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ENVIRONMENTAL PLANNING AND MANAGEMENT IN NORTH SHOA: AN INTEGRATE ASSESSMENT IN GEDEMSA WATERSHED OF THE BLUE NILE BASIN

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Abstract: *The main objective of this research project was to prepare a sustainable resource utilization plan based on an environmental assessment of the Gedemsawatershed of the Blue Nile Basin. The study has been carried out using geospatial technologies in conjunction with quantitative methods. The biophysical and socio economic data derived from satellite imagery, topographic maps, land and soil surveys , observation and reviewing reports to produce planning units and alternative development options were used. As a result, three planning units were created and developed as planning unit I, Planning unit II and planning unit III. Accordingly, planning unit I comprised 20.4% of the study area and it was characterized by steep slope, shallow soil depth, and wurch agro climatic zone and with some eucalyptus plantation coverage. This sub unit was delineated for environmental rehabilitation and natural resource conservation site. Planning unit II comprised 42.1% of the study area and it was characterized by moderate slope, intermediate soil depth, Dega and Wurch agro climatic zone and with agricultural activities, grass land and settlements. This sub unit was ideal site for dairy farming activities and range land. Planning unit III included 37.5 % of the study area that characterized by gentle slope, high soil depth, Dega agro climatic zone and with traditional irrigation practices. This sub unit was ideal site for modern agricultural activities. Moreover, since the study area was located at the upper catchment of the Blue Nile Basin, it should be well conserved and rehabilitated in order to minimize soil erosion, increase the discharge amount of streams and reduce the massive sediments in the lower catchment of the Renaissance Dam in Ethiopia. Therefore, in order to alleviate the present environmental and socio-economic problems in the country particularly in the watershed, any development activity needs to be done based on environmental planning. SSDI should be developed for integration work.*

Keywords: *Environmental Planning, Geospatial Technologies, Planning Units, SSDI*

1. INTRODUCTION

1.1 Back Ground

Ethiopia is in a continuing effort to alleviate the urgent situations of rural poverty, food insecurity, and environmental degradation by designing the Agricultural Development Led Industrialization (ADLI) with primarily concern of addressing the agricultural production and pursuing to Industrial development. The recent Growth and Transformation Plan (GTP) of the government is one of the best indicators to achieve the strategy. This strategy is dependent on the realization of a system of sustainable agricultural development which in turn depends on the sustainable use of the country's natural resources and its environment in general. It is because the livelihood of human societies is highly dependent on the inventory, description, analysis, planning and management of natural and human resources. This Process is an integrated and harmonized type of public policy which leads to a balanced regional development. (Goodland R. 2002). It is recognized that Ethiopia is currently experiencing rapid changes in socio-economic realms on one hand and threatened by the rapid population growth, the fragile environment and the brutal environmental changes, particularly the climate change on the other hand. Our near past showed us these delicate imbalances between utilization and the carrying capacity of the environment, along with other factors have resulted in environmental degradation, drought, famine and disasters. Because of these problems, Ethiopia is currently working development by incorporating environmental considerations. For this purpose, the executive organ of the federal government has established Environmental Protection, LandAdministrationand Use Agency. In line with the federal government, the hierarchy descends down up to the Woreda level. The agency is responsible for cadastral surveys, land use plan preparation, Land use planning, issuance of land holding certificates, protection of unique renewable resources and regulation of land uses.

1.2. Research Problem

Gedemsa Watershed where this study focuses is one of the watersheds in the Blue Nile Basin, located in BasonaWorana woreda of North Shoa Zone. Physiographically, it is part of the Shoa plateaus and highlands. It is densely populated because of the favorable climate and relatively productive soils. However, it is highly susceptible to environmental degradation and population pressure. Fortunately, to mitigate the problems, the Ethiopian

government launched different programs and established institutions to deal with these issues since mid 1990s. However, information as to the performance and status of the environmental planning and management are not investigated whether they are being implemented worse or better, whether there is positive impact on the lives of people and the environment. This study not only assesses the existing strategy but also comment for new strategy in accordance with the scientific and applicable perspectives. The integrated analysis was based on natural resource inventory and a description of the present resource utilization and assessment of socio economic conditions to Apart from the environmental assessment and sustainable development analysis, the study also focuses on urgent environmental problems, i.e. unsustainable land use practices on steep slopes. In this way the research provide concrete results besides information. The study also combines environmental planning with watershed management, the guiding principles of sustainability; since environmental planning is the process of facilitating decision making to carry out development with due consideration given to the natural environmental, social, political, economic and governance factors and provides a holistic frame work to achieve sustainable outcomes.

1.3. Objectives the Research Project

The general objective of this study was to examine and explore the status and conditions of the environmental planning and management in the Gedemsa watershed.

The specific objectives of the study are;

i. To make inventory, description and mapping of the present resource utilization and land use classification
ii. To examine and assess the status of the present physical and socioeconomic environment in the watershed
iii. To develop, prescribe and prepare maps of planning units for the implementation of the alternative scientific and applicable sustainable environmental development.

1.4. Significance of the Research Project

This research project was initiated out of the need for better sustainable resource utilization and development planning in Gedemsa watershed, the Blue Nile Basin. Out of the research project, investment proposals for feasible projects on short, medium and long term can be submitted to donors and government for financing and which greatly

contribute to poverty alleviation. It will also important for policy makers, program implementers, researchers, and the general society at large. It shall also be replicated and extended to other areas.

1.5. Research and Environmental Planning Methodology

In order to achieve the objectives of the study, different types of data were used to be analyzed and treated in a more detail manner. Therefore, information was gathered on biophysical and socio economic basis and reviewing reports, documents, satellite imagery, topographic and thematic maps, field surveys and observation. Finally, the data has been stored, analyzed and interpreted by using geo informatics and quantitative techniques since Environmental planning is an activity that requires the manipulation and presentation of geographical data.

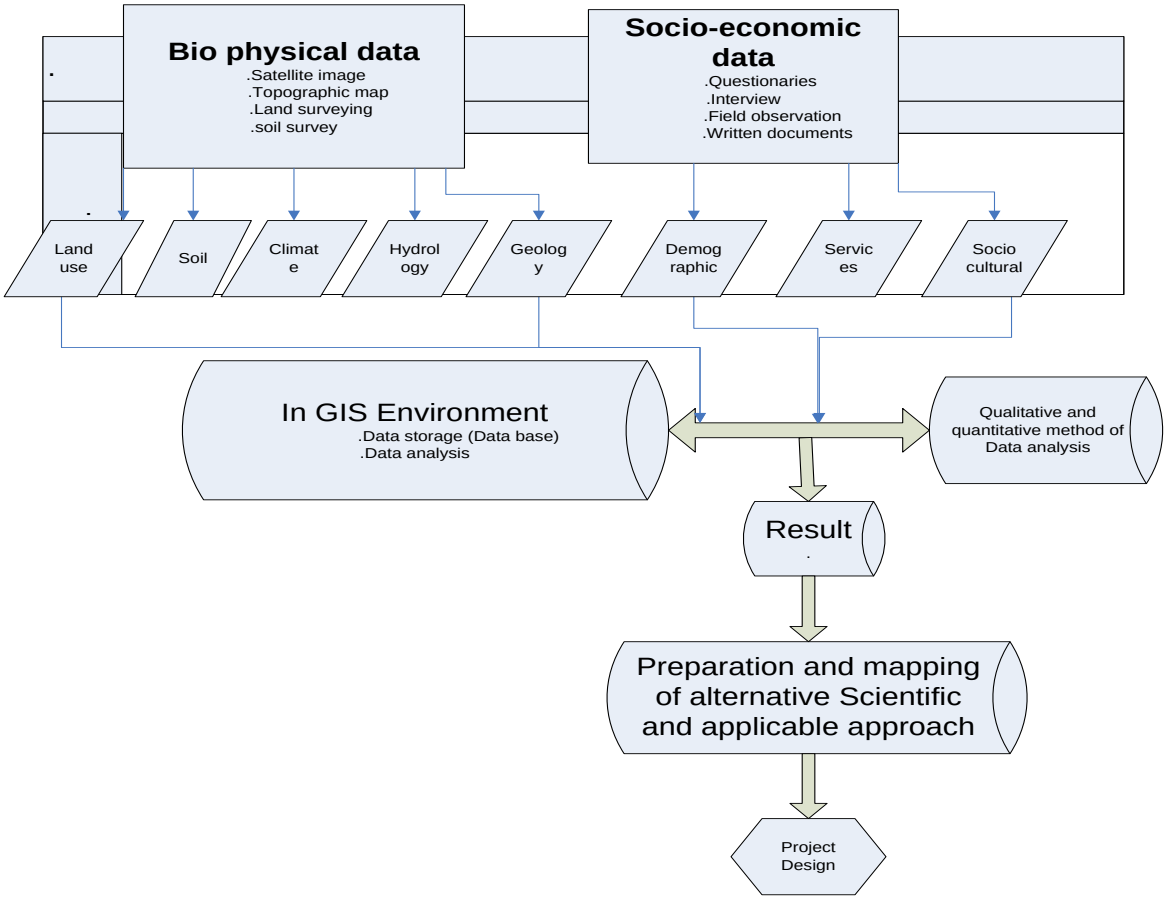

Figure 1. Flow Chart of the Research Methodology (Own source)

1.5.1 Land and Soil Surveying Techniques

Since geographical space is the basis of environmental planning, land surveying is essential for this research project to measure, manipulate analysis and model the watershed. Thus,

land surveying has been implemented starting from spatial data collection with GPS to create kebele digital maps and to verify boundary of the watershed by taking important control ridge coordinate points since the watershed has been already delineated and prepared from SRTM data with the help of ArcGIS software particularly by Spatial analysis extension of hydrology. Topographic map with scale of 1:50,000 were also used to supplement the delineation of the watershed. Soil surveying is one of the back bones to environmental planning. Therefore, soil surveying was also implemented in conjunction with the FAO soil base maps. Hence, land surveyors collected spatial data for each soil types to realize and substantiate at the ground.

1.5.2 Image Processing

Landsat image (ETM+) which was imaged during December 08, 2002 was employed for land use/cover classification. To this purpose, Satellite Image needs pre-processing before utilized as the input of GIS. One of them is Geometric correction (geometric rectification). Image which is received or recorded by the satellite is displaced from the true area on the surface of the earth because of the factors that comes from the satellite itself and the environment. As a result, it needs geometric correction by using different methods. One of the techniques is collecting the GCP (ground control points) by using GPS receiver. Moreover, the researchers have also created GCPs from scanned topographic map of the area with the scale of 1 – 50,000. Furthermore, the image was geometrically rectified and developed to mosaic and the image was spectrally enhanced by different techniques and methods to be seen and visualized clearly with naked eye for further image classification. Moreover, in order to produce land use map of the study area from Landsat image, land surveying was administered to collect Training points (samples) for supervised classification of the images. After the image had been classified, the surveyors verified the land use patterns in the watershed using the land use map which is generated from Landsat images.

1.5.3 Sampling Techniques of Socio economic Survey

The Gedemsa Watershed covers approximately 65.5% of the area of the three kebeles i.e Bakelo, Keyt and Goshuhager. For this reason, the researchers have taken the sample population according to the area proportion of each kebele in the watershed as depicted in table 1 and 2.In order to get the desired socio economic information from the watershed; stratified sampling was employed by taking 28.6% of the house hold heads from the

watershed. Then, simple random sampling was under taken to select the respondents. Accordingly, the researchers administered the sample in the following manner.

Table 1. Distribution of Area Coverage in the Watershed

Kebels	Area of Kebeles (km^2)=Y	Area of Kebeles in the watershed(km^2)=X	Proportion in % (X/Y)×100
Bakelo	42	30.6	72.9
Keyet	33.9	26.1	77
Goshu Hager	26.3	10.1	38.4
Total	102.2	66.8	65.5

Source: Field Survey, 2011 (Own data)

Table 2. Distribution of Samples taken from the Watershed

Kebels	House hold heads in kebele	House hold heads in watershed	Sample taken from watershed
Bakelo	1966	602	148
Keyet	1110	290	86
Goshu Hager	941	95	48
Total	4017	987	282

Source: BasonaWoranaWoreda Administration Office, 2011

1.5.4 Participatory Environmental Planning Procedures and Tools

After the completion of technical procedures, it needs to conduct need assessment of the community in the watershed. Accordingly, need assessment was undertaken using the principles of local level participatory planning to supplement the result of the scientific research.

1.5.5 Location Map Gedemsa Watershed

Gedemsa watershed is geographically bounded between 9.67^0 North and 9.72^0 North, and 39.60^0 East and 39.73^0 East. It has about area coverage of 71 km^2 (7086 hectares). The watershed is used as a unit of study because during the past decades, more of the complex environmental challenges have been addressed by using a watershed approach. According to the U.S. Environmental Protection Agency (EPA), environmental management using a watershed approach constitutes “a coordinating framework for environmental management that focuses public and private sector efforts to address the highest priority problems within hydrologically defined geographic areas” (U. Sunday Tim, 2003). The Gedemsa River and its tributaries draining the catchment are some of the many streams that feed the Jemma River, Which in turn drains into the Blue Nile.

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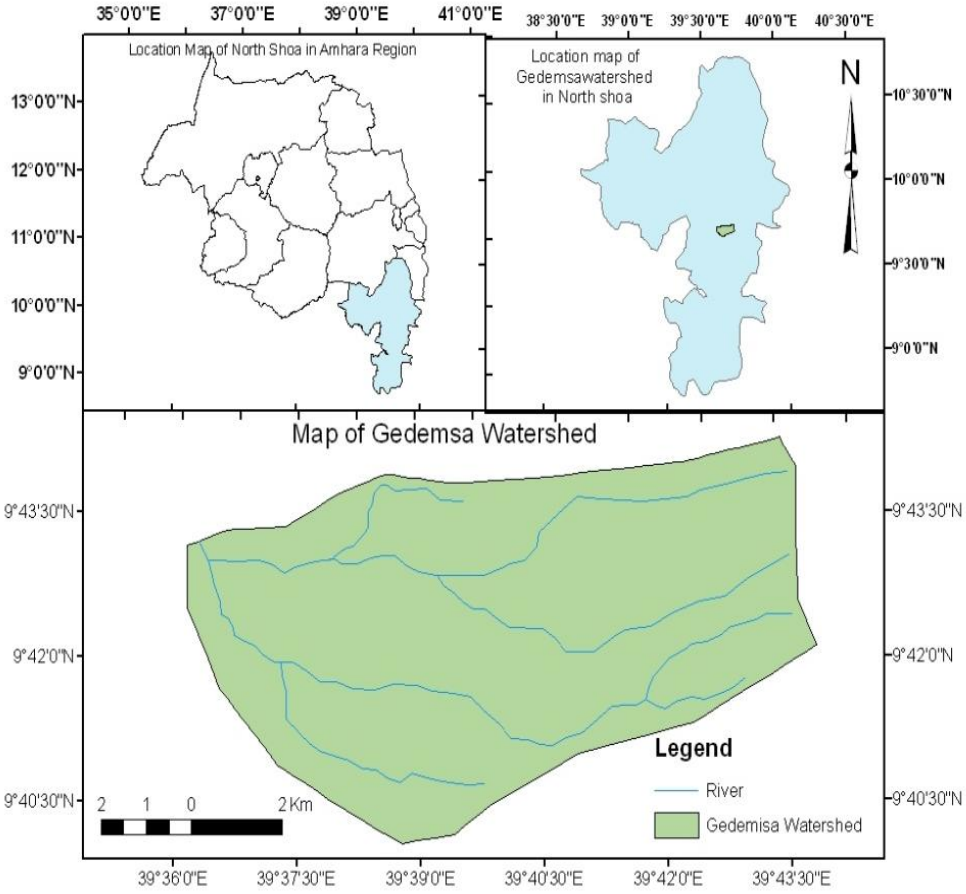

Figure 2. Location Map of Gedemesa Watershed (ETHIO GIS & TOPO graphic map

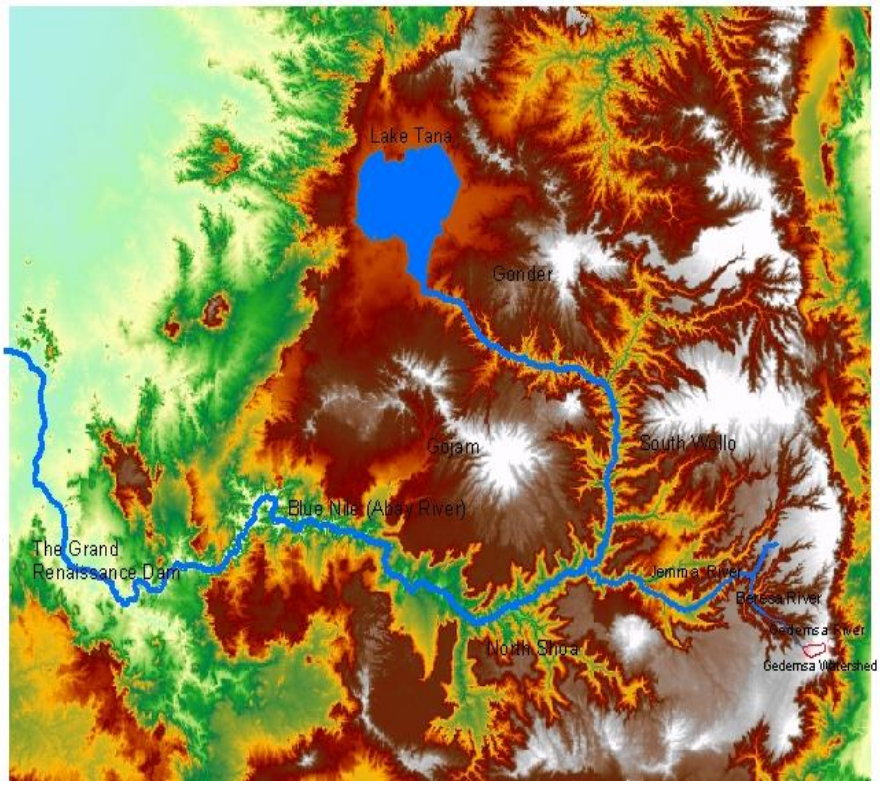

Figure 3. Map of Gedemsa watershed in the Blue Nile Basin (SRTM)

2. ASSESSMENT, DATA ANALYSIS AND INTERPRETATION

2.1 Socio-Cultural Environment of the Watershed

2.1.1. Demography

According to the kebeles' administration sources of 2011, the total population of the three kebeles was about 14330 of which Keyet, Bakelo and Goshuhager contributes 5756,4755 and 3819 respectively. Since the study area covers 65.5% of the area of the three kebeles, the watershed has been assumed to constitute 65.5 % of the total population and house hold heads of the kebeles. As a result, the total population and the density in the watershed have been calculated about 9364 and140.2 pop/km^2, respectively.

The North Eastern and Eastern parts of the catchment had a lit bit denser population than the other parts of the catchment because of the presence of small towns. In addition, villages near to the main road and public services were also densely populated.

2.1.3. Socio economics

The base of economy in the watershed was subsistence agriculture characterized by rain fed crop cultivation and supplementary livestock raring. Although different types of crops are cultivated, barley, bean, pean and wheat are the predominant crops. Table 6 shows the distribution of economic activitiesof sample households in the watershed.

Table 3. Economic Activity of the Respondent

Economic Activity	Number of the respondents	Percentage from sample
Subsistence Agriculture	278	98.6
Petty Trade	4	1.4
Total	282	100%

Source: Field Survey, 2011

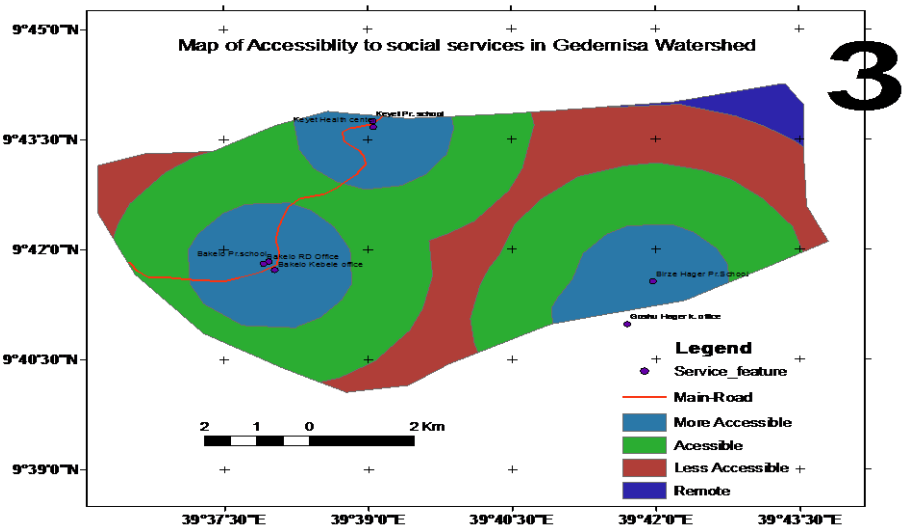

Figure 4. Map of Accessibility to social services

2.2 Bio physical Environment of the Watershed

2.2.2. Soil

Based on FAO soil classification and the Soil survey, the watershed is covered by two major soil types i.e. Cambisols and Regosole. The eutric cambisols cover about 35.7km^2(50 %),eutric regosols 29.5 km^2 (41.5%), vertic cambisol 3.7 km^2 (5.2%) and chromic cambisols 2.1 km^2(3%).

Regosols are very weakly developed mineral soil in unconsolidated material. They are prevalent in eroding lands particularly mountainous, arid, and semi-arid areas (FAO, 2006). Cambisols are at the beginning of soil and profile formation that are young soil with medium and fine textured materials derived from alluvial, colluvial and Aeolian deposits. They are suitable and productive for agricultural activities. However, since their formation is associated with active erosion areas, environmental conservation schemes should be done in parallel (FAO, 2006). In Gedemsa watershed, cambisols are predominant in Bakelo and some parts of Keyet and Goshuhager kebele.

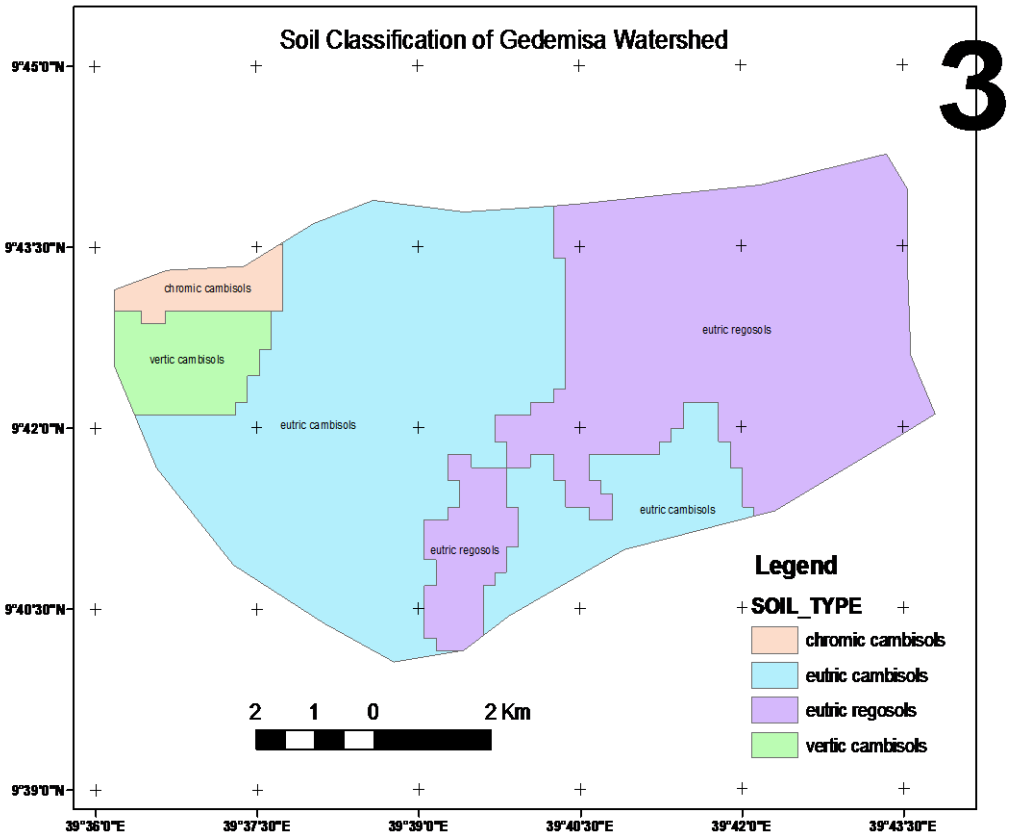

Figure 5. Soil Map of the Watershed

2.2.3. Drainage

Gedemsa watershed has two main streams i.e. Gunagunit and Bakelo. According to the respondents, there was reducing trend of stream discharge particularly in the Gunagunit stream, one of the major tributaries of the Gedemsa River. The respondent associated the problem with the presence of eucalyptus trees at the sources of the springs. In addition to this, the researchers observed the agricultural practices and environmental degradations at the steep slopes. Generally the watershed has a drainage density of 0.71 km/km^2 and 0.54km/km^2 with wet and dry season, respectively.

3.2.4. Slope Analysis

Slope analysis was carried out in the watershed from SRTM (Shuttle Radar Topographic Mission) data with resolution of 90m by 90m in GIS environment. The result showed that the watershed was predominated by moderate steep (39.1%) followed by rolling slope (28.3%) and the steep slope (10.1%). It means nearly 80% of the area of the watershed was covered by the three types of slopes. The area was vulnerable to environmental degradation i.e. soil erosion. As a result, the watershed needs environmental rehabilitation schemes like reforestation, soil and water conservation works. Although it was settled by peasant farmers, sustainable resource utilization should be deployed to resolve the conflict arising between the natural and the socio economic systems.

2.2.5.1Image Classification

According to Lillisand and Kieffer, (2000), Image classification is defined as the extraction of distinct classes or themes such as land use and land cover classification categories, from satellite imagery. There are two primary methods of image classification methods utilized by image analysts, unsupervised and supervised classification. Supervised image classification is a method in which the analyst defines small training sites on the image, which are representative of each desired land cover category. The delineation of training areas, representative of a cover type is most effective when an image analyst has knowledge of the geography of a region and experience with the spectral properties of the cover classes. In this research the two image classification methods was utilized.

2.2.6 Land Use/Cover Mapping of the Study Area

“Land cover is the observed biophysical cover on the earth’s surface”. The same document also defines land use as the arrangements, activities and inputs that people under-take on a certain land cover type, (FAO, 2000). According to these definitions, land cover corresponds

to the physical condition of the ground surface, e.g., forest, grassland, concrete pavement, while land use reflects human activities such as the use of the land like industrial zones, residential zones, and agricultural fields. The above definitions establish a direct link between land cover and the actions of people in their environment i.e. land use may lead to land cover change. Generally, land cover does not coincide with land use. A land use class is composed of several land covers. Remote sensing data can provide land cover information rather than land use information. In this particular study Landsat image which was imaged during December 08, 2002 was employed for land use/cover classification. Accordingly, the image classification generates dominantly five land use classes. Those are agricultural land, forest land, grass land, bare land and settlement land. The proportions of those are as follow in the table below:

Table 4. Land Use/Cover of Gedemsa Watershed

Land use	Area(Ha)	%
Settlement	364.3	5.1
Grass	1394.9	19.6
Forest	904.4	12.7
Bare	1093.4	15.3
Agriculture	3367.7	47.3
Total	7124.7	100

Source: Landsat image2002 Analysis Result, 2011

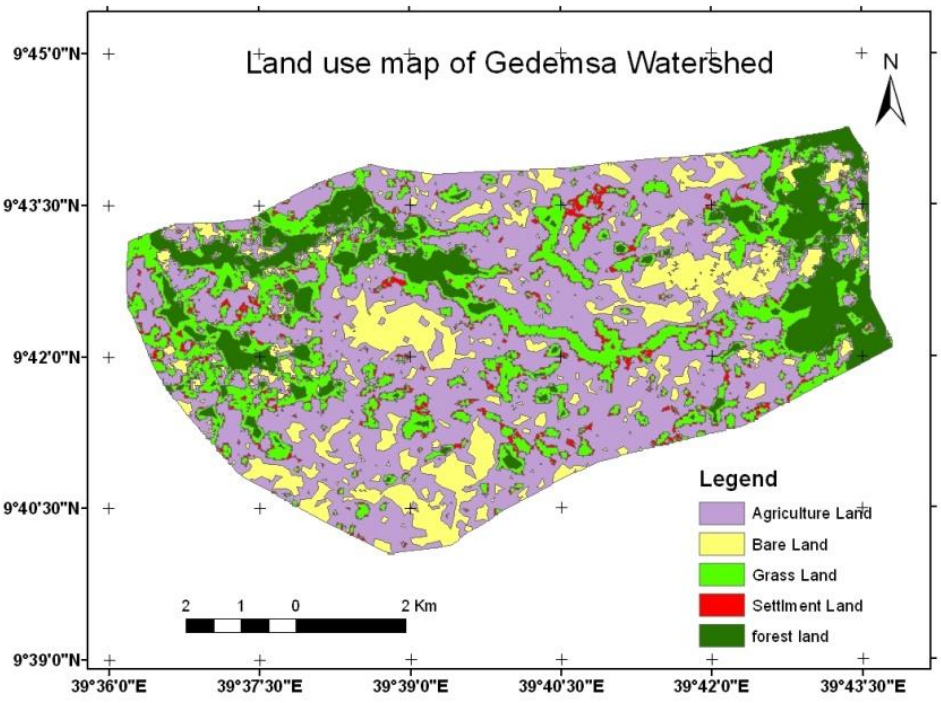

Figure 6. Land Use land Cover Map of Gedemsa Watershed

3. SPATIAL PLANNING OF GEDEMSA WATERSHED

3.1Preparation and Analysis of Planning Units

The purpose of the planning unit is to provide a geographical basis for problem analysis, for identification, visualization and presentation of constraints and development opportunities and options. The delineation of planning unit is a critical step in the planning process, because the units form is the basis of the spatial planning frame work. Planning units represent areas with similar potentials, constraints and similar development strategies and interventions will apply to such areas. In this research, the criteria employed in the delineation of physical planning units include: soil, land use, agro climatic zone and slope. On the other hand, the existing accessibility and population density were considered. The purpose of planning units in the watershed is to obtain a general overview of the potentials and constraints for improved environmental planning and management.

Table 5. Criteria for planning unit preparation

Planning Unit requirement	Unit	P1	P2	P3
Soil depth	Meter	<30	30-60	60-90
land use	Land Units	Forest, Settlement, Bare land	Grass land	Agricultural Land
Slope	%	25-60	12-25	0-12
agro climatic zone	Elevation (Meter)	3310-3662	3029-3310	2795-3029

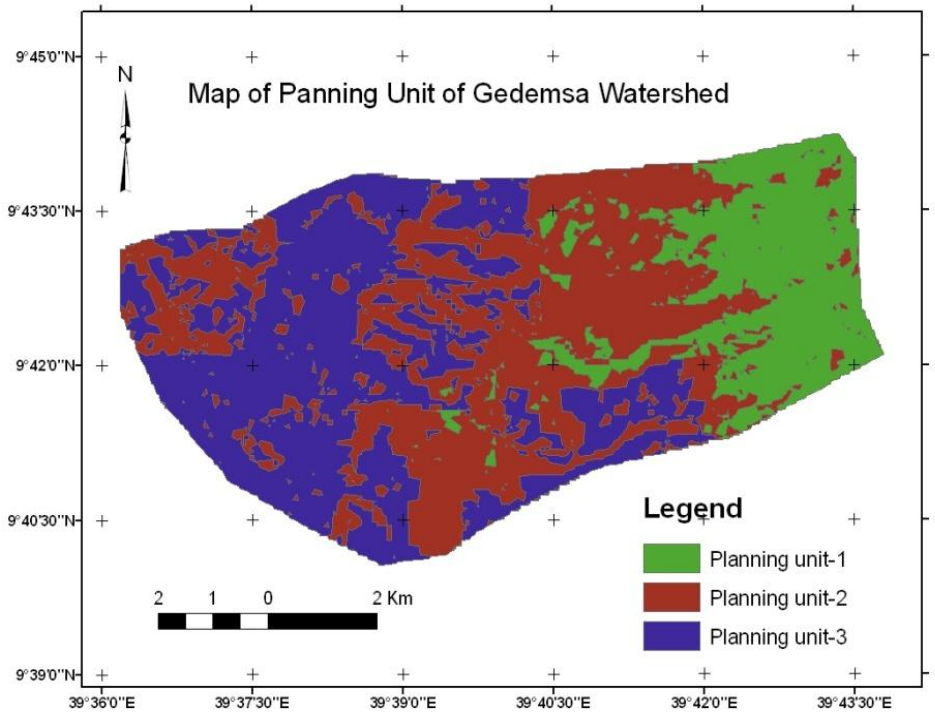

Figure 7. Map of the Planning Units in Gedemsa Watershed

3.2. Alternative Development Options in the Watershed.

This section describes the alternative development options which are considered important in sustainable resource utilization plan and environmental management. The alternative options have been developed from GIS based data integration and need assessment of the community in the particular watershed. The researchers also considered the policies and strategies of the government. In order to implement the alternative development options, the researchers developed three spatial planning and management units.

Planning Unit I

This is one the three planning units (spatial management units) located predominantly in the upper catchment of the watershed. The morphology of the sub region has the following physical characteristics; It has relatively steep slope (25%-60%), erodedand shallow soil depth (<30m), Wurch agro ecological zone (3310-3662 m a.s.l).The land use/land cover of the planning unit was mainly eucalyptus plantation. which was planted by Fuel Wood Project during the Derg regime. In addition, the area was covered by bare lands and settlements. The area coverage was about1355 hectare, (20.4% of the watershed) of which Keyet, Bakelo and Goshuhager account 11.9%,8.1% and 0.4% respectively. Accordingly, since it is located in the upper catchment dominated by steep slopes, shallow soil and bare lands, the planning unit needs urgent environmental rehabilitation works like reforestation, soil and water conservation practices. Promotion of forest cooperatives in the planning unit might support the integral development activity.

Planning Unit II

Among the three planning units, planning unit II accounts the largest area coverage located predominantly at the middle catchment of the watershed. The morphology of the sub region has the following physical characteristics; It has rolling and moderate steep slope (12%-25%), intermediate soil depth (30m-60m), Dega and Wurch agro ecological zone (3029-3310 ma.s.l).The land use/land cover of the planning unit is mainly agriculture, grass land and settlement. The area coverage is about 2797 hectare, (42.1% of the watershed) of which Keyet, Bakelo and Goshuhager account 20.4%, 17.9% and 3.8% respectively. Accordingly, since it is rolling and moderate steep slope, intermediate soil depth with favorable climate, the planning unit is an ideal site for dairy farming activities, range land management. Environmental rehabilitation works are necessary for sustainable resource

utilization in the planning unit.

Planning Unit III

The planning unit is the most suitable site for farming agricultural practices, since it has flat and gentle undulating slope, high soil depth, and very favorable agro ecology. The morphology of the sub region has the following physical characteristics; It is flat and gentle undulating slope (0-12%), high soil depth (>60m), Dega agro ecological zone (2795-3029 m a.s.l).The land use/land cover of the planning unit is mainly farm land. The area coverage is about2495 hectare, (37.5% of the watershed) of which Keyet, Bakelo and Goshu Hager account 6.7%, 27.5% and 3.3% respectively. Although the planning unit has been already for agricultural land, it is rain fed and subsistence agriculture with some traditional irrigation practices. Thus, in order to make the planning unit productive, modern agricultural practices and inputs needs to be introduced.

4. CONCLUSIONAND RECOMMENDATION

4.1. Conclusion

The main objective of this research project was to prepare a sustainable resource utilization plan based on an environmental assessment of the Gedemsawatershed, the Blue Nile Basin. The integral analysis was carried out based on natural and socio-economic resources inventory and description of the present resource utilization. In order to achieve the objectives of the study, different types of data were needed to be analyzed and treated in a more detail manner. Therefore, the study has been carried out using geospatial technologies in conjunction with quantitative methods to gather, analysis, interpret and mapping of the biophysical and socio economic data derived fromsatellite imagery, topographic maps, land and soil surveys , observation and reviewing reports to produce planning units and alternative development options by integrating all layers. It has about area coverage of 71 km2 (7086 hectares).The watershed was found densely populated, severely eroded and deeply dissected. The main land uses/cover are agriculture (47.7%),Grass land(19.6%), Bare land (15.3%),Forest (12.7%) and settlement (5.1%). It has Dega and Wurch agro climate and the entire area is covered by volcanic rocks mainly basalts of the tertiary age. Need assessment in conjunction with geo spatial analyses in the watershed reveals that the main problems of the communities are lack of fertile land, infrastructure and house hold energy. Finally, alternative development units were

developed. As a result, three planning units were created and developed as planning unit I, Planning unit II and planning unit III. Accordingly, planning unit I comprises 20.4% of the study area and it is characterized by steep slope, shallow soil depth, and Wurch agro climate and with some eucalyptus plantation coverage. This sub unit was demarcated for environmental rehabilitation and natural resource conservation site. Planning unit II comprises 42.1% of the study area and it was characterized by moderate slope, intermediate soil depth, and Dega and Wurch agro climate and with agricultural activities and grass land and settlements. This sub unit was demarcated for dairy farming activities, range land. Planning unit III comprises 37.5 % of the study area and it was characterized by gentle slope, high soil depth, Dega agro climate and with traditional irrigation practices. This sub unit was demarcated for modern agricultural practices.

4.2 Recommendations

The research project provides a building block for successive environmental planningworks and foundations for further research. The researchers noticed that there is no well designed environmental planning to regulate and enforce the environmental protection and rehabilitation practices and ensure sustainable resource utilizations in the watershed. Moreover, the study area is located at the upper catchment of the Blue Nile Basin, it should be well conserved and rehabilitated in order to minimize soil erosion, increase the discharge amount of streams and reduce the massive sediments in the lower catchment dams like the Renaissance Dam in Ethiopia. Standard Spatial data infra structure should be deployed at national level to integrate and unify different institutions which work on spatial data. For many years, agencies at the various governmental levels have been collected data about land, but for the most part they have worked independently and without coordination. Too often this has meant duplication of effort, or it has been found that data collected for a specific purpose. In order to alleviate the socio-economic and environmental problems in the watershed, the current development activities need to be managed through effective environmental planning and management.

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