ROLE OF EDUCATIONAL INSTITUTIONS IN EDUCATION AND RESEARCH IN HYDROLOGY

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INTRODUCTION

Hydrology as a discipline gained importance largely because UNESCO and WMO recognised its importance in water resources development in the Third World. This recognition led to the declaration of 1965-75 as the International Hydrological Decade, resulting in the establishment of post- graduate courses such as the one at Roorkee, and organisation of national committees of I.H.D. in member countries of U.N. We, in India, recognised the manpower need in the area of hydrology and introduced hydrology as a separate course or part of Water Resources Engineering course in Civil Engineering Curriculum at the undergraduate level. This was done as most of the Engineers involved in water resources development in India joined the departments with basic degree in Civil Engineering. Over the years, the role of Agricultural Engineers and other disciplines such as Hydro- meteorology, Geophysics was also duly recognised in achieving the goals of water resources development projects and hydrology found its way in the curriculum of these disciplines. The exposure of the students at under- graduate level to the discipline of hydrology was not sufficient for the graduates to undertake hydrologic analysis to provide answers to or means of obtaining answers to real life problems in water resources development. However, Engineers, trained to this level in their undergraduate courses, are eminently suitable for further training. This led to the establishment of postgraduate programmes in Water Resources in various Indian Educational Institutions. These courses not only trained knowledgeable manpower for the profession but also created a nucleus of teachers in the educational institutions with knowledge of scientific principles, tools of analysis and the ability to apply these in appropriate context. This led to development of Ph.D. programmes in some of these institutions wherein these teachers explored and researched in the area of Empirical Hydrology by observation, analysis of records and developed empirical relationships at the catchment scales, explored the tools of analysis for various real-life situations, Developed mathematical/simulation models of the hydrological cycle or explored the inter-relationship between various hydrological components. The activity was given a major push by the Ministry of Human Resources Development by providing a special grant to various institutions in the country to develop infrastructure (computers, Image processing equipment etc.) facilities. The type of institutions involved in education and research in hydrology can be categorised under three heads.

1)Institutions imparting education leading to award of Bachelor's degree in Civil Engineering, Master's and Doctoral degree in Hydrology/ Water Resources.

2)Institutions admitting students leading to award of Bachelor's degree in Agriculture Engineering and Master's and Ph.D. degree in Water Resources or allied areas.

3)University departments of Geophysics awarding Master's and Ph.D. degrees in Hydrometeorology, Limnology, Geohydrology and Atmospheric Sciences.

This paper explores the role of these units in the Educational Institutions in promoting Hydrology. These units are expected to perform three roles, namely, Academic, Scientific and Professional. The paper identifies the goals subhead wise and suggests measures which are necessary to attain the specified goals.

ACADEMIC ROLE

The academic role of any such unit is to impart instructions at undergraduate, postgraduate and doctoral level. The instruction should be relevant and help to produce creative and innovative Engineers/Scientists well versed in the latest tools and scientific concepts so that they can attain a stature that enables them to provide leadership with credibility in hydrology. The role of postgraduate programmes in influencing the quality of instruction even at undergraduate level in these units is very significant. The infrastructural and other needs to perform the above roles effectively in hydrology are -

a)availability of Computer Hardware and generalised application software such as Spreadsheets, Compilers for various languages, Image Processing System and relevant software for data interpretation such as GRASS or Erdas, HEC packages etc.

b)Access to the latest literature on the subject i.e. Books, Journals both national and international in the area of hydrology and allied areas.

c)Information on hydrological/hydrometerological parameters collected on Indian basins such as Discharge, Precipitation, Evaporation, Ground water, Soil Moisture etc.

d)On-line access to databases in premier Central and State Govt. organisations such as Central Water Commission, India Meteorological Department etc.

e)Continuous updating of curriculum to reflect the latest advances in Hydrological Sciences.

f) Audio-visual and other aids for effective communication.

g)Books and monographs incorporating the latest curriculum needs.

The above needs are a prerequisite for achieving the academic goal of producing creative and innovative hydrologists well versed in latest concepts and tools. The needs at a), b), c) and d) need a national effort such as the one mounted by Ministry of Human Resources Development. This work should also be taken up by the Ministry of Water Resources so that trained manpower of requisite calibre becomes available to the country. The needs at e, f and g is the responsibility of these units. This need should be met through specific projects funded by curriculum development cells so that updated material becomes available to the Educational Institute which are not endowed with the facilities at a), b), c) and d) or are involved only in undergraduate teaching.

The results of such projects need to be disseminated through short- term summer and winter programmes funded by the Indian Society of Technical Education.

SCIENTIFIC ROLE

The scientific role of these Educational Units is to carry out research to understand fundamental hydrological processes and to discover 'why' of the practical solutions to the water related problems. It is also expected that these units continuously keep on evaluating the advances in allied sciences, observational and data handling technologies for their relevance to hydrologic design and analysis. These units should help to identify the studies which need to be taken up to answer the questions arising out of the growth of scale of interference with nature. The units should make a special effort to publish their research in international journals.

The above role is a normally expected role from these academic units in the Educational institutions. However, this role is being questioned by the decision makers in the Government and users agencies. A working party in Britain (1979) under the chairmanship of Lord Baker studied this problem in depth and defined Engineering Research as under.

> "Engineering Research should be considered as the combination of new scientific discovery with the practical design and development of a real product or process of proven, or potentially likely, utility. Involvement by industry is essential at all stages of research, development and design, whether it be done in the physics or materials laboratory as basic research or in an engineering laboratory or drawing office for product design and development."

This shift in emphasis to find solutions to engineering problems has always been there in hydrology. However, hydrologists are now questioning this shift and would want that the universities should work on principles rather than tools to solve Engineering problems. As mentioned above in the first para, the advances in observational technologies, data handling technologies and other allied sciences is bringing in this shift. Global studies are being done to look at the long-term scenarios because of these developments. For example, Landsat and GOES Satellite data has been used to run a basin Scale hydrological model (Duchon et al., 1992). Radar in conjunction with Satellite data calibrated against independent measurements, such as network of telemetric raingauges is already being explored to update information on distribution of rainfall at 15 minutes intervals for use in real-time forecast models (Capovilla, Chander et al., 1989). More physical reality is being brought into the modelling exercise by using composite images of soil type, land-use to identify vegetation indices relevant to run off (Schulz, 1988).

The requirements for achieving the scientific role are :

1)Availability of hydrometeorological, hydrological, topographic, water quality, vegetable cover complex and other data to these institutions.

2)Funding joint short projects for Master's dissertation of students in these courses.

3)Availability of remotely sensed data from Indian and Foreign satellites for research and dissertation of students.
4)Computer networking of Libraries of these institutions with those of the National Institute of Hydrology, Central Water Commission, India Meteorological Department, National Geophysical Research Institute etc.

This role would not benefit the country unless the trained manpower is utilised by the departments in upgrading their own hydrological skills. Since most of the organisations involved in water resources development are Government establishment, it is necessary that these departments should carry out an inhouse study to project the manpower need at various levels and sponsor their officers to such programmes in these Educational units. This is important as their recruitment process does not allow the direct employment of Masters and Ph.D. degree holders. We at the IIT Delhi had built-in flexibility to admit these officers on a part-time basis to our Graduate programmes. These officers brought in relevance to our instruction as well as projects and helped Central Water Commission to maintain their standards of hydrological skills. This also helped the IITD to take up topics for research which were needed for the immediate need of the organisation. For example, a study entitled "Integrated Sizing of a Group of Reservoirs" using network linear programming carried out by an officer of National Water Development Agency was accepted for the award of Doctoral degree in 1993.

PROFESSIONAL ROLE

For Academics in Engineering Hydrology, it is a professional necessity to have interaction with the professional organisations. What should be the form of this interaction? Usually, this interaction takes place through a) Consultancy, b) Water Resources Department sponsored courses, c) Membership of Policy-making bodies in Water science and technology area, d) Continuing Education Programmes, e) Interaction through Joint research projects with inhouse R&D organisations of the water resources departments, f) National Projects in the Mission Mode etc.

Prof.M.M.Sharma of University Department of Chemical Technology, Bombay during Prof.V.Ramakrishna Memorial Lecture at IIT Delhi on January 30, 1991 defined the characteristics of Academia and reasoned how they are most suitable in the consultancy mode to interact with the profession.
According to him,

1)Academics are in knowledge business and are engaged in transfer of knowledge and in producing knowledge.
2)They are competent to guide/conduct research and accept failure philosophically and take success with modesty.
3)They are known for their reproductive value and soon become dispensable to the organisation.
4)They are able to integrate rationality and intuition. The potential in universities is much more than that has been recognised as they do have the spiritual freedom.

5)They are able to appreciate that group interactions can stimulate or even incite an individual to innovate.
6)They work under several constraints such as resource crunch and are frugal. They work in a competitive international environment.
7)They are expected to demonstrate their capabilities on an international basis and publish papers in journals with top citation indexes that too with limited financial resources.
8)The academics have a knack of bringing disparate subjects together and getting more out of existing assets, data and facts.

The above characteristics make them eminently suitable to offer consultancy of the following type :
a) Consultancy through brain storming. b)Consultancy involving mathematical analysis of problems, Modelling and Simulation of water resources both in real-time as well as off-line, system analysis etc. c)Consultancy on review and appraisal of existing systems and their modernisation and optimal operation. d)Consultancy for development of Future Vision.

As stated above, the academics are in knowledge business, therefore, the development of courses/course material for inhouse training in departments is their obvious strength. They are best suited to identify the training needs at each level and define goals of the training. Having defined the goals, they can play a major role in curriculum design and development of course material.

They can play this role only if they have the open support of the decision-makers in the departments and R&D establishment of these professional organisations. The professional organisations have recognised the contributions that can be made by Educational institutions in day-to- day professional work and have in the recent past involved Professors in the above mentioned roles. Further one finds Professors in decision-making and advisory committees wherein they interact with experience professionals and help the country to take long-term decisions for the development of water resources.

For example, we at IIT Delhi have interacted with the top professional organisations of the country such as Central Water and Power Commission, Kosi Board of Consultants, State Irrigation Departments, Consulting Engineering Services, New Delhi, C.C.Patel and Associates, New Delhi, Water and Power Consultancy Organisation, New Delhi etc.

During this interaction, my colleagues have introduced new technologies, new tools, developed simulation models, developed software for hydraulic designs, as well as carried out problem-oriented work wherein intuition and rationality were integrated to solve problems with limited data.

It is hoped that this interaction will increase further with the new initiative of the Planning Commission to sponsor Drought and Flood Project in the Hazard Mission at the IITs.

CONCLUSION

1. The role of Educational Institution in Education and Research in hydrology has been categorised under 3 subheads, namely, Academic, Scientific and Professional including Public policy and decision-making at the national level.

2. The Academic role is to produce knowledgeable professionals at Bachelor's degree level who are exposed to Physics, Chemistry, Maths Computation, Environment Science, Hydraulics and Hydrology, Systems Engineering and Remote Sensing Courses and are competent to receive post- graduate training in Hydrology/Water Resources.

The Goal at the Graduate level is to produce hydrologists who are creative and innovative. They should be well versed in the latest concepts and tools and should be able to attain a stature that enables them to provide leadership with credibility.

3. The scientific role of these institutions is to carry out basic and applied research of international standard in hydrology. This is absolutely essential if these units wish to create manpower which can assume leadership in hydrology with credibility.

4. The professional role of these units is a necessity to maintain the relevance of academic programmes. It brings out the capability of these units to apply their knowledge to solve real-life problems and promote interaction with the units who employ their products. Their performance in this role brings academics to policy making and decision-making bodies at the national level and brings direct benefits to these units, professional organisation as well as the country.

5. The need for Human Resources Development policy in Water Resources departments is emphasised to assimilate the results of the efforts of Educational units in national development.

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