WATER TECHNOLOGY TRANSFER AND INFORMATION DISSEMINATION IN DEVELOPING COUNTRIES

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Summary

Expected developments still elude the less developed countries in spite of the substantial efforts put into importation of foreign technology, most often at very high per capita cost. This is mainly due to the failure to assimilate the technology into their specific physical and socio-economic entities; as a result of this there seems to be little diffusion of imported technology into their local conditions. One of the key limitations to the harmonious development and management of water resources in developing countries is the lack of human and institutional capacity necessary to assimilate the modern advances in science and technology to affront the complex interactions of the hydrological cycle with the societal needs, whilst conserving the environment. The problem is to create an effective mechanism for the transfer of knowledge and information to the needy developing world.

This article therefore looks at the pressing issues facing developing countries with respect to the specific outlook of water technology transfer, modalities of information dissemination as a process of continuing education and the role of relevant United Nations and non-governmental organisations. The discussions also considers mechanisms for technology transfer and information dissemination in developing countries through cooperative and joint research efforts, international and regional networking facilities and the role of UN and NGOs.

The developing countries cannot by themselves absorb all the financial costs for the introduction of new technologies mostly needed for monitoring and management of hydro-climatic data and also rationalising water resources development in a situation of diminishing resources and general lack of human skills. There is therefore an urgent need to formulate a mechanism based on international cooperation to facilitate and reduce costs inherent in technology transfer. Attempts can also be made at attracting water professionals engaged in professional practice in the developed countries while not impairing the legitimate occupational aspirations of the local personnel.

1. Introduction

Cursory examination of historical development of water resources reveals that, with the exception of ancient Rome, most of the early progress was made in what today are developing countries. It is ironic that the present exigencies for technology transfer are towards the countries where such water resources technologies were first developed and introduced. For example, most of the civilisations like the Egyptian, Mesopotamian, Chinese, and the Aryan civilisations of India and Sri Lanka were all founded on irrigated agriculture. Another aspect of ancient organisation of irrigated agriculture can be found in the Andean civilisation of South America where hydraulic technology was used primarily to increase productive capacity of the land through socio-political institutions which were used for the allocation of water and the organisation of the construction and maintenance of hydraulic structures and networks. This means that apart from countries of Sub Sahara Africa, most of the developing countries possess millennia of water culture. The level of water resources development in many countries of the developing world is very low in almost all the water use sectors. This could be a blessing in disguise if proper policy frameworks for planning, development, and management of water resources in such countries can be devised, taking advantage of the advancement in water science and technology and also the positive and negative experiences of the developed countries through appropriate technology transfer mechanisms. The dynamic relationship between water resources technology and development lies not with the technology per se but with the organisation of water and land management. This leads to the argument about the appropriateness of technology within a given socio-economic milieu. If technology is to be considered as a tool, be it hardware or software, then the question of appropriate technology scales down to a problem of choice which is a human responsibility. Technology transfer to developing countries, for it to be effective, must be accompanied by a long term process of human and institutional capacity building within an enabling environment with the necessary general infrastructure and conducive professional climate and incentives.

The concept of capacity building encompasses a country's human, scientific, technological, organisational, institutional and resource capabilities. In the developing countries, especially in sub-Saharan Africa, there is a general lack of specialists in planning, systems analysis and modelling in hydrology and water resources. In particular, Africa does not have an adequate number of highly motivated and skilled cadres of water professionals who can effectively deal with the complex issues of water scarcity, climate variability and joint management of international waters. The key technological factor is the existence of critical gaps in water resources data, namely, information and knowledge about ground and surface water bodies. Inadequate technological know-how is another factor. A prerequisite for successfully addressing the pressing water problems is to change from the fragmented approach to an integrated approach to water resources management (IWRM). One of the major constraints in the development of water resources in Africa has been identified as inadequate human and institutional capacity for IWRM. A first step in this regard is the establishment of an enabling environment at national level that will include policies and institutional arrangements for water resources management and allocation between competing demands. Education and training is therefore urgently needed for water related personnel in the developing countries to help them adapt to and utilise new scientific and technological achievements in order to face the challenges posed by the ever growing water resources demand and challenges of environmental degradation.

2. The specific outlook of water technology transfer to developing countries

Expected developments still elude the less developed countries in spite of the substantial efforts put into the importation of foreign technology, most often at very high per capita costs. This is mainly due to failure to assimilate the technology into their specific physical and socio-economic entities, as a result of which there seems to be little or no diffusion of imported technology into local conditions. It is now clear that the mechanism of vertical technology transfer which is point to point relocation of technology is not feasible in the less developed countries. Instead a horizontal approach in which technology transfer is accompanied by a long term capacity building initiatives are more appropriate. This will then create the necessary conditions to absorb new technologies both as product-related and as process-related technologies. This implies the adaptation of a new technology to a different environment through creative transformation and application. There is therefore a need to create specific organisational structures, policy programmes and conscious planning for the infusion of new technologies to back the efforts at rational water resources development and management in a sustainable environment. It is also recognised that the capability of a country, a region or the water sector to exploit a particular technology is determined by its overall technological level, which is rather low in most developing countries. It becomes therefore essential for the developing countries to give due priority to the establishment of effective infrastructure on which efficient adaptation and diffusion of technology can be based. The experiences of modern Japan and the rapidly industrialising Asian countries like South Korea, Taiwan, and Singapore indicate that effective long term strategic planning is indispensable. This in turn requires diverse efforts including:

- Raising the level of schooling of the general public,
- Increasing the proportion of the population with higher education,
- A relatively high proportion of scientists and engineers,
- Emphasis on research and development,
- Creation of an environment which encourages research and development in the operational and private sectors,
- Strengthening of state-university-industry collaboration and, and
- Creating an enabling environment and incentives for professional practice.

Specifically, water resources technologies are more process-oriented than product-related since their application is not only to develop and manage water projects but also to improve the general perception of the dynamic interaction between the elements of the water cycle, human society and the natural ecosystem. Research and development is therefore considered as one of the key tools for an effective technology transfer to developing countries within the general human and institutional capacity building process.

2.1. Appropriate Technology or Effective Technology

The term *appropriate technology* has sometimes misleading connotations, not only in developing countries but also in those producing substitutive technologies at cheaper prices. It has assumed more socio-economic implications than the actual problem solving necessity that the technology must address, and has been confused with affordability. The object of study in hydrology and water sciences is not created by society but exists according to its own laws of occurrence, undergoing continuous transformations due to human impact in a changing environment. The measure of the appropriateness of a technology has to be evaluated on the basis of how much knowledge and benefits could be accrued from its application. In water resources the concept of first class and second class products cannot exist, since a water project not adequately designed and executed could cause great damage. Most failures in water projects in developing countries are not due to improper technological application but rather due to lack of knowledge and skills that must accompany the selection and use of a given technology. The other problem is the problem of data collection, archiving and retrieval, which until just a few years ago was still in a manual form. Most developing countries are now slowly acquiring personal computers for data management, most often through bilateral aid and grants. With the increasing awareness of the global nature of hydrological processes, gradually moving from narrow catchment hydrology into a global one, the choice of technologies should not transfer the unequal socio-economic levels of development onto the physical hydrological scale. For example, the general lack of climatic and hydrological data sets in the developing countries is impeding research into climatic teleconnections and climate change studies both at the continental and at the global scale. The effectiveness of technological use in water resources assessment, development and management must be measured by the efficiency of prediction of water availability and the general reduction of the uncertainties inherent in the quantitative perception of the water cycle elements. An example can be cited of the general low water use efficiency in irrigation systems and in water supply distribution networks in developing countries. In order to reduce the large component of unaccounted-for water in supply networks, there is a need to infuse modern technologies for effective control and real time monitoring of pressures in the distribution pipes. This could offset further capital investment in water supply. One other issue of technology transfer centres mostly on the suitability of labour intensive technologies to the socio-economic situations in developing countries. Labour intensive technologies require more time consuming and complex management systems, whereas modern technologies simplify management practices and are more effective in solving water problems. The example given in *Water Resources Technology Transfer and Capacity Building* on the comparison of the use of the velocity-area method versus the ultrasonic probe for discharge measurement amply demonstrates this relationship between the level of labour intensiveness and management, and also with the final product, i.e. to obtain a time series of discharges.

2.2. Manpower Needs and Skills

One of the key limitations to a harmonious development and management of water resources in developing countries is the lack of human and institutional capacity necessary to assimilate the modern advances in science and technology to affront the complex interactions of the hydrological cycle with the societal needs whilst conserving the environment. There is an urgent need for human expertise and institutional capacity towards the achievement of this goal.

It is a fact that the capacity needs in developed countries are more directed to the rational use of already stressed water resources while in the developing countries the emphasis is still on proper water resources assessment and development. An example is given below to show the type of water resources concerns identified in the African Water Vision as specific key resource and demand issues which human and institutional capacities need to address:

a. *Resource Side Issues*

- Multiplicity of transboundary water basins
- High spatial and temporal variability of rainfall
- Growing water scarcity
- Inadequate institutional and financing arrangements
- Inadequate data and human capacity
- Inadequate water resources development
- Depletion of water resources through human actions

b. Demand Side Issues

- Access to safe water supply and sanitation services
- Water for food and energy security
- Too much wastage of water
- Threats to environmental sustainability

Apart from the professional level, there is also lack of technicians both in quantity and quality to operate and maintain instruments and other technological needs of the water sector.

2.3. International Cooperation

There are strong physical and socio-economic bases for international cooperation in water technology transfer in order to enhance the monitoring of the hydrological cycle, freshwater resources, climate change dynamics and hydrometeorological extreme events. The global interconnections in water resources can be summarised as follows:

Physical

- Catchment hydrology to global hydrology: The complex interaction of the hydrological cycle with the environment including the feedbacks which exist between the components of atmosphere, lithosphere and biosphere of planet Earth.
- Regional and continental teleconnections between climatic anomalies: Analysis of spatial and temporal teleconnections of atmospheric anomalies such as the Southern Oscillation phenomenon—El Nino.
- Climate change: Development of Atmospheric General Circulation Models and their coupling mechanisms with the regional and local hydro-climatic processes.

Socio-economic

- National water resources to global water resources: The interaction of local and regional water use with the global water needs and the import/export of what is now referred to as “virtual water”.
- Land use and environmental change: The control of land use practices like deforestation and desertification which have negative feedbacks on the climate and the hydrological cycle.
- Disparity in technological and socio-economic development: the North-South disparity means different levels of water resources development, of scientific and technological knowledge and of data collection coverage both in time and space.

Specifically, efforts of international cooperation should be addressed towards:

- technology transfer through aid programmes and grants,
- the promotion of exchange of information, experience and knowledge regarding water resources, and
- identification and development of joint activities in the areas of training, research and development.

3. Modalities of information dissemination as a process of continuing education

It is well known that there is a rich store of scientific and technological knowledge and information bases available in the developed world whilst these are mostly lacking in the developing countries. The problem is to create an effective mechanism for their transfer to the needy developing world. In the developed countries, water resources attained a very high level when scientific and technological methods and tools had not reached the present level of sophistication. Due to this situation, water resources management in developed countries is directed more towards correcting the imbalances between the physical and the social aspects of water resources development and management. In the developing countries where the process of harnessing water resources for national development is at an early stage, the efforts of water resources management are to be directed more towards effective and rational planning and development of available water resources. But then, in developing countries, apart from the obvious problems of finance, there is also the problem of the manpower necessary to embrace all the diverse forms of water resource systems and their interaction with the environment and society, and hence the necessity of a system of continuing education.

As at present, most of the sub-Saharan African countries do not have the academic potential and infrastructure necessary to establish highly advanced postgraduate training courses of such a duration and intensity that can guarantee the most needed skills for sustainable water resources development and management. Yet in the age of globalisation, global aspects of education and training should not be ignored. The concepts of global climatic and hydrological teleconnections, and also of the ongoing processes of climate change all call for international cooperation in the monitoring and development of water resources within a global outlook. Technologically, hydrology and water resources activities in recent years have been largely influenced by the developments in computer and telecommunication technologies. Methodologies for hydrological and water resources assessment and modelling involve extensive use of computers and others like radar and satellite systems. Obviously, continuing education should, apart from training, cover dissemination of critical information on the use of these technologies for remote sensing, satellite imagery, telemetry, computer-based water resources management and decision support systems for irrigation, water supply, environmental control and others. Such an information transfer mechanism can also be effectively carried out through networking systems which involve active contacts and exchange instead of the more diffused form of journal publications.

3.1. Capacity Building Networking of Water Institutions

Another critical factor hindering the effective participation of stakeholders and policy makers is the limited access to information and knowledge. Over the past decade IHE, UNDP, WBI, UNESCO, IRC and other partners have organised a series of symposia on ‘Water Capacity Building’; A special subchapter will be dedicated to the role of UNESCO Chairs and Networks in developing countries. The first symposium (1991) defined the concept of capacity building and outlined a strategy for implementation. The second symposium (1996) recommended the establishment of an international network on capacity building, which resulted in the recently launched “International Network for Capacity Building on Integrated Water Resources Management (Cap-Net)’. The third symposium held in November 2001, encouraged the creation of thematic collaborative clusters and focussed on education and training demands. One of the thematic clusters is on the development of regional Water Education and Training Networks, especially in developing countries.

There is a general lack of information regarding activities in research and academic institutions amongst the countries of the developing world. A networking system can be institutional or thematic and can also be active or formal. Institutional networking is more of a top-down arrangement and as such if not well motivated could end up being passive and hence formal. On the other hand, thematic networking which is formed around research themes and sector interests can create active partnerships amongst participating institutions and can therefore be considered a bottom-up process. The second option can also attract participation of private and public water sector development agencies and industries. Taking advantage of modern information technology, as a first step, website data from research and academic institutions can be realised even at continental levels, with specifications on their relevant thematic research areas and facilities available for joint research partnerships with other interested institutions. Already the Global Water Partnership through its regional technical advisory committees is putting into action various regional networks of water professionals. One of the earliest and most advanced regional networks is the "Network for Building Capacity for Water Resources Management in Southern Africa" (WaterNet) which is being documented to serve as a guideline for the ongoing process of creating regional networks in other areas.

3.2. Regional and National Networks

Apart from the existing regional Technical Advisory Committees of the Global Water Partnership which are leading in the global efforts at coordinating activities and disseminating information on integrated water resources management, its associated programme "International Network for Capacity Building on Integrated Water resources Management (CAP-NET) is encouraging and supporting the creation of regional capacity building networks.

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Biographical sketch

Dr. Kodwo Andah was born in 1947 in Ghana. He is the Scientific Co-ordinator of the Water Resources Research and Documentation Centre, WARREDOC, of the University for Foreigners of Perugia, Italy. Dr. Andah obtained his M.Sc. in Civil Engineering with specialisation in Hydraulic Structures at the Patrice Lumumba Friendship University in Moscow in 1978. He later obtained his PhD in 1983 at the Hydrology and Water Resources department of the same University. He was invited by the Hydraulic Institute of the University of Genoa to carry out a research programme in Quantitative Geomorphological Approaches to River Basin Analysis and Response in 1984. He moved to Perugia in 1986 to coordinate the activities of the then newly founded Centre. WARREDOC's main activities are centred on organising an International Advanced Course on Water Resources Management for developing countries. He lectures on *Hydroemeteorological Data Collection Techniques and Network Design*, and also on *Quantitative Geomorphology of River Drainage Networks*. He also supervises case studies on real world hydrological and water resources problems brought in by the participants from Africa and Asia in particular.

His research interests cover Geomorphological Characterisation of River Networks and Hydrological Response, Analysis of Extreme Hydrological Events, Analysis of Water Resources Systems, Modelling of Agricultural Droughts, Capacity Building in Water Resources Management.

Dr. Andah has participated and continues to participate in various capacity building initiatives sponsored by the European Commission, specifically in EUWATERMAN, the European Union SOCRATES/ERASMUS Project co-ordinated by Budapest University of Technology and Economics on the development of water management policies in Europe, and he has been a member of the Management Committee of the TEMPUS Joint European Project on *Decision Making for Flood Protection* within a process of continuing education and institutional capacity building for Public Administrators in the Czech Republic. He has had a number of special service agreement consultancies with WMO. He has extensive experience in organising and coordinating international scientific meetings and summer schools not only on water resources but also on hydrogeological disaster prevention. He is presently engaged in the organisation of a 6-month postgraduate training course on Integrated Water Resources Management for water professionals from sub Sahara African countries. Dr. Andah has been nominated as a member of the Peer Review Committee for the publication of the African Water Development Report (AWDR). He is an author and co-author of more than 60 scientific and technical papers and has edited a number of proceedings.