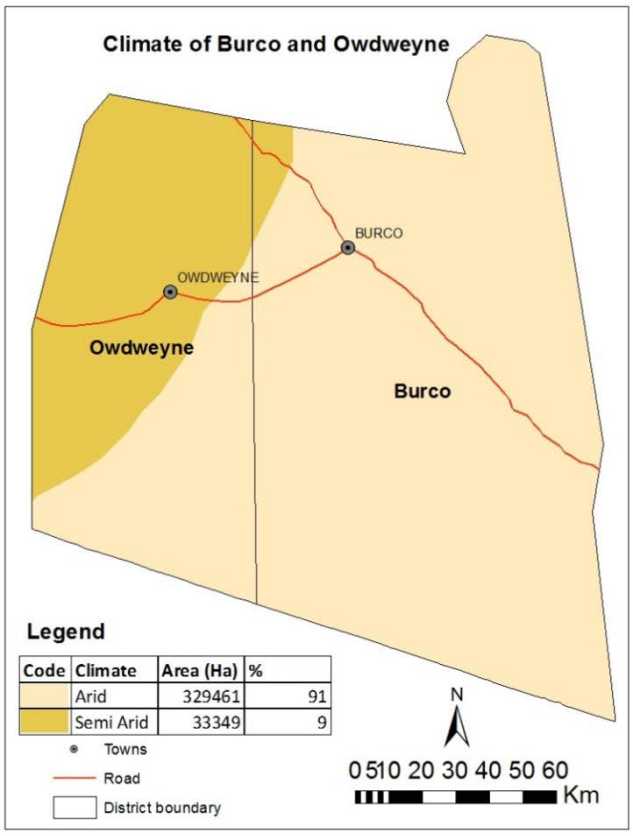
Annex 1: Land resources of Burco and Oodweyne

The land resources including climate, irrigation water, land cover, land use as well the livelihoods of the two districts are elaborated as follows:

Climate

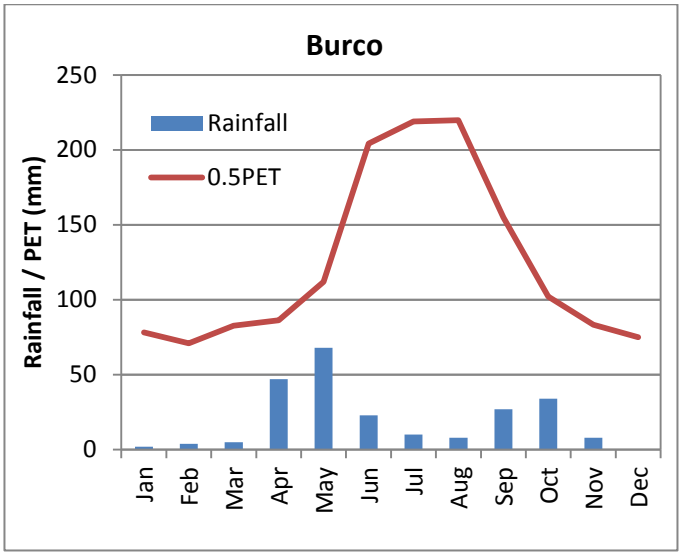
Burco and Oodweyne districts are both located in Hawd Plateau south of central part piedmont of Al or Golis Mountains. Burco district is predominantly in an arid zone while a small portion of Oodweyne district south of the Al or Golis Mountain towards Hargeisa is semiarid and the rest is arid.



The arid zone receives a total annual rainfall of between only 200 and 300 mm and the rainfall lasts for a maximum of three months. Rainfall usually comes in heavy showers and a large proportion is lost through runoff since the country slopes towards the Indian Ocean. The region experiences high temperatures throughout the year. The average temperature is around 27^{o} C. The relative humidity (RH) percentage is less than 50% (except in the rainy periods

when RH is greater that 80%). The landscape Potential Evapotranspiration ranges1300-3000mm and is more than six times the rainfall. In these areas only drought resistant plants grow.

The semiarid zone receives 400 to 600 mm of annual rainfall with the rainfall season slightly exceeding three months. The average temperature remains between 20–24^{o} C. The relative humidity is less than 50% except in the rainy periods when RH exceeds 80%. The Potential Evapotranspiration of the semiarid zone varies 1300-3000mm and is one and half times the rainfall and therefore plant growth is normal unless drought occur.



Figure

The rainfall is distributed irregularly across the region into two rain seasons (Gu and Deyr) that are interspaced by two dry seasons (Xagaa and Jiilaal). The modest temporal distribution of the rainfall in Somaliland, like in any other dry environment, further limits and constrains the productivity of the land. The four seasons are summarized below:

- ***Jiilaal*** - This is a dry season occurring from December to mid-March. During this season the region experiences cool and dry air. January and February are actually the coolest months of the year. Relative humidity is relatively high with low wind speeds during this season.

- ***Gu* –** This is the longer rainy season, lasting from late march to mid-June and with relatively wet and hot conditions. During this season, there is plenty of water in most areas and is a breeding period for the livestock. Rainfall increases from west to east of the region.
- ***Xagaa* –** This is a dry season occurring from late June to September. Though generally a dry season, the western part of Oodweyne district receives scattered showers. Other parts remain very windy and dry.
- ***Deyr* –** This is the short rainy season lasting form October to November. The rainfall received is less than that of the *Gu* rainy season.

In the arid Zone, there is a very limited potential for rainfed cropping and although cropping is possible, irrigation is absolutely essential for success. Vegetation growth is usually normal for plants suitable for arid environments.

In the semiarid zone there is a good potential for rainfed cropping, but irrigation is indispensable for reliable and good crop harvests. Some drought-resistant crops such as sorghum and millet may give reasonable yields, but there is still a risk of unreliable rainfall and subsequent crop failure.

Agriculture Irrigation Water

In Burco and Oodweyne districts there are 60 and 3 boreholes respectively, which were tested for salinity levels by SWALIM. 25 out of the 63 boreholes have low water salinity hazard for crop irrigation, 24 have medium hazard, 18 have high hazard and 3 have very high hazard. There are also 60 dug wells in these two districts. The water quality for irrigation of the 60 dug wells can distinguished as 25 low, 14 medium, 18 high and 3 very high salinity hazards. Also there are 24 dug wells that have no water salinity hazards and are suitable for crop irrigation. Another 24 wells have medium water salinity; therefore their water should be used with more attention to avoid land degradation.

Soils of Burco and Oodweyne

Within Burco district the soils comprise Calcisols (48%), Regosols (35%), Solonchaks (15%), Leptosols (10%) and Cambisols (1%); whereas in the district of Oodweyne, the soils include Calcisols (42%), Solonchaks (27%), Leptosols (19%) and Regosols (12%).

Calcisols: are common in this arid region of Burco and Oodweyne and they are regularly associated with highly calcareous parent materials. These soils have varying textural classes from loamy sand through sandy loam to silt or clay loams. The soils are deep soil with good internal drainage and aeration. They are suitable for plant root penetration and excellent medium for growth. Nutrient status is from moderate to low, CEC is low, pH is alkaline and no sodium content. These soils are not susceptible to excessive erosion. Vast areas of Calcisols are under shrubs, trees, grasses and herbs and are used for extensive grazing. Some vegetable crops are grown successfully on irrigated Calcisols. In some places, arable farming is hindered by stoniness of the surface soil and/or a petrocalcic horizon at shallow depth.

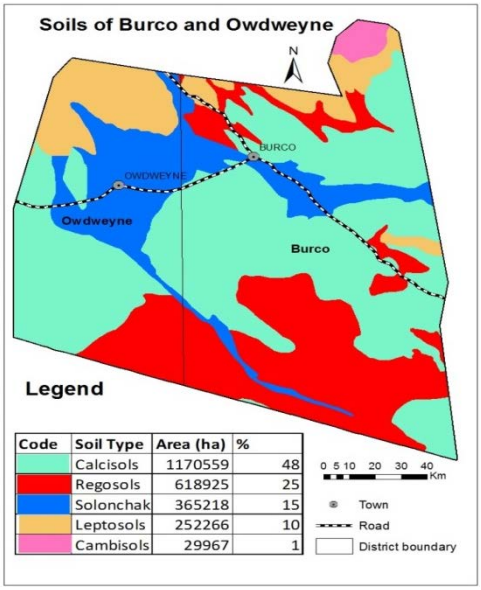
Regosols: are found in the districts of Oodweyne and Burco which is located in arid areas. They are very weakly developed mineral soils in unconsolidated materials with only thin surface horizons. Regosols are extensive in eroding lands such as mountainous regions and include all soils that could not be accommodated in any of the other soil groups. These soils are shallow and sandy loam or stony texture and weak structure. They have low water holding capacity and high permeability to water which make them sensitive to be water deficient. Nutrient content of the Regosols is low and no salinity problem. They are used as grazing land.

Solonchaks: are soils that have a high concentration of soluble salts at some time in the year. They are found in both Burco and Oodweyne districts largely confined to the arid and semiarid climate zones and coastal regions. Solonchaks overlay on gypsum bedrocks. In many cases the soil cover is intermittent with bedrock exposed in places. They are commonly very shallow from 20 to 30cm depth, sometimes reach 50cm depth. They have silty clay loam or silty clay texture, a weak soil structure of crumb or platy peds. The soils have friable or powdery consistency, particularly when dry. They are strongly saline with high

concentrations of soluble salts as the soil contains very high gypsum content which gets dissolved when water comes on the soil surface during the rainy seasons of the year. Salts dissolved in soil moisture remain behind after the evaporation of the water and accumulate on or just below the surface. In these soils carbonate contents are more or less high and they have low nutrient content. The salt built up in the top layers would restrict plant growth in the region. These soils are susceptible to erosion, solution and formation cavities.

Leptosols: Leptosols are found in hot and dry districts of Oodweyne and Burco. Leptosols are common in mountainous regions at high or medium altitude, particularly Al/Golis Mountains, and with strongly dissected and eroding areas. The Leptosols in the area are very shallow soils over continuous rock that is extremely gravelly, stony or extremely rich in coarse fragments. They have excessive internal drainage and very low water holding capacity. Soil fertility is low. Most of these soils are covered by forest and woody plants commonly used for extensive grazing and wood collection.

Cambisols: are soils with at least an inception subsurface soil formation. Transformation of parent material is evident from structure formation and mostly brownish discoloration, increasing clay percentage, and/or carbonate removal. They are found in piedmont of the Golis Mountain sloping towards the Gulf of Aden north east Burco town which is arid. The soils are deep with loamy texture; structure is moderate; has good water conductivity and good water holding capacity; low nitrogen and phosphorous content. The soils are under woody vegetation cover which is used as grazing land.

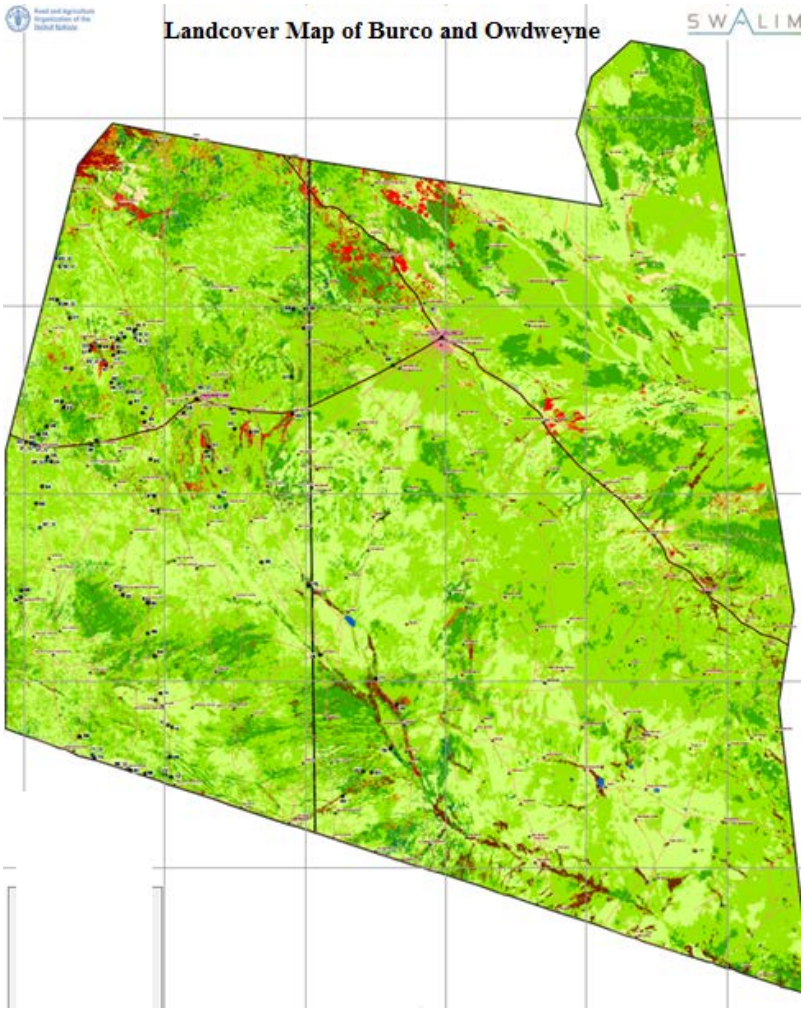


Landcover of Oodweyne and Burco

The methodology applied consists in a mixture of automatic classification and visual interpretation. The two districts have been mapped with a wall-to-wall approach, which means that the figures derived from this work represent the **real extension** of each class mapped. It is a land cover/land use mapping in the strict sense of the word and the entire study area is thoroughly analysed.

The legend, made of eighteen Land Cover classes, was setup using the standard FAO Land Cover Meta Language (LCML) and gives an unprecedented detail in the description of the Natural Vegetation of the area. In fact, ten land cover classes have been created to discriminate grassland, scrubland and woodland with different vegetation cover.

The area is not estimated but represent the real extent of each land cover class and the dataset produced gives a comprehensive mapping of all the 18 land cover classes present in the legend, with very accurate figures of the area covered by each of them. The legend fully characterizes the land cover features, which are described with LCML, a standard classification system and all the classes are accurately geo-located. The dataset produced could be used as baseline for a change assessment analysis.

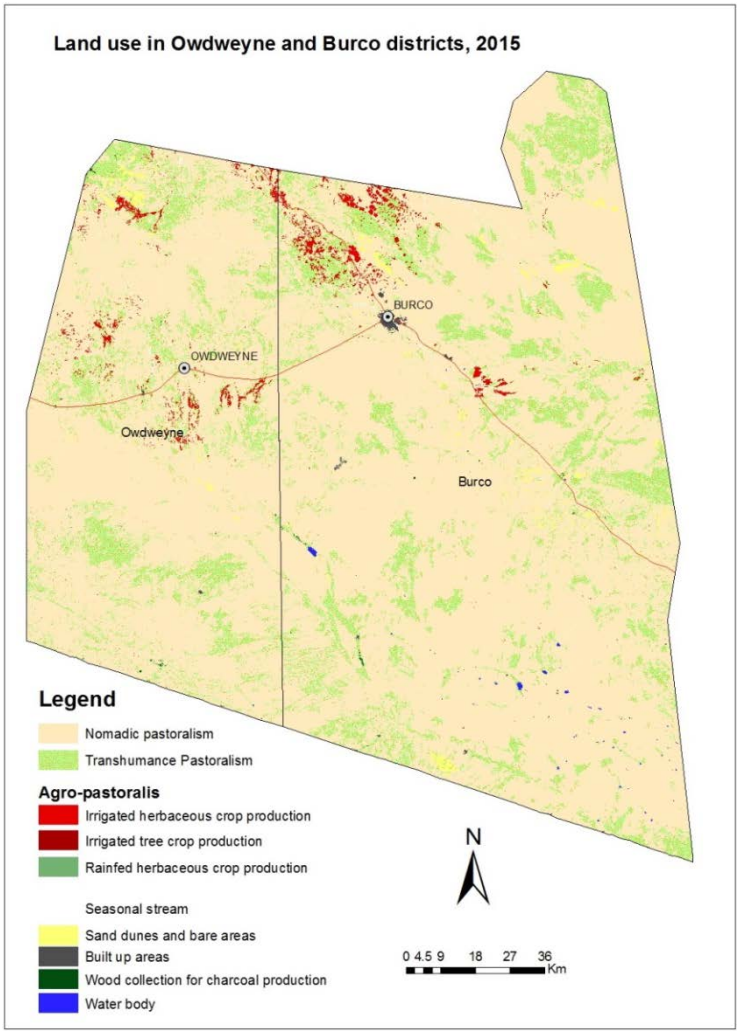


The following self explanatory legend elaborates the various classes of landcover together with extent in hectares and percentage coverage. The other details are combined in landuse section of this chapter.

CLASS (MAP CODE)	TOTAL (ha)	%
AGRICULTURE		
Trees Crop Irrigated (TCI)	63	0.002
Herbaceous Crop Rainfed (HCR)	506	0.01
Herbaceous Crop Irrigated (HCI)	24,209	0.7
NATURAL VEGETATION		
Grassland Open to Close (GOC)	19,719	0.6
Sparse Grasses & Shrubs (SGS)	896,338	26.1
Shrubs Very Open (SVO)	2,044,722	59.6
Shrubs Open (SO)	345,347	10.1
Shrubs Close (SC)	12,433	0.4
Trees Sparse (TS)	10,697	0.3
Trees Very Open (TVO)	7,333	0.2
Trees Open (TO)	6,847	0.2
Trees Close (TC)	526	0.0
Woodland Open to Close (WOC)	39,852	1.2
BARE,BUILT UP & WATER BODIES		
Bare Area (BA)	15,376	0.4
Sand (SA)	12	0.0003
Seasonal Water Body (WB)	1,348	0.04
Wadi& Riverbed (WA)	4,753	0.1
Built-Up Area (BU)	3,301	0.1
Total	3,433,382	100.00

Landuse of Burco and Owdweyne

Following is the overall analysis based on output surveys, SWALIM analysed the data technically to characterize the land uses. Characterisation included agronomic aspects, constraints and opportunities, etc. Positive and negative aspects of each system and ways of improving them from the perspective of the land users were highlighted. Land user perspectives were cross-checked against technical aspects described by the surveyors. The results of this overall characterisation are mapped for the Owdweyne and Burco districts as follows:



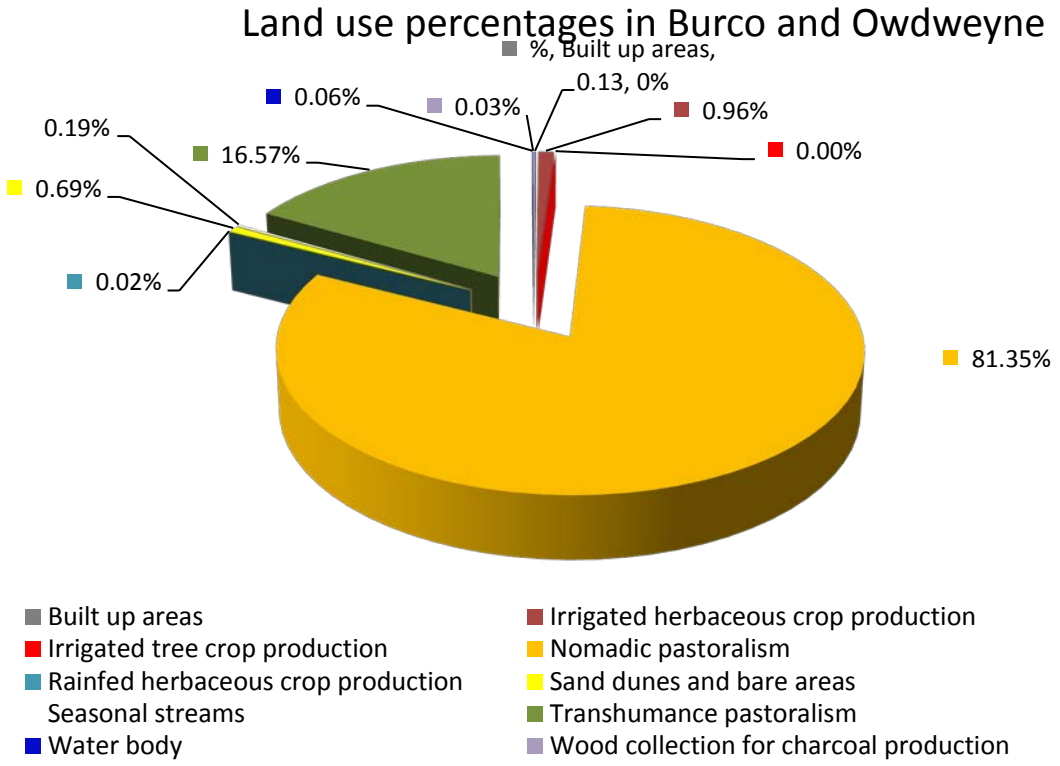
Land use in Owdweyne and Burco districts, August 2015

The land use map comprises of the following 10 classes; Nomadic pastoralism, Transhumance pastoralism, Irrigated herbaceous crop production, Irrigated tree crop production, Rainfed herbaceous crop production, Seasonal streams, Sand dunes and bare areas, Built up areas, Wood collection for charcoal production and Water body.

The following table shows each area covered by the land use class. Nomadic pastoralism is the most dominant land use class. Other land use classes and their area covered are also shown as follows:

Land use	**Area (km^2)**	**Area (Ha)**	**%**
Built up areas	33	3300	0.13
Irrigated herbaceous crop production	236	23600	0.96
Irrigated tree crop production	0.64	64	0.003
Nomadic pastoralism	20030	2003000	81.35
Rainfed herbaceous crop production	5	500	0.02
Sand dunes and bare areas	169	16900	0.69
Seasonal streams	47	4700	0.19
Transhumance pastoralism	4081	408100	16.57
Water body	14	1400	0.057
Wood collection for charcoal production	7	700	0.028
Total	**24623**	**2462264**	**100**

Land use class and area covered in Burco and Owdweyne



The description of each land use is elaborated as follows:

Nomadic pastoralism

This was the most practiced land use in Burco and Owdweyne. This land use involved haphazard, extensive grazing characterised by territorial limits practiced by the pastoralists. In this land use, land improvement systems included mainly berkad. Other improvements included wells, wars, dams, reservoirs and soil bunds in their order of dominance. For this land use, input level remained low with insignificant number of those interviewed reporting they used any machinery or any form of farm management. No machinery is used whatsoever.

Animals kept were mainly camel, followed by goat, sheep and cattle. Other rare animals included donkey. All these animals provided milk, meat and skin. All the animal types were found to be in average body condition at the time of the field survey. Few animals were in good condition while mostly cattle were in bad body condition. Reasons for poor animal

body condition were attributed to influx of animals from other parts of the region and shortage of *Gu* rains.

There existed quite a substantial amount of enclosures in the two districts. These enclosures were mostly fenced off and the main purpose of them was to provide fodder for the market. Berbera was the main market for the harvested fodder. However, the enclosures were a source of conflicts among the community members.

Water sources in the dry season for the animals included mainly berkad followed by shallow wells. However, the shallow wells and berkads are used during all seasons to provide water to the animals. In the rainy season, the animals walk for less than 5 kilometres to water while in the dry season they walk for more than 5 kilometres.

Droughts remained the most dominant constraint to livestock production in the two districts. Other constraints included animal diseases, lack of veterinary services, low prices offered for purchase of animals and absence of ready market for the animals to be sold. Opportunities to livestock production included presence of good soils, closeness to markets and good roads that make communication easy.

Charcoal production was minimal at the time of the field surveys, with most of those interviewed indicating that charcoal was not produced in these areas.

Land degradation in this land use class is widespread with sheet and gully erosion being the most common types of land degradation. Soil and Water conservation structures are wanting, and where they occur, they are mostly soil bunds. Some rock dams are also present.

Soil bund constructed for soil and water conservation

Transhumance Pastoralism

Transhumance Pastoralism involved animals being moved in a regular pattern associated with water and forage availability. The following is a detailed characterisation of transhumance pastoralism in Burco and Owdweyne.

Land improvement systems included mainly berkad, and others are wells, wars, dams, reservoirs. Input level remained low with no use of machinery. Efforts to improve on management of farm were found to be minimal with few of those interviewed indicating that they had fenced off their farms.

Livestock kept wass dominated by cattle, followed by sheep and then goats. The products, from all the three animals, include meat, milk and skin. The body condition of the animals was average for most of them and good for a few. This may be attributed to the fact that the forage condition was found to be moderate. Enclosures were found to be common and involved fenced grazing lands, the grass from which was mostly harvested for sale in the market in Berbera and to a lesser extent, Owdweyne and Burco. They are illegal, established

without blessings of the community as a whole and were a source of great conflict in the community as most pastoralists feel they deny them grazing grounds for their animals.

Berkeds provide water to the animals during all seasons while shallow wells were used mostly during the dry season. Access to water by the animals in the wet season was less than 5 kilometres while in the dry season it was more than five kilometres. Constraints associated with livestock production include majorly, water shortage then animal disease and low market prices for livestock products. Opportunities to livestock production included availability of good pasture for the animals, accessible markets and good roads.

Cutting of trees for charcoal production was not an issue in this land use. However, land degradation was evident with all forms of soil erosion, gully, sheet and rill, being visible. Soil and water conservation structures were minimal. Structures present included soil bunds and rock check dams.

Livestock production - Sheep, goats, donkeys and camels

Sand dunes and bare areas

Sand dunes and bare areas are devoid of vegetation and are a result of land degradation. 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.

Plate: Bare areas

Agro-pastoralism

Agro pastoralism, also called semi-sedentary grazing, is land-use where crops are managed together with livestock farming with animal herds taken out daily. Land improvement systems included mainly berkad, and others are wells, drainage and boreholes. Input level remained low with some agro-pastoralists practicing medium input level in their agro-pastoral activities. Use of farm machinery is moderate with many of the agro-pastoralists not using farm machines. Efforts to improve on management of farm were found to be common with many of those interviewed indicating that they had fenced off their farms and some having built soil bunds on their farm. Agro pastoralism is further divided into Irrigated herbaceous crop production, Irrigated tree crop production and Rainfed herbaceous crop production as shown in Figure 1. Irrigated crop production is further classified into Flood recession cultivation.

In Burco and Owdweyne, Agro-pastoralism can be classified into two categories: Low Input and Medium Input Agro-pastoralism. ‘Input’ refers to material input such as seeds, fertilizer, pesticides, etc.

Low Input Agro-pastoralism

Tractor use is not as extensive as in medium input rainfed agriculture. Intercropping of maize and sorghum is very common. Bunding is less extensive than in the medium input category. In both cases, the use of local seeds for planting is widely practiced.

Medium Input Agro-pastoralism

Tractor use is more extensive, with all those interviewed acknowledging their use in the fields. Intercropping is not popular. Seed is mainly local in variety, but a few farmers have imported improved seeds from the Ministry of Agriculture. Fields are larger than 2 ha in average size. Soil bunding is more widespread. The use of fertilizer and manure is negligible in this category.

Types of Crops – crops grown are mainly maize and sorghum, but also include tamarind (xamar), dates, tomato, water melon, guava and Catha edulis (qat, khat, or miraa in Kiswahili (see Plate 1)). Crops varieties planted are always local.

Intercropping – intercropping is common and includes tomato and pepper, Catha edulis and grass, sorghum, beans and grass. Farm size is mostly 2 to 5 hectares.

Grass crop for fodder

Purposes of Crop Production – crops are produced for food, market and fodder for animals. In most cases, post-crop residues are cut and stored as animal feed (see Plate ?) and fed to animals during fodder scarcity in the dry season. Crops that have failed to mature due to moisture stress are also harvested and used as animal feed.

Crop Condition and Limitations to Agricultural Production – performance of maize and sorghum in Burco and Owdweyne is not as good. There were more reported cases of maize and sorghum crop failure. Crop failure was attributed to harsh climatic conditions of low rainfall. Fewer cases of less fertile soils were also reported.

Agronomic Aspects – use of fertilizer is limited but use of manure is common. Use of pesticide and machinery is rare. Seeds used are local.

Farm Training – The farmers have not received any farm training.

Constraints to Agricultural Production – constraints include problem of pests, lack of farm capital and not being able to harvest and channel water to the farms and drought. Farm machinery is wanting and farming equipment is lacking. The agro-pastoralists just cannot afford it!

Opportunities – current opportunities to the agro-pastoralists include fertile soils, presence of roads that lead to the market and availability of markets themselves.

Agro-pastoralism also involves keeping of semi-sedentary animals. Sedentary pastoralism occurs around homesteads and settlements, usually consisting of dairy animals, and weak, sick and young animals that cannot walk for long distances. The animals are taken out daily by herders from the village sheds to the communal rangeland. The practice exerts pressure on pasture around settlements.

All other characteristics pertaining to Sedentary Pastoralism are similar to those of Transhumance Pastoralism.

Some of the agro-pastoralists also practice nomadic pastoralism.

Animals kept by the agro-pastoralists include camel, goat, sheep and cattle. All other characteristics of the animal production system are similar to those of transhumance and nomadic pastoralism.

Charcoal production is not practiced but there is evidence of land degradation with wind and water erosion being evident. Water erosion is in form of gully, rill and sheet erosion. Water and soil conservation structures are wanting with limited soil bunds and rock dams in the area.

Bad-land as a result of severe land degradation

Flood recession cultivation

Flood recession cultivation is practiced in areas that are seasonally flooded when it rains and by runoff from adjacent areas. Soils in these areas retain enough moisture to support crops. The crops cultivated are fruit trees and vegetables.

Land improvement systems included wells, drainage, berkad and boreholes. Input level remained low with some practicing medium input level in their crop production activities. Use of farm machinery is minimal. Management of farm, by fencing, was found to be low.

Crops include fruit trees and grass for fodder. Intercropping occurs for example between papaya, citrus, date palms and guava.

These farmers qualify for agro-pastoralism as they also engage in livestock production. Characteristics of livestock production in this land use type are similar to the one pertaining to agro-pastoralism. Enclosures are not common here, but where they occur, they may involve production of fodder for sale in the market of Berbera. These enclosures are a source of conflict within the communities and individuals. The shallow wells provide water for the livestock in the dry season while the wars provide water for livestock in the wet season. Source of water for the animals is less than 5 kilometres in the wet season while in the dry season the source of water may get to more than 5 kilometres.

Constraints to livestock production include incidence of animal diseases, drought, lack of proper livestock management skills, wanting sound range management policy and low prices offered for animals sold. Opportunities to livestock production include the availability of free grazing land, availability of livestock markets, and availability of access roads to the markets and absence of too many enclosures. Enclosures make it difficult to graze the animals freely.

Land degradation was evident in this land use class with gully, rill and sheet erosion being visible. Soil and water conservation structures are scarce but where present, include rock dikes.

Dike and canals for channelling water for crop production

Wood collection for charcoal production

Wood collection for charcoal production is apparently not a common practice, occurring only where there are trees. Trees are scarce in Burco and Owdweyne. The trees felled for charcoal production include Acacia bussei and A.etbaica. Other tree species cut for charcoal production include Acacia nilotica. Charcoal production has been banned in Somaliland by the government authorities and therefore the practice is illegal.

Built up areas

Built up areas have a high concentration of buildings and people, forming towns or urban settlements. Notable features include shops, schools, hospitals, roads, offices and other social amenities. They offer a ready market for charcoal and other farm produce. Towns offer consumer supplies to the rural settlements.

Water body

Water bodies during the time of the activity occurred in form of ponds, dams and pools of water resulting from the rain. The water bodies are used for irrigation and for watering animals.

Seasonal streams

Seasonal streams included dry river beds which get filled with water when it rains. They are stony and sandy and are in some cases used when digging a shallow well. In this case, the shallow wells may provide water for irrigated agriculture.

Livelihoods in Burco and Owdweyne

According to data collected in August 2015, livelihoods in Burco and Owdweyne are majorly Pastoral. The different livelihoods can represented by the different types of activities practiced on the different land cover types of the two districts (see Figure 1). This map compares well with the livelihoods map produced by FAO FSNAU in 2014 (Figure 2). Crop production occurs in the northern parts of the two districts mainly by irrigation using water from hills in the north. The Pastoral livelihood occurs in two forms; Nomadic and Transhumance pastoralism.

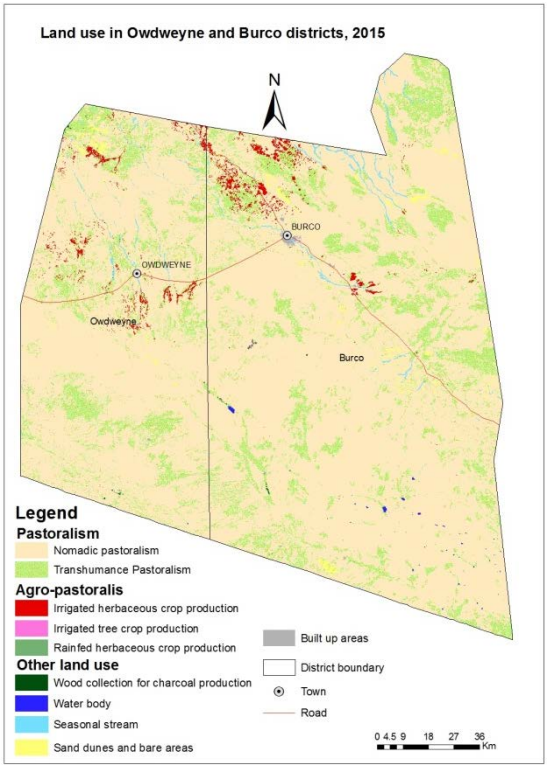


Figure: Land use in Burco and Owdweyne, August 2015

Animals kept as a source of livelihood include mainly Camel, followed by goat and sheep and cattle while the crops grown include Sorghum, tomato, Watermelon, Pepper, Lemon, Guava, Dates, Tamarind, Cotton, Maize and Sesame.

Livestock sales

Livestock sales include mainly Goats then Sheep and Camel. Selling of Cattle is rare. Watering of livestock in the dry season is mainly by use of Berkad water followed by Shallow_well and borehole.

Sale of crops

Most crops are grown at subsistence level. However, some crops are grown for sale and include Tomato, pepper, Palm, Guava, Lemon and sesame. Growing of these crops is by hand, tractor and ox-plough. Input level into the farming activities is low but some farmers use fertilizer and pesticides. Wild foods also constitute sources of food for the families. Few of those interviewed also indicated that relief food provision also occurs in the study area.

Annex 2: Soils analysis of Somaliland

Landform	Locality	Type	Depth	Texture	Structure	Drainage	pH	Fertility			Salinity	Moisture Holding Capacity
					Grade		Average	N	P	K		
Piedmont and Coastal Plain	Guban	Arenosols	Deep	Loamy	Very weak	Highly permeable	Strongly alkaline	Low	Low	Medium	Not saline	Low
		Calcisols	Deep	Clay	Moderately to Strong	Well drained	Moderately alkaline	Low	Adequate to excessive	High	Not saline	Good
		Fluvisols	Deep	Sandy loam	Weak	Good water conductivity	Moderately to strongly alkaline	Low	Low	Good	Medium	Good
		Leptosols	Very Shallow	Rocky and stony or extremely gravelly	Nil	Excessive internal drainage	N/A	Low	Low	Low	Low	Very low
		Regosols	Shallow	Sandy loam or stony	Weak	well drained	Moderately alkaline	Low	Low	Good	Not saline	Very low
		Solonchak	Deep	Silt clay or sandy clay	Weak	Low water conductivity	Strongly alkaline	Low	Low	Low	High	Low
Mountainous and Highland	Oogo, Karkaar	Cambisols	Deep	loamy	Moderate	Well drained	Moderately alkaline	Low	Low	Good	High	Good

		Leptosols	Very Shallow	Rocky and stony or extremely gravelly	Nil	Excessive internal drainage	N/A	Low	Low	Low	Low	Very low
		Regosols	Shallow	Sandy loam or stony	Weak	well drained	Moderately alkaline	Low	Low	Good	Not saline	Very low
		Solonchak	Deep	Silt clay or sandy clay	Weak	Low water conductivity	Strongly alkaline	Low	Low	Low	High	Low
Plateaus	Oogo, Hawd	Calcisols	Deep	Clay	Moderately to Strong	Well drained	Moderately alkaline	Low	Adequate to excessive	High	Not saline	Good
		Cambisols	Deep	loamy	Moderate	Well drained	Moderately alkaline	Low	Low	Good	High	Good
		Leptosols	Very Shallow	Rocky and stony or extremely gravelly	Nil	Excessive internal drainage	N/A	Low	Low	Low	Low	Very low
		Gypsisols			Weak	Low water conductivity		Low	Low	Low		
		Regosols	Shallow	Sandy loam or stony	Weak	well drained	Moderately alkaline	Low	Low	Good	Not saline	Very low
		Vertisols	Deep	Clay	Strong	Slow water conductivity	Moderately alkaline	Very low	Low	High	Low	Good
Valleys	Tgdheer, Nugaal	Calcisols	Deep	Clay	Moderate to Strong	Well drained	Moderately alkaline	Low	Adequate to	High	Not saline	Good

	and Dharoor								excessive			
		Leptosols	Very Shallow	Rocky and stony or extremely gravelly	Nil	Excessive internal drainage	N/A	Low	Low	Low	Low	Very low
		Regosols	Shallow	Sandy loam or stony	Weak	well drained	Moderately alkaline	Low	Low	Good	Not saline	Very low
		Solonchak	Deep	Silty clay or sandy clay	Weak	Low water conductivity	Strongly alkaline	Low	Low	Low	High	Low

Annex 3: Water sources analysis of Burco and Owdweyne Districts

Source Type	District	Source Name	EC (µS/cm)	EC mmohs /cm	Salinity Hazard	Source Type	District	Source Name	EC (µS/cm)	EC mmohs/cm	Salinity Hazard
Borehole	Burco	Dakhanyado BH1	7040	7	Very high	Dug Well	Burco	Karasharka 1	584	0.584	Low
Borehole	Burco	Dakhanyado BH2	1407	1.407	Medium	Dug Well	Burco	Karasharka 2	1212	1.212	Medium
Borehole	Burco	Hog-Mashruuca BH2	1432	1.432	Medium	Dug Well	Burco	Ulasan	1900	1.9	High
Borehole	Burco	Hog Mashruuca BH1	1324	1.324	Medium	Dug Well	Burco	Beer 2	872	0.872	Medium
Borehole	Burco	Salebankulul	1941	1.941	Medium	Dug Well	Burco	caynaba	2370	2.37	High
Borehole	Burco	Aden Suleiman	12030	12.03	Very high	Dug Well	Burco	Halli bixisay	3750	3.75	Very high

Borehole	Burco	Buqleye BH1	1380	1.38	Medium	Dug Well	Burco	higlo	2050	2.05	High
Borehole	Burco	Burco Water Agency BH9	2519	2.519	Medium	Dug Well	Burco	Beer 3	875	0.875	Medium
Borehole	Burco	Muslim Charity Water	3160	3.16	Very high	Dug Well	Burco	Beer 4	874	0.874	Medium
Borehole	Burco	Xareda Mineral Water Factory	1526	1.526	Medium	Dug Well	Burco	Beer 5	876	0.876	Medium
Borehole	Burco	Burco Water Agency BH13	2700	2.7	High	Dug Well	Burco	Koridh	2750	2.75	High
Borehole	Burco	Dahabshil	7850	7.85	Very high	Dug Well	Burco	Ceel Baxay dugwell 2			
Borehole	Burco	UNHABITAT BH1	2320	2.32	High	Dug Well	Burco	Ceel Baxay dugwell 3	3530	3.53	Very high
Borehole	Burco	Aroori Orphans	2390	2.39	High	Dug Well	Burco	Dibis dugwell 1	338	0.338	Low
Borehole	Burco	Aden Garas	1430	1.43	Medium	Dug Well	Burco	Fiqiayuub	5360	5.36	Very high
Borehole	Burco	Burco Meat Factory	3130	3.13	Very high	Dug Well	Burco	Dhanqari GebaGabo	1150	1.15	Medium
Borehole	Burco	Burco Water Agency BH10	2630	2.63	High	Dug Well	Burco	Ceel Dheer 3	524	0.524	Low
Borehole	Burco	Dr. Ahmed H. Hasan	9360	9.36	Very high	Dug Well	Burco	Qoryaale dugwell 2	525	0.525	Low

Borehole	Burco	Jambaq Farm	3150	3.15	Very high	Dug Well	Burco	Qoryaale dugwell 3	512	0.512	Low
Borehole	Burco	Anam International Company BH1	2430	2.43	High	Dug Well	Burco	Higlo	535	0.535	Low
Borehole	Burco	Maaxda Mineral Water	2430	2.43	High	Dug Well	Burco	Ceelka Qudbiga	2480	2.48	High
Borehole	Burco	Abdi Ali	2280	2.28	High	Dug Well	Burco	Ulasan 1	2478	2.478	High
Borehole	Burco	Sodani	2120	2.12	High	Dug Well	Burco	Qoryaale dugwell 4	572	0.572	Low
Borehole	Burco	Suleiman Kulul BH2	220	0.22	Low	Dug Well	Burco	Wadhan dugwell	382	0.382	Low
Borehole	Burco	Suleiman Kulul BH1	2001	2.001	Medium	Dug Well	Burco	Ceel Gooni Shallow well 1	477	0.477	Low
Borehole	Burco	Ternary Factory	3580	3.58	Very high	Dug Well	Burco	Ceel Biilicle	1845	1.845	Medium
Borehole	Burco	Abdala Alnuri School	7360	7.36	Very high	Dug Well	Burco	Beer Burco Yar 1	315	0.315	Low
Borehole	Burco	Ali Qoys	320	0.32	Low	Dug Well	Burco	Ceeg	2750	2.75	High
Borehole	Burco	Hassan Hirsi	2720	2.72	High	Dug Well	Burco	Doqoshay	2145	2.145	Low
Borehole	Burco	Huda Farm	1332	1.332	Medium	Dug Well	Burco	Harrada Gubato Xil	306	0.306	Low
Borehole	Burco	Indha Deero	3550	3.55	Very high	Dug Well	Burco	Kal Qudhun	2373	2.373	Medium

								dugwell			
Borehole	Burco	Mahamed Jama Galal	9510	9.51	Very high	Dug Well	Burco	Qoryaale dugwell 5	525	0.525	Low
Borehole	Burco	Mahamed Ahmed Bihi	530	0.53	Low	Dug Well	Burco	Qoyta dugwell	386	0.386	Low
Borehole	Burco	Ilays Soap Factory	1439	1.439	Medium	Dug Well	Burco	Kirir	535	0.535	Low
Borehole	Burco	Agomaha BH3	2170	2.17	High	Dug Well	Burco	Beer 1	542	0.542	Low
Borehole	Burco	Suleiman Kulul BH3	543	0.543	Low	Dug Well	Burco	Ceel Gooni Shallow well 2	545	0.545	Low
Borehole	Burco	GTZ BH1	1681	1.681	High	Dug Well	Burco	Ceel Gooni Shallow well 4	555	0.555	Low
Borehole	Burco	Burco Water Agency BH8	1684	1.684	High						
Borehole	Burco	GTZ BH2	1806	1.806	High	Borehole	Owdweyne	Arab BH1	456	0.456	Low
Borehole	Burco	Aroori Livestock	1238	1.238	High	Borehole	Owdweyne	Dubur BH1	555	0.555	Low
Borehole	Burco	Sibakhti	2280	2.28	High	Borehole	Owdweyne	Barwodharag BH1	1316	1.316	Medium
Borehole	Burco	DRC	3150	3.15	Very high	Dug Well	Owdweyne	Bali Qaasim	1900	1.9	High
Borehole	Burco	Timawayn	1470	1.47	Medium	Dug Well	Owdwey	Bera	930	0.93	Medium

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Borehole	Burco	Burco Water Agency BH11	1548	1.548	Medium	Dug Well	Owdweyne	ceradle maxle	1400	1.4	Medium
Borehole	Burco	UNHABITAT BH2	3165	3.165	Very high	Dug Well	Owdweyne	Dubur/SHW001	340	0.34	Low
Borehole	Burco	UNHABITAT BH3	2310	2.31	High	Dug Well	Owdweyne	Wadama	2590	2.59	High
Borehole	Burco	Kaasaar Village	3999	3.999	Very high	Dug Well	Owdweyne	Becrato	710	0.71	Low
Borehole	Burco	Buqleye BH2	1704	1.704	High	Dug Well	Owdweyne	Owd Xaxi	1740	1.74	High
Borehole	Burco	Burco Water Agency BH3	2376	2.376	High	Dug Well	Owdweyne	ceel bilcile	1040	1.04	Medium
Borehole	Burco	Burco Water Agency BH4	3397	3.397	Very high	Dug Well	Owdweyne	Beerato dugwell 3	593	0.593	Low
Borehole	Burco	Kabadheere BH1	1313	1.313	Medium	Dug Well	Owdweyne	Ceel Xume dug well 2	1600	1.6	Medium
Borehole	Burco	Burco Water Agency BH5	3386	3.386	Very high	Dug Well	Owdweyne	Ceel Xume dugwell 6	1600	1.6	Medium
Borehole	Burco	Maax Mineral Water Factory	2642	2.642	High	Dug Well	Owdweyne	Harasheikh dugwell 5	2684	2.684	High
Borehole	Burco	Maandeeq	1633	1.633	High	Dug Well	Owdweyne	Harasheikh dugwell 7	2670	2.67	High
Borehole	Burco	Maxied Yasin	2663	2.663	High	Dug Well	Owdweyne	Harasheikh Dugwell 8	2684	2.684	High

Borehole	Burco	Saleebaan Kuul BH2	2223	2.223	High	Dug Well	Owdweyne	Ceel Xume dug well 3	1650	1.65	High
Borehole	Burco	Soodaani	2077	2.077	High	Dug Well	Owdweyne	Beerato Dugwell 4	2508	2.508	High
Borehole	Burco	Yusuf Cali Qays	725	0.725	Low	Dug Well	Owdweyne	Beerato Dugwell 6	2508	2.508	High
Borehole	Burco	Faatax	3999	3.999	Very high	Dug Well	Owdweyne	Beerato dugwell 5	3060	3.06	Very high
						Dug Well	Owdweyne	Beerato dugwell 2	2932	2.932	High

TDS ppm or mg/L	EC dS/m	Salinity hazard
<500	<0.8	Low
500 - 1000	0.8 - 1.6	Medium
1000 - 2000	1.6 - 3	High
> 2000	> 3	Very high

Dug Well	Owdweyne	Beerato Collection Dugwell	3999	3.999	Very high
Dug Well	Owdweyne	Owdweyne collection wells 3	2295	2.295	High
Dug Well	Owdweyne	Dubur dug well 2	775	0.775	Low
Dug Well	Owdweyne	Harasheikh dugwell 6	2650	0.265	Low
Dug Well	Owdweyne	Dubur dug well 1	775	0.775	Low
Dug Well	Owdweyne	Dubur dug well 3	775	0.775	Low

Location	Boreholes	# of Dug wells	Water Salinity Hazard level
Burco	5	18	Low
Burco	14	8	Medium
Burco	23	7	High
Burco	18 60	3 36	Very high
Oodweyne	2	7	Low
Oodweyne	1	6	Medium
Oodweyne	0	11	High
	3	24	