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Participatory Rural Appraisal for Diagnostic Analysis of spate irrigation systems in Raya Valley, Ethiopia

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Abstract

Spate irrigation is a complex and unique form of water management, which represent the main source of irrigation water in semi-arid river catchments. Water is diverted from seasonal rivers by using diversion structures made by stones, earth and brushwood, located within the river bed. The modernisation of spate irrigation realised in Raya Valley (northern Ethiopia) resulted in disappointing performances. One of the main reasons for this failure was the poor consideration of the characteristics of seasonal catchments and local communities' needs and preferences. Local farmers, who showed a deep knowledge of the river system, were involved only at the level of consultation. The aim of this research was to develop a participatory Diagnostic Analysis (DA) for a traditional non-modernised spate irrigation system in Raya Valley, in order to involve local farmers within the development process, and to build a solid knowledge basis for effective improvements. A Participatory Rural Appraisal (PRA) of the Harosha spate irrigation system was undertaken. PRA techniques focusing on spatial, temporal, socio-economical and spatiotemporal aspects of the system were performed with local farmers in order to identify and rank main problems and constraints to development. Farmers recognised the need of more resistant diversion structures and gabion walls for the stabilisation of the river bank. The involvement of farmers also helped to highlight that not only irrigation-related problems, but also flood-related problems threaten agricultural production and rural livelihoods. Rather than an irrigation system approach, an approach integrating irrigation development and flood risk mitigation is suggested for framing future development strategies.

Keywords: participatory rural appraisal, indigenous knowledge, rural development, water harvesting, Ethiopia, Tigray, arid climates

1 Introduction

Spate irrigation is a unique and ancient form of water management typical for ephemeral river catchments (namely wadis) in arid climates. The technique is based on the diversion of seasonal wadi flash floods with the use of diversion bunds, built within the river bed during dry periods. Spate irrigation has been practiced since 3000 BC, and today it covers around 3 million hectares of irrigated land around the world in areas distributed in arid and semi-arid zone of Near East, Africa, South and Central Asia and Latin America (Van Steenbergen *et al.*, 2010). In these contexts, spate irrigated agriculture is often not recognised as part of the formal irrigation sector, while it is usually one of the main sources of livelihood for the poorest sector of society.

In arid areas, wadi represents the only source of runoff available, and erratic and scarce rainfalls could not sustain agriculture. Spate systems allow turning flash floods into productive water for irrigation and other agricultural activities, while the deposition of fine sediments

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suspended in diverted water contributes to soil fertility. In addition to this, local populations have developed great wisdom in spate irrigation systems construction and they have reached effective management strategies and water rights systems, which allow coping with the unpredictability typical of wadi flows (Van Steenbergen *et al.*, 2010).

Despite its relevance for rural livelihoods and the potential as strategy for water management in arid climates, spate irrigation has been neglected in the technical literature (ibid.). Only in the last 20 years, governments, development agencies and NGOs have started recognising the relevance of spate systems for rural livelihoods and development in arid areas and began to implement modernisation programmes (Mehari *et al.*, 2011).

Spate irrigation in Ethiopia has developed relatively more recently than in other countries, due to the increasing food demand caused by population growth (Van Steenbergen *et al.*, 2010). In the northern arid Tigray region, the regional government has made strong efforts to improve traditional irrigation systems in the last 15 years, mainly focusing on the rural area of Raya Valley (Kidane, 2009; Van Steenbergen *et al.*, 2011) where spate irrigation has been practised for centuries (Kidane, 2009; Yazew *et al.*, 2014). In spate systems of Raya Valley, structural problems represent the main constraint. Diversion structures, which are built as spur-shape discharge separators using local material, such as earth, brushwood and stones, are usually washed away by most powerful spate flows. This leads to a lack of irrigation water and to a high need of labour for diversions maintenance and reconstruction after floods. A recent modernisation process based on the construction of new diversion structures and improvement of the channel systems, used more resistant material, such as concrete and gabions (Kidane, 2009; Yazew *et al.*, 2014).

Despite high investments, the result of this modernisation process was disappointing. Most of the interventions were dominated by an engineering approach, applying a design strategy typical for irrigation systems of permanent rivers. Farmers' ideas and preferences, their specific technical knowledge of spate systems management, their own well adapted institutional system and knowledge of local environment and hydrology were not considered and incorporated in the design. As a result, most of the modernised systems stopped to operate due to technical problems, related to a wrong assumption of river system hydrology, in particular sedimentation, and to institutional problems related to new operation and management strategies (Kidane, 2009; Erkossa *et al.*, 2014; Yazew *et al.*, 2014; Libsekal *et al.*, 2015). On the other hand, research showed that, despite structural problems, traditional farmer managed spate irrigation systems are performing better than modernised ones, due to the technical knowledge and experience of the farmers, who have been using the technique for centuries. For effective improvements in spate irrigation systems, the involvement of farmers in the planning and design phase is required (Kidane, 2009; Erkossa *et al.*, 2014; Yazew *et al.*, 2014; Libsekal *et al.*, 2015).

The aim of this work was to develop a participatory Diagnostic Analysis (DA) of a traditional spate system, in order to identify with local farmers the main problems and to set the ground for the design of appropriate technical solutions.

The DA concept is expressed as the "appraisal and analysis of existing irrigation systems with the objective to identify problems and to define the causes or constraints, underlying these problems" (Falciai, 1996). DA was conceived as the first part of a four-phases development model (Clyma *et al.*, 1977) but it has then been used in other development methodologies (Dedrick *et al.*, 2000; Bruscoli *et al.*, 2001). The technique is based on the analysis and identification of existing problems in order to develop appropriate solutions (Bresci & Letterio, 2007).

Participatory Rural Appraisal (PRA) was adopted for system diagnostic, in order to describe and identify major problems. PRA was defined by Chambers (1994) as "family of approaches and methods to enable local (rural or urban) people to express, enhance, share and analyse their knowledge of life and conditions, to plan and to act", and can be used as a tool for participatory diagnostic analysis of rural systems (Bruscoli *et al.*, 2001; Bresci & Letterio, 2007). The key concept in PRA is that local people are creative, capable of carrying their own analysis, identifying problems and constraints, planning and eventually taking actions. Researchers and field workers should act as facilitators and help local people to carry on their own system analysis. PRA involves a series of methods, which can be used and adapted to each case study, ranging from simple spatial representations of the study area (participatory mapping) to matrix ranking of different options. The information generated with PRA is shared and discussed with local farmers, providing a consistent ground for planning future development (Chambers, 1994).

2 Materials and methods

2.1 Study area

The analysis was carried out for Harosha spate irrigation system, located in the south of Raya Valley, in Harele *tabia* (municipality). Harosha wadi flows from west highlands of southern Raya Valley to the eastern valley (Fig. 1), where it ends spreading the flows in many channels, namely its distributary system (Nichols, 2009).

The spate irrigation system is located in the distributary system of the wadi. The first diversion structure (D1) is located upstream of the first division of the distribution system, on the left side (Fig. 2). Three further diversions (D2–D4) are on the left side of the northern branch of the river, before the road to Addis Ababa. Downstream the bridge, six smaller diversions are located on the left side of the northern branch and, more downstream, three on the right side. Harele villages are built on the right side of the northern branch. On the right bank, a gabion wall is protecting the villages from floods. The analysis was focused on the command area of the 4 upstream diversions, identified as Diversion 1 (D1) to Diversion 4 (D4), starting from upstream. A scheme of the area is shown in Figure 2.

The rainy season covers the months of June, July and August, with the possibility of early rains during April and May. The mean annual rainfall is 724 mm, the mean annual potential evapotranspiration about 1752 mm y^{-1} (Hagos, 2010).

2.2 Participatory Rural Appraisal

PRA techniques were organised according to the classification proposed by Tesfai & de Graaff (2000), adding a fourth category: techniques focusing on spatial, temporal, socio-economical and spatio-temporal aspects of spate irrigation system. PRA was carried out from April to June 2014 with the help of a local interpreter for both oral and written communication. The analysis was carried out mainly with male farmers in the field, as women are usually carrying out household or non-agricultural work. Women farmers who are living alone were involved in a final meeting for problems discussion.

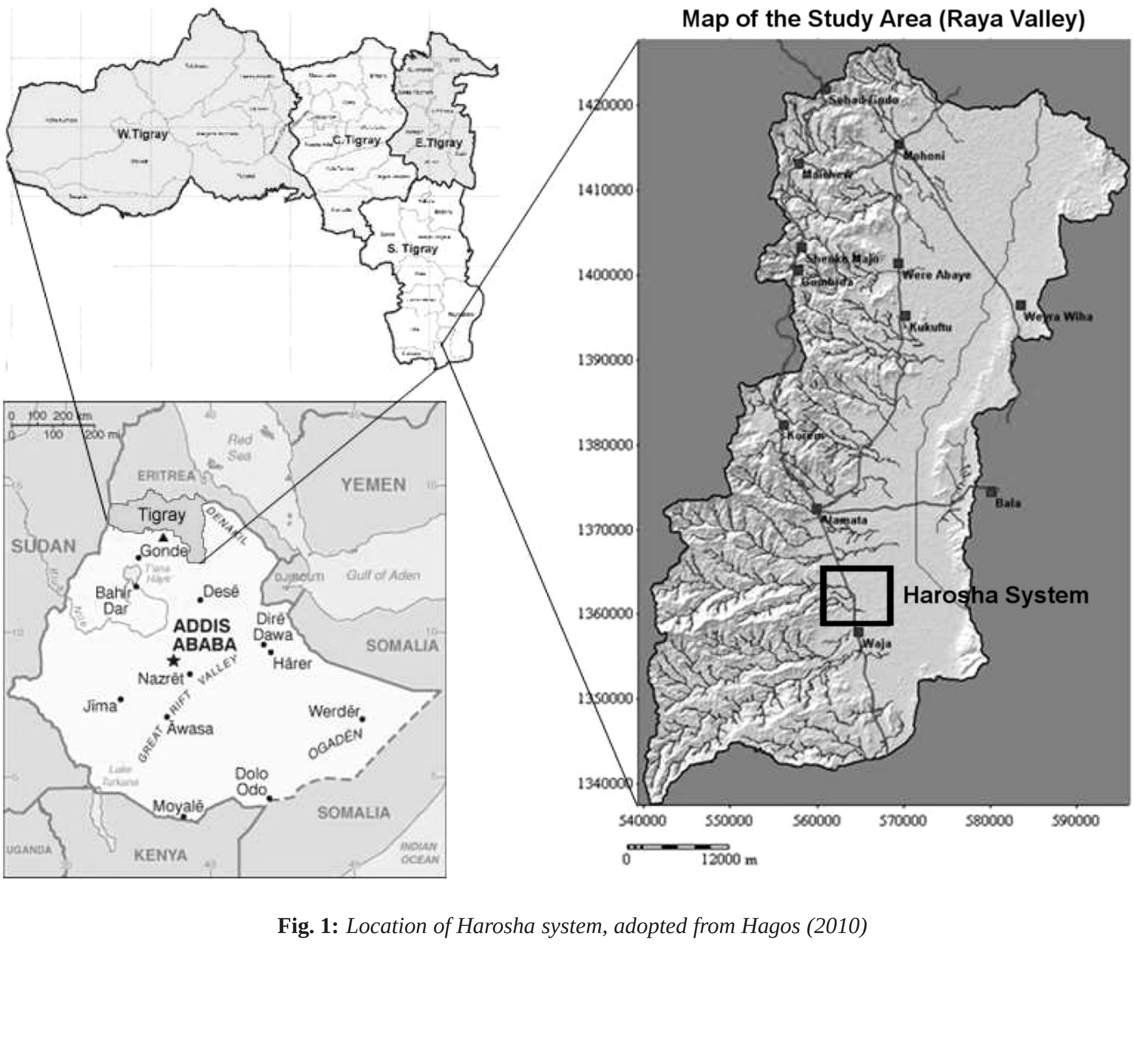


Fig. 1: *Location of Harosha system, adopted from Hagos (2010)*

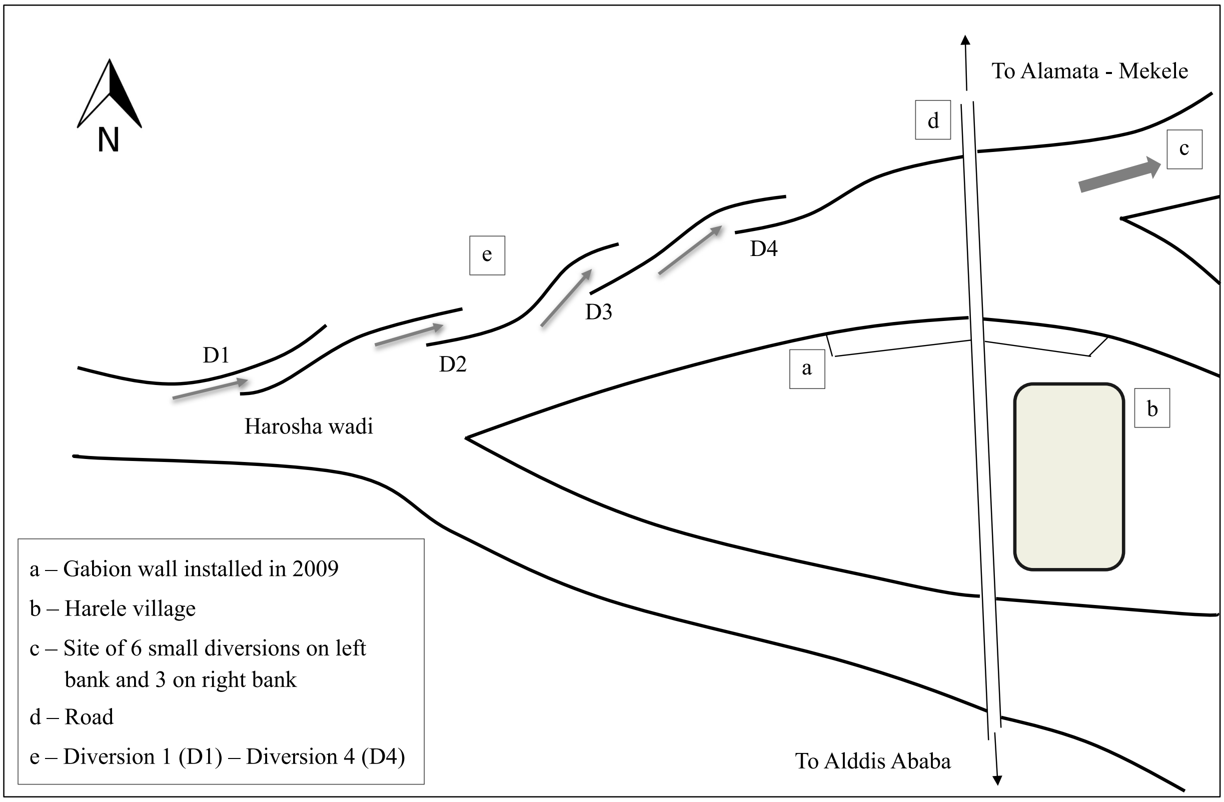


Fig. 2: *Scheme of study area and diversion sites*

2.3 Techniques focusing on spatial aspects

Participatory maps: Participatory mapping of the system was realised asking a group of four farmers to draw a sketch map of the command area. The map helped to obtain detailed information on the spatial characteristics of the system, to identify the main structures and it was used for planning the following PRA activities.

Field walks: Field walks were realised to acquire information about the system operation and water management at field level. The walk started with one or two farmers and interviews were done with other farmers met during the walks.

Transects: Transect walks were realised with groups of three or four farmers in order to obtain information about the differences found along one precise path in the system. The transect paths were made along canals for understanding the influence of the distance of each field from the diversion structure on water availability and sediment loads.

Structure analysis: Diversion structures were object of a more detailed analysis. A structured questionnaire about the characteristics of a diversion was realised with farmer representatives of the area. Design discussion: In a final meeting, to which all farmers were invited, a discussion on possible technical solutions was undertaken, as part of PRA analysis. The discussion involved about forty farmers.

2.4 Techniques focusing on temporal aspects

Trend lines: Trend analysis was realised to evaluate, year by year, the river water availability, irrigation water availability for the farmers, damage to diversions, erosion and crop production considering the last 5 years. Trend lines were realised for the command area of each diversion, with groups from three to four farmers. Values ranging from 1 to 5 were used for the representation of the considered variables, in order to facilitate the discussion and comparison of the values throughout the years.

Seasonal calendar: The calendar of farming activities throughout the year helped to understand farming and irrigation practices. Calendars were realised with the same groups of participatory maps.

Semi Structured Interviews (SSIs) on hydrology: SSIs about the hydrology of the wadi were realised in order to obtain information on the river system and how to organise a structured hydrological analysis, utilising living memory. Two to three SSIs were realised for the command area of each diversion.

Hydrological analysis: Wadis are commonly characterised by a lack of hydrological information, making hydrological modelling difficult. Most experienced farmers were involved for an analysis of the water levels in the wadi, selecting a cross section in which the level identification was simple for the farmers. Discharges were calculated using slope-area method (Van Steenbergen *et al.*, 2010). The following data were analysed:

- Maximum flow level within living memory
- Average of the maximum yearly levels within living memory
- Level of “high”, “medium” or “low” flow during the years according to farmers’ experience.

The number of occurrences of each of the above mentioned flow levels was defined, considering the cases of a dry, normal and wet year. The total flow time and the peak time were also analysed.

As the selected cross section was located in the northern branch of the system, the discharge calculated with slope area method was corrected with the following formula (Eq. 1), for obtaining the discharge of the full basin:

$$Q_i^* = f \cdot Q_i(y) \qquad (1)$$

where

- Q_i^* is the full catchment discharge occurring before the first division on the wadi distributary system, for the level i ($m^3\,s^{-1}$)
- Q_i is the discharge for level i, calculated with slope area method from the depth y ($m^3\,s^{-1}$)
- f is the full discharge factor, calculated as (Eq. 2):

$$f = \frac{L_1 + L_2}{L_1} \qquad (2)$$

in which L_1 and L_2 are the width of northern and southern branches (Fig. 2).

2.5 Techniques focusing on socio-economical aspects

Interviews: One or two farmer representatives for each diversion command area and government officials from the agricultural bureau of Harele were interviewed.

SSIs: SSIs on socio-economical aspects were realised with farmers, considering history of the system, problems in the system, management structures (WUAs, representatives, rules and regulation), off-farm activities (what, when, how much, income). Nine SSIs were carried out with single farmers and in small groups (2–3 people).

Ranking of problems: The problems identified in the PRA activity were ranked in a meeting, just before the design discussion, to which all farmers were invited. The ranking methodology was organised providing “problem sheets” in which a problem was written and drawn (for farmers who cannot read). The sheets were used to visualise the ranking. The ranking was agreed with a free discussion, without the use of discussion tools such as pair-wise ranking. Figure 3 shows problem sheets.

Fig. 3: *Problem sheets used during PRA*

2.6 Techniques focusing on spatio-temporal aspects

Crop production analysis: Georeferenced crop production trend lines were realised by asking farmers to rank from 1 to 5 the crop production of their fields for the last 5 years. Each trend line was associated to a GPS point taken on the field, in order to analyse how crop production trends vary with the position in the system. 28 trends were realised.

3 Results

3.1 Spatial aspects

3.1.1 Characteristics of the command areas

Participatory maps, field walks and transect walks were used to gain detailed information about the command area. The area covered around 70 ha, with roughly

150 households owning irrigated lands. Each family holds one or more plots in different parts of the system with an average plot size of 75×50 m. Each diversion deviates water to a primary canal, which delivers irrigation water to a determined area, namely the command area. In the command areas of D2, D3 and D4 primary canals convey water to secondary canals that deliver water to fields. In the D1 command area, two secondary canals are present, then water is conveyed to the fields through tertiary canals. Field canals convey water to each plot from the secondary or tertiary canals. The canal system is managed using micro diversion bunds (Fig. 4) placed inside the canals which are built and breached to direct water according to the irrigation order (Table 1).

The primary canal of D2 is being lengthened by farmers in order to extend the command area, allowing more farmers to have water. Farmers reported that there is generally no problem with the water delivery.

3.1.2 Diversion structures

Diversion structures in traditional spate systems are usually conceived as structures built with local materials like earth, stones and wood, in order to be easily repaired and adapted by the farmers to the morphodynamical evolution of the river. On the other hand, fixed concrete structures may result out of place from one to the next year, due to the continuous shifts of wadi beds (Van Steenbergen *et al.*, 2010; Yazew *et al.*, 2014). Structure analysis and field walks revealed that diversion structures present in Harosha system area characterised by the typical "spur-type" design, as described by Van Steenbergen *et al.* (2010), namely bunds, parallel to the flow, used for deviating a part of the discharge into a diversion canal.

Table 1: *Main characteristics of the command areas under the respective diversion structures (D1–D4)*

Diversion	*Number of parcels in the command area*	*Command area* [ha]	*Number of secondary canals*	*Number of tertiary canals*
D1	100	25	2	20
D2	80	20	15	–
D3	50	15	10	–
D4	40	10	10	–

Fig. 4: *Micro diversion bund at field level*

The shape and the design of diversion structures are reported to be effective. In particular, the solution of using multiple diversions allow the farmer to be capable of irrigating a part of their land even if a diversion got broken, as they own land in more than one command area. Despite the advantages of traditional diversions, the main problem of diversion structures is that they are too often broken or washed away by flows.

To alleviate the heavy burden for reconstruction to farmers, local government has financed the use of gabions for reinforcing earthen diversion structures after floods in 2010. D3 and D4 were reinforced with gabions, which were installed by the farmers, and showed higher resistance to wadi ephemeral flows.

The following local techniques were described by farmers:

- *Upward slope of diversion canals:* farmers build diversion canals with upward slope in order to slow down water velocity and facilitate sedimentation in the first part of the channel. The system is working, but the upward slope reduced the amount of water diverted. Farmers suggested a refined design for optimising the balance between sedimentation and diversion efficiency.
- *Fuse structures:* fuse structures are used for diversion management. During high flows, farmers amount a pile of earth at the intake point, in order to avoid excessive flow in the diversion canal. During dry periods, farmers extend the diversion spur with a smaller earthen bund, in order to intercept low flows.

3.1.3 River bank collapse

In 2009, local government built a gabion wall for flood protection on the right side of the northern branch of the distributary system, in front of diversion structures sites (position "a" in Fig. 2). Gabion walls reduced the available section for water flows. As a result, the left bank of the channel collapsed, causing a reduction of cultivable lands. A loss of 13 ha in 3 years was reported. Farmers observed that protection walls should be built more distant from the wadi bed.

3.2 Temporal aspects

Temporal analysis revealed that flood protection structures were built in 2009, in 2010 abundant rains led to good crop production in the whole command area, but high flows washed away all the diversions. In 2011, diversions were rebuilt, reinforced with the use of gabions, financed by local government. 2013 was reported to be the driest year of the last decade.

Specific trend lines realised for each diversion (Fig. 5a to 5e) show that more water is available for D1 which is located upstream of the first subdivision of the river. This results also in higher water availability for farmers, leading to a better crop production, and higher erosion of the left bank. Trends 5b and 5d showed how D3 and D4 have been more resistant, leading to better water availability for farmers throughout the years.

Figure 6 shows the seasonal calendar of farming activities. For ploughing activity, most farmers used animal traction. Livestock rearing is found in all households; especially cattle and small ruminants. Some farmers have off-farm activities such as being civil worker in a neighbouring city.

Table 2 shows the results of the hydrological analysis realised considering local people's experience of seasonal and historical floods. Observed water depths were used as input for the discharge analysis.

Table 3 shows the results of the discharge calculation. The discharge of wadi flow events may range on average from 22 to 194 $m^3 s^{-1}$, with peaks up to 750 $m^3 s^{-1}$, making it extremely difficult to design structures capable to abstract low water flows without being damaged by peak flows.

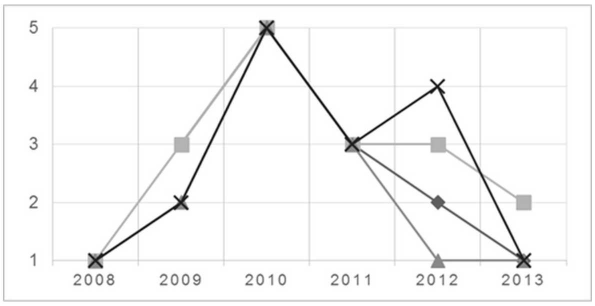
3.3 Socio-economical aspects

One or two farmer representatives are elected as *Abo-Mais* (father of the river) for each diversion, and they stay in charge for life. Their duties are to organise system operation and maintenance, direct water delivery, and apply and collect penalties.

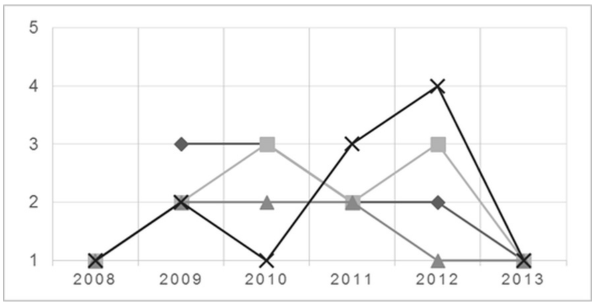
Farmers get water rights according to their contribution to maintenance works. Old and ill farmers, and female farmers alone, receive water even without any work contribution. If female farmers participate to maintenance works, they get water first, regardless of the time of contribution. If there is enough discharge, all tertiary canals are opened at the same time and water is delivered according to a list for each canal. If the discharge is not sufficient to supply all the canals together, water is delivered according to an aggregated order, considering all the canals as a whole. Penalties are applied if a farmer is not respectful of irrigation rules and may range from 50 to 100 Birrs (2.20–4.40 Euros). The penalties paid are used for buying building materials.

3.4 Spatio-temporal aspects

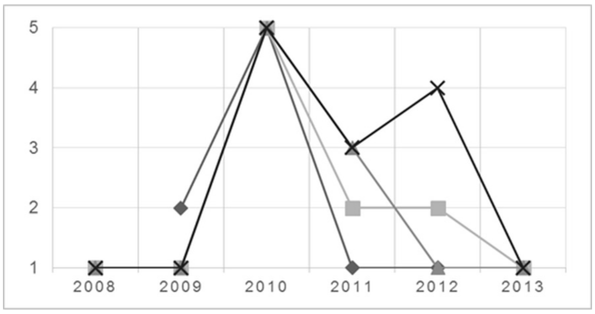
The crop production analysis trends, realised at single household plot level, confirmed the information gathered with trend lines made at diversion level: 2010 was reported as the most productive year, due to high



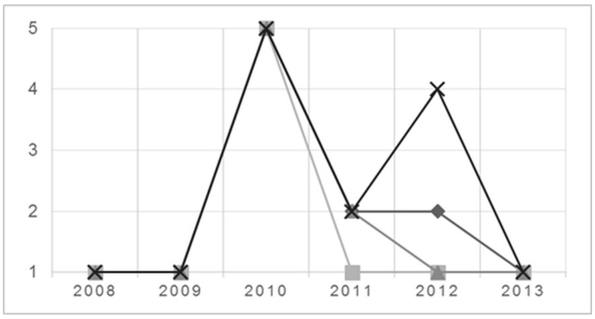
(a) *Water availability in the river*



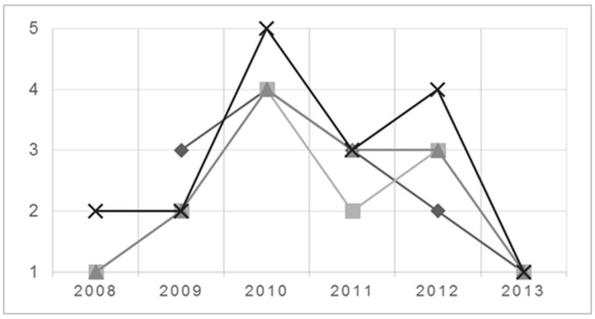
(b) *Water availability for the farmers*



(c) *Damage to diversions*



(d) *Bank erosion*



(e) *Crop production*

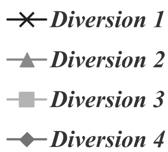


Fig. 5: *Trend lines of the four diversions on a scale from 1 (low) to 5 (high)*

Activity	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Diversion building	■					■						
Ploughing		■	■									
Seeding (maize, sorghum)				■	■							
Seeding (teff)						■						
Maintenance works on diversion							■	■	■			
Removing of weeds									■			
Harvesting (teff, sorghum)										■		
Harvesting (maize)											■	
Threshing												■

Fig. 6: *Seasonal calendar of farmer activities*

Table 2: *Hydrological analysis results*

Type of flow	Observed water depth [cm]	Duration		Number of occurrences		
		to peak [hr]	to end [hr]	dry year	average	wet year
Maximum flow level within living memory	400	–	–	–	–	–
Mean level of the yearly maximum within living memory	220	–	–	–	–	–
High	180	2	8	1	2	6
Medium	100	1	5	2	3	8
Low	50	0.5	2	3	4	12

Table 3: *Application of the slope area method to the Harosha catchment*

Level	y [m]	Name	Q [$m^3 s^{-1}$]	Q^* [$m^3 s^{-1}$]	Definition
y_{max}	4	Q_{max}	455	750	Maximum discharge within living memory
y_y	2.2	Q_y	165	272	Discharge from the average of the maximum yearly levels within living memory
y_h	1.8	Q_h	118	194	Discharge from the average level of a “high” level flow
y_m	1	Q_m	44	72	Discharge from the average level of a “medium” level flow
y_l	0.5	Q_l	14	22	Discharge from the average level of a “low” level flow

rainfall while 2011 and 2012 showed an average production, even if high labour input was requested for diversion maintenance. 2013 was the driest year, with lower crop production. In particular, the following localised tendencies were observed:

- In 2011 and 2012, farmers far from the river received less water and obtained lower yields.
- During 2013, farmers who own land near to the river, managed to divert some water and obtained good crop production, ranging from 4 to 5.
- Farmers whose land is located on the bank are losing cultivable terrain due to bank collapses.

3.5 Problem analysis and ranking

The problems of the systems were discussed and ranked during the final meetings. Farmers defined the following priority rank:

(1) *Weakness of diversion structures:* Diversion structures break down too often, leading to heavy maintenance works to assure system operation.

(2) *Lateral erosion:* Cultivable land loss due to bank collapses.

(3) *Flood risk for villages:* High discharges often causes floods in Harele *tabia* villages.

(4) *Flood risk for fields:* Fields are often flooded by Harosha river, leading to water logging problems, especially for Teff cultivation.

(5) *Size of the diversion structures:* The present size of diversion structure is too small and the diversion efficiency is low.

(6) *Sedimentation:* Due to upward slope diversion, sedimentation can be efficiently managed in the system and does not represent a significant problem.

(7) *Lack of manpower:* It was reported that some farmers do not participate to maintenance works because they are discouraged by system performances. However, this represents a management problem for the system as a whole.

(8) *Lack of materials:* Lack of building materials is not perceived as a problem.

(9) *Presence of weeds:* The presence of pests and parasite plants was reported, but is it not considered a relevant problem. Weeds, which are especially causing problems in case of early rains, are removed by farmers through ploughing.

During the discussions, farmers explained that they want to focus on technical solutions for the first two recognised problems. During the analysis of possible technical solutions, farmers strongly supported the use of gabions for new diversion structures, explaining that the gabions installed in D3 and D4 showed good resistance and that the community would be able to install and maintain the structures by itself. According to that, farmers also suggested to protect the river banks with gabions to reduce the damage of floods on crops and villages.

4 Discussion

Spate irrigation represents a vital source of livelihood for rural population of Ethiopia, and modernisation of spate systems, where correctly implemented, has been proven to significantly reduce the poverty level of farmers by providing stable access to water resources (Hagos *et al.*, 2014). However, the low consideration of local farmers knowledge of the technique resulted in a poor design and led to the failure of most of the modernised systems implemented over the last twenty years (Erkossa *et al.*, 2014; Yazew *et al.*, 2014).

The use of PRA for the Diagnostic Analysis of the traditional spate irrigation system proved to be a feasible method to learn about farmers' views and knowledge on the management of spate irrigation. The DA carried out for Harosha spate irrigation system showed that the main constraint of the system is represented by the structural weakness of traditional diversion structures, built with local materials. PRA analysis also provided a solid ground for the development of technical solutions.

There is no need for a heavy engineering intervention on the canals system, and a modification of irrigation rules and management is not requested. Proposed solutions should maintain farmers' own technical solutions, like upstream diversion canals and the use of fuse structures, which are working with good results in Harosha system.

In previous studies realised in the framework of spate irrigation modernisation, hydrological analysis has been identified as one of the critical factors for new systems development, in order to design structures that can be consistent to the typical nature of wadi floods (Erkossa *et al.*, 2014). In the present study, discharge calculation was made possible by farmers' experience. Results showed an extreme uncertainty related to hydraulic structures design, given by the typical characteristics of wadi contexts. Spate irrigation systems should be designed to be resilient to the impact of extreme flows, which can also modify the morphology of wadi bed. In this situation, the reconstruction of diversion structures can be considered an actual part of the management system (Mekdaschi Studer & Liniger, 2013; Van Steenbergen *et al.*, 2010). Nevertheless, like in other studies realised with the participation of local farmers in Ethiopia (Erkossa *et al.*, 2014), DA showed how the current diversion structures of Harosha system need to be improved to reach a sufficient stability in the medium term, reducing the heavy burden for maintenance and reconstruction to farmers.

While most of the literature on spate irrigation modernisation focuses on single-intake design solutions (Embaye *et al.*, 2012; Libsekal *et al.*, 2015), structure analysis and design discussion have shown that the current design of multiple spur diversion structures is suitable for a wadi context, where the strategy of multiple intake points could be more resilient as a single intake system. The latter could completely fail if the single diversion structure is damaged or destroyed.

Farmers emphasised that gabions could represent a suitable solution for building new structures, as they can be installed and maintained by farmers themselves. Gabion structures also represent a flexible solution that can resist to deformations imposed by large floods and river morphological modifications, typical of wadis, better than rigid concrete structures. In addition to this, a spur deflector made in gabions would maintain the use of traditional technical solutions adopted by farmers, like fuse structures and upstream slope canals for sediment management. Solutions for reducing the high sediment load, typical of wadi flows, have been tested by other authors by using a design approach based on computational hydraulic modelling, like diversion canals with changes in section (Embaye *et al.*, 2012). The PRA analysis showed that upstream canals have a good performance for sediment control and can be considered for further technical design.

Spate irrigation development strategies in Ethiopia have focused mainly on the modernisation of the irrigation structures (Mehari *et al.*, 2011; Embaye *et al.*, 2012; Erkossa *et al.*, 2014; Yazew *et al.*, 2014; Libsekal *et al.*, 2015). PRA results showed that lateral erosion of the river bank, flood damages to villages and flood damages to cultivations were indicated by the farmers as the second, third and fourth relevant problem of the system. Structures for flood risk mitigation are considered necessary by local population, in order to alleviate flood damages on rural systems, considering both crops and human settlements. To frame effective spate development strategies, an integrated approach is then necessary, considering both irrigation development and flood risk mitigation for rural communities.

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