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Assessment of Water Supply Systems in Karrayu Pastoral Area, Oromiya Region, Ethiopia

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Abstract

This paper examines the major sources of water supply and their challenges in the pastoral areas of Karrayu. To achieve this objective, mixed method research including qualitative and quantitative methods, has been used. Multistage stratified sampling was used to identify 120 sample respondents from 3pastoral and agro-pastoral kebeles along Awash National Park and Metahara Estate Farm in Fentale Woreda. Semi-structured interview, focus group discussion, deep personal interview and field observation together with GPS readings of geospatial data were employed to collect primary data supplemented by secondary data sources. The collected data were analyzed using descriptive statistics. Arc GIS 9.1 and ERDAS software were used to depict the spatial distribution of water point of the study area. The study identified natural/earthen ponds, traditional ponds, modern ponds, cistern, boreholes, irrigation canals, salty pipe-waters and river water points as major sources of water supply. The finding also indicated lack of water development schemes, which is below the other pastoral areas in Oromia region. The fluoride ion concentration of water from the Awash River was found 2.2mg/l, which is higher than WHO standard (1.5mg/l) while its turbidity is 569.25 that is 113.85 and 81.32times greater that the WHO and National Standards, respectively. The depth of boreholes ranges from 41 to 113m that were not fenced and hence affected by effects of degradation and high siltation. About 85.5%, 77.5%, 65%, 60% and 56.7% of the local community perceived such challenges that led to severe water scarcity as existence of estate farms and Awash National Park, climate change and frequent drought, conflict on water points, population growth, and mismanagement of water sources. This calls for holistic role of different stakeholders to be integrated to devise proper interventions mechanisms to access the local community with sustainable water supply system thereby sustain livelihood of the pastoral and agro pastoral community of Karrayu.

Key Words: Fentale, Karrayu, Local Community, Pastoral, Water Sources

Introduction

Water is among the most indispensable land resources with no substitute for living organisms and wellbeing of the environment. It is also essential for food production, economic development and socio-cultural phenomena (Vallis 2006). This renewable resource is finite, scarce and vulnerable for depletion and contamination that made it scarce and unable to meet ever-increasing demands in many parts of the world

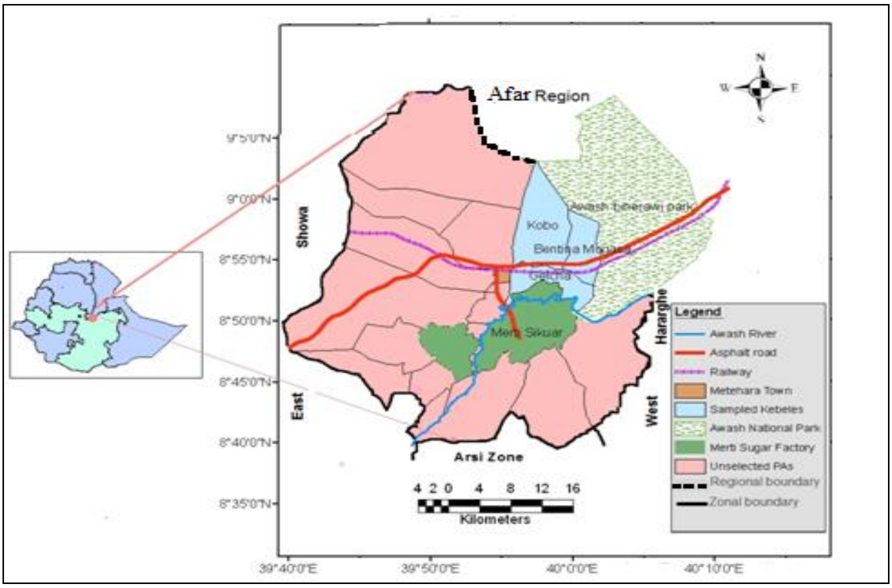
(UNEP 2005). In terms of both quality and quantity of water supply, household water scarcity is a pressing problem that becomes acute over time in developing countries (Webb 2004). Daily trudge and queue at the well, sickness in the family and occasional children's death are among the others in the life and livelihood of the people (Andrew 1987). About two billion people in rural areas of developing countries suffer from inaccessibility and impurity of water supply. Most countries in Africa are struggling with declining per capita water supply and rising demand by rapidly growing population. Nearly a fifth of African countries faced with food emergency and will be stressed by water shortage in 2025 (Web 2004).

There is spatio-temporal variation in the distribution of water resources in Ethiopia (MoWR 1999a). Duration and distribution of rainfall is inadequate and erratic in pastoral and agro-pastoral areas. Prolonged drought remains one of the major causes of asset losses and resource depletion as households are challenged with severe water supply (Abdi 2008). These areas are also characterized by unpredictable climatic conditions, ecologically fragile environment, frequent drought, flood, conflict, and food insecurity. These in turn have accelerated the water scarcity to its climax (Mesfin 2000). The assessment of water sources and their challenges in the pastoral and agro-pastoral areas like *Karrayu* area is a contemporary issue that contributes to sustainable use and management of water sources and intervenes and favors sustainable livelihood improvement and rural development in the study area.

Materials and Methodology

Descriptions of the study area

Location and Topography: *Karrayu* land currently known as Fentale woreda is located in Eastern Shewa Zone of Oromia, Central Ethiopia. It is astronomically located from $8^{0}42'$ to $9^{0}00'$N latitudes and $30^{0}30'$ to $40^{0}11'$E longitudes (Figure 1). The capital town of the woreda is Metehara, which is about 200km east of Addis Ababa. The topography of the woreda constitutes flat, undulating plains, hills and mountain ridges, ranging in altitude from 950 to 2007meters above sea level (masl).



(**NB:** Woreda= district, administrative unit equivalent)

Figure 1. Location map of the sample kebeles of Fentale woreda

According to OIDA (2007), soils of Fentale woreda are dominated by Andosols and Leptosols. Most of them are reddish in color, and ranges from silty clay to sandy loam in texture. The dominant tree species grown in *Karrayu* area are *Acacia senegali* (colloquially known as *Burquqqee)*, *Acacia tortolis* (*Xaddacha*) and *Acacia etaica (Ajo*). Among these, *Acacia senegali* and *Acacia tortilis* are highly deforested for fuel wood and charcoal production.

Climate and Hydrology: According to meteorological data registered at Awash (1965-1984) and Metehara (1985- 2007) stations, the *Karrayu* pastoral and agro-pastoral area receives the mean annual rainfall of 553mm ranging from 276.5mm to 898.5mm. The highest rainfall records are received during the summer season (June to September) followed by four to eight consecutive dry months (October to May) in the area. The district is located in semi-arid (*kolla)* climatic zone with mean annual minimum and maximum temperatures of 17.3 and 32.5^{0}c, respectively. The average monthly and annual temperatures were nearly 25^{0}c and 26^{0}c, respectively. The total annual rainfall of the area ranges between 400 and 700 mm (Ayalew 2001). But such areas may also be categorized under *lower kolla* (dry/ arid) climatic zone as the temperature is above 25 and rainfall below 800mm (MOA/FAO/UNDP 1983).

Awash River is the only perennial river that crosses the area while Lake Basaka has continued to expand in size from 3km^2 to 42km^2 from 1964 to 2007, respectively (Halcrown 1978; MoWR 1999b; OIDA 2007). Surface water of Lake Basaka contains 28mg/l of fluoride ion that is well above the global (1.5mg/l) and the national (3mg/l) Drinking Water Guideline for fluoride ion (Bedilu 2005).

According to Bedilu (2005), the Awash River fluoride concentration (2.2 mg/l) is higher than WHO standard (1.5mg/l) but less than the Ethiopia Drinking Water Quality Standard (3mg/l).The river water is still good in the concentration of Manganese, Nitrate, Chloride, Iron, Sodium and Sulfate by both guidelines. In contrast, its turbidity 569.25mg/l, which is about 81 and 114 times greater than that of Drinking Water Quality Guideline of Ethiopia (7) and WHO (5), respectively. Therefore, without any treatment, using Awash River for drinking is undeniably harmful for human the health. MoWR (2002) underlined that, drinking water exceeding required standard will have negative impact on users. But, during dry periods, in the study area, Karrayu pastoralists have been relied on the sewage irrigation of Awash River which carries the pollutants of Awash River from upper basins and from the nearby Metehara Sugar Factory. Accordingly, the community is vulnerable to water pollution from upper basin of Awash River and the nearby Sugar Factory. Moreover, the high fluoride ion concentration of Lake Basaka has been affecting the suitability of underground water sources for drinking. For example, deep motorized deep wells are serving the community of Debit, Ilala and Benti in the kebele around the lake (OIDA 2007). The life and livelihood of the community in Fentale woreda are threatened by the increasing expansions of the surface water of Lake Basaka.

Socio-Economic Features: The total population of Fentale woreda in 2007 was 82255, of which 53% and 47% are male and female, respectively while urban and rural dwellers constitute 25% and 75%, respectively (FWARDO 2007). According to focus group discussions (FGDs), Karrayu has two major tribal divisions namely *Dullacha* and *Basso*. Karrayu inhibited as a single dominant group in Fentale woreda until 1950s and 1960s. Since then, *Ittu* and Somali community continually have permanent settlements in Karrayu area (Ayalew 2001). Pastoral system is the dominant livelihood base of Karrayu people by rearing cattle, goats, sheep and camels that account for 33%, 26%, 21%, 20% and 5% of their livestock, respectively (Figure 2). In some places, agro-pastoral livelihood system began since 1980s as a response to scarcity of feed and water, and consequent weakening of their pastoral means of livelihood (Ayalew 2001). They cultivate maize, sorghum, groundnut and onion (FWARDO 2007).

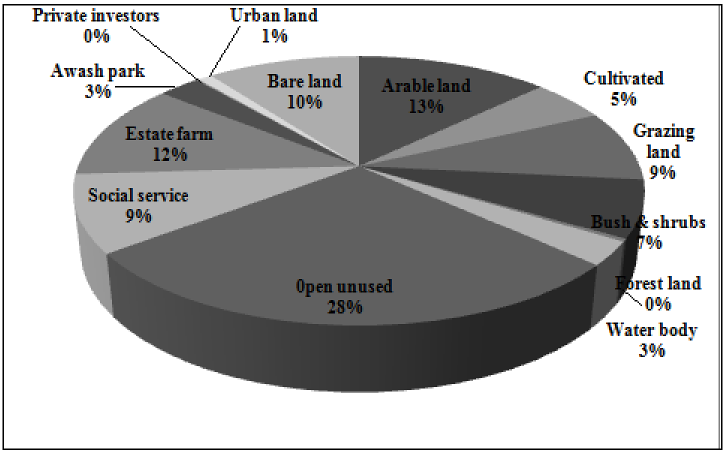


Figure 2. Land Use Classifications of Fentale Woreda

Pastoral and agro-pastoral land use/cover of Fentale woreda accounts for about 27% of the total 133965ha area of land. On the other hand, about 38% is occupied by open land and degraded bareland, and 15% by Awash National Park and agricultural plantations (Figure 2). During prolonged dry seasons, pastoral and agro-pastoral people overhaul with their livestock for feed and water. As the community has food insecurity and low income, most of the households generate their income by selling fuel wood and charcoal at urban center. This leads to deforestation of grazing habitat in the woreda. Moreover, Lake Basaka, Awash National Park, the Metehara Sugar Factory and its associated agricultural estate farms have encroached onto major portions of grazing lands in the area. The agro-pastoral and pastoral livelihood of the community continue to be affected by both natural and human-induced factors, which in turn block and/or hinder access to the actual and potential grazing and agriculture lands in the area.

Design and sampling procedure

The study used accessibility, degree of water scarcity and representation of pastoral and agro-pastoral system as criteria to select Gelcha, Kobo, and Banti Mogassa kebeles as study areas in Fentale woreda. Multistage stratified random sampling was used to select 120 sample households (SHHs). Primary data was gathered using semi-structured interview, focus group discussion (FGDs), deep personal interview, key informants and field observation together with GPS readings of geospatial data of all the accessible water points and schemes. Relevant secondary data was reviewed from different published and unpublished documents.

Data analysis

The qualitative and quantitative data gathered from various sources were analyzed using descriptive statistics. Arc GIS 9.1 and ERDAS software were used to depict and interpret spatial distribution of water point of the study area.

Results and Discussion

Characteristics of major sources of water supply

There was spatio-temporal variation in the distribution of water sources in the area. In Karrayu area, surface water constitutes most of the water supply sources including different ponds, cistern, boreholes, irrigation canals, salty pipe waters and river water points (Figure 3; Table 1). Ponds are the most popular means of harvesting rainwater for human and cattle water consumption in the area. Usually ponds are dug by household heads, group of individuals and neighbors, local communities and organizations (government and NGOs).

There are traditional and modern ponds that are locally identified and used by the community. Some are used during the rainy seasons while others are preserved for dry seasons (Table 1). Furthermore, cistern, boreholes, irrigation canals, salty pipe-water and river water points are used systematically and alternatively to secure water availability for the prolonged dry seasons and during and after short rainy season (Figure 3; Table 1).

Table 1. Major water sources and schemes and their seasonal pattern of use

Schemes and Points of Water Sources	Local Identifications (Local ID)	Seasonal Patterns Per Sample Kebeles		
		Gelcha	Kobo	Banti
Natural Ponds	*Haroo Qarsaa*	-	Rainy Seasons	-
Traditional Small Ponds	*Haroo Aadaa* *	Rainy Seasons	Rainy Seasons	Rainy Seasons
Big Ponds	*Haroo Ammayyaa*	Dry Seasons	Dry Seasons	Dry Seasons
Modern Small Ponds	*Haroo Qorqoorroo***	Dry Seasons	Dry Seasons	Dry Seasons
Cistern	*Haroo Qadaaddoo*	-	Dry Seasons	-
Boreholes	-	-	-	Dry Seasons
Irrigation Canals	-	Dry Seasons	Dry Seasons	Dry Seasons
Salty Pipe waters	-	Dry Seasons	-	-
River water points	*Haroo Melkaa*	Rainy & Dry Seasons	-	-

(**NB:** *If owned by private households and by neighborhoods are called *Haroo dhunfaa* and *Haroo Ollaa*, respectively; **also identified as *Haroo Care* to refer those established by CARE).

Natural ponds (*qarsaa*) are based on harvesting rainwater by using naturally formed depressions at different slopes of Mount Fentale. Water harvested from such ponds stays only for two to three weeks after the rain stops. According to FGDs, *qarsaa* are the most preferred water source by both human and livestock population because of their taste and ease for use that is incongruent with the study conducted by Ayalew (2001).

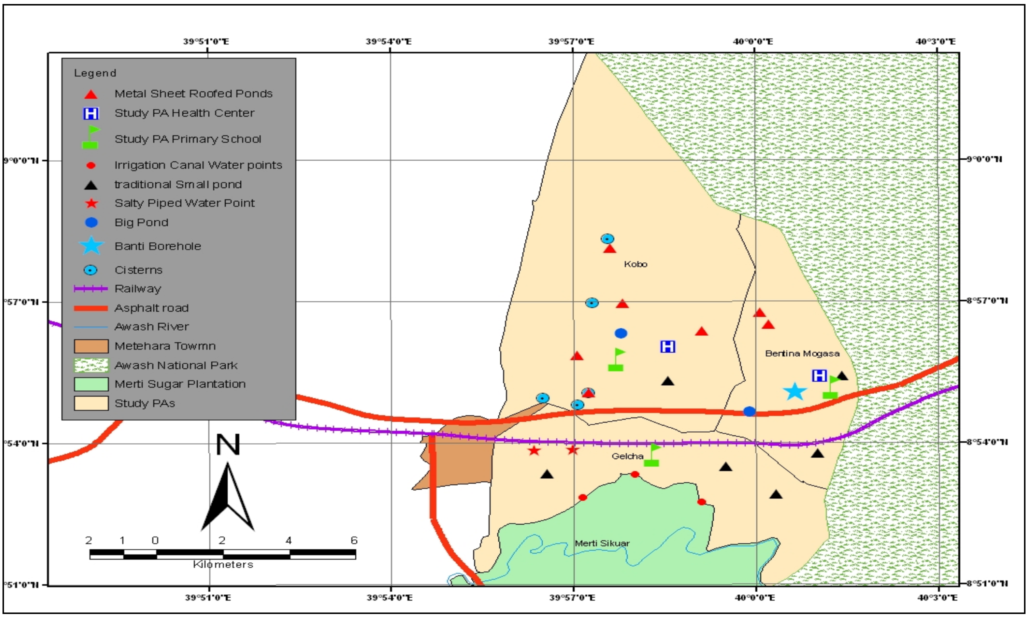


Figure 3. Location of existing small and big ponds in the study areas

There are man-made ponds: private ponds (*Haroo dhunfaa*) that are dug by individual family members locally while communal ponds (*Haroo Ollaa*) owned by neighborhoods and/or members of community in the neighborhoods. Traditional small ponds are not only numerous and small in size, but are also preferably used for domestic consumption, and are relatively well protected than communal ponds, which are owned at village and kebele level. Traditional small ponds are major sources of water for human and livestock population during rainy seasons throughout the sample area of the study (Table 1). The local community developed traditional mechanisms and strategies to await the completion of the small ponds and preserve the big ponds for consumption during prolonged dry season.

The characteristic features of these major sources of water to the pastoralists and agro-pastoralists of Karrayu are presented in Table 2. The major sources of water supply vary in their duration of service, means of opening them, and their unique characteristics. Among the major sources of water in the area, natural ponds (*Haroo*) are obtained from rainfall and have short life cycle only during or after rainy days. On the other hand, most sources are the result of digging underground water either on individual or neighbours bases (in the case of traditional small ponds) or using machinery by community or organizations (in the case of modern ponds, big ponds and bore holes). The rest are either due to running water across the pastoral and agro-pastoral area, irrigation canals, or salty pipe water points (Table 2).

Table 2: Characteristic Features of Sources of Water Supply in the Study Area

Duration	Area Opened by	Unique Features
	Natural Ponds (*Haroo*)	
Short duration of services: 3 to 4 weeks after rain.	Local communities and organizations (governmental and NGOs).	Runoff and over flow from the surrounding hill slopes; most preferred by both human and livestock; accessed by only Kobo kebele and others who bring their cattle very close to the feet of Mount Fentale.
	Traditional Small Ponds	
Mostly used for home consumption until they are exhausted.	Individual family members or owned by individual or few members of neighborhoods	*Haroo dhunfaa* (private ponds): small in size but numerous; those dug by individual or few members of neighborhoods (*Haroo Ollaa*);
	Big Ponds	
Serve for longer period of times (1-3months) following the drying up of small ponds.	Ponds excavated at village or Kebele level;	Manually or mechanically opened; surrounded by highly degraded and devoid of vegetation and grasses;
	Modern Ponds	
Also named "*Haroo Care*" by the community as they are introduced in the area by Care–Ethiopia. These modern ponds are locally grouped as "*Haroo qorqoorroo*" (Metal sheet roofed pond) and "*Haroo qadaaddoo*" (Cistern).	Dug by different organizations (government and NGOs); inefficiently designed and hence their worked roof collapse within one to two years which is difficult for the user to sustain it;	Such a single pond is constructed to serve 20 to 30HHs in the neighborhood. Both types are walled up with stone, bricks and plastered with cement; highly hate the metal sheet roofed modern ponds for its roof collapses less than 2years; lost their metal sheet roof and left open;
	Irrigation Canals Water Points	
During prolonged dry period,		Highly polluted irrigation canals; diverted from Awash river; such modern water schemes also run out of function frequently because of managerial and technical rooted problems;
	River Water Point (Malka)	
Watering points for prolonged dry season;		Prior to introduction of State Farms and National Park used by pastoralists in long periods;
	Salty Pipe Water Points	
-Gelcha villages rely on this salty water for domestic consumption during short to long dry periods;	-Lined from Metehara Estate Farm villages by Care-Ethiopia NGO in 2007;	Established water committee at the village is unfunctional; salty ground water source with high fluoride content;
	Boreholes	
Consists of one borehole, one overhead steel tanker, 50m^3 reservoir and water points;		Functional deep wells are with better water supply atmosphere; functional ones have daily water supply that could not support daily water demand; queue at the borehole common takes the whole day throughout dry period.

The summary of community assessment and evaluation of the sources of water supply is presented in Table 3. Accordingly, based on the advantages and disadvantages of these sources of water supply, the assessment indicated that *qarsaa,* big ponds, metal-roofed ponds, borehole and Ajo Tare irrigation canal are preferred since they provide permanent water supply to a large population. However, each of the sources of water supply in the area has its own drawbacks that need immediate intervention for sustainable water resource and livelihood development of the pastoral and agro-pastoral community of the area.

Table 3: Community Evaluation of Different Water Sources

Types of Water Schemes	Community Evaluations	
	Advantages	**Disadvantages**
Qarsaa	- more potable; naturally existed and does incur cost.	- small in volume; inaccessible; formed in grazing areas around dry seasons.
Small ponds	- used by limited households; best in proximity; less susceptible for degradation	- quickly dries up; serve few population; polluted by neighbors waste
Big ponds	- used for longer period and support more populations	- sever degradation, siltation, highly polluted and susceptible to arouse more conflicts.
Metaled ponds	- better in proximity & reduces evaporation	- short lifespan and highly polluted
Cistern	-better in proximity& reduces evaporation	- unseen cracking; arouses more conflicts
Borehole	- Permanent water supply; support more populations	- sever degradation; arouses more conflicts; livestock diseases expansion; high cost; salty; and too hot.
Salty pipe water	- Permanent water supply	- too salty; healthy problem; not ample for livestock
Melka Akake	-relatively good in quality; permanent water supply; support more populations	- inaccessible for most beneficiaries.
Ajo Tare irrigation canal	- Permanent water supply; support more populations	- highly polluted and far from most villages

Challenges of water supply

Lack of Water Development Schemes: Karrayu has been relying on underground water supply sources excavated by household heads, neighborhoods, community, different NGOs, and government bodies. Before the year 1996, Fentale woreda had 3 water schemes relatively similar with Bule Hora and Yabelo woredas with 4 schemes but below Abaya woreda of Borena zone which has 9 schemes. Currently there is only one water development scheme in Fentale woreda compared to 15, 4 and 15 in the aforementioned respective woredas (Table 4). Unlike other pastoral woredas in the region, rural water supply of Fentale has gone down in some areas the schemes ranges from 14 to 29 except Yabelo (4) and Fentale (1) (Table 4). Only 64% (7/11schemes) were actively functioning in Fentale while in other pastoral and agro-pastoral woredas both the total number and the actively functioning schemes are greater by 2 times (as of Yabelo) and about 15 times in Liben woreda (Table 4). Moreover, rural water supply in Fentale woreda had declined slightly from 25.37% in 2003 to 23.51% in 2007 (Table 4). Conversely, rural water supply of selected pastoral woredas in Borena Zone (Bule Hora, Yabel and Abaya) and Guji Zone (Odo Shakoso and Liben) had slightly increased during these periods. The issue of equity in the distribution of water development schemes in the pastoral and agro-pastoral woredas of Oromia seems require further investigation to enable fair access of the pastoral and agro pastoral community to water supply system in the area.

Table 4. Distribution of rural water supply in selected pastoral areas of Oromia

Name of woreda	Commission Years				Current Types and Status of Water Schemes							
	Pre-1996	1996-2000	2001-2005	Post 2006	DPW	SHT	HDW	SPT	SPD	Fun	Malfun	Total
Borena Zone												
Bule Hora	4	7	17	15	13	11	4	11	4	39	4	43
Yabelo	4	6	8	4	12	10	0	0	0	17	5	22
Abaya	9	4	34	15	4	22	12	22	2	57	5	62
Guji Zone												
Liben	1	19	115	29	8	27	120	9	0	92	72	164
Odo Shakiso	1	15	25	14	0	33	16	6	0	36	19	55
East Shewa Zone												
Fentale	3	4	3	1	9	2	0	0	0	7	4	11

(**Source:** Adopted from OWRB, 2007; **NB**: DPW-Deep well; SPT- Spring on point; SHW–Shallow well; SPD-Spring with distribution; HDW- Hand dug well).

As can be depicted from Figure 4, the borehole water points are insufficient for the study area. About 50% (9/18 kebeles) in Karrayu were served by these water supply schemes (Table 5; Figure 4). As the result of shortage of boreholes in the Karrayu area, the community with their livestock is usually crowded around the few boreholes in their vicinity, especially during the dry periods.

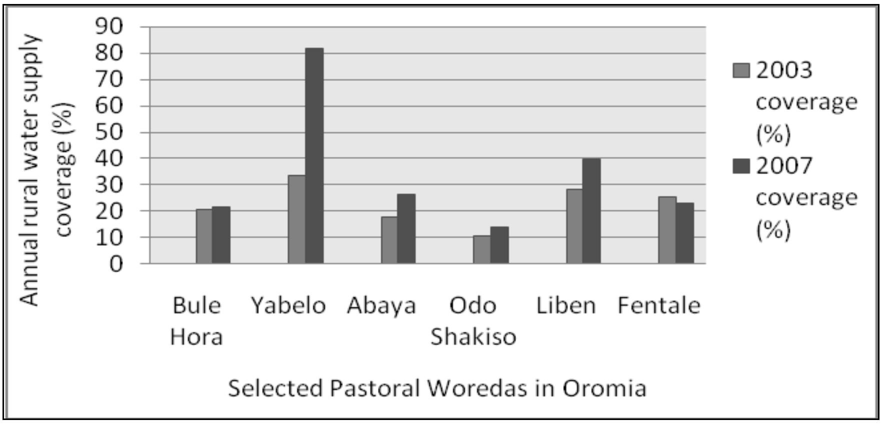
Table 5. Boreholes bored by different organizations in the Fentale woreda

Location of Kebeles	Name of Borehole	Depth (meter)	Bored by	Borehole Opened	Discharge	Status
Ilala Karari	Sebo Ber	77	GV	1993/4	2 l/sec	Functional
	Ilala	41	GOAL	1998/9	-	,,
Debiti	T/ Dera	74	GTF	1998/9	9.4 m^3/hr	,,
	Debiti	90	GV	1970/4	4.5 l/sec	,,
Banti	Banti Mogasa	92	GV	1993/4	4.2 l/Sec	,,
Turo	Turo Bedonota	68	GOAL	1998/9	-	Not-functional
Fateledi	Fateledi	110	CARE	2003/4	-	,,
Tututi	Meliba	93	CARE	1998/9	4.2 l/Sec	Functional
	Tututi	113	GV	1998/9	-	,,

(**NB:** lt/sec=liter per second; m^3/hr= cubic meter per hour)

High Concentration of Fluoride ion: In the sampled kebeles of Fentale woreda, the borehole depths ranges from 41 m at Illa Karari to 113 m at Tututi (Table 5). The deeper the wells are, the higher the concentration of objectionable minerals, compared to those found in the shallow wells (Forrest 1977). This can be seen from the boreholes serving the communities in Debiti, Ilala and Benti that are characterized by high fluoride ion content and almost the same taste as that of Lake Basaka (OIDA 2007).

Siltation: The underground water source is accessed through salty pipe water points at Gelcha and borehole planted at Banti kebeles. There are two piped salty underground water points located in Gelcha kebele. These water points are lined from Metehara Estate Farm Villages by Care-Ethiopia NGO in 2006/7. The Metehara Estate Farm workers do not use this salty underground water source for drinking purpose because of its high fluoride ion content. Despite this, the residents in Mesgida and Somale neighborhoods in Gelcha villages rely on this salty water for domestic purposes during short and long dry periods. This may indicate the vulnerability of the beneficiaries unless there are quick interventions.



Source: Adapted from ORWIR 2007.

Fig.4. Rural water supply converges of selected pastoral woredas of Oromia

Lack of Proper Management: Boreholes are permanent sources of water supply for the Karrayu. Furthermore, most boreholes rarely provide service for one to two months during the dry period due to lack of maintenance. On the other hand, the boreholes at Turo Bedenota and Fate Ledi are not functional due to siltation of boreholes, damage of pumping motor and lack of spare part, and encroachment of Metehara Sugar Factory.

The community in the study villages highly hates the metal sheet roofed modern ponds. Users indicated that, such ponds are inefficiently designed and hence their worked roof collapses within one to two years, which makes it difficult for the user to maintain frequently. Accordingly, almost all such ponds in the surveyed PAs lost their metal sheet roof and were left open. Unlike small traditional ponds, the modern ponds are deeper (5 to 10m) with narrower diameter. Hence, when they are left open, sheep, goats and other animals even children fell into it and died. Such incidents have polluted the turbid water in the ponds. Owing to these adverse effects, the community strongly dislikes these ponds.

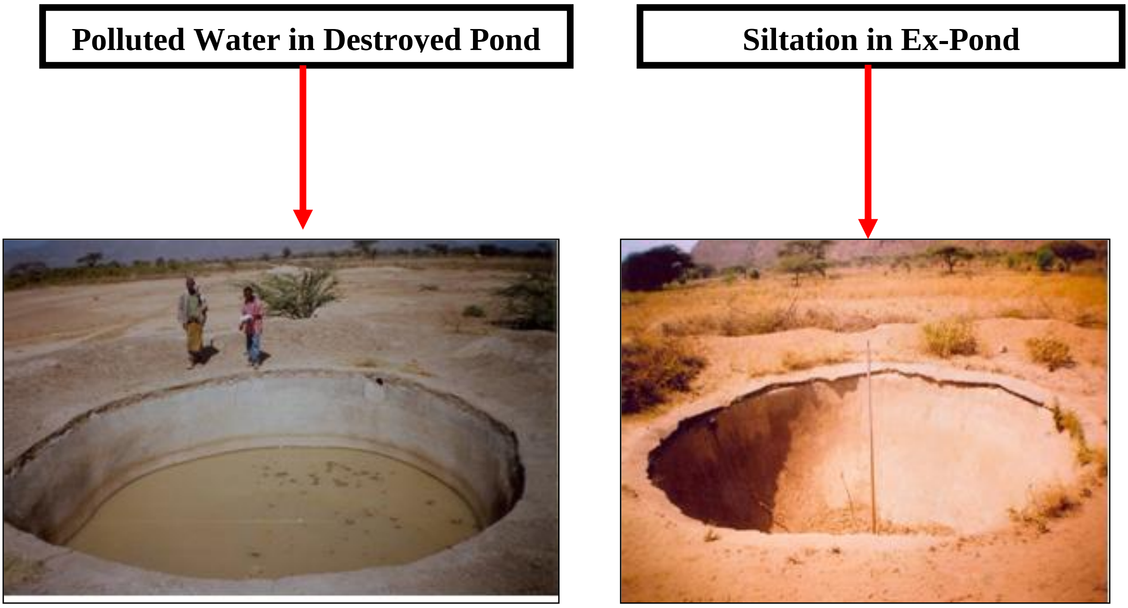


Plate 1. Contextual Features of Unfunctional Ponds

According to Richard & Bashir (1995) and Omsa (2005), ponds are rapidly silted up and highly exposed to pollution. Similarly, all ponds in the surveyed PAs do not have any kind of fences to protect them from animal and human misuse and they are devoid of vegetation (Plate 1). Both human beings and livestock use the pond water at the same place. There was no livestock watering trough around the big ponds. For instance, the big pond in Kobo PA that was located close to the bottom of Mount Fentale ridges collects runoff water that carries huge alluvial soil. This usually brings about siltation of the pond within a short period of time. Moreover, the communities wait for the concerned NGO or government for the maintenance metal sheet roofed ponds. But, no bodies revisit the scheme once they leave, and this is done even without clear transfer of the scheme to the local community. Accordingly, almost all of these schemes left open and lead to the death of both small animals and even children when they are accidentally into them. Surprisingly, contrary to deep-rooted hatred of these water schemes by pastoralists, still the schemes are being bored in the study areas. This implies that local community participation and decision making are not given due attention in the development of water schemes in the area. Thus, sustainable use and management of water schemes in particular and rural development activities are not free from subjectivity due to different biases being in favor of new projects rather than ensuring sustainability of existing schemes (Admasu 1996). Hence, the participation of local community and introduction of water development schemes in the Karrayu area need further investigation.

Climate change and Land Degradation: Usually big ponds are excavated by either manual or mechanical means at village level to serve for one to three months and large populations. The micro-basin of these ponds is highly degraded and devoid of vegetation and grasses (Plates 2). The water in big ponds is used mostly from October to December when small ponds get dry up. The interviewed elders at most villages underlined that the existing ponds (namely *qarsaa*, small ponds and big ponds) dry up at faster rate in the recent years than earlier years (15-20). In the past years, water in ponds stayed for several months (some years back, they stayed even throughout the year). But today, all ponds dry up from October to mid-December. This may be attributed to such factors as decreased rainfall amount, high evapo-transpiration, increased water demand by both human and livestock population, in situ land degradation, etc.

NB: 1=Destroyed water pumping generator; 2=unfunctional water tanker at hill of water tower; 3=cattle trough for water consumption; 4=degraded land around the borehole and 5=unfunctional water point.

Plate 2. Contextual features of unfunctional boreholes of Banti Mogassa

Local Perception on Challenges: The responses of SHHs on local perception of the challenges to the water scarcity are presented in Table 6. About 85.5%, 77.5%, 65%, 60% and 56.7% of the local community perceived existence of estate farms and Awash National Park, climate change and frequent drought, conflict on water points, population growth, and mismanagement of water sources as challenges of water scarcity. However, contamination of water and financial constraints were perceived as challenges by about 47.5% and 40.8% of the SHHs, respectively.

According to the local community, Metehara Sugar Factory and Awash National Park are the main organizations that contribute towards the aggravation of steady growing water scarcity since the past two to three decades. They blocked pastoralists' access to vast grazing land and several water points along Awash River bank during the dry periods. Hence, the pastoralists were forced to rely on unsafe and undependable temporary surface and underground water sources especially during the dry period. Yet, these organizations failed to show fruitful effort to uphold the aforementioned problem of pastoral and agro-pastoral community.

Table 6. Local perceptions by pastoral and Agro-pastoral community of Karrayu on issues related with water scarcity

R No	Perception of water scarcity causes	Respondents	
		No	**%**
1	Existence of estate farms and National park	103	85.8
2	Climate change and frequent drought	93	77.5
3	Population growth	72	60
4	Conflict on water points	78	65
5	Contamination of water	57	47.5
6	Financial constraint	49	40.8
7	Mismanagement of water sources	68	56.7
8	Others*	35	29.2

Source: Field Survey Jan, 2009; **NB:***includes inappropriate technology, punishment from ***Allah*** and distortion of cultural norms. Multiple responses are included.

Conclusion

The study examined the major sources of water supply and investigated the natural and anthropogenic challenges in the pastoral areas of Karrayu. The major sources of water identified include natural/earthen ponds, traditional ponds, modern ponds, cistern, boreholes, irrigation canals, salty pipe-waters and river water points. However, each of the sources of water supply in the area has its own merits that should be capitalized and demerits that should be intervened to maximize benefits from the water supply system and secure sustainable water system to the pastoral and agro-pastoral community of the area. Water scarcity especially during the prolonged dry periods was found to be a major problem. There are numerous interrelated challenges of water scarcities in the study area among which are; the lack of water development schemes, high concentration of fluorine ions, siltation, lack of proper management and maintenance, climate change/ variability and drought, and land degradation. Moreover, almost little/

no participation of the local community in the rehabilitation of old water sources and introduction of new ones were identified.

The issue of equity in the distribution of water development schemes in the pastoral and agro-pastoral woredas of Oromia requires further investigation to enable fair access of the pastoral and agro pastoral community to water supply system in the area. There is the need for an integrated and holistic approach by all stakeholders in the study area to come up with sustainable management and use of water sources, and ways to improve the overall water supply system in the study area.

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