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Assessment of Drivers, Pressures and Their Impacts on Biotic Integrity and Community Livelihood Along the River

(Studied in Awash Rivers, Ethiopia)

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Abstract: *This study was conducted in upper Awash river to assess drivers, pressures and their impacts on biotic integrity and community livelihoods. Driver, Pressure, State, Impact, Response (DPSIR) model of river pollution approach was used for identification of drivers, pressures, state, impact and responses. The river has many socio-economic advantages and the people have close intimacy to the river. As the status of river is being changed, no tangible measure is being taken to prevent the condition. The researcher believes the main reason is lack of adequate data on the river water quality and absence of proper assessment methods. In this research, primary and secondary data were collected and analysed using appropriate statistical software. Accordingly three data collecting instruments were used. Questionnaire is used to collect data from householders. Interview is used for key informants and observation check list was used on the selected three stations. Random purposive sampling technique was employed. The data collected through questionnaire and observation checklist was tabulated in to frequency tables.. The result of the study showed that the main driving forces identified for pollution of Awash River are population growth, urbanization, agriculture, car wash and industry. The main pressures that created major problem in the river are different in-stream activities, household and urban wastes, agricultural inputs through runoff and industrial wastes. The result obtained in the study indicated that human and animal using the river water are exposed to different diseases, the biotic integrity of the river is affected in the downstream sides, and the physcochemical composition was changed along the river with increased degradation. The first response to prevent the main drivers of Awash River pollution is the protest of the residences against improper waste disposal method of paper mill factory. The second important response is the research conducted by university community to deliver updated information to the concerned bodies about the status of the river. We recommend the community should avoid river side intensive grazing, dispose wastes properly and participate in reforestation program along the river side. The local government should be committed to implement environmental regulations of the country on proper waste disposal mechanisms from paper mill factory, launch reforestation and awareness creation programs. Higher learning and research institutions should develop assessment methods to evaluate the status of the river water and prepare development projects for sustainable utilization of the river.*

Keywords: *upper Awash river, drivers, pressures, impact, community.*

1. Introduction

Water is critical for sustainable livelihoods and is impossible for a single life to live without it. Water never exists alone, but it is a part and parcel of ecological unit consisting of land, substrate structures, flora and fauna. Combinations of various natural factors and anthropogenic activities in the rivers and their catchments are, however, affecting the river water qualities and their biodiversity. In Ethiopia, human activities such as land use and modification, urbanization, human settlement and other practices associated with rapid population growth are the major water quality degrading factors (Zinabu G/mariam *et al.*, 1989; Fasil Degefu *et al*., 2013).

Water is a renewable natural resource. It is delivered from the atmosphere in the form of rain, snow, hail, fog, and condensation and returns to the atmosphere by evaporation and transpiration. While on the earth, it runs over the ground to lakes, rivers, streams, and oceans and seeps into the ground to be taken up by growing plants to become a part of the ground-water reservoir, eventually discharging also to streams, rivers, lakes, or the ocean (Hennigan, 1969).

Knowledge of water, chemical composition and its properties is necessary for the solution of scientific and applied problems concerned with water use for human domestic and other activity such as water supply (drinking, hygiene, public, industrial, agricultural), fish-breeding, recreation, hydropower and hydraulic engineering, reclamation, exploration and exploitation of mineral deposits, etc.(Johnson *et al.*, 1997).

Despite its importance, water is the most poorly managed resource in the world. The existing tendency of industrialization and urbanization may contribute greatly to the poor quality of water through indiscriminate disposal of solid waste, industrial effluents and other toxic wastes which are the major environmental issues posing threats to the existence of human being (Hennigan, 1969). Water pollution is any change chemically or biologically in water quality that has a negative impact on living organisms in this water and those who use this water. The effects of water pollution not only impact people, but they also can kill animals, fish, and other organisms. It also disturbs the food chain (Johnson *et al.*, 1997).

Water quality is a complex concept related to physical, chemical and biological characteristics of natural water rather than its level, volume or flow which is collectively referred to as water quality. Water quality relates to 'condition' of water as it affects biological habitat and human use (Johnson *et al.*, 1997). Composition and concentration of chemicals and nutrients, gases, temperature, pH, conductivity, erosion deposition process, the substrate and turbidity are among physicochemical characteristics making up the integrity of river ecosystem (UNEPA, 2002).

According to the drivers, pressures, state, impact and response (DPSIR) framework there is a chain of causal links starting with 'driving forces' (economic sectors, human activities) through 'pressures' (emissions, waste) to 'states' (physical, chemical and biological) and 'impacts' on ecosystems, human health and functions, eventually leading to political 'responses' (prioritization, target setting, indicators). Describing the causal chain from driving forces to impacts and responses is a complex task, and tends to be broken down into sub-tasks, e.g. by considering the pressure-state relationship (Turner *et al.*, 1998).

According to Turner *et al.* (1998), the objective of DPSIR frame work is to identify the drivers, pressures, state, impact, and response and then to improve the standard of living of the population living beside the river. Therefore, there is a need to assess the drivers, pressures and their impacts on biotic integrity and community livelihoods along upper Awash River in the centeral highlands of Ethiopia. The researcher believe that, this finding can provide important information to environmental managers and to the public at large about the main river pollutants of upper Awash river and their impacts on biotic integrity and community livelihood.

2. Materials and Methods

2.1 Study Area

The study area, upper Awash River is located in west shoa zone Dendi district about 80 km west of Addis Ababa, capital of Ethiopia. (Fig. 1). The district has a total area of 109,729 ha with altitude range from 2000-3200 m.a.s.l. Based on the 2005 CSA population census; - the total population of Dendi district is estimated at 256,896. The favorable climatic

condition for both crops and livestock production has been attributed for more population in the region. The district has some natural endowments to attract tourists and researchers. Among these, Chilimo-Gaji forest is one of the 58 national forest priority areas of Ethiopia. The forest represents the remnants of the dry afro-montane forest in the central plateau of Ethiopia (Melaku Bekele, 2003). Also this district is well known for its rich water resources among which Awash River and Lake Dandi are the most important water resource. Lake Dandi is one of the highland lakes found in the district, and has a high tourist potential.

2.2 Description of study sites

The study sites are characterized based on physical, chemical, and biological and land-use information. Especially, various human activities such as washing clothes, bathing, spraying of herbicides due to agricultural practice, effluents of industry, discharges of chemical fertilizers from the surrounding farm lands, that pollute the water. The topographic features and habitat structure were also considered as factors while selecting the study stations. As well as, Geographic position and altitude of the study stations were measured using Global Position System (GPS).

Accordingly, three study stations were selected and designated as; sampling station at Awash Arera (S-I), Awash above Paper mill factory (S-II), and Awash below Paper mill factory (S-III) (Fig. 1).

- Station I: is located below the confluence point of the two streams Awash Arera and Gare arera where human and natural impacts are comparatively less from station II and station III. There is some natural vegetation which is scarcely planted at the river bank. In this study station, activities such as grazing and deforestation are common.
- Station II: is located below the bridge and near to Ginchi town. Anthropogenic activities such as farming and grazing, cattle watering, bathing, washing clothes and car washing are a common practice.
- Station III: is located below the Ginchi town and established around the paper mill effluent discharge site. Anthropogenic activities such as farming and grazing, washing clothes and bathing are also a common practice in addition to paper mill wastes.

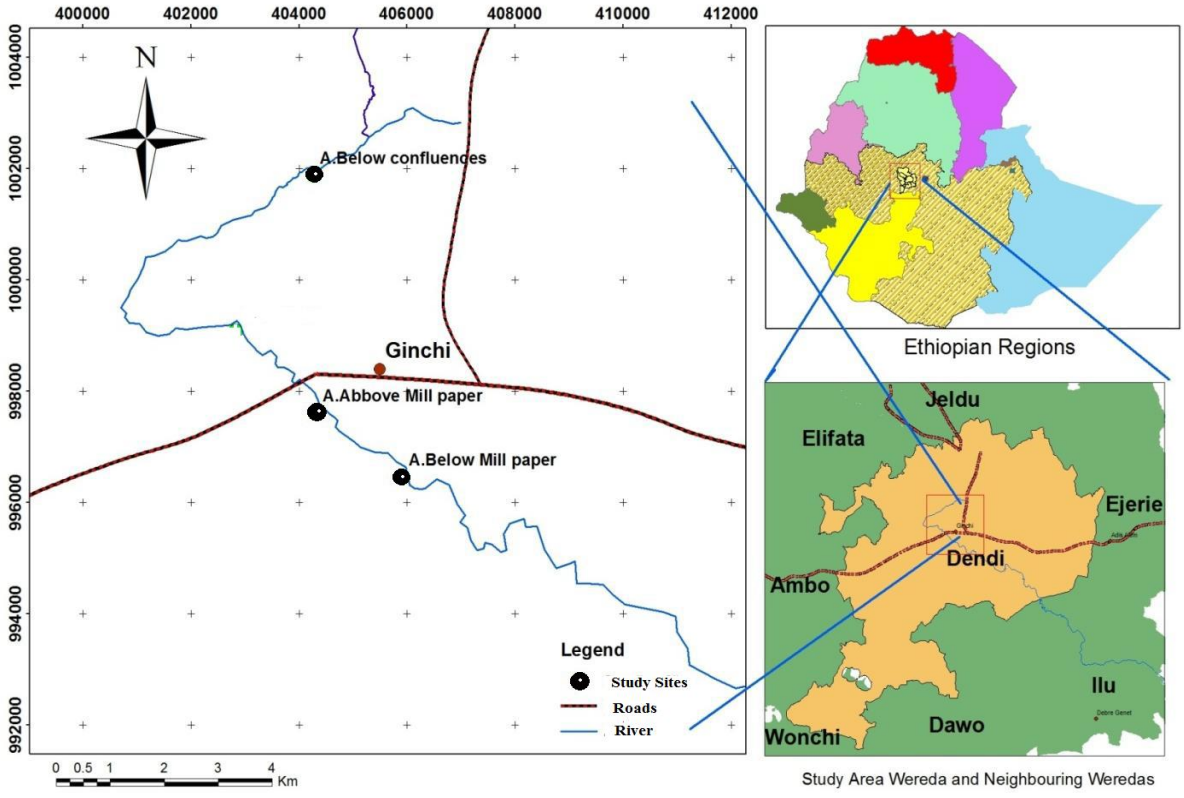

Figure 1: Map of the study area showing the sampling sites.

2.2 Sampling

The target populations of the research were the residence of Ginchi town and the surrounding rural residences adjacent to the river. Respondents were selected by purposive simple random sampling method. The sample size for households are calculated based on Yamanes (1967) formula at 93% confidence level 7% precision level.

$$n=\frac{N}{1+N(e^2)}$$

Where n is sample size, N is population size, e is level of precision.

2.3 Sample size

Purposive sampling strategy was used to select 198 respondents from Ginchi 01, Ginchi 02 and Gare arera kebele where anthropogenic activities are carried out in the river. The total number of respondents selected was based on the proportion of the population in each kebele.

2.4 Data Sources

To achieve the objectives of the study, data was collected from both primary and secondary sources.

The primary data was collected from selected respondents using structural questionnaire. In addition key informant interview with selected community and administrative leaders, and experts from related offices was made using checklist in all three study stations.

Secondary data were acquired from published and unpublished materials which are available in the form of books, journal articles, websites, government policy briefs, research papers and other relevant documents from the concerned administrative offices.

2.5 Data collection methods

Three data collecting instruments were used to collect data in the study area. Questionnaire was used to collect data from residence that lives beside the river. Interview was used to collect data from local administrators and community leaders. Observation checklist was used to gather data on the main phenomenon related to the river and pollutants. Data analysis is made based on data collected through these data collecting instruments.

2.6 Household survey

The householder survey using the interviewer administered questionnaires was the major data collection process of the study. The questionnaires involved open ended and close ended questions. It was prepared in English and translated into Amaharic and Afan Oromo to make data collection easily and communication is understandable. Before conducting the actual data collection process, the first draft of questionnaires was pre-tested in order to evaluate the accuracy of the questionnaire such as missing of data and in consistency of data, understand interviewers' concepts on questions and their ways of surveying procedures evaluate the nature of respondents and estimate the time required to fill a single questionnaire. Finally the actual data collection process from sample population was conducted after every correction or comments were made on information obtained from pre-test results. The data were collected by enumerators trained before data collections commenced.

2.7 Interviews

Interviews were conducted with different respondents at different levels by the researcher. At kebele level, three leaders of Ginchi 01, Ginchi 02 and Gare arera kebeles were interviewed. At the community leaders level three individuals from three kebeles were selected for interview. Further, from Dendi district level, Environmental protection and climate change office head and one environmental protection expert were interviewed.

2.8 Field observation

In contemporary field research, field observation is the most important technique to collect data. This is because sometimes the information that the researcher gather from the informants might contradict with that of the real situation. Therefore, field observation is better to get first-hand information from the primary sources.

2.9 Method of data analysis

The quantitative data were analyzed using SPSS software version 20. Descriptive statistics such as frequency and percentage were used to analyze the data, which were collected from householder respondents using questionnaire. And then according to DPSIR model frame work data analysis was done.

3. Results and discussion

3.1 Awash River and its use for the community

The results of questionnaire, observation and interview revealed that, there is relatively a difference in the responses regarding Awash River used for drinking between station I and station II respondents. One can generally recognize from these findings that majority of the station I householders used river water for drinking. On the other hand the householders who lived around station II and III used pipe water for drinking. This implied that the people who live in Gare Arera kebele use river water for drinking.

The results of data revealed that, there is no significant difference in the responses of all stations about upper Awash River use for household consumption. Accordingly majority of the residence in all stations used the river for household consumption.

According to collected data upper Awash River for washing clothes and swimming depicted that, almost all of the community in station I used river water for household use.Whereas, majority of the informants in station II used pipe water for their household consumption. Therefore, one can generally come upon from this finding that majority of the residences in the three stations used river water for household uses. The results of data collected through the interview and observation confirmed the fact that the residences use the river for household use. Significant proportion of people in the study area used the Awash River for washing the clothes of the family. This clearly indicated the river is polluted by various wastes and nutrients on daily base by people washing their clothes along the river. This finding agrees with the accepted view that most detergents and washing powders contain phosphates, which are used to soften the water among other things, these and other chemicals contained in washing powders affect the health of all forms of life in the water (Saifullah *et al.*,2012).

3.2 The effects of animals on Awash River

The analysis of the data indicated that all stations confirmed that more than half of the residences had animals and nearly all the animals use the river for dinking directly. Large number of animals was observed drinking along the river. It is also proved that there were no watering pools for animals in the three stations under study. Therefore there is great possibility of pollution due to animals waste while the animals drink directly from the river. Due to pollution of the river, the residences in station III forced to use the tributary kerensa for searching relatively clean water for their animals.

Overgrazing is an activity that cause the land to be barren. Barren land is volunrable for acute erosion which directly affect the quality of the water in the river.In addition, the interview was intended to get information about, whether they have a grazing land allocated in the kebele to prevent pressures on river bank forest or not. Based on interview result, the station one leaderes responded that their animals grazed along river grass and in the chilimo forest. Whereas, the station II and station III interviewee revealed that their animals grazed along river grass and on thier owen farmland. There is no cummunity grazing land allocated for animals in the three kebeles of the study area. Based on the questionery, residences who owned animals used river bank grass and forest for continous grazing which created barren land near the river. Therefore,it is possible to make a generalization that overgrazing along the river reduce the quality of the water by soil ingridents infiltrated to the river mainly during rainy season.

3.3 Waste disposal and Awash River

The result of this study showed that there are improper waste disposal mechanisms in the study area. The respondents in station I and station III villagers dropped their household wastes on the field. There are also people who dispose their wastes directly to the river. Large number of people in the study area (33.8%) had no toilet which can badly pollute the river. The observation check list proved that people were observed dropping their household wastes along the river in all study stations. Moreover, there is great number of Vehicles washed on the river leaving their wastes and different chemicals on the river which aggravated the pollution of the river in the study area. This study result agreed with Saifullah *et al.*, (2012) who reported many people dump their garbage into streams, lakes, rivers, and seas, thus making water bodies the final resting place of

cans, bottles, plastics, and other household products.

3.4 Pollution in Awash River and Community perception

Analysis of data from the questionnaire, interview and observation clearly demonstrate the householder's perception about the main causes of river pollution, water borne disease and impacts of pollution. Accordingly significant proportion of the population perceived Awash River is being polluted. According to the community perception as indicated on the result of the questionnaire, the major source of river pollutant in station I was human wastes, in station II chemical wastes and in station III was industrial wastes. The above result indicates that, there are differences on the main source of pollution among the three stations. The data collected through the interview proved that the community leaders have also similar perception to the householders as far as Awash River pollution. But they cannot create pressure on administrative leaders to enforce environmental laws regarding Awash River in the study area. From the above results it is possible to make a comment that the main chemical pollution source comes from washing the vehicles with the physical contact of the vehicles and the river. Moreover the paper mill factory released the chemical wastes into the river during night which is greatly affecting the Community health and the biotic integrity of the river environment. The results of the study are in accordance with, waste releasing industries include textile, leather tanning, paint, plastics, pharmaceutical, paper and pulp industries are major sources of water pollution and they are sources of highly toxic pollutants, including a variety of organic chemicals and heavy metals Ashraf *et al.*, (2010).

As far as the impact of river pollution is concerned householders and community leaders have similar perception. The result of the data showed that majority of householders who live in all stations had the perception of human and livestock health is being affected by polluted water. According to them the main health problem related to river pollution is the prevalence of waterborne disease. Based on the HMIS data of Ginchi health center 5 years back, the main disease which frequently affect the residences in the study area include skin disease, diarrhea with dehydration, diarrhea non-bloody, diarrhea with blood (dysentery), Helminthiasis and un specified disease of the skin. Most of these diseases are caused by water pollution (Appendix 1). Water polluted by agriculture or households cause damage to human health or the environment (EPHA, 2009).

In Addition Dendi district livestock and fishery resource office data of 5 years back, showed that the major disease which frequently affect the livestock in the study area are chemical toxicity. Significant number of livestock dies due to this reason yearly (Appendix 2).

3.5 Abundance and diversity of benthic macro invertebrates on upper Awash River as pollution indicator

According to Ayana Chimdo (2016), the over-all decrease in the number of taxa and the disappearance of the sensitive taxa like Plecoptera and presence of only a few numbers of Ephemeroptera and Trichoptera especially at the lower reaches of study area can be related to the increase in anthropogenic activities such as irrigation activities, catchment urbanization and the discharge of industrial wastes and chemicals from the paper mill. Aschalew Lakew (2014) reported that, paper mill waste was the worst stressor for deterioration of water quality and cause significant reduction of benthic invertebrate diversity directly by intoxication and indirectly by changing water quality parameters. The paper mill effluent produces negative impacts to water quality as they contain diverse kinds of compounds such as fiber, suspended solids, organic matter and excess nutrients (Owens, 1991) and some of which have harmful sub lethal or lethal effects (McLeay, 1987; Jones *et,al.*,2012).

3.6 Structure of macro invertebrates at the sampling stations

Ayana Chimdo (2016) reported that, macro invertebrate community composition varied among types of stressors. For example, in Station III a paper mill effluent impacted site and in Station II, with different anthropogenic activities such as washing clothes and car, cattle drinking, bathing and discharge of different sewage from the urban, red Chironomidae was the most abundant and dominant taxon. This observation is in line with the accepted view

that tolerant species become abundant in degraded streams and rivers (Birenesh Abay, 2007; Mekonen Teferi *et al.*, 2013; Aschalew Lakew and Moog, 2015a).

3.7 Relationship between water quality and macro invertebrates

According to Ayana Chimido (2016), the species diversity is positively correlated with water quality although human activities have led to reduction of macro invertebrates. Some anthropogenic activities like; agricultural activities, paper mill factory, grazing and water pumping cause the changes among physicochemical parameters which, lead to a severe impact on the benthic invertebrates of river. Data on (Fig. 2 and Fig. 3) showed that as habitat and water quality are degraded, number and percentage of EPT decreased, while percentages of diptera and red chironomids increased. There were significant correlations between macro invertebrates and most environmental variables, which is in line with the study of Baye Sitotaw, (2006); Aschalew Lakew (2015a). Additionally, H-FBI increased with increasing disturbance (organic pollution). According to Hilsenhoff, 1988 It is evident that Station III (6.5) and Station II (5.8), were failed under fairly poor, while, Station I (4.9) were failed under Good water quality class. This result indicated that the presence of high water pollution in station III followed by station II.

3.8 Measures to prevent Awash River pollution

According to the result of data collected by the questionnaire, indicated that majority of the householders who lives in the three stations had common understanding as community should be the responsible to protect Awash river from pollution. On the other hand, the analysis of the interviewee data showed that the main responsible body to protect the river from pollution is the government. On the contrary the observation data demonstrated that the community and local leaders are not responsible to protect the river from pollution. It is not expected from the responsible community to drop household wastes to the river. It is not also expected to wash different vehicles along the river. There is no any intention to enforce the government to implement environmental protection law of the country. The main drivers, pressures, states, impacts and responses of upper Awash River as expressed by DPSIR model is presented as follows (Fig. 2).

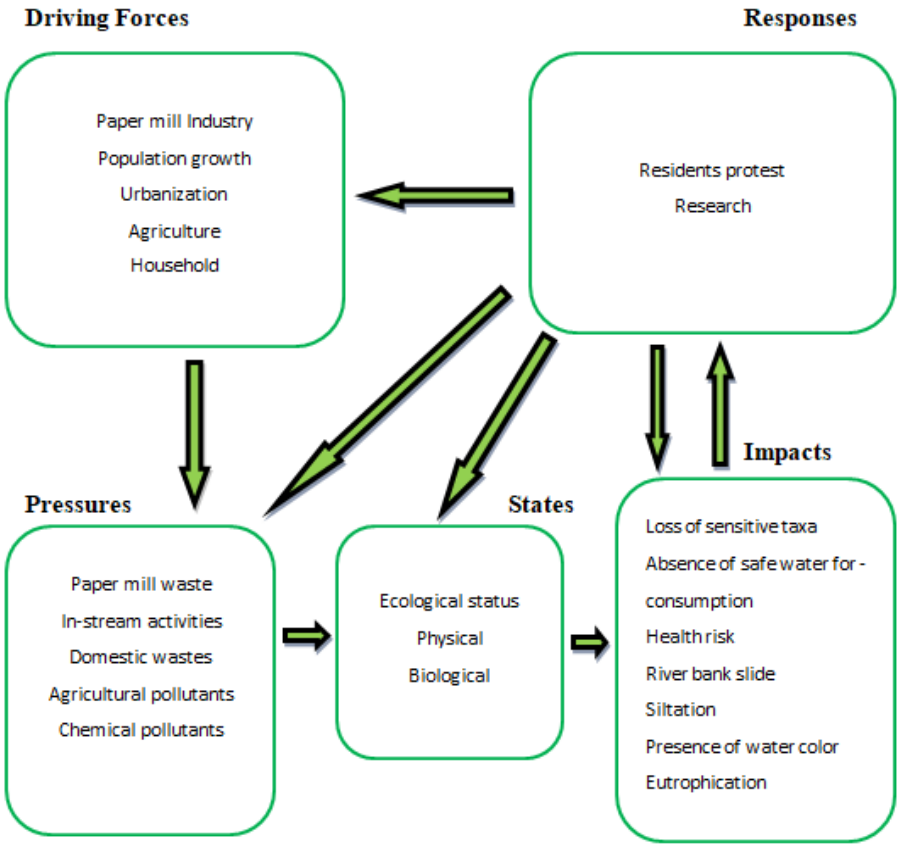

Figure 2: DPSIR model of upper Awash River in Ginchi study area.

The analysis of interview and observation data on the different measures to be taken to protect Awash River from pollution is also made. Based on the interview data the most important measure taken in order to protect the river was enforcing the factory owners to dispose their industrial waste properly. Based on the local community protest against the improper waste disposal of the factory, the government decided to close the factory until it establishes primary and secondary waste treatment plants. However, the factory continued production in short time without proper waste disposal method. Data of the observation proved the industrial effluents were released from the factory during night. The remnants of chemicals are observed during morning hours in station III near the location of the factory. This clearly proved that the factory is irresponsible to the river safety and health of the environment. The local administrators are reluctant to make pressure on the factory for its responsibility to protect the river. According to local administrators the factory was established without EIA study. This is not the way out for the problem created by the factory. According to the interviewee, different kinds of measures are suggested to protect the river from pollution. They suggest that: the community should prepare grazing land and watering pool for their animals and should not dispose the household wastes on the field and along the river. The local government should prepare awareness creation programs for the community about river pollution and its impacts. Furthermore the local government should inspect car wash along the river by the proper implementation of the river law of the country.

4. Conclusion and Recommendations

Based on the findings of the present study, the following conclusion and recommendations are forwarded.

4.1 Conclusion

The findings of the study indicate that Awash River water is used by Gare Arera kebele householders for drinking. The people who lived at all stations used the river for household consumption. Large number of people washed their clothes and body and thus the river is polluted by wastes and chemicals on daily base by people washing their body and clothes along the river. Due to these activities a pressure is

created on the river which deteriorated its water quality.

There are improper household and urban waste disposal methods in the study area which can affect the Awash River. The people dispose their wastes in the field near the river and to the river directly. Moreover large number of people in the study area had no toilet. These improper waste disposal practices can badly pollute the river. As the result degradable and non-degradable wastes were observed floating along the river.

The main energy source for household use is firewood that comes from the forest in the catchment along the river in the study area. As the result of searching fire wood in the riverine forest is being deforested and the catchment area is being degraded. Huge amount of soil is infiltrated to the river which changed the color of the river water to brown.

The residents in the study area own livestock. These livestock graze on open field near to the river and on the forest sides of the river which created barren land. Animals also used the river water for drinking directly, moreover they leaving their wastes on the water. Large area of land is cultivated for different crops in the study area. Farmers use different fertilizers for their farm land. Chemicals and fertilizers are infiltrated to the river. Due to farming and animal rearing agricultural pollutants are affecting the quality of the river.

There is large number of vehicles washed in the river leaving their wastes and different chemicals on the river which aggravated the pollution of the river in the study area. Oily fluid was observed floating over the river water.

The main source of chemical pollution for Awash River in the study area is the paper mill factory located close to the river Awash. The drainage system of the factory is linked directly to the river. There is no any treatment of the waste used by the factory. Chemical effluents are released from the factory during night after the protest by the residents against this wrong activity of the factory. Remnants of yellowish, white and reddish substances are observed during morning near the location of the factory and down part of the river. Even though the residents were opposing the factory's action, still the factory did not show any responsibility to treat its wastes in the proper way. As the result of the chemicals, the human and animals health is vulnerable to different waterborne and water related diseases. Additionally the biotic integrity of the river is impacted downstream of the river.

Even though the result of the study showed that large number of residents and local leaders in the study area had understanding on river pollution and felling of responsibility. Most of their actions did not show their understanding and level of responsibility about Awash River.

Therefore the main driving forces identified in the study area are population growth, urbanization, agriculture, car wash and paper mill industry. The main pressures that are created on Upper Awash River around Ginchi town are wrong use of the river, household and urban wastes, agricultural pollutants, chemical pollutants and paper mill effluents. Due to the drivers and the pressures created on the river, the color of the water is changed, wastes and oily fluid are observed floating on the river. As the result of the drivers and pressures created on the river, human and animal health is exposed to different diseases, the biotic integrity is impacted and the physical structure of the river water is changed. Regarding the first response to prevent the main drivers of upper Awash River pollution in the study area is the protest of the residents against wrong waste disposal method of paper mill factory. The second important response was the research conducted by university and research institutes deliver updated information to the concerned bodies about the status of the river.

4.2 Recommendation

From the results found and conclusions drawn we recommend the following for the main stakeholders of the upper Awash River.

- The community and administrative leaders should prepare grazing land and watering pool for their animals.
- The community should participate on reforestation programs on the catchment area to maintain the ecological balance disturbed due to deforestation.
- The householders in the community should not dispose the wastes on the field and along the river and should have private and community toilet.
- The local government should be committed to make pressure on the factory to implement proper waste

disposal technique to fulfill its responsibility to protect the river.

- The local government should prepare awareness creation programs for the community about river pollution and its impacts.
- The local government should inspect car wash along the river by the proper implementation of the river law of the country.
- The university community in general and the environmental science in particular should make detailed research on the chemical changes of the river water and their impact on the ecosystem.
- Higher learning and research institutes should prepare applicable project plan and implement to prevent the main drivers of the river pollution so that the river can benefit the society for their sustainable development.

5. Acknowledgments

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7. Appendix

Table 1. Awash River and its use for the community

Variables		Station I		Station II		Station III		Total	
		n	%	n	%	n	%	n	%
Main sources of water for drinking	Pipe water	-	-	44	48.3	51	66.2	95	48
	River water	16	53.3	-	-	-	-	16	8
	Spring water	14	46.7	34	37.4	20	26	68	34.3
	Water well	-	-	8	8.8	2	2.6	10	5.1
	Packed water	-	-	5	5.5	4	5.2	9	4.5
	Total	30	100	91	100	77	100	198	100
Main sources of water for house hold use	Pipe water	-	-	31	34.1	20	26	51	25.8
	River water	24	80	28	30.8	35	45.4	87	43.9
	Spring water	-	-	6	6.6	4	5.2	10	5.1
	Water well	6	20	26	28.6	18	23.4	50	25.2
	Total	30	100	91	100	77	100	198	100

Table 2. place of washing families cloth

Variable		Station I		Station II		Station III		Total	
		n	%	n	%	n	%	n	%
Place of washing families' cloth	At home	2	6.7	37	40.7	24	31.2	63	31.8
	Along river	26	86.6	54	59.3	53	68.8	133	67.2
	Spring water	2	6.7	-	-	-	-	2	1
	Total	30	100	91	100	77	100	198	100

Table 3. Livestock and awash River

Variables		Station I		Station II		Station III		Total	
		n	%	n	%	n	%	n	%
Owner ship of livestock	Yes	26	86.7	52	57.1	49	63.6	127	64.1
	No	4	13.3	39	42.9	28	36.4	71	35.9
	Total	30	100	91	100	77	100	198	100
Main source of water for livestock	Pipe water	-	-	-	-	-	-	-	-
	River water	26	100	50	96.2	37	75.5	113	89.0
	Water well	-	-	2	3.8	2	4.1	4	3.1
	Others	-	-	-	-	10	20.4	10	7.9
	Total	26	100	52	100	49	100	127	100

Table 4. Waste disposal & Awash River

Variables		Station I		Station II		Station III		Total	
		n	%	n	%	n	%	n	%
Method of disposing household wastes	By burning	6	20	43	47.2	14	18.2	63	31.8
	On the field	22	73.3	36	39.6	50	64.9	108	54.5
	To the river	2	6.7	12	13.2	13	16.9	27	13.6
	Total	30	100	91	100	77	100	198	100
Availability of Toilet	Yes	10	33.3	75	82.4	46	59.7	131	66.2
	No	20	66.7	16	17.6	31	40.3	67	33.8
	Total	30	100	91	100	77	100	198	100

Table 5. Vehicles washed along the river

Observation issue	Observation days	Station II	
		7:00am-6:00pm	
		n	%
Number of vehicles washed along the river.	Monday	13	6.4
	Tuesday	21	10.4
	Wednesday	23	11.4
	Thursday	18	8.9
	Friday	22	10.9

	Saturday	49	24.3
	Sunday	56	27.7
	Total	**202**	**100**
	Mean	**28.9**	

Table. 6 Awash River and Community perception

Variables		Station I		Station II		Station III		Total	
		n	%	n	%	n	%	n	%
Awash River is getting polluted	Yes	18	60	78	85.7	77	100	173	87.4
	No	12	40	13	14.3	-	-	25	12.6
	Total	30	100	91	100	77	100	198	100
Major source of pollution in your surrounding	Human wastes	10	55.6	8	10.3	-	-	18	10.4
	HH wastes	8	44.4	16	20.5	-	-	24	13.9
	Animal wastes	-	-	10	12.8	-	-	10	5.8
	Chemical wastes	-	-	44	56.4	30	39	74	42.8
	Industrial wastes	-	-	-	-	47	61	47	27.2
	Total	18	100	78	100	77	100	173	100

Table 7. Community perception on polluted river water

Variables		Station I		Station II		Station III		Total	
		n	%	N	%	n	%	n	%
Perception on polluted river water cause disease	Yes	26	86.7	87	95.6	77	100	190	96
	No	4	13.3	4	4.4	-	-	8	4
	Total	30	100	91	100	77	100	198	100
The major problem faced as a result of pollution	Human health	24	92.3	60	69	35	45.5	119	62.6
	Animal health	2	7.7	18	20.7	30	39	50	26.3
	Diminished ecosystem	-	-	9	10.3	12	15.6	21	11.1
	Total	26	100	87	100	77	100	190	100

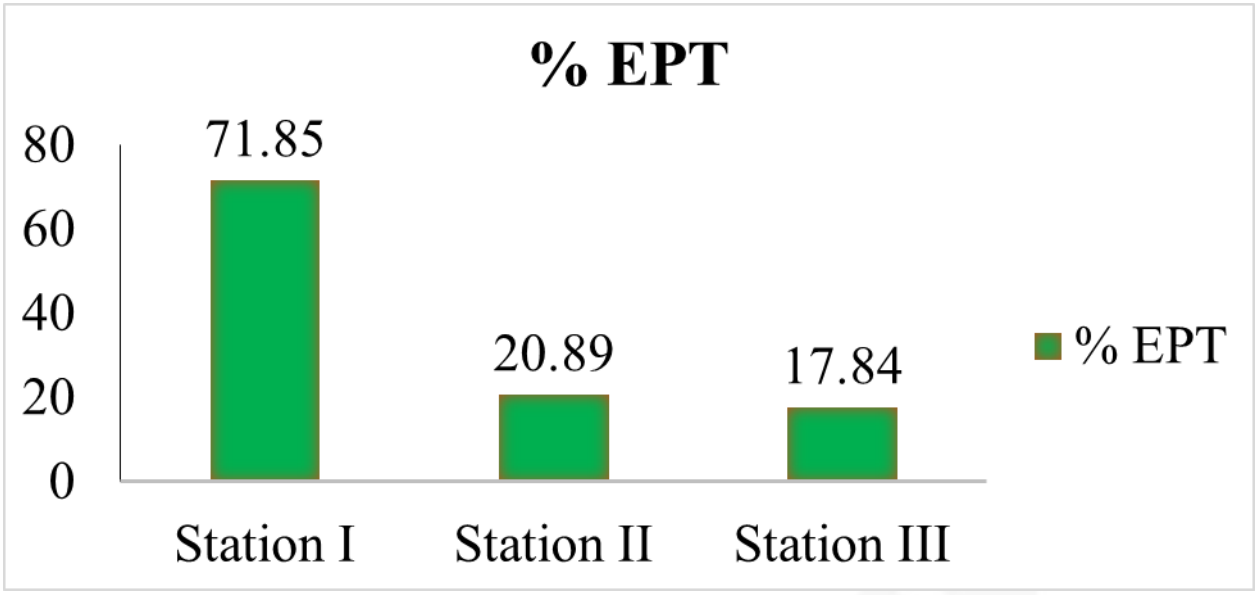

Figure 3

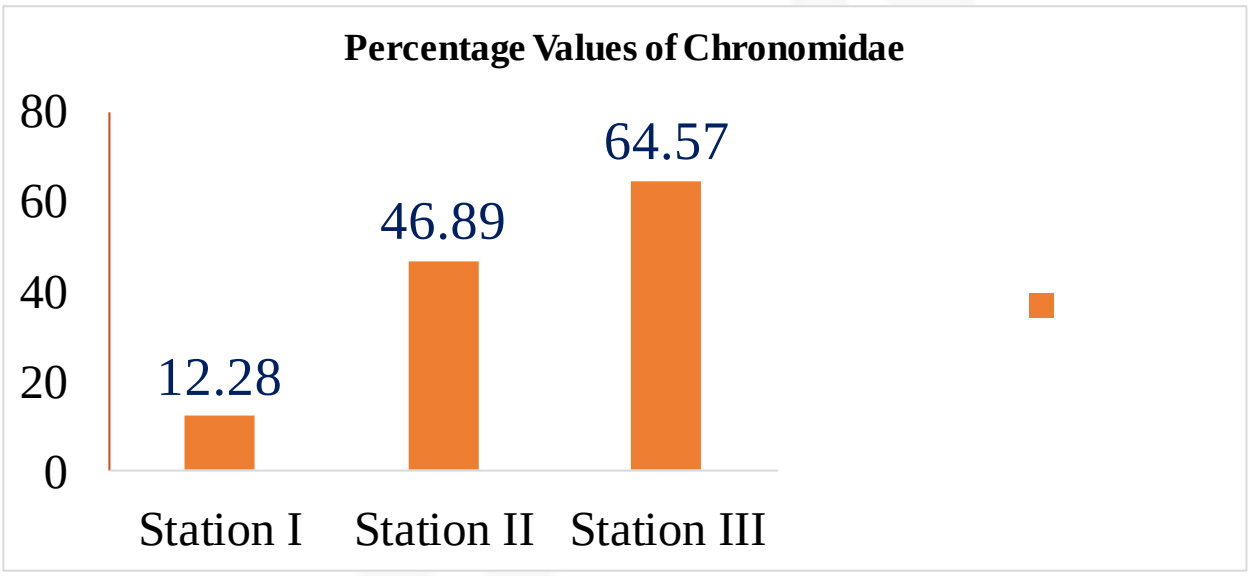

Figure 4.

The main water born/ related diseases which frequently affecting the residences in the study area, Impacts on human health 5 years back.

Types of water borne diseases on human health.	In 2004 E.C	In 2005 E.C	In 2006 E.C	In 2007 E.C	In 2008 E.C	In 2009 E.C
Skin disease	-	276	691	598	509	439
Other unspecified disease of the skin	-	168	243	273	243	211
Diarrhea non bloody	-	206	158	133	81	80
Diarrhea with blood (dysentery)	-	101	17	9	16	9
Diarrhea with dehydration	-	672	1570	984	490	243
Helminthiasis	-	154	376	297	351	304
Death by water toxicity	-	-	-	-	-	-

Source: HMIS report of Ginchi health center (2017).

The main water born/ related diseases which frequently affecting the livestock's in the study area, Impacts on livestock 5 years back.

Types of water borne/related diseases on livestock health.	In 2004 E.C	In 2005 E.C	In 2006 E.C	In 2007 E.C	In 2008 E.C	In 2009 E.C
Leach	1200	1520	1430	1320	1231	1500
Lice	65	74	96	115	130	100
Ascariasis	48	24	35	45	23	10
Chemical toxicity	-	126	185	170	190	200
Death by water toxicity	-	9	16	42	51	33

Source: Dendi district livestock and fisheries office, (2017).