Evaluating Implication of Long Term Watershed Development on Plant Diversity Dynamics in Maybar Sub-Watershed, South Wello Zone, Ethiopia

Tilahun Taye*, Awdenegest Moges

Department of Soil Science, Ambo University, Ambo, Ethiopia

Research Article

ABSTRACT

Long term watershed management in Ethiopia was evaluated starting from the 1980's, in different agro-ecologies. A study was conducted to investigate the implication of long term watershed management on the plant diversity dynamics in Maybar sub watershed, North-eastern Amhara, Ethiopia. Plant diversity data was collected through focus group discussion with key informants, transect walks and field observation. Each plants could been categorized under their nature of plantation such as cultivated crop, fruit and Vegetables, cultivated tree, shrub and herb, grass, wild or semi wild tree and shrub and Other (weed, Herb, Bush…), and the existence also classified as past and current condition. Then, analysis was done by SPSS16.0 statistical software. The results showed that while two types of indigenous plant species currently disappeared, newly introduced plant species had been increased by 14.41% from the previous plant species diversity. Cultivated trees, shrub and herb, fruit and vegetables and grass species relative proportion have been increased by 52.98%, 18.18%, and 1.8% respectively. In contrast, plants categorized under cultivated crops, wild or semi wild trees and shrubs and others (weed, wild herb, bush) has been decreased by 25.31%, 18.31%, and 11.37% respectively. Therefore, long term watershed development has a positive impact on plant diversity improvement.

INTRODUCTION

Watershed is the overall components of biophysical, social and political aspects of a defined hydrological unit of an area. It provides essential roles for the life, such as food, habitat, social and economic services. Therefore development of watershed in a sustainable manner is a long history. It is the continual practice of protecting natural resource by stabilizing soil, water and vegetation with environmentally and ecologically suitable manner. It has a multiple benefits such as improving livelihoods of the community and improving the biodiversity. But natural resource degradation is a serious problem in the Ethiopian highland due to steep slopes, intensively cultivated, high intensity rainfall, a sparse vegetation cover and significant direct runoff generation [1-5].

Anthropogenic factors of natural resource degradation or habitat loss is among the main threats of plant biodiversity. It may be the cause to alteration of land use management that affects plant diversity in an area. Therefore to alleviate this problem watershed planning provides an ideal opportunity to consider conservation of biological resources.

Starting from 1970's, in most part of Ethiopia watershed management program was started which brings to many anthropogenic and natural factors such as economic, social and political aspects which results land use and land cover change. Land use land cover change in an area could be a means to alter the status of plant biodiversity and runoff and sediment load status. The land use land cover change impact directly proportional to with the alteration of natural resource. The land use land cover change of an area could alter either positively or negatively vegetation cover, soil depth, recharge of groundwater table, crop production and productivity and improvement in fodder

availability [6-10].

Therefore, protected area and watershed management creates great opportunities for reclaiming degraded land, improving soil fertility, water resources development, increasing agricultural production, vegetation generation and high composition of species. Natural resource development projects and the intervention of local community on a conservation practices have a great role for plant diversity improvement. In addition it could enables to propagation of indigenous trees and biodiversity conservation. Enclosed or protected area had been a significant role for the rehabilitation of degraded land and improvement of biodiversity. It also important to higher species richness and regeneration of native species. While on the earth there are around 4, 80, 000 plant species, only 67% of them are identified. In case of Ethiopia this proportion didn't appropriately determined. Even if plant biodiversity generation is one of the outputs of the developed watershed, its dynamics over the years didn't appropriately determined.

Since the 1980's, the soil conservation research project had established six monitoring stations of the multi scale watershed in the different parts of Ethiopia. Among these monitoring stations, Maybar is one of them which accumulated dataset in terms of various aspects. Therefore the aim of this study is to investigate the long term watershed development contribution on plant species diversity dynamics at the catchment level [11-15].

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MATERIALS AND METHODS

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Description of the study area

Location: Maybar is located in the sub-humid northeastern part of the central Ethiopian highlands in Southern Wello Administrative Zone near to Dessie Town (Figure 1). It was SCRP's first research site that was established in June 1981. Maybar watershed drains into the Borkena River, which flowing to the Awash River basin. The gauging station is located at 39°40' E and 11°00'N. According to the physical geographic survey, the catchment is characterized by highly rugged topography with steep slopes ranging between 2500 and 2860 m.a.s.l. within a topographical catchment of 116.19 ha area. Slopes range from over 64% to less than 6% [16-20].

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Figure 1. The study site.

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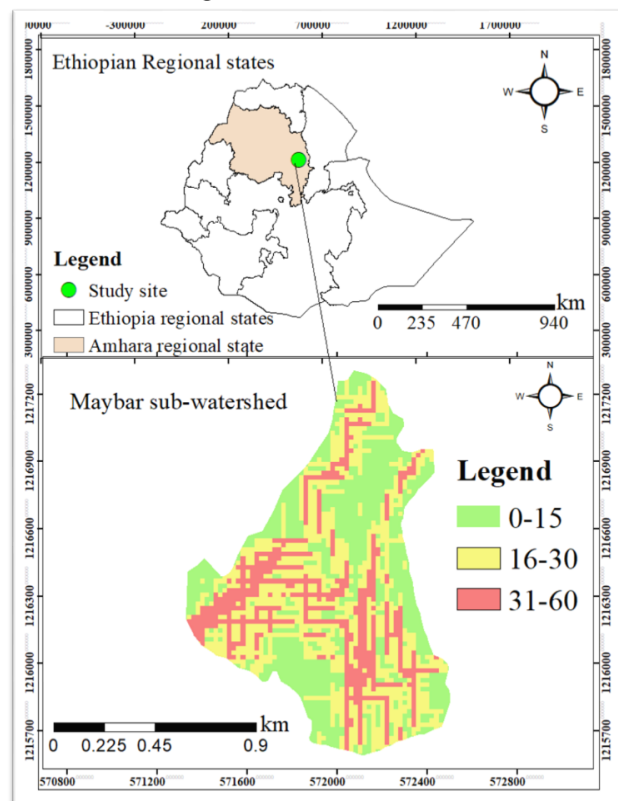
Climate

The maybar research watershed receives an average annual rainfall of 1325 mm/yr. The annual mean minimum and mean maximum temperatures at the study area for the periods from 1999 to 2006 are 11.43 and 21.6°c respectively. Maybar area is characterized by a bimodal rainfall pattern with the erratic distribution. The small rainy season (Belg) occurs from March to May, while the main rainy (Kiremt) season occurs from June to September with a dry season from October to February [21-24].

Soil type and agricultural activities

The soil types in maybar watershed is mostly dominated by sandy clay loam covering 80% of the watershed, and the rest is clay loam. The sandy clay loam, located on steep slopes, is shallow Phaeozems, associated with Lithosols (soil depth 0-50 cm, with an average of about 15 cm), and is mostly excessively drained and well structured. The clay loam, located on gently flat slopes, is moderately deep to deep Haplic Phaeozems. The people of the maybar catchment exercise a rain fed, subsistence oriented mixed crop livestock production farming system with ox drawn farm implements. The major crops are Tef, Wheat, Barley, Pulses (faba bean and field pea) and Maize on an average landholding of 0.5 to 1 ha per household Soil conservation in the form of level soil and stone bunds was introduced in the research catchment between March and July 1983 through a food for work campaign conducted by the ministry of Agriculture. Some area closures followed in 1986 when approximately one tenth of the population of the area was resettled to Wellega, only to return some years later. Small scale agriculture with a mixture of crops and livestock, fields plowed with oxen, and subsistence production is typical of the area.

Land use and vegetation

The Maybar research unit is representative of the Moist Weyna Dega/Moist Dega climatic belt. According to Hurni, et al. Approximately 60% of the total catchment area is cultivated whereas 20% is woodland and 20% is grassland. The grassland is mainly located on the lower and flatter slopes. The croplands are generally at mid slope and the grass and woodlands are near the divide of the watershed and on the shallowest soils.

Methods of data collection and analysis

In order to assess the plant biodiversity dynamics of the catchment small group was formed with the key informant people from the community and assess the whole catchment with them by systematic transect walk and record the current plant diversity. The basic historical questions were developed about the previous plant biodiversity condition and historical calamities of the catchment and recording the local name of each plant; available habitat and category of use and the time of existence and abundance of distribution was the basic information of each plant.

Based on a different perspective of key informants, persons were selected who could directly or indirectly involve in any aspects of the watershed development activities. Since, 15 key informant persons were selected based on different age groups, educational status, and gender.

In order to provide an in depth exploration of reliable information about the developed questions, focus group discussion was conducted. After collecting the overall biodiversity that existed in the catchment-based on past and current time series have been grouped on six main categories (based on available habitat and nature of species) as cultivated crop, fruit and vegetables, cultivated tree, shrub and herb, grass, wild or semi wild tree and shrub and other (weed, wild herb, bush…). The grouping system also adjusted with discussing the member of participants during the focus group discussion. There is no clear distinction between past and current time hierarchies. But for the common understanding abundance in the past category means the plant that existed previously (watershed development starting or late 1980's) but currently either presents or not. Besides abundance in the current category also the plants that have been existing currently but previously either present or not (Figure 2).

Figure 2. Group discussion and diagram of the catchment drawn by participant farmers.

Finally, for each plant species determine the score of abundance which is highly (3), medium (2), low (1) and absent or no abundant (0) for both current and past condition. Then analysis was done by using SPSS16.0 software and interpreted with the frequency of abundance and availability of the trend. The basic assumption of this study on the impact of plant diversity improvement was led through watershed development activities. In order to determine the past and present plant diversity status, focus group discussion was made with the local community (Table 1).

Table 1. Description of participant.

Gender	No.	Age group	Educational status
Male	2	30-35	Primary school
	4	30-40	Up to grade 4
	3	40-50	Read and write
	1	>60	Read and write
Female	2	40-50	Read and write
	1	>50	Non-educated
	2	30-40	Up to grade 4

RESULTS AND DISCUSSION

Plant biodiversity dynamics

Based on the above procedural methodologies the total plant species diversity of the study area had been identified. Since, from the total plant biodiversity of the catchment 111 number of plant species was existed starting from the previous time but currently, this number has been increased to 127 with the loss of two species. This implies that the number of plant species diversity is increased by eighteen newly introduced. The percentage proportions of each species category have been presented in Tables 2 and 3 for the past and current respectively.

Table 2. Category of plant species available in the past.

| Category of species	Number of abundances	Percentage
Cultivated crop	11	9.9
Fruit and vegetables	10	9
Cultivated tree, shrub and herb	7	6.3
Grass	18	16.2
Wild or semi wild tree and shrub	28	25.2
Other (weed, wild herb, bush…)	37	33.3
Total	111	100

Previously, the plant species under weed, wild herb and bush categories was dominated. It indicated that it could available under all over the catchment. In contrast cultivation tree, shrub and herb are the lowest proportion from the total biodiversity (Table 3).

Table 3. Category of currently available plant species.

Category of species	Number of abundances	Percentage
Cultivated crop	10	7.9
Fruit and vegetables	14	11
Cultivated tree, shrub and herb	17	13.4
Grass	21	16.5
Wild or semi wild tree and shrub	27	21.3
Other (weed, wild herb, bush…)	38	29.9
Total	127	100

The proportion of abundance that categorized under cultivated crops, wild or semi-wild trees and shrubs and others (weed, wild herb, and bush) has been decreased. It's reduced by 25.31%, 18.31%, and 11.37% respectively (Figure 3). As the key informant indicates that most locally destroyed due to their low productive potential and the indigenous wild trees and shrubs also changed by the exotic tree and shrubs (e.g. Strawberry/Enjori and tree health/Asta was the earliest bush plants), whereas different acacia tree species and valuable fruit trees and grass species were currently introduced.

Figure 3. Change of abundance in the past and current plant diversity in percent.
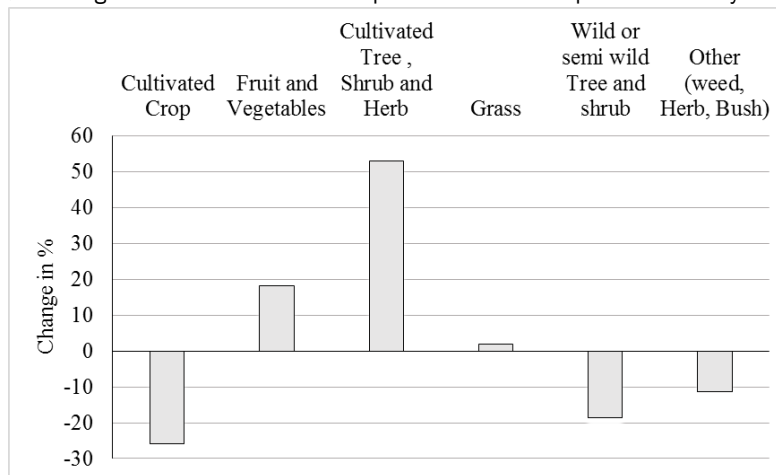
In contrast, cultivated trees, shrub and herb, fruit and vegetables and grass species relative proportion have been increased by 52.98%, 18.18%, and 1.8% respectively. It is expected that under watershed development activity introduced plant species have been increased and the local species also regenerated. It is agreed with different biodiversity dynamics and watershed development impact studies. Since, watershed development have been incorporates different biological and physical soil and water conservation activities. These various types of biological soil and water conservation measures could been improve the vegetation status of the watershed and most of the degraded part of the watershed also protected that results regenerate different types of plant diversities. In addition in order to improve the livelihood of the community, different horticultural and improved crop varieties also incorporated. On the other hand some plant types also dis appeared from the area. It may be due to the factor of climate change and the newly introduced plant type succession system may be affected them. This is in lined with different research reports. Such as integrated watershed management bearings ecosystem balance and climate change regulation. It also contributes a significant role to natural resource conservation which results to biodiversity and ecosystem improvement (Tables 4 and 5).

Table 4. Level of species abundance during the past time.

Level of abundance	Total frequency	Percentage
Absent	18	14
Low	45	34.9
Medium	53	41.1
High	13	10.1
Total	129	100

Table 5. Level of Species abundance during the current time.

Level of abundance	Total frequency	Percentage
Absent	2	1.55
Low	43	33.33
Medium	48	37.21
High	36	27.91
Total	129	100

One of the effectiveness of watershed management intervention is improving plantation tree and vegetation diversification. A number of wild food (wild edible plants) are found to be threatened where agricultural expansion and overgrazing are contributing to major threats. The plant diversity and determinant factors in central Ethiopia study indicated that the number of tree and shrub species increased with the increased household location. In addition, land use type and household wealth status significantly influenced tree and shrub species richness. It also influenced by the farm size of the household which it could positively affected by the area of farm size.

The dominance of exotic tree species in farming landscapes may replace the native tree species in the long term. In

order to correlate with the land use land cover change, its trend is positively correlated with wild and semi wild plant and grass species with shrub and grassland classes. The reduction and fragmentation of shrub land and natural grassland led to the decline of wild plants. The watershed interventions increased the vegetative index or greenery, reduced runoff, soil loss, and land degradations and improved the bio diversity in fragile ecosystems.

Long term natural resource conservation measures positively affects the ecosystem services of the area which results of successful regeneration of biodiversity over the time. Watershed management used to ensuring the sustainable agriculture which results of development of ecosystem diversity. Ecosystem diversity has a significant role to the improvement of biodiversity habitat.

On the other hand development could be the cause to land scape changes which related to the biosphere system of the earth which results climate change and loss of biodiversity. It may the cause of the alteration of ecosystem services which out puts some unfit species may be disappeared or out of the system. Therefore, in this study the cause of some species may of the result of climate change and ecosystem diversity dynamics.

In other study, soil and water conservation activities with protecting the area indicated that a significant role on vegetation regeneration and improvement of plant species diversity. It is more prevalent on the sustainable and long term watershed development programs. Similarly, watershed development program not only conserving the environment but also it could enhance the crop diversification and patterns which results of making alternative farming system.

CONCLUSION

Watershed management is the practice of enhancing natural resource and balancing of entire ecosystems with incorporating various natural resource conservation techniques such as biological and physical soil and water conservation activities. In this study the trend of plant diversity dynamics which results the long term watershed development program was assessed with participating the local community.

Therefore, the result indicated that plant biodiversity dynamics of the watershed was affected by the watershed development activities which results positive improvement of the species. Currently cultivated trees, shrub and herb, fruit and vegetables and grass species relatively increased while cultivated crops, wild and semi wild trees, weed and bush species also decreased relatively. Currently the total plant diversity has been increased by 14.41% relative to the previous. It indicates the watershed development technologies such as plantation of degraded land, protecting the area and biophysical soil and water conservation measures that implemented in the study area had been contribute to the plant species improvement. In contrast two types of plant species also disappeared from the area that may be due to the climate change and variability or introducing of newly plant species affect the ecosystem services of the watershed which could be affected thus lost species. Therefore the interaction effect of the plant diversity and the total wealth of the ecosystem service should be determined.

Acknowledgment

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