

# Assessment of Natural Resources in Ketech Watershed, East Gojjam Zone of Amhara National Regional State, Ethiopia

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**Abstract:** A study was conducted in Machakel wereda, East Gojjam Zone of Amhara National Regional State, Ethiopia to assess the current status of natural resources in Ketech watershed. Purposive sampling methods were used to select kebeles (districts), and the respondents were selected randomly. A sample of 100 respondents from three kebeles (districts) was used in the study. The result revealed that 78% of the respondents said Ketech watershed is under high pressure, but 22% of the respondents disagree. Major threats to Ketech watershed were deforestation, overgrazing, agricultural land expansion, flooding and consequent gully formation, and their combined effects. The Pearson correlation also indicated the effect one variable has on the other, indicating a possible conservation measures to be taken in the studied kebeles. Logistic regression analysis predicted two variables (income generating activities and status of exploitation of common resources) to have a significant effect on respondents' decision about the status of ketech watershed. A holistic approach to landscape conservation measures are highly needed so as to halt the ongoing environmental degradation.

**Keywords:** Watershed, Environmental Degradation, Natural Resources

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## 1. Introduction

Natural resources are the main actors of an ecological balance that needs to be protected and used in a sustainable way. Watershed, an area that drains to a common outlet [9], as being one of the natural resources, serves a different purpose *vis - a - vis* source of water for animals, human, agricultural activities, habitat for animals, plants, microorganisms and ecological balance. However, both natural and anthropogenic factors are threatening its existence in many parts of the world. Soil erosion, changes in farming systems, excessive abstraction of water, over grazing, deforestation and pollution are the major causes of changes in watershed [9]. According to [11], watershed degradation in Ethiopia is one of the main constraints for agricultural productivity, caused by both human and natural phenomena, including erratic rainfall, rugged topography and unsustainable land management practices, both in areas of food crops and in grazing lands.

In the worst scenarios, it can also be a cause for social problems. This study was, therefore, conducted to assess the status of natural resources in ketech watershed and make current information available for conservation interventions.

## 2. Methodology

### 2.1. Study Area

Machakel Wereda is found in East Gojjam Administrative Zone of Amhara National Regional State, Ethiopia. Geographically the Wereda is located at 10° 19' 75" to 10° 41' 00" N latitude and 37° 16' 46" to 37° 45' 42" E longitude. It is 330 km from Addis Ababa and has an altitude range of 1500-3800 m.a.s.l., with average temperature of 27°C and 1500 - 1800 mm annual rainfall [16]. Machakel Wereda is divided into 24 rural Kebeles (districts), with a total population of 118,097 [8].

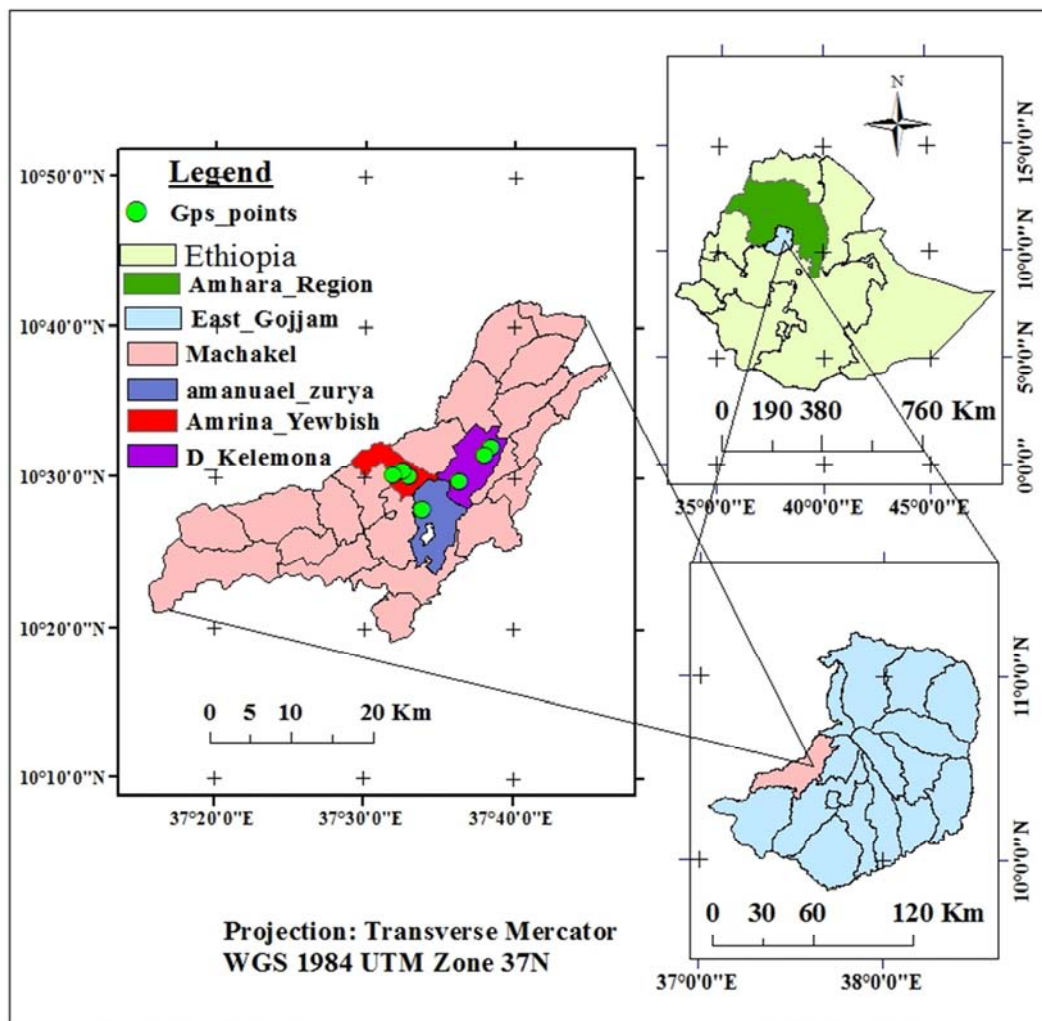


Figure 1. Map of the study Area.

## 2.2. Data Collection

Purposive sampling methods were used to select Kebeles (districts), whereas the respondents were selected randomly. A sample size of 100 respondents from three districts was used in the study. Data were collected through group discussion with key informants and individual farmer interview using semi structured questionnaires. The study area was mapped with ArcGIS [4].

## 2.3. Statistical Analysis

The data was analyzed using [21] and descriptive statistics was used to estimate the frequencies of the respondents. To assess a statistical significance of comparisons of different variables, Pearson's Correlation was used. In addition, binomial logistic regression was also used to predict factors that influence respondents' decision of state of Ketech watershed. Whether a respondent leveled Ketech watershed as pressured or not was framed in a binary choice model. Assuming  $y$  to represent a dichotomous variable that equals 1, if the respondent leveled the watershed as pressured and 0 otherwise. The model of the probability of levelling the

watershed as pressured or not,  $P(y_i=1)$ , was represented as:  $\ln [P(y_i=1)/1-P(y_i=1)] = \beta_0 + \beta_1 (\text{Marstat}) + \beta_2 (\text{Ingenact}) + \beta_3 (\text{Status}) + \beta_4 (\text{Rules}) + \beta_5 (\text{Threats}) + \beta_6 (\text{Edusta})$ .

## 3. Result

### 3.1. Socioeconomic Characteristics of the Respondents

The study was conducted in east Gojjam zone, Machakel wereda in three selected kebeles, namely: Debre kelemu, Amari and Amanuel zuria where by 35, 33, and 32 people in each kebeles were interviewed, respectively. Out of the total 100 people interviewed, 75% were males and 25% were females. 95% of respondents were married, 1% was single, 1% was divorced and 3% were widows. The respondents' age is categorized into 5 groups. 18% of the respondents were found in the age group between 25 and 34, 31% of the respondents were in between 35 and 44, 26% of the respondents were found in age group between 45-54, 17% of the respondents were found in age group between 55-64, and 8% of the respondents belonged to age group between 65-74 years. The educational status of the

respondents was categorized as illiterate, informal schooling, elementary, and high school with the values of 32%, 47%, 19%, and 2%, respectively. The number of household members of the respondents ranged from 2 to 12, with average value of 5.84. 90% of the respondents say that they are a member of an organization working on environmental issues but the remaining 10% didn't join any organization. 75% of the respondents are living closer to the watershed which takes them only 30 minutes or less by walk, 18% of them live at a distance that takes them 30 minutes to an hour, and the remaining 7% are living far away from the watershed which takes them 1 to 2 hour walk to get to the watershed. The livelihoods of most of the respondents (67%) depend on farming, animal production (9%), and both farming and animal production (24%). Respondents are getting the following services from the Ketch watershed, i.e. water supply (32%), source of fuel wood (24%), animal feed (29%) and medicinal plants (15%) used as remedies for both human and animal diseases. The major threats in the Ketch watershed were identified by the respondents as deforestation (13%), overgrazing (18%), agricultural land expansion (26%), flooding/gully formation (31%), and a combination of all these (8%), but 4% of the respondents said there is no threat at all. 78% of the respondents agreed that Ketch watershed is under high pressure, while 22% of them oppose this idea. 83% of the respondents said that groundwater is the source of Ketch watershed, but the other 17% said the source is different tributaries coming from the high lands. On the other side, they were also asked to list the different reasons how water is lost from the watershed, and they listed them as irrigation (47%), siltation (12%), evaporation during the dry season (10%), a combination of irrigation and siltation (29%), and all together (2%).

### 3.2. The Diverse Natural Ecosystems of the Study Area

The studied area is composed of different topography including mountain, forest, grazing area, crop land, settlement areas and a vast amount of rugged topography with steep slopes through which the Ketch watershed makes its way to tributaries of Abay river. In these different topographies of the land, there exists a number of plant and animal species, including the major ones, but not limited to, Livestock—(cattle, sheep, poultry), Cereals - (barley, wheat, tef, maize,), Fruits - (apple, peach), Vegetables - (potato, carrot), Wild Mammals—(hyena, baboon, fox, monkey, wart hog, rabbit, sivet, impala), Arachnida—(scorpion), Reptiles—(snakes, lizards), Amphibians (frog), Birds (francolin, guinea fowl, falcon), Insects—(termites, ants, grasshopper, butterfly, Tree species - (eucalyptus, Acacia sp., *Cordia Africana*, *Juniporous procera*, *Croton macrostachys*), grass species—(Bermuda grass, rid - *Arundinaria donax*, Mech - *Gizatia scabre*, Adyo - *Carcopsis spp.*, Asendabo - *Setaria verticulate*, Sinar - *Avena abyssinica*, Engcha - *Strychnos innocua*, Gortebe - *Plantage spp.*).



Figure 2. Gullies in the study areas.

Land, being the major resource of livelihoods of the respondents, is used for different purposes as listed by themselves as the following; home garden (35%), cultivated field (30%), forest (15%), grazing area (20%). Almost all of them (99%) indicated the existence of pockets of areas in the landscape where ecosystems are protected under formal or informal forms of protection, but one replied otherwise. The respondents were asked how they manage common resources (e.g. grazing land, wildlife, forest), and gave the following mechanisms; with the help of grazing regulation (8%), control of wildlife poaching (10%), control of deforestation (3%), and a combination of all these (47%). However, 32% of them reported that the common resources are not managed sustainably. So as to identify the load on the common resources, they were asked about the general status of exploitation of common resources, and 48% of them said the common resources are sustainably managed, 49% of them said the common resources are partially managed and 3% of them said the common resources are overexploited. When asked

about the existence of rules aimed at resource management in the community, the respondents indicated that there are traditional authorities and customary rules (75%), co-management arrangements (e.g. joint forest management, between local people and government (3%), and a combination of these (22%). 86% of the respondents said that these legal environments are supportive to resource management but 14% of them considered it as ineffective. In order to know who is making use of common resources and who is not, respondents were asked if access to resources in the watershed is fair and equitable for all community members, including women at household, community and landscape level. 80% of them said yes and 20% said no. They were also asked if households in the community involved in a variety of sustainable, income generating activities, and majority of them (86%) indicated that they are not involved in such an activity. However, 14% of them said they are involved in an income generating activities such as bee keeping.

**Table 1.** Socioeconomic characteristics of the respondents.

Variables	Percent (%)	Frequency
Age Groups		
25-34	18	18
35-44	31	31
45-54	26	26
55-64	17	17
65-74	8	8
Sex		
Male	75	75
Female	25	25
Marital status		
Married	95	95
Single	1	1

Variables	Percent (%)	Frequency
Divorced	1	1
Widowed	3	3
Size of the family		
2	4	4
3	7	7
4	14	14
5	17	17
6	24	24
7	15	15
8	13	13
9	3	3
10	1	1
12	2	2
Educational status		
Illiterate	32	32
Informal schooling	47	47
Elementary	19	19
High school	2	2
Total	100	100

### 3.3. Farmers Perception About the Status of Ketech Watershed

The respondents' decision about the 'state of Ketech watershed' differs with a great margin. Out of the total 100 respondents, 78% respondents said it is under high pressure, but 22% of the respondents disagree. The correlation between different variables can be used as a source of information on how each variable is affecting the other, hence shading light on the conservation measures to be taken. The Pearson correlation between different variables and their significance level is given in Table 2.

**Table 2.** The Pearson correlation between different variables and their significance.

Variables		Pearson Correlation	Sig. (2-tailed)	N
Status i.e. status of exploitation of common resources (sustainably managed, partially managed, over exploited)	Pressure on the watershed	-.416**	0.000	100
Status i.e. status of exploitation of common resources (sustainably managed, partially managed, over exploited)	Economic activity respondents involved in	-.229*	0.022	100
Income generating activities	Pressure on the watershed	-.327**	0.001	100
How is water lost from the watershed?	Threats to the watershed	.308**	0.002	100
Current land use	Threats to the watershed	.223*	0.026	100
Current land use	Sex of respondents	.453**	0.000	100
Current land use	How is water lost from the watershed	.306**	0.002	100
Is the legal environment supportive?	Distance from the watershed	-.216*	0.031	100

\*\* Significant at 0.01 level (2-tailed), \* Significant at 0.05 level (2-tailed)

### 3.4. Factors Affecting Farmers' Decision on the Level of Pressure on Ketech Watershed

Logistic regression analysis was estimated using [21] to predict factors that influence respondents' decision on the state of Ketech watershed and the result is presented in Table 3. Income generating activities (Ingenact) and status of exploitation of common resources (Status) had a significant effect on respondents' decision about the status of Ketech watershed. The other independent variables didn't affect respondents' decision. The percentage of correct prediction of the logit model was 82%.

**Table 3.** The results of logistic regression analysis (N=100), \*=significant at 0.05.

	B	S. E.	Wald	df	Sig.	Exp (B)	95% C. I. for EXP (B)	
							Lower	Upper
Marstat	.682	.573	1.418	1	.234	1.979	.644	6.083
Ingenact	-1.737	.791	4.829	1	.028*	.176	.037	.829
Status	-1.166	.361	10.455	1	.001*	.312	.154	.632



	B	S. E.	Wald	df	Sig.	Exp (B)	95% C. I. for EXP (B)	
							Lower	Upper
Rules	-.435	.414	1.105	1	.293	.647	.287	1.457
Threats	.361	.230	2.468	1	.116	1.435	.915	2.251
Edusta	-.109	.364	.090	1	.764	.897	.439	1.830
Constant	2.822	2.165	1.698	1	.193	16.809		
-2 Log likelihood	78.207							
Percentage of Correct Prediction	82							

Note; Marstat=the marital status of the respondents, Ingenact=income generating activities, Status=status of exploitation of common resources (sustainably managed, partially managed, over exploited), Rules=existence of rules aimed at resource management in the community, Threats=major threats of ketch watershed, Edusta=educational status of the respondents

## 4. Discussion

The findings of this study indicated that Ketch watershed is under high pressure, which was confirmed by 78% of the respondents. Only 22% of them said that it is not under high pressure. There are possible justifications that can support this result. Majority of the human population (75%) of the studied kebeles (districts) live closer to the watershed (< 30 minutes by walk) and use the resources intensively. According to the respondents the watershed is being used as the major water supply both to human and livestock (32%), as a source of fuel wood (24%) because there is no alternative energy, as an animal feed (29%), i.e. grazing area and fodder/grass from the forest and medicinal plants (25%) increasing the pressure on the watershed. The recent available human population of Machakel wereda is 118,097 [8], which is believed to be higher than this now. This tells that there is a huge demand for food that caused intensified land use, hence increasing soil erosion and threatening the watershed. Increase in human population reported as the main threat to other Ethiopian highlands too. The highlands constituting majority of land is currently under stress due to rising population pressure and their conservative socio economic practices [23], [7]. According to [1], an increasing rate of population growth, being as the cause for deforestation, leads to an increased demand for fuel wood that speeds up deterioration of natural resources. The mean household members of the respondents, 5.84 indicated the amount of pressure each household is putting on the watershed, looking for more resources to meet its subsistence need. Farmers educational status, which is related to their level of understanding about the conservation practices of natural resources can also contribute for the status of an area. [20] reported that education of household had a positive influence to households' participation in wetland resource management activities. In the studied kebeles/districts, 32% of the respondents are illiterate, which took higher proportion of the respondents, exacerbating the problem as they have limited knowledge and adaptation to any natural resource management practices. The major economic activity observed in the studied areas is intensive farming, which exacerbates the deterioration of an area, if not done properly. Intensive agriculture that plans to meet the increasing demand for food will accelerate soil erosion [13] threatening the productivity of fertile cropping areas as they are continually degraded. 13% of the respondents agreed that

there is a deforestation activity in the studied areas that, among others, severely affects the land cover exposing it to soil erosion by wind and run-off during the dry and rainy season, respectively. The same trend was reported by [14] that serious soil erosion problems faces Gedeb watershed in the same wereda, due to unsustainable land use practices such as deforestation, intensive crop cultivation and overgrazing combined with increasing pressures from population growth and erratic rainfall. [19] conducted spatial estimation of soil erosion risk by land-cover change in the Andes of Southern Ecuador and concluded that vegetation cover, rainfall and topography are the most important factors for potential soil erosion. It has also been reported that the observed high rates of soil erosion in different parts of Ethiopia is mainly caused by extensive deforestation due to the prevalence of high demand for fuel wood collection and grazing into steep land areas [3], [13]. Land degradation, which can be caused by increased soil erosion and deforestation, as happening in Ketch watershed, lead to both loss of agricultural production and increased risks of flooding, siltation and sedimentation [1]. According to [15], in Ethiopia, agricultural productivity and economic growth are being hindered by soil erosion and declining fertility through land degradation. These threats are also clearly observed and indicated by the respondents in ketch watershed. Overgrazing or removal of vegetation covers exposed an area to different kinds of soil erosion. In Ketch watershed, 18% of the respondents said that there is an overgrazing problem which exacerbates soil erosion and the formation of gullies. This result is in line with what [10] reported where by loss of plant species diversity reduces erosion resistance, and increased net annual soil loss. In the same manner, [2], reported that overgrazing was shown as a main cause of land degradation. The local weather condition and land topography are also contributing a lot to the current soil erosion problem. Machakel wereda/district has an altitude range of 1500-3800 m.a.s.l. with average temperature 27°C and 1500 - 1800 mm annual rainfall [16]. Steep slopes and rugged topography of the land being covered with no or small vegetation accelerates the soil loss, especially during the rainy season (June to Mid-September). As the human population is continuously increasing, there is a very high demand for food. So as to fulfill this demand, people need to have a land, which is extremely limited resource. Therefore, they are forced to farm everywhere including the steep slopes and marginalized lands. This kind of land use accelerates the

process of soil erosion in the area. The most serious problem reported by 31% of respondents of Ketech watershed is flooding and gully formation. Gully erosion, which is defined as “the erosion process whereby runoff water accumulates in narrow channels and removes considerable amount of soil from this narrow channel over a short time period” [22] is observed almost all over the area in Machakel wereda being triggered by inappropriate land use and extreme rainfall events. It is causing a loss of tremendous amount of soil that is supposed to be a productive farm land and hence, negatively affecting the crop yields in the area. Gully development in the Ethiopian high lands resulted in a decrease of soil moisture and a corresponding crop yield reduction on plots located near the gully walls [17]. [12] also indicated that the most threatening factor of degradation in Hawassa-Zuria district in Ethiopia is gully erosion due to vegetation removal from the watershed that threatened the livelihood of the local people. Gully erosion threatens the soil resource, lowers crop yields in intergully areas through enhanced drainage and desiccation, and aggravates flooding and reservoir siltation [18]. A similar situation whereby gully formation was related to a land use/cover change and degradation of a vegetation cover on steep slopes was reported by different authors [18], [6]. According to [5], a land use change is expected to have a greater impact on gully erosion than climate change. According to the respondents, the sources of Ketech watershed are ground water (83%) and different tributaries (17%), which could be considered as a reliable source throughout the year, but unfortunately mismanagement of this very resource is causing problems to the area. Answering to the question how water is lost from Ketech watershed, 47% of the respondents indicated that they use it for irrigation purpose though its success rate is questionable as there is clearly observed soil erosion in the studied areas. They have also reported problems of siltation (12%), evaporation during the dry season, and a cumulative effect of both irrigation and siltation (29%).

The correlation between status of exploitation of common resources and pressure on the watershed in the studied areas was negative and highly significant ( $P < 0.01$ ). If common resources are sustainably managed, there will be reduced or even no pressure on the watershed. The status of exploitation of common resources in Ketech watershed also had a negative and significant ( $P < 0.05$ ) correlation with the type of economic activity the respondents are involved in. In Ketech watershed, the only economic activity which accommodates all the respondents (100%) and being practiced intensively is farming/animal production. This intensified farming activity that is even being practiced on land geographically not suitable for farming, indeed, vividly indicates how bad the current status of exploitation of common resources (forest, grazing lands) are. Diversified economic activities other than farming/animal production are highly needed in the studied areas so as to minimize the burden on the grazing lands and forests. The presence or absence of income generating activities in the studied areas was negatively and significantly ( $P < 0.01$ ) correlated with the pressure that is being exerted on

the watershed. Majority of the respondents (86%) do not involved in a variety of sustainable, income generating activities. However, in one way or another, they all depend on the watershed for fulfilling their livelihoods, which in a way exerts a lot of pressure on the watershed. There was a positive and significant ( $P < 0.05$ ) correlation between the variables, how water is lost from the watershed and different threats to the watershed. According to the respondents, water was being lost via irrigation activities, siltation and evaporation during the dry season. The absence of proper management of the water resources in Ketech watershed contributed a lot for the already existing major threats the watershed is facing (deforestation, overgrazing, agricultural land expansion, flooding/gully formation). The correlation between current land uses and threats to Ketech watershed was also positive and significant ( $P < 0.05$ ). The land is being used as home gardens, cultivated fields, grazing land, forest and settlement. The intensification of these uses contributes to the high level of threats the watershed is in. Moreover, the current land use was positively and highly significantly ( $P < 0.01$ ) correlated with the sex of respondents. The descriptive statistics showed that 75% of the respondents were males, who are fully engaged in the only available economic activity, i.e., farming/animal production. This indicates how male gender is associated to all the activities related to land. In addition to that, the current land use in Ketech watershed also positively and significantly ( $P < 0.05$ ) correlated with the variable, how water is lost from the watershed as well. All the activities being implemented on the land are directly related to the way how the water resource is used. There was a negative and significant ( $P < 0.05$ ) correlation between the variables, contribution of the legal environment (community based landscape governance) focusing on protection of natural resources, and the distance from the watershed (where the respondents live). This result indicated that the legal environment, which intends to protect the watershed, effectively governs only respondents living closer to the watershed. Those living far away from the watershed were not governed by the legal system.

Different factors that affected the decision of the respondents on the status of Ketech watershed were estimated with the logistic regression. Even though not significant, marital status of the respondents (Marstat) affected their decision on the current status of the watershed. As the number of married individuals increases, so does the pressure on the watershed because their demand to be fulfilled as a family also increases. The presence or absence of income generating activities other than farming significantly ( $P < 0.05$ ) affected the respondents' decision in such a way that it decreases the pressure on the watershed as people have an option to get other income to fulfil their livelihood. The current status of exploitation of common resources, which was presented to respondents as “sustainably managed, partially managed or over exploited”, significantly ( $P < 0.05$ ) affected their opinion about Ketech watershed. Theoretically, if any of the natural resources is sustainably managed, there will be no pressure on the environment. Therefore, the

respondents' justification that a watershed will be less pressured when there is proper and sustainable management is convincing. The existence of rules, regulations and enforcement aimed at resource management in the community plays a great role in conservation programs. Increase in Respondents' traditional authorities/customary rules, and co-management arrangement (e.g. joint forest management between local people and government) (Rules), and their educational status (Edusta) which broadens their level of understanding of natural resource conservation, even though not significant, affected their decision on the status of the watershed.

## 5. Conclusion

This study revealed that ketch watershed, which 78% of respondents agreed about its being in pressure, was threatened by deforestation, overgrazing, agricultural land expansion, flooding/gully formation, and a combination of all these. The correlation between different variables indicated the possible activities on which conservation measures are to be taken on. In the logistic regression analysis, 'income generating activities' and 'status of exploitation of common resources' had a significant effect on respondents' decision about the status of ketch watershed.

## Recommendation

Landslides and gully formation are serious environmental problems in the studied areas. These areas also faced with severe shortage of water in the dry season. Therefore, holistic approach to landscape conservation measures, including water harvesting techniques is highly needed so as to halt the ongoing environmental degradation and to tackle the water shortages.

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