



Effect of agriculture on surface water quantity and quality in Gilgel Gibe watershed, southwestern Ethiopia

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Abstract Monitoring water quality and quantity is crucial to be sure that water resources are sustainably used. However, there is no monitoring system of water quantity and quality in southwestern Ethiopia, despite expansion of agricultural activities demanding water resources. The objective of this study was to investigate the effect of agriculture on water quantity and quality with special emphasis on irrigation in southwestern Ethiopia. Data of water quantity was collected from four rivers and four irrigation canals during dry season of 2023. Physico-chemical water quality data

was collected from 35 sites. Water quantity was calculated by estimating the water discharge of the rivers and irrigation canals. Weighted arithmetic water quality index was calculated to assess the status of the studied rivers. Principal component analysis was used to identify the relation of the sites with water quality parameters. This study revealed that the average amount of abstracted water for irrigation from the four studied rivers was 22,399 m³/day during the studied period, and the average percentage of abstracted water was 17%. Sites downstream of the irrigation site were characterized by poor water quality compared with the upstream sites. Sites surrounded by agricultural land use were correlated with chemical oxygen demand, electric conductivity, nitrate, orthophosphate, water temperature, and pH, whereas all sites surrounded by forest were positively correlated with dissolved oxygen. This study indicates that agricultural activities have a negative impact on surface water quality and quantity if not managed properly. Hence, we recommend sustainable use of water resources for the planned irrigation expansion.

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Introduction

From the total available water on Earth, only less than 3% of the world's water is freshwater (Baballe

et al., 2022; Dansharif et al., 2023). Out of this, only 0.04% of it may be utilized for human consumption or human activities and more than two-thirds of it is frozen in glaciers and ice caps (Baballe et al., 2022; Dansharif et al., 2023). Regardless of providing ecological and economic values, freshwater ecosystems are highly threatened (Mekonnen & Manderso, 2023; Mekonnen & Tekeba, 2024). In developing countries like Ethiopia, freshwater ecosystems are under threat due to land use and different economic activities (Chawaka et al., 2018; Geleta et al., 2023). These activities have a negative impact on water quality and quantity (Geleta et al., 2023; Mereta et al., 2012). Consequently, changes in physico-chemical water quality and reduced water quantity as result of land use affect freshwater biodiversity (Kanownika et al., 2020; Mereta et al., 2012). Moreover, intensive land use also affects the water resources by reducing seasonal stream flow (Mekonnen & Manderso, 2023).

Agriculture and urbanization are among the most important causes affecting freshwater resources in tropical countries (Alavaisha et al., 2021; Camara et al., 2019). This is especially true for developing countries like Ethiopia as a result of increased demand for food and thus agriculture such as irrigation and economic development including industrialization (FDRE, 2011). The Ethiopian government recently adapted its policy to increase agricultural production for example via large-scale wheat irrigation to assure food security (Effa et al., 2023). Whereas large-scale irrigation is used to achieve food security, it also affects water quantity and quality. Recent studies on Ethiopia's irrigation systems reveal that in most of the water sources utilized for irrigation, the flow of the river downstream reaches zero levels. As a result, during the dry months of the year, there is a critical water scarcity affecting livestock, sanitation, and ecosystem services (Geleta et al., 2023; NBI, 2020; Shewit et al., 2017; Taye et al., 2021).

Monitoring water quality and quantity is crucial to be sure that water resources are safe and sustainably used (Chapman & Sullivan, 2023). It can also help to achieve the United Nations Sustainable Development Goal 6 which entails increasing the proportion of water bodies with a good ambient water quality and ensure sustainable withdrawals and supply of freshwater to address water scarcity. Many developed countries in Europe have environmental policy such

as the Water Framework Directive (WFD) for monitoring of freshwater ecosystems. Regardless of having a water management policy, the majority of developing countries like Ethiopia lack a monitoring network checking the water resources resulting in lack of evidence-based decision-making (Babiso et al., 2023).

The Gilgel Gibe watershed is one of the most important surface water resources of Ethiopia, which has been considered an important area for irrigation and hydroelectric development. Considerable investments in surface water irrigation are planned and carried out by the government in this watershed to improve food security. In addition, this watershed is characterized by fast urban expansion which is affecting the water resources in the area (Bakure et al., 2020). Therefore, water resource monitoring and conservation should be incorporated before resource extraction problems become irreversible.

Surface water irrigation and intensification efforts will require information on water quantity and quality to manage withdrawal during the dry season, especially when the rivers contribute to hydropower generation in order to maintain sufficient flow. Despite the importance of the Gilgel Gibe watershed for food security and hydropower generation, the effect of agriculture on both water quantity and quality of rivers is not studied. Previous studies conducted in this watershed mainly focused on spatio-temporal hydroclimate variability (Anose et al., 2021), impact of human disturbance on wetland biodiversity (Chawaka et al., 2018), deterioration of stream flow monitoring (Haile et al., 2022), and analysis of physico-chemical water quality parameters for streams under different land use activities during wet season (Bakure et al., 2020). However, there is no study conducted combining both water quality and quantity aspects to investigate the effect of agricultural activities with special emphasis on irrigation in the Gilgel Gibe watershed to our knowledge. In addition, although there are studies conducted on the impact of irrigation on water quality in the rift valley regions of the country, there is no study conducted in southwestern Ethiopia, despite serious wheat irrigation expansion in the catchment. Therefore, it is crucial to investigate the effect of agriculture on both water quantity and quality of river ecosystems to give evidence-based insight for decision-makers to develop management strategies for sustainable use of water resources in southwestern Ethiopia. Moreover, investigating the

amount of water abstracted for irrigation and its effect on water quality can give insight for equitable use of water by the community living downstream of the rivers. The objectives of this study were (1) to investigate the effect of agriculture on water quality of rivers in southwestern Ethiopia and (2) to analyze the effect of irrigation on water quality and quantity in order to give insight on future management strategies for sustainable water use.

Materials and methods

Study area

This study was carried out in seven rivers located in the Gilgel Gibe watershed in the southwestern part of Ethiopia: Gulufa, Beyan, Nada Guda, Nada Qala, Makulo, Awetu, and Merewa rivers which flows through forest and agricultural land (Fig. 1). Four rivers (Beyan, Makulo, Nada Qala, and Nada Guda)

were selected to investigate the effect of irrigation on surface water based on intensive wheat irrigation. In these rivers, irrigation canals directed water from the rivers to the fields which involved water moving by gravity over soil from canals to the field. The area has an average annual temperature of 22–32 °C and the catchment’s altitude ranges from 1096 to 3259 m a.s. (Chawaka et al., 2018). The average annual precipitation ranges between 1000 and 2800 mm (Gonfa, 1996; Chawaka et al., 2018; National Meteorological Agency, 2020).

Water quality data

During the dry season of the area, from January to March 2023, physico-chemical water quality data was gathered from 35 sampling locations along seven rivers (Gulufa, Beyan, Nada Guda, Nada Qala, Makulo, Awetu, and Merewa). The selection of sampling locations per river depends on the presence of vegetation, previously cultivated agricultural land with no

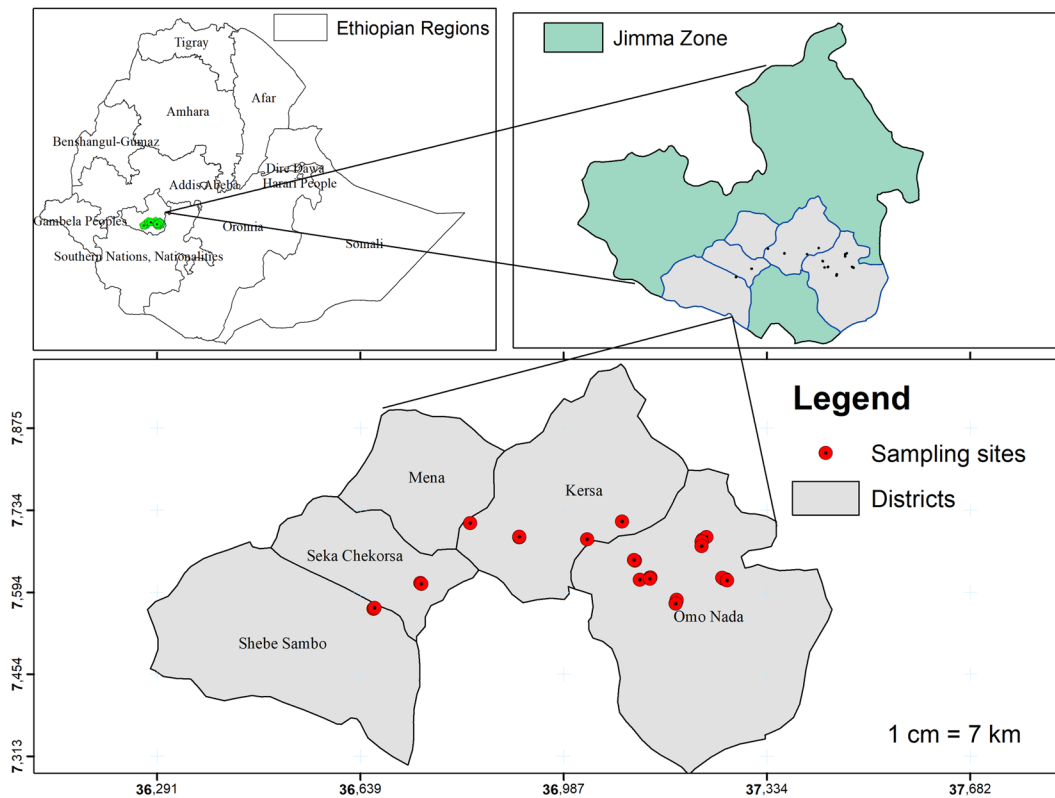


Fig. 1 Map of the study sites and its geographic location within southwest Ethiopia

irrigation activities adjacent to the rivers and sites with irrigation activities including water diversion and cultivation. Only dry season data were collected since this is the period where irrigation takes place. Out of 35 sampling locations, 21 sites were located adjacent to agricultural activities including irrigation and 14 sites were surrounded by forest with no irrigation activities. To investigate the effect of irrigation on water quality, 24 sampling locations from four rivers (Beyan, Nada Guda, Nada Qala, and Makulo) were surveyed where the adjacent land use is mainly wheat cultivation following the method of Alavaisha et al. (2019). Each river was divided into three zones (zone A, B, and C) (Alavaisha et al., 2019) and two sampling locations were monitored in each zone with a total of six locations per river. Zone A was located upstream, which is surrounded by forest with limited human activities and located above the water diversion point of the irrigation canal. Zone B was located at the mid-stream with only water abstraction through an irrigation canal and at the constructed dam for water diversion. Zone C was located downstream adjacent to the wheat irrigation where the use of agricultural chemicals and fertilizers is common. Physico-chemical water quality parameters such as dissolved oxygen (DO), electrical conductivity (EC), pH, turbidity, and water temperature were measured in the field using a multi-probe meter. Two liters of water samples was collected at each site and transported to the laboratory for analysis of chemical variables such as chemical oxygen demand (COD) and phosphate and nitrate (NO₃, mg/L) using standard method according to APHA (1995).

Water quantity data

Water abstraction was measured three times per day from January 2023 to March 2023 at the main river and at the irrigation canal. There is no regular monitoring of water discharge in the selected river before this study and the discharge of the rivers was estimated based on the data obtained only during the study period. The discharge of the rivers in cubic meters per second was estimated by multiplying the area of flow in the main river with the velocity of the flow following the method of Taye et al. (2021). The area of the flow was obtained by multiplying the width of the canal as well as the river by the depth of the flow. The float method was used to estimate the velocity of the flow and the time required

for a floating material to travel a certain distance was measured as ascribed by Taye et al. (2021). Considering an overestimate of the average velocities when using the float method, surface velocities obtained from this method were multiplied with a correction factor of 0.85 (Salazar et al., 1994) to get actual river velocities. The same procedure was followed to estimate the water discharge of the irrigation canal. The percentage of the abstracted water from the rivers during the irrigation period was calculated by multiplying the amount of water discharged in the canal by 100 and dividing the result by the discharge of the river.

Data analysis

The Water Quality Index for the rivers was calculated from DO, EC, pH, water temperature, COD, phosphate, and nitrate using the weighted arithmetic water quality index method following Brown et al. (1970). Water quality parameters are multiplied by a weighting factor and are then combined using a simple arithmetic mean by the following equations:

$$WQI = \sum WiQi/Wi \quad (1)$$

The quality rating scale (Qi) for each parameter is calculated using the following formula:

$$Qi = (Vi - V0)/(Si - li) \quad (2)$$

where Vi is the estimated concentration of the i^{th} parameter in the analyzed water $V0$ is the ideal value of this parameter in pure water $V0=0$ (except pH=7.0 and DO=14.6 mg/L). Si is the recommended standard value of the i^{th} parameter.

The unit weight Wi for each water quality parameter is calculated by using the following formula:

$$Wi = K/Si \quad (3)$$

where K =proportionality constant and can be calculated by:

$$K = \frac{1}{\sum(\frac{1}{Si})} \quad (4)$$

The rating of WA-WQI from 0 to 100 where 0–25 excellent, 26–50 good, 51–75 poor, 76–100 very poor, > 100 unsuitable for consumption.

Principal component analysis (PCA) was used to explore the relation between land use and

environmental variables. The significance of the fitted vectors was assessed through a 999 permutation procedure. To investigate the variation of physico-chemical variables between land use and between irrigation zones, analysis of variance (ANOVA) was conducted. All statistical analyses were conducted by R software (R development core team, 2023).

Results

Effect of agriculture on water quality

The findings of this study indicated that the average water quality parameters varied between forest and agricultural land use sites in the study area (Table 1). Dissolved oxygen concentration was significantly lower at sampling locations situated adjacent to agricultural land use ($P < 0.0001$) whereas concentration of COD, orthophosphate, and water temperature was higher ($P = 0.003$, $P = 0.008$, and $P = 0.001$ respectively) compared to locations surrounded by forest land use (Table 1). Although the concentration of EC, pH, and nitrate was higher at sites surrounded by agricultural land use, compared to the forested sites, no significant difference was observed.

According to the calculated value of the WQI, the samples collected from sites surrounded by forest land use showed a good water quality with a value of $WQI = 44$ whereas the samples collected from agricultural sites were categorized under poor water quality with a WQI value = 68.

The first and the second axis of the PCA explained a total variation of 60%, where the first axis explained 38% of the variance and the second axis explained 22. The PCA biplot in Fig. 2 indicated that sites surrounded by agricultural land use were correlated with COD, EC, nitrate, orthophosphate, water temperature, and pH, whereas all sites surrounded by forest land use were positively correlated with DO).

Effect of irrigation on water quality

The water quality varied depending on irrigation activities in the study area. Significantly higher COD, phosphate, and nitrate concentrations were found at the sites situated downstream of the irrigation zone (zone C) ($P = 0.04$, $P = 0.01$, $P = 0.004$ respectively) compared to zone A which is characterized by no irrigation activities and zone B with only water abstraction. EC and pH showed no significant difference between the three zones: upstream (zone A), at the water abstraction zone (zone B), and downstream of the irrigation (zone C) (Fig. 3). A higher average DO concentration was observed upstream of the irrigation zone, whereas the average water temperature was higher at the irrigation inlet (zone B).

The samples collected upstream of the irrigation zone with less irrigation activities showed a good water quality (Table 2). The water quality at the inlet of the irrigation where water abstraction takes place and downstream of the wheat irrigation could be categorized as poor water quality according to the calculated WQI Table 3.

Effect of irrigation on water quantity

The water discharge for the studied sites and the amount of water abstracted for irrigation, and irrigated area in ha is presented in Table 4. Beyan river has the highest water discharge followed by Nada Guda and Nada Qala rivers with a discharge of 51,206 m³/day, 34,455 m³/day, and 33,230 m³/day, respectively. The amount of diverted water for irrigation per river ranged from 2377 to 14,339 m³/day. In all locations, water is diverted to irrigation fields for 24 h. The highest water abstraction was measured at the irrigation canal of Beyan River with a value of 14,339 m³/day to irrigate 469 ha as indicated on Fig. 4 and Table 4. Although Makulo river discharge and the area of the irrigation are low

Table 1 Summarized average water quality parameters in agricultural land use and forested sites, where DO is dissolved oxygen, EC is electric conductivity, WT is water temperature, and COD is chemical oxygen demand

Land use	No. of sites monitored	DO (mg/L)	EC (µs/cm)	pH	WT (°C)	COD (mg/L)	Phosphate (mg/L)	Nitrate (mg/L)
Forest	14	7.2	61.4	7.7	20.6	16.6	0.1	0.4
Agriculture	21	6.4	77.4	8.1	22.2	84.4	2.2	1.7

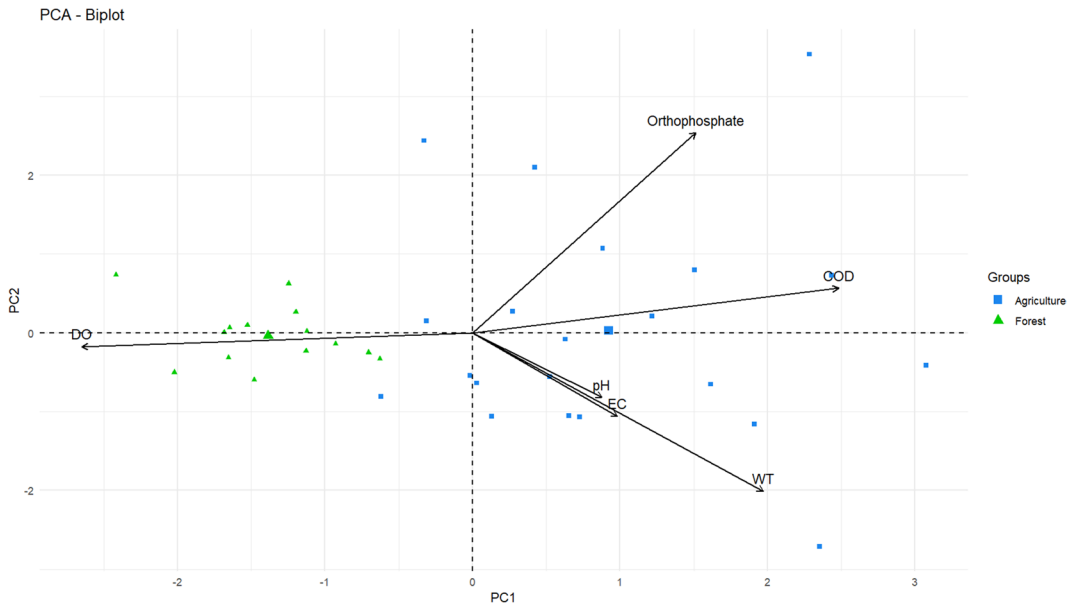


Fig. 2 PCA biplot indicating the relation of study sites with physico-chemical water quality, where DO stands for dissolved oxygen, COD stands for chemical oxygen demand, WT stands for water temperature, and EC stands for electrical conductivity

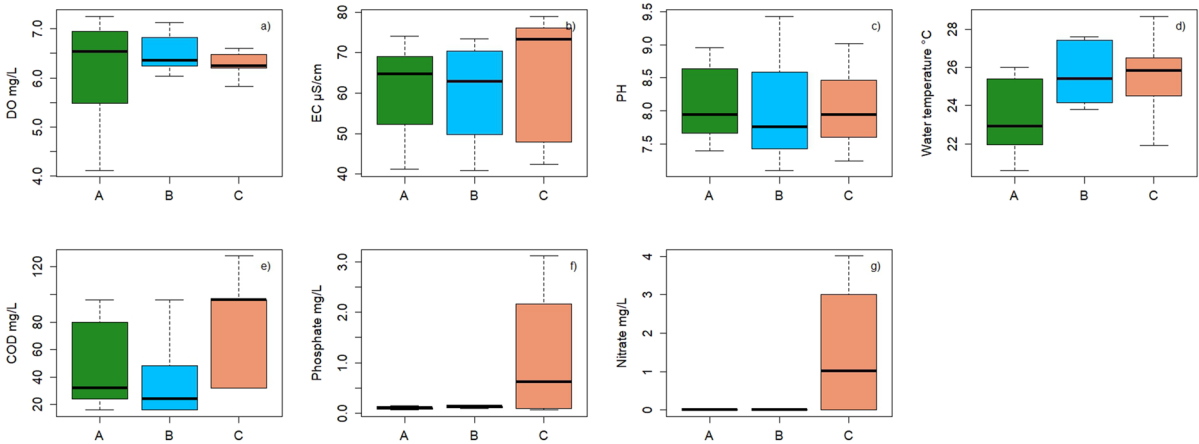


Fig. 3 Boxplot of physico-chemical water quality at irrigation land use, where letter 'A' represents upstream of the irrigation canal, letter 'B' represents the irrigation canal and dam with

water abstraction, and letter 'C' represents downstream sites adjacent to wheat irrigation with extra input of pollutants from irrigation

Table 2 Water quality of the studied rivers at irrigation land use based on Weighted Arithmetic Water Quality Index (WA-WQI)

Location	WA-WQI value	Water quality
Upstream with no irrigation effect (zone A)	43	Good
Irrigation dam and canal (only water abstraction) (zone B)	65	Poor
Downstream of wheat irrigation (water abstraction and extra input of pollutant from irrigation) (zone C)	64	Poor

Table 3 Calculation of Weighted Arithmetic Water Quality Index (WA-WQI) of the studied rivers

	Parameters	Standard value (<i>Si</i>)	Ideal value (<i>Ii</i>)	Monitored value (<i>Mi</i>)	Sub-index value (<i>Qi</i>)	Weightage unit (<i>Wi</i>)	<i>Wi</i> × <i>Qi</i>
Zone A	DO (mg/L)	7	14	6.85	100	0.274	27.376
	EC (µs/cm)	750	0	60.00	8	0.003	0.020
	pH	8.5	7	7.40	40	0.222	8.893
	Water temperature (°C)	25	0	22.30	89.2	0.076	6.742
	Phosphate (mg/L)	5	0	0.09	1.831	0.378	0.692
	Nitrate (mg/L)	50	0	0.01	0.02	0.038	0.001
Zone B	DO (mg/L)	7	14	6	121	0.270	32.664
	EC (µs/cm)	750	0	68.45	9.127	0.003	0.023
	pH	8.5	7	7.5	90	0.222	20.008
	Water temperature (°C)	25	0	27.4	109.6	0.076	8.284
	Phosphate (mg/L)	5	0	0.51	10.2	0.378	3.855
	Nitrate (mg/L)	50	0	0.9	1.8	0.038	0.068
Zone C	DO (mg/L)	7	14	6	100	0.270	26.995
	EC (µs/cm)	750	0	77.4	10.32	0.003	0.026
	pH	8.5	7	7.6	60	0.236	14.173
	Water temperature (°C)	25	0	22.19091	88.763	0.076	6.709
	Phosphate (mg/L)	5	0	2.186364	43.727	0.378	16.526
	Nitrate (mg/L)	50	0	1.740909	3.481	0.038	0.132

Table 4 Average river discharge and irrigation water abstraction in m³/day of the studied rivers

Name of river	River discharge in m ³ /day	Irrigation water abstraction in m ³ /day	% of water abstracted for irrigation	Area of irrigation in ha
Nada Qala	33,230	2377	7	25
Beyan	51,206	14,339	28	469
Makulo	9916	3790	38	21
Nada Guda	34,455	1893	5	41

compared to the other rivers, the percentage of water abstracted for irrigation was higher. The amount of water abstracted for irrigation ranges from 5 to 38%. The lowest percentage of irrigation water abstraction was observed at Nada Guda (5%) followed by Nada Qala (7%) to irrigate 41 ha and 25 ha of agricultural land respectively. On the other hand, higher water abstraction (38%) was observed at Makulo river to irrigate an area of 21 ha. The estimated average water abstraction per hectare is 2.16 m³/day/ha with the highest water abstraction observed at Makulo river and the lowest water abstraction observed at Beyan river (Table 4).

Discussion

This study indicated a significantly higher concentration of orthophosphate concentration at sites situated near agricultural fields compared to sites located in forest ecosystems. These findings indicate the danger of increased risk of eutrophication of water resources in the study area. This result is in line with the result of Fetahi (2019) who reported high risk of eutrophication of water bodies due to agricultural input of nutrients in Ethiopia. In addition to higher nutrient concentrations at agricultural sites, positive correlation of COD, EC, pH, and water temperature with

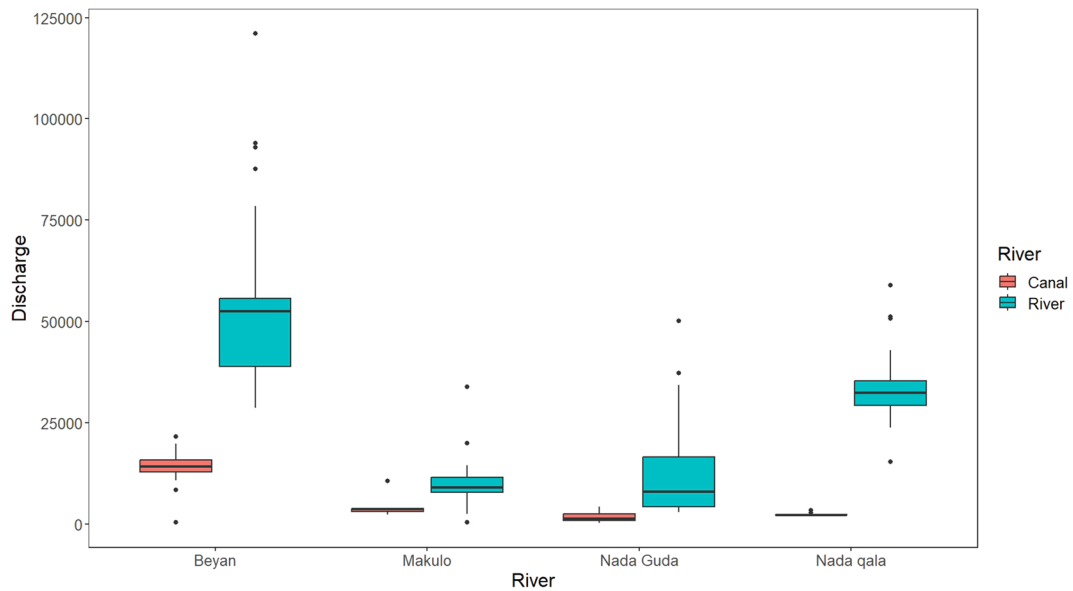


Fig. 4 Boxplot indicating water discharge in cubic meter per day for the studied rivers and irrigation canal

sampling sites situated adjacent to agricultural fields was observed. This might be due to extra input of chemicals and sedimentation (erosion) from agricultural sites to the rivers. It is reported that agricultural activities mineralize organic matter in the soil, reduce infiltration, and increase runoff which intensifies erosion rates (FAO, 2018). Compared to the sites located adjacent to agricultural land use, lower phosphate, lower water temperature, higher DO concentration, and good water quality were observed at forested sites. This result is in line with the findings of Duffy et al. (2020) who reported that forests (or vegetated buffer strips) reduce the risk of pollutant transfer to water courses and have a positive impact on water quality.

This study also revealed that irrigation has a double effect on water resources by affecting both water quantity and quality. Accordingly, significant higher COD, phosphate, and nitrate concentrations and poor water quality were observed downstream of the irrigation relative to upstream. The application of fertilizers and chemicals on the irrigated fields could explain the relatively high level of COD, nutrients, and poor water quality according to the WQI measured at the downstream sites. Increasing irrigation for crop production and promotion of high-value crop production are among the key national development policies of Ethiopia in order to achieve food

security (FDRE, 2011; MoFED, 2010; NPC, 2015; Effa et al., 2023). However, the realization of such developmental policy increases the consumption of water for irrigation, increases pollution, and causes loss of biodiversity (Taye et al., 2021; Geleta et al., 2023; MEA, 2005). Alavaisha et al. (2019) also found higher nutrient concentrations at sites downstream of irrigated agricultural land. Another study by Teklu et al. (2018) also indicated that the majority of the physico-chemical water quality parameters exceeded the Ethiopian maximum permissible limits (MPL) as a result of irrigation in the Ethiopian Central Rift Valley. Higher DO values and good water quality upstream of the irrigation can be ascribed to lower human activities and no irrigation. It is well studied that high human activities and disturbance can reduce the DO concentration and water quality in the water bodies (Haddis et al., 2014; Zhou et al., 2022) due to the need of oxygen for organic decomposition.

Ethiopia is referred to as the water tower (Effa et al., 2023) with enormous stocks of water found in the southwestern part of the country. This study investigated small rivers that are tributaries of the Gilgel Gibe river, however with relatively high water discharge ranges from 33,230 to 51,206 m³/day during the dry season. Despite adequate availability of water, poor management of water resources for irrigation such as poor design of irrigation canals and

intensive use of fertilizers may lead to water pollution and water scarcity in the study area. This is currently already observed in Makulo river which is characterized by a relatively small irrigation area, but where higher water abstraction (38%) was observed compared to the other studied rivers. Although Beyan river is characterized by a higher water discharge and a larger irrigation area, only 23% of the water discharge is abstracted for irrigation. This is lower than the result of Vogels et al. (2020) who estimated an average of 28% of the excess water consumption which is used for small-scale irrigation in Ethiopia. The average water abstraction per hectare (0.025 l/s/ha) is lower than the finding of Taye et al. (2021) who found 0.9 l/s/ha in the Lake Tana sub-basin although water requirement varies depending on soil condition and types of crop. However, considering the future plans of the government to expand wheat irrigation in the study area following the new launched home grown economy policy, the irrigation and water abstraction will become higher. In addition, this study is conducted only in a small part of southwestern Ethiopia and the amount of water used for irrigation is likely to be much higher when the whole irrigation area is considered. According to the MEA (2005), the construction of dams and other structures such as irrigation canals along rivers has moderately or strongly affected flows. Furthermore, recent research on Ethiopia's irrigation systems indicates that in a majority of the water sources used for irrigation, downstream river flows approach near-zero levels. Consequently, during the dry months of the year, there is a severe shortage of water for livestock, sanitation, and several ecosystem services (Geleta et al., 2023; NBI, 2020; Taye et al., 2021). Water resources may face more stress, especially in the country's arid and semi-arid regions, which are already suffering from drought due to climate change. Besides the effect of irrigation on water quality and quantity, its effect on biodiversity through blockage of migration routes and chemical exposure is reported in different parts of Ethiopia (Mequanent et al., 2021; Van Ranst et al., 2011).

Globally, agriculture has a large impact on water quantity and water quality. Irrigation is one of the agricultural activities that alter terrestrial water quality and water quantity through water withdrawal from rivers, lakes, reservoirs, and aquifers as well as through nutrient inputs (MEA, 2005). Considerable efforts have been made to simulate the impact of

irrigation on water resources at local/regional/global scales using different models (Haddeland et al., 2006; Leng et al., 2015). However, limited studies in developing countries like Ethiopia on the details of irrigation representations such as amount of water abstracted for irrigation, irrigation water source, irrigation method, and its impact on water quality can lead to uncertainty in understanding the impacts of irrigation at global scale. Nevertheless, this study represents a significant effort toward enhancing knowledge on the impact of agriculture including irrigation, on surface water using the original field data and laboratory experiments. Moreover, it helps to achieve the sustainable development goals (SDG) of (1) SDG 6.3 which states about water quality and (2) SDG 6.4 which states water-use efficiency and sustainable withdrawals of water.

Conclusion

Freshwater ecosystems in southwestern Ethiopia are under high pressure due to increased agricultural activities. Currently, irrigation is considered the best option to achieve food security in the country. Although irrigation is expanding in the Gilgel Gibe watershed, its effect on water quality and quantity has not been studied before. This study gives insight on the effect of agricultural activities on water resources with special emphasis on the effect of irrigation on the water quality and quantity of the rivers situated in Gilgel Gibe watershed. The results revealed poor water quality in the rivers downstream of irrigation fields compared to the relatively natural upstream sites. The amount of water abstraction varied depending on the size of the river, irrigation area, and irrigation structure. The amount of abstracted water for irrigation from the four studied rivers was 22,399 m³ for 75 days, and the average percentage of abstracted water was 17%. In addition, wastage of water due to poor management and poor irrigation structure was observed in the study area which needs mitigation strategy. This study conducted only on few rivers located at upstream of Gilgel Gibe water shade due to limited financial and logistic support. If all irrigation sites in the Gilgel Gibe watershed were included, the water abstraction is by far greater than our calculations. This can reduce the water flow to downstream thereby affect downstream users of the community.

Thus, more detailed studies are recommended on the total area that is irrigated at the upstream of the Gilgel Gibe water shed, the total amount of water abstraction by irrigation activities, and its impact on downstream users. In addition, integration of eco-friendly agriculture to the existing agricultural policy is recommended to achieve food security without harming the environment.

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Author contribution Selamawit Negassa Chawaka led the study, conceptualized, designed and performed research; Pieter Boets, Peter Goethals, Seid Tiku Mereta and Venkata Ramayya Ancha participated in writing, review and editing the draft.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Ethical responsibility of authors All authors have read, understood, and complied as applicable with the statement on “Ethical responsibilities of Authors” as found in the Instructions for Authors.

Consent for publication This paper has not been published elsewhere.

Competing interest The authors declare no competing interests.

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