

Small-scale irrigation development in the wetlands of South-West Ethiopia

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Abstract

The basic problem of water distribution in the world is the temporal and spatial differences that exist in the supply and demand of water. The general solution of this problem lies in adjusting water supply and demand so that the demand will always be smaller than or equal to the supply. Storage of water is one of the most useful methods for changing the amplitude and phase of the water supply. Such storage of water can be carried out only through knowledge of the water resources of the region being considered. Water resource potential is said to be abundant in Ethiopia but still difficult and expensive to exploit. A rational management and development of water resources is required to effectively and efficiently utilise water resources to achieve food self-sufficiency and food security. With this background, it is essential to develop a small-scale irrigation system. Harnessing some of the sizable rivers can produce some medium- to small-sized irrigation projects. Data were collected to show some preliminary figures about irrigated and potentially irrigable areas for some regions in West Shewa. Using a deterministic hydrologic model, the water balance of four representative rivers in West Shewa were simulated and analysed. The simulation showed that rainfed agriculture may be practised in West Shewa for seven months (March to September), and the rest of the months should be supplemented with irrigation. This implies the importance of the development of small-scale irrigation even in wet region. The small-scale irrigation development will be beneficial for this region for (a) supporting the realisation of food self-sufficiency and food security; (b) improving the living quality and standard of the people through the provision of sustainable agriculture; and (c) enhancing the contribution of irrigation in attaining national development priorities, programmes and objectives.

Introduction

The growing intensity in the utilisation of water necessitates the assessment and control of water resources. Better knowledge of the temporal and spatial variations of water supplies is a precondition for the planning, investment and regulation of systems of water distribution. The basic problem of water distribution of the world is the temporal and spatial differences in the supply and demand of water. The general solution to this problem lies in adjusting

water supply and demand so that the demand will always be smaller than or equal to the supply. Storage of water is one of the most useful methods for changing the amplitude and phase of the water supply. Such storage of water can be carried out only through knowledge of the water resources of the region being considered. The quantitative statement of the balance between water gains and losses in a certain watershed during a specific period of time is known as the water budget. The water balance equation makes use of the outflow-inflow relation. A proper understanding of the role of water in agriculture requires a careful analysis of the nation's water budget.

Water resource potential is said to be abundant in Ethiopia but is still difficult and expensive to exploit. Because of the highly erratic nature of rainfall in Ethiopia, drought is a very serious social problem. The streams are difficult to dam for many reasons, among which are: inadequate storage sites, extremely high seasonal flow during the big rain period, low water retaining capacity, high sediment loads, and transportation of boulders during high flow seasons. Considering the present status of irrigation development and management in West Shewa, it is likely that irrigation has considerable potential to further increase in agricultural production and the income of people in the irrigated areas, both through construction of new projects and more efficient management of existing ones. While this view is likely to be correct, analysis of the existing situation indicates that if irrigation is to play a crucial role as an engine for further expansion of agricultural production, the management and organisation of irrigation systems, including their institutional implications, must be substantially improved.

Harnessing some of the sizable rivers can produce some medium- to small-sized irrigation projects in West Shewa. These schemes will require surface water storage, spillways and a network of main, secondary and tertiary canals. Investment costs are likely to be high. These schemes may be economical if irrigation benefits are combined with hydropower and flood control benefits. So far as technical aspects are considered, currently insufficient geological and hydrological data are available for planning and constructing large multi-purpose dams and reservoirs. Additional data will be necessary on sedimentation rates, and how these may be influenced by the construction of dams. While traditional irrigation has been practised for several decades, there is considerable need both to expand the currently irrigated area and to improve the efficiency of existing systems. There is no question that for the future economic development of the region, irrigation development and management must play an important part. It should, however, be noted that before major irrigation projects can be developed, the farmers should be well-oriented on how to use the water resources.

Decision making in irrigation development

The choice of specific irrigation and water management methods must depend on the support of all those affected by management changes. Participation of stakeholders is fundamental in the planning process of small-scale irrigation. Planning involves deciding which irrigation method and water management strategy to pursue from among a number of possible options. This decision will not only be made at the beginning of a project but

throughout its lifetime in response to monitoring and evaluation of project progress and changes in the environmental system. The group of people who are responsible for implementing them should make decisions. Decision can be made using three phases, namely intelligence phase, design phase and choice phase. The intelligence phase is concerned with identifying exactly what the problem is. The design phase sets the criteria by which a decision will be made, identifies the options available and attempts to predict the outcome of each option. The choice phase comprises the selection of the best option from those available. Stakeholders can contribute to each of these phases in different ways. In the intelligence phase, consultation with stakeholders is crucial as small-scale irrigation development problems always relate in some way to water use by people. During the design phase, stakeholders can help identify the options available and will be able to provide information to help predict likely outcomes. Following the choice phase, it is important that the decisions made are endorsed by as many stakeholders as possible, otherwise the proposed plan will not receive the stakeholder support required to implement it.

Merits of small-scale irrigation

Small-scale irrigation is widespread and has a vital role to play in Ethiopia. The success of small-scale systems is due to the fact that they are self-managed and dedicated to the felt needs of local communities. Indeed, small-scale schemes are defined as schemes that are controlled and managed by the users themselves. Traditional irrigation schemes make up the most dominant form of small-scale irrigation in the region, and some of them are well managed.

The main advantages of small-scale irrigation are:

- much lower investment costs, and in a majority of cases these costs are borne by the community
- do not involve dams or storage reservoirs, hence no population displacement is involved
- less demanding in terms of management, operation and maintenance
- no land tenure or resettlement implications
- no serious adverse environmental impact
- allow a wider diffusion of irrigation benefits and
- permit farmers to learn irrigation techniques at their own pace and in their own way.

To support small-scale irrigation, efforts should be made to enhance and improve the efficiency and productivity of traditional irrigation. For example, the most persistent problem of traditional river diversion schemes in this country is the impermanence and fragility of the headworks, which are almost always made of brushwood and earth, and which are often washed away during heavy rains and have to be frequently repaired. Farmers always complain that repairing the headworks requires too much labour. Improving the durability of the headworks and other infrastructure could contribute to efficiency and productivity. Secondly, farmers should have access to simple, cheap and environmentally friendly water technologies such as hand pumps and shallow tube wells. Thirdly, improving the marketability of irrigation produce will serve as an important incentive. This may require building access roads, offering better prices, and improving product quality. These

and similar measures of support will mean that non-governmental organisations (NGOs) and private enterprises will have to play a more active role. The responsibility of the state will then be to create an enabling environment for greater NGO and private sector interventions. Small, user-managed schemes work best if there is no state intervention or if such intervention is kept to a minimum. The state should focus on providing needed services such as credit and finance and on building up basic infrastructure.

Small-scale irrigation in south-western Ethiopia

Because of topographical conditions, irrigation development in southern Ethiopia is highly site-specific and accordingly generalisation may be misleading. Overall water from the large and medium size rivers that flow through the hills cannot be used, since they cut deep through the area, which means that river water levels are at too low of an elevation relative to the fields to be irrigated for effective utilisation. Consequently, irrigation in the hills is mostly dependent on smaller rainfed streams, some of which have very limited base flow, while others seem to dry up during the dry season. These streams are difficult to dam for many reasons, among which are: inadequate storage sites, extremely high seasonal flow during the big rains, low water retaining capacity, high sediment loads, and transportation of boulders during high flow seasons.

Harnessing some of the sizable rivers can produce some medium- to small-sized irrigation projects in this region, with command areas ranging between 250 and 15 thousand hectares. These schemes will require surface water storage, spillways and a network of main, secondary and tertiary canals. Investment costs are likely to be high. These schemes may be economical if irrigation benefits are combined with hydropower and flood control benefits. So far as technical aspects are considered, currently insufficient geological and hydrological data are available for planning and constructing large multi-purpose dams and reservoirs. Additional data will be necessary on sedimentation rates, and how these may be influenced by the construction of dams.

In south-western Ethiopia, the practices of obtaining water from small streams for supplementary irrigation include surface stream diversion, minor storage schemes based on farm-pond types of impoundment, pumping where energy is available either in the form of electricity or diesel, water turbines driven by the hydraulic energy of streams, or conveying water by pipes. The choice of a specific irrigation method depends on a variety of factors and constraints, overall economics of the scheme, subsidies available, accessibility of the site, quality of the soil, extent of irrigable land, and seasonal variation of available water. Very little information exists on the prevailing groundwater and the soil moisture conditions in the region. The locations of the localised pockets of groundwater, estimates of volumes of water that can be extracted on a sustainable basis, and their potential exploitation for agriculture can only be considered when more detailed geological maps of the region are available.

Small-scale irrigation in West Shewa

Irrigation is not new in West Shewa. It has been practised for several decades. What is remarkable, however, is the tremendous expansion of irrigation during the past two decades. Irrigation was highly intensified since 1984, because of the 'food self-sufficiency programme' declared by the government. In 1987, several projects were designed with the joint action of the governments of North Korea and Ethiopia with the aim of boosting the productivity of producers' co-operatives. Along with this programme several farmers were trained in irrigation water management. Unfortunately the programme terminated in 1999. It was observed that the farmers highly profited from those small-scale irrigation projects.

Considering the present status of irrigation development and management in West Shewa, it is likely that irrigation has considerable potential to further increase agricultural production and the income of the people in the irrigated areas, both through construction of new projects and more efficient management of existing ones. While this view is likely to be correct, analysis of the existing situation indicates that if irrigation is to play a crucial role as an engine for further expansion of agricultural production, the management and organisation of irrigation systems, including their institutional implications, must be substantially investigated and improved. Some research works were carried out in the areas of planting time, irrigation interval, crop water requirements, irrigation and water balance, farmers' participatory research etc. by development agents, and research and higher learning institutions. There is a great problem in getting sufficient trained manpower in relation to the number of farmers in the area. Therefore, a large number of trained manpower is required to support the farmers of the region.

On the basis of data collected from 10 *woredas* of West Shewa, some preliminary figures were shown about irrigated and potentially irrigable areas for the region (Table 1). Much of the land currently under furrow irrigation in West Shewa is in the Bako, Dibdibe, Denbeli, Guder and Ketta regions. The data collected for West Shewa identifies 1322 ha of land under furrow irrigation, which accounts for about 35% of the total irrigable land in Western Shewa (Table 1).

The Indris Small-scale Irrigation Project is located in Guder, a small town located 137 km west of Addis Ababa on the road to Nekemt. EEC/PADEP VI had funded a project on the Indris Scheme for two years (1992–94) to rehabilitate the headwork and main canal system. This project assisted the farmers in strengthening their water users association, drafting rules and regulations for managing their scheme and in developing a rudimentary schedule for distributing the irrigation water and organising maintenance. Due to a number of factors, including the activities of the Shewa PADEP Project, the farmers have dramatically increased the area cropped on the scheme during the dry season from 45 ha in 1990/91 to 170 ha in 1993/94. This increase has not been accompanied by a comparable increase in the available water supply. The German Agro-action and Abebech Gobena Orphanage and School have jointly financed another small-scale irrigation project on Indris River near a village called Mutulu with a command area of about 150 ha. The Ministry of Agriculture has planned to construct small earthen dams and ponds in the future.

Table 1. Irrigation in West Shewa.

<i>Woredas</i>	Main crops	Irrigated area (ha)	Source	Irrigable area ¹ (ha)
Illu	Cabbage, tomatoes, carrot, onion	16	River	180
Dibdibe (Wenchi <i>woreda</i>)	Maize, lentil, onion, potatoes, carrot, cabbage, tomatoes, sugar cane, green pepper	367	River	33
Walmara Goro (Walmara <i>woreda</i>)	Cabbage, potatoes, carrot, cauliflower	15	River	–
Mukadima Abay	Vegetables	80	River	–
Denbeli Ketta	Cabbage, onion, maize, tomatoes	300	River	–
Bako <i>woreda</i>	Mango, coffee, sugar cane, bananas, tomatoes, cabbage, green pepper	386	River	1000
Jattoo Dirki (Chelia <i>woreda</i>)	Maize, sugar cane, bananas, chat	30	River	90
Aga and Illu (Aadaa Berga <i>woreda</i>)	Barley, maize	20	River	27
Chilanko (Jaldduu <i>woreda</i>)	Potatoes, onion	5	River	30
Tolee <i>woreda</i> (42 farmers associations)	Vegetables	103	River spring	202
Total		1322	River	1562

1. Potential expansion.

Water budget in West Shewa

Computation of water balance and modelling the process of transformation of rainfall to streamflow need measurements of the appropriate meteorological variables. Therefore, calculation of the areal distribution of precipitation from point measurement and determination of the areal potential evapotranspiration (PET) from the necessary meteorological information were carried out. Areal rainfall was estimated from point rainfalls with the HYBSCH model (Taffa 1989, 1990b, 1991) which uses the hypsometric curve method. From these simulations, it was estimated that the average annual discharge of the rivers originating in West Shewa and flowing to the Abay river amounts to 20 billion m³, which is equivalent to 634 m³/s of continuous flow. While this total quantity of water is undoubtedly substantial, the river flows have significant seasonal fluctuations. An inadequate number of river gauging stations and their improper allocation make it difficult to estimate the amount of land that can be properly irrigated in West Shewa by surface water.

Results, discussion and recommendations

From the above simulations, the West Shewa watershed has a total water deficiency of 632 mm from October to April (1966–84) (Table 2). From May to June there was soil moisture

recharge, that is soil comes to field capacity towards the end of June and moisture becomes available for optimum plant growth. From May to September there was a total water surplus of 696 mm, with the highest surplus at the end of July giving rise to peak streamflows at the beginning of August. From October to the end of November, stored soil moisture is utilised by plants, which means there is some amount of moisture available for plant growth, although not at optimum rate.

Table 2. Average water balance for West Shewa (1966–84) in mm, as simulated using HYBSCHE model.

Model	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P	23	41	83	78	153	194	256	249	204	73	26	18
PET	158	116	121	148	100	74	54	51	81	132	127	172
RET	34	25	45	69	71	69	54	51	81	129	90	65
RO	0	0	0	0	9	56	165	180	123	18	1	0
Sm	2	1	1	1	26	43	47	40	38	37	3	1
cSm	-1	-1	-1	0	22	17	4	-7	-2	-2	-34	-2
Smd	135	75	38	70	-	-	-	-	-	59	101	154
Sms	-	-	-	-	53	120	202	198	123	-	-	-

Notes: (P = precipitation; PET = potential evapotranspiration; RET = real evapotranspiration; RO = surface runoff; Sm = soil moisture; cSm = change in soil moisture; Smd = P - PET, soil moisture deficit; Sms = P - PET, soil moisture surplus).

High amounts of water surplus are associated with areas of high rainfall and/or low PET. Rainfed agriculture can be practised for seven months (March to September), and the rest of the months should be supplemented with irrigation.

To help the water users association (WUA) and to manage the scarce water supply fairly and efficiently, it is essential that a more effective water management system is introduced. For this to be done, detailed information is needed not only on how much water is available but also how that water is being distributed and used. Guidelines also need to be prepared of ways in which the water management on schemes could be improved. Construction of small earthen dams and ponds shall be encouraged for the development of small-scale irrigation systems.

It is also necessary to expand farmer-managed irrigation systems (FMIS). FMIS are simple irrigation systems that are constructed and maintained by the farmers, with limited or no involvement of government agencies. Such systems mainly supply supplementary irrigation during periods of rainfall deficiency. If the government institutions provide some supervision, technical assistance, grants, and loans, it is possible to expand FMIS at relatively lower investment and operation cost since farmers could contribute labour to the construction. There is no doubt that for the future economic development of an agrarian country like Ethiopia, irrigation development and management must play an important part.

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