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Baseline survey and environmental protection project impact assessment by using geospatial techniques, in WazeSharamicro watershed, Arbaminch Ethiopia

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Abstract: Environmental protection for WazeShara micro watershed was started to be implemented since 2011. Baseline survey of land use land cover was not conducted before project implementation. Due to this base line survey was conducted for the study area. In addition to LULC baseline survey the impact of environmental protection project by the stakeholders was analyzed in terms of land use land cover change. To do so Land Sat TM satellite imageries for 1985, 1995, 2011 and 2019 from USGS Website was used. The images are classified in ERDAS IMAGINE 2014 and further analyzed in ARC GIS 10.3 software. For the purpose of this work a false color composite of 5.4.3 for Land Sat Seven images and 6.5.4 for Land Sat Eight images was applied. The result indicates a continuous increment of bare land, decrement of shrub land, forest and grazing land up to 2011. The other condition revealed after 2011 by this work was a continuous decrement of bare land cover and grazing land. Significant increments in shrub land and forest land cover types are observed. In addition to quantifying temporal land use land cover changes this study also generate a matrix of land use land cover changes after 2011 i.e after project implementation.

Key words: Land Use, Land Cover, baseline survey, GIS, Satellite image

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I. INTRODUCTION

1.1. Background of the study

FAO define land as " a delineable area of earth terrestrial surface encompassing all attributes of earths biosphere immediately above or below the earth surface, including those of the near surface climate, soil and terrain forms, the surface of hydrology (including shallow lakes, rivers, marshes and swamps), the near surface sedimentary layers and associated ground water reserve, the plant and animal population, the human settlement pattern and physical result of the past and present activity"

Land use land cover change refers to the quantitative in the aerial extent of a given type of land use or land cover respectively. However land cover change may result from either from land conversion (a change from one cover to another), or land modification (alteration of structure or function without whole scale change from one type to another) or even maintenance of land in its current condition against agents of change. Similarly land use change may involve either conversion from one type of use to the other(change in mix and pattern of land use in an area) or modification of certain types of land use like change in the intensity of use or alteration of its use characteristics(Helen, nd).

Land use/land cover (LULC) changes play a major role in the study of global change. Land use/land cover and human/natural modifications have largely resulted in deforestation, biodiversity loss, global warming and increase of natural disaster-flooding. These environmental problems are often related to LULC changes. Therefore, available data on LULC changes can provide critical input todecision-making of environmental management and planning the future(Selçuk, 2008).

The land use/land cover pattern of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space. The terms "land use" and "land cover" are often used simultaneously to describe maps that provide information about the types of features found on the earth's surface is called as land cover and the human activity that is associate with them (Monalishaetal, nd).

Land use is the term that is used to describe the use of land by humans, or actions modifying or converting land cover. It includes such uses as human settlements, protected areas and agriculture. Within those broad groups are more refined categories, like urban and rural settlements, irrigated and rain fed fields, national parks and forest reserves, transportation and other infrastructure. The other is Land cover which refers to the natural vegetative cover types that characterize a particular area. Examples of wide land cover categories consist

of forest, tundra, savannah, desert or steppe, which in turn can be sub-divided into more refined categories representing specific plant communities (Alex, 2002)

The growing population and increasing socio-economic necessities creates a pressure on land use/land cover. This pressure results in unplanned and uncontrolled changes in LULC. The LULC alterations are generally caused by mismanagement of agricultural, urban, range and forest lands which lead to severe environmental problems such as landslides, floods etc (Selçuk, 2008)

A much broader range of impacts of land-use/cover change on ecosystem goods and services were further identified. Of primary concern are impacts on biotic diversity worldwide, soil degradation, and the ability of biological systems to support human needs. Land-use/cover changes also determine, in part, the vulnerability of places and people to climatic, economic, or sociopolitical perturbations (Eric etal, 2003).

Land is one of three major factors of production in classical economics (along with labor and capital) and an essential input for housing and food production. Thus, land use is the backbone of agricultural economies and provides substantial economic and social benefits. Land use change is necessary and essential for economic development and social progress.

GIS can help us to know the past the present and the future dynamism by providing tools and functions necessary to analyze, store and present the processed imageries at different temporal and spatial scale. Having such information one can understand the dynamism of land use land cover in a very precise manner.

WazeShara micro watershed is one of the environmental protection project sites of stakeholders working in environmental protection. Previously it was used as an open pasture field and a source of fuel wood for the surrounding community. These practices of the local community causes a very severe environmental degradation which causes soil erosion and flooding that trigger the damage of natural and human resource of the local community.

So this paper analyzes the land use land cover change before the and after the project implementation.This was done in order to conduct a baseline survey and to assess the project impact which has been implemented since 2011.

1.2 Objectives

The main objective was to conduct land use land cover change analysis before and after project implementation.

1.2.1 Specific objectives

1. To conduct a base line survey for WazeShara (LULC change analysis before project implementation)
2. To conduct project impact analysis for WazeShara (LULC change analysis after project implementation.

1.3 Methods Used

Baseline survey was conducted for 26 years starting from 1985 to 2011 GC by classifying land use land cover of 1985, 1995 and 2011 using supervised method of classification. A nine years project impact was analyzed starting from 2011 to 2019 using Landsat TM image for 2011 and Landsat 8 image for 2019. When classifying imageries a false color composite of 5,4,3 for Land Sat Seven and an FCC of 6,5,4 for Land Sat 8 image was used. Arc GIS 10.2 and ERDAS 2014 arethe two important software's used in this work.

1.3.1 Source of data

USGS web site is the main source for satellite imageries (Landsat TM of 1985, 1995, 2011 and Landsat 8 for 2019). In addition to the land sat imageries SPOT image of 2006 was used from Ethiopian Mapping Agency and it was used as a reference while classifying images. GPS measurement was another source of information for ground control points of different land cover types and boundary data.

1.3.2 Location of wazeshara Micro watershed

It is located within ArbaminchZuriaworeda of GamoGofazone.The name WazeShara watershed is adopted from the two kebeles in which the watershed is located.

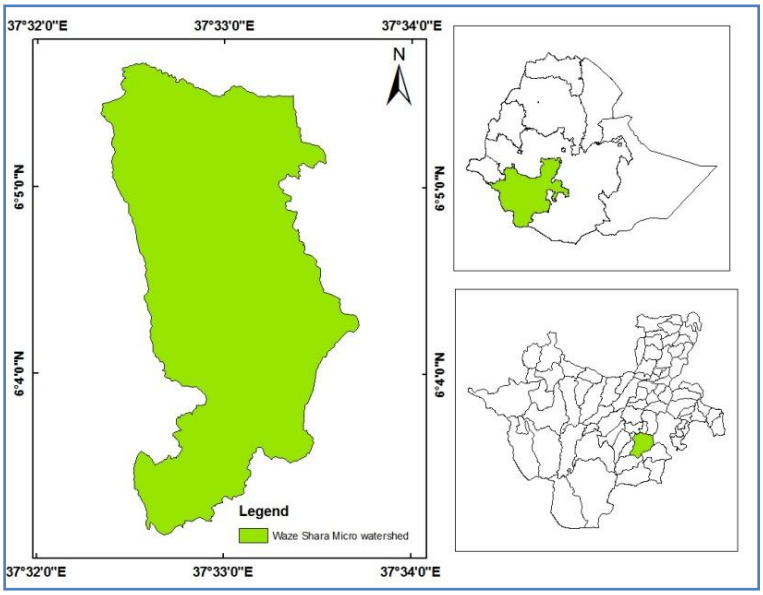

Fig 1: location map

1.3.3 Flow Chart of Activates

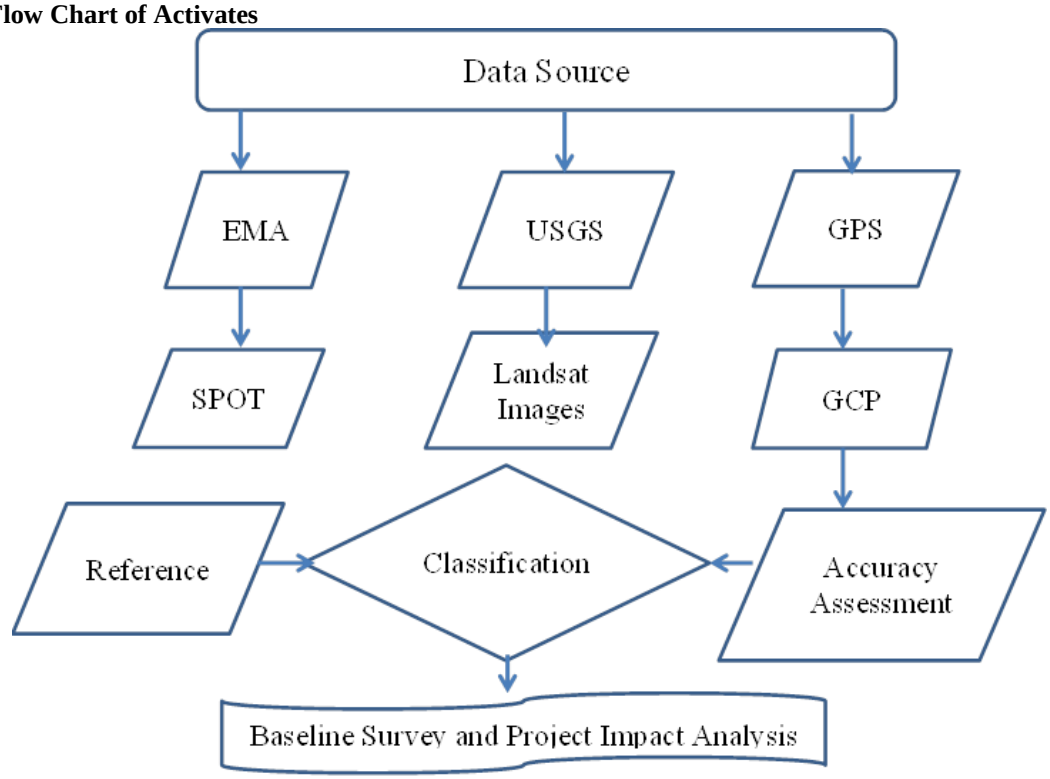

Fig 2: flow chart of activities

3. Base line survey (LULC change) for 26 years

This paper analyzes land use land cover dynamism of WazeShara for 26 years starting from 1985 to 2011. As we observed it from our field visit shrub land, bare land, forest and grazing land are the common land use land cover type in the area. Accordingly it was classified considering four land use land cover typesand m.

2.1 Land use land covers change of 26 years

Table 1: land use land cover change from 1985-2011

	1985		1995		2011	
Name	Area	%	Area	%	Area	%
Shrub Land	123	18.41	168	25.14	123	18.41
Forest	184	27.54	69	10.32	109	16.31
Grazing Land	253	37.87	313	46.85	250	37.42
Bare Land	108	16.16	118	17.66	186	27.84
Total	668		668		668	

In 1985 grazing land was about 37.87% followed by Forest with 27.54%, and shrub land with 18.41%. In the same year bare land was the last in terms of area size with 16.16%. After ten years i.e. in 1995 grazing land cover 46.85% of the total land area followed by shrub land and bare land with 25.14% and 17.66% respectively. The last land cover in terms of area was Forest with 10.32% from the total land area.

In the last year of analysis (2011) i.e. after 16 years a significant dynamism of land use land cover was observed. The largest land use land cover was grazing land bare land and shrub land with 37.47%, 27.84% and 18.41% respectively. The least land cover in this year was forest with 16.31 % coverage.

Grazing land was the dominant land use in each year of analysis but this does not mean absence of dynamism for this land use type. In 1995 a significant increment in sizewas observed and a significant decrement in 2011were noticed.

2.2 percentage change of LULC before project implementation

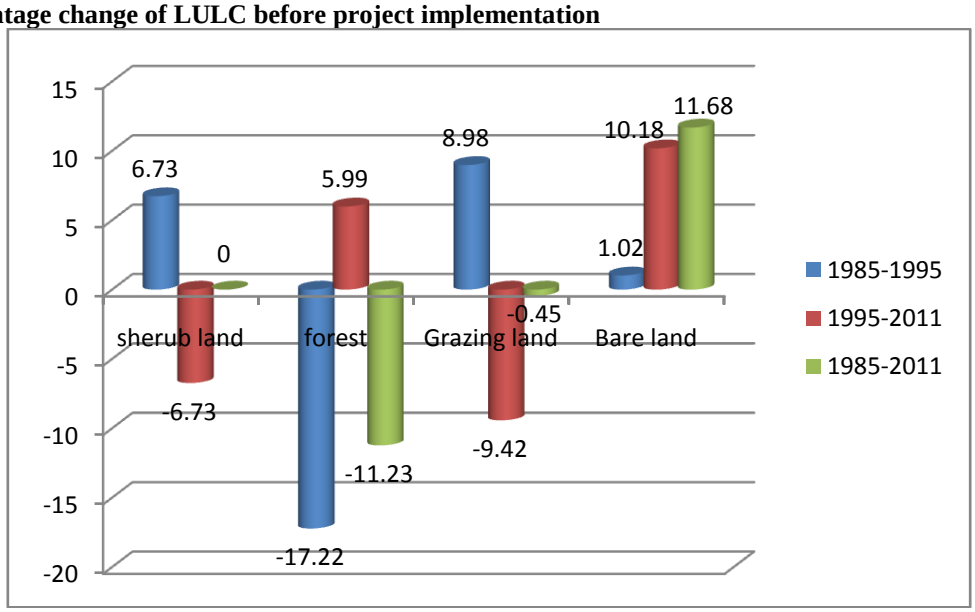

Fig 3: graph of percentage change for the baseline survey

As it is shown on the above graph bare land is the only land cover class that shows a continuous increment. In the first ten years bare land increased by 1.02%, in the second analysis year it increased by 10.18%. Generally this land covers class in 26 years increased by 11.68%. Grazing land experienced both positive and negative changes within 26 years. A positive change is observed between 1985 and 1995. This land cover class shows -9.42 and -0.45 in the same years of analysis.

Forest land cover also experience both positive and negative changes in the second year of analysis and first and third years of analysis. This land cover decreased by -17.22% from 1985-1995 and by -11.22% from 1985-2011. For this land cover type a 5.99% increment was observed from 1995 to 2011. When it comes to shrub land a 6.73% increment was observed in the first ten years. In the next analysis year it decreased by -6.73%. From 1985 to 2011 grazing land remains unchanged.

2.3 Annual rate of change

As it is shown on the table below within 26 years shrub land is unchanged due to this fact its annual rate of change value is zero. In each year a -2.88 hectare of forested land was decreased in size followed by grazing land with -0.11 hectare annual rate of change. The size of bare land was increased by 3 hectares in each year from 1985 to 2011.

Table 2: Annual rate of change in land use land cover

Land cover Name	Annual rate of change in hectare
Shrub Land	0
Forest	-2.88
Grazing Land	-0.11
Bare Land	3

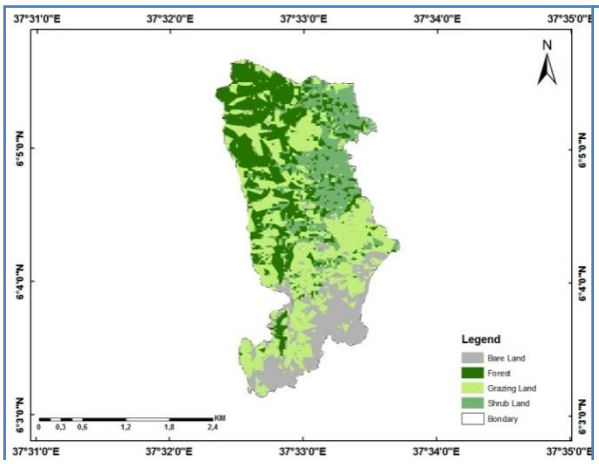

Fig 4: LULC map of 1985

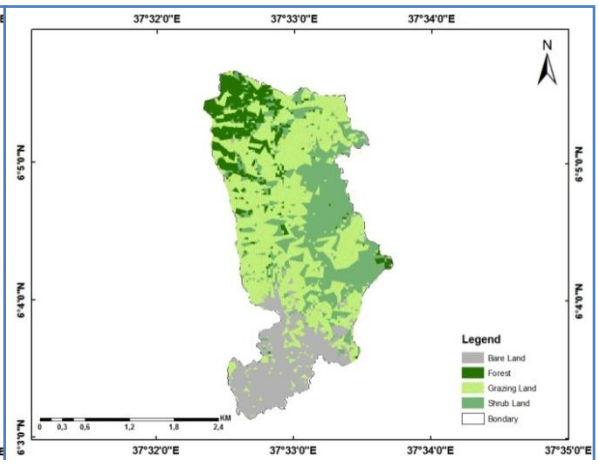

Fig 5: LULC map of 1995

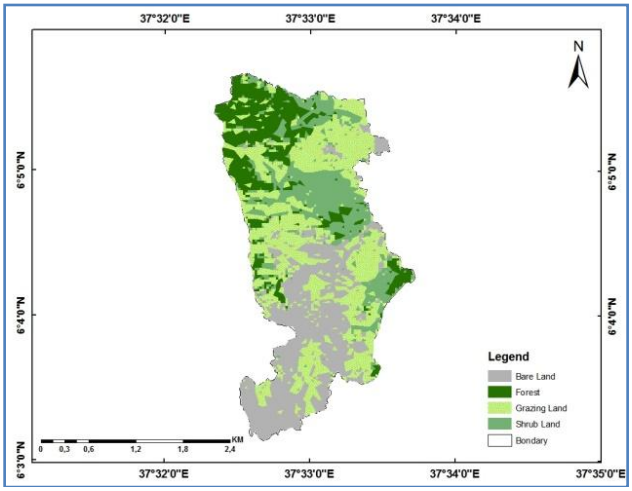

Fig 6: LULC map of 2011

2.4 Project impact Assessment

Environmental protection for WazeSharamicro watershed was started in 2011 and being implemented still now. Due to this the current work assessed it's impact on the physical land cover starting from 2011. Area enclosure for the protected site, plantation in some part and keeping the whole area from human and animal intervention are the main activities conducted by environmental protection project in collaboration with the local community.

Table 3: land use land cover change after project implementation

Name	Area ha 2011	%	Area ha 2019	%
Shrub Land	123	18.41	279	41.76
Forest	109	16.31	115	29.19
Grazing Land	250	37.42	195	17.21
Bare Land	186	27.84	79	11.82
Total	668		668	

After nine years of project implementation a significant positive change (123-279ha) in shrub land is observed. The other large increment is in forest land cover from 109ha to 115ha of land area. The remaining two land cover typesi.e grazing land and bare land are decreasing in size from 250-195 hectares and 186-79 hectares for grazing land and bare land respectively.

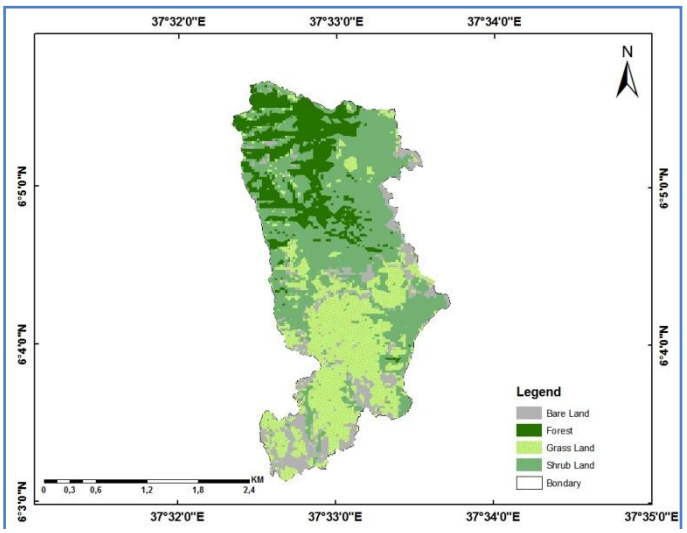

Fig 7: LULC map of 2019

2.4 Annual Rate of Change After project Implementation

Table 4 Annual Rate of change after project implementation

Name	Rate
Shrub land	17.33
Forest	0.6
Grazing Land	-6.11
Bare land	-11.88

As the above table shows due to project activities in each year shrub land is increasing by 17.33 ha. The forest land cover is also increasing by 0.66 ha in each year of project implementation. Grazing land and bare land are decreasing by-6.11 and -11.88 hectares of land. A detail of change from each land use land cover to the other are indicated in the matrix analysis for impact assessment.

2.6 Matrix analysis

Table 5 Change matrix result from 2011-2019

	2019				
2011	Shrub Land	Forest	Grazing Land	Bare Land	Total
Shrub Land	81	38	2	2	123
Forest	40	65	1	3	109
Grazing Land	132	12	91	15	250
Bare Land	26	0	101	59	186
Total	279	115	195	79	668

After the nine years of project implementation out of 123ha (in 2011) of shrub land 81ha of it remains unchanged, 38ha of shrub land is converted in to forest land cover, 2ha of shrub is converted in to grazing land and 2ha of shrub land is changed in to bare land. When we see the amount of change to shrub land cover type from the other land covers the largest conversion is observed in grazing land with 132ha of land followed by forest and bare land with 40ha and 26ha of land respectively.

Out of 109ha of forested land 65ha of it remains unchanged, 40ha of forested land is converted in to shrub land, and 1ha of forested land in2011 is changed in to grazing land and 3ha of land converted in to bare land. When it comes to conversion to forest shrub land cover type is the first in terms of amount of conversion with 38ha followed by grazing land. In the same year bare land did not changed in to forest land cover type.

From the total 250ha of grazing land cover in 2011 only 91ha of this land cover remains unchanged. The largest conversion from this land cover is a conversion in to shrub land with 132ha and a conversion to bare land and forest are the last two conversion from grazing land with 15ha and 12 ha respectively.

In 2011 the size of bare land was about 186ha due to project implementation after nine years 101ha of bare land is changed in to grazing land, 26ha of land is changed in to shrub land but there is no conversion from bare land to forest land cover. The remaining 59ha of bare land are not changed. When we see a conversion in to this land cover a change from grazing land, forest and shrub land are observed with 15ha, 3ha and 2ha correspondingly.

III. CONCLUSIONS AND RECOMMENDATION

3.1 Conclusion

As the result indicates up to 2011 a continuous increment of bare land cover type (with 3ha per year) was observed. This was due to overgrazing and deforestation in the area which in turn causes environmental degradation and flooding in Shara and KulfoKebeles. Within 26 years the size of shrub land remains unchanged but there was a decrement in forest and grazing land cover types with -2.88 and -0.11hactares annually. These were the main reason for intervention by stakeholders to conduct environmental protection. After 2011 a significant increment of shrub land and forest land cover types were observed, a very large and continuous decrement of bare land areas were also noticed.

The other important observed thing in the micro watershed after project implementation(although the size is small) is the presence of change from shrub land to bare land, forest land to bare land and grazing land to bare land cover type. This indirectly indicates the existence of deforestation, over grazing and human intervention in the watershed.

3.2 Recommendations

So as to improve the physical cover of the watershed the following actions are recommend.

1. Project sustainability to keep the existing positive changes of LULC,
2. Planting trees and grasses in the watershed so as to increase the size of forest, shrub land and grazing (grass land) areas,
3. Structural soil and water conservation practices in steep slope areas,
4. Designing a means to benefit the society from the protected area and
5. Increasing awareness of the society about the pros and cons of environmental degradation in the area.

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