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UNDER GRADUATE EDUCATION IN HYDROLOGY

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ABSTRACT

This paper deals with the development and formulation of the undergraduate course in Hydrology, mainly in the Technical Institutions, against the authors experience of 37 years in teaching and research in IIT, Kharagpur. With the demand for water increasing for development rapidly and with increasing concern being realised for environmental protection the science of hydrology should be given increased weightage in many educational programs leaving alone Engineering. A thorough review of such courses and syllabi is presented in this paper.

1. INTRODUCTION

With fast growing population, increased expectations of all living standards, the demand for a rather limited resource like water is ever increasing. And so the need for updating the curricula in Civil Engineering and allied fields, along with the modern developments in science and technology. In September 1987 the country initiated the National Water Policy based on the concept that water is a scarce and precious natural resource to be planned, developed and consumed as such in an integrated and environmentally sound basis.

Since water is the basic need for drinking and agricultural production and for human development and balanced biosystems. It should be preserved in a proper environment of which it is a principal factor. As such the advances in hydrosciences should be part of any modern pedegogical education as also for general public awareness through the various information media.

2. CHANGING PATTERN OF EDUCATION

The pattern of Education, specially at the undergraduate Engineering levels, has been undergoing continuous changes for technological development. Several decades ago in the Engineering Education hydrology was only in study of rainguage and elementary aspects of rainfall, with a little empirical approach only.

3. HYDROLOGY

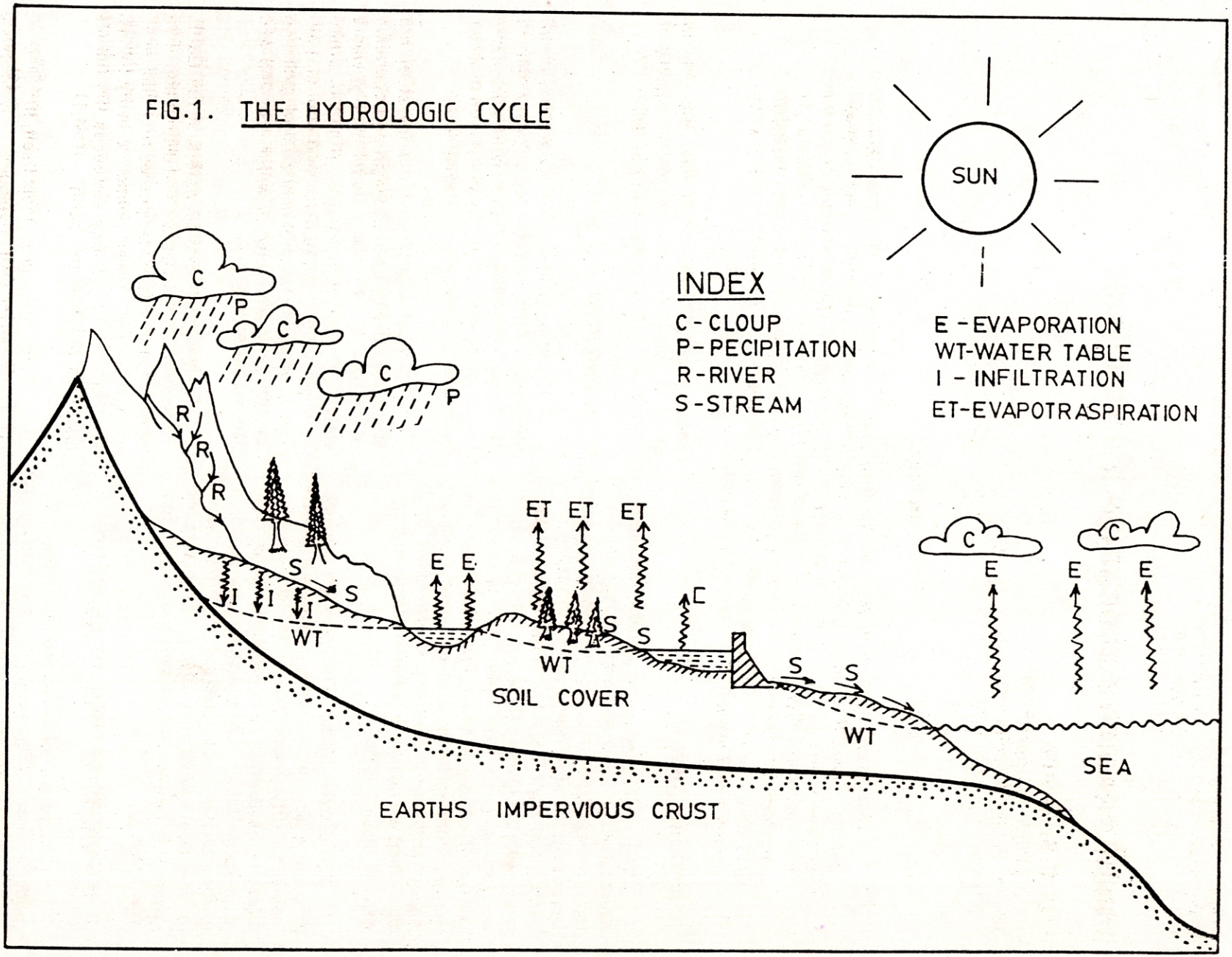
Hydrology deals with the waters of earth, their origin, distribution etc. Hydrology is defined strictly as the study of the hydrologic cycle (Fig.1) which is the perpetual circulation of water between the earth and its atmosphere.

Practical aspects of Hydrology study are found in such tests as the design and operation of the hydraulic structures, water supply, waste water treatment and disposal, irrigation, drainage, hydropower generation, flood control, navigation, erosion and sediment control, pollution control, recreational use of water, fish and wild life protection etc.

"Hydrology treats of waters of the Earth, their occurrance, circulation and distribution, their chemical and physical properties and their environment, including their relation to living things. The domain of hydrology embraces the full life history of water on the earth". (Ref.1).

In the vedic age of India itself, the Science of Hydrology was well developed. The following translation from the Athervana Veda shows the

FIG.1. THE HYDROLOGIC CYCLE



importance given by our country's ancestors to this subject. (Ref.2). Athervana Veda:

"O vapour-laden winds rise from the sea and move (and fly heat, as the sun does) towards the sky; leading the thundering rain producing winds and flowing water to saturate the earth".

4. HYDROLOGY IN MODERN TIMES

In recent years due to increased concern for the environment and aggravatory environmental problems like pollution of air, water etc. There is need for including subjects like hydrology in the undergraduate courses of sciences and humanities as well. Floods and droughts are increasingly affecting the earth's biosystems, as serious natural disasters, which are preventable with the modern developments in technology.

5. THE HYDROLOGY CYCLE

The core part of subject of Hydrology as applied to Civil Engineering and allied subjects like Agricultural Engineering can be physically illustrated by "Hydrologic Cycle" which is given in Fig.1.

It can be seen broadly from the figure, that this subject can be divided into two parts:

(a) Surface Hydrology: which deals with the hydrosphere phenomenon on the earth's surface.

(b) Sub-surface or Ground Water hydrology: which deals with the phenomenon of water, its availability etc. under the earth's surface or ground through wells etc.

6. GENERAL SCHEME OF U.G. COURSE IN ENGINEERING

The objective of any U.G. course will be to introduce to a reasonable depth for the student a subject of social relevance and development of his aptitude for further studies or for his vocational development and social development. In such a frame of work of his curriculum, a modern subject like hydrology can be introduced either as a compulsory subject or as an elective, towards the end of the course. It is needless to emphasise here that the development of such a modern subject like hydrology especially, requires adequate infrastructural facilities like adequate trained faculty and laboratory and establishment etc.

In the U.G. courses of Civil Engineering itself there had been very significant changes in the syllabus, for the hydrology subject and the allied subjects. This is also due to the fact that other Civil Engineering subjects also for their development have definite relationship in areas like highway drainage, water supply and sanitation etc.

Here again the Civil Engineering course and the curriculum are designed in various Engineering colleges, Regional Engineering colleges, Institutes of higher learning etc. with specific objectives of research basic, applied, for vocational training etc. against their resources.

In basic aspects hydrology can be considered as an interdisciplinary subject of Civil Engineering and Agricultural Engineering. But in qualitative studies it is more important for the Civil Engineering. Along with similar subjects like meteorology, it can be introduced as a somewhat similar interdisciplinary subject for Geological or Geophysical sciences, Atmospheric sciences etc. at the U.G. level.

7. CIVIL ENGG. COURSE AND CURRICULUM

In the U.G. course of Hydrology the topics can generally be grouped into:

a) Rainfall study
b) Runoff (or) streamflow study
c) Storage study

The other part, namely ground water is generally included as well hydraulics and is covered also with Irrigation Engineering. While the above scheme is for Civil Engineering U.G. Course. Agricultural Engineering U.G. Courses have a subject like ground water, where surface hydrology is again briefly covered.

8. SYLLABUS: CONTENTS FOR U.G. COURSES

The course content and emphasis will depend upon (a) the faculty resource (b) general income work of the allied courses and (c) pre-

requisite nature of advanced courses and the emphasis for research, design or professional applications.

a) Rainfall studies

Precipitation and its different forms: processes of its occurance, like conventional, orographic frontal rainfall, monsoons etc.

Raingauges, manual and recording types their importance etc.

Rainfall depths at a station, daily, seasonal and annual, variations, trends, frequencies, intensity etc.

Areal rainfall, depth, duration, etc.

Losses in Rainfall:

Evaporation, transpiration, infiltration, methods of estimation.

b) Runoff study:

Streamflow measurement; water level gauges, manual and recording types; stage-discharge curves.

River flow, hydrographs, flood estimation by baseflow separation; flood hydrographs.

Unit hydrograph; concepts and estimation. Application for runoff estimation, Synthetic Unit Hydrograph.

c) River Basin:

Its characteristics, area, slope, stream density etc.

Unit hydrograph characteristics; depending on basin characteristics.

d) Storage study:

Storage reservoirs, types of storage; water supply demands; streamflow mass diagrams; estimation of storage requirement.

9. Advanced Hydrology

An advanced course in hydrology can be offered at the final year level for Civil Engineering, with emphasis on models development, with orientation to water resources, environmental etc. projects, either as introduction to research problems, or for field design applications.

Advanced treatment of the above curriculum with detailed analytical methods, computer applications etc. can be done in this course. Additional topics like time series analysis, Statistical and probabilistic studies of rainfall, streamflow, flood routing methods for reservoirs, channels; flood forecasting, Reservoir storage planning, and operation; real time flood forecasting; ground water development and modelling; droughts and so on.

10. WATER RESOURCES ENGINEERING LABORATORY

This is generally of 3 hours laboratory course in 3rd year of B.Tech. course in IIT's and other Engineering colleges for oue semester. The students study the application of hydrological equipment like rain gauges, stream flow current meters, sediment samplers, water level recorders etc. Experiments on electric analogy studies of flow nets in seepage flow, storm hydrographs, critical flow meters etc. are included along with other hydraulic experiments.

11. FLOOD CONTROL

An elective subject in final year. This is offered as an elective in eight semester of final year Civil Engineering with loading 3 lectures hours and zero sessional periods, weightage of 3 credits at IIT, Kharagpur.

The syllabus consists of the following:

Methods of estimating the design storm, design flood; statistical and probabilistic methods; empirical formulae, curves, spillway design flood. **Flood Routing Methods:** Reservoir characteristics and routing, channel routing, stage routing.

Flood Control Methods: Flood control by reservoirs, embankments, channel improvement; flood plain zoning, flood proofing; flood forecasting and warning.

Advantages and disadvantages of each of these methods.

Estimation of flood damages, methods of their minimisation.

Flood control economics: Cost benefit diagrams single and multiple methods in economic analysis case studies etc.

12. OTHER ELECTIVES

These can be offered alongwith the other specialisations in Agricultural Engineering, Rural Development etc. With suitable modifications in their syllabii.

a) Ground water hydrology
b) Soil Conservation
c) Computational techniques in Water Resource Engineering
d) River Engineering
e) Water Resources Project Planning
f) Flood Management
g) Coastal Engineering
h) Remote Sensing and photogrammetry
i) Irrigation & Drainage
j) Watershed management etc.

These electives can be introduced in the 7th or 8th semester of courses, if the necessary prerequisites like Irrigation & Hydrology courses are done compulsorily in the earlier semesters.

13. PROJECTS IN HYDROLOGY

Experimental and or analytical nature. In the eighth semester of the final year course in Civil Engineering or allied courses individual projects under supervision of teachers can be assigned to students as shown in Annexure-I.

14. CONCLUSION

The availability of water for human sustainance and development is becoming a crucial problem in modern times. Futuristic projections by top expert organisations like World Bank etc. have been emphasising their matter of concern in recent years. Study of hydrology in professional courses as well as other undergraduate courses needs to be given due importance, as has been done in the case of environmental science as compulsory very recently.

15. REFERENCES

The following are recommended are general reading:

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3. Guide to Hydrometric Practices: World Meteorological Organisation, Geneva 1974.
4. Bhagirath: Central Board of Irrigation & Power, New Delhi.
5. Water Resources of India, Central Water Commission, New Delhi, Publication No.30.
6. India's Water Wealth: Dr. K L Rao, Orient Longmans.
7. Report of study committee on Education and Training, Central Water Commission, Ministry of Water Resources, New Delhi, 1991.
8. Yojana: Planning Commission, Government of India, New Delhi.

ANNEXURE

List of topics for one semester project of student individually in hydrology and related water resources studies.

1. Rainfall studies of a river basin
2. Hydrologic data collection and network planning
3. Planning and allocation of water in Irrigation
4. Real time forecasting of floods
5. Remote Sensing in hydrology and basin planning
6. Stochastic studies in hydrology
7. Rainfall-runoff modelling
8. Basin studies for unit hydrograph
9. Evapotranspiration studies
10. Computer modelling of hydrologic processes
11. Environmental problems in hydrological studies
12. Case studies of floods, droughts
13. Socio-economic problems related to water logging, flood control, land use etc.
14. Yield studies of wells.