Synthesis of research issues and capacity building in water and land resources management in Ethiopia

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Abstract

This paper presents an overview and synthesis of the key research and capacity building issues arising from the workshop presentations and papers. Three days of intensive deliberations by professionals from various research, development and governmental organisations, and of diverse disciplines, backgrounds and nationalities have clearly acknowledged that water management issues remain very crucial for poverty alleviation and rural development in Ethiopia—whose overwhelming proportion of the population depends on smallholder agricultural production, which is highly constrained by water availability (absence of perennial rivers, high spatial and temporal availability of rainfall etc.). This situation, over the years, has generated a critical need for efficient water and land management to reduce production risks and hazards, and enhance stable agricultural and livestock production. Recent decades have witnessed various efforts in the area of irrigation and supplementary irrigation (and other development initiatives), employing various water harvesting technologies, construction of micro-dams, diversions structures etc. which were largely combined with traditional yield-enhancing methods to facilitate sustainable smallholder agricultural production.

Most of these efforts did not only fall short of their desired objectives of improving smallholder production conditions but also generated a host of others such as:

- large-scale irrigation schemes (e.g. Awash Basin and elsewhere) resulted in secondary soil salinisation where large tracts of land have gone out of production
- spontaneous construction of micro-dams across the country (especially in Tigray) is associated with human and livestock health hazards that in some cases have resulted in abandonment of the dams
- production potential of extensive watersheds remain largely unexploited or inappropriately used, resulting in extensive degradation of fragile lands, and so on.

The potential for effectively integrating crops and livestock management in the context of growing water in complementary crop–livestock systems remains largely unexploited, especially from the perspective of efficient water and land utilisation. The limited success of most of the technologies in Ethiopia calls attention to a dire need for research and capacity building to understand the complex issues of water and land management, so as to enhance

national and local capacity to deal with water and land management issues to enhance food security, poverty alleviation and national economic development.

Introduction

The issue of population growth and the impending need to increase agricultural production in Ethiopia was well acknowledged at the workshop. The dual role of agriculture in providing rural livelihood and enhancing national and local level food security for the masses was also clearly articulated. Agriculture accounts for about 85% of total employment and generates 75% of exports earnings (World Bank 2000). Crops contribute about 80% of the gross value of the agricultural sector, which constitute about 40% of the gross domestic product (GDP) (FAO 2000). The relevance of agriculture (and livestock) to the economy are highlighted, which raises a critical need for examining the physical and agro-ecological framework conditions that characterise agricultural production in the country, as emphasised in many of the papers.

The country's diverse agro-climate was vividly presented to comprise the central massive highlands (up to an altitude of 4000 metres above sea level, masl) that support about 90% of the rural population, and accommodate agricultural and agro-pastoral activities, and the relatively less densely populated lowlands characterised by extensive livestock production or pastoralism. Over 70% of the country is either arid or semi-arid, characterised by low and erratic rainfall both in terms of spatial and temporal distribution. The potential for crop production in large parts of the country using traditional methods remain uncertain and often subject to crop failure and severe fluctuations in yield. This situation is further exacerbated by recurrent droughts and associated famine, which causes heavy loss of human and livestock lives especially in pastoral areas (Futterknecht 1997; Kamara 2001; MoWR 2001). The incidence of droughts is reiterated to be a natural phenomenon that cannot be entirely ruled out, but it is strongly believed that their impact on human life can be significantly reduced through efficient management of water and land resources in the country.

Water and land resources

The workshop acknowledged the abundance of natural resources in the country, but called specific attention to the under-utilised status of most of these resources—about 122 billion cubic metres of surface water is available in 12 river basins and 22 lakes, plus an appraised groundwater of about 2.6 billion cubic metres (WWDSE 2001). The potential for sufficiently tapping this water for domestic and productive purposes, however, is lessened by uneven spatial and temporal distribution, and unpredictable availability (Belaihun; Gulilat; Paulos).[1] While close to 90% of the country's water resources occur in four river basins[2] that host no more than 40% of the population, about 60% of the population living in the east and central river basins depend on less than 20% of the country's water resources

1. Throughout this synthesis, author references are to papers presented in this workshop.

(Gulilat). Though information on the distribution of the available groundwater resources in the country is limited, it is posited that the water table is relatively deep and that yields are low, making the exploitation of groundwater expensive for agricultural use (Gulilat). Despite these natural constraints and technical limitations, it is clearly acknowledged that the country's potentially utilisable water resources are largely unexploited—it is not even clearly documented which proportion of the potentially utilisable water resources the country can use within international legal provisions. Thus, this initiative in research and capacity building for water management for Ethiopia could not have been more timely (H.E. Shiferaw Jarsso, 2002, opening speech of this workshop).[3]

The uneven distribution of the productive lands was also acknowledged and highlighted (Paulos). More than 40% of the arable lands in the country occur in the highlands, containing about 95% of the regularly cropped area and two-thirds of the country's livestock population (Ewnetu et al. 1999; Paulos). With high population density of over 400 people per km^2 in some areas, most of the highland is threatened by land degradation, which threatens agricultural production and environmental sustainability.

Therefore, agricultural production in the country—both crops and livestock—depends largely, on sustainable land and water management. While land management issues may have received a great deal of attention in the past (Bruce et al. 1994), water management issues have received far less attention (Paulos). Although the country has a 50-year experience in basin level management approaches (Gulilat), attempts in the early 1970s to prepare a National Water Code that would articulate water issues was never off the ground. This issue only regained recognition after the establishment of the Ministry of Water Resources in 1995, which eventually released the National Water Resources Strategy in 1999, a document that now emphasises a comprehensive and integrated water resources management approach.

Water and land management issues in Ethiopia

Among the most pressing issues associated with land and water resources management are secondary salinisation, nutrient depletion, water pollution, de-vegetation, soils erosion and, to some extent, grazing. Soil degradation especially on fragile lands and groundwater depletion were highlighted (Mintesinot and Mitiku; Paulos; Penning de Vries et al. 2002). These processes are feared to lead to long-term (perhaps irreversible) deterioration and reduction of the potential and actual productivity of land, with adverse effects on agricultural productivity, with serious food security implications at both the national and local levels. It was also acknowledged that most of the instruments for checking these trends, especially the necessary water related policies, plans, strategies and laws, are largely in place. The current challenge, therefore, was identified to be in the area of implementation, including harmonisation of the water sector with other sectors. Existing institutions are also building on previous efforts to begin to fill in capacity gaps and pull on opportunities in linking existing research and capacity building activities (Gulilat). In this context, various

2. These include the Abay (Blue Nile), Tekeze, Baro-Akobo and Omo-Gibe basins, largely occupying the west and south-western parts of the country.
3. Minister of Water Resources, Government of Ethiopia.

issues were highlighted under different sub-sectors and specific needs for research and capacity building highlighted, with a word of caution that action be better taken today, for '... tomorrow may be too late' (Paulos).

Irrigation

The irrigation potential was presented as one of the most underutilised opportunities in the country. The country has an irrigable land of about 3.3 million hectares of which only about 5% developed to date, with about 55% of the developed area being traditional irrigation (MoWR 2001; Gulilat). At the end of the 1990s, the area under small-scale irrigation was estimated at around 64 thousand hectares while that of medium- and large-scale were appraised at 112 thousand hectares, of which 22 thousand hectares were new small-scale irrigation schemes implemented since 1992 (WWDSE 2001; Gulilat). The nation has a National Irrigation Development Strategy, which has the goal of utilising the country's natural potential (in water and land resources) to achieve food self-sufficiency at the national level, generate export earnings, and provide raw materials for industry on a sustainable basis (MoWR 2001). Specific objectives include expanding the irrigated area, improving the productivity of water in irrigated agriculture, ensuring the financial and technical sustainability of irrigated areas, and effective mitigation of water-logging and salinity. Small-scale irrigation, which is found in much of the country (Shewa, Tigray, Hararghe, Gojjam and North Omo), offers the potential for improved food security, agricultural diversity and productivity. There is considerable experience with small-scale irrigation, but the extent and potential has not been quantified and general documentation is sparse (CRS 1999).

Small-scale irrigation

Compared with other irrigation strategies used in Africa, properly implemented smallholder irrigation with appropriate technologies may have a considerable potential in improving rural livelihoods, although the viability of such systems becomes questionable when the financial responsibility rests entirely on the community in the absence of institutional support services that enhance market orientation (Kamara et al. 2002; Shah et al. 2002). Given the complex set of constraints facing smallholder producers, providing access to irrigation water by itself is not enough; smallholders also require a broad range of support services (access to inputs, credit, output markets), knowledge of farming and secure land tenure. Achieving economic viability of smallholder irrigation on a market-oriented basis requires access to support services and opportunities for producing high value crops. Thus, it was acknowledged that the issue of smallholder irrigation expansion should be viewed far beyond the narrow scope of just providing irrigation water and land, to include institutional linkages, access to markets and other support services that enhance production on a sustainable basis.

Large-scale irrigation

State run farms, which include large-scale irrigation systems, were reiterated as major components of efforts to develop the country's agricultural sector, notably in the Awash Valley. However, productivity of these top–down managed systems over the decades has been disappointing—the farms have been beset by a number of environmental, technical and socio-economic constraints. The large scale systems in the Awash basin and elsewhere suffer from water management practices that have resulted in rising ground water tables and secondary soil salinisation where large tracts of land have gone out of production (EARO 2001; Paulos). In some instances (including small-scale irrigators), farmers considered irrigation as an evil practice due to losses of crops and arable land resulting from bad irrigation practices (EARO 2001). This has also been associated with conflict and water-related diseases that have undermined the sustainability of such large-scale irrigation systems under the prevailing circumstances.

Water harvesting

Recent efforts have been largely centred around water harvesting, in some cases on a large-scale through community initiatives, but in most cases state-supported—the so called micro-dams. Water harvesting and micro-dam construction have been largely promoted to capture runoff water for multiple uses, including domestic, irrigation and livestock especially in the northern part of the country. This widespread dam construction and promotion of micro-dams is, however, slowly becoming questionable, as the negative impacts (mostly agronomic and health hazards) in some cases outweigh the benefits, leading to abandonment of the dams and associated land in some cases (Mintesinot and Mitiku; Mitiku et al. 2002). It was acknowledged that this situation is largely due to insufficient baseline studies (technical, socio-economic, agronomic) at the inception of these dams, and the consequent lack of adequate scientific knowledge on the long-term impacts of the water harvesting systems, both in terms of hydrology of the production system and socio-economic and environmental outcomes. While many are convinced that water harvesting can indeed make a difference in the country in terms of responding to the nation's food security needs, there is a consensus among experts on the huge need for scientific information on both indigenous and introduced water harvesting technologies to understand their particular characteristics and constraints, and appreciate the needs for adaptation for successful water harvesting in the country.

Wetlands/aquatic ecosystems

Wetlands are increasingly recognised as an important component of not only the environment, but the economic system as whole, with communities drawing much of the resource requirements from such systems. The relevant challenge therefore is striking a critical balance between beneficial uses of wetlands for generating livelihood for rural communities without compromising environmental values and uses. Direct use of water from wetlands affect hydrology in the basin, may cause pollution, eutrophication and

sedimentation from human activities, which may place these important systems at risk. For beneficial uses of wetlands to be sustained, water and land resources management practices need to be based on principles that support these ecosystems. Even at a global level, the characterisation of the relationship between the water resources and the ecosystems is only now beginning to receive the attention it deserves (Global Dialogue on Food and Nature). In Ethiopia, where information on the characteristics of the wetlands and associated ecosystems is limited, the knowledge gap necessary to develop best management practices is large, and requires committed long-term research and capacity building.

Drainage

Inadequate natural drainage causes water logging, salinisation and, in some cases, deterioration of soil quality through erosion, leaching, destruction of soil structure or even soil losses (Mintesinot and Mitiku; Paulos; McCornick et al. 2003). These processes lead to an eventual decline in the productivity of agriculture, and may subsequently lead to abandonment. The Middle Awash Valley, for instance, and the localised problems with the small-dam developments in Tigray are two of the areas in the country where salinisation, caused by inadequate drainage, has resulted in declining productivity and subsequent loss of land. Furthermore, in the highlands, water logged soils during the rain season, were recorded to reduce the length of the growing season for rainfed agriculture (Gebrehiwot et al. 1997). At the same time, it was acknowledged that purpose-built drainage networks are expensive and difficult to justify. Localised initiatives were recognised as more feasible, including water management strategies and interventions that target problem areas, but noted to require scientific understanding of the local climate and agronomy, agro-ecology, hydrology (water table, water quality, groundwater movements), cropping systems and management practices. Developing capacity at the local level to understand these factors, and considering drainage as a component of water management and the practical interventions that could be adopted, was also recognised as necessary.

In summary, the critical issues regarding agricultural drainage in the country were highlighted to include: the paucity of information on the specific characteristics of drainage constraints; the absence of the capacity (and perhaps resources) at all administrative levels to mitigate the constraints; and the absence of knowledge on the indigenous drainage approaches. With regards to water quality, issues of particular importance were noted to exist in the Awash River and the Rift Valley rivers (Girma Tadesse 2002, personal communication). With Addis Ababa in the headwaters of the Awash valley, discharge of untreated wastewater and pollutants into the river, is a serious issue. Downstream uses in the most developed river in the country include domestic water supply and irrigation. Elevated levels of fluoride, which exist naturally in the groundwater in the Rift Valley and the Awash basin, however, make these sources unsuitable for domestic water supply (WWDSE 2001).

Livestock

The livestock sub-sector is very important in Ethiopia not only for local level food security for the growing population but also for generating foreign exchange. Despite its relatively low contribution to the GDP, livestock plays a paramount role in generating rural employment: less than 10% of the total land area of Ethiopia is cropped (FAO 1996), and extensive land use in the form of pastoral and agro-pastoral production dominates the production systems. In the highlands, livestock husbandry is combined with crops in a sedentarised system with open grazing and relatively high cropping intensities and livestock densities. The pastoral lowlands, which include Afar in the north-east, the Somali in the south-east, the Borana in the south and other minor groups, supply robust livestock to both the domestic markets and international markets, and are thus noted as important source of foreign exchange (Kamara 2001; Paulos).

Despite this relatively important role, it is noted that water for livestock and human needs in pastoral communities remain a critical problem (Paulos). Pastoralists are often compelled to trek for days in search of water at high temperatures and under stressed conditions. Water supply for nomad relies mainly on occasional water in ponds and puddles and in few instances, e.g. the Borana, traditional deep wells under very primitive conditions whose water retention potential varies with rainfall (Kamara 2001). It is therefore not uncommon to find the prevalence of water borne diseases (diarrhoea, amoebic dysentery, bilharzias etc.) among such communities, whose water sources (ponds, puddles, runoff, rarely rivers and irrigation canals) are largely polluted or unrefined for domestic use. It is also noted that providing water under pastoral circumstances is difficult, primarily because of low population densities, nomadic culture and harsh environmental characteristics. Also, in providing new water sources (boreholes, ponds and cisterns or birka) in these semi-arid areas, there is a risk of the livestock population rising above the carrying capacity of rangeland, and a potential for aggravating the impact of catastrophic events such as droughts.

Of particular importance was looking at possibilities of improving the productivity of livestock and associated opportunities for poverty reduction (Peden et al.). The potential for integrating crops and livestock in a 'cut-and-carry' and grazing system such that livestock relies on the consumption of crop residues and free fodder was highlighted as worth giving attention. In a context of growing water scarcity, such systems as are posited as having high efficiency of water use since the water for crop production would have been used with or without the animals feeding on the residues (Peden et al.). Being a by-product of crop production, the crop residue does not require additional water for providing valuable feed for livestock, while livestock provides farmers with additional value in terms of consumable and marketable outputs (meat, milk etc.) without incurring significant additional demand for water. These sort of opportunities, including the role of livestock in urban and peri-urban agriculture, where water use efficiency is increased or other outputs generated without necessarily using additional water were acknowledged as worth examining for adoption and up-scaling where appropriate (Peden et al.).

Environment

Irrigated agricultural production was acknowledged as one which will continue to be an important component in the development of Ethiopia, given the availability of water and land resources, and the direct and indirect socio-economic and economic benefits. However, as in other developing countries where irrigation consumes between 70 to 90% of available water, it is noted that there can be significant negative impacts including ecosystem deterioration in the form of water and land degradation, reduction in biological diversity, social and economic impacts, and so on. These impacts have already been observed in the relatively developed Awash valley, and are noted to appear in other basins especially in the northern parts of the country (Mintesinot and Mitiku; Mitiku et al. 2002).

Health

The increased incidence of water related diseases such as malaria, schistosomiasis and diarrhoea have been associated with the development of irrigated agriculture in the Awash Valley, small dams in Tigray and elsewhere in Ethiopia (Mintesinot and Mitiku; Mitiku et al. 2001). Diarrhoea accounts for over 46% of infant mortality in Ethiopia. To a large extent, environmental and health issues associated with irrigation and water development in Ethiopia are noted to be linked to the limited knowledge of the issues, lack of capacity and resources to investigate and mitigate the constraints and limited knowledge of indigenous practices used to protect human health or the environment (Manoncourt and Murray 1996). As in other parts of the world, it was recommended that building irrigation systems and water harvesting structures such that diseases are prevented is a more effective way of reducing health hazards, rather than curing diseases, which is sometimes impossible. In this regard, several examples and methods were highlighted, based largely on practical experiences especially in Asia (Boelee).

Water supply and sanitation

Ethiopia has a very low level of water supply coverage, with only 17 and 35% of the rural and urban population having access to safe drinking water, and similarly low levels of sanitation coverage. This issue is recommended as one that should be paramount in considering the management of the water resources of Ethiopia.

Urbanisation

Already the second most populous country in sub-Saharan Africa, the country faces increasing population growth and rural–urban migration. The population of Addis Ababa is, for instance, projected to almost double its present 2.5 million by the year 2025 (WWDSE 2001). Uncontrolled urbanisation places an increasing pressure on the land and water resources of the surrounding area, altering the natural hydrology and degrading the

quality of the water, which in turn impacts the downstream users, and ecological services downstream. Moreover, the peri-urban agricultural activities in the form of vegetable production and livestock have become increasingly recognised in terms of their importance to livelihoods and food production, and possible impacts on public health and the environment. The potential for peri-urban agriculture as a significant source of income and livelihoods for the urban poor needs critical examination.

Hydropower

Estimated at 26 KWh, the per capita power generation capacity of Ethiopia is one of the lowest in the region, and is only about 15% of that of Kenya. Only around 13% of the population of Ethiopia has access to electricity (WWDSE 2001). This contrasts sharply with the hydropower generation potential of the country, estimated at about 150 TWh, which is 100 times greater than the existing capacity currently being utilised (WWDSE 2001). It is also asserted that some of the older reservoirs are gradually silting up, further diminishing the generation capabilities that are already far below expectations. This issue remains crucial and is prioritised in the National Water Resources Strategy, especially in view of the fact that Ethiopia's power generation potential, if effectively and efficiently exploited, makes it possible for the country to export power to neighbouring countries and earn foreign exchange (MoWR 2001).

Integrated water resources management

In an effort to operationalise its commitment to effective and efficient water management issues in the country, the Government of Ethiopia has developed a comprehensive National Water Strategy, based on the principles of Integrated Water Resources Management (MoWR 2001; Gulilat). Among others, the strategy emphasises strategic issues under general water resources management, and a detailed elaboration issues relating to hydropower development, water supply and sanitation, and irrigation development within the context of integrated water resources management from a basin perspective. The development of Integrated River Basin Development Master Plans has already been completed for four basins, and the Mereb, and the intention is to undertake the same for the six remaining major drainage basins, namely Wabi Shebele, Awash, Genale-Dawa, Rift Valley Region, Aysha and the Ogaden (MoWR 2001). In particular, the Awash Basin is noted as one, which presents an immediate challenge to manage the water resources in an integrated manner, given the rapid rate of urbanisation in the upper catchment with, among other things, the impact on water quality, and the relatively developed state of the water resources within the basin. In such basins, it is important to take a basin perspective, not only with regards to the water quantity, but water quality as well (McCornick et al. 2002).

Recent advances in integrated water resources management were also highlighted and discussed from a basin perspective (Sally). Among others, the relative importance of various water management strategies at the development, utilisation and allocation stages of basin

development were highlighted. The significance of these phases of basin development especially in the context of a closing basin were discussed, highlighting available tools and methodologies that could be relevant for strategic management of water resources in Ethiopia's river basins (Sally). The strengths of these tools in leveraging the bargaining position of different stakeholders (including nations) in water negotiations (e.g. shared basins such as the Nile) were elaborated.

Research opportunities and capacity building requirements in water and land management

The presentations and discussions in the workshop highlighted many relevant issues of water and land resources management in Ethiopia. While noting that not all of the presented problems can be addressed at the same time, it was also recognised that some of the issues present opportunities for research and capacity building especially in the context of the existing (favourable) national policies and highly committed political will. There is already some knowledge on most of the issues raised, but most of it remains incomplete, hence the need for capacity to generate new knowledge and aid implementation. Also, much of the existing sources of information on water and land resources management in Ethiopia recognise that there is considerable relevant experience, but a paucity of information on indigenous practices, successful interventions and lessons learned.

Identified knowledge gaps

This section presents a summary of the issues, or knowledge gaps, identified during the workshop. Further details on issues discussed in the working group sessions are also presented.

- small-scale irrigation: it was recognised that there is a lack of effective strategies and tools for the implementation of small-scale, community-managed irrigation in Ethiopia. In particular, the following areas need attention:
  - strategies that enhance community participation in smallholder irrigation; strategies that enhance improvement of traditional technologies, and adaptation and scaling up of already tested modern technologies; strategies that enhance the realisation of multiple uses of water for productive purpose including livestock, and combination of activities that maximised the efficiency of water use
  - institutional issues and linkages (including tenure and property rights
  - ensuring access of smallholders to other institutional support services such as markets, credit and extension
- large-scale irrigation: effective strategies and tools for improving performance and productivity of medium- and large-scale irrigation systems to:
  - mitigate of the recurrent problem of land degradation resulting from salinisation of irrigated lands
  - alleviate of the problem of water logging of irrigated and rainfed areas and

  - address the problem of rising water tables and its consequence on soil salinisation
- research that highlights the relationship between irrigation and food security at various levels (local level/national level)
- potential and strategies for the sustainable development and utilisation of groundwater for irrigated agriculture
- enhancing the accomplishment of drought mitigation role of groundwater in pastoral areas
- livestock linkages to water in a context of increasing water productivity from a systems perspective with water as a key nutrient in livestock systems; role of water in certain metabolic aspects of livestock management
- research on water productivity in agriculture in general
- water pricing and cost recovery issues in irrigation and other sectors needs to be critically examined
- examining the potential for fisheries in many parts of the country
- closely studying the inter-linkages between water-related health and environment; a deeper understanding of causative agents and applying preventive methods rather than relying on cure, which in some cases cannot at all be achieved
- critically examining the impact of increased urbanisation (e.g. Addis Ababa) on land and water resources, and the role of urban/peri-urban agriculture in contributing to food security through
  - generating livelihood of the family, and meeting immediate food security
  - upstream–downstream issues and water quality
  - health issues and the environment (sustainability)
  - agroforestry issues not well articulated but remains a research priority.

Capacity gaps

Specific areas where further capacity is required, in addition to implementing activities related to the above gaps in knowledge, include:

- national level institution or network to co-ordinate, link, support and disseminate results of water and land resources research and capacity building
- capacity in the formation and operation of effective water users associations (WUA) in various catchments
  - effective community-based water supply and sanitation organisations
  - enhance capacity for participation in the management of trans-boundary rivers, e.g. as partners in the Nile Basin Initiative (NBI)
  - adapt technologies and practices for smallholder irrigation
- capacity in dealing with property rights issues related to land and water
- capacity to form and operate credit and marketing co-operatives
- capacity for data collection, management and dissemination
  - surveying and mapping of land title and demarcation of resource boundaries
  - hydromet services, training and education, field trial and research station services
  - monitoring of domestic water supply and quality

- capacity gaps—process
  - regional level to provide support services to small-scale community managed irrigation systems
  - linkages between research and extension/dissemination (impact of research)
  - public–private partnership for water supply (and sanitation) provision and
  - investigation and mitigation of the environmental impacts of irrigated agriculture.

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