
Management and Utilization of Sor and Gebba Rivers: Comparative Analysis

Asafa Tasgara, Negera Gudeta

Department of Civics and Ethical Studies, Faculty of Social Science and Humanities, Mettu University, Mettu, Ethiopia

Email address:

asefatasgara@gmail.com (A. Tasgara), negera2017gudeta@gmail.com (N. Gudeta)

To cite this article:

Asafa Tasgara, Negera Gudeta. Management and Utilization of Sor and Gebba Rivers: Comparative Analysis. *International Journal of Management and Fuzzy Systems*. Vol. 7, No. 3, 2021, pp. 64-70. doi: 10.11648/j.ijmfs.20210703.14

Received: March 5, 2021; **Accepted:** May 21, 2021; **Published:** September 4, 2021

Abstract: This study is concerned the utilization, conservation and management of Sor and Gebba Rivers. The improper management, utilization and conservation of water resources may amount to not merely the occurrences of conflict among and between riparian but also hinder the national development of a given country. Ethiopia is depicted as the water tower of Northeastern Africa (Horn of Africa) where aridity is the rule due to ineffective and poor utilization and conservation of water. The overall objective of this study is to examine the management and utilization politics of Sor and Gebba rivers comparatively. To achieve the objectives, the study employed descriptive research design as the research design of this study. The study also employs qualitative approach and in depth interview, document analysis and observation as data collection tools. The researchers have managed to collect data and made in-depth interview with number of respondents from Ilubabor zone and Bunno bedelle zones water development offices, and from some selected woredas which have proximity to two of water resources such as Yayyo and Hurrumu woreda Water development offices. According to respondents, both rivers yet to receive attention from government officials of the area, scant attention was paid to the fisheries potential of Sor and Geba rivers which resulted from different factors including lack of budget, skilled man power in the area and institutional bureaucracies. At the end, the reviews and analysis of all relevant secondary sources was made to supplement and substantiate the primary data collected by key informant interview and observation and the data collected from secondary sources was analyzed with the data collected from primary sources through qualitative data analysis. The finding of this study revealed that, Sor and Gebba rivers potential wasn't harnessed to be utilized for local community for economic development and Sor and Gebba rivers unutilized by local community due to financial constraints and again received less protection, conservation and management of from local community and concerned government officials at local, regional and national level due to lack of awareness. Therefore, government should allocate enough budget to utilize the maximum potentials of Sor and Gebba rivers for different purposes such as hydro-electric power generations, micro and macro irrigations, tourist attraction, swimming poll, fisheries and other purposes to realize economic development of the nations and local community.

Keywords: River Utilization, Management, Soor and Gebba Rivers

1. Introduction

1.1. Background of the Study

Water defines everything of plant, animal and human life. Water is necessary for all forms of human, animal and plant life. It is essential for overall human wellbeing and supports all aspects of human living [6]. Furthermore, water plays an important role in supporting productive human activities such as agricultural, energy and industrial production, sanitation, transportation services, fishing and tourism [16]. Successful

utilization, exploitation, management and conservation of water resources are vital for human development and development of national economy of world nation states [12]. The same is true for Ethiopia. The proper planning, design, construction and operation of water resource uses are essential for living things on biosphere and economic development of the country [11].

However, improper management, utilization and conservation of water resources may amount to not merely the occurrences of conflict among and between riparian but also hinder the national development of a given country.

Ethiopia is depicted as the water tower of Northeastern Africa (Horn of Africa) where aridity is the rule due to ineffective and poor utilization and conservation of water. Inland water bodies of Ethiopia are estimated to be about 7400 km² of lake area and about 7000 km of river length (Wood and Talling, 1988). Of these water resources, Baro River is rich in freshwater resources found in South Western parts of Ethiopia [2]. However, lack of proper planning and misuse of water resources which is defining feature of Ethiopian water resources can bring environmental deterioration [13]. The same is true for Baro river basins and its tributaries including both Gebba and Sor rivers.

Among the nine river basins in Ethiopia (Mereb, Angereb, shebelle, Tekeze, Awash, Omo, Blue Nile etc.) in Ethiopia, Baro River and its tributaries basin has abundant water resources which up to now have not been developed to any significant level. The Baro-Akobo basin tributaries are unrealized potential, under-populated by Ethiopian standards, and with plenty of land and water [14] Baro River is created by the confluence of the Birbir and Gebba Rivers, east of Metu in the Illubabor Zone of the Oromia Region. From its source in the Ethiopian Highlands it flows west for 306 kilometers (190 mile) to join the Pibor River. The Baro-Pibor confluence marks the beginning of the Sobat River, a tributary of the White Nile and Baro and its tributaries drain a watershed 41,400 km² (16,000 sq mi) in size. The river's mean annual discharge at its mouth is 241 m³/s (8,510 ft³/s) [2]. Baro River is the only navigable river in Ethiopia. Thus this study intended to comparatively analysis the utilization, and management of Gebba and Sor rivers, (the tributaries of the Baro river basins) [4].

1.2. Statement of the Problem

Effective and proper natural resources utilization including water resources for national and local development remains at the top of countries national policy. The same is true for Ethiopia. Water and national development is inextricably linked because the proper utilization and management of the water resources boosts countries' economic growth and contribute greatly to poverty reduction [7].

It was to this end that, Ethiopian government formulated Agricultural Development Led Industrialization (ADLI) which is long-term development strategy to fight against poverty and ensure economic development through exploiting natural resources including water resources, especially by dam construction and irrigation schemes, water reservoir and canals. However, though attempt was made to especially through designing policies and strategies the utilization and management of water resources in Ethiopia remain low in practices. Much of task wasn't done yet and Water resource is one of the most unutilized resource in Ethiopia.

Few works have been undertaken on hydro politics of Sor and Geba Rivers by different individuals at different times; however, the scope of those studies was confined to the economic importance of water resources, fishes types found in Sor and Gebba Rivers. For instance, [3] studied the

diversity, relative abundance and some biological aspects of fishes in geba and Sor Rivers, baro-akobo basin, southwest Ethiopia. The finding of their study disclosed the types of fishes found in two water resources but it didn't reveal the utilization, the conservation and management (hydro politics) of water resources. [2] Studied land use land cover change and its implication on surface runoff: a case study of baro river basin in south western Ethiopia.

The finding of this study revealed that land use land cover change has not only disrupted ecological balance of the watershed but also increased surface runoff. However, the finding of his study didn't reveal the utilization, management and conservation of Baro River and its tributaries especially Gebba and Sor rivers. Thus, though few works have undertaken on this study area, the scope of those study overlooked the politics of water utilization, conservation and management of Sor and Gebba rivers. The management and utilization of Sor and Geba rivers is inadequately studied and list documented area.

To the best knowledge of the researchers none of those studies comparatively scrutinized the management and utilization of Sor and Gebba Rivers and unlike previous studies; this study critically scrutinizes the hydro politics of Sor and Gebba Rivers comparatively. Hence, due to the existence of literature gap in the area of under study, this study could add some knowledge to the existing literature on the area of the utilization, conservation and management of Sor and Gebba Rivers (tributaries of Baro River).

1.3. Objective of the Study

1.3.1. General Research Objective

The overall objective of this study is to examine the management and utilization politics of Sor and Gebba rivers comparatively.

1.3.2. Specific Research Objectives

Specifically, this study intended to achieve following objectives:

- 1) To examine the utilization of Sor and Gebba rivers by local community.
- 2) To assess the managements of Sor and Gebba Rivers
- 3) To scrutinize the conservation and protection of Sor and Gebba Rivers.

2. Research Methods and Methodology

2.1. Introduction

This chapter presents the research methodology employed in this study. Under this chapter, research design, methods of data collection such as key informant in-depth interview, and document review, sampling techniques such as purposive and, methods of data analysis and ethical consideration will be presented.

2.2. Research Design

Research design is structure with in which research is

conducted and it is useful for facilitating the smooth sailing of research operation and make research efficient as possible by generating detail information about the study under investigation with minimum effort, time and finance [10]. Case study research design was employed in this study because case study research design is qualitative research design where researcher focus on one or a small number of bounded cases, each of which is studied within its distinct context and study made in depth rather in breadth and more emphasis is given on full analysis of limited number of events or conditions and interactions. By employing case study research design this study deeply analyzed and examined the management and utilization of Sor and Gebba rivers comparatively.

2.3. Research Methodology

Research methodology is the way through which researcher solves the research problem in a very systematic way and the science which shows how research is done scientifically. In this study qualitative research methodology was employed because qualitative research methodology concerned with the subjective assessment of attitude, opinion and behavior of certain groups of people and generates result based on the non-quantitative form. By considering these attributes of qualitative research approach and nature of the study, researchers employed qualitative methodology in this study and examined the management and utilization of Sor and Gebba rivers by local community comparatively. Moreover, qualitative research methodology is also useful to investigate social phenomena, socially constructed events and individual experiences by using different strategies of inquiry such as narratives, ethnographies and case study [11]. Therefore, the study employed qualitative research methodology and scrutinized the utilization and management of Sor and Gebba rivers in comparative analysis.

2.4. Methods of Data Collection

The objective of this study is to assess the utilization and managements of Sor and Gebba rivers. To achieve the intended objective of the study, data was collected from both primary and secondary sources. The primary data was collected through qualitative techniques/tools of data collections such as key informant in-depth interview and the secondary data was collected from books, journal article, newspaper, proceedings, government reports, proclamations and regulations, FDRE constitution, international and regional documents, unpublished materials and web sources to back and strengthen the data collected from the primary sources. Accordingly, reviews and analysis of all relevant secondary sources was made to supplement and substantiate the primary data collected by key informant interview and observation and the data collected from secondary sources was analyzed with the data collected from primary sources through qualitative data analysis.

2.4.1. Key Informant In-depth Interview

Key informant in-depth interview is qualitative technique

of data collection that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea. It is also useful to collect the detail information from the respondents, acquire much more detail information and to explore new issues in depth¹.

Accordingly, by using key informant in-depth interview data collection technique the researchers have managed to collect data and made in-depth interview with number of respondents from Ilubabor zone and Bunno bedelle zones water development offices, and from some selected woredas which have proximity to two of water resources such as Yayyo and Hurrumu woreda Water development offices.

2.4.2. Document Analysis

Document review or analysis was used in this study to supplement the data collected from primary sources because document analysis is qualitative research methods which enable researcher to elicit meaning, gain understanding, and develop empirical knowledge and it is also useful tool in combination with other qualitative research methods as a means to back and strengthen the data collected by techniques of primary data collection [8]. Accordingly, literature and documents on the management and utilization of non-trans boundary water resources in Ethiopia. Beside this, review of previous studies on utilization and management of water resources in Ethiopia was also made to find the unstudied gaps and to back and strengthen data collected by techniques of primary data collection.

2.5. Sampling Technique

Sampling technique is the systematic and scientific ways of selecting a representative part of a population for determining parameters or characteristics of the whole population. In this study purposive sampling technique was employed to select respondents from the target population.

Purposive sampling technique is the most commonly used technique in qualitative research approach where the researcher purposefully selects the most knowledgeable respondents to answer the research questions [16]. Additionally, purposive sampling technique also include expert sampling where the researcher selects people and experts whom he/she think and believe knows area under study well than rest of the people [17]. This study employed purposive sampling technique to purposively select respondents from woreda officials and from two zonal water development offices.

2.6. Method of Data Analysis

The data collected by key informant in-depth interview, and document analysis are qualitative in nature. Qualitative method of data analysis was used to analyses the data obtained from primary sources and secondary sources

1. Boyce C. and Palena N. (2006). Conducting in-depth interviews: A guide for designing and Conducting In-depth Interviews for evaluation Input. pathfinder international tool series Monitoring and Evaluation.

because the qualitative data analysis started during data collection because researcher need to document in-depth interview, focus group discussions and daily observations relevant to the study [8]. Interview guideline questions were prepared both in Afan Oromo version. Data obtained through taken notes during in-depth interview was transcribed in the form of documents; the data collected through in-depth interview in Afan Oromo version was translated to English version while transcription was undertaken, and the data obtained through documentary review was analyzed qualitatively. Thus, a qualitative method of data analysis was employed to analyze the data collected from both primary and secondary source.

2.7. Ethical Consideration

Like other profession, research has its own ethics which include the protection of privacy, confidentiality of respondents and avoiding subjectivity during data collection. Research ethics basically describes how the researcher would approach the participants of research and collect data [15]. In this study, researchers have used various research ethics. In the first phase researchers have presented the introductory letter to research participants. Additionally, researchers have introduced themselves who are they, from where they came and the purposes of the study. Furthermore, the participants were informed that the information they gave to researcher and their response would be used for academic purposes alone and they were told not mention their name during interview and their identity would remain anonymous unless they want to reveal it.

Hence, the researcher has to ensure the confidentiality and anonymity regarding the information and identity of the respondents, some of respondent's names were kept confidential and anonymous due to the political sensitivity of the of subject under study.

3. Data Presentation and Analysis

3.1. Management and Utilization of Sor and Gebba Rivers

Water plays a pivotal role in sustainable development, including poverty reduction. The use and abuse of increasingly precious water resources has intensified dramatically over the past decades, reaching a point where water shortages, water quality degradation and aquatic ecosystem destruction are seriously affecting prospects for economic and social development, political stability and ecosystem integrity [9]. Given the importance of water to poverty alleviation, human and ecosystem health, the management of the water resources becomes of central importance.

The current water issue is often more a crisis of governance than a crisis of physical scarcity, as scarce water resources are allocated inefficiently, unregulated pollution compromises water quality, weak water service providers fail to serve the public and social and environmental concerns are left unaddressed.

The Baro-Akobo basin tributaries are unrealized potential, under-populated by Ethiopian standards, and with plenty of land and water [14]. Gebba and sor rivers which the tributaries of Baro River has immense potential for irrigation, hydroelectric power generation, tourist attraction, fisheries, swimming pool and many other purposes. But, they are yet receive attentions from government officials and other concerned body to play its role in national and local development.

In terms of fisheries alone, Sor and Geba rivers (Baro-Akobo) river basin has huge potential. According study made by mulugeta [19] there is total of eight species and one *Garra* species of fishes representing seven genera and four families were identified from Geba and Sor Rivers. However, it is yet to receive attention from government officials of the area, scant attention was paid to the fisheries potential of Sor and Geba rivers which resulted from different factors including lack of budget, skilled man power in the area and institutional bureaucracies.

3.2. Conservation of Sor and Geba Rivers by Local Community

Ethiopia is blessed with ample water resources in central, western and south western parts, while most of North Eastern and Eastern parts of the country are relatively dry. The distribution and availability of water is erratic both in space and time. Hence, despite abundance in some parts Ethiopia is highly water-scarce due to lack of cooperative and coordinated development and management of water resources. Sor and Geba rivers, the tributaries Baro river are not also out of this fact [18].

Water resources are equivalent with life for local community and entire human life as it mean a lot in the livelihoods and lives of human being. This is fact in the case Sor and Geba rivers (the two major tributaries of Baro river). Thus, the local community should protect and conserve these water resources so as to ensure the sustainability of the water resource and keep it clean from waste and disposal. However, what is fact on the ground is quite different. Sor and Gebba rivers are lifeline for the majority of surrounding local people but no attention has been paid to preservation and protection of these water resources neither by local communities nor local government officials. This is resulted from different factors inter alia, lack of awareness on the potential uses of these water resources, lack of enough finance to create awareness for the local community and lack of human resources².

The potentials water resources less understood by local government officials and local community. This forced the local community and government officials to pay a little attention to these two water resources and its protection and conservation. For instance, Sor fall is a huge tourism potential and could be served as the income sources and revenue generation for Ilu Ababor zone. But, its not well

2. Key informant interview with officials from Ilu Abba Bor and Bone Bedelle water and natural resources management and administration.

developed, protected and conserved to utilize its potential by attracting tourist, the same is true for Geba river fall, no attention is paid yet by government and non-governmental organizations to harness this potentials so that it would contribute its part to national and local socio-economic development.³

The water resources have been also used by zonal admiration for local community water supply, different micro irrigation and even hydro power generation if it's properly harnessed. However, nobody managed to understand these all potentials and committed to conserve and protect it from pollutant and waste disposal [1].

In a nutshell, both Sor and Gebba rivers has various potentials for irrigation, swimming pool and other recreational activities, fishing, tourist attraction and hydropower generations which can boost the socioeconomic development of local community and contribute to the national development it is properly harnessed. However, no attention was paid yet by government official and local communities to utilize these potentials and protect and conserve them to realize the sustainable utilizations of these water resources without compromising the interest of the coming generation. To realize the maximum utilization, conservation and protection of these water resources by local community and local, regional and national government, there has to be better understanding of the potentials of water resources and its numerous utilizations. Furthermore, there has to be a connection between government and private sectors on the development, utilization and conservation of Sor and Geba rivers so as to contribute to local and national development.

3.3. The Potential Utilization of Sor and Gebba Rivers for Hydropower Generation

Sor and Geba rivers have huge potential for hydropower generation but, little attention has been paid to invest on these potentials. Gebba river alone has the capacity to produce an estimated 391MW of electricity. In 2014, the Ethiopian Government has awarded a contract for the construction of a new Gebba River Dam. The cost of the contract is US\$700m. It will be built along Gebba River, near the border of Jimma and Illubabur zones of the Oromia Regional State [5].

The contract for the new Gebba River Dam was awarded through the Ethiopian Electric Power Corporation (EEPCo), which is mandated to producing, transmitting, distributing and selling electrical energy in accordance with economic and social development policies and priorities of the Ethiopian government. The contract for the project was awarded to SINOHydro and CGCC and Sur Construction.

The finances for the project will be made available through loans from the Chinese government, through China's Exim Bank. The new Gebba River Dam will be the most costly ever built in Ethiopia in terms of cost/megawatt, once

complete. According to sources, it will be more costly/mw by about twice the amount spent on the Grand Ethiopian Renaissance Dam (GERD), which is currently the largest dam in Africa. It is projected to produce 391MW of electricity [20].

However, the project remain at the paper level, due to commitment on the side of the government officials and pressure from the local community on the government so as to make them committed to their promise to invest on the rivers. In the same vain, Sor river have been producing 0.5 MW electricity which have been used by government to supply energy to entire woreda of Ilu Aba Bor zone, Gambella and Dambidollo town before it has cease producing hydor power generation due its technical problem several years ago. Since then, nothing has been said about the maintenance of this micro project and it remains out of use since then. This can be resulted from different factors, including financial constraints, lack of commitment from the side of the government officials, lack of awareness about the potentials of the water resources for hydropower generation and skilled man power in the area⁴.

Thus, though the two rivers has huge potential for hydro-power generation and electricity which can improve the lives and livelihoods of local people and socioeconomic development of the nation in general, both government and private sector failed to invest in hydropower generation project on these rivers. This not merely holds down national economic development of Ethiopia but also invigilated right access to electricity rights of the local people. In turn it will contribute to deforestation as the local community forced to use charcoal in order have access to electricity which in turn affects the health conditions of the local people.

Furthermore, investing in the hydro-power generation may play a significant role in creating job opportunity for the youths in the area which can improve the lives and livelihoods of the youth and it also used as to transfer technology and infra structural development in the area, but these all opportunities has remain hidden from the eyes of the government officials and investors. Two waters resources have also huge potential for tourist attraction and irrigation schemes which can create excessive jobs opportunities for local communities. However, these all potentials are less known by officials and private sectors.

Therefore, these two rivers (Gebba and Sor) are less known and underutilized by government officials, private sectors and local communities for irrigation schemes, fisheries, hydropower generations due to lack of adequate finance, skill man power and commitment from the side of the government.

3.4. Utilization and Management of Sor and Geba Rivers: Comparative Analysis

Though the two rivers has a huge potential for irrigation,

3. Interview conducted with expert from trousim office of Yayu woreda, Ilu Aba Bor zone.

4. Key informant interview for expert from Ilu Aba Bor Water resource development and management bureau.

fisheries, swimming pool, recreational activities, hydropower generation, tourist attraction and other economic benefits, it remain underutilized, less conserved and protected. However, relatively speaking Sor rivers is more utilized than that Gebba rivers, this due to the nature of river because sor river flows not in hilly as to that of Gebba rivers, for instance Sor river is utilized for ritual activities such as Irrecha celebration which celebrated as “Irrecha Malka Sor” by Ilubabor zone communities annually in the mid of November. However, Gebba River is not utilized for such activities due the nature of flow of the river⁵.

Furthermore, sor river use for micro irrigation by farmers during dry season to produce different products such potatoes and tomatoes where as in the cases of Gebba river the local communities has no potential to use it for irrigation purposes due to the nature of the river

Sor River is also utilized by Mettu town and Hurumu town water development bureau to supply clean water for the entire resident of the town while Gebba river is not used for clean water supply. Moreover, Sor River has been producing 0.5 MG which was used to supply energy for the surrounding communities though it has paused due to technical problems now. While Gebba River remain unutilized either for irrigation fisheries or hydro power generation.

In terms of management and conservation both rivers are less conserved and even Sor river polluted by waste disposal from mettu town and pollutants coffee washing factory due its proximity to the town by its nature. This made Sor River more vulnerable to pollution and waste disposal whereas Gebba River is has no such vulnerability due to the flow of its nature⁶.

In a nutshell, though both river are less conserved and utilized by local community and the government due financial constraints, skilled man power and lack awareness, relatively speaking, Sor river is more utilized as compared that of Gebba river which is not contributing any value to local communities and entire country, sor river has been utilized by local communities for micro irrigation, ritual activities, and hydro power generation.

4. Conclusion and Recommendation

4.1. Conclusion

Water defines everything of plant, animal and human life. Water is necessary for all forms of human, animal and plant life. It is essential for overall human wellbeing and supports all aspects of human living. Harnessing this natural resources and utilizing its potential is paramount to realize the national development by satiating ever growing energy need of the nations. Ethiopia is also not out of this fact. Proper utilization and conservations of water resources are key to foster economic development of local community. This study

examined the utilization and managements of Sor and Gebba Rivers (tributaries of Baro –Akobo) river comparatively.

The finding of this study revealed that both Sor and Gebba rivers are un-utilized rivers by local community due financial constraints, however, sor rivers relatively utilized by local community than that of Gebba rivers.

In terms water resources conservation and management, the finding of this study disclosed that, both Gebba and Sor rivers are not protected and conserved by local community and concerned government officials from two zonal administrations due to lack of awareness. Thus, both water resources has not received protection, management and conservation from local community and the concerned government authorities of two zonal administration.

4.2. Recommendations

The finding of this study revealed that, Sor and Gebba rivers potential wasn't harnessed to be utilized for local community for economic development and Sor and Gebba rivers un-utilized by local community due to financial constraints and again received less protection, conservation and management of from local community and concerned government officials at local, regional and national level due to lack of awareness. Thus, taking proper measures is the only viable means to improve the utilization, management and conservations of Gebba and Sor rivers (Baro- Akobo tributaries). Therefore, the following recommendations are forwarded to the concerned body if utilization and conservation of potentials Sor and Gebba Rivers are to be realized to achieve sustainable development at local and national levels.

- 1) The government should allocate enough budget to utilize the maximum potentials of Sor and Gebba rivers for different purposes such as hydro-electric power generations, micro and macro irrigations, tourist attraction, swimming poll, fisheries and other purposes to realize economic development of the nations and local community
- 2) The national government should give due emphasis for non-trans boundary water resources utilizations and protections such as Gebba and Sor river and harness its potential for national development in line with trans-boundary water resources.
- 3) Iluabor and Bunno bedelle zonal administration work hand in hand to utilize, conserve and protect Sor and Gebba rivers for local development by searching alternative finance sources in addition to government budget.
- 4) There should be awareness creation for local community who have proximity to both of water resources, on how they can utilize, those water resources, protect and preserve the those water resources to improve their economic livelihood and life.
- 5) Local community should mitigate their difference by pacific means alone with regard to utilization of those water resources.
- 6) The government should invest on the utilization of Sor

5. Interview with expert from Tourism office of Ilu Abba Bor Zone, Oromia National Regional State, Ethiopia.

6. Interview with officer from Ilu Aba Bor zone water development and management bureau.

and Gebba rivers for different purposes such as energy, irrigation project, fisheries, tourist destinations and others to

- 7) improve the life of the local people of two zonal administration

References

- [1] Agwata, J. (2005). Water resources utilization, conflicts and interventions in the Tana basin of Kenya.
- [2] Alemayehu Kasaye. (2015). Land Use Land Cover Change and Its Implication on Surface Runoff: A Case Study of Baro River Basin in South Western Ethiopia. *Journal of Environment and Earth Science*. 5 (8) 2015.
- [3] Asnake, Kefale. (2011). Narratives of Developmentalism and Development in Ethiopia: Some preliminary explorations. In the European Conference on African Studies, Uppsala, Sweden.
- [4] Awulachew, S., Yilma, A. D., Loulseged, M., Loiskandl, W., Ayana, M., & Alamirew, T. (2007). *Water resources and irrigation development in Ethiopia*.
- [5] Ayalew, D. W. (2018). Theoretical and Empirical Review of Ethiopian Water Resource Potentials, Challenges and Future Development Opportunities. *International Journal of Waste Resources*, 8 (4).
- [6] Chenoweth, J., 2008. A re-assessment of indicators of national water scarcity. *Water International*, 33 (1), pp. 5-18.
- [7] Commission on sustainable development (2004). Making water part of economic development. The economic benefits of improved water management and services.
- [8] Creswell, J. (2009) *Research design: Qualitative, quantitative, and mixed methods approach*, 3rd ed. Sage Publications.
- [9] Fana, Gebresenbet. (2016). Land Acquisitions, the Politics of Dispossession, and State-Remaking in Gambella, Western Ethiopia. GIGA German Institute of Global and Area Studies.
- [10] Kothari C. (2004). *Research Methodology; methods and techniques*. Second revised edition. New age international publisher, New Delhi.
- [11] Kurunthachalam SK (2014) Water Conservation and Sustainability: An Utmost Importance. *Hydrol Current Res* 5: e117. doi: 10.4172/2157-7587.1000e117.
- [12] Manase, G., (2009). The strategic role of water in sustainable economic growth and development: the case of South Africa. In *Water, sanitation and hygiene: sustainable development and multisectoral approaches. Proceedings of the 34th WEDC International Conference, United Nations Conference Centre, Addis Ababa, Ethiopia, 18-22 May 2009* (pp. 439-444). Water, Engineering and Development Centre (WEDC) Loughborough University of Technology.
- [13] Mengistu Woube (1999). Flooding and sustainable land–water management in the lower Baro–Akobo river basin, Ethiopia.
- [14] Mesgana Berhane (2013). Estimation of Monthly Flow for Ungauged Catchment (Case Study Baro - Akobo basin). Addis Ababa University unpublished MA thesis.
- [15] Norwegian National Research Ethics Committee (2016). *Guide line for research Ethics in social science, humanities, law and Theology*. 4th edition.
- [16] Reddy N. Mulualem B. and Firisa Ch., (2018). Assessment of Surface Water Potential Based On Watershed Modeling: A Case of Sor Watershed, Ethiopia. *International Journal of Basic and Applied Sciences*. 7 (3) Pp. 102-114.
- [17] Sharma G. (2017). Pros and cons of different sampling techniques. *International Journal of Applied Research* 3 (7), 749-752.
- [18] Singh, A. S., & Masuku, M. B. (2014). Sampling techniques & determination of sample size in applied statistics research: An overview. *International Journal of Economics, Commerce and Management*, 2 (11), 1-22.
- [19] Theodore H., (2004). *Applying the Concept of Sustainability to Water Resources Management*.
- [20] Wang, C., Wang, G., Feng, Z., Ji, X., Li, Q., Zhang, Z., & Song, D. (2011). Comprehensive utilization of the water resources in small watershed. *Procedia Environmental Sciences*, 10, 1509-1512.