Challenges and opportunities in capacity building for water resources development and research in Ethiopia: The AWTI experience

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Abstract

This paper presents the past and present activities and contributions of the Arbaminch Water Technology Institute (AWTI) towards water resources development capacity building, particularly in human resources development and research. The crucial bottlenecks for inadequate undertakings in water resources research in Ethiopia are identified as insufficient institutional set-up, inadequate skilled human resources, and insufficient finance and facilities. Approaches such as human resources capacity building combined with research-oriented teaching and sufficient emphasis for water resources research are the key issues for the way forward. Furthermore, the establishment of a water research institute addressing various sub-sectors of water needs is emphasised.

General

The Arbaminch Water Technology Institute (AWTI) was established in 1986 with the general objective of promoting the advancement of water resources development of the country.

Among the many specific objectives, the main ones are:

- providing theoretical and practical education designed for producing low, intermediate, and high level manpower in various aspects of water technology
- conducting research that can ensure the utilisation of water resources for the nation's progress and development and
- preparing, planning and conducting refresher courses in response to the specific training needs forwarded by relevant water sector organisations

The programmes of the institute have undergone certain modifications now that the institute is in the state of transformation to a university.

The future objectives and missions of the institute as a full-fledged university (i.e. Arbaminch University (AMU), which is under articulation), include: focusing on technical subjects in training and educating the manpower needs among others in water technology,

engineering, applied sciences and business and management, which have high relevance for capacity building programmes in Ethiopia.

The AWTI contribution in capacity building

Although the institute will in future grow to a university level, it will continue and retain its unique set-up in eastern Africa as a water technology institute. Since 2001, the institute has opened additional water related programmes in Meteorology in BSc degree and advanced diploma levels, and Hydraulic/Hydropower and Irrigation Engineering in postgraduate programmes.

Since its establishment, the institute has trained a substantial number of professionals and skilled manpower, which would serve the water sector and conduct a number of research projects. The alumni have found wide acceptance within the country and abroad. Table 1 shows the achievements in the number of graduates who are trained at AWTI to date, which shows a total of 1371 engineers and aid engineers of which over 95% are related to the water sector development. Furthermore, there are over 1100 admitted students in water related fields at AWTI.

In addition, AWTI has contributed significantly in training water and related technicians serving in the country. In this regard, in about 22 short-term courses leading to certificates training and refresher programmes, about 1285 people are trained for a period of three to nine months.

Water resources research challenges in Ethiopia

Major drawbacks

Water resources research in Ethiopia is not adequately addressed, though there is tremendous need for it. Research is a vital tool for the exploitation of sustainable water resources. The necessities and preconditions are not set for water resources research to be effectively conducted for meaningful contribution in the sector. Among the necessary requirements are: institutional capacity, financial, human resources and facilities.

Institutional arrangement

- until recently the water sector in general was not given adequate emphasis and did not mature institutionally to attain the status it deserved
- the sector arrangement was not stable, and institutional arrangements within the sector have not been permanently established
- almost no regard was given to research:
  - there is no establishment within institutions such as the then Water Resources Commission/Natural Resources and Environmental Protection or the existing

Ministry of Water Resources. The office of Research and Publication in Arbaminch Water Technology Institute has no financial resources of its own.
  - there is no independent institute of research for the water sector
- whatever existed as research are results from study documents geared towards project development or *ad hoc* or sporadic research conducted individually or institutionally mainly focusing on something else such as education and training.

Table 1. *Number of students, by discipline, who graduated from the Arbaminch Water Technology Institute (AWTI).*

Field of study	Period since first graduation	No. of graduates
Degree		
Hydraulic Engineering	1991–1995, 1998–2001	231
Irrigation Engineering	1991–1995, 1998–2001	179
Sanitary Engineering	1992–1995	65
Water Resources Engineering	1996–1998	106
Civil Engineering	2001	39
Electrical Engineering	2001	17
Mechanical Engineering	2001	20
Total		657
Advanced diploma		
Irrigation and Drainage		41
Water Supply and Sewerage		165
Hydraulic Engineering		156
Irrigation Engineering		47
Sanitary Engineering		75
Water Resources Engineering		26
Civil Engineering	2001	27
Building Technology	2001	41
Total		578
Diploma		
Hydrology Technician	1988–1990	52
Water Laboratory Technician	1988–1990	39
Soil Laboratory Technician	1988–1990	45
Total		136
Grand Total		1371

Financial resources

The financial resources for water resources research purposes in Ethiopia are usually obtained through either the Ethiopian Science and Technology Commission (ESTC) on

the Ethiopian Government side, or from non-governmental organisations (NGOs). The other sources, which might be available, are not directly accessible to researchers.

Human resources

Human resources for the purpose of research is not adequately developed and organised. Those institutions like AWTI have no adequate manpower to cover all the teaching, training and research activities. There is always a tendency to provide research a last priority, thus, research suffers as a consequence.

Facilities

Research facilities needed for the purpose of applied research are not established in a given centre. Research facilities like physical modelling facilities, numerical modelling facilities etc. would be needed. Those institutions, established with relevance to water, have serious deficiency not only in faculties but also in facilities and infrastructure to competitively undertake research.

Thus, to undertake a meaningful research contributing towards a water resource development, the above major drawbacks need to be addressed. It is important to mention here that currently there is enough recognition for the water resource sector in Ethiopia. For example, water is considered as a third important pillar for the Agricultural Development Led Industrialisation (ADLI) strategy of the country, next to labour and land. There are also many other useful policy statements relevant to research and development like that included in the Water Resources Management Policy and ESTC Priority Programmes.

The need for water resources research

While on the one hand Ethiopia is a water tower of Africa, it is also a drought affected and water scarce country. Water is indeed the most important resource that needs to be researched, developed and utilised for the well-being of the Ethiopian people and to speed up socio-economic development.

Water resource has positive and negative roles. Positively it can be used for drinking, irrigation, hydropower etc. Water can also negatively influence socio-economic development in the form of flood, erosion, sedimentation etc. To appropriately utilise water means to enhance the positive and minimise the negative roles of water. To utilise water in a sustainable manner, it is necessary to understand the quantity and quality in space and time through studies and research and technological, financial and human resource potential.

In Ethiopia, since there is no established research endeavours contributing towards sustainable use of the water resources, it is high time to move ahead and give due emphasis for water resources research.

Research and dissemination activities in AWTI

General

Although highly imbalanced by the teaching need, there is a strong interest in AWTI to conduct research. There are some completed research projects mainly focused on the southern part of Ethiopia. These outcomes including other research outputs are disseminated through a yearly symposium on 'Sustainable water resources development in Ethiopia'. This symposium is now in its seventh cycle. Proceedings of the previous workshops can be obtained from AWTI.

ESTC and the German Development Cooperation (GTZ) mainly support the research activities conducted in AWTI. Almost all of the sponsorships are not with earmarked budget but with competitive application. Most of the research undertakings are also geared with research based human resource capacity building and research-oriented teaching in collaboration with partner universities abroad.

To look into the research activities in AWTI, the following few paragraphs show an example of group research activities undertaken with the support from GTZ. The joint title of this group research can be described as 'Abaya and Chamo basin water resources research'. The research has got a number of components (Figure 1).

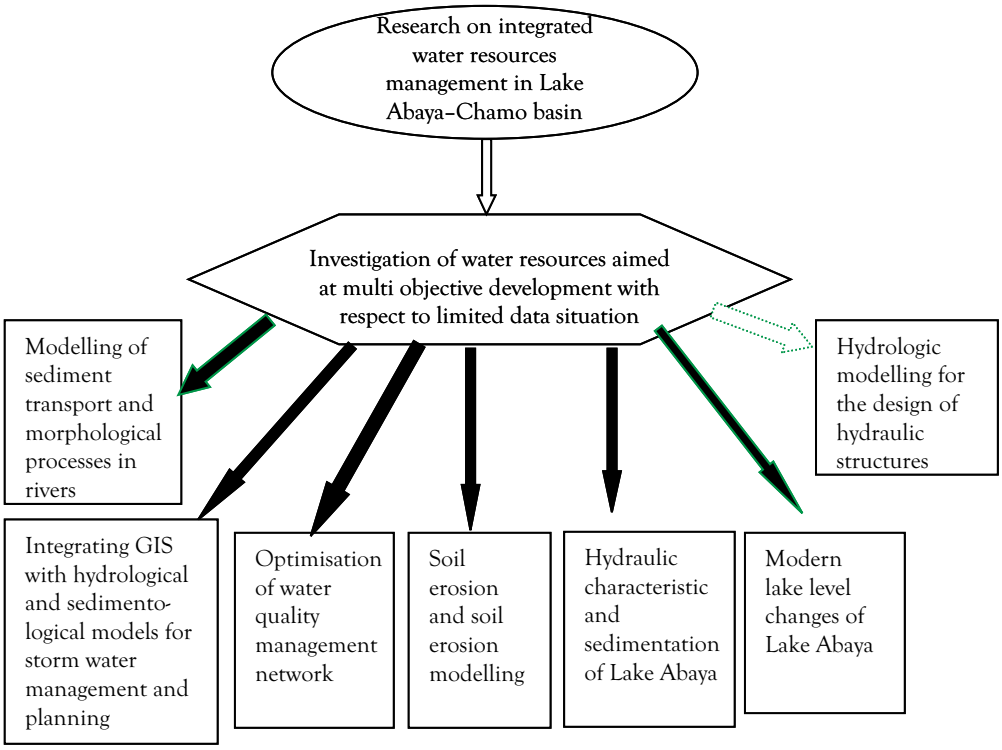

Figure 1. *Ongoing research projects (in rectangles) based on the initial concept and completed project entitled 'Investigation of water resources aimed at multi-objective development with respect to limited data situation'.*

Results of Abaya–Chamo basin research

The Abaya–Chamo lakes drainage system, physical characteristics, meteorological and hydrological data, water use information, potential information, interaction of nature and man etc. were not known or not put together in a systematic manner usable to any meaningful purposes such as development or research. Figure 1 shows the conclusion of the first investigation, and what has been identified as possible research areas.

Systematic and appropriate methodologies are followed and results in water resource assessment under limited data situation are obtained. The outcome helps to comprehensively understand the water resources, assess the available potentials and design projects whereby the use of this vital resource can be enhanced and impacts can be evaluated. These have been undertaken by using the Abaya and Chamo lakes drainage region, which is the sub-basin of the Ethiopian Rift Valley lakes basin, as a case study (Figure 2). The assessment started from basic identification of the rivers and drainage system.

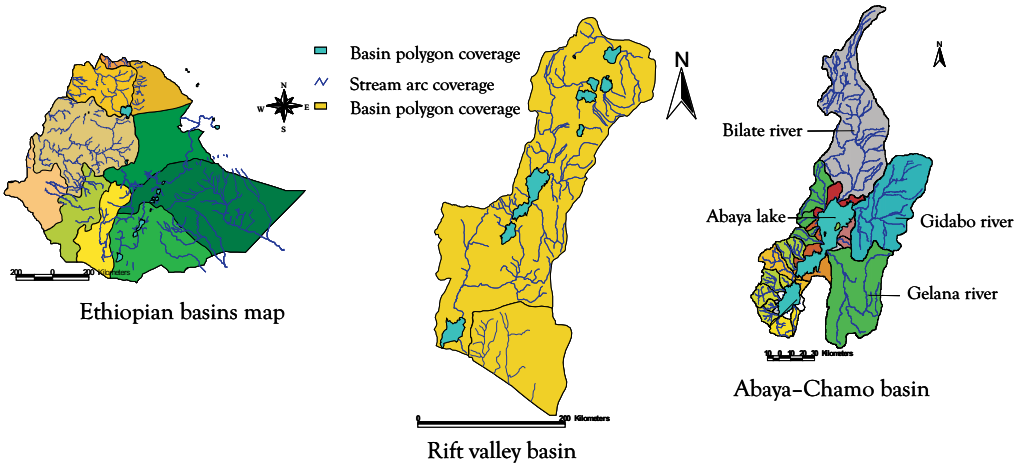

Figure 2. *The Abaya and Chamo Lakes drainage region.*

The region has been modelled using the geographic information system (GIS) and hydrologic model. Subdivision of the drainage areas into sub-basins/watersheds enabled identification of gauged and ungauged sites and thereby derivation of detailed physical parameters, which can be used as inputs to various hydrologic and hydraulic modelling. The basic development of the drainage area under GIS enabled easy addition of layers for updating and management of additional water resources data and analysed information. Using echo-sounder and Global Positioning System (GPS) both Abaya and Chamo lakes have been surveyed. Through transferring the data into digital form, various morphometric characteristics and water resources capacity curves of the lakes have been derived for the first time.

Using the collected and compiled data, spatial distributions of parameters such as rainfall and temperature elevation are developed. Homogenous regions based on rainfall have been identified. Evaluation of simplified relationship of rainfall and runoff provided

inadequate basis for runoff estimation. A new conceptual, two-parameter, rainfall–evaporation–soil moisture–runoff–monthly water balance model is developed, calibrated and evaluated. The model is particularly useful for simulating runoff in cases of limited hydrometeorological and physical data and where climatic conditions lead to large rainfall variations. The results of both calibration and validation show that the model performs quite well, and is employed to generate runoff for ungauged areas and extension of runoff data.

Various procedures and methodologies are derived or adopted to estimate parameters in assessment of demand and potential and design of water projects. These include estimation of expected runoff, its reliability and methods of its control; regional flood growth curves which can be used to estimate magnitude of flood for small structures in the region; expected water demands in drinking water supply and irrigation; and general identification of irrigation and hydropower sites. Through developing a general lake/reservoir water balance model, simulation of the lakes' water level and other time varying parameters (such as area and volume) are made possible. The model is used in assessment of various scenarios and impacts of various existing and future uses and sediment inflow conditions. Furthermore, based on the prevailing conditions suggestions are highlighted how to reverse the current deteriorating situations.

The adopted or developed underlying theories and obtained results could be applied to other areas. Due to the fact that data are limited, the results have characters of assessment. However, the results show clearly the sensitivity and vulnerability of the entire system. Developed results provide wide understanding of the water resources system, the availability of potentials, certain guidelines for the execution of projects, how impacts can be evaluated, how urgently proper management system are needed and have to be developed. Furthermore, the results of this research have strongly indicated the need for further research and already founded basis for certain new research projects as schematised in Figure 1.

The way forward and conclusion

In looking forward, water resources research in Ethiopia, which enhances development of the country, should be given recognition. Sustainable development towards food and water security can only be achieved through proper control and utilisation of water resource whose technicality is supported through applied research, in combination with land, human and financial resources. As can be seen in Figure 3, the rivers of Ethiopia are having large flow volume throughout the year. To make use of water for development, water distribution should be evened out temporally.

Sustainable and judicious development of the water resource of Ethiopia demand, among other things, good scientific and technical capabilities which help to curb a number of problems related to using the available water resources potential.

Water resources development that is not sustainable is ill planned. Fresh water resources are scarce and finite. Consequently, there are many ways to jeopardise the future use of water, either by over-exploitation or destroying resources. Besides physical aspects of

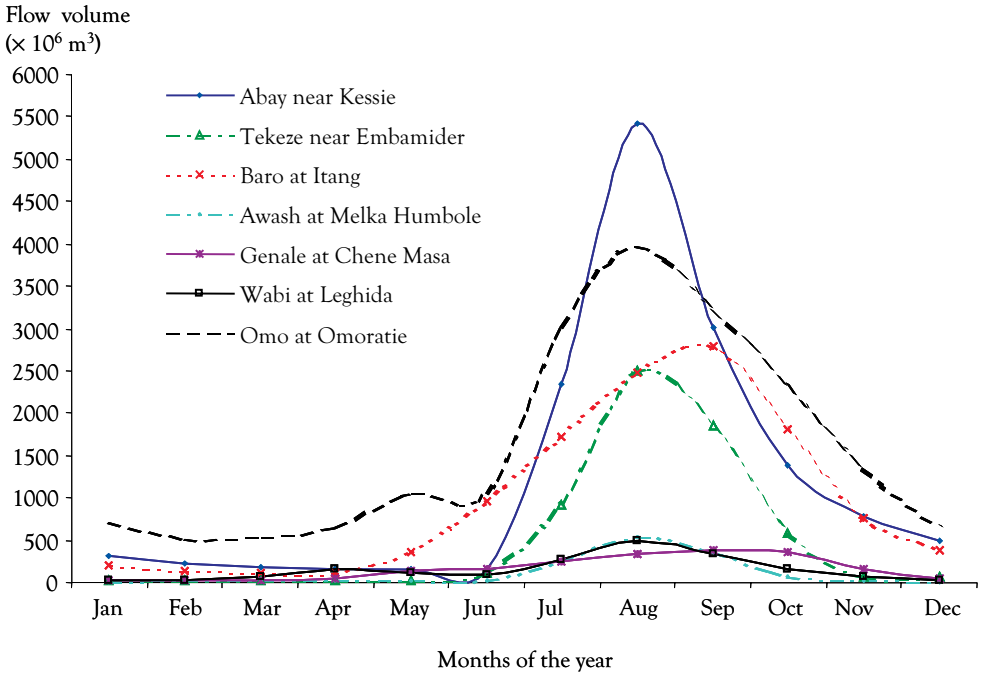

Figure 3. *Average monthly flow of some major Ethiopia rivers.*

sustainability, there are social, financial and institutional aspects. Sustainability can be defined as:

- technical sustainability (balanced demand and supply)
- financial sustainability (cost recovery)
- social sustainability (stability of population, demand and willingness to pay)
- economic sustainability (sustaining economic development or welfare and production), institutional sustainability (capacity to plan, manage and operate the system) and
- environmental sustainability (no long-term negative or irreversible effects).

Such aspects could be checked and controlled through study and research.

Although it is imbalanced and erratic in its spatial and temporal distribution, Ethiopia is blessed with ample amount of water resources that can be developed and utilised for the wellbeing of the nation and its society. It is, however, unfortunate that this resource is not yet exploited to the required level to secure the need for clean water, the demand for food, the needs to provide the energy supply to enhance industrial growth and protect the balance of deteriorating environment. In general, the ability in Ethiopia to use and enhance the positive role of water and reducing the negative impacts has been very limited.

Today, the water sector has been taken as one of the top priorities by the government. The sector strategy has also identified goals to be achieved in the near future to register results. The endeavours should, therefore, be supplemented through appropriate research, sustained through financial, manpower, and institutional and technical facilities.