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Original Research

Assessment of Hydroelectric Dam and Its Effects on Forests and Rural Livelihoods: The Case of Fincha-Amarti-Nashe, Ethiopia

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Abstract

The study was aimed to assess the effects of the Fincha-Amarti-Nashe hydroelectric dam on residents' livelihoods and forests, as well as suggesting potential solutions. A qualitative research approach with two-stage sampling techniques were deployed to select samples for the study. Simple statistical analysis was used to analyze the data collected from sampled households and development agents from the sub-watershed. The findings indicated that the main cause of the forest's decline was the lack of grazing areas since the neighboring hydroelectric power plant occupied most of their agriculture and grazing lands to accumulate water. As a result, farmers were forced to extend their grazing and farming areas towards the forests. According to the farmers' responses, the dam affected their grazing pasture, and consequently, the production of meat, milk, and other has considerably decreased. The scheme's management must acknowledge the issues and devise a long-term plan of action that stabilizes and sustains their way of life. Moreover, the nation's water resource initiatives, including the building of hydropower dams, need extensive environmental monitoring.

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INTRODUCTION

Electricity will continue to be necessary for decades to come in developing nations like Ethiopia due to rapid urbanization and population growth. For this reason, electricity is still essential for enhancing the lives of millions of impoverished people in these nations (Egré & Milewski, 2002). Hydropower is the primary source of electricity in many nations, including Ethiopia, even though energy is produced from a variety of sources (Mitigation, 2011). The main goals of dam construction are flood control, irrigation, energy production, and water supply (Dixon *et al*., 1989). There are other linked environmental and social consequences in addition to these direct advantages; some of these effects are benefits, but they are more likely to be costs (Dixon *et al*., 1989). Reservoir growth worldwide has been justified by the historical assumption that the economic advantages of reservoirs outweigh their costs (Liu & Speed, 2009), as quoted in (Okuku *et al*., 2016).

Nevertheless, it has not yet been considered how these initiatives may affect residents' lives and forest resources negatively (Kraljevic *et al*., 2013). Building of hydroelectric dams has significant negative effects on the environment, there is a surprising diversity in the negative social and environmental effects that can arise from these dams (Ledec & Quantero, 2003). The most significant effects are typically brought about by the reservoir's and dam's long-term existence and functioning, albeit some only happen during construction. According to Tejaswi (2007),

decisions that have a direct impact on the livelihoods of indigenous people and local communities are usually made without considering their individual and collective rights to forest resources.

Ethiopia has enormous potential as a major supplier of sustainable energy in the form of hydropower (Kedanemariam & Mishra, 2013). Among the rivers of this country, Fincha River is a river which has a vast potential to be a multipurpose dam that could store water for irrigation, power generation, and recreational uses in addition to fisheries (Asefa, 2016). In 1973, the Fincha Dam was built. The Fincha watershed refers to the entire region that empties into this dam. When the watershed was first constructed, it consisted of a network of hilly plateaus with various streams and sporadic rivers feeding pasture ground in the center, which was originally flooded. An area of around 100 km^2 was drowned by the lake that was created when the dam was completed, but a few years later, the area grew to about 149 km^2 (Assefa, 1994), a second dam was built to span the Amarti-Nashe River, which ran parallel to the Fincha River. A total of 431 km^2 of the watershed region were occupied by water and an extra 331 km^2 of grazing and agricultural area were submerged by the program according to Olana (2006).

Even though, the area coverage of the dam is increasing considerably, the consecutive impacts on other surrounding land uses and coverages like forest lands and on the livelihoods of the society have not been researched. Therefore, the purpose of this study was to assess the impacts of Fincha-Amarti-Nashe dam on forests and the lively hoods of the local peoples.

RESEARCH METHODOLOGY

Description of the Study Area

Location of the Study Area

The Fincha-Amarti-Nashe dam is situated in the Fincha watershed, western region of Ethiopia, along the longitude lines of 37º 3' to 37º28'30" E and latitudes of 9º10'30" to 9º46'45" N (Figure 1). In administrative terms, it is situated in Horro/Guduru Wallaga zone, Oromia region, western Ethiopia. Fincha watershed is situated in the Blue Nile River Basin, 310 kilometers northwest of Addis Ababa. It drains parts of the districts Abbayyii-Coomman, Jimmaa-Gannatii, Jimmaa-Raaree, Guduruu, Hababo Guduru, Jardaga Jarte, Horro-Buluk, Cooman Guduru and Horro (Tessema & Semane, 2019).

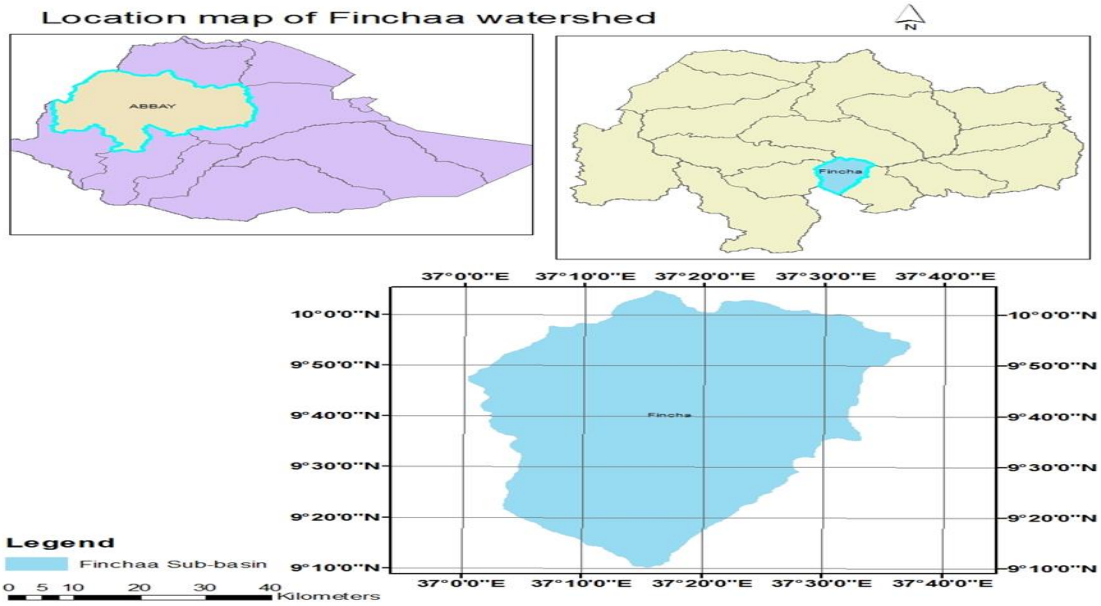

Figure 1. Location map of Fincha watershed

Rainfall and Soil Type

The average annual rainfall in the region is roughly 1350 mm (Asefa, 2016), and the terrain of the dam is on a valley height with neighboring mountains reaching above 2500 meters (Above sea level). Around the watershed, clays and haplic luvisols make up most of the soil in the Fincha-Amarti-Neshe catchment. Because of its varied mineralogy, comparatively high nutrient content, and presence of weather able minerals, luvisols soil is often considered fertile. This kind of soil makes up most of the agricultural lands in the watershed (Asefa, 2016).

Methods of Data Collection

The data needed for this study was gathered through conducting survey by distributing questionaries and asking oral questions. In addition, all needed supportive were collected from secondary data sources such as published articles and books.

Sampling Method

Two-stage sampling techniques were used to select samples from Fincha-Amarti-Nashe watersheds. Firstly, purposive sampling method were used to select sub-watersheds from the Fincha-Amarti-Nashe watersheds. In this case, four sub-watersheds, were selected by using their relative proximity to the reservoirs as selection criteria. Accordingly, Jabel, Didibe-Kistana, Cheneni, and Malka were the chosen sub-watersheds. In a similar vein, four (4) development agents with more

substantial on-the-ground experience in the watersheds were deliberately chosen.

Secondly, from the households living in the selected sub-watersheds, households having residency home closer to the water reservoirs and within the radius of 500m from the edge of water body and relatively living closer to water reservoirs were identified. This selection criteria were used by the reason that the impacts of the schemes are more severe for society living adjacent to the schemes than others. Accordingly, 17 households, were selected from Jabel, 15 households from Didibe Kistana, 14 households from Cheneni and 24 households from Malka sub-watersheds. Accordingly, the total 68 households were chosen.

Method of Data Analysis

Simple statistical analysis was used to analyze the data collected from sampled households and development agents from the sub-watershed. Accordingly, Descriptive statistics such as cross tabulation and percentages were used to analyze the data collected by using questionaries and asking oral questions.

Research Approach

Qualitative research approach was employed in the study since qualitative research approach is by its nature aimed to understand the social reality of individuals, groups, and cultures as nearly as possible and the approach involves the process of collecting, analyzing, and interpreting non numerical data. This research approach is compatible with the nature of data, data collection method, way of analysis and interpretation used in the study.

RESULTS AND DISCUSSION

The Adverse Effect of the Dam on Forest

The result of descriptive analysis shown that 29.16% of the respondents said the primary cause of the forest's depletion is the lack of grazing areas (Table 2), The majority of the respondents strongly argued that the neighboring hydroelectric power plant have been occupying many of their farms and grazing for the water impoundment (Table 1). These farmers were cleared the surrounding vegetation and started cultivating the land. Together with the farmers' answers to our inquiries about the reasons behind deforestation, we also noticed that the watersheds were severely damaged. There are very few remaining trees, which indicates that human activity has had a profoundly detrimental effect on the resource.

Since many forestlands have been turned into dam bodies, the construction of dams frequently causes significant changes in land use and negatively affects forest resources (OADB, 1996). According to the study of Olana (2006), between 1957 and 2001, more than 1.2 km^2 of the forest was transformed into waterbodies, representing a net loss of 46% in 44 years. A 95% of responders who were orally questioned claimed that these watersheds had extremely dense trees, but that everything was severely deteriorated once the dam was built, to the point that we can no longer even claim that our watersheds have woods. We were aware of the extent of the devastation of the watersheds' forest resources during our fieldwork. The degree of deforestation is shown by the small patches of shrubs and bushes in each of the three watersheds and the scattered little fragments of multipurpose trees and shrubs located close to the dam.

Farmers were heavily involved in increasing their farmland due to a lack of other means of income, which was another significant factor in the depletion of forest resources. Furthermore, people who live in these watersheds use resources for different purposes, such as fuel wood, charcoal, construction material, farm equipment, and furniture on a larger scale.

Table 1. The response of farmers on the impacts of the dam on forests, agricultural lands, and grazing lands

No	Questions	Possible impacts of the dam	Frequency	Percentage (%)
1,	What are the negative impacts of the dam on the environment?	Forest degradation, deforestation	18	25
		Loss of agricultural lands	21	29.16
		Loss of grazing land	19	26.38
		Loss of residential areas	12	16.66
		Others	2	2.77
2	What are the positive impacts of the dam?	Creation of job opportunity	14	19.44
		Electric utility	19	26.38
		Fishery	10	13.88
		Others	8	11.11
3	The negative impacts of dams on social and cultural aspects	Nothing	21	29.16
		Avoiding them not to interact with their relatives and neighbors	30	41.66
		Lack of road to rich religious institutions and to undertake social and cultural activities such as, '*Idir*, 'Iqub**', weddings, funerals, and others	36	50
		Others	6	8.3

** Iqub (also spelled iquib or equb) is a traditional means of saving in Ethiopia and exists completely outside the formal financial system.*

** Idir is a traditional social gathering in the form of an association which assists at the time of burial ceremonies*.

Cultivation and Grazing Lands

The presence of the hydroelectric dam resulted in the loss of the agricultural and grazing lands of the watersheds, just like it did for the forests. According to the findings, 26.38% of the respondents that, the dam was affected their grazing pasture. The products from livestock has declined as they have not been given compensatory grazing lands. However, farmers were heavily involved in growing their farming and grazing fields since they had no other source of income. Consequently, the farmers have started to develop the land by clearing the existing flora, and their livestock have been grazing in the forest (Table 2). In agreement with the farmers' response, the field survey report by Assefa (1994) revealed that, the Abbay Chomman district's farmland area grew from 403.3 km^2 in 1957 to 478.8 km^2 in 1980 and 607.1 km^2 in 1985 because of deforestation. Due to farmers' expansion of their croplands to other areas, or, to put it another way, the conversion of formerly covered lands by forests, grazing fields, and other land uses into croplands, there was a net increase of 50.6% over 44 years in 2001

(Olana, 2006; Asefa, 2016). (Table 2). The hydroelectric dam's main negative consequences on the environment, forests, and other land uses are depicted in the table below.

Table 2. Land-use change due to Fincha-Amarti-Nashe hydropower dam.

Former land use	Current land use	Direct impact	Indirect impact
Forest	-Agricultural land and grazing land -roads -Tunnels and other components of the project -Water reservoir	-Loss of biodiversity -Soil erosion -flooding -Loss of wildlife habitat -Land degradation -Loss of timber and non-timber forest products	-Reduced agricultural productivity -Disturbance of the water cycle -Climate change -Increased local and global temperature
Agricultural land	-Water reservoir -Roads, tunnels, and or other components of the projects	-Reduction of farmland - Reduction of Agricultural production -Reduction of household and national income	-Food insecurity -Malnutrition
Grazing land	-Water reservoir -Roads, tunnels, and or other components of the projects	-Loss of forage -Reduction of livestock number and their products -Reduced household and national income	- Food insecurity -Malnutrition - Lack of animal power for tillage and transportation

Impact of the Dam on the Lively hoods of Local Peoples

Abebe (2014) claims that dams frequently deal with social and environmental problems. Urban residents generally benefit from the dams, but the large community surrounding the projects frequently has challenges in maintaining their standard of life, including food insecurity and other effects on their physical, cultural, and spiritual well-being (Asefa, 2016; Juss et al., 2014). The Fincha-Amarti-Nashe hydroelectric dams negatively impacted their socioeconomic activity, as 91.66% of the study participants confirmed (Table 1). About 70% of the farmers in the watersheds claimed that changes in the area's employment and production systems occurred during the hydroelectric plant's construction. Some young people were given the chance to work on the project part-time, but the pay was inadequate, so as a result, it imposed an adverse impact on agricultural production.

Social and Environmental Problems of the Dam

Reservoirs have the potential to submerge or destroy cultural goods, such as archeological, historical, paleontological, and religious sites and artifacts (Beck, *et al*., 2012; Tilt & Gerkey, 2016). Farmers who reside in their original homes and migrate into the towns due to water reservoirs taking up their agricultural land exacerbate urbanization in the towns located close to watersheds (Juss et al., 2014). The construction of hydroelectric dams has resulted in serious environmental problems (Kraljevic *et al*., 2013). As a result, there are several social repercussions of deforestation; for indigenous tribes, "civilization" typically implies the end of their traditional way of life and the dissolution of their social structures. Nobody can dispute the requirement to conduct an environmental and social impact assessment before initiating any developmental project and to put the best plans in place to eliminate or significantly reduce any potential negative effects on the environment and the way of life for the communities residing near the dam (Abebe, 2014).

Numerous watersheds within the dam lack access to clean water, decent roads, electricity, and other infrastructure (Assefa, 1994). Since the project mistreated them, farmers have voiced grievances against the government and project management. Furthermore, many of the residents of the surrounding community stated that until the situation is resolved, they are not willing to see the project there. Flooding and other hazards that could jeopardize the farmer's survival are also associated with the Fincha Dam. Accordingly, the research conducted by (Regasa & Jabir, 2019) found that the dam was extremely vulnerable to the possibility of a breach failure since the peak discharge by overtopping mode is 8761.23 m^3/sec, which is 7.33 times greater than the likely maximum flood of 1196 m^3/sec.

Hydropower Dam and Compensation

Concerns over the committee's compensation procedure have been voiced by farmers. The assessment and payment were not appropriate and occasionally overestimated for the farmers who were related to the members of the compensation committee, but their land was undervalued and insufficient for the mass victims. Furthermore, while they too experienced hardships because of the project, many farmers who believed they had no property rights over the flooded area despite owning a portion of the common lands used by the project were not included in the compensation. The research conducted by (Olana, 2006; Asefa, 2016) made it abundantly clear that only a small percentage of landlords received compensation for the loss of tangible assets including land, homes, and trees. Because the process was halted by the land reform of 1975, which transferred private land ownership to the state, most landlords were unable to receive fair compensation.

The farmers claimed that because of excess and poor management, even a few of the farmers who had received compensation had already spent all their money. The relevant authority failed to educate the public about responsible financial management and how to invest in businesses that can provide long-term employment for their families. Many participants in this research stated that, whenever they engaged in commerce, intermediaries cheated them. Indeed, it is difficult to shift from farming activity to trading in a short period, as farmers dwelling in these watersheds have suffered. Because of this, even the prices of houses in nearby cities have shown considerable increase. In line with this, the results of the study by (Chandy *et al*., 2012) confirm that the construction of dams brings disturbance and instability on the socio-economy of society. The short-term job opportunity creation solely did not solution to reduce the negative economic impacts of nearby dam on the rural community around (Chandy *et al*., 2012).

Hydro-electric Dams and Displacement of People

It has been shown by various academics that while dams are a desirable development goal, the people whose homes, farms, and surrounding areas are submerged find it difficult to accept (Chandy *et al*., 2012). Because the study's primary focus was on farmers' responses, the precise number of displaced persons from the study area could not be determined. On the other hand, 14% of the survey households were moved from their native villages between 1973 and 1995, according to a similar study carried out in the study region (Abebe, 2014; Asefa, 2016). One of the biggest negative societal effects of hydroelectric projects is frequently forced relocation. Significant environmental problems could also result from this, such as the alteration of natural habitats to make room for rural people who have been resettled (Ledec & Quintero, 2003).

CONCLUSION AND RECOMMENDATION

For nations like Ethiopia, hydroelectric dams are essential to developing their green economies. Aside from improved agricultural production and irrigation systems, significant industrial development has resulted from increased electricity generation. In Fincha watershed, three water reservoirs were built to accumulate water mainly for the purpose hydro-electric generation and irrigation of sugarcane to produce sugar. From the schemes establishment and up to now the surface area of the water reservoirs is increasing in a fastened manner. Consequently, the farmers have been strongly arguing that, the neighboring hydroelectric power plant have been occupying many of their farms and grazing for the water impoundment. As a result, farmers were heavily involved in increasing their farmland due to a lack of other means of income, which was another significant factor in the depletion of forest resources. The farmers' deforestation to expand agricultural lands resulted in the loss of biodiversity, products, and services from forests, land degradation, a decrease in agricultural production, and consequently in income for the farmers and the country's economy. Environmentally, culturally, and socio-economically, the project have been negatively impacted the local communities. Even though they needed a solution to continue living, the farmers in the watersheds claimed that the government had disregarded them and had done little or nothing to help.

This study proposes the following recommendations and potential solutions:

- ✓ Farmers should look for other sources of income outside agriculture as much as possible
- ✓ The administration of the woredas found in Fincha watershed should support and facilitate planting of trees on damaged fields.
- ✓ By including the farmers in the watershed, all relevant entities need to work on initiatives to conserve water and soil.
- ✓ The agricultural office of the woreda ought to nurture seedlings of multipurpose tree species, such as fruit trees, and provide them to farmers.
- ✓ Fincha-Amarti-Nashe hydroelectric power administration ought to assist in the development of infrastructure inside the watersheds.
- ✓ All parties involved in the watershed must take part and look for a solution to improve the quality of life for the local population.
- ✓ The scheme's administrators need to acknowledge the issue and devise a long-term plan of action that will assist the people, stabilize them and preserve their quality of life.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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