Research and development in land and water resources

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Introduction

The rapid increase in population necessitates an adequate management of Ethiopia’s land and water resources. Agriculture is unthinkable without land and water. Agriculture could be effective only when it gets sufficient water at the right time. Therefore, to ensure sustainable agricultural development, there should be reliable supply of land and water as well as land and water management systems. If people engaged in agriculture get sufficient water throughout the year, it is possible to harvest higher yields from a smaller size of land and keep labour busy on production throughout the year.

Ethiopia is a country of great geographical diversity with high and rugged mountains, flat-topped plateaux, deep gorges, incised river valleys and rolling plains. Altitude ranges from the highest peak at Ras Dejen, 4620 metres above sea level (masl), down to the depression of the Kobar Sink, about 110 masl. Physical conditions and variations in altitude have resulted in a great diversity of climatic conditions, soils and vegetation cover.

The physiography of the country gives rise to a wide array of climatic zones, which range from tropical to temperate. Rainfall regimes of the country show that the mean annual rainfall varies from more than 2500 mm to less than 60 mm. Places such as the Afar Depression experience the highest mean annual temperature in the country at 45°C from April to September. The lowest mean annual temperature in some highland areas is observed to be around 0°C or lower.

The altitudinal ranges of Ethiopia provide a variety of climatic conditions, which permit the cultivation of a variety of agricultural crops and land uses. About 43% of the country is classified as highland (above 1500 masl), where most of the population (about 88%) practice mixed crop-livestock agriculture. The largest proportion of the country are the lowlands, where pastoralism is the main activity of the people.

The Ethiopian Rift Valley separates the Nile drainage system, the Indian Ocean drainage system and other drainage systems, which have no outlet to the sea. Ethiopia has a substantial amount of potential water resources, though its distribution and occurrence through time and space is erratic. On average, the surface water potential amounts to over 110 billion cubic metres per annum. Ethiopia, known as the ‘water tower’ of north-eastern Africa, is faced with the fact that all its large rivers (except Awash) flow into neighbouring countries. About 90% of the annual runoff goes to the rivers that flow into The Sudan, Egypt, Somalia and Kenya.
The irrigation potential of Ethiopia is estimated to be about four million hectares of which only about 5% is developed. Since irrigation development is associated with heavy consumption of water, this may cause serious conflict with riparian states as it certainly reduces the quantity of the trans-boundary waters. There is a need to continue the present effort of establishing the principles of co-operation for the use of regional and trans-boundary waters for irrigation.

Hydropower potential has been estimated to be 170 thousand GWh/yr, whereas less than 1.5% of the potential is used. Although there is a large, untapped potential for hydropower production, access to electricity is low and it is a constraint to economic growth.

Ethiopia is one of the poorest and least developed countries in the world. The current population is estimated at 66 million with an annual growth rate of about 3%. The economy is highly dependent on agriculture consisting of crop production and livestock rearing.

Poverty is the central issue of the economic problem. Major indicators of poverty in Ethiopia could be lack of farm land or small size of farm land per household, lack of the major means of production, households with large numbers of dependants, low nutritional status of rural communities particularly that of children and the wide spread prevalence of infectious diseases.

Ethiopia had been self sufficient in staple food and was classified as a net exporter of food grains till the late 1950s. However, since the early 1970s, domestic food supply failed to meet the food requirements of the people. Even though sufficient quantities of food have been produced in most of the good years, the average food production during the last decade remained almost stagnant. In the 1960s, the average per capita food production was about 280 kgs per year; however, it has fallen to about 160 kgs per year during the last 30 years.

More than half of the population is food insecure. Food insecurity problems of the country mainly emanate from limitations of rural land holdings, where more than one-third of the households cultivate less than 0.5 ha of land under rain-fed agriculture with minimal agricultural inputs.

Ethiopia’s livestock population is the largest in Africa and the tenth largest in the world. Livestock are an integral part of nearly all the farming systems and are the principal capital of the farmer. Cultivators own about three-quarters of the livestock, and pastoralists own the remaining quarter. The recurrent droughts severely affected livestock and crop production. The deteriorating environmental conditions have also adversely affected feed resources.

Watershed management

Ethiopia has varied landscapes, ranging from rugged highlands in the central part, to the wetland areas of Gambella, and to the deserts of the Afar and the Ogaden area. Rainfall is highly variable across the country, from season to season, and from year to year. This variability subjects the country to frequent droughts and famines. Deforestation, population growth, overgrazing, and use of marginal lands have intensified erosion. Land degradation is serious in the highlands, contributing to low soil productivity and poor
agricultural production. High erosion also causes downstream sedimentation, which can significantly decrease reservoir life.

The objective of watershed management is to improve the standard of living of the population living within the watersheds, decrease population pressure, and increase land productivity so that sustainable livelihoods and land use practices can be secured for the target populations. Without action, the challenges of food insecurity and famine, environmental degradation, and rapid population growth will intensify. Yet, through co-ordinated efforts of different stakeholders, production of food and energy, mitigation of droughts, arresting watershed degradation, reducing sedimentation, and improving the environment can be achieved. It is possible to capture these opportunities in a sustainable manner to benefit the people.

Any watershed management intervention for Ethiopia must address the root causes of land degradation, soil erosion, sedimentation and loss of soil fertility. Population pressure, fuel wood demand, lack of alternative sustainable livelihoods, and illiteracy are some of the root causes. In view of the multi-sectoral nature of the problems, a comprehensive and integrated approach is required. Treating the symptoms, as opposed to addressing the root causes, will lead to a downward spiral of degradation and poverty.

The first benefit of appropriate watershed management is to reduce soil erosion and the subsequent siltation rate of reservoirs thereby maximising the benefits of irrigation and hydropower projects. The second important benefit will be an overall increase in land productivity, which will yield higher agricultural outputs and thus enhance food security and alleviate poverty.

Widespread and high rates of soil erosion are serious problems in Ethiopia. The severity of the geological erosion is due to a combination of an aggressive climate, steep topography, and erodible soil types. Human activities in the catchments, including land clearing for agriculture and particularly overgrazing and firewood stripping, have resulted in a rapid acceleration of the erosion processes. The rapid population growth has further exacerbated the soil erosion and deforestation. An annual average sediment yield of 10 to 1500 t/km² in the south-western, northern and eastern parts of the country is observed. Unless proper conservation measures are taken high sediment loads in the rivers continue to cause siltation problems in reservoirs and lakes.

During drought times, many springs and streams dry up, and crop production becomes practically impossible. During the severe drought Ethiopia experienced in 1984 affecting both The Sudan and Egypt, the annual yield of the Nile River at Aswan dam fell to only 42 billion cubic metres, which is half of the mean. The prevalence of drought forced people to look for opportunities for survival including abandoning their home and migrating to temporary camps. Those who were unable to move or cope were doomed to perish. The deterioration of the natural environment compounded the human and livestock death toll.

Various factors, such as human and livestock population growth, poverty, expansion of agriculture and demands of wood, are threatening the management of land and water resources in Ethiopia. Comprehensive and integrated programmes and inter-disciplinary approaches are critical to fully use land and water resources and to safeguard those resources against deterioration.
Sustainable management of land and water resources is essential for the alleviation of poverty, economic development and the enhancement of the well-being of the Ethiopian people. Poor people depend heavily on forest products. They collect and sell forest products to obtain cash for purchasing basic needs and services. In addition, wood is the only affordable, and often the only, fuel.

Investments, policy related strategies, and regulations related to land and water resources need to be formulated in the context of a broad resources strategy, which takes the long-term view and considers the ecosystem and socio-economic structure that exist in river basins. The key element is the need to develop a comprehensive framework based on a multi-sectoral approach that reflects the country’s social, economic and environmental objectives.

The country needs to build its technical, institutional and organisational capacities to effectively manage its land and water resources. In many cases, the institutional and organisational capacities will need to be developed at national and local levels. More support is needed from international agencies in capacity building including training and research. Strengthening the institutions dealing with land and water resources in Ethiopia, building their managerial capacity and improving co-operation and co-ordination between federal and regional governments are vital for sustainable development in the country. In addition, user participation will be important in creating a sense of ownership among land and water users and as a means of improving operations and cost recovery.

Identified research and development (R&D) programmes in the water sector

Higher Education Institutes (HEIs) that are involved in water sector research and development activities include: Addis Ababa University (AAU), Arbaminch Water Technology Institute (AWTI), Alemaya University of Agriculture (AUA), and Mekelle University (MU).

There are national institutions (non-HEIs) that carry out R&D in collaboration with universities, or institutions carrying out applied research, or institutions conducting strategic research. The most important organisations include: Ethiopian Agricultural Research Organization (EARO), National Meteorological Services Agency (NMSA), Geological Survey of Ethiopia (GSE), and Engineering Design and Tool Enterprise (EDTE).

For research to contribute to the national development, the potential users’ capacity to appreciate and actually use the relevant technology made available by research is decisive. Equally decisive are the planning, organisation and management of research in the research institutions, and its development and promotion. Any water sector R&D organisation has to serve not only government organisations but also the private sector. The major beneficiaries of water related R&D results include: Ministry of Water Resources (MoWR), Ministry of Agriculture (MOA), Environmental Protection Authority (EPA), Regional Irrigation Development Offices (RIDO), private sectors involved in the water sector (such as
Consultants, Contractors etc.), and non-governmental organisations (NGOs) involved in water development.

R&D efforts in the land and water sector, particularly by the HEIs, become ineffective and inconsequential due to several factors such as:

- lack of a defined responsibility and accountability for charting out R&D programmes based on centrally determined objectives, policies and priorities and

- lack of transparency at every level of the higher learning organisational set up.

The objectives of most HEIs are too general, too vague and lacking clarity and focus. Clear objectives and optimisation of a productive research linkage between the HEIs, government organisations and the private sector is highly desirable.

R&D in the water and land sectors is faced with problems related to institutional development, funding, human resource development, information management, adequate planning as well as effective dissemination and adoption of research findings.

Information gathering on land and water R&D being undertaken by scattered institutions is extremely scanty, haphazard and no comprehensive database is available on the ongoing and completed research. There is a need to know what land and water R&D projects are being carried out, what they lead to, where they take place, when they are likely to be completed and their expected findings. There is a further need to know which personnel are involved in what projects, their capabilities etc. This key deficiency of the present information management leads to less than satisfactory planning, monitoring and evaluation of research programmes.

Recruiting for research involves strategies for attracting well-qualified staff. It also involves devising strategies for providing quality research training. Lack of sufficient local capacity in graduate training forces the country to depend on external training, which has its own risks and shortcomings including high cost, appropriateness of training for local needs, disassociation from the home environment, and brain drain.

MCE (2002) carried out a study on research and development activities in the water sector to assess the existing situation and proposed alternatives for future action. The study has identified four divisions with a total of 23 R&D programmes.

- Water resources assessment and management which consists of five R&D programmes such as: climatic characteristics, surface water hydrology, groundwater hydrology, water quality management, and watershed management
- Water resources development which consists of eight R&D programmes: water supply, sanitation, water supply for livestock, irrigation, drainage, rain water harvesting, hydropower, and multi-purpose projects
- Engineering and technology which consists of six R&D programmes: construction site and materials investigation, hydraulic structures, traditional technology, technological development, choice/selection of technology, and technology management
- Socio-economics or social sciences, which consists of four R&D programmes: finance and economics, institutions and stakeholders, capacity building, and policy and legislative issues.

This classification allows R&D activity in the water sector to be categorised according to the field of research to be undertaken. While this classification includes individual
specialised fields of national interest, it generally reflects the overall structure of disciplinary fields and related subfields taught at universities or tertiary institutions.

Since R&D activities within the area of land and water are inter-disciplinary in nature, all the identified R&D programmes could be involved depending on the nature of the specific problems. However, the R&D activities relevant to land and water shall concentrate on issues that would produce relevant practical results and significantly contribute in:

- promoting practices of efficient and appropriate watershed management to maximise water yields and quality and minimise sediment yields
- incorporating environmental conservation and protection requirements as integral parts of land and water resources management
- minimising and mitigating as much as possible, the negative environmental impacts associated with land and water resources development
- promoting and enhancing traditional and localised water-harvesting techniques in view of the advantages provided by the schemes dependence on local resources and indigenous skills
- introducing and transferring rainwater-harvesting techniques that have been successful elsewhere for agricultural purposes
- providing sustainable and objective-oriented training on the relevant areas of land and water resources management and develop and implement effective means to efficiently utilise and sustainably retain trained manpower and,
- building and strengthening the capability to search, select, negotiate, transfer, use and modify appropriate technologies for prospecting and development of land and water resources.

**Proposed organisational arrangement**

The need for a R&D organisation (institute) in the water sector, is not only apparent, but is also becoming more urgent as sectoral objectives and planned development programmes are receiving enhanced attention from the government, the public and concerned international bodies.

As competition between uses and users increase, the requirements for water are also growing. The competition between countries sharing a water source will be addressed through equitable allocations that are bound to include factors such as economic viability, cost effectiveness, and non-harmful impact, all requiring practical solutions to the various constraints. The environmental dimension of water resources development, both negative and positive, at the local and international levels, will require intelligent solutions based on scientific and practical research.

The existing national R&D capability in the water sector can only be described as minimal. These capabilities have so far demonstrated little impact on the development of the sector. The need for a comprehensive and integrated management of R&D is critical.

The overall review and analysis of the national water sector R&D capabilities and its limited achievements have led to the conclusion that the establishment of a water resources R&D institute is of crucial national importance. The institute should be an autonomous
organisation having the overall responsibility and powers regarding all national R&D efforts in the water sector.

The overall objective of the proposed water sector R&D organisation (institute) is to contribute towards the implementation of the country’s long-term policies and development objectives within the sector itself, and other related development programmes. The specific objectives include:

- contributing towards strengthening the national capability to undertake R&D activities in all fields of the water sector
- undertaking, and cause the undertaking of, multi-disciplinary research to resolve problems, alleviate constraints and maximise opportunities in the development of the country’s resources
- promoting the use of research results to enhance sectoral development and
- operating as depository and documentation centre for data, information and research undertakings related to the water sector.

The major duties and responsibilities of the institute include:

- initiating and conducting R&D on water resources particularly in the field of assessment, management, development, engineering, technology and socio-economics
- guiding, planning, co-ordinating, integrating and monitoring R&D activities in the water sector
- studying the application of various research results carried out in other countries to this end, the preservation of a collection of related materials, literature and scientific data
- co-operating with and providing consultative services to the different agencies on questions falling with the functional sphere and capability of the institute
- disseminating research findings through reports, publications and other appropriate media, and acting as a forum for constructive dialogue on water resources development and management
- operating as depository and documentation centre for all research in Ethiopia that are related with water resources development
- training personnel involved in specialised data collection, investigation, research methods and applications
- strengthening the existing R&D executing and support institutions in the water sector and establishing new ones as necessary
- undertaking effective training of R&D manpower locally and abroad as necessary and on the basis of the sub-sectoral need and plan to produce the desired quality and quantity
- promoting efficient and sustainable relationship and interaction among the R&D, higher learning and development institutions
- providing the necessary support and incentives to strengthen the participation of the private sector and the community at large, especially women, in the R&D activities of the sector
- encouraging and supporting the participation of professionals engaged in the R&D of the water sector in relevant national, regional and international conferences, symposia and workshops to enable them to acquire knowledge and experience essential to their work
• creating a conducive working condition to workers engaged in R&D activities of the water sector and establishing a system for the provision of incentives, recognition and protection of rights for those that achieve satisfactory results
• establishing and strengthening R&D co-operation with international organisations and foreign governments in such a way that it contributes to national water sector R&D capability building
• building and strengthening national capability in project studies, design and other engineering works and consultancy services in the water sector and,
• allocating the required budget for undertaking the R&D activities of the sector and creating suitable conditions to encourage the private sector to contribute to the sectoral R&D through its own initiatives.

Issues for discussion
1. It is a well-known fact that Ethiopia is the ‘water tower’ of north-eastern Africa since 90% (about 110 billion cubic metres per annum) of the annual runoff that originates in Ethiopia flows to neighbouring countries. However, the maximum amount to which Ethiopia is entitled (or eligible) to use is not known.
2. Although the residents of Addis Ababa have relatively better access to alternative energy sources such as electricity, gas, kerosene as well as alternative construction materials such as stone, blocks and bricks, more than half of the residents use firewood, charcoal and dung as energy sources and about 80% of the housing construction material is wood. Why?
3. Deforestation, high population growth, overgrazing and use of marginal lands have intensified land degradation through the process of erosion. Another way of looking at the problem is by making assumptions on whether poverty is the root cause of land degradation or vice versa. What strategy should thus be adopted to solve the problem?

References