Spate Irrigation in Ethiopia: Potential, Development Status and Challenges

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Abstract

The paper highlights the current development status of spate irrigation in Ethiopia and its challenges. It discusses the huge potential of spate irrigation in Ethiopia and highlights the possibility of transforming this high spate potential to drought-prone lowland parts of the country and to growth centers. It also addresses the development attempts so far and the challenges faced, including traditional and modern practices. This article raises critical issues like land tenure systems and water and land use rights in areas where spate irrigation is practiced and where there are potential users of spate irrigation. Finally, it forwards its recommendations.

Old, improved and combined spate irrigation practices are prevalent in Ethiopia. Most spate farms in the southeastern parts of the country are traditional. Improved spate irrigation is being implemented almost in all areas where there is traditional practice. Population pressure, natural calamities, and loss of the bulk of grazing lands in pastoral areas of the country have led to increased use of spate water. The recent, problem-driven, water-centered growth approach has given due emphasis to this potential, resulting in preparation of integrated land use plans and implementation of water-related projects in the lowlands.

Lack of basic services like roads, potable water, power supply, and education coupled with harsh health issues like malaria, are hampering development in most spate irrigation areas. Sedimentation, change in stream/river morphology, and failure of structures are also some of the technical challenges. As spate water use increases, the problems of land tenure and water use rights grow. Modern land and water administration laws and regulations in spate irrigation areas have failed to address water rights; water allocation of perennial flows is different from spate irrigation water. Increased inequity and use conflict are seen in some areas.

Defining the most beneficial agronomic practice of spate farms, introduction of market-oriented agriculture, conjunctive use of shallow groundwater and surface water, respecting the traditional rights of the pastoral communities and involving farmers in planning, designing and decision making are priority actions.

Key words: *Land and water rights, pastoralists, conjunctive use*

Introduction

Ethiopia is located between 3^0N and 15^0N latitude and 33^0E and 48^0E longitude. It has a total area of about 1.13 million km^2. It is the second most populous country in Africa with a population of about 80 million. Ethiopia is an ancient country with a rich diversity of people and cultures and a unique alphabet that has existed for more than 3,000 years. About 85% of the country's populations are rural. Since 1991 Ethiopia has had a federal administrative structure, which constitutes the federal government and nine regional governments. The National Regional States are further divided into 580 districts *(woredas)* and about 15,000 lower administrative units *(kebeles)*.

Topographically, Ethiopia is divided into a huge central plateau surrounded by lowland plains creating good potential for spate irrigation. The Ethiopian plateaus include elevations as high as 4,620 m while the lowlands descend to 125 m below sea level at Dalol, Afar. It also has numerous active volcanoes. Ethiopia lies within the tropics, wherein every place has overhead sun twice a year. In Ethiopia, temperatures are greatly influenced by changing altitude. Extremes in temperature range from the mean annual temperature of 34.5 °C in the Danakil depression at 120 m below sea level to a minimum temperature below zero on mountain slopes of over 4,000 m above mean sea level.

In Ethiopia, the major factors influencing rainfall are the intertropical convergence zone, the northern trade winds and the southern monsoons. The country has both bimodal and unimodal rainfall profiles. Annual rainfall in the country ranges between 2,700 mm in the southwestern highlands and less than 200 mm in some parts of the northern and southeastern lowlands with a further decrease to 100 mm in the northeastern lowlands.

Available information indicates that nearly 70% of the total arable land in Ethiopia receives an annual rainfall of less than 750 mm. The areas with annual rainfall of 500-750 mm are believed to support optimum level of agricultural activities, if the annual rainfall distribution is undisturbed and proper land management is applied. However, the annual rainfall distribution of most parts of Ethiopia, including the highlands, not only lacks uniformity but is also highly unpredictable in its interannual variations (MoA 2001; Ephraim et al. 2003). The overall coefficient of rainfall variability ranges from 10 to 50%.

Altitude is the single most important factor influencing climatic control of the country. The main climatic regions of Ethiopia are dry, tropical rainy and temperate rainy. About 66% of the total area of the country is considered as arable land. About 10.3% and 12.5% of the total land area are intensively and moderately cultivated, respectively. Only 1.6% of the country is covered under perennial crops. The country is largely dependent on the agriculture sector, which provides 86% of employment and 57% of GDP. Income in Ethiopia is highly variable from year to year, partly due to frequent and severe droughts (MoWR 2002).

Materials and methods

Modern spate irrigation has not been given due attention by researchers and scholars in agricultural fields. It is less than a decade since a systematic intervention has been made by the government and NGOs. As a result, there are no well-documented references to be cited. The main sources of information to compile this profile included observation in the field, annual performance review reports by implementing agencies and some publications that indirectly document spate issues. A review of previous reports and articles provided the major source of information to prepare this paper.

Site visits in some of the spate irrigation potential and practicing areas in Hararge, Borena, Afar, Omo Valley and Tigray were used to assess and characterize the different practices and validate foreseen scenarios. Informal interviews were done with the user communities to learn about the indigenous knowledge, and the pros and cons of improved spate irrigation systems, land tenure, existing water use practices, and gender and other issues. Development agencies, such as the water bureaus, were approached for data on spate irrigation projects and productivity.

Findings

Attempts have been made to evaluate the spate potential of Ethiopia. This paper highlights the possibility of transforming the high spate potential into the actual development and growth center. It also addresses the development attempts made so far and the challenges faced, including traditional and modern practices. In addition, this paper raises critical issues like land tenure and water and land use rights in areas where spate irrigation is practiced amongst potential users.

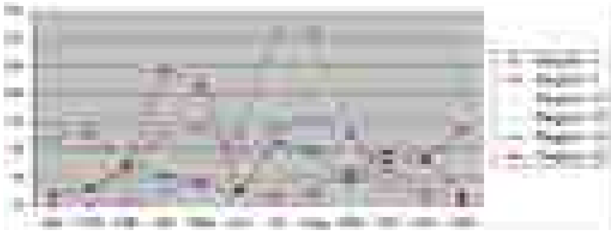
Discussion

Water Resources Potentials of Ethiopia

The mean annual specific runoff varies from zero to 35 $ls^{-1}km^{-2}$. Minimum flows occur from December to March. Apart from the big rivers and their tributaries, there is hardly any perennial flow in areas below 1,500 m. In general, perennial streams and springs exist only in the vicinity of mountains with an annual rainfall of more than 1,000 mm.

The country's annual renewable freshwater resources amount to some 122 billion m^3yr^{-1} (Bm^3yr^{-1}) contained in 12 river basins, which is only 1,525 $m^3yr^{-1}capita^{-1}$ share. However, only 3% remains in the country. At this stage, the country withdraws less than 5% of its freshwater resources for consumptive uses. The western portion of the country, with only 40% of the total land area, generates 83% of the surface water potential. It is estimated that 54.4 Bm^3yr^{-1} of surface runoff and 2.6 Bm^3yr^{-1} of groundwater could be technically developed for consumptive use. It is also estimated that in addition to clean water supply to its entire population, up to 3.7 Mha of land and 30,000 MW of power can be developed using the available water resources potential. However, only less than 300,000 ha of the irrigation and 854 MW hydropower potentials, respectively, have been developed so far. The current level of irrigation development is lower than 50% of the over 600,000 ha of irrigable land that should have been developed to meet the food demand of the present population in addition to what is being cultivated under rain-fed agriculture. The clean water supply coverage is only about 50% (DHV 2002; UNESCO 2004). See Figure 2.1 for rainfall pattern as a percentage of mean annual rainfall for six selected representative regions.

Figure 2.1. Rainfall pattern as a percentage of mean annual rainfall for six selected representative regions.



1.1 Drought and Famine in Ethiopia

Droughts are major social, environmental and economic disruptive forces in Ethiopia. They have caused heavy loss of human and livestock populations, mass starvation and mass drift to relief centers and nearby towns and cities. Five major droughts in two decades have left most Ethiopian households reeling, and hundreds of thousands of people still live on the brink of survival (UN 2008).

About 30 major drought episodes have been recorded over the last nine centuries (Workneh 1987). Thirteen of these droughts covered the whole country and were reported to have been severe. A dozen of the recorded droughts and famines took place in the 20th century out of which five occurred during the period 1972-1991. The last two decades have been marked by catastrophic and widespread droughts and famines occurring 2-3 years on average as compared to every 7-10 years over the previous decades.

The climatic conditions of the drought years were characterized by either failure, late or early onset of, or inadequate, rainfall during the small and/or main rainy seasons (Workneh 1987; UNESCO 2004). Apart from the oceanic factors that cause climate-induced droughts, terrestrial factors such as changes in ecological and demographic conditions resulting mainly from rapid population growth and anthropogenic activities such as extensive cultivation and overgrazing are major causes of drought.

1.1 Spate Irrigation in Ethiopia

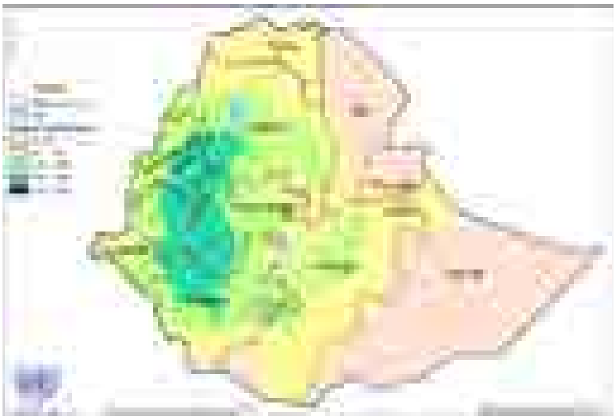
Definition of spate irrigation in Ethiopia

The definition of spate irrigation in Ethiopia differs from place to place. Generally, the meaning of the word spate is using seasonal floods to compensate for rainfall shortages and erratic rainfalls that could have affected seasonal harvests. In areas of traditional spate irrigation practices they have local names for spate irrigation. In southeast Ethiopia *'Gelcha'* is used for spate irrigation with a literal meaning of 'divert the flood into the farm.' *'Telefa'* is used in the northern parts of Ethiopia with the literal meaning of 'diversion.'

Potential and cultivated areas in spate irrigation

Ethiopia is known as a water tower of Africa for its peculiar geomorphologic and climatic setting. No drainage is coming in but flows out radiating in all directions. Arid and semiarid regions constitute 60% of the country's surface area with a rainfall variable coefficient of 50% (Figure 2.2). The remaining 40% is a recharge area with surplus rainfall with most of it flowing untouched through the surroundings.

Figure 2.2.Annual rainfall map of Ethiopia (OCHA 2006).



Lowlands with thick and fertile alluvial covered plains and availability of runoff flowing across these plains of millions of hectares of land are suitable for spate irrigation in Ethiopia. See slope gradient below (Figures 2.3, 2.4 and 2.5).

Figure 2.3. Slope gradient.

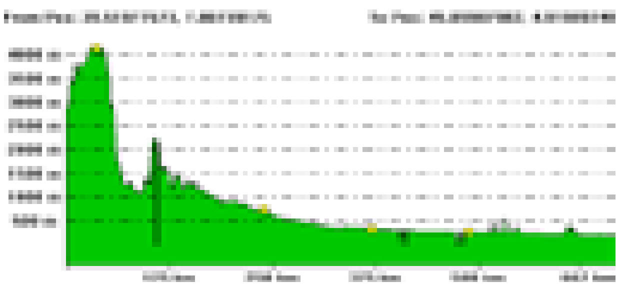
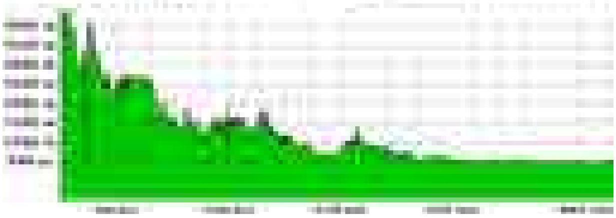


Figure 2.4. Slope gradient from northern highlands to southwestern lowlands.



As mentioned above, Ethiopia is suffering from repeated drought and most of its lowland areas are food-insecure. With increasing population and land degradation the food-insecurity problem is affecting even the highland areas. The main reason for the occurrence of drought is the erratic nature of rainfall and a moisture deficit for full crop growth (Figure 2.5). Various attempts have been made to harvest rainwater, floodwater, and groundwater to tackle the food security problem. Hundreds of thousands of ponds and hand-dug wells were constructed throughout the country in 2004/05 but the effort was not as successful as expected. Figure 2.6 shows a comparison of effective rainfall and evapotranspiration, in the eastern Ethiopian lowlands.

Figure 2.5. The densely populated recharge zone (highland) and the underutilized moisture-stressed lowlands.

Figure 2.6. Comparison of effective rainfall and evapotranspiration, in the eastern Ethiopian lowlands.

The radial flow from every side of the middle part of the country is considerable and can be captured before entering the deep-cut gorges. It is possible to cultivate the most food-insecure arid parts of the country by making diversion canals of various scales.

Development status

Despite the burning need and the prevailing problem little is done in Ethiopia to use spate water for irrigation. The history of water harvesting in Ethiopia dates back to the pre-Axumit period (560 BC) (Getachew 1999). It is a common and growing practice, particularly in arid parts of the country.

In East Ethiopia farm runoff is collected in small embankment gullies, and the ponded water is used for irrigating valuable (perennial) crops, such as chat (Chat cadulis), coffee and fruit trees. Use of seasonal floods originating from eastern highlands and ending up in the lowlands has been practiced in Dire Dawa area since the 1980s. Many farmers along these riverbanks are practicing flash flood spreading for crop production. Farmers in these areas were able to establish simple diversion (using wooden trash and soil materials) canals to convey the floodwater into their farms.

Similar activities are found in the northern parts of the country, Tigray, Amhara and southern regions. Runoff irrigation is widely practiced in the Chercher Plains around Mahoni and Waja near Alamata in Tigray, the Gato Valley in North Omo, parts of eastern and western Hararghe, and many other places. The practice in the Gato Valley also includes the use of ridge ties to retain the moisture around the plants. Similarly, the people in Konso, Gidole and many other parts of the southern region have been exercising the art of conserving soil and water. These traditional rainwater harvesting techniques use the soils as a media, particularly using bench terraces and trash lines on their cultivated lands (Habtamu 1999). Figure 2.7 shows spate irrigation practicing areas in Ethiopia.

Figure 2.7. Spate irrigation practicing areas in Ethiopia.

According to various recent estimates, the area of traditional spate irrigation farms in north, south and southeastern parts of the country exceeds 100, 000 ha. But areas under improved and modern operational spate irrigation do not exceed 20,000 ha. Figure 2.8 shows traditional and modern spate canals, southeastern Ethiopia. Spate projects under design and construction exceed 50,000 ha and each year numbers of new projects are added, especially in the southeastern parts of Ethiopia. From a very recent report (Annual Report, January, 2008) by the Ministry of Federal Affairs of Ethiopia it is learned that the total area covered by spate irrigation in the lowland parts of the country is 140,000 ha (see Figure 2.7 for major spate areas).

Figure 2.8. Traditional and modern spate canals, southeastern Ethiopia.

Administration of spate irrigation

Administratively, farm structures and farms are mostly private. But irrigation schemes are mostly public. O&M of spate structures are administered by both public and private parties.

Size of spate irrigation systems

There are three scales of perennial irrigation systems in Ethiopia. Schemes larger than 3,000 ha of irrigable land are categorized as large scale, those from 200 to 3,000 ha as medium scale and any scheme below 200 ha as small scale. As improved spate irrigation is new and its coverage is limited to a few localities no agreed scale is assigned. Oromia is using its own range of <500 ha as small, 500 to 2,000 ha as medium and >2,000 ha as large comparing the level of complexity and manageability with perennial irrigation schemes.

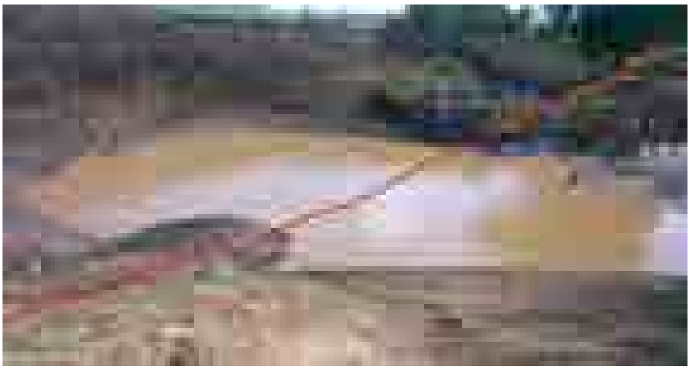
Characteristics of spate irrigation systems

Almost all traditional systems are managed by farmers and are small scale in size. Infrastructural upgrading of traditional systems is done by local governments and in very limited cases by NGOs with labor and material contribution from the user community. O&M of these improved systems are totally handled by the community; local government and NGOs offer occasional support when costs and damages to the structures are beyond the capacity of the users. Construction of medium- and large-scale spate irrigation schemes is done mostly by government and seldom by NGOs. In one of the regional governments, Oromia, an enterprise has been given a mandate to own/administer large perennial and spate irrigation schemes. It covers all the investment costs and distributes water to the users on cost recovery principles. It is planned that water use fees will compensate for O&M of main, secondary and tertiary canals and the weir site. Permanent staff and all necessary equipment for maintenance of the scheme will be assigned for each scheme.

Sources of water for spate irrigation

The main source of water for spate irrigation is seasonal flows in the dry streams. Using water harvesting and groundwater recharging techniques, farmers in some areas use water from ponds and shallow groundwater reserves to irrigate their farms (Figure 2.9). Such practice is growing fast, and the need for centrifugal pumps is increasing at higher rates.

Figure 2.9. Pumping water for supplementary irrigation from remnant ponds along traditional spate flow canals.



Water distribution methods

The more commonly used water distribution method is spreading flood in individual fields followed by field to field supplies where users are organized in WUAs. Extensive distributions are not common as most spate irrigation systems are limited in size.

Water diversion structures

Most diversion structures in traditional spate irrigation areas are spurs. They are constructed from earth, brushwood, sorghum roots, sand-filled bags and the like. Modern systems are constructed from masonry, concrete and gabions or combinations of the above with metal control gates. In some cases, sheet metal canals are used to convey water in places of valley crossings as shown in Figure 2.10.

Figure 2.10. Use of sand-filled bags and sheet metal to distribute water.

Use of stone, brushwood and trunks and making trenches to guide the water flow are common traditional techniques to protect bank and train wadis. In improved and modern spate irrigation systems, masonry walls and gabions are commonly used for this purpose.

Water distribution rules and rights

Although there are federal water policies, laws and regulations, these are not well-enforced. Therefore, there are no well-defined and common water distribution rules and rights in Ethiopia. Traditional rules and norms are more potent than the less-enforced government water policy and regulations. The followings are the most common prevailing practices.

a) Plot demarcation: Soil bunds are used as plot boundaries and rarely exceed 50 cm in height.

b) Breaking diversion bunds: WUAs set schedules for each farmer to break diversion bunds. The amount of water to be abstracted depends on the amount of flood. The dimensions of diversion bunds are judged by the WUAs.

c) Flow division: The same approach applies as above.

d) Sequence in which fields along channels are irrigated: Normally irrigation starts from upstream users and is fairly distributed to downstream lowland users. In most spate irrigation areas, the practice is started by the most moisture-stressed downstream users and as spate expands upstream the use right of those downstream beneficiaries is protected by leaders of the smallest administrative units, community elders and WUAs.

e) Depth of irrigation: Total coverage of plots is the minimum requirement; the depth varies depending on the frequency and quantity of flood. In most spate irrigation farms it does not exceed 20 cm. In high flood areas it goes as high as a meter.

f) Practices regarding second and third water turns: The same above-given principles apply.

g) Large and small floods: Areas inundated by large floods are cultivated following the retreat of the rivers. Thousands of hectares of land are cultivated using such overflows from large perennial rivers. This may/may not be categorized as spate irrigation.

Enforcement of water distribution rules

Regarding water distribution rules, the smallest administrative units intervene to enforce agreed rules and the implementing public organizations give technical assistance. In most spate areas water distribution is linked with farmer engagement in maintenance activities. To be eligible for access to water, users are forced to engage in canal clearing and maintenance.

Modalities used for maintenance of spate irrigation schemes

In terms of maintenance of spate systems in Ethiopia the most demanding one is maintenance of the main canal; this is commonly done by the community with technical assistance from local government or NGOs. Maintenance of individual fields is done by farm owners themselves. When maintenance on the individual field is beyond the capacity of a single farmer or his family he/she asks for assistance from neighbors using the traditional cooperation systems called 'debo' or 'jigi' (depending on localities). Commercial farmers farm out most of the maintenance work to local contractors. In some food-insecure areas communities are paid grains as part of the food-for-work program to maintain spate structures.

Soil-moisture conservation techniques used in spate irrigation

The common practice to conserve soil moisture is plowing before irrigation so as to create a porous media to help the water to infiltrate deeper and retain as much moisture as possible. Conservation tillage and soil bunds are also common but are mostly applied after sowing the field.

Risks of spate irrigation and adaptation of cropping strategies

In areas of longer flood flows the major risk that farmers face is the flood itself, which frequently washes away farms and breaks structures. In areas of low spate flows there is a risk of crop failure as a result of interrupted flow. Among the various cropping strategies that are practiced by farmers, growing local varieties adapted to local agro-climatic conditions is the main one followed by using improved drought-resistant seeds. Intercropping and adopting short-seasoned crop types (after confirming the failure of the first one) is also common. Even without anticipating risk, farmers in eastern Ethiopia practice intercropping to satisfy their various requirements and to enrich the soil nutrients. Haricot bean, rape seed and chat (Catha Endulis) are main secondary crops to be cultivated during the main rainy season.

Crops and productivity of spate farming

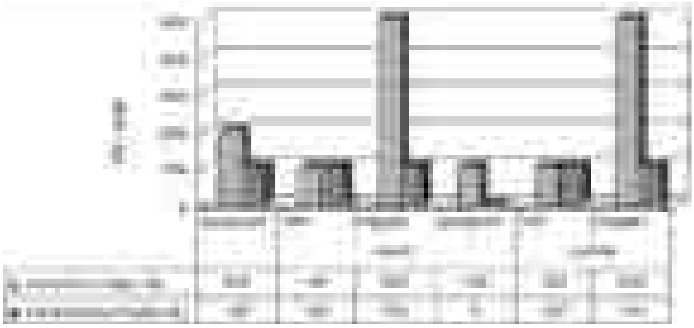
Types of cultivated crops depend on preference of the community. Although sorghum is the main crop to be cultivated in spate irrigation areas some communities do not like sorghum as a food crop. In such areas, maize replaces sorghum. Cereals, mainly wheat, are also cultivated as a food crop. Productivity of spate irrigated farms has recorded a tenfold increase with the same farm management and input at a recently completed spate scheme. Wheat production in one of the spate irrigation farms in central Ethiopia has risen to 3.2 tons on an irrigated field against 0.3 ton on an adjacent nonirrigated plot. The main income-generating practice in spate areas is cultivation of vegetables. In eastern parts of the country cultivation of khat is also the main income-generating practice. Sesame is also common in some localities.

In 1998, one farmer on a spate irrigation farm in Lage Oda Merga PA in eastern Ethiopia was able to raise his sorghum yield from 3 to 8 quintal (1 quintal=100 kg) in 1.2 ha of land. Another farmer raised his farm productivity from 8 quintals to 20 of sorghum, again from the same size of land. The low yield of the farmers was due to the use of local variety, red sorghum, Jildi (Getachew 1999). Figure 2.11 shows sorghum and wheat under spate irrigation, eastern Ethiopia.

Figure 2.11. Sorghum and wheat under spate irrigation, eastern Ethiopia.

As mentioned in a survey done by Ephraim et al. (2003) in northern Ethiopia, farmers described the difference in productivity of certain crops by giving examples. Accordingly, sorghum production in one of the spate farms showed a change of about 100% because of runoff diversion, while in another farm absence of runoff may have caused a total loss. Chili pepper production showed a tremendous increment under spate irrigation, i.e., under rain-fed (dry) condition the yield is a mere 1,000-1,200 $kgha^{-1}$ but runoff diversion increases chili pepper yield up to 5,000 $kgha^{-1}$ (Figure 2.12). On the other hand, the production of Tef has no significant change in volume of production due to flood irrigation. However, availability (application) of the flood irrigation has an effect on improving the quality of Tef grains, which enhances the market prices due to the higher consumer preferences for the latter. Therefore, use of the flood irrigation for Tef still has a benefit to farmers as it ultimately increases the price of Tef at the market (ibid.).

Figure 2.12. Yield differences due to flood diversion.



Source: PRA report, December 2001

Cost of development of spate irrigation system

Incurred costs for development of spate irrigation projects vary spatiotemporally. In remote parts of the country although labor cost is cheap or free and locally available material is free or cheap, the cost of mobilization and demobilization of machinery makes it expensive. The scale of projects also affects the cost. In modern structures the local community input is minimum (not more than 10%) and as a result the project cost is high, whereas the contribution of the community in improved spate irrigation systems is so high that this makes it cheaper. As estimated from ongoing spate projects, the current construction cost of spate projects ranges from USD 170 to 220 ha^{-1} for non-permanent headworks, including soil bunds, gabion structures and diversion canals and up to USD 450 for permanent headworks for small systems including diversion weirs and bunds. The cost of permanent headworks for large systems including diversion weirs, breaching bunds and siphons as estimated from the ongoing project (Koloba Spate Project) ranges from USD 330 to 450 ha^{-1} (OIDA Annual report 2007).

Gender and spate irrigation

Spate irrigation is a labor-intensive task and involves almost all segments of the community, except small children (Figure 2.13). Involvement of men, women and children depends on the degree of complexity of the task and cultural issues. The main responsibilities of men and women in spate are summarized in Table 2.1 below.

Table 2.1. Roles in spate irrigation schemes by gender.

Activity	Men	Women
Infrastructure-related	✓	
Operation (water distribution)	✓	
Maintenance	✓	
Agricultural practices	✓	✓
Harvesting	✓	✓
Marketing	✓	✓✓

Figure 2.13.Women and children participating in the development of a traditional spate irrigation system.

Constraints of spate irrigation

Constraints of spate irrigation are multidimensional. The limited experience combined with the lack of due attention by researchers, government, NGOs and donors makes it more difficult to overcome the problems. The following are the major constraints pointed out by different authors and clearly seen in the fields.

1. Rapid deterioration of physical conditions of systems

This problem is prominent in traditional irrigation areas where farmers are forced to maintain the main canal and others whenever there is high flood. The loose structures made of bush or soil is washed away by flood and they frequently lose a portion of the soil in such events. Erosion of riverbanks and loss of a portion of farm lands is also common in some areas. Although they are not as destructive as on the traditional systems these problems also affect improved and modern systems. Frequent silting up of diversion canals is also one of the prominent problems facing spate systems in Ethiopia (Figure 2.14).

Figure 2.14. Damaged flume structure and silt-filled canal.

2. Rainfall variability

Availability and quantity of floodwater that may reach farm plots of households depend on the overall rainfall received in the upstream. However, the floodwater only complements the actual rainfall directly received on the farm plots, which primarily influences the different aspects of the microclimate to favor plant growth. In most arid parts of the country the contribution of the floodwater of whatever magnitude is, therefore, minimal in the absence of direct rainfall on the area. Therefore, despite the existence of the traditional spate irrigation systems that provide lifesaving irrigation water, the production system remains as rain-fed agriculture that makes farmers vulnerable to intermittent shocks unavoidable in the event of failure/shortage of seasonal rainfall.

3. Equity

There are cases where equity is a problem on spate schemes. The case in northern Ethiopia is one example. According to a PRA survey done by Ephrem et al. (2003), there are certain aspects of the traditional spate irrigation system that limit its equitability aspect. Individual users are given a date by leaders of their water user association for their turns to use floodwater. However, no flood may occur on that predetermined date, and if there is no rainfall in the upstream on that date the person's turn will be cancelled. Under such institutional arrangements, particularly with an unreliable rainfall pattern, individual households might miss an entire seasonal flood.

4. Lack of government financial support and extension services

The above-mentioned survey also identified lack of support in spate areas as a very limiting factor. There are no significant efforts made by development and research institutions to address the rigorous demands of risk minimization in the spate irrigation areas. Although farming communities have managed to deal with their environmental constraints through different locally innovated technologies and adoptive sociocultural setups, obvious gaps exist in terms of providing research and development support to improve promising traditional practices. This would mean opportunities for communities to share knowledge across areas and the capacity to upgrade local technologies.

On the other hand, lack of visible external interventions towards long-term enhancement of the risk management capacity of poor farmers (e.g., improving existing traditional practices) will limit the contribution of the traditional spate irrigation systems to sustainable food security in the study area and other areas with a comparable setting. Moreover, in the absence of a focus on the creation of alternative livelihood opportunities and improvement of the institutional and structural status of the area (extension, markets, credit and infrastructures, etc.) the sustainability of the existing farming systems and production practices seems unreliable (ibid.).

5. Lack of market opportunities

Production of high-value vegetables in remote parts of the country is hindered by the lack of access to markets. In eastern Ethiopia, farmers with adequate water and suitable land for vegetable growth are forced to cultivate maize or plant sugarcane and other nonperishable crops. Most farm produce is not market-oriented, but is mainly for home consumption. Absence of clustering of small and fragmented smallholder plots, infrastructure and communication is also a problem that hinders market-oriented farming practices.

6. Land tenure

Land is public property in Ethiopia. Fragmentation of land in smallholdings and the increasing trend of shrinking landholding across time influence the ability of land users to cope with their problems, as well as investment on improved technologies. Another constraint for investment on sustainable spate systems noticed during the PRA study mentioned above was the absence of landownership. Due to absence of clear landownership, farmers cultivate the land under temporary arrangements and expect the land to be taken away from them during the next land redistribution. Under these conditions, farmers may perceive investment in long-term land improvement (construction of high labor input structures, conserving riverbank erosion, etc.) as inappropriate because they are unlikely to reap the benefit of their work. Therefore, farmers prefer low or no investment in technologies, which may lower opportunities to improve productivity.

Conclusions

There are millions of hectares of land, which can be spate irrigated, are food-insecure and currently receive relief aid. These areas can be transformed to have a food surplus and become development centers by using the available spate potential and the suitable fertile arable land. Therefore, systematic assessment of spate potential in the lowlands of Ethiopia and implementing feasible spate irrigation projects are essential to change the existing food-insecurity scenario in the lowlands of Ethiopia.

Conjunctive use of spate systems as a means of soil and water conservation adds more value to spate irrigation practices. Water stored in the subsurface will be utilized in the absence of floods, and the alluvial deposit helps minimize the cost of fertilizer inputs.

The agronomy of spate irrigation systems should be given greater attention. Production of high-value crops, such as sesame and groundnut, supported by research and proper land use plans should be implemented. Parallel with this the market conditions must also be improved. Donors, NGOs and all stakeholders should learn from existing successful spate practices and assist farmers to combat poverty.

References

Awulachew, S.B.; Merrey, D.J.; Kamara, A. B.; Van Koopen, B.; De Vries, F. Penning; Boelle, E. 2005. *Experiences and opportunities for promoting small-scale/micro irrigation and rainwater harvesting for food security in Ethiopia.* IWMI Working Paper 98, 2005. Addis Ababa, Ethiopia.

DHV Consultants BV. 2002. *National water supply and sanitation master plan.* Addis Ababa, Ethiopia.

Ephraim, Alamerew; Berhanu, Fentaw; Seid, Ali. 2003. *Traditional rainwater harvesting systems for food production: The case of Kobo Wereda, Northern Ethiopia.* Mekele, Ethiopia.

Frank van Steenbergen, 1999. *Rainwater harvesting in Ethiopia.* 25th WEDC Conference, Addis Ababa, Ethiopia.

Habtamu Gessesse. 1999. Rainwater harvesting concepts and issues. Paper presented at the Founding Conference of the Ethiopian Rainwater Harvesting Association (ERHA). December 17, 1999. Addis Ababa.

Ministry of Agriculture. 2001. *The second five-year action plan of soil and water conservation activities.* Addis Ababa, Ethiopia.

Ministry of Water Resources. 2002. *Water sector development programme main report.* Addis Ababa, Ethiopia.

Awulachew, Sileshi Bekele; Yilma, Aster Denekew; Loulseged, Mekonnen; Loiskandl, Willbilbald; Ayana, Mekonnen; Alamirew, Tena. 2007. *Water resources and irrigation development in Ethiopia.* IWMI Working Paper 123. Colombo, Sri Lanka: International Water Management Institute (IWMI).

UNESCO (United Nations Educational, Scientific and Cultural Organization). 2004. *National water development report for Ethiopia.* Addis Ababa, Ethiopia.

Weldeab, Teshome. 2003. *Irrigation practice, state intervention and farmers' life-worlds in drought-prone Tigray, Ethiopia.* The Netherlands: Wageningen University.

Workneh, Degefu. 1987. Some aspects of metrological drought in Ethiopia. In Drought and hunger in Africa, ed., Glantz, M.H. *CUP23-36.*

Yilma, Silashi. 2005. *Water harvesting technologies and challenges to Ethiopia.* Addis Ababa, Ethiopia: International Livestock Research Institute.

Project feasibility and design reports and annual performance reports on Oromia Regional Government Spate Irrigation schemes of various years (Various unpublished reports and plans)

Annual performance reports on Tigray Region Spate Irrigation schemes of various years

UN Integrated Regional Information Networks(Various unpublished reports and plans)