Mapping Somali cities
Training manual

UN-HABITAT
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Why this manual?
Maps are not simple representations of the real world on a much smaller scale. They are a tool to organize information. With maps, it becomes much easier to investigate a place’s infrastructure, economy and settlement information, which are all very important facets of population and development situation.
Maps can also easily and concretely show change through time, and allow to understand one place’s trend and plan for the future. They help you figure out where you are and how to get where you want to go.
While many data are available across different sectors and key actors, there is no official cartography which represents Somalia as it is now. In this sense, Somalia is, by many ways, an unexplored territory. The limitations in access of many parts of its extension made very difficult to provide updated, reliable and verified information from a spatial prospective.
With concrete improvements in the governance of the country, from the Federal level to the Federal Member States established in the last years, to the administrations at district and municipal level, the chance is to coordinate different level of spatial data and produce an updated cartography. This would contribute in an effective way to develop a shared understanding of the complexity of Somalia territory and support the country’s development.

What is the manual about?
The manual is meant to feed into a training course for base mapping in Somalia. It serves as an introduction for local government and other interested stakeholders, guiding through the different scales and themes relevant to the context, the different sources available, and different visualization requirements.

Who is the target for this course?
This course is designed as an introductory training module, which would enable participants to equip themselves with foundation principles, further disseminate the knowledge or train others.
The end-users of the course are intended to be local government staff (ministries, district), as well as other stakeholders (e.g. NGOs and international agencies), particularly those engaged in development activities that deal with infrastructure, agriculture, hydrology, land administration, urban planning, solid waste management, or natural resource management.
The course assumes a basic knowledge of concept of Geographic Information systems (GIS) and the use of QGIS 3 (a free and open-source cross-platform GIS software).
In selecting participants, ensuring geographical and gender distribution, a range of expertise and experience as well as diversity of ethnic and religious backgrounds would augment the mutual learning experience.
By the end of the course participants should be:

- familiar with
- aware of
- able to

Limitations

The manual is structured to work with other material. That is:

- a set of base layers
- QGIS projects and styles

The layers made available are not meant to constitute to only source for the production of the maps, but they are the most updated publicly-available spatial layers sufficient for the elaboration of most of the thematic maps reputed necessary for a basic representation of the territory at district level. The training attendees will be able to collect further data and enrich their maps with ground-level information.

Building up local governments technical capacity

This manual is part of a UN-Habitat strategy for building up capacity of local and state government in Somalia and laying the foundation for the establishment of functional urban development departments able to cope with the tremendous urban development challenges of the country. Mapping is only one of the technical skills at the base of urban planning. Others training developed in coordination with the current one are:

- Rapid urban profiling and land use mapping
- Urban risk mapping and resilience planning
- Roles and responsibilities in urban planning
Very first step is defining what to represent and at what scale, the drawing limits. Mapping cities through Geographic Information Systems (GIS) makes it possible to identify and work with different city areas of influence. For this task, it is suggested to work in one of these two scales:

- **Regional scale (RS)**, which integrates the areas, cities and settlements that are less than an hour’s drive from the studied city. It is considered that the average speed of a car on a National Road is approximately 70 km/hour. Therefore, an area of 75 km radius is established around the city.
- **Urban Scale (US)**, which focuses on the urban area and its most immediate surroundings.

**Regional scale**

- **City**
- Buffer 75,000 meters
- Influence area
- Oriented minimum bounding box

**Urban scale**

- **City**
- Buffer X meters (depends on the size of the city)
- Urban area
- Oriented minimum bounding box
To do this, it is suggested to start from a layer of points that identifies the position of the city, creating a layer that identifies the area of study and simplifies the following steps. These cropping layers/bounding boxes define the boundaries of the site to be reviewed, and they also limit the working area if the data is too heavy to allow for a fluid workflow. This work is not necessarily a linear process. Scale and limits could be modified based on new finding in the future.
How to map?

It is necessary to pre-select and prepare the information before starting to work with it. For this purpose, it is important to sort out the downloaded or received information from work layers into different folders - the information will be used later on the maps. This step provides a more organized arrangement of information and avoids having unused layers in the workspace. The separation of data is also useful in case of data loss or damage.

Once the information is downloaded, it is necessary to do a pre-selection by triage, processing the information. Later we will do an evaluation to decide which layers are needed. These layers will be extracted directly from the chosen source (and named according to the nomenclature defined in page 09), and projected in the chosen CRS.
Triage

Information triage is the selection of relevant information for the mapping. This requires opening each layer in QGIS and looking at both the visible information and the information present in the attribute tables. It is also necessary to download or choose some layers instead of others filtering by the latest update -which appears in the download portal. The most recent ones, or those with higher quality information, will be chosen to make the maps.

The scheme of page 07 shows the sources of the layers that were selected to make the working layers.

Projection in Coordinate Reference System (CRS)

To avoid problems while working, every layer must be projected in CRS **WGS 84/UTM 38N EPSG: 32638**. If layers are not projected it can be impossible to operate with them. For that it is important to choose in the Properties of QGIS project as Predefined Coordinate Reference System, WGS 84/ UTM 38N EPSG: 32638.

If a layer is correctly located but the CRS is not the chosen one it is necessary to (by right clicking on the layer), “Save as” (QGIS 2.18) or “Export” (QGIS 3.12) modifying the CRS of the layer.

If a layer is not correctly located it is necessary to, first, change its CRS (right clicking on the layer on “Properties”) and change CRS; then, it is necessary to (by right clicking on the layer), “Save as” (QGIS 2.18) or “Export” (QGIS 3.12), modifying the CRS.
### Where to obtain information...

#### International organizations
- **UN OCHA**
  - [https://data.humdata.org/](https://data.humdata.org/)
- **FAO SWALIM**
  - [https://spatial.faoswalim.org/layers/?limit=20&offset=0](https://spatial.faoswalim.org/layers/?limit=20&offset=0)
- **FAO GEONETWORK**
- **GLOBAL SHELTER CLUSTER**

#### Open maps
- **HOTOSM**
  - [https://www.hotosm.org/](https://www.hotosm.org/)
- **OSM**
  - [http://download.geofabrik.de/africa.html](http://download.geofabrik.de/africa.html)

#### Open datasets from satellite images
- **ALOS PALSAR | ASF Data Search Vertex | DEM 30M**
  - [https://search.asf.alaska.edu/](https://search.asf.alaska.edu/)
  - *needs registration*
- **TANDEM-X | DEM 90M**
  - [https://download.geoservice.dlr.de/TDM90/](https://download.geoservice.dlr.de/TDM90/)
  - recommended for basin scale hydrologic analysis *needs registration*

#### Tracing / Teledetection from aerial view
- **Bing aerial**
  - *With OpenLayers plugin*
- **Google satellite**
  - *With OpenLayers plugin and registration in Google Cloud Platform with Gmail account to set up an API key from "Maps Javascript API"
- **Google Earth**

#### Goverment
This manual is for base mapping. The layers made available are not meant to constitute to only source for the production of the maps, but they are the most updated publicly-available spatial layers (UN system, international organization and open sources) sufficient for the elaboration of most of the thematic maps reputed necessary for a basic representation of the territory at district level. The training attendees will be able to collect further data and enrich their maps with ground-level information.

In addition to the sources of data suggested, the layers could be completed with the information that country institutions could have.
How to organize information?

Main folders

00 Drawing limits
  (layers p 06-07)

00 Political Administrative Entities
  (layers p 14)

01 Topography and Hydrology
  (layers p 15)

02 Land
  (layers p 16)

03 Built
  (layers p 17-21)

Example of folders organization
Inside every main folder the information can be organized by theme, according to the sources, or according to scale. This will vary depending on how the information was produced, on the availability and size of the information, or on the map needs.

However, it is always recommended to maintain the hierarchy in naming the files and folders as described below. This allows to retrace and identify the contents of the layer without opening it.

* Government should create a database to be upgraded and maintained of ground-level and validated data.
Political/Administrative Entities

This information is generally well organized, but national and regional boundaries can vary greatly depending on the source and the time of mapping.

In this document the border of Somalia is considered to be demilited by the administrative boundaries as made available by UN OCHA.
Hydrology and topography information is extracted from different DEM models. A first hydrological approach is made with TANDEM-X (cell size: 90 x 90 meters) information for the whole Ogaden Basin (and, partially, for the Central Coastal Basin). This information allows to extract contour lines for regional scale. A second and more precise hydrologic analysis to extract local drainage network is made with ALOS PALSAR DEM (cell size: 30 x 30 meters) from 2007 to 2011. The DEM also allows to extract Hillshade. Even if Ogaden Basin information is not represented on the maps, it allows for the study of hydrologically connected sites; this information is therefore available in the folders.

More information about accuracy of ALOS PALSAR for extracting Drainage network in arid and semi-arid environments:

Landscape information at regional level is obtained from FAO SWALIM and FAO Geonetwork. This information has a fairly high resolution, so at the closest scales it is necessary to adapt it to the actual scale of representation; either by integrating information sources that have a higher resolution, or tracing from aerial images or -if possible- by taking field data.

**Land cover - RS**
- Polygon
- Land cover of Somalia (Globcover Regional) (2005)
- Land cover of Ethiopia (Globcover Regional) (2005)
- Publication: May, 11th; 2009 at 15:49
- Resolution: 300 m

**Geology - RS**
- Polygon
- Geology Abbate et al. (1993)
- Publication: December, 11th; 2019 at 17:02

**Land use system**
- Polygon
- Somalia Landuse system (2007)
- License: Open Data Commons Open Database License
- Publication: December, 3th; 2019 at 16:15

**Landform**
- Polygon
- Somalia Landforms (2008)
- License: Open Data Commons Open Database License
- Publication: December, 3th; 2019 at 16:49

Union of both layers and Eliminate sliver polygon tools - for small polygons A<2Ha

**Land form and use - RS**
- Polygon

**Cropland - RS**
- Polygon
- Somalia_Cropland_GFSAD_30m_2015
- Publication: December, 4th, 2019 at 17:28
- Credits: GFSAD

**Trees -US**
- Polygon

**Google satellite**
*With OpenLayers plugin

Supervised classification
*https://docs.qgis.org/2.18/en/docs/user_manual/processing_algs/saga/imagery_classification.html
03 Built environment

This folder contains information from different sources; additionally, documentation is often not as thorough and well-organized. Therefore, it is proposed to not only perform a series of transformation operations, but also to create databases that allow the available information to be updated and represented in a homogeneous way. To this end, a series of fields have been created which are common to all the tables, and which allow a first approximation to an urban database.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TYPE</th>
<th>NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic object selection</td>
<td>Specific type of object</td>
<td>Official name / Other known names -if relevant-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SOURCE_1</th>
<th>SOURCE_2</th>
<th>DISTRICT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source that the element was extracted from</td>
<td>Source quoted by the first source from which the element was originally taken from</td>
<td>Name of the district where the element resides</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REGION</th>
<th>STATE</th>
<th>CURRENT_ST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the region where the element resides</td>
<td>Name of the state where the element resides</td>
<td>R= Revised / It is most likely to be at this stage NR= Needs revision / It is unlikely to be at this stage</td>
</tr>
</tbody>
</table>
Road information requires manual prioritization of transport routes. Although a large proportion of roads are found in OSM, there are often many problems with the road hierarchy. This requires consulting other sources - Aerial Bing, Google satellite and Google Earth - and comparing different readings of the road network.
Information on buildings and urban spaces is scarce and can be found in many different sources. That is why we propose a 4-layer organization. The work to be done consists of comparing the different databases and integrating the information available in these databases. In some cases the sources repeat information so it is necessary to check the information to avoid duplication.
20

Others

<table>
<thead>
<tr>
<th>GROUP</th>
<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water source</td>
<td>&gt; Berkad</td>
</tr>
<tr>
<td></td>
<td>&gt; Borehole</td>
</tr>
<tr>
<td></td>
<td>&gt; Dam</td>
</tr>
<tr>
<td></td>
<td>&gt; Dug well</td>
</tr>
<tr>
<td></td>
<td>&gt; Water tower</td>
</tr>
<tr>
<td></td>
<td>&gt; Other</td>
</tr>
<tr>
<td></td>
<td>&gt; Not classified</td>
</tr>
</tbody>
</table>

Fusing two layers after verifying that some points do not refer to the same point. If this is the case, only include the point from Strategic water sources. Include as well all the fields present in the Strategic Water Sources map. Points classified by OSM as “Water Well” are classified as “Not classified”.

Strategic Water sources | point
---
Strategic Water sources in Somalia | FAOSWALIM February 2018
https://spatial.faoswalim.org/layers/geonode/SOM_Strategic_Water_Sources_Feb2018/
License: Open Data Commons Open Database
Publication: September, 26th; 2019 at 13:30

OSM Facilities | line
---
http://download.geofabrik.de/africa/somalia.html
License: Attribution-ShareAlike 2.0 Generic (CC BY-SA 2.0)
Adaptation of fields present in downloadable .xls file to used fields
Group: Refugee IDP Camp

IDP Camps

Google Earth
https://www.google.com/intl/es/earth/

Other sources
Paper maps etc

Drawing an approximation of the city limits evolution though aerial images and old maps
https://support.google.com/earth/answer/148094?hl=en

GLOBAL SHELTER CLUSTER
https://cccm-cluster-somalia.github.io/OPSMAP/#moreinfo

Historical - US*

Water sources

Layer that contain water sources and data about its maintenance and quality

OSM
http://download.geofabrik.de/

FAO SWALIM
https://spatial.faoswalim.org/layers/?lim-it=20&offset=0
How to represent information?

Plan representation always starts from the Base maps, both on regional scale (US) and urban scale (RS). In the rest of the maps, certain layers are included or highlighted to give rise to specific content maps.

**Specific information**: layers with specific information wishing to be presented in each map (facilities, watersources, IDP Camps, etc).

**Cover layer**: we can apply the City clip layer used to define the drawing limits (pg 09) with a transparency. Overlapping this cover layer will facilitate reading the specific information above the base map.

**Base map**: it is recommended to remove the layers of the base map that do not contribute to the reading of each case.

---

**1.0. Base map**

*US includes*

- from top to down-
  - AdmN
  - Area
  - Buildings
  - Trees
  - Transport
  - Roads (all)
  - Water sources
  - Water drainage
  - Landform and use * US

**1.1. Facilities**

*US includes*

- from top to down-
  - AdmN
  - Facilities and infrastructures
  - with different codes for different groups and selected types-

**1.2. Hidrology**

*US includes*

- from top to down-
  - Water sources
  - represented three times, showing both water source type and water quality indicators-
  - Water drainage

**1.3. IDP Camps**

*US includes*

- from top to down-
  - IDP Camps
  - size of the location depending on the population of the camp-

**1.4. Urban growth**

*US includes*

- from top to down-
  - Historical

---

**2.0. Base map**

*RS includes*

- from top to down-
  - AdmN
  - Settlements
  - Transport
  - Roads (only truck roads)
  - Hillshade
  - Water sources
  - Water drainage
  - Landcover
  - Landform and use * RS

**2.1. Hidrology**

*RS includes*

- from top to down-
  - Water sources
  - represented three times, showing both water source type and water quality indicators-

**2.2. Topographic**

*RS includes*

- from top to down-
  - Base map
  - represented with a color gradient
  - the same for all the maps-

**2.3. Geology**

*RS includes*

- from top to down-
  - Base map
  - represented with the same colors and codes than Geology map in SWALIM Atlas of Water and Land

---

Legend

Map content

Additional information

Logos, credits, sources, disclaimer, authors, etc.

Page Format

Scale

North
Organising the map

Information on buildings and urban spaces is scarce and can be found in many different sources. That is why we propose a 4-layer organization. The work to be done consists of comparing the different databases and integrating the information available in these databases. In some cases the sources repeat information so it is necessary to check the information to avoid duplication.

Legend
Map content
The symbology established for each of the layers (roads, buildings, water sources, etc), can be copy from one project map to another:
- By right clicking Style/Copy Style on the layer that we want to copy and Style/Paste Style on the recipient layer.
- By saving the style as a new template in Layer Properties/Symbology/Style/Save Style.

Map content
- Roads and buildings
- National road
- Regional road
- District road
- Local road
- Access road
- Track
- Buildings and plots
- Trees
- Land
- City and settlements
- Pastoralism (low density) on grassland
- Pastoralism (low density) on grassland
- Hydrology and water sources
- Drainages network
- Water sources

Page Format
Scale
North

Additional information
Logos, credits, sources, disclaimer, authors, etc.

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Examples of representation

URBAN SCALE
  1.0 Base map
  1.1 Facilities
  1.2 Hydrology
  1.3 IDPCamps
  1.4 UrbanGrowth

REGIONAL SCALE
  2.0 Base map
  2.1 Hydrology
  2.2 Topographic
  2.3 Geology
Urban scale
1.0 Base Map

Layers used
- from top to down -
  AdmN
  Transport
  Water sources
  Roads (all)
  Buildings
  Area
  Trees
  Water drainage
  Landform and use * US

Galkayo
Base Map
Roads and buildings
- National road
- Regional road
- Local road
- Access road
- New expansion road
- Track
- Buildings and plots...
Transport infrastructures
- Airport
Land
- City
- New expansion
- Plain | Cropland
- Plain | Pastoralism (high density) on grassland
- Plain | Pastoralism (low density) on shrubland
Hydrology and water sources
- Drainage network
- Water sources

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Urban scale

1.1 Facilities

Layers used
- from top to down -

Facilities and infrastructures
-with different codes for different groups and selected types-

Regional scale
(Transparency)

Base map*US
Layers used
-from top to down-

Water sources -represented three times , showing both water source type and water quality indicators-

Water drainage

Base map*US except Water sources and drainage

Galkayo
Hydrology and water sources

Hydrology
- Temporary water ponds

Drainage channels
- 1 (Strahler order)
- 2 (Strahler order)

Water sources
- Borehole
- Dam
- Deep well
- Not classified, other

Water quality
- No data available

Total Dissolved Solids
- 600 mg/L ≤ TDS < 1000 mg/L
- 1000 mg/L ≤ TDS

Electrical conductivity
- 2000 μS/cm ≤ EC ≤ 3000 μS/cm
- 3000 μS/cm < EC ≤ 4000 μS/cm
- 4000 μS/cm < EC

*UN-Habitat for a better urban future
Urban scale
1.3 IDP Camps

Layers used
(from top to down):
IDP Camps
-size of the location depending on the population of the camp
Base map*US
Urban scale

1.4 Urban growth

Layers used
- from top to down-
  Historical
  Base map*US

Galkayo
Urban Growth
Built-up area
- Before 1973
- 2003
- 2020
- New development

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Layers used
- from top to down -
- AdmN
- Settlements
- Transport
- Roads (Only truck roads)
- Hillshade
- Water sources
- Water drainage
- Landcover
- Landform and use * RS

Galkayo

Base Map | Regional scale

<table>
<thead>
<tr>
<th>Layers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Border and limits</td>
<td>Drainage network and water sources</td>
</tr>
<tr>
<td>National border</td>
<td>- Chapasals</td>
</tr>
<tr>
<td>Regional limit</td>
<td>+ Water sources</td>
</tr>
<tr>
<td>District limit</td>
<td>Land cover</td>
</tr>
<tr>
<td>Settlements</td>
<td>Mosaic forest or shrubland grassland</td>
</tr>
<tr>
<td>Regional Capital</td>
<td>Open grassland</td>
</tr>
<tr>
<td>District Capital</td>
<td>Closed to open herbaceous vegetation (or lichen and mosses)</td>
</tr>
<tr>
<td>Settlement</td>
<td>Sparse vegetation</td>
</tr>
<tr>
<td>Roads</td>
<td>Mosaic vegetation/cropland</td>
</tr>
<tr>
<td>National road</td>
<td>Rainfall cropland</td>
</tr>
<tr>
<td>Regional road</td>
<td>Landform and land use</td>
</tr>
<tr>
<td>District road</td>
<td>Plan: Pastoralism (high-density)</td>
</tr>
<tr>
<td>Airports</td>
<td>Plan: Pastoralism (high-density) with scattered oasis farming</td>
</tr>
<tr>
<td></td>
<td>Pan: Pastoralism (low density) with scattered oasis farming in a gypsum surface</td>
</tr>
</tbody>
</table>

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### Regional scale

#### 2.1 Hydrology

Layers used:
- from top to down:
  - Water sources represented three times, showing both water source type and water quality indicators.
  - Water drainage
  - Regional scale (Transparency)

**Base map** RS except Water sources and drainage

#### Galkayo

Hydrology and water sources | Regional scale
---
Drainage network - Strahler order -

<table>
<thead>
<tr>
<th>Water source type</th>
<th>Water quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water sources</td>
<td>No data available</td>
</tr>
<tr>
<td></td>
<td>500 mg/L &lt; TDS &lt; 1000 mg/L</td>
</tr>
<tr>
<td></td>
<td>1000 mg/L &lt; TDS</td>
</tr>
<tr>
<td></td>
<td>Electrical conductivity</td>
</tr>
<tr>
<td></td>
<td>2000 μS/cm &lt; EC &lt; 3000 μS/cm</td>
</tr>
<tr>
<td></td>
<td>3000 μS/cm &lt; EC &lt; 4000 μS/cm</td>
</tr>
<tr>
<td></td>
<td>4000 μS/cm &lt; EC</td>
</tr>
</tbody>
</table>

- **Borehole**
- **Dug Well**
- **Not classified**

---

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Regional scale
2.2 Topographic

Layers used
-from top to down-
Base map*RS
dem instead of Land layers
DEM
represented with a color gradient
-the same for all the maps

Galkayo
Topographic map | Regional scale
Contour lines
- 10 meters
- 50 meters

Elevation
- 200 meters
- 300 meters
- 400 meters
- 500 meters

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Regional scale

2.3 Geology

Layers used
- from top to down
- Base map*RS instead of Land layers
- Geology represented with the same colours and codes than Geology map in SWALIM Atlas of Water and Land

Galkayo
Geological Map | Regional scale

*Late Neocene to Present
- $R$ | Clayey sediments deposits alternating with fossiliferous clays, sometimes with oololiths (Cretaceous) and calcarenites with oololiths (Eocene-Miocene)
- Muddy succession

*Oligocene to early Miocene
- $Q_w$, $Q_b$ | Calcareous sands and sandy clays, limestones, and marls found in wells (continental “Mud Bala”)
- $Q_b$ | Limy limestones and marls (Pliocene-Lower Pliocene)

*Maastrichtian to Early Miocene
- $R_{Mi}^n$ | Aamadi Limestone, shell limestones, often nodular, with corals, pelagic and foraminifers, and intercalations of marls and cherts