Towards a Spatial Data Infrastructure for Somalia using Open Source standards

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ABSTRACT

SDI is a well known concept in Africa. Many countries are on the way to having a formal SDI strategy. Certain countries such as Somalia are starting the process of nation building after years of war. These countries stand to leapfrog other African countries by implementing current SDI best practices. The FAO-SWALIM project is in the unique position to be able to assist Somali authorities in providing some of the building blocks for SDI development, even though SWALIM does not have the legal mandate to do so. This paper highlights what SWALIM can currently contribute and what significant work (and resources) are still required for a Somalia National SDI.

INTRODUCTION

The concept of a Spatial Data Infrastructure (SDI) has become well known in countries in Africa in the last 5 years. Countries such as South Africa, Kenya, Botswana, Mali, and Nigeria (amongst others) are on the way to having a formal, national SDI strategy (Lance, 2003). Certain countries are lagging behind in this development, including Sudan and Somalia, who are starting a process of nation building after years of war. These countries stand to leapfrog ahead of the other African countries by implementing current best practices that have been tried and tested by many other countries before them.

Of course, governments of these countries have more important priorities than looking at legislation and processes to implement SDI, but the FAO-SWALIM project is in the unique position to assist the Somali authorities in the SDI process with building capacity, and compiling information and procedures that can be handed over to the relevant authorities when the time is right. There are still many problems associated with Somalia including a lack of a stable government system, security concerns because of clan conflict, hostage taking and also extremist activity. However, once there is lasting peace and a stable environment, Somalis stand to benefit from information technology and will be able to make a huge leap forward and implement current best practices in spatial information management and SDI.

Keeping the above in mind, it must be said at the outset that FAO-SWALIM does not have the mandate to build a Somalia SDI. Also, SWALIM does not have the legal or institutional authority or capacity to focus on the framework of SDI building, but SWALIM does have some components that could be used to *plug-in* to an SDI framework when the time is right.

ABOUT FAO-SOMALIA WATER AND LAND INFORMATION MANAGEMENT (SWALIM)

SWALIM is a European Commission (EC) funded project (with a 5% contribution from UNICEF) requested by various Somali administrations, non-governmental organisations, development agencies and UN organisations on behalf of Somali communities whose lives largely depend on water and land resources.

One and a half decades of civil strife in Somalia led to loss and damage of most of the water and land related information collected in the previous half century. No successful water or agricultural development can be achieved without realistic data on the available resources. For planning purposes raw data have to be turned into information required by decision makers, donors and investors. SWALIM is trying to recover lost information from all over the world and, at the same time, re-establish data collection networks in collaboration with partner agencies.

The project is implemented by the Food and Agriculture Organisation (FAO) of the United Nations and its objective is to contribute to the improvement of water and food security in Somalia by:

1. Collecting data needed for water and land resources management.
2. Generating user friendly information from the data.
3. Storing the information in easily accessible data bases and disseminating through conventional and electronic media.
4. Building capacity in the three regions of Somalia so that they will be able to take over SWALIM functions in the future.

Specific activities include:

- Mapping of water sources (boreholes, berkads, shallow wells, etc.).
- Rehabilitation of the national rainfall and river flow data collection and processing network.
- Initiation of a flood warning system.
- Evaluation of the potential for harvesting rain water.
- Surveying of main irrigation systems.
- Mapping land resources.
- Assessment of land suitability.
- Evaluation of erosion and land degradation.

SWALIM data and information is freely available to anyone working in related fields in Somalia though different outlets including the website (www.faoswalim.org), email request, SWALIM information resource center and dedicated Liaison Offices in Somalia. Dissemination media include web downloads, searchable catalogue, information CDs, reference library and stand alone databases and applications. SWALIM can be contacted by email at enquiries@faoswalim.org.

The project supports interventions by others, and serves the needs of Somali regional administrations to which capacity building support is offered. The long term assumption is that emerging and future Somali administrations will take information based approaches and will treat information baselines as priority assets. In the current absence of a central government, FAO acts as custodian of the information produced by the project, for hand over at a later date.

SWALIM also works with many partner NGOs and international agencies working in the field, which are collecting essential baseline data on a continuous basis. SWALIM acts as a repository for all this information and then processes, manages and disseminates the information to relevant agencies.

WHY SDI?

Spatial information (or data specific to locations on the earth's surface) provides the common language and reference system to establish linkages and balance between economic, environmental and social capital in order to improve upon the basis for societal response. Access to spatial data, and the policies governing that access, is crucial in shaping policies, programmes and projects (Lance (Ed), 2004).

Spatial data forms an essential part of the knowledge available in modern information and communications science. It is required at all levels of administration, the economy, and science and by the public at large. It is the basis for planning in numerous fields. It aids agencies, governments and communities in providing information to ensure critical infrastructure, protect the environment and deal with public health and safety issues as well as day-to-day resource management decision-making (Lance (Ed), 2004).

The Plan of Action of the World Summit on Sustainable Development (WSSD) recognized that the implementation of Agenda 21 and the achievement of the internationally agreed development goals, including the Millennium Development Goals (MDG) and the plan itself, require the development of "information systems that make the sharing of valuable data possible, including the active exchange of earth observation data" (United Nations, 2002). This is equally true for the realization of objectives of the New Partnership for African Development (NEPAD). Planners and policy-makers will require a vast amount of spatial information to address the majority of the aspirations articulated by these goals and initiatives. There is a recognized need to facilitate access to public information and participation, to provide affordable local access to information, to integrate existing information systems and to ensure public participation in decision-making (Lance (Ed), 2004).

The United Nations Economic Commission for Africa (UN-ECA) has also implemented the Mapping Africa for Africa (MAFA) initiative which has identified fundamental datasets that are necessary for basic planning within any country. A tender bid has been prepared by the South African Department of Land Affairs – Directorate Surveys and Mapping (for MAFA) for doing an inventory of what data are available in each African country. A needs analysis on what needs to be done by each country to enable them to have the fundamental datasets is also part of the contract document.

Access to reliable and up-to-date spatial information reduces the uncertainty in planning and management for agencies and local governments by helping identify and analyze situations and issues. The value of the information and the effectiveness of the decision-making/planning processes are very closely related to the quality and completeness of the information, and the manner in which it is made available. In this respect data access, management, integration, analysis and communication are key components. Within all these components the need for standards is critical (Australian Local Government Association, 2004). Mansourian *et al* (2004) also argue that SDI as an infrastructure in spatial data production, management, sharing and access can be an appropriate framework for facilitating disaster management through timely access to reliable information

Many agencies are both information providers and receivers. This means they collect and use data for their own purposes, as well as making it available to other users. Standards form a key ingredient underpinning the management of data and information (Australian Local Government Association, 2004).

Benefits of standards for data include (Australian Local Government Association, 2004):

- Increased data sharing.
- Improved data consistency.
- Increased data integration and interoperability.
- Better understanding of data.
- Improved documentation of information resources.
- Improved control over data updating activities and development of new versions of datasets.
- Improved data security.

Agencies invest significant resources, including time and money, each year in collecting and maintaining data. Despite this investment, data collected by different agencies often use different standards to collect, store, document and provide access to, data. The resulting inconsistencies may create major inefficiencies and limit effectiveness (Australian Local Government Association, 2004).

Inconsistent data increases the time, effort and cost to assimilate datasets to enable area comparison, address broader regional strategic issues requiring the combination of data from more than one agency, or to analyze trends in the status of local communities over time. As more information becomes available agencies, local governments and their communities want to compare information across districts and/or regions. Users of spatial information are increasingly demanding (Australian Local Government Association, 2004):

- Consistency between related data
- Seamless maps not interrupted by artifacts such as map sheet boundaries, local government boundaries or regional/international borders.
- Consistent descriptions of similar features so that a feature is defined the same way.

TOWARDS A SPATIAL DATA INFRASTRUCTURE (SDI) FOR SOMALIA

The term *Spatial Data Infrastructure* (SDI) is often used to denote the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data. The SDI provides a basis for spatial data discovery, evaluation, and application for users and providers within all levels of government, the commercial sector, the non-profit sector, academia and by citizens in general (Nebert (Ed), 2004).

The growth and adoption of Geographic Information Systems (GIS) around the world has led to investments in spatial data and networked systems, developing them to their full advantage. Thus, we have the SDI phenomenon. This technology makes a difference in the world. In education, environmental management, disaster response, agriculture, health care, transportation planning, delivery of clean drinking water, the management of power delivery, lands-records management, combating poverty, defense and security, GIS is used everyday by government, agencies and citizens. SDIs are becoming an essential element of each country's information and communication technology (ICT) plan. Well maintained SDIs empower people and the institutions that serve them. This is critical in the effort to realize the United Nation's MDGs and build a better world in the 21st century (Dangermond in Masser, 2005).

The word *infrastructure* is used to promote the concept of a reliable, supporting environment, analogous to a road or telecommunications network that, in this case, facilitates the access to geographically-related information using a minimum set of standard practices, protocols, and specifications. Like roads and wires, an SDI facilitates the conveyance of virtually unlimited packages of geographic information (Nebert (Ed), 2004).

An SDI must be more than a single data set or database; an SDI hosts geographic data and attributes, sufficient documentation (metadata), a means to discover, visualize, and evaluate the data (catalogues and Web mapping), and some method to provide access to the geographic data. Beyond this are additional services or software to support application of the data. To make an SDI functional, it must also include the organizational agreements needed to coordinate and administer it on a local, regional, national, and or trans-national scale. Although the core SDI concept includes within its scope neither base data collection activities or myriad applications built upon it, the infrastructure provides the ideal environment to connect applications to data – influencing both data collection and applications construction through minimal appropriate standards and policies (Nebert (Ed), 2004).

A SDI makes sense at the local, national, regional and global level where the overlap and duplication in the production of geographic information is paralleled by insufficient flows of geographic information among different stakeholders due to a lack of standardization and harmonization of spatial data bases. Once the importance of providing geographic information as an infrastructure similar to road and telecommunication networks is recognized, it makes sense to ensure that a consistent Spatial Data Infrastructure at the local, national and global level is developed (Nebert (Ed), 2004).

According to Warnest, *et al* (2005), SDI is also a crucial component in providing the best available information for good governance of the community. In most societies, citizens' view government at all levels with suspicion. It is the responsibility of government to change that perception and that can only be achieved by performance coupled with good governance and transparency (Grant, 1999). Ting & Williamson (2001) concede that unfortunately, modern societies still have some way to go before they will have the combination of legal, institutional, information technology and business system infrastructures required to support sustainable development objectives for the community.

The above paragraph illustrates the problems associated with SDI's in developing countries, if previous research has already found that even modern developed societies still have some way to go in order to provide a sustainable SDI model that combines legal the correct legal framework with the correct technologies and the optimal business model.

Four key concepts underpin all SDIs (Masser, 2005):

1. The overriding objective of an SDI is to maximize the use of spatial information. This requires ready access to the geographic information assets held by a wide range of stakeholders in both the public and private sector.
2. SDIs cannot be realized without coordinated action on the part of governments and agency partners.
3. SDIs must be user driven. Their primary purpose is to support decision making for many different purposes.
4. SDI implementation involves a wide range of activities. These include not only technical matters such as data, technologies, standards, and delivery mechanisms, but also institutional matters related to organizational responsibilities and overall national information policies, as well as questions relating to the availability of the financial and human resources needed for this task.

The question, however, is how to implement these activities in Somalia and the questions are not easily answered. These issues go beyond the current scope of SWALIM. A huge amount of coordination and funding would be necessary to begin implementation of a

Somalia SDI. An outline of what components an ideal SDI should have and what the current status is for Somalia are now given briefly.

The 'ideal' SDI: The characteristics of what may be described as an 'ideal' SDI are outlined below (Nebert (Ed), 2004);

- There is a common spatial data foundation organized according to widely accepted layers and scales (or resolution) that is available for the entire area of geographic coverage (parcel, neighborhood, city, county, state, nation, etc.) to which other geospatial data can be easily referenced.
  A common spatial data foundation does not exist in Somalia. Agencies use their own data collection methods and different projections, spheroids and datums are used. There are no commonly accepted datasets on various themes, except on a few rare occasions such as the SWALIM water sources datasets.
- The foundation (or core) data are readily accessible and available at little or no cost from user-friendly and seamless sources to meet public needs and encourage conformance by producers of other geospatial data.
  In Somalia, many agencies work in isolation and do not share their data. Other agencies sell their data while others provide it freely. There is no warehouse structure setup to act as a data clearinghouse.
- Both foundation and other geospatial data, as required and specified co-operatively by data producers and users, are updated according to commonly accepted standards and measures of quality.
  Only in specific sectors, such as water resources do agencies in Somalia work together to harmonise data collection and avoid duplication of effort.
- Thematic and tabular data are also available on terms not incompatible with the foundation data.
  Data in Somalia are available in all kinds of formats and there is no accepted standard format for the distribution of spatial or tabular data.
- Cost-effective, geospatial data produced by one organization, political jurisdiction, or nation is compatible with similar data produced by other organizations, political jurisdictions or nations.
  In Somalia this is the case at SWALIM where international standards for collection and documentation of information (e.g. ISO 19115 metadata collection) were used where possible. This may not be the case with other organizations.
- Geospatial data can be integrated with many other kinds or sets of data to produce information useful for decision makers and the public, when appropriate.
  This is the case with agencies with enough GIS and IT expertise to be able to convert data into information for decision making. A lot of capacity building is needed in Somalia, not only to convert data to information, but to be able to interpret that information that can be applied to a practical decision.
- Responsibility for generating, maintaining, and distributing the data is widely shared by different levels of government and the private sector. Governments take advantage of private-sector capabilities available at reasonable prices rather than maintaining dedicated capabilities.

There is an active private sector in Somalia that flourishes (especially in the Information Technology sector) due to the lack of government controls.

- The costs of generating, maintaining, and distributing such data are justified in terms of public benefits and/or private gains; overlap and duplication among participating organizations is avoided wherever possible.
  Costs of data collection and distribution are justified in Somalia as long as information ends up in the hands of the Somali authorities where it will benefit the most. Overlap and duplication of efforts is largely minimized due to a lot of donor coordination by the Somalia Aid Coordination Body (SACB).

As mentioned above, several factors determine a country's (or region's) ability to make effective use of available spatial or geographic information, namely (Lance (Ed), 2004):

- Clearly defined core (or base) spatial data sets,
- The adherence of geographic datasets to known and accepted standards,
- Accessible documentation about existing geo-information (metadata),
- Policies and practices which promote the exchange and reuse of information, as well as
- Adequate human and technical resources to collect, maintain, manipulate and distribute geo-information.

Core or base datasets are defined in this article as *the minimum primary sets of data that cannot be derived from other datasets, and that are required to spatially represent phenomena, objects, or themes important for the realisation of economic, social, and environmental benefits consistently across Africa at the local, national, sub-regional and regional levels.* This definition has been adopted from the user needs analysis conducted by the Human Sciences Research Council (HSRC) in collaboration with EIS Africa for the United Nations Economic Commission for Africa's (UN-ECA) Mapping Africa for Africa (MAFA) initiative (Gyami-Aidoo *et al*, 2005).

The user needs analysis survey was answered by various regional centres, international organizations, universities, United Nations agencies and African government agencies. A weighting system was applied according to the *importance* rating of each respondent for a particular dataset, keeping the above definition in mind. From the survey results, Table 1 shows the identified 'candidate' fundamental datasets.

Table 1. *Fundamental geospatial datasets for Africa (Gyamfi-Aidoo, et al, 2005).*

Level	Category	Data Theme	Data Set	Definition
0	Primary Reference	Geodetic Control Network	Geodetic control points	List of coordinates with information on the history of establishment of the network as well as network design in digital map/GIS format.
			Height datum	List of heights of primary height points in digital map/GIS form (vertical datum surface)

Level	Category	Data Theme	Data Set	Definition
			Geoid model	Geoid-ellipsoid separations (heights at individual points) to convert from GPS observations to heights
I	Base geography	Rectified Imagery	Aerial photography	Aerial photography
			Satellite imagery	Satellite imagery
		Hypsography	Digital elevation model	Vertical distance from the earth's surface to a base defined by the adopted height datum
			Spot heights	Heights of peaks
			Bathymetry	Vertical distance of earth's surface from base defined by Lowest Astronomical Tide
		Hydrography	Coastline	The limit of land features usually at mean high water level.
			Natural water bodies	Location of watercourses, drainage network, and all inland water bodies (streams, rivers, canals, ponds, lakes, etc.)
II	Administration and spatial organisation	Boundaries	Governmental units	Limits of administrative and jurisdictional authority (International, national, sub-national boundaries, and local government areas)
			Populated places	Population centres including urban areas, towns, localities, and rural settlements
			Enumeration areas	Boundaries of areas delineated for the purpose of collecting demographic census information
		Geographic names	Place Names	Official and local names of places
			Feature Names	Official and local names of cultural and geographic features (including roads)
		[Land management units/areas]	Land Parcels/Cadastre	A consistent framework of land parcel/cadastre boundaries defined for land tenure purposes, referenced to a common datum
			Land Tenure	Current, proposed and historical details of all tenures, e.g., details of ownership, vesting, and including traditional forms of land holding.
			Street Address	Unique Street Address of parcels/properties
			Postal or zip code zones	Boundaries of post code areas
			Land use planning zones	Boundaries of areas of permitted/restricted land use defined by planning authorities (includes conservation areas, heritage sites, and restricted areas)
	Infrastructure	Transportation	Roads	Network of physical roads and carriageways

Level	Category	Data Theme	Data Set	Definition
			Road centrelines	Centreline of roads and carriageways
			Railways	Network of railway lines
			Airports and ports	Location of airports, sea ports, and navigation aids
		Structures	[Bridges and tunnels]	
		Utilities and services	Power	Locations of trunk or national grid power line networks and major assets/installations, and sources
			Telecommunications	Locations of trunk communication networks and major assets
III	Environmental Information	Natural environment	Land cover	Observed bio-physical cover over on the earth's surface[1]
			Soils	Boundaries and classifications of soil resources
			Geology	Boundaries and classification of geological units

The technical underpinning of a SDI is a common framework of standards, tools and services based on these standards. In this three-tier model, applications work with metadata and data content and services that exist on the enabling infrastructure. The following United States Federal Geographic Data Committee (FGDC) technical elements are important components of a SDI (Nebert (Ed), 2004):

- Quality metadata (*and quality data. Metadata documentation can be excellent, but it refers to a dataset that might be irrelevant).*
- Residence of metadata in on-line directories.
- Good data management.
- Access to services on-line.
- Their documentation in directories.
- Reference implementations of software to demonstrate capabilities.

SWALIM have some of the components of an SDI, in various stages of development, which could be *plugged* into an SDI structure, but SWALIM, by no means, have the mandate or capacity to implement an SDI for Somalia. One of these components is a solid baseline of information which covers most of the fundamental datasets identified in Table 1. This information is generated by SWALIM but also includes data shared by other agencies and international organizations. A solid baseline of information is essential especially in countries where an emergency situation exists so that intervention strategies are based on fact and not perceptions. The authors' experience in Africa is that lack of data is no longer a problem; the problem nowadays is the lack of *well documented* datasets. In fact there is so much data that organisations can be overloaded with datasets and it becomes a lottery over which datasets to use and which are the most accurate.

[1] Di Gregorio, 2005

Another component of an SDI that is in the preliminary stages of implementation is an online metadata catalogue service allowing users to search for data as well as access, via download, of certain datasets. The software that will be used is called GeoNetwork. Geonetwork relies on open source[2] software that provides a metadata clearinghouse for geo-referenced data and information (Food and Agriculture Organisation and World Food Programme, 2005). The metadata catalogue conforms to the International Organisation for Standardisation (ISO) metadata standard 19115 and 19139 as well as FGDC and Dublin Core metadata standards. GeoNetwork also uses the Z39.50 protocol for remote search, allowing agencies running GeoNetwork nodes to search each others databases. Z39.50 is an open standard that enables communication between systems that run on different hardware and use different software (Turner, 1997). It is documented in the ISO standard 23950.

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GeoNetwork also allows access to the actual spatial data and information (not only the metadata) through a portal (desktop or internet) (Food and Agriculture Organisation and World Food Programme, 2005) and therefore provide another component of an SDI i.e. access to data.

SWALIM are also evaluating several ways to provide interactive web mapping services. These services will be based on the Open Geospatial Consortium (OGC) standards for Web Map Services (WMS) or Web Feature Services (WFS) and the software used will be open source. Using these OGC standards, users will be able to connect to a whole host of other web map services which use the same standards.

Table 2 shows the SDI components mentioned by the GSDI Cookbook, SDI Africa and FGDC and compares SWALIM activities that could complement an SDI initiative. A third column is also included to show SWALIM shortcomings with said activity.

Table 2. *Comparison of SDI components with SWALIM activities.*

SDI Component (GSDI, SDI Africa or FGDC)	SWALIM Activity	SWALIM shortcoming
Clearly defined base data sets	Mapping of water sources, Rehabilitation of the national rainfall and river flow data collection and processing network, Initiation of a flood warning system, Evaluation of the potential for harvesting rain water, Surveying of main irrigation systems, Mapping land resources, Assessment of land suitability, Evaluation of erosion and land degradation	These activities may or may not contribute to basic data sets, but mapping of water sources, land cover, landform (and the satellite imagery needed for interpretation) relate directly to basic datasets as defined by Gyami-Aidoo, *et al,* 2005
Adherence to known standards	Yes, ISO 19115 metadata, FAO-UNEP Land Cover Classification System (LCCS) for land cover (also an evolving component of ISO TC211)	
Quality metadata	Yes, complete metadata for spatial data as well as complete metadata for books and articles	Lack capacity[3] for metadata entry and lack capacity to communicate with other agencies to ensure correct and complete metadata.
Good data management	Yes, SWALIM has an Information Resources Unit	Although SWALIM Information

[2] The term *open source* refers to a set of licenses that require unfettered access to the human-readable *source code* from which all computer programs are made (Holmes, *et al*, 2005)

[3] Lack of capacity here does not refer to current SWALIM capacity to meet current project objectives, but refers rather to capacity that would be needed if SWALIM should take the role of SDI implementation.

	(IRU) which is responsible for the maintenance of all SWALIM databases	Management is good, SWALIM still lack the capacity for accurate data entry
Accessible metadata	Yes, searchable through FAO AGRIS system for publications. Access to spatial data through GeoNetwork is coming soon.	On the intranet, but not available to the public as yet. Work on making spatial datasets available in GeoNetwork is done on a piecemeal basis
Online metadata	Yes, searchable through FAO AGRIS system. Access to spatial data through GeoNetwork is coming soon.	On the intranet, but not available to the public as yet
Online data portal	Planned in the future through GeoNetwork	Still planned and currently in the preliminary stage of implementation
Update of data according to commonly accepted standards and measures of quality	Yes, the Somalia Water Information Management System (SWIMS) is used by all partner agencies for water sources in Somalia. Africover land cover is being updated and upgraded using the same methodology (LCCS) to ensure comparisons. All newly collected data is documented according to ISO 19115 metadata standards.	
Policies and practices which promote the exchange and re-use of information	Yes, SWALIM has MOU's with various partner agencies and SWALIM's mandate is to share information resources. SWALIM participates in many working groups coordinated by the SACB. SWALIM initiation of the Somalia Interagency Mapping and Coordination group	Mostly informal agreements
Overlap and duplication among participating organizations is avoided wherever possible	Duplication is avoided through various working groups, on various themes, of agencies working in Somalia	
Data can be integrated with many other sets of data to produce information useful for decision makers	Yes, SWALIM has a GIS section where most data sources can be integrated.	Lack of capacity to assimilate all possible sources of spatial data and come up with a final version for all agencies
Responsibility for generating, maintaining, and distributing the data is widely shared	Yes, SWALIM relies on data input from the field by partner agencies and regional government bodies	SWALIM has no legal framework in Somalia and has no say regarding which data may or may not be distributed and by what means
Data produced is compatible with similar data produced by other organizations	Yes, spatial data produced by SWALIM is in shapefiles which can be read directly or imported by all GIS software.	
Data available at little or no cost	Yes, data is transferred to agencies and other interested parties at no cost or cost recovery basis	
Adequate human and technical resources to collect, maintain, manipulate and distribute geo-information	Yes, SWALIM has an IRU and GIS unit. Part of the SWALIM mandate is to collate, manipulate and re-distribute information	SWALIM lack the resources to be able to do this job effectively and efficiently on a continuous basis

As can be seen from Table 1, SWALIM plans to have many of the components of an SDI in place such as good fundamental datasets, searchable online metadata clearinghouse and access to spatial data online, but much more work is needed in the implementation of standards and services as well as coordination between agencies and the Somali authorities. SWALIM may not be in the ideal position to further the SDI concept but SWALIM are at the moment the best suited (with the additional resources) and SWALIM are in the unique position to hand over all the components to the Somalia authorities when appropriate.

Figure 1 shows the SWALIM information management framework as conceived in 2005. It shows the data flow from the SWALIM theme groups to the field and *vice versa*. It depicts data accessible through a Client Service Platform which in the future will include GeoNetwork for searchable and accessible spatial data. At the moment the FAO-International Information System for the Agricultural Sciences and Technology (AGRIS) is in place. AGRIS was created by FAO in 1974 to facilitate information exchange and to bring together world literature dealing with all aspects of agriculture. The system however was created for publications and documentation and not for spatial data. Therefore it has been decided that GeoNetwork will be run in parallel with AGRIS. AGRIS will allow the search of the publications SWALIM have available while GeoNetwork will serve the spatial data.

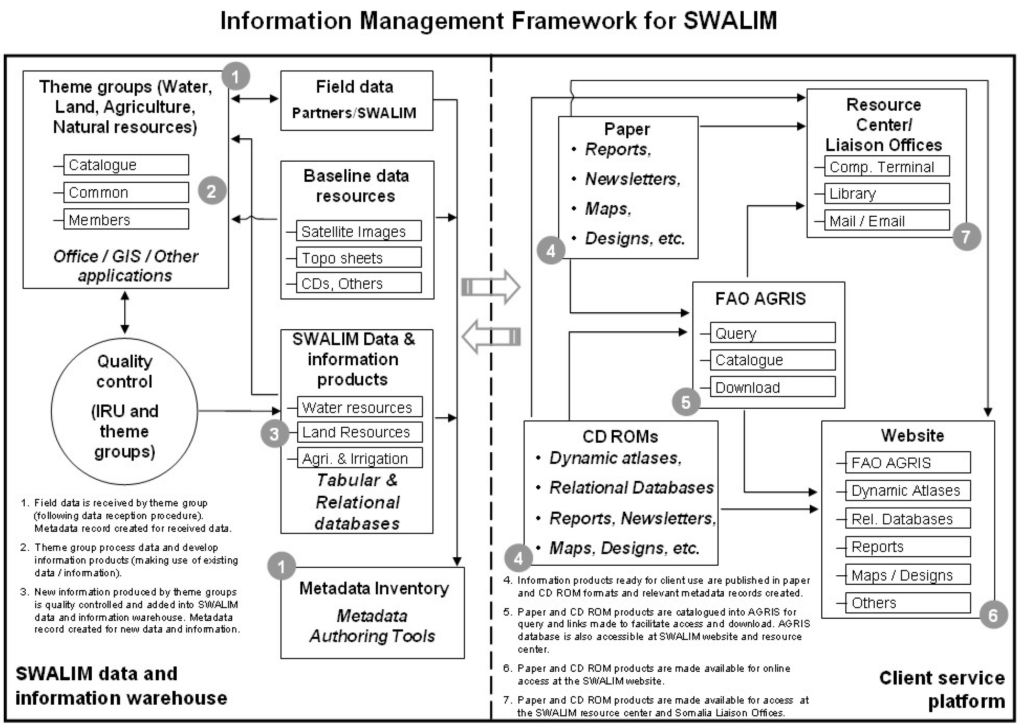

Figure 1. *SWALIM information management diagram (FAO-SWALIM, 2005).*

While some of the SDI components appear to be in development, ultimately it is the *handing over* that is the critical aspect. What is missing is an adequate governance regime for maintaining what will have been set up. According to the United States (US) National States Geographic Information Council (NSGIC), the critical success factors for (US state-level) inter-agency GIS coordination are (Government of California, 2004):

- Establish a full time, paid Geospatial Information Officer (GIO) with the authority and resources to coordinate statewide geospatial information technologies and data production in support of the state's business and strategic plans.

- GIO has a formal relationship with State GIO.
- A politician or executive-maker is sponsor.
- Responsibilities for developing the National Spatial Data and a State Clearinghouse are assigned.
- State government has the ability to work and coordinate with local governments, academia and the private sector.
- Sustainable funding to meet projected geospatial needs.
- GIO has the authority to enter into contracts and receive and expend funds.
- The Federal government works through the state GIO.

The above critical success factor are based on the best practices in the United States that have been set up only after years of experience and understandably Somalia is quite away behind reaching these criteria. Table 2 shows the NSGIC critical success factors and the current status in Somalia/SWALIM.

Table 2. NSGIC *Critical success factors and the Somalia/SWALIM situation.*

NSGIC Success Factor	Status in Somalia/SWALIM
A full-time, paid coordinator position is designated and has the authority to implement the state's business and strategic plans.	SWALIM has a position relating to spatial data coordination but the coordinator has not authority to take decisions on behalf of the government of Somalia. .
A clearly defined authority exists for statewide coordination of geospatial information technologies and data production.	Somalia/SWALIM has no such authority, although an informal group (Somalia Interagency Mapping and Coordination – SIMaC) has been initiated by SWALIM to help coordinate agency data and mapping activities.
The statewide coordination office has a formal relationship with the state's Chief Information Officer [, the Governor's cabinet] (or similar office).	SWALIM coordinates with Somali authorities but the links are not well enough established
A champion (politician or executive decision-maker) is aware and involved in the process of coordination.	Somalia has no such champion for geospatial matters.
Responsibilities for developing the National Spatial Data Infrastructure and a Clearinghouse are assigned.	This responsibility has not been formally assigned, but SWALIM have some elements in place in the future.
The ability exists [for state government] to work and coordinate with local governments, academia and the private sector [on geospatial matters].	SWALIM coordinates with other agencies and Somali regional authorities but not on all matters related to geospatial information, although the recently established SIMaC group could provide this coordination role.
Sustainable funding sources exist to meet projected [geospatial] needs.	No such funding is available in for Somalia/SWALIM.
Coordinators have the authority to enter into contracts and become capable of receiving and expending funds [in pursuit of high priority state geospatial projects].	This does not exist in Somalia/SWALIM.
The Federal government works through the statewide coordinating authority.	There is no clear regional coordinating entity for geospatial information in Somalia

Many countries and companies have something that looks like an SDI in place but in effect it is not compatible with many other systems that surround it that could possibly provide complementary services or information. The tenets of an SDI should reinforced by standards and specifications that will allow interoperability (Nebert, pers. comm. 2006). The author has experienced this situation in South Africa and the United Nations where very good internet mapping services have been set-up but they cannot connect to other WMS or WFS using OGC standards or *vice versa.*

Kate Lance (pers. comm.. 2006) sums up the situation for many countries in Africa, especially the case of Somalia, *Many projects, focusing on the public sector, have built datasets, set up clearinghouses and portals, established working groups, drafted data policies etc., but once a project ends, the SDI components are not maintained. I see maintenance squarely as a public administration issue. SDI efforts must be embedded in routine bureaucratic processes and accountabilities – planning, personnel management, budgeting, reporting, etc. You have an especially difficult situation in Somalia, where government operations are not yet routine, so how can you ensure that SWALIM will be embedded?*

FUTURE ACTIVITIES AND CONCLUSION

From the discussion it can be seen that SWALIM will have many of the components of an SDI in place by the end of the project, but there is currently no available funding or mandate to take the further necessary steps (legal framework and formal country wide coordination) so as to ensure that this does in fact take place. SWALIM will, however, continue to generate basic core datasets such as land cover and water sources information. Current activities include an irrigation geo-database, rainfall and climate network stations and consequent data collection and collation of soils, geological and hydrological data.

In the near future, SWALIM will have completed a basic land assessment and plans are in place to provide online access, not only to metadata, but spatial data as well. All SWALIM activities and work plans originate from inputs given by Somali authorities at various stakeholder workshops; therefore SWALIM has the endorsement of the current Somali authorities. SWALIM also plans to have a searchable online catalogue for spatial data (through GeoNetwork), conforming to international standards to ensure interoperability with other agencies, and plans are at the beginning stages for a web mapping service.

SWALIM’s plans also conform to the wider UN strategic plan for geographic information based on a philosophy of an open, interoperable approach to geographic information systems (UN Geographic Information Working Group (UNGIWG), 2005). The open source components chosen to help build the Somalia SDI are based on Open GIS Consortium (OGC) and ISO standards and therefore will ensure conformance to the wider UN SDI. The emphasis on open source software is summarized in Holmes, *et al* (2005) where it states: *money spent on tailoring the software can go towards developing local skills and capacity, since no large company in some other country owns the code and there is no need to pay license fees that tie users to a single vendor. This allows more culturally sensitive solutions instead of a one size fits all answer imposed from the outside.*

SDI implementation can be deconstructed into a number of technical and institutional concerns, but an overriding requirement is *cross-agency alignment of geospatial investments* (Lance, 2005) and the SWALIM initiated Somalia Interagency Mapping and Coordination (SIMaC) will hopefully go a long way in tackling this problem.

The problem remains on how to ensure a smooth handover of SWALIM activities to emerging Somali authorities and how to ensure that SDI legal and coordination frameworks can be developed and embedded in Somali legislation and daily administrative routine. In Puntland, the Ministry of Planning publishes 'Puntland Facts and Figures' and Somaliland have a cadastral survey unit in conjunction with the University of Hargeisa. Building on existing capacities within Somalia, these units could be used and expanded in the future for SDI implementation; however investigations into current capacity and future resource needs would have to be conducted. Inter-agency cooperation and acceptance would have to be greatly strengthened, as well as links with local Somalia authorities to ensure that all parties contribute to a common goal of having open and accessible information.

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