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The Link between Ethnobotany and Watershed Development for Sustainable Use of Land and Plant Resources in Ethiopia

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Abstract

A watershed is a naturally delineated unit of land that drains water, sediment, dissolved materials and biota to a common outlet along a stream channel. Its development and management creates an opportunity for different people to consider elements of watershed for optimum production with minimum disturbance to the environment. This review paper aims to understand how the knowledge of ethnobotany is important to manage plants in the landscape for better watershed management. To achieve this, the review was focused at concepts and working principles of watershed management; elements of watershed; historical development of watershed management in Ethiopia with its achievements. Furthermore, application of ethnobotany in the understanding and management of watershed and experiences of other countries in using human knowledge of plant for watershed management based on the published facts are key issues addressed by this review. In general, the literature reviewed showed that for watershed development and management, the contribution of local people's knowledge, consortium approach and adoption of new technology are important to achieve desired result for insuring sustainable utilization of natural resources in a given watershed.

Keywords: Watershed; Ethnobotany; Natural resource; Landscape

Abbreviations: AMAREW: Amhara Micro-Enterprise Development, Agricultural Research, Extension, and Watershed Management; CRGE: Climate Resilience Green Economy; CSWCRTI: Centeral Soil and Water Conservation Working Center; EthiOCAT: Ethiopian Overview of Conservation Approach and Technology; FFW: Food for Work; GIZ: The German Agency for Technical Cooperation; GWC: Green Water Credit; ILRI: International Livestock Research Institute; IWMI: International Water Management Institute; LLPPA: Local Level Participatory Planning Approach; MoA: Ministry of Agriculture; MoARD: Ministry of Agriculture and Rural Development; MOFED: Ministry of Finance and Economic Development; MERET: Managing Environmental Resources to Enable Transitions to more Sustainable Livelihoods; PSNP: Productive Safety Net Program; SWAT: Soil Water Assessment Tool; UNEP: United Nations Environment Program; USAID: United States Agency for International Development; WEAP: Water Evaluation and Planning; WFP: World Food Program

Introduction

A watershed is a naturally delineated unit of land that drains water, sediment, dissolved materials, and biota to a common outlet along a stream channel [1]. Many years back, Achouri [2] also defined hydrologically as an area that water at surface or subsurface flow to a given drainage system or common outlet. Desta et al. [3] Defines watershed based on what it has, i.e., watershed is made up of the natural resources in a basin, especially water, soil, and vegetative factors. At socioeconomic level a watershed includes people, their farming system and interactions with their land resources, coping strategies, social, economic and cultural aspects.

Throughout the world, especially In Asia and Africa, poor farmers tend to be associated with marginal lands and low yields [4] and they struggle to cope with a diverse array of agro-climatic, production and market risks [5]. Similarly deforestation, accelerated soil erosion, and land degradation are serious problem in Ethiopia [6] and forest degradation Projections indicate that unless action is taken to change the traditional development path, an area of 9 million hectare might be deforested between 2010 and 2030 [7]. Over the same period, annual fuel wood consumption will rise by 65% leading to forest degradation of more than 22 million tons of woody biomass.

The above mentioned global as well as national problems are solved by watershed development projects. Some of the sampled studies in different countries like in Ethiopia [8-11] in Kenya [12], in China [13] and in India [14] were confirmed that restoration of natural resource is possible through this program by addressing biophysical, socio-economic, and institutional and policy issues. The watershed approach enables planners to harmonize the use of soil, water and vegetation in a way that conserves these resources and maximize their productivity. In Ethiopia, continued performance in this sector has been contributing to the achievement of the countries green economy plan to the would be abatement potential of 250 Mt CO_2 emission to the global community and multiplying GDP per capital from 380 USD in 2010 to over 1800 USD in 2030 [7]. Therefore continuous review to synchronize different approaches and adopting new concepts is in demand.

Objective of the review

The general objective of this review is to integrate the discipline of ethnobotany and looking new approaches for better watershed management in Ethiopia. The review is specifically helpful to study watershed concepts and working principles in Ethiopia; to pinpoint activities done on watershed that demands the knowledge of ethnobotany for better achievement; to study the experiences other countries regarding the use of plant knowledge for watershed management; to initiate people to study ethnobotany and apply it in

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watershed management and related areas.

Methods of the review

To prepare this review, the author has used published facts from internet including edited books, journal articles; country watershed intervention assessment reports by NGOs, research institutes, and governmental stakeholders. In general, secondary sources are used throughout this paper.

Review on Watershed Development and Management

Concepts and working principles of watershed management

Approaches that help to conceptualize watershed: A watershed perspective looks at the whole landscape to address natural resource issues. This approach is becoming a common practice among communities and resource managers throughout the world [15]. Restoration and maintenance of the physical, chemical, and biological integrity of watersheds require decision making that balances human (economic) and natural (environmental) systems. Eventually, its activity is defined by outcomes [6]. Environmental problems such as habitat loss, water contamination, dwindling freshwater supplies, desertification, urbanization, nonpoint source pollution, and ecosystem impairment are often a result of complex processes that require systems-based thinking, a central concept in watershed management [16].

Principles of watershed management

Main principles: The principles of watershed management that are acceptable and can be used as a basis for reasoning differ in different countries due to the social, cultural and geographical differences. In the Ethiopian context, the principles of watershed management went on perfecting due to the lessons learnt from different pilot projects done in different regions since its beginning. In 2005, Ministry Agriculture and Rural Development together with different NGOs prepared Community Based Participatory Watershed Development guide book [3] that contains working principles governing overall management of watersheds that include: Participatory; Gender sensitive; Building up on local experience, strength and what works; Realistic, integrated, productive and manageable; Watershed logic and potential respected and The need for flexibility at different levels; Cost sharing and empowerment/ownership building; Complementary to food security and rural development.

Size of the watershed: The size of a watershed to be chosen for land development/soil conservation depends up on the objective (s) of the nature of the land development planning to be attempted. In the Ethiopian context it should be in between 500 and 1000 ha [3], a conventional size for planning soil and water conservation treatment. As Bekele et al. [17] indicated that Watersheds, which are less than 40 ha, are designated as small watershed while those more than 40 ha are designated as large watersheds whereas in 15 different watershed work reviewed by Borah and Bera [18]. The size varies from 3.46 km^2 to 8927 km^2.

Elements and management of watershed

Biophysical (water, land and vegetation): The watershed includes climate (rainfall, winds), drainage and water, soil, vegetation, specific topographic features (gradient and length of slope, altitude, shape and direction and past current erosion features (rill, gullies, landslides and the like) Land use includes homesteads, cultivated land, grazing land, forest (natural and artificial), degraded areas used for various purposes [19]. Some areas have more potential than others However, watershed development applies to potential as well as less potential areas, as both are not only interconnected but also can recover or improve their productivity with specific set of measures and management [17].

Socio economic features: The socio-economic elements and characteristics of a watershed involve population, farming system, social setups, economic activities, vulnerability profile, gender and the like. Watershed development planning is in principle an approach that fits community level planning. It aims to improve the livelihood of the community [3,20,12].

Watershed management: Watershed management is a way of looking at relationships among people, land and water in a watershed to obtain optimum production with minimum disturbance of the environment [21]. The new concept is outlined by Farrington, et al. [22] with highly concerned not only with stabilizing soil, water and vegetation, but also with enhancing the productivity of resources in ways that are ecologically and institutionally sustainable. Kerr [23] has also been tried to link the management practices as a means to increase rain feed agricultural production, natural resource conservation and poverty reduction in the semiarid tropical region of south Asia and sub Saharan Africa. Late alone integrating all elements of watershed [18], adaptation of new technology compatible to the existing land use [24] are critically important to solve the existing economic problems.

The watershed is the appropriate hydrological unit for technical efforts to manage water and soil resources for production and conservation [25]. In spite of this, watershed management is complicated by the fact that it rarely correspond to human-defined boundaries. Watershed projects distribute costs and benefits unevenly, with costs incurred disproportionately upstream, typically among the poorer farmers, and benefits realized disproportionately downstream, where water use is concentrated and richer farmers own most of the Land. Because of this, green water credits (GWC) are recently applied in the Kenya Tana Basine [12] intended to arrange payments by downstream businesses to upstream farmers.

Green water refers to water held in (unsaturated) soil above the groundwater table, available for transpiration and evaporation, while blue water refers to surface- and ground water in aquifers, rivers and other water bodies [26]. These two water systems have been used properly by proper watershed management. The green water conservation in the upper catchment results replenishing the groundwater aquifer, [2] reducing river peak flows, because of reduced surface run-off, thereby regulating river flow; [3] avoiding costly sedimentation of water reservoirs and reducing the intake of sediments into the pipe networks of hydropower plants and water supply systems [27]. For all these, the lower catchment water and hydro electricity companies should refund reasonable amount of money about the service they obtained.

To facilitate the negotiation how much water and hydro electricity companies should pay, the amount of water and soil must be known. Computer simulation quantitative models, like soil and water assessment tool (SWAT) [28] and The Water Evaluation and Planning (WEAP) [29] are used to quantify conservation potential, financial benefit, C-sequestration, and a regulating ecosystem service of all measures used for augmenting degradation of water and soil.

The need for watershed management in Ethiopia

The landscape (People, land, soil, water and vegetation): Seventy nine percent of Ethiopia's land has a slope in excess of 16%, and at least one –third of this area has a slope of 30% or more [30]. As a result,

43% of the country, where 88% of the population lives, is more than 1,500 meters above sea level [31]. Consequently the Ethiopian highland mass is the center of the economic activity of these much population, 75% of livestock and the source of many of the country's major rivers including the Blue Nile [32-34].

Practically the Ethiopian highland systems are thus known for poorly managed rain fed agricultural practices, combined with the absence of adequate cover, which result in a heavy flush of water that washes away the soil [6]. Farmers cultivating the rugged terrains in the regions of Tigray and Amhara (Wollo, North Gonder and North Shewa) frequently abandon their farmlands after the topsoil is washed away. Due to this, the soil depth is reported to be 10 cm or less in many areas [35].

Studies indicated that in many areas erosion exceeds soil formation. In the highland regions of the Abay basin soil loss in areas cultivated through traditional practices amount in the order of 122-128 tons/hectares/year. This figure, more than doubles in the absence of vegetation cover i.e., in the Baro sub catchment it reaches to 46-425 tons per hectare per year from 5-60% slop. Similarly in the Tekeze basin, Quiha sub catchment soil loss amounted to be 33 tons per hectare per year [31]. The cumulative impact of soil erosion in the Ethiopian high land results annual average sediment yield ranges between 10 tones per Km2 in the Southern part of the country and 1500 tones per Km^2 in the northern eastern part of the country [36].

Because of continuous degradation, Ethiopia is ranked the ninth most susceptible country in the world to natural disasters and weather-related shocks [37] and climate change is likely to exacerbate this situation, making extreme weather events more frequent and intense, increasing water stress and further reducing agricultural productivity. Above all, Ethiopia's population is growing, further increasing the difficulty of improving the food and nutritional security of the poor. At current rates, 270 people will need to gain a living from each square kilometer of arable land by 2050, compared with 125 per Km^2 now [38].

To reverse the problem, watershed is an ideal unit for planning and development of land, water and vegetation resources. The practical evaluation of watershed development in countries like India that share similar farming style, mainly rain fed agriculture, reveal that through watershed development there has been: (i) recharge of groundwater aquifers as evidenced by increase in water levels and rise in number of wells, (ii) reduction in soil erosion, (iii) increase in cropping intensity, (iv) change in cropping pattern leading to higher value crops, (v) increase in crop productivity, (vi) reduction in rural and urban migration, and (vii) rise in overall biomass in the watershed [5].

Water resource: Ethiopia has adequate average annual rainfall, several major rivers and lakes, and significant groundwater resources. The total renewable surface water resources are estimated at 122 billion cubic meters per year from 12 major river basins and 22 lakes [39]. Among these, the high land contributes the major river system's (the Nile, Awash and Omo) [40] that needs high management due to its topography. Late alone this, the high land is the site of trans- boundary river, the Nile, systems having a potential of economic growth by regional integration both in river related production and in trade and infra-structure interconnection beyond the river [41].

Due to this fact, the Nile basin initiative (NBI) is established in 1999 as an intergovernmental organization, and has been viewed as a transitional arrangement to foster cooperation and sustainable development of the Nile River for the benefit of the inhabitants of those countries [42]. This is because; hydronomic (water management) zones are instrumental in identifying and prioritizing water management issues and opportunities in different parts of a river basin [43]. To Promote Improved Rainwater and Land Management in the Blue Nile (Abay) River Basin Cooperation is also possible for sustainable utilization of the river system by green water credit system (GWC) implemented in the Kenyan Tana basin by watershed approach [12].

A practical example is also exist in the Mekong River Basin a similar water length (The Mekong is one of the World's largest rivers, almost 5000 km long, it runs from the Tibetan Plateau to the South China Sea through six countries: China, Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam) as defined by the four Lower Mekong Basin (LMB) countries that includes Cambodia, Lao PDR (People Democratic Republic-a mountainous landlocked communist state in southeastern Asia that achieved its independence from France in 1949), Thailand and Viet Nam has resulted in an economically prosperous, socially just and environmentally sound Mekong River Basin. This is to promote and coordinate sustainable management and development of water and related resources for its Member Countries' mutual benefit and the people's well-being [1]. Similarly, due to the presence of Transboundary Rivers, the Nile, in Ethiopia, river basin based development will be a means of integration to other countries for sustainable development [44].

Historical development of watershed in Ethiopia

Practice of watershed development in Ethiopia since its start: The conception of watershed management in Ethiopia was started following the 1970s and 1980s recurrent droughts [45] with the aim of solving problems like drought, recurrent food insecurity and poverty due to poor management of the Ethiopian highlands. The extent of this degradation was dramatically highlighted in the FAO Ethiopian Highlands Reclamation Study [46] conducted in Tigray Region, which estimated that over 50% of the land area was significantly eroded; net annual soil losses from cropland were estimated at about 100 tons/ha. To revert the problem, large-scale technical soil conservation interventions using Food for Work (FFW), supported by the World Food Program (WFP) was implemented by the former Ethiopian government (the "Derg") in a top-down manner with little genuine farmer involvement.

During the transition to a new government in 1991, farmers spontaneously destroyed many of the conservation structures established during the program [47]. Late alone this, a planning unit for developing large watersheds comprised 30-40 thousand hectares that makes difficult to manage. However, large-scale efforts remained mostly unsatisfactory due to lack of effective community participation, limited sense of responsibility over assets created, and unmanageable planning units.

The government of Ethiopia decided to perform one pilot operation with community based watershed management approach in 1997 in Tigray Region to address the problem with the support from Irish Aid by drew initial lessons from India's particularly rich experience in participatory watershed management [48]. India as indicated by Chisholm and Woldehann [49] and Kerr et al. [50], water harvesting in the upper catchment permits rapid ground water recharge in the lower part so that previously totally dependent on un reliable rain-fed production were transformed with remarkable speed in to areas of irrigated production. The pilot program was also assisted by complementary government investment i.e., land certification providing tenure security incentive for investment [48].

As Tongul and Hobson [38] indicated that the government with the support of World Food Program (WFP) developed Managing Environment Resources to enable Transitions to More Sustainable lively hood (MERET) program across five regions (Amhara, Oromiya, SNNP, Tigray and Somalia) and Dire Dawa resulted rehabilitation of more than 400, 000 hectare of degraded land in 2003. In 2005 and onwards, other complementary programs to MERET i.e., Productive Safety Net (PSN) and Sustainable Land Management (SLM) program with the support from various donors and leadership from within the ministry of agriculture was developed and published National community based participatory watershed development planning guide line [3] and the Ethiopian Overview of Conservation Approach and Technologies [45] These two published guide books along with related policies and strategies are being utilized to implement watershed management throughout the country.

Achievements in watershed management in Ethiopia: Ethiopia has a history of watershed management initiatives dating back to the 1970s. The basic approach has shifted from top-down infrastructure solutions to community-based approaches through time [3] for better achievement. There is now a supportive policy and legal framework in the form of policies that facilitate decentralized and participatory development, institutional arrangements that allow and encourage public agencies at all levels to work together to rehabilitate degraded lands.

Over the years, more than 400,000 hectares of degraded land have been rehabilitated under MERET, helping households raise their incomes in absolute and relative terms, as well as increasing agricultural production. A recent impact evaluation [51] found that two-thirds of all MERET households (compared to less than half of the control site households) have escaped from poverty during the past ten years in that MERET has delivered a 20% reduction in poverty in its project areas. Besides, the AMAREW project also restored 586 hectares by area closure, performing 1410 km length of hill side terraces on total land area of 1500 ha in Yaku and Lenche Dima for soil and water conservation [8].

The impact assessment evaluation of PSNP program by Tongul and Hobson [38] also resulted in reduced sediment in streams by 40-53 percent in areas closed to grazing and cultivation (Closed Areas); increased woody biomass and forage production three to four-fold; increased water availability and quality; increased ground water recharge and improved downstream base flow of streams; lessened damage from seasonal floods enhanced downstream crop production through soil and water. Other site specific watershed intervention assessment studies reduce the problem of a 'decrease' or 'fluctuation' in crop yield at lower and upper catchment area of the watershed [10], increased ground water quality and productivity of the aquifer [9].

The Abrha Atsbha Natural Resource Management Initiative in the Tigray Region has resulted in improved soil quality, higher crop yields, greater biomass production, and ground water functioning and flood prevention. Honey production has increased by 300% over three years and incomes from vegetable and spice production have also tripled. Farmers have developed agro-forestry systems, integrating high-value fruit trees – avocado, citrus, mango and coffee among others. On their farms to generate improved incomes, food security and nutrition [19]. In recognition of all the above change, it received a prize in 2012 from UNDP supported equatorial prize among more than 800 entries from around the world.

Experience of watershed management in other countries

Many countries in the world have been doing watershed management in order to rehabilitate natural resources backed by repairing the broken ecological services. Watershed based rehabilitation of natural resource has been bringing change in different countries. The existing facts witnessed by the Chinese and Indian experiences were presented here to show the power of watershed management to alleviate poverty, build up sustainable livelihoods and rehabilitate degraded lands.

Watershed development in China: Even though watershed management in China was started many years ago, the country achieved remarkable successes in watershed management since the beginning of 1950. The 50 year watershed development work in China reported by Lixian [13] indicated that 859,000 Km^2 (around 85 million hectare of land) was developed by watershed management, of which 43.33 million hectares of soil and water conservation activities, 4.67 million hectares economic forest were planted, 4.3 million hectares were preserved by planting grass, 13.33 million hectares basic farmland were built, and lots of facilities of soil and water conservation were built, thus resulting in effectively checking the development of soil erosion. All the existing facilities of watershed management can increase their capacity of conserving more than 25 billion m^3 of water and of decreasing more than 1.5 billion tons of soil erosion each year.

In the report, one of the huge achievements very important to Ethiopia for adoption is development of a new field of study that helps to integrate many subjects for effective implementation of watershed program. This field of study is applying cybernetics (the fields of science concerned with processes of communication and control especially the comparison of these processes in biological and artificial systems) to a "human-watershed" ecological economic system management. The different subjects studied in this field are:- "Controllable character" of "human-watershed" system; "The most economical control" of a "human-watershed" system; "Observable character" of "human-watershed" system; "The most economical observation" of "human-watershed" system; "Stabilization" of "human-watershed" system; "Harmonization" of "human-watershed" system and "Intellectualization" of "human-watershed" system.

Watershed development in India: About 60 percent of total arable land (142 million ha) in India is rain-fed, characterized by low productivity, low income, low employment with high incidence of poverty and a bulk of fragile and marginal land [14]. Rainfall pattern in these areas are highly variable both in terms of total amount and its distribution, which lead to moisture stress during critical stages of crop production and makes agricultural production vulnerable to pre and post production risk. This challenge has been addressed in India through watershed development.

The India government to make the rain-fed agriculture productive, they started watershed management at the end of the 18th century. But the government supported program was fully implemented in the mid-1950.This full implementation is practiced by establishing strong central institutions, a Central Soil and Water Conservation Research and Training Institute (CSWCRTI), that coordinate eight different soil and water conservation working centers in different areas [52] and Government of India [53] linking all programs with NGO,s and Funding agencies [52], conduct operational joint research projects to validate the technologies [21], establishing watershed development fund in the national bank for agriculture and rural development [5].

The institutions also seriously supported by different ministries

like Ministry of Agriculture, the Ministry of Rural Development, the Ministry of Environment and Forest, the Indian council of Agricultural results, with the aim of watershed development is clearly reflected in the national level policy documents, namely Agricultural Development Policy, Water Policy, Land Policy, Forest Policy and 'Watershed development Guidelines towards watershed programs successfully met the initial three principal objectives of raising income, generating employment and conserving soil and water resources [14].

Recently India extensively done farm ponds to bring long lasting solution for continued drought Over a period of many centuries (between 1801 and 2002), India has experienced 42 severe droughts One of these, in 1979, cut food grain production by 20 percent; another, in 1987, damaged 58.6 million hectares of cultivated land, affecting 285 million people. In the last decade (2002-2012), three major droughts hit the country, including the one in 2012 that shaved off half a percentage point from the Asian giant's gross domestic product (GDP) (http://www.kpit.com/csr/activities/Farm-Ponnds). Therefore, pond farm is away through solution that recently performed in the agricultural land scape to harvest rain water for crop production.

Application of Ethnobotany to the Understanding and Management of Watershed

Definition and concepts of ethnobotany

The American botanist, Harshberger [54], first defined the term "ethnobotany" in 1896 as "the studies of plants used by primitive and aboriginal people" [54]. Since then, many attempts have been made to provide a descriptive definition. In broad terms, ethnobotany is the study of the relationship and interactions between plants and people [55]. It includes collaboration with disciplines such as Ecology, Chemistry, Anthropology, Economics, and Linguistics [56]. However, the amount of interdisciplinary work done in ethnobotany needs to be increased in the future [57,56] due to the growing interest of researchers from different discipline to document plant use by primitive people.

Human race has been dependent on plants both for their material needs and emotional needs since its evolution. This enables to evolve a unique system of knowledge on the utilization and conservation of plant genetic resources [58]. This plant use knowledge has several important advantages over projects that operate outside them [59]. Practically, indigenous peoples knowledge is the basis for local level decision making in agriculture, health care, food preparation, education, natural resource management and a host of other activities in rural community [60].

Application of ethnobotany for proper watershed management

Management of watershed requires all actions in watershed from small erosion control project to develop large scale restoration of the landscape. In the landscape ecology, plants have traditionally been the focus on so much research because plants are producers [61] and its knowledge influences the detailed components of watershed including soil and water conservation practices, integrated pest and nutrient management, crop diversification and livestock production [62]. Its diverse application is pronounced due to its existence at different parts of watershed i.e., upland vegetation, riparian vegetation, and wet land vegetation and intern exerts important influence up on various watershed processed [63,64] effect on erosion, hydrological processes and influence on bank stability, channel morphology and water animals. And hence the ethnobotanical study of all these plants has a lot of significance to support all actions in a given watershed.

The search for answers to many of the problems of conservation and sustainable development in developing countries requires a more holistic approaches that need to correspond more closely to the multi-dimensional realities of people's lives, acknowledgement of the knowledge and wisdom of local people and their close engagement in the identification of problems and potential solutions [65]. To accomplish these, Applied Ethnobotany, an interdisciplinary subject, is well placed to surmount the divisions imposed by the narrowness of many modern academic fields and professions concerned with human livelihoods and the environment [66]. It can also be applied for many practical purposes like land-use development, agriculture, forestry, cultural conservation, education and the development of the health food and herbal medicine industries [67].

New watershed management paradigms also emphasize that watershed management should be part of a local socioeconomic development process that focuses on multi stakeholder participation and linking social, technical and policy concerns from all sectors in a collaborative process [68].

Activities that highly demand the knowledge of ethnobotany in watershed management

Area closure in watershed management: These days, efforts are underway to replenish the denuded vegetation of Ethiopia in line with the need to cater livestock fodder and other tree products. To this effect, enclosing areas has been instrumental towards materializing the major goal; achieving conservation based sustainable agriculture. It is also a means to maintain biodiversity in the dry lands of the region within the rural community [69,70]. This alternative has gained wide acceptance, for two reasons [71]. The land now produce grass for animals and in addition it is protecting downstream areas from erosion while at the same time improving infiltration and ground water conditions, as a consequence springs re-emerging. The second reason is that this system requires lower investment as compared to community plantation areas, as it only needs a guard to protect the land, and the community to set rules and regulations though which trespassers will be punished [72].

To manage area closure in Ethiopia, the Ministry of Agriculture and Rural Development prepared a guideline in 2005 [3]. Some Ethnobotanical study like plant use by Haile and Gebrehiwot [73], medicinal plants used by the Zay people by Rainer et al. [74], wild edible plants by Giday [75] and study of useful plants by Balemie and Kebebew [76] and knowledge utilization of these and other ethnobotanical studies are highly important to perform the main core measures that should be done in a given area closure indicated by the guideline. But due to lack of strong link with the ethnobotanical research results and the watershed management office, the results have not as yet been used to reinforce the watershed management.

Apiculture in watershed management: Bareke et al. [77] indicated that integration of intermediate beekeeping technology with conservation of watershed can enhance the income of households and encourages planting of bee forages which directly contribute to sustainable watershed managements. Due to beekeeping intervention, the planting of bee forage species has increased by two folds. The attitudes of beekeepers towards watershed integrated beekeeping technology is a very important phenomenon to take into consideration for planting of multipurpose bee forage species. Many countries introduced improved beekeeping as reforestation incentives, paying special attention to plant flowering trees that provide nectar and

pollen whilst generating income for local communities from bee products Wassihun et al. [78], FAO [79], Steffan-Dewenter and Kuhn [80]. Diversification of cropping systems such as vegetables, legumes, oilseeds, and forage crops in watershed improved the rain water harvesting capacity and the impacts on environmental resources [81].

Crop varieties planted in watershed observed as major honeybee forage and important to maximize honey yield and spread the farmer's economic risk. Moreover, the crop growers benefited from the pollination services of the honeybees indirectly but not yet quantified. Application of the diverse techniques of quantitative ethnobotany can be applied here. A mixture of different weedy species maintained between crop boarders and uncultivated land of watershed contributed as major honeybee forage, rain water harvesting, watershed biodiversity conservation and climate adaption as well [82]. Therefore, for good results the above activities need proper ethnoagricultural (all traditional methods of agriculture and all activities related with agriculture where plants are involved) studies to synchronize all agricultural activities for better apiculture investment.

Gully treatment: For successful gully rehabilitation activities, different people in Ethiopia use Gabion cheek dam, sand bag and wood materials. These physical structures were also stabilized by biological means i.e., growing plants, in either part of the gully, at the bottom of physical structures, on the floor of the gully and at the bank of the gully. For effective implementation of gully treatment through biological means, ethnobotanical studies of multipurpose plants in relation with gully treatments have got many fold advantages. Different activities that need plants for gully treatments outlined by the Community Based Participatory Watershed Development Guideline [3] i.e., live check dams, reinforced bundling/wattling, layering of vegetative material, gully bed plantations and terrace stabilizations are highly demanding the knowledge of ethnobotany for better achievements.

Experiences of other countries in applying ethnobotany in watershed management

In the development of watershed analysis and management process many countries like China, India and Ethiopia revise their program from top to bottom to bottom to top management approach [3,5,13]. Similarly the American people use the native people's knowledge for watershed management. This can be presented below.

The Environmental Protection Agency's (EPA's), Office of Wetlands, Oceans, and Watersheds (OWOW) and the American Indian Environmental Office (AIEO) have collaborated on a joint project to develop a comprehensive Watershed Analysis and Management (WAM) methodology [15]. The objective is to produce a customer-tailored watershed analysis and management framework that includes geographic-specific analytical assessment methods and application techniques for addressing a wide range of environmental issues. In this guide book, plant knowledge of the tribes are properly integrated. The tribal pilot projects involving the Penobscot Indian Nation (Maine), Potawatomi Tribe (Kansas), White Mountain Apache Tribe (Arizona), and Quinault Indian Nation (Washington) provided excellent examples for applying watershed analysis in different regions of the country and using different approaches.

The Watershed Analysis and Management (WAM) process outlined with the assistance of Native Americans (who have distinctive cultural and spiritual connections to the land) is one tool that can be used to heal and restore the bonds between the community and the land. The assessment, generally relies on readily available environmental information from maps, reports, and existing databases (modern watershed assessment techniques) in combining with indigenous knowledge produced valuable insights about historical conditions, resource trends, and restoration opportunities. Tribal elders and other long-time residents can provide local knowledge about changes in watershed conditions [64].

Conclusions

Ethiopia has started watershed development to manage natural resources in the rain-fed agricultural landscape systems many years ago. This program is mainly operated to control soil and water erosion to maximize agricultural products. The pilot programs in the Abrha Atsbha natural resource management initiative in the Tigray Region has resulted best result. Since then the program were scale up and implemented in different regions and bring reasonable changes even if the extent of degradation in the Ethiopian high lands is very high. The watershed management demands consortium approach that links all functional sectors to bring sustainable landscape based development throughout the country. The program must acquire best experiences from other countries like establishing institutes which offer different field of studies that address all activities in watershed similar to China and establishing strong office to mediate funding organization, research institute and the community similar to India and also use people's knowledge to prepare watershed analysis and management similar to America. Acquiring practically tested approaches like green water credit and other scientific ones might also help the program to bring the desired change. Even though the program was come about some sort of changes, for effective management the following should be addressed by the program managers and collaborators: There should be a link between Research institutions and Universities with Ministry of Agriculture and Rural Development; To use ethno botanical research results done so far for effective watershed management; To pin point proper indicators and evaluation methods to assess the impact of all activities in the watershed; To facilitate ethnobotanical studies at different scale of watershed and apply the result in watershed management and related areas and To evaluate and adopt new technologies (Green Water Credit (GWC).

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References

1. Bach H, Clausen T, Dang T, Emerton L, Facon T, et al. (2011) From local watershed management to integrated river basin management at national and transboundary levels. Mekong River Commission, Lao PDR.
2. Achouri M (2002) Forests of water towards effective watershed management: international expert meeting on forests and water from 22 -22 November, shiga. Japan forestry officer, forestry department.
3. Desta L, Caurcci V, Wendem AA, Abebe Y (2005) Community Based Participatory watershed development: A guideline. Ministry of Agriculture and Rural development, Addis Abeba, Ethiopia.
4. Rockstrom J, Barron J, Fox P (2003) Water productivity in rain-fed agriculture: Challenges and opportunities for smallholder farmers in drought prone tropical agro-ecosystem. In: Kijne JW, Barker R, Molden D (eds.) Water Productivity in Agriculture: Limits and Opportunities for Improvemen.t CABI Publishing, Wallingford, UK, pp. 145-162.
5. Sharma R, Joshi MM, Dala SK, Haridas CK (2001) Foreward. In: Watershed at Work. Department of Agriculture and Co-operation, Ministry of Agriculture, Government of India, New Delhi.

6. Bishaw B (2001) Deforestation and land degradation in the Ethiopian high lands: A strategy for Physical recovery. Northeast African Studies 8: 7-25.

7. Ethiopia's Climate-Resilient Green Economy (2011) Federal Democratic Republic of Ethiopia (FDRE). Green economy strategy, pp. 2-114.

8. AMAREW (2007) Amhara Micro-enterprise development, Agricultural Research, Extension, and Watershed management (AMAREW) Project Terminal Report July 2002-December 2007.

9. Tadesse N, Bheemalingeswara K, Abdulaziz M (2010) Hydrogeological Investigation and Groundwater Potential Assessment in Haromaya Watershed, Eastern Ethiopia. MEJS 2: 26-48.

10. Wolka K, Moges A, Yimer F (2010) Farmers' perception of the effects of soil and water conservation structures on crop production: The case of Bokole watershed, Southern Ethiopia. African Journal of Water Conservation and Sustainability 1: 071-080.

11. Addisu S, Goshu G, Selassie GY, Tefera B (2013) Evaluation of Watershed Development Plan and Technology Adoption Level of Farmers in Amhara Region, The case of SWHISA Project, Ethiopia. International Journal of Scientific and Research Publications 3: 1-10.

12. Kauffman S, Droogers P, Hunink J, Mwaniki B, Muchena F, et al. (2014) Green Water Credits –exploring its potential to enhance ecosystem services by reducing soil erosion in the Upper Tana basin, Kenya. International Journal of Biodiversity Science, Ecosystem Services and Management 10: 133-143.

13. Lixian W (2002) Theory and Practice of Watershed Management in China. Beijing Forestry university, 100083, Beijing.

14. Joshi P, Pangare V, Shiferaw B, Wani S, Bouma J, et al. (2004) Socioeconomic and Policy Research on Watershed Development in India: synthesis of past experience and needs for future. Ind J Agri Econ 59: 303-320.

15. Barbour M, Brossman M, Caldwell J, Chen S, Currie J, et al. (2002) Watershed Analysis and Management (WAM) Guide for States and Communities. Seattle 357.

16. Randhir TO (2007) Watershed Management Issues and Approaches. IWA Publishing, p. 146.

17. Bekele S, Lemperiere P, Tulu T (2009) Training Manual on agricultural water management. Improving Productivity and Market Success (IPMS) of Ethiopian farmers project. International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia.

18. Borah D, Bera M (2004) Watershed-scale hydrologic and nonpoint-source pollution models: review of applications. American Society of Agricultural Engineers 47: 789-803.

19. Kallenbaugh B, Lantin A, Taylor S, Craig R, Burke M (2008) Watershed management integrating people, land and water.

20. Evans A, Giordano M, Clayton T (2012) Investing in agricultural water management to benefit smallholder farmers in Ethiopia. AgWater Solutions Project country synthesis report. IWMI Working Paper, International Water Management Institute, Colombo, Sri Lanka, p.152.

21. Paul DK (1997) Rain-fed farming system development in India: retrospect and prospect. In: Katyal JC, Farrington J (eds.) Research for rain-fed farming. Overseas Development Institute, London.

22. Farrington J, Tutton C, James AL (1999) Participatory watershed development: Challenges for the Twenty- First Century. Oxford University Press, New Delhi 61: 382.

23. Kerr J (2002) Watershed development, environmental services, and poverty alleviation in India. World Development 30: 1387-1400.

24. FAO, World Bank (2001) Farming systems and poverty. Improving farmers' livelihoods in a changing world. FAO and World Bank, Rome and Washington, DC.

25. Drake K, Hogan M (2013) Watershed management guide book: a guide to outcome-based watershed management. Integrated Environmental Restoration Services Inc. Publication, p. 300.

26. Falkenmark M (1995) Land-water linkages. FAO land and water bulletin, Rome, pp. 15-16.

27. Hunink JE, Niadas IA, Antonaropoulos P, Droogers P, de Vente J (2013) Targeting of intervention areas to reduce reservoir sedimentation in the Tana catchment (Kenya) using SWAT. Hydr Sci J 58: 1-15.

28. Neitsch SL, Arnold JG, Kiniry JR, Williams JR, King KW (2002) Soil and water assessment tool (SWAT). Theoretical documentation, version 2000. College Station (TX): Texas Water Resources Institute.

29. Droogers P, Hunink J, Kauffman S, Van Lynden G (2011) Costs and benefits of land management options in the Upper Tana, Kenya: using the water evaluation and planning system– WEAP. Green Water Credits report: ISRIC –World soil information.

30. Campbell J (1991) Land or Peasants? The Dilemma Confronting Ethiopian Resource Conservation. African Affairs 90: 5-21.

31. World Bank (2006) Ethiopia: Managing Water Resources to Maximize Sustainable Growth: Water Resources Assistance Strategy, p. 119.

32. FAO (1998) Ethiopia: Soil Fertility Initiative, Concept Paper, Investment Centre Division of the Food and Agriculture Organization, Rome.

33. Sonneveld B (2002) Land under pressure: Impact of water erosion on food production in Ethiopia. Netherlands Shaker publishing.

34. EPA (Environmental Protection Authority of Ethiopia) (1997) The Conservation Strategy of Ethiopia. Addis Ababa.

35. Hurni H (1988) Degradation and Conservation of the Resources in the Ethiopian Highlands". Mountain research and development 8: 123-130.

36. MoWR (Ministry of water Resource) (2002) Water Sector Development Program. Report, Addis Ababa.

37. Sida L, Gray B, Asmare E (2012) IASC Real-time evaluation of the humanitarian response to the horn of Africa drought crisis-Ethiopia. Interagency Standing Committee.

38. Tongul H, Hobson M (2013) Hunger Nutrition and Climate Justice A New Dialogue: Putting People at the Heart of Global Development, 15-16 April Dublin, Ireland.

39. MoWR (Ministry of Water Resources) (2002) National Water Supply and Sanitation Master Plan. Interim Master Plan, DHV Consultants BV and DHV Ethiopia. Addis Ababa.

40. Zewdie A (1994) Water Resources Development in Ethiopia: An Evaluation of Present experience and Future Planning Concepts. Reading. Ithaca Press.

41. Grey D, Sadoff C (2002) Water Resources and Poverty in Africa: Essential Economic and Political Responses. Paper presented at the African Ministerial Conference on Water, Abuja, Nigeria, April 29-30.

42. Salman SMA (2013) The Nile Basin Cooperative Framework Agreement: a peacefully unfolding African spring?. Water International 38: 17-29.

43. Solomon S, Seleshi B, Molden D, Aster D (2012) Spatial characterization of the Nile Basin for improved water management.

44. Seleshi Bekele A, Vladimir S, David M, Don (2012) The Nile River Basin Water, Agriculture, Governance and Livelihoods. New York.

45. Mohamed YA, Loulseged M (2008) The Nile Basin Water Resources: Overview of key research questions pertinent to the Nile Basin Initiative. (IWMI Working Paper 127) International Water Management Institute, Colombo, Sri Lanka, p, 34.

46. EthiOCAT (Ethiopian Overview of Conservation Approch and Technology) (2010) Sustainable land management technologies and approach in Ethiopia. Addis Ababa, p. 320.

47. FAO (Food and Agriculture Organization) (1986) Highlands Reclamation Study, Ethiopia, Final Report, Vol. I, Rome.

48. Admassie Y (1995) Twenty Years to Nowhere. Department of Sociology, Uppsala University, Uppsala.

49. Chisholm N, Woldehann T (2012) "Managingwatersheds for resilient livelihoods in Ethiopia" In.

50. OECD, Development Co-operation Report. Lessons in Linking Sustainability and Development. OECD Publishing.

51. Kerr J, Pangare V, George P (2001) "Sustainable Agriculture and Natural Resource Management in India's Semi-Arid Tropics". In: Lee D, Barrett C (eds.) Trade offs or Synergies?

52. Shiferaw B, Kebede T, Reddy V (2008) "Community Watershed Management in Semi-Arid India: The State of Collective Action and its Effects on Natural Resources and Rural Livelihoods". CAPRi Working Paper, No. 85, International

Food Policy Research Institute, Washington, DC. United Nations Environment Program (UNEP) and International Water Management Institute.

53. Sutter P (2012) MERET Impact Evaluation Report. Technical Assistance to NGOs. TANGO.
54. Samara JS (1997) Status of research on watershed Management, centeral soil and water conservation Research and Training Institute, Dehradun.
55. Harshberger JW (1896) Purposes of ethnobotany. Botanical Gazette 21: 146-154.
56. Government of India (2001) Mid-term Appraisal of Ninth five year plan. Planning commission, New Delhi.
57. Balick MJ (1996) Cox AP. Plants, people and culture. The science of ethnobotany Scientific America Library, New York, USA.
58. Prance GT (1991) what is ethnobotany today? Journal of Ethnopharmacology 32: 209-216.
59. Martin GJ (1995) Ethnobotany: A conservation manual. Chapman and Hall, London.
60. http://www.fao.org/docrep/article/wfc/xii/0613-b1.htm
61. Indigenous knowledge (1992) Biodiversity conservation and development. Keynote address at the International Conference on Conservation of Biodiversity in Africa: Local Initiatives and Institutional Roles, 30 August-3 September, Nairobi, Kenya.
62. Nimachow G, Joshi R , Dai O (2011) Role of indigenous knowledge system in conservation of forest resources – A case study of the Aka tribes of Arunachal Pradesh. Indian Journal of Tradational Knowledge 10: 276-280.
63. Young KJ (2007) The Green World. Info base Publishing, New York, p. 121.
64. Wani SP, Garg KK (2008) Watershed management, concept and principles. International Crops Research Institute for the Semi- Arid Tropics (ICRISAT) Patancheru 502 324, Andhra Pradesh, India.
65. Currie J (2000) Watershed Analysis and Management (WAM) Guide for Tribes, p. 369.
66. Rios SL, Bailey RC (2006) Relationship between riparian vegetation and stream benthic communitiesat three spatial scales. Hydrobiologia 553: 153-160.
67. Cunningham AB (2001) Applied ethnobotany. People, wild plants use and conservation. Earthscan publication ltd., London and Sterling.
68. Hamilton AC, Shengji P, Kessy J, Khan AA, Lagos-Witte S, et al. (2003) The purposes and teaching of Applied Ethnobotany. People and Plants working paper 11. WWF, Godalming, UK.
69. McClatchey W, Alexandra P, Flaster T, McClatchey V (1999) An evaluation of educational trends in Economic Botany.
70. FAO (2006) The new generation of watershed management programs and projects. FAO Forestry Paper 150. Food and Agriculture Organization of the united nations, Rome.
71. Birhane E (2002) Actual and Potential Contributions of Enclosures to Enhance Biodiversity in Drylands of Eastern Tigray, with Particular Emphasis on Woody Plants. SLU (Swedish University of Agricultural Sciences).
72. Gebrehiwot K (2003) Ecology and Management of Boswellia papyrifera (Del.) Hochst dry forests in Tigray, northern Ethiopia. George –August Universität, Göttingen.
73. Gebrehiwot K (2004) Dry land agroforestry strategy for Ethiopia. Dry lands Agroforestry Workshop 1st-3rd September. ICRAF Headquarters, Nairobi-Kenya.
74. Haile M, Gebrehiwot K (1997) Opportunities and constraints for afforestation in Tigray: the case study of Dega Tembien. Paper presented at the 13th International Ethiopian Studies, 13-14 Dec, okyo, Kyoto, Japan.
75. Rainer W, Paul S, Worede A, Paul E (2011) Plant use in Odo-Bulu and Demaro, Bale region, Ethiopia. Journal of Ethnobiology and Ethnomedicene 7: 1-28.
76. Giday M (2001) An ethnobotanical study of medicinal plants used by the Zay people Ethiopia.-CBM: sskriftserie 3: 81-99.
77. Balemie K, Kebebew F (2006) Ethnobotanical study of wild edible plants in Derashe and Kucha Districts, South Ethiopia. J Ethnobiol Ethnomed 2: 1-9.
78. Bareke T, Wakjira K, Addi A (2014) Investigating the role of apiculture in watershed management and income improvement in Galessa protected area, Ethiopia. Agriculture, Forestry and Fisheries 3: 380-385.
79. Wassihun B, Asfaw Z, Demissew S (2003) Ethnobotanical study of useful plants in Daniio Gogde (Home-Gardens) in southern Ethiopia. Ethiop J Biol Sci 2: 119-141.
80. FAO (2003) Food and Agriculture Organization of the United Nations Rome State of the World's Forests.
81. Steffan-Dewenter I, Kuhn A (2003) Honeybee foraging in differentially structured landscapes. In B-Biological Sciences. Proceedings of the Royal Society of London Series 270: 569-575.
82. Decourtye A, Mader E, Desneux N (2010) Landscape enhancement of floral resources for honey bees in agroecosystems. Apidologie 41: 264-277.
83. Adugna W (2002) Genetic diversity analysis of linseed under different environments. PhD thesis, Department of Plant Breeding, Faculty of Agri. University of the Free State, Bloemfontein, South Africa.
84. Kumsa T (2014) Integrating Improved Beekeeping as Economic Incentive to Community Watershed Management: The Case of Sasiga and Sagure Districts in Oromia Region, Ethiopia. Agriculture, Forestry and Fisheries 3: 52-57.