

Use of Geospatial Technologies for Environmental Protection in Ethiopia

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Abstract

Ethiopia is a country of great geographic diversity and endowed with natural resources. Natural resources are the foundation of the economy. In spite of its wealth of natural resources, Ethiopia is one of the poorest and least developed countries in the world. An increase in population, and some conflicting demands have led to a great portion of the biological resources being used in unsustainable manner. The Ethiopian rural environment has suffered an accelerating devegetation leading to diminishing soil fertility, soil erosion, increased severity of the impact of drought, and a further reduction in the ability to produce food and other biological resources demanded by increasing human and animal populations. Land degradation especially soil erosion and depletion of nutrients is a critical environmental problem facing the country.

It is obvious that sound natural resource management and planning is essential, to tackle the above-mentioned problems and to bring about sustainable development, consequently poverty reduction. Therefore, environmental and natural resources information should be available at all levels of the public and decision makers to support decision making process and planning for sound natural resource management leading to sustainable development and environmental protection for the country in general. To this end, the use of space technology /remote sensing and geospatial technologies are very crucial and inevitable for environmental monitoring, natural resource mapping, early warning systems and disaster management.

This paper identifies the studies conducted by Environmental Protection Authority (EPA) and different sector institutions in relation to environment and the use of geospatial technologies for environmental protection in Ethiopia.

1. Introduction

Ethiopia is a country of great geographic diversity and endowed with natural resources. Natural resources are the foundation of the economy. In spite of its wealth of natural resources, Ethiopia is one of the poorest and least developed countries in the world. An increase in population, and some conflicting demands have led to a great portion of the biological resources being used in unsustainable manner. The Ethiopian rural environment has suffered an accelerating devegetation leading to diminishing soil fertility, soil erosion, increased severity of the impact of drought, and a further reduction in the ability to produce food and other biological resources demanded by increasing human and animal populations. Land degradation especially soil erosion and depletion of nutrients is a critical environmental problem facing the country.

Renewable natural resources, i.e. land, water, forests and trees as well as other forms of Biodiversity, which meet the basic needs for food, water, clothing and shelter have now deteriorated to a low level of productivity. In many areas of Ethiopia, the consumption of wood is in excess and in unsustainable manner. This leads to deforestation, with the expansion of rain fed agriculture.

Despite the presence of mineral resources in quantities and qualities suitable for exploitation, they currently contribute only about 2 per cent of the GDP. Not more than 1 per cent of the potential of Ethiopia's vast water resources for irrigated agriculture and hydropower generation have been developed.

Ethiopia's rich natural and cultural heritage permeates every facet of daily life and provides a powerful and socially cohesive force in the national consciousness. It can also provide a major attraction for tourists and is an important element in the development of a tourist industry. However, much of this heritage and culture is under threat through neglect, and lack of awareness for its socio-cultural values.

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2. Use of Geospatial Technologies for Environmental Protection in Ethiopia

Several studies have been studied in different sectors related to the environment. Major studies conducted by EPA and different sector institutions and their use of geospatial technology are discussed here.

2.1. Environmental Protection Authority (EPA)

Environmental Protection Authority (EPA) is established with the responsibilities to environmental protection, regulation and monitoring for the sustainable use of environmental resources.

Objective of EPA

The objective of the Authority is to formulate policies, strategies, laws and standards, which foster social and economic development in a manner that enhances the welfare of humans and the safety of the environment sustainable, and to spearhead in ensuring the effectiveness of the process of their implementation.

Some of the Powers and Duties of the Authority are:

1. Establish a system for environmental impact assessment of public and private projects, as well as social and economic development policies, strategies, laws, and programmes;
2. Prepare and avail to the government as well as the public a periodic report on the state of the environment of the country;
3. Coordinate, promote and, as may be appropriate, carry out research on environmental protection;

The environmental policies with regard to Environmental Information Systems are:

- To adhere to the principle that the right to live in a clean and healthy environment carries with it the right to be informed about environmental issues and to develop an appropriate information system;
- To ensure that all environmental data collection and analysis as well as information dissemination are coordinated and as far as possible standardized but not centralized;
- To ensure that there be a central point or agency at which it is possible to have access to widely used information and to ascertain the type and location of any specialized data and information.

Environmental Protection Authority, as stated in the proclamation on the Establishment of Environmental Protection Organs, required to prepare and avail to the government as well as the public a periodic state of the environment report. Accordingly, EPA produced the first state of the Environment report, in August 2003. In preparing this report, Annual Daily Mean Temperature, Rainfall Regime, and Wetlands, has been mapped.

EPA, to implement the policies has Environmental Information Center, as one of the functional units, though not yet strengthened. The Environmental Information Center collects and compiles information from different sources.

The center has developed geospatial database for environmental datasets like Ecological Zones, Annual Rainfall, Annual Daily Mean Temperature, Wetland Areas, and Protected Areas. Some of the indices for environmental monitoring are rainfall, vegetation, carbon dioxide, and turbidity. Turbidity is the pureness of the water. The amount of algae tells the amount of turbidity. Water Hyacinth also pollutes the water (lakes). However, use of remote sensing and geospatial technologies in the center is in its infancy. This is due to lack of appropriate hardware and software.

It is evident that the use of space technology (satellite images) and geospatial technologies would result with accurate and reliable information on the state of the environment as well as natural resource mapping. For instance, in undertaking Wetlands inventory, and monitoring pollution of water bodies (by industrial waste, water hyacinth etc).

Resource Mapping using space technology/remote sensing would be possible in these areas.

- Mapping Protected Areas
- Mapping Wetlands
 - Inventory and delineation
- Natural resources inventory and mapping (Wild life, Forest, etc.)
- Pollution
 - Water Hyacinth
 - Industrial waste disposed to rivers

Hardware and Software used in EPA

Hardware

Computers

Scanner

Software

Microsoft Access – Data storage

Arcview GIS 3.2 – Data Analysis

Windisp – Satellite Image analysis, when data is available from NMSA

2.2. National Meteorological Services Agency (NMSA)

National Meteorological Services Agency is mandated for providing meteorological data. As its duties and responsibilities NMSA, Collect all meteorological data, Publish and disseminate analyzed and interpreted meteorological data and meteorological forecasts, and give advance warning on the adverse weather conditions, disseminate advice and educational information through the mass media, and provide upon request meteorological services to any person.

To realize its tasks, the installation of MeteoSAT Receiving stations over Ethiopia has been done by NMSA in the early 90s. Currently, it is not operational. When the receiver is operational, meteorological data will be made available by NMSA, sharing the data from the MeteoSAT station to EPA and DPPC (Disaster Prevention and Preparedness Commission). This will be used for vegetation monitoring, rainfall estimation and early warning systems, prevention of natural disaster and food security.

NOAA satellite images are downloaded free from the Internet. Forest fires are forecasted from NOAA image taken during night time (NMSA). SPOT image also used for vegetation monitoring. SPOT images from 1998-2000 Dec. are free data available from IGAD site for the IGAD region.

Data Analysis

Vegetation Monitoring Techniques:

- Field observation
- Remote sensing observation /data (NDVI from MeteoSAT satellite Image)
- Agroclimatological yield models

NDVI from AVHRR (NOAA satellite) is also used for vegetation monitoring. The data analysis is done by Windisp image processing software.

Rainfall estimation

The economies of most countries in Africa are dependent on the rain-fed agriculture. The variability of rainfall greatly impacts on socio-economic activities. Rainfall monitoring and prediction in space and time are therefore a critical aspect for the sustainable socio-economic development of the region.

However, monitoring and prediction activities are hampered by the fact that most of rainfall observations in the region are based on a sparse rain gauge observational network.

Satellite technology provides some real potential for comprehensive rainfall monitoring in space and time. However, most of the satellite rainfall estimation techniques are still experimental. It can be used for seasonal forecast for early warning systems.

Hardware and Software Used

Hardware

Computers
Receivers
Rain Gauge

Software

Windisp software for MeteoSAT satellite data analysis (NDVI and RFE)
Arcview for display

2.3. Ethiopian Mapping Authority (EMA)

Ethiopian Mapping Authority mandated to undertake mapping at a national level and to provide geospatial data. EMA conducted different studies in the following areas.

- Assessment of refugee's Impact on the Environment in Eastern Ethiopia, in coordination with United Nations High Commission for Refugees Bureau of Ethiopia (UNHCR-BOE) and Administration for Refugees and Returnees Affairs (ARRA).
- Impact of Resettlement
- Impact of Tannery Industry on the rivers
- Pollution on the Lakes (Koka, Abijata, Awassa)

Assessment of refugee's Impact on the Environment in Eastern Ethiopia

The purpose of the environmental impact assessment was to investigate the environmental state pertaining to the long-term presence of refugees in two areas of Eastern Ethiopia, using remote sensing and geoinformation techniques.

The study areas are:

Darwanaji-Teferiber and
Jerer Valley – Kevribeyah-Hartishek camps and their surroundings.

Using remote sensing and GIS, the study attempts to realize the following objectives.

- To undertake Land Use/Cover and environmental change detection studies based on time series satellite data at and around the refugee centers;
- To select potential sites for environmental restoration measures;

- To produce comprehensive thematic maps for planners, decision makers and environmentalists.

Change detection study requires multi-temporal data. Therefore, in the study they include satellite images of pre refugee arrival (1988) and post refugee arrival (1998).

To identify the physical environment before the arrival of refugees and augment the 1988 satellite image analysis, aerial photographs of 1966 were interpreted.

Data analysis

The digital image analysis and interpretative works were divided into three basic groups. Preprocessing, information extraction and presentation of the output, i.e., in the form of thematic maps, tables and a written recital account on the study.

To assess the degree of environmental degradation, vegetation was taken as an indicator (index). With a change in vegetation, the other components of environment, such as soil, climate, surface and groundwater quality and quantity also change.

After the necessary geometric corrections on the raw images were done, a Normalized Difference Vegetation Index outputs were produced. The Normalized Difference Vegetation Index outputs of 1988 and 1998 were overlaid so as to see the changes in the vegetation conditions in the study areas.

Hardware and Software Used

Appropriate software and hardware were used for digital image analysis and interpretation and GIS activities. The hardware and software used are:

Digitizing tablet for data capture
Scanner for rasterizing analog data
Computers
Plotter and printer for hard copy production
GPS
Stereoscope for aerial photo interpretation
AutoCAD for vector data capture
ERDAS Imagine 8.3 for digital image analysis
Arcview for the display of raster/vector data
ArcINFO for editing features

Industrial Pollution

Landsat TM used to identify the pollution of lakes and rivers by the waste disposed from the industries. Map of 1:100000 scale was produced as an output.

2.4. Woody Biomass Inventory and Strategic Planning Project

The Woody Biomass Inventory and Strategic Planning Project is mainly working on traditional energy sources such as fuel wood, dung and crop residuals. It conducts the demand and supply study on a household survey basis for traditional energy consumption.

The project is also involved on the production of National and Regional Atlases. All regional states are mapped with a scale of 1:1,000,000 except the Somalia regional state, which is under study. The main products included in the Atlas are:

1. Wood fuel consumption
2. Sustainable yield of Woody Biomass
3. Mean Annual Rainfall
4. Temperature zone
5. Traditional Ecology
6. Farming and Pastoral Systems
7. Soil (Soil classification adopted from FAO)
8. Land Use/Land Cover – using Landsat TM images of 1986-1989
9. Forest Areas and Cover
10. Natural Pasture

Hardware and software used

Hardware

Plotters

Digitizers

Computers

Scanners

Software

Arcview 3.2

ArcINFO

PAMAP GIS 5.2B (Canadian software) for digitizing features, editing and data analysis

Geomatica 9.1 for image analysis

Recently ArcGIS 8.3 is used

ArcIMS for web mapping – the digital data will be made available on the Internet after completing this project.

3. Initiatives for Environmental Information Exchange

Environmental data are created by different bodies, and may not be interoperable to be shared and used at a national and regional level. Africa Environmental Information Network (AEIN) is addressing the issue of Environmental information exchange in the region. The initiative is endorsed by the African Ministerial Conference on Environment (AMCEN) as a means for harmonizing and promoting access to data in the Africa region, and acting as “a basis for tracking environmental changes using quantitative indicators on national needs.” The overall goal of AEIN is to strengthen the capacity of African countries to use good quality information on environmental assets to make informed investment choices at national and sub-national levels, and manage these assets on a sustainable basis. Ethiopia is one of the selected countries (13 countries) and EPA is a focal point for AEIN.

Therefore, Environmental Protection Authority has taken the initiative to put in place Environmental Information Management System, which can be achieved through networking sector organizations that have potential for generating Environmental Information. To effect the initiative, it is believed that there is a need to assess existing environmental information management status and develop a comprehensive Environmental Information Management strategic plan.

Accordingly a National Technical Committee is established which contains experts of high-level information management professionals drawn from different federal institutions to undertake this activity. This committee will provide assistance in establishing an appropriate national networking mechanism to support the implementation of the environmental management information system.

This will create a network for exchange of environmental information, and reduce duplication of efforts and wastage of resources in environmental information management in particular and in the areas of environment management and protection activities in general.

4. Conclusion

Assessment of possible impacts on the environment prior to the approval of a public instrument provides an effective means of harmonizing and integrating environmental, economic, cultural and social considerations into a decision making process in a manner that promotes sustainable development.

To bring about development by utilizing the natural resources sustainably, environmental and natural resources information should be available at all levels of the public and decision makers.

Therefore, the use of space technology /remote sensing and geospatial technologies are very crucial and inevitable for environmental monitoring, natural resource mapping, early warning systems and disaster management.

5. Recommendation

1. Environmental Information Center of EPA has to be strengthened. This could be

Capacity Building:

- ☞ Training personnel in the use of space technology and geospatial technologies.
- ☞ Providing high-resolution satellite imageries.
- ☞ Providing Powerful Image Analysis / Remote Sensing Software and GIS software.
- ☞ Providing the necessary equipments and hardware.

2. Creating a mechanism to exchange data with in the different institutions concerned with the environment.

- ☞ National Environmental Information Network Initiative.
- ☞ National Spatial Data Infrastructure.

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