Seasonality Revisited

Perspectives on Seasonal Poverty

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Water-Bound Geographies of Seasonality:

Investigating seasonality, water, and wealth in Ethiopia through the Household Water Economy Approach

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Water-Bound Geographies of Seasonality:
Investigating Seasonality, Water, and Wealth in Ethiopia through the Household Water Economy Approach

(Draft)

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This paper presents findings from a pilot HWEA assessment in Bale, Oromiya under the Livelihoods Integration Unit (LIU) and the Ministry of Agriculture and Rural Development (MoARD), Ethiopia; a rapid food and water security assessment in SNNPR under Community Housing Fund International (CHF) during the 2008 Belg emergency in Ethiopia; and work carried out under RiPPLE (Research-inspired Policy and Practice Learning in Ethiopia and the Nile Region). RiPPLE is a 5-year Research Programme Consortium funded by the UK's Department for International Development (DFID) aiming to advance evidence-based learning on water supply and sanitation (WSS). The RiPPLE Consortium is led by the Overseas Development Institute (ODI), UK, working with the College of Development Studies (CDS) at Addis Ababa University, Ethiopia; the Ethiopian Catholic Church Social and Development Coordination Office of Harar (ECC-SDCOH), Ethiopia; the International Water & Sanitation Centre (IRC), the Netherlands, and WaterAid, Ethiopia.

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A. Introduction

Precursors and Linkages: Household Economy Approach (HEA)

The Household Water Economy Approach (HWEA) is a new approach that was designed in 2007-08 to bring analytical rigour to understanding the inter-linkages between water security and food security. Designed to build on approaches and methodologies that have already achieved buy-in and skills/capacity development, it has also been developed to link to and inform the livelihoods monitoring and early warning systems in place in Ethiopia.

Ethiopia's Disaster Management and Food Security Sector and the Livelihoods Integration Unit (LIU) therein currently uses the Household Economy Approach (HEA) as the analytical framework with which to assess food and livelihoods-based needs of its populations affected by a range of shocks such as those related to weather, markets, policies, or health. Many other countries, and agencies within them, particularly in sub-Saharan Africa, but also in Asia, Eastern Europe, and Latin America, have also incorporated HEA into their early warning frameworks or have turned to it to better understand the livelihoods and needs of their populations.

The premise behind both HEA and HWEA is that an understanding of how people will be affected by shocks or hazards in a bad year is only possible if an understanding is achieved of how people piece together their livelihoods – and in the case of HWEA, secure access to sufficient water to meet livelihoods needs – in normal years. An analysis of household economy aims to systematically determine how people live, what puts different households at risk of food or non-food shortages, and what type of responses are most appropriate (see FEG, SCUK, RHVP 2008 for more detail).

More than simply relevant to emergency response, however, the HEA is to be at the core of Ethiopia's emerging disaster risk management system that is capable of both *corrective* (current disasters) and *prospective* (future potential disasters) risk management[1] (Boudreau 2009). In Ethiopia, where emergencies are endogenous to the country, and have posed a perpetual threat to much of its population for centuries, the capability to bridge the emergency-development divide is particularly urgent.

The strength of HEA's ability to serve this task lies in its ability to transform a descriptive analysis into a predictive one, where scenario-based risk assessment is at the centre of providing dynamic, targeted recommendations for building resilience and reducing vulnerability – as well as responding to current shocks faced by populations (Boudreau 2009).

The Missing Link: Water

Much as the emergency-development divide is impossible to bridge without a systems-based (as opposed to a sector-based) approach to understanding how hazards and vulnerabilities interact to create disaster risks, the livelihoods picture is incomplete without a holistic understanding of the interdependencies of food security and water security.

[1] The UNDP Bureau for Crisis Prevention and Recovery differentiates between two types of risk management: *Prospective disaster risk management* should be integrated into sustainable development planning. Development programmes and projects need to be reviewed for their potential to reduce or aggravate vulnerability and hazard. *Compensatory (or corrective) disaster risk management* (such as disaster preparedness and response) stands alongside development planning and is focused on the amelioration of existing vulnerability and reduction of natural hazards that have accumulated through past development pathways. Compensatory policy is necessary to reduce contemporary risk, but prospective policy is required for medium- to long-term disaster risk reduction.

Access to safe water in drought – one of the most common hazards in Ethiopia – is consistently a major problem, and water-related disease resulting from restricted water availability and access often causes more fatalities than does starvation in times of famine. Integration of water security into traditionally food-centred assessments contributes to the formulation of more effective and creative multi-sectoral responses (e.g. Calow et al., 2002; Ludi, 2009). Because water interventions often have long-term impacts and consequences, if planned for properly, it would also strengthen prospective risk management.

This is where the Household Water Economy Approach aims to fill in the gaps. Until recently, livelihoods analysis has under-appreciated how crucially water contributes to production, and to the ability of households to secure the resources they need to survive. In reality, access to food, income and water are linked in important ways, particularly during drought. HWEA aims to link household economy with access to water at household level – and strengthen our understanding of livelihoods and our responses to threats to livelihoods.

B. Methodology

Methodological Components

The Household Water Economy Approach has three components:

1) **Water Baselines** – which address both **water availability** and **water access** within each geographical unit of analysis, or livelihood zone.[2] Water access baselines capture quantified data on access to sources of water by different wealth groups, across seasons, and across uses (e.g. domestic and productive). Detailed hydrogeological data and mapping enables characterisation of groundwater potential – or the ability of aquifers (or sub-surface rocks) to store and transport water during normal conditions and drought – in specific geographic areas, as well as identification of areas vulnerable to groundwater drought.[3] Water point coverage lends to this information on local water availability.
2) **Hazards Analysis** – which is based on seasonal or other assessments and which quantifies shocks or hazards[4] and translates them into quantified economic and water access consequences at household level.
3) **Outcome Analysis** – which projects the impact of the hazards in relation to survival and livelihoods protection needs, or thresholds. See Annex B for an explanation of these thresholds.

Quantified information on water access, and its importance in relation to specific livelihoods strategies, forms the baseline datasets that form the foundation of an analytical tool, the Water Impact Analysis Sheet (WIAS). The WIAS provides an interactive interface that allows for input of seasonal hazards information and which provides outputs in the form of data and graphs illustrating impact on water access and livelihoods at household level.

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[2] A livelihood zone is a geographical area that shares similar agro-ecological characteristics, livelihoods strategies practiced by the population (e.g. pastoralism, agro-pastoralism, cropping strategies agriculturally), and access to markets.

[3] Groundwater drought is a term used to describe a situation in which groundwater sources fail as a direct consequence of drought (see Calow et al 1997). Groundwater is water stored below the surface in aquifers. Aquifers are simply subsurface rocks that store and transport water. The better the storage and transport properties of an aquifer, and combined with adequate recharge from e.g. rainfall, the greater the potential that groundwater will be available during drought or during periods of high demand.

[4] A shock or hazard is an event or process that significantly affects households' access to food, income, and water. Examples include drought, cyclones, market failure, policies, war, etc.

HWEA Assessments and Research

Three HWEA assessments and research are addressed in this paper. They are summarised briefly below.

1. **HWEA pilot assessment in pastoral areas of Bale Zone, Oromiya Region, Ethiopia.** The assessment took place in March and April of 2008 under the LIU and MoARD alongside LIU HEA baseline data collection in Bale Pastoral (BPA) Livelihood Zone.

2. **Rapid emergency water and livelihoods needs assessment in three livelihood zones in north-eastern SNNPR, targeting vulnerable populations in Alaba, Mareko, Badewacho, and Gumer weredas.** The assessment took place in May and June of 2008 and was commissioned by Community Housing Fund International (CHF). It aimed to assess water and livelihoods needs of vulnerable populations in the above areas in order to inform immediate action and priority setting for emergency response and mitigation activities by CHF and other agencies. Identification of innovative responses that paired non-food based support with traditional food-based support was a central emphasis of the assessment.

3. **RiPPLE-funded action-research HWEA study in East and West Hararghe and Shinile Zones, Oromiya and Somali Region, Ethiopia.** The ongoing study is one component of RiPPLE's Growth Long-term Action Research Project (Growth LARS),[5] which focuses on how investments in the Water and Sanitation Sector (WSS) contribute to poverty reduction, sustainable livelihoods and pro-poor growth. Within this, the HWEA case study aimed at providing an information system and analytical tools to assess water access of different wealth groups at household level within different livelihood zones. The study's objectives include the following:

    a) Assess baseline household access to water for various water uses (domestic and productive) across wealth groups in a transect of livelihood zones (LZ) from highland to lowland (Wheat, Barley & Potato (WBP) LZ; Sorghum, Maize & Chat (SMC) LZ; and Shinile Agro-Pastoral (SAP) LZ) with a focus on assessing how differential access to water affects livelihoods security and potential for resilience in different livelihood zones.

    b) Drawing on groundwater availability mapping undertaken by BGS, assess how the groundwater resource base affects the opportunities for household water security in each livelihood zone and how the resource base might affect opportunities for water-based adaptation measures in the future.

    c) Assess likely impacts of climate change-related geophysical shocks and hazards (e.g. increased incidence and intensity of drought, increased rainfall variability, etc.) on household access to water and on livelihood security to better identify the most vulnerable groups and geographic areas.

    d) Assess likely impacts of climate change adaptation schemes on different households in each livelihood zone.

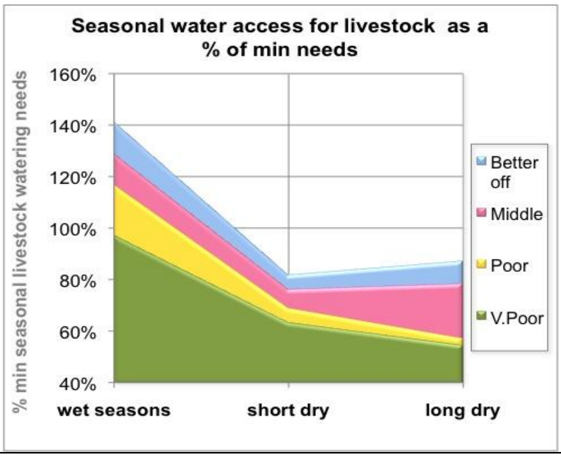
[5] For further information see www.rippleethiopia.org.

C. Quantifying Seasonal Access to Water

Because water is a daily need for both humans and livestock – the latter which are significant to household livelihoods in virtually every rural livelihood zone in Ethiopia – and access to water depends so heavily on seasonal changes in rainfall and groundwater flows, quantifying access to water must be done seasonally. Understanding seasonal access to water is mandatory for understanding periods of resilience and vulnerability within the yearly production cycle.

There is perhaps no livelihood system for which this is more true than pastoralism, in which livelihood strategies are wholly dependent on access to water for livestock. Quantifying seasonal water access uncovers important lessons for targeting, timing of monitoring, and responses in drought years. An illustration of how access to water for livestock is quantified is presented in Figure 1 for Bale Pastoral (BPA) Livelihood Zone (Oromiya Region, Ethiopia).

Figure 1. Seasonal access to water for livestock in BPA Livelihood Zone



Source: Coulter 2008a.

Fluctuations in seasonal access levels vary widely in Bale and are, broadly speaking, related to rainfall levels. In the wet seasons (*gena* from March to May and *hagaya* from September to October), all households can access water at nearby ponds and seasonal pools that collect after the rains. In the dry seasons, pastoralists must excavate water from dried riverbed pits – an arduous task – and migrate during the second half of the long dry *bona* (Nov – Feb) season to perennial rivers to secure enough water during that period.

What stands out from the findings above is that very poor and poor households are not able to secure enough water in the dry seasons of a normal year,[6] falling far short of 100% minimum needs. All households see their water access drop by nearly 60% from the wet to the short dry *adolesa* season (June – August). However, wealthier households mobilize resources to ensure that their livestock obtain nearly 85 to 90% of minimum water needs in the long dry *bona* season when water needs are highest due to depletion of graze and its moisture content, hotter temperatures and high transpiration, and accumulating dehydration of animals.

While middle and better off households increase water access for their livestock from the short dry *adolesa* season to the long dry *bona* season by 3% and 8%, respectively, very poor and poor households have limited household asset bases from which to draw. They see their livestock water access drop a further 10 to 15% in the *bona*, facing watering deficits of at least 40% of minimum needs. This is illustrated in Figure 1.

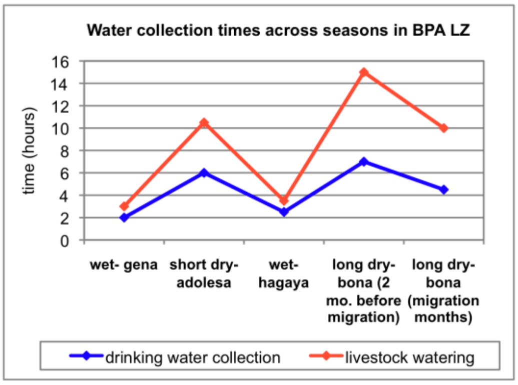
The failure of the poorer wealth groups to secure enough water for their livestock in the dry seasons has significant implications for their ability to maintain assets and generate

[6] Furthermore, water intake requirements for livestock are substantially lower in the wet season due to the moisture contained in graze. Moisture content in graze is estimated at 70% to 75% during the wet seasons under Sahelian conditions. Moisture in forage drops to around 10% in dry seasons with average temperatures of greater than 27^{o}C (Pallas 1986 in Taddesse and Misra 2007; Taddesse 2003). See Annex C for a table listing seasonal water intake requirements for livestock in Sahelian conditions.

wealth. Such low seasonal access levels significantly undermine livestock condition and increases susceptibility to disease (which is further compounded by lower expenditure on veterinary care). The prices that poor wealth groups receive for their livestock are at least 15 to 20% lower than those fetched by the wealthier households. Finally, milk yields per animal are 50% to 75% lower for stock of poorer households compared to the better off.

The reasons behind these wealth-based disparities in seasonal access among wealth groups are related to asset bases. Very poor and poor households have smaller household sizes (approximately 6 compared to upwards of 9 to 11 for the better off) which limits their release of labour to water livestock. Labour is particularly important for water collection in this zone because extraction of water from excavated pits that are at least 5m deep requires more than one person in the long dry *bona*. Water must be lifted out and poured into livestock troughs for animals. Figure 2, which shows seasonal collection times, speaks to the huge time investment required to access water in the dry seasons.

Figure 2. Water collection times by season in BPA Livelihood Zone



Source: Coulter 2008a.

Wealthier households also have higher cash reserves to pay labour to assist with or water their livestock herds. Finally, social capital of wealthier households and better access to information on livestock management may play a role in the ability of these households to increase frequency of watering and volumes accessed per livestock head during the dry seasons.

Implications for Emergency Monitoring and Response

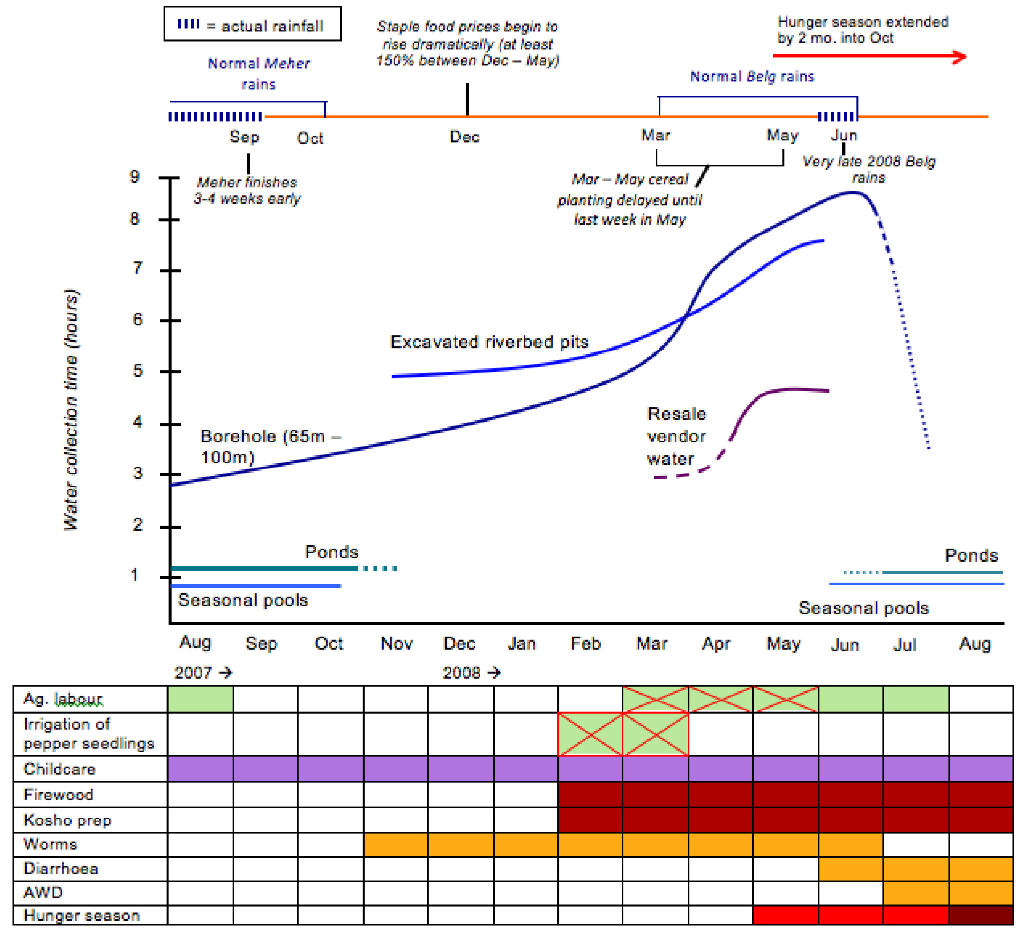
Generation of this quantified seasonal access trend data is important for monitoring and response in drought periods. In this case, it suggests that given the high deficits for very poor and poor households in the dry seasons of a *normal* year, livestock of poorer households may need targeting earlier in the emergency cycle. Understanding seasonal deficits in the baseline year enables responses to reach the most vulnerable herds *before* their condition deteriorates past the point when interventions can still protect livestock assets.

D. Assessing Seasonal Conflicts of Labour Allocation: Seasonal Calendars of Water Access

For each livelihood zone assessed through HWEA, a seasonal calendar of water access exists. The calendar facilitates identification of times during the year when there are competitive demands for labour, resources, and time. Figure 3 below is an example of a seasonal calendar of water access for Alaba Mareko Lowland Pepper (AMP) Livelihood Zone, in SNNPR. It is paired with a hazard timeline of the emergency period during the 2008 *Belg* season[7] in that area.

[7] The belg season in Ethiopia is traditionally referred to as the ‘short’ rains, but in fact, it is the main rains for much of the southern areas of Ethiopia, as well as a north-south corridor in eastern Amhara. It is particularly important for SNNPR, where belg-dependent crops make up a significant proportion crop production.

Figure 3. Seasonal calendar of water access in a hazard year – Alaba Mareko Lowland Pepper (AMP) Livelihood Zone, SNNPR



Source: Coulter 2008b.

The seasonal calendar in Figure 2 takes traditional seasonal calendars one step further by plotting collection time for each source of water by month of access which, combined with knowledge of other seasonal activities, opens a window into household decision-making on labour allocation among domestic and productive activities. Comparing collection times and water source behaviour (e.g. yield, quality, etc) in normal years and in hazard years can inform understandings of the likely impacts of hazards on household time constraints.

The set of hazards indicated above in Figure 3 for 2008 in SNNPR included extremely high staple food price inflation (reaching 150 to 175% of the previous year's prices), which reduced purchasing power dramatically; early termination of the 2007 *meher* rains (usually from July to October); and a very late start to the 2008 *belg* rains in the last week of May (usually from March to June).

The calendar reflects the spike in collection time at boreholes – the only safe source of water in the livelihood zone. By March when the rains were supposed to have arrived, collection time had risen to 5 hours at boreholes and rose sharply to 7 to 9 hours once boreholes started breaking down. Information on hydrogeology (see next section) and water point management collected during an emergency assessment revealed two important and related trends. First, most boreholes in the zone that continued to have water during the drought had minimum depths of at least 80m. Second, those boreholes that did reach water table levels at that depth were placed under excessive stress as the number of borehole points were reduced. This was due to the handful of boreholes (under 80m deep) that dried up early in the drought period, as well as the high rates of breakdown of boreholes over 80m (over 30% above and beyond breakdown rates in normal years) brought on by excessive stress on pump equipment from the substantially increased demand from the population as all other sources dried up or became difficult to access.

The calendar also highlights the conflict over allocation of scarce labour during the hazard period from March to August due to increased demands on women and children's time required for water collection. Poor households in particular – with fewer household members, no donkeys to transport water,[8] and fewer and smaller jerry cans – were forced to choose between allocating their labour toward water collection, which required at least 7 hours per day, and allocating it to collection and sale of firewood and/or kosho (enset) preparation to generate extra cash for food purchase.[9] In the absence of labour opportunities for men due to the delay in the planting season brought on by the failure of the rains, these activities were some of the only coping strategies available to the household – and are all a woman's, not a man's, domain. Not surprisingly, women reported that the time that they could devote to childcare dropped to marginal levels.

The calendar in Figure 3 also highlights the linkages between incidence of diarrhoea and water access at ponds and seasonal pools, which people turned to once the rains began in late May, because unlike the borehole, they were free, and required only an hour of collection time per day. Despite their convenience, these sources became heavily contaminated with polluted floodwater once the rains started at the end of May. Intestinal problems related to worms, on the other hand, were linked to water collection during the dry season at excavated riverbed pits, where breeding conditions were favourable for amoeba and parasites.

E. Understanding the Geography of Seasonality: Hydrogeological Investigations

The importance of groundwater

Groundwater is often the most important source of water during dry seasons, as well as drought. Long after surface water sources like rivers and streams dry up, groundwater can still be accessed through wells, springs, and boreholes. This 'buffering' capacity – or the capacity of aquifers to store and transport water once recharge to the aquifer (e.g. through rainfall) is reduced – can vary significantly across different areas, and in some places, under certain conditions, groundwater sources can fail (Calow et al. 2002).

An important new component of the HWEA methodology is assessment of groundwater availability through hydrogeological investigations at the local level. This component of the methodology builds on extensive work done by the British Geological Survey (BGS), elaborated on in MacDonald et al. 2005. Combined with information on population and livelihoods strategies, which exert pressure on surface and groundwater sources, we can achieve a more sophisticated understanding of the linkages between how seasonal water availability affects water access at household level during different periods of the year, and how these impact on livelihood opportunities and constraints and vice versa.

[8] Donkeys are usually accessed by poor households in a normal year through donkey sharing arrangements in this zone because of long travelling distances to water sources. But due to the extended dry season, middle and better off households terminated these arrangements in order to minimize the risk of their donkeys from dying.

[9] Not only did better off households have larger and higher number of storage and transport (donkey) assets, which enabled them to collect water less frequently – they also had more cash reserves to purchase water from vendors, at 30 birr (about 30 cents) per 20L jerry can – an expensive price. Purchasing from vendors involved the lowest collection time of all water sources.

In addition to compilation of existing maps on geology and hydrology, rock samples at working and abandoned water source sites in each livelihood zone are collected and geographically stored using GPS.[10] Local observations on hydrogeology and water source performance seasonally and in drought years, as well as community management and attitudes towards each source, are recorded during a 'hydrogeology walk'.[11]

This information is analysed and output into a series of maps and information that can then be used to identify areas that are a) vulnerable to groundwater drought – where water supply through groundwater is likely to be much reduced or unavailable during dry seasons and exacerbated during drought; b) areas where groundwater is likely to be available during dry seasons and drought, and therefore where groundwater interventions may be effective; and c) areas where groundwater quality is already, or is likely to be in future groundwater schemes, a problem (e.g. high salinity or fluoride content[12]). It also informs understandings of limitations and opportunities for water use for productive and domestic activities in the livelihood zone.

The maps and hydrogeological data can ultimately provide guidance on what types of groundwater interventions can be supported and are possible given the geophysical characteristics of the livelihood zone.

For instance, Figure 4 below describes variations in water availability and seasonality of sources due to hydrogeological and climatic variations across a highland to lowland transect of livelihood zones in eastern Oromiya and northern Somali Regions, Ethiopia.

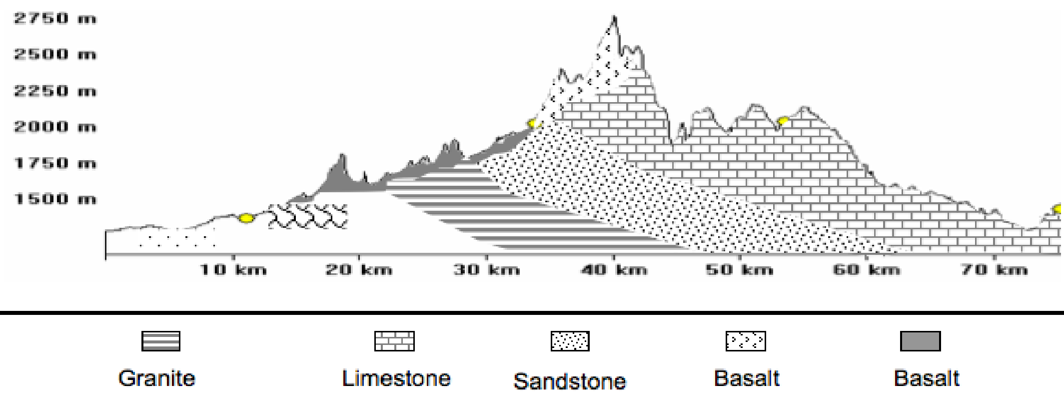
[10] Global positioning systems, which record the geographic coordinates of places where e.g. data is collected or sources located.

[11] Information on yield, quality, seasonality (i.e. the rate of response of the aquifer to changes in recharge levels) are taken across seasons at water sources within the livelihood zone. Again, see MacDonald et al. 2005 for a detailed description of the hydrogeology walk.

[12] BGS has produced a map of areas in Ethiopia where fluoride content in groundwater stores is higher than deemed safe by the WHO. Excessive consumption of water high in fluoride content can lead to dental fluorosis, and in more advanced stages, skeletal fluorosis, whose symptoms include calcification of ligaments, crippling deformities of the spine, muscle wasting, and neurological defects. See also: www.rippleethiopia.org/documents/stream/20080624-fluoride-mapping-poster.

Figure 4. Hydrogeological and water resources availability variation across highland to lowland livelihood transect in East & West Hararghe (Oromiya) and Shinile (Somali) Zones

	Shinile Agro-Pastoral (SAP)	Sorghum Maize & Chat (SMC)	Wheat, Barley & Potato (WBP)	Sorghum, Maize & Chat (SMC)
Water sources	Some boreholes, riverbed excavations, seasonal pools & ponds & rare base flows.	Cold springs dominant source of water for irrigation and domestic water supply. Springs represent discharge of groundwater to depressions formed by faulting. Ponds also common.	Cold springs and roof water harvesting are the common sources of water supply.	Cold springs are common sources of water supply; sinkholes and karsts also exist.
Climate	Dry, hot and arid with evaporation far exceeding rainfall.	Mild temperatures, relatively higher rainfall than SAP.	Relatively cold mean annual temperature, high diurnal variation in temperature, lowest evaporation. Semi-humid climate.	Mild temperature, relatively higher rainfall than SAP.
Hydro-geology	Recharge to aquifers mainly from flash floods. Streams are seasonal. Aquifers are volcanic rocks, and groundwater is often saline. Deep groundwater tables.	Recharge to volcanic aquifers takes place from rainfall. Main discharge takes place to cold springs in depressions. Seasonal variation in spring discharge is indicative of local recharge with limited regional flows emerging into this zone. Rift-related faults are main source of ground-water occurrence and movement. Ground-water contains low total dissolved solids (TDC).	Recharge to aquifers takes place from rainfall. Isolated peaks are the site of groundwater scarcity or outflow. Discharge takes place in depressions or to springs. Shallow groundwater tables. Biological pollution likely.	Aquifers are mainly sedimentary rocks. Springs emerge at the food of the highlands. In some areas, limestone is karstified and is the main source of groundwater. Shallow groundwater tables. Biological pollution likely.



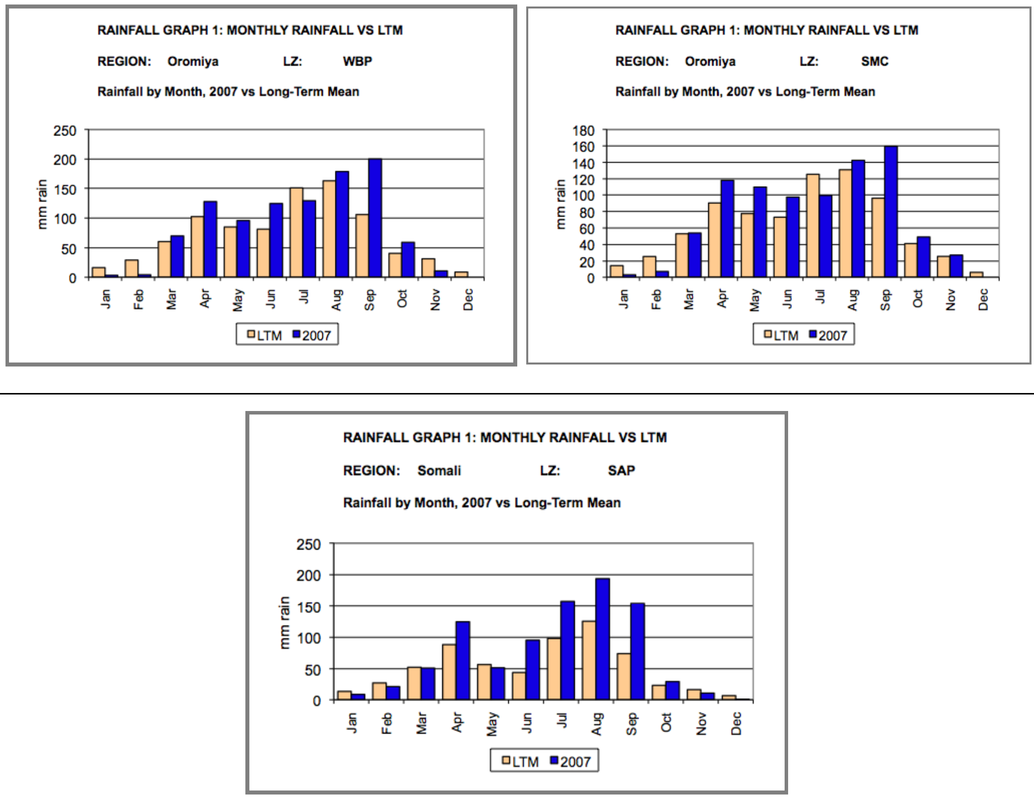
Source: Kebede and Zeleke 2009.

Seasonality of groundwater sources

Assessing a) recharge to the aquifer, which occurs through rainfall or surface water flows (e.g. floods, rivers, ponds) and b) aquifer type – in other words, rock type – allows us to determine groundwater availability.

Looking at seasonal rainfall and long-term average mean levels gives us half of the equation above. A rainfall analysis tool for all of Ethiopia's livelihood zones is available through the LIU. Figure 5 presents rainfall for the transect livelihood zones in Oromiya and Somali regions. Long-term average mean rainfall levels generally decrease with altitude. WBP receives a long-term mean of approximately 900 mm of rainfall per year; SMC 750mm per year, and SAP just over 600mm per year. Seasonal rainfall trends pit October through February months with the lowest rainfall levels in all zones, although SAP has a more bimodal rainfall pattern than the midland and highland zones.

Figure 5. Monthly rainfall in the baseline year compared to the long-term average mean (LTM) for highland to lowland transect livelihood zones

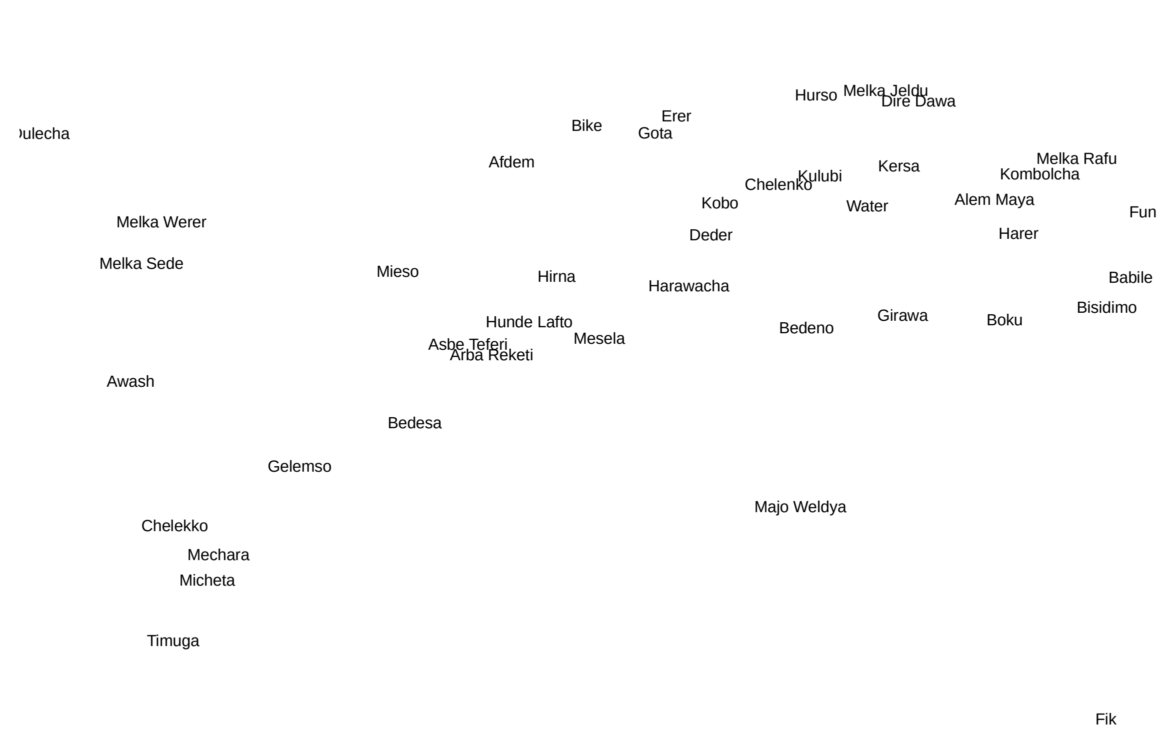


Source: Rainfall analysis tool, LIU. Developed by Mark Lawrence, FEG.

Looking at aquifer type gives us the second half of the groundwater availability equation. Figure 6 presents the susceptibility of water table levels to changes in rainfall levels in the three livelihood zones.[13] The higher the susceptibility, the higher the 'seasonality' of the aquifer – in other words, the greater the variation in groundwater table levels, and thus groundwater-fed water source yields, given a change in rainfall levels. From this map, we see that in these areas, response rate and 'seasonality' of groundwater-fed water sources increases with altitude.

[13] See Annex D for a conceptual diagram illustrating the response of different types of aquifer to the same change in rainfall or recharge.

Figure 6. Vulnerability / speed of response to changes in environmental parameters as measured by aquifer storage properties in East / West Hararghe & Shinile highland to lowland transect.



Speed of aquifer response: 7 6 5 4 3 2 1

Water table response ranges from a rank of 1 to 7, where 1 represents the slowest response rate and 7 represents the fastest response rate. The larger the number, the higher the vulnerability of the aquifer to changes in climate/variation/seasonality.

Source: EIGS 1993 and 1996; Kebede and Zeleke 2009.

Highland seasonality and implications for responses

Due to steep slopes, small aquifer sizes, and high transmissivity (or ability to transport) water of the aquifer types, most highland areas including those in the Wheat, Barley & Potato (WBP) Livelihood Zone have a response rate of 7 (in red). Groundwater recharged by rainfall in the highland zone travels quickly away from the highlands into the midlands and lowlands. This suggests that in drought periods, groundwater-based responses may not be a viable option unless localized fractures can be found with pockets of groundwater.

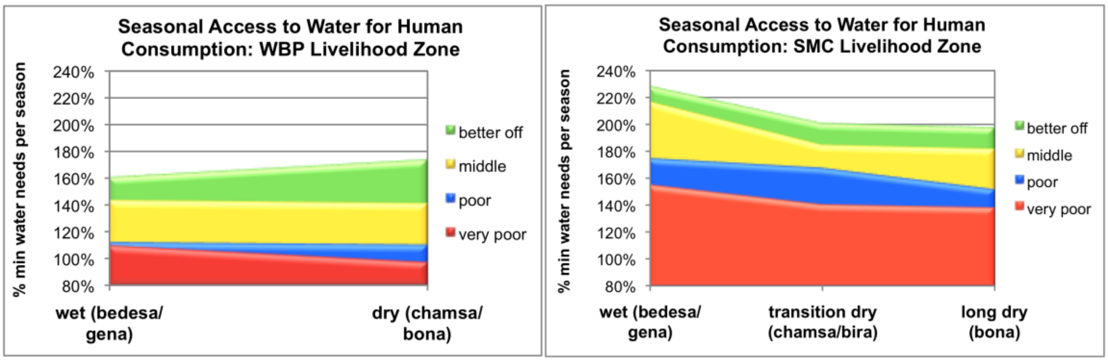
This high level of seasonality also indicates that a drop off in rainfall leads to quickly decreased spring yields. This trend is elaborated by household water access baseline data from household interviews and local observation, which reflects no 'transitional' water access period in between dry and wet (as occurs in other livelihood zones – see Figure 6), and a doubling in collection time from roughly 1.5 hours during the wet season to about 3 hours in the dry seasons. Households report a decline of spring yield within days of rainfall terminating. Dry season queuing time increases as some springs dry up and more people are forced to collect at the remaining perennial, but now lower yielding, springs that are still fed by groundwater. Long-term rainfall analysis suggests that drought is not a frequent occurrence in WBP Livelihood Zone. However, should a serious drought occur in this area – for instance, if climate trends shift in the next decades – the vulnerability of the zone to such conditions would be high in this traditionally groundwater-secure area.

Midland seasonality and implications for responses

Seasonality is lower and groundwater potential slightly higher in the midland Sorghum, Maize & Chat (SMC) Livelihood Zone, which is characterised by moderate seasonality and response rates ranging from 4 to 6 (blue to green).[14] Despite lower rainfall (recharge) levels, groundwater remains in the aquifer for longer periods of time in SMC – although spring sources are still characterised by seasonal variation in yield.

The higher groundwater availability and slightly lower seasonality of groundwater flows in SMC Livelihood Zone may be a contributing factor to the higher water access levels of households in that zone compared to WBP Livelihood Zone, although relative wealth and related asset bases is as well. Access levels for water for human consumption are presented below in Figure 7.

Figure 7. Access to water for human consumption: highland WBP and midland SMC Livelihood Zones



This information on groundwater availability suggests two important points. First, water point data tells us that hand-dug (shallow) wells and deep wells are currently few in number in SMC Livelihood Zone. However, groundwater is present at shallow depths, as indicated by hydrogeological data and observations of water availability in shallow wells in the zone. Development of protected hand dug wells is therefore possible. It is also desirable, particularly from a public health standpoint. Most of the population access water from unprotected springs, which are susceptible to contamination and the source of water-related diseases. Furthermore, looking at population figures, we see that human population is moderate in density, and livestock populations are not high; particularly given rainfall levels in the zone, development of hand-dug wells or boreholes is likely not to lead to over-abstraction and localized depletion of groundwater tables around wells. Rules concerning water use for irrigation (practiced already by a small proportion of the population) would need to be instituted to prevent localized depletion, however. Second, boreholes and even shallow hand dug wells may be effective options during serious drought periods.

[14] Hydrogeological data tells us that this is due to recharge from both rainfall and groundwater flow from the highlands, and a topography characterised by depressions (underlain by alluvial deposits, which have high storage properties) in which ground and surface water collects.

Spring protection would also be an appropriate and important intervention in both WBP and SMC, as most springs become highly contaminated, due partly to their role in serving multiple uses of water – domestic, livestock watering, and also irrigation. Access points for each use are generally not separated in this zone. Lastly, to reduce the seasonal decline in the yield of springs, construction of artificial recharge enhancement structures such as ponds may also be appropriate to increase the water retention in the zone. Ponds may also direct livestock and irrigation users away from springs, which can be confined to domestic use to reduce risk of contamination.

Lowland seasonality and implications for responses

Seasonality and response rates in lowland Shinile Agro-Pastoral (SAP) are low – ranging from 1 to 4 in most areas. This suggests that, despite lower rainfall levels, even in the dry seasons, water is still available from dug-out excavations in dried up riverbeds. It is also likely to be available in drought as well, though at deeper depths. Households in lowland SAP Livelihood Zone concur, reporting the continued presence of water in excavated pits through most drought periods (although water quality declines substantially, and depth of pits must be increased to at least 15m compared to 5 to 10m in normal years). The retention of water in excavated pits during dry seasons and drought suggests that construction of sub-surface dams to facilitate storage and extraction of water would be an effective preventative and resilience building measure in this zone. This would be particularly useful given the high volumes of water required for livelihoods in this zone due to reliance on large livestock herds for income and food sources and as a form of insurance against drought.

Figure 8. Extracting water in the dry season from riverbed pits in Shinile Agro-Pastoral LZ

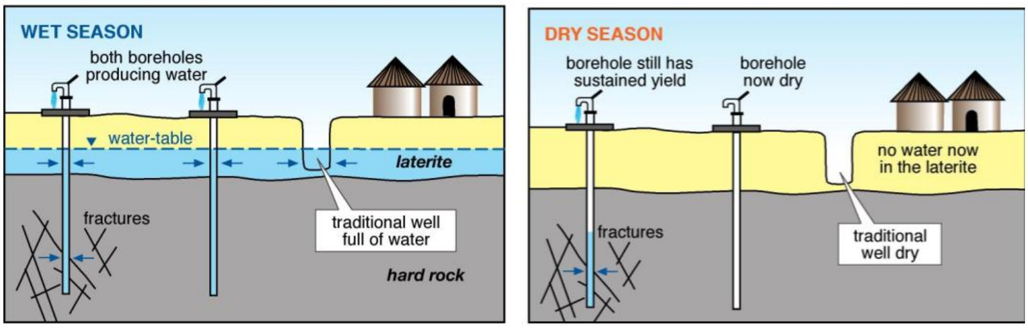
As noted in Figure 4, however, other than in areas surrounding seasonal riverbeds, groundwater is not found close to the surface in most areas (usually water tables have depths of at least 30 to 40m) – and does not emerge at the surface in the form of springs as it does in the midlands and highlands. Thus boreholes with submersible pumps are the only other option to tap groundwater in the lowland livelihood zone in the dry seasons.

Seasonality: a factor in improper siting of boreholes?

HWEA also collects, in its ‘hydrogeology walks’, information and data on why and when sources fail or are abandoned by the community. This kind of information is central in identifying interventions appropriate to both the physical characteristics of the zone as well as the social and economic motivations and interests of communities.

Information collected on abandoned boreholes in lowland SAP Livelihood Zone suggests that despite the relatively low seasonality of groundwater sources, it is imperative that siting of boreholes occurs during the dry season, rather than the wet season. A large number of abandoned boreholes had been drilled at the end of the fiscal year (when cash had a mandate to be spent), which occurs in the middle of the wet season (in June). These were found to have been abandoned because they dried up during the dry seasons. This suggests that water tables were high when drilling took place and so crews stopped drilling when they reached water – but did not account for the drop of the water table during the dry seasons. The diagrams in Figure 9 illustrate a situation similar to this and emphasize the importance of properly timed siting of water supply interventions and properly implemented hydrogeological surveys to ensure source behaviour is adequate for the population in the dry seasons and drought.

Figure 9. Implications for water supply of a drop in seasonal groundwater tables



Source: A. MacDonald, BGS

E. Scenario Analysis: Intensifying Seasonality

Scenario analysis is at the heart of HEA's predictive capacity and the power of its tools to assist planning, as well as monitoring and evaluative work. Scenario analysis for both HEA and HWEA use baseline data on food, income, and expenditure (for HEA) and access to water for human consumption, hygiene and sanitation, and productive activities (e.g. livestock watering, irrigation, etc.) as the foundation from which to project impacts of hazards at household level.

For HWEA, quantified data on coping strategies undertaken by households in bad years are used to assess the ability of different households to mobilize and secure additional water. This may mean increasing expenditure on water from boreholes, paying for water sold in water markets, migration or travel to other working or higher yielding sources farther away, etc.

Hazard data defining the problem is based on assessment of conditions or a projection of estimated future conditions. Such data could include information on water table level drops, changes in source yields or changes in availability of water during specific months (e.g. rivers drying up for additional months of the year); and water quality tests which indicate water as unsafe for consumption by humans in particular source types.

Scenario analysis for the 2008 *Belg* emergency in Alaba Mareko Lowland Pepper (AMP) Livelihood Zone in SNNPR (discussed above in Section D) from an integrated assessment combining HEA and HWEA data and analysis is presented below to illustrate the importance of looking at the relationship between seasonal vulnerabilities restricting access to water and their impact on households' ability to secure adequate food and income during hazard periods.

The drought in the *Belg* of 2008 precipitated a continuation of the dry season in AMP Livelihood Zone that resulted in water scarcity and severe water shortages, particularly in

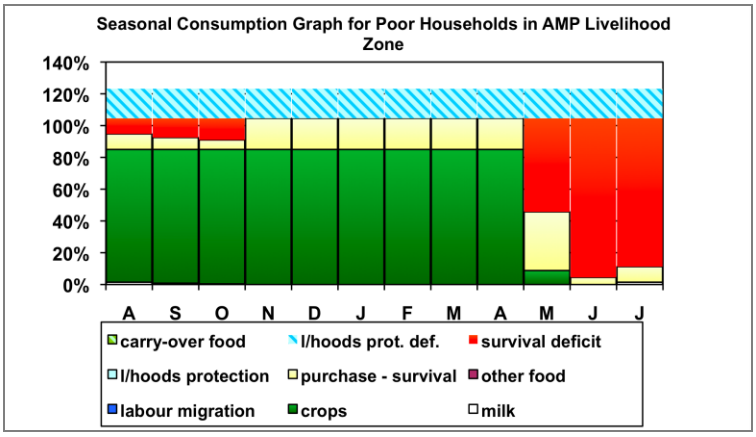
Alaba and Mareko Weredas. Falling water tables and higher than normal demand from the population had exacerbated the breakdown of an estimated 30% of previously functional boreholes, as discussed above. Communities from up to 10 Kebele Associations (KAs) or communities used the remaining functional boreholes (compared to 1 to 2 in normal years), placing great stress on the infrastructure, particularly in light of only moderate yields at these sources (1.5 to 3 L/sec). Water availability at the only other dry season water sources – excavated riverbed pits – had declined by an estimated 20 percent, with groundwater recharging pits at significantly lower rates.

The water scarcity problems of the drought also brought consequences for access to food and income by the population. Although the most serious impacts of the drought would not be felt until the *Meher* harvest, which would be delayed by 1 to 2 months due to the late onset of the *Belg* rains, income normally obtained from labour during the *Belg* planting – significant to poor households in bridging the hunger season – was not available during the *Belg*. The sharp rise in staple food prices beginning in December of 2007 also reduced households' purchasing power substantially, compounding the labour problem.

The households that were some of the worst off in the emergency, however, were a substantial proportion of the population in Alaba woreda who had experienced significant damage to their crops from floods during the previous *Belg* and *Meher* rains. Cereal and cash crop pepper yields were reduced by an estimated 20 to 30% of yields elsewhere.

The Livelihoods Impact Analysis Spreadsheets (LIAS) indicated that, as a result of these hazards, survival deficits had begun to emerge in those areas. The seasonal consumption graphs were able to identify *when* those deficits began to emerge. Figure 10, which reproduces the seasonal consumption graph for Alaba-Mareko Lowland Peppers Livelihood Zone, indicates that poor households began to experience survival deficits (indicated in red) in May of 2007, with deficit levels peaking in June and July.

Figure 10: Seasonal Consumption for Poor Households in Flooded Areas of AMP Livelihood Zone, SNNPR, 2007-2008[15]

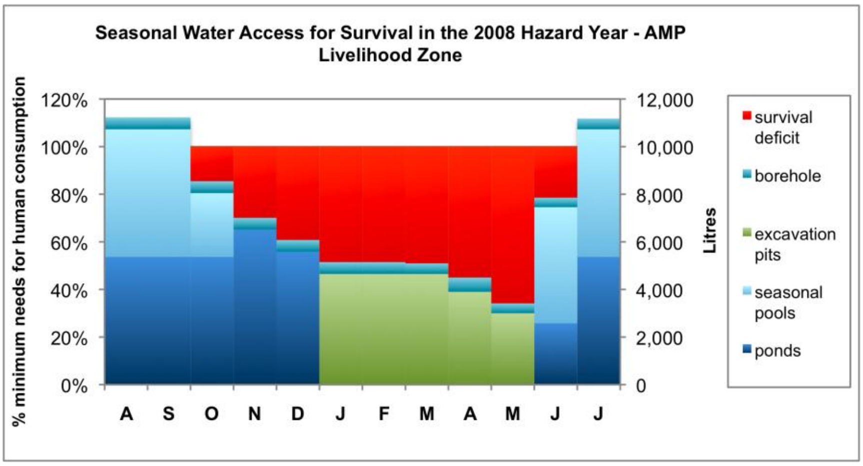


However, poor households had already been facing significant water for survival deficits since October, as they usually do in a normal year. Unlike in a normal year, however, deficits began to climb in April when the rains failed to resume, contributing to weakened household productivity during those months. Water for survival deficits reached over 60% in May – right at the point when households were also facing significant survival deficits on the food side. This is shown in Figure 11.

15 August 2007 to July 2008.

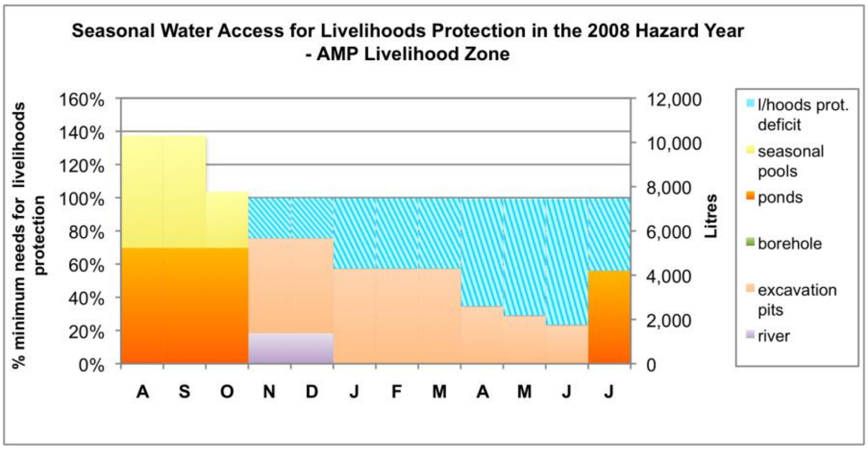
Furthermore, although access in terms of quantity had resumed normal levels in June, quality was a significant concern due to the onset of the rains, which brought flooding and the transport of contaminants into ponds and seasonal pools that most poor households turned to once the drought had stopped. Cases of diarrheal disease, typhoid, and AWD peaked in June through August, as noted in the seasonal calendar of water access in Figure 3. Although wealthier households had enough cash to continue to resort to boreholes, poor households sought to reduce expenditure as much as possible and turned predominately to accessing ponds and seasonal pools despite the risk of disease.

Figure 11. Seasonal Water Access for Survival for Poor Households in AMP Livelihood Zone, SNNPR, 2007-2008



Water for livelihoods deficits was also significant during the emergency period. Figure 12 indicates that poor households failed to secure nearly 80% of their water needs for livestock and irrigation of pepper seedlings during May and June, with decreasing access levels running up to that seasonal peak.

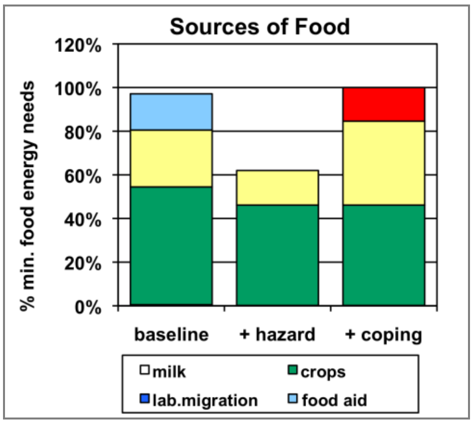
Figure 12. Seasonal Water Access for Livelihoods Protection for Poor Households in AMP Livelihood Zone, SNNPR



Importantly, the water for livelihoods protection deficits had serious consequences for food security during the following *Meher* of 2008. Typically, famers irrigate pepper seedlings prior to transplanting them into fields in late April and May. However, due to decreased access to water at excavated riverbed pits, conflicts over allocation of scarce labour among coping strategies (kosho production and firewood collection and sale), water collection for human consumption and irrigation activities, as well as the cutting off of donkey sharing arrangements by the better off, the poor failed to irrigate their peppers seedlings in the *Belg.*

Because cash crop pepper is the single most important source of cash income for poor and wealthier households alike – making up 30% of poor households' baseline income - the failure to irrigate was significant, and resulted in a 50 to 65% loss of pepper production. This loss, along with the delayed harvest and inflationary constraints on purchasing power of staple food, contributed to 15 to 20% survival deficit for poor households.

Figure 13. Sources of Food for Poor Households in AMP Livelihood Zone, SNNPR, 2008-2009



Work under the RiPPLE program in Ethiopia on the transect of livelihood zones in Oromiya and Somali Regions will also look at scenario analysis projecting impacts of climate change on household access to water and resulting impacts on food security and livelihoods. It promises to yield productive insights into climate change measures and policy on water and livelihoods.

E. Conclusions

The water sector has long been concerned with the public health angle of poor water supply in communities, both for development, and also during emergencies such as drought. Partly due to the difficulty in measuring access until this point, and an adherence to traditional focus on 'developed' sources and public health concerns, many water sector assessments and data collection been limited to collection of data on water point density (e.g. number of improved water points per population unit in a given area) and epidemiological concerns. While important, these methods do not inform enough our understanding of the significant linkages between water security and food security which are often at the heart of survival and livelihoods protection of populations in normal as well as bad years.

Furthermore, development practitioners have known for a while now that timing of responses is crucial to the effectiveness of their programs and response systems. In practice, it has often been more difficult to identify and predict if and when a hazard will force households past the point when they can no longer rely on their own resources to sustain survival or livelihoods.

The HEA and HWEA methods and tools discussed in this paper can contribute to more sophisticated early warning as well as disaster risk management systems tools. In addition, assessing food security and water security together in a way that allows for analytical linkages to be made between various and related sectors has the potential to strengthen our ability to creatively and more holistically address the root causes of vulnerability to particular hazards as well as their immediate effects and develop appropriate responses. Information on vulnerability of specific groups or areas to seasonal water stress and related income deficits might also help identify potential pathways of climate change induced stress on water resources and related impacts on household's access to food and income. This, in turn, can help in designing appropriate adaptation strategies.

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Annex A: HWEA Methodological Components

i) Livelihood zoning

Livelihood zoning for the LIU's Oromiya Region baseline data collection took place initially through zoning workshops with regional and district experts[16]. For HWEA in Ethiopia, the following sources of information can be assessed to reach a broad characterization of water availability, access, and use patterns as a part of water-livelihood zone verification:

- Groundwater availability mapping, carried out at a national scale by the British Geological Survey (BGS) in 1999 – 2000 for Ethiopia (see Calow et al., 2002)
- Hydrogeological reports (on the Wabi-Shebele and Genale-Dawa river basins in the case of BPA) which include data and information on geology, hydrogeology, aquifer productivity, broad indications of water quality, etc.
- Population data in the livelihood zones
- Information on livelihood activities in the area (i.e. livestock keeping in BPA)

ii) District interviews with key informants

Interviews with district water officers and health personnel yield information on water availability through water sources used by the population in the district, allowing for a further refinement of water-livelihood zones. Information available on water-related disease incidence across seasons and years is collected as well.

iii) Village level interviews with key informants and wealth groups

At village level, teams interview community key informants to obtain information on local water source quality, reliability, yield/capacity across seasons, and access constraints. Teams then carry out intensive interviews with different wealth groups to obtain a detailed account of how each income group obtains water for three primary uses:

a) Human consumption (drinking, cooking; must be potable)

b) Hygiene and sanitation (bathing and laundry)

c) Productive uses – in the case of Bale Pastoral Zone, water for livestock

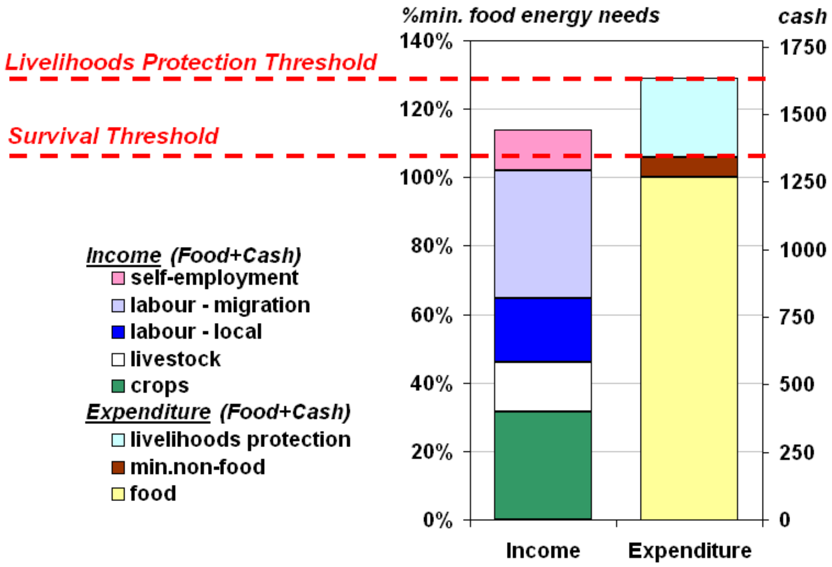
These interviews collect information on quantities of water obtained from each water source for each use, across seasons. Rigorous semi-structured interviews are the primary means of obtaining information in wealth group interviews. The data on actual water use collected during the wealth group interviews was then compared to the standards set out below to determine whether households meet their needs in the reference year.

16 Livelihood zones are areas in which people share broadly the same patterns of livelihoods – in other words, the same production systems, such as agriculture or pastoralism; as well as patterns of trade and exchange. They are delineated according to agro-ecological characteristics (climate, soils, topography, etc.) and access to markets. Water-livelihood zoning for HWEA aims to delineate areas of broadly similar patterns of water availability, access and use. These will often be very similar to HEA's livelihood zones as surface and groundwater availability/hydrogeology and rainfall characteristics of an area are important determinants of agro-ecology and influence the range of livelihoods opportunities available to people.

Annex B: Survival and Livelihoods Protection Thresholds for HEA and HWEA

Figure A: Comparison of Projected Income against Two Clearly Defined Thresholds

Projected total income is compared against two thresholds defined on the basis of local patterns of expenditure.



The Survival Threshold represents the total income required to cover:

a) 100% of minimum food energy needs (2100 kcals per person), plus
b) the costs associated with food preparation and consumption (i.e. salt, soap, kerosene and/or firewood for cooking and basic lighting), plus
c) any expenditure on water for human consumption.

Note: *Items included in categories b) and c) together make up the minimum non-food expenditure basket, represented by the brown bar in the expenditure graphic.*

The Livelihoods Protection Threshold represents the total income required to sustain local livelihoods. This means total expenditure to:

a) ensure basic survival (see above), plus
b) maintain access to basic services (e.g. routine medical and schooling expenses), plus
c) sustain livelihoods in the medium to longer term (e.g. regular purchases of seeds, fertilizer, veterinary drugs, etc.), plus
d) achieve a minimum locally acceptable standard of living (e.g. purchase of basic clothing, coffee/tea, etc.)

HWEA Thresholds

Water for Survival: Human Consumption Threshold represents the minimum volume and quality of water required for survival, specified by SPHERE as a minimum of 5 litres per person per day.

The Hygiene and Sanitation Threshold represents the minimum volume of water required to maintain hygiene and sanitation activities, specified by SPHERE standards as 10 litres per person per day. This is not included in the Water for Survival Threshold above for the purposes of the assessments discussed in this paper.

The Water for Livelihoods Protection Threshold represents the minimum volume of water required to sustain household livelihoods activities so that food and income needs for livelihoods protection (see above) are met. Livestock protection needs are included as a livelihoods activity, as are other productive uses of water such as irrigation. Specific water consumption standards for livestock under various conditions are found in Annex C of this paper.

Each of the thresholds are measured as a percent of 100% minimum needs.

Annex C: Seasonal Water Requirements for Livestock in Sahelian Conditions

Table A1. Daily water requirements for livestock (Lpcd) across seasons*

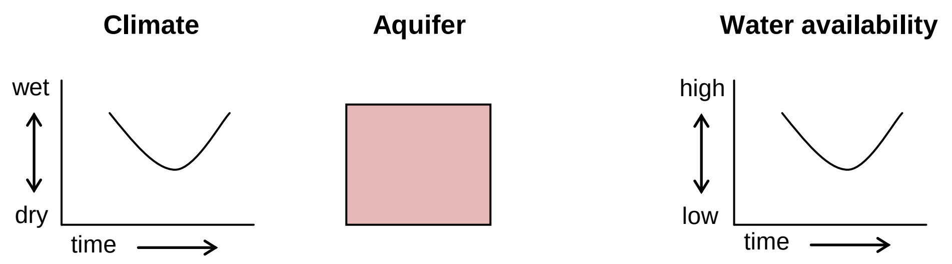
Daily Water Requirements – Livestock (Lpcd)	Wet seasons (23 - 27^{o}C)	Short dry (15 – 21^{o} C)	Long dry (27^{o}C)
	voluntary intake	voluntary intake	voluntary intake
Camels	13	25	28
Lactating camels	17	30	33
Cattle	9	20	22
Lactating cows	13	26	29
Goats	2	4	4
Sheep	2	4	4
Horses & donkeys	5	16	18
Hens	0.10	0.10	0.10

* Voluntary intake is the daily amount of water drunk by an animal assuming that feed contains 70-75% moisture during the wet season and 10-20% moisture during the dry season.

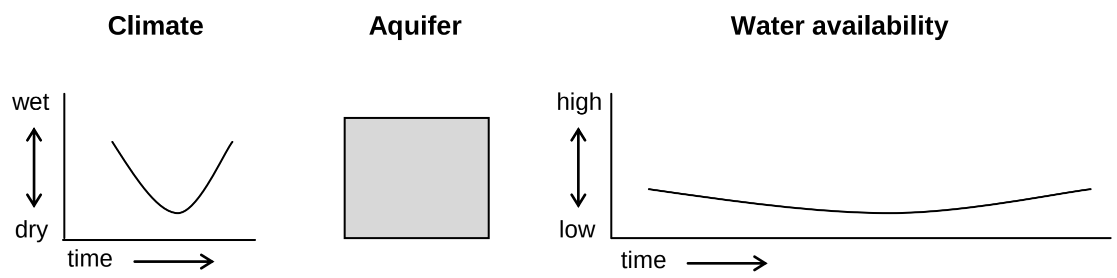
Annex D: Conceptual Diagram on Aquifer Seasonality and Response to Changes in Rainfall

Figure A2. Conceptual diagram: Aquifer response to changes in rainfall

Case A. The aquifer responds quickly to changes in climate / recharge



Case B. The aquifer responds slowly to changes in climate / recharge, and small variations are buffered over the long-term



The response of the aquifer to changes in climate / rainfall / recharge is a function of the aquifer's storage capacity, its transmission properties (ability to transport water through pores and fractures), and the amount change. In Case A, the aquifer response rapidly to a decrease in rainfall, while in Case B, the aquifer responds more slowly over a longer period of time. Buffering time can be as short as less than a day or extend into centuries.