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The Place of Hydrology in Science

The explosive growth of hydrology has given immediate concern as to how its scientific boundaries can be defined and how its shape can be fitted into the existing institutional or organizational pattern — or better still how the pattern can be altered to accommodate it.

Price and Heindl (1968) considered it necessary to scan the literature for definitions of hydrology, and in an examination of 31 such definitions they found that no argument exists against hydrology as 'the science of water', but that opinion varies as to its scope. In its narrowest sense it has been restricted to one or two aspects of water, such as ground water or surface water. In its broadest sense it includes meteorology and oceanography.

Most modern definitions, including that of UNESCO (1968), differ only semantically from the one of the Ad Hoc Panel on Hydrology of the U.S. Federal Council for Science and Technology (quoted by Chow, 1964), which defined hydrology as "*the science that treats of the waters of the Earth, their chemical and physical properties, and their reaction with their environment, including their relation to living things. The domain of hydrology embraces the full life history of water on the Earth.*"

In this definition, hydrology includes oceanology (but not oceanic life) and studies of atmospheric water. This is supported indirectly by the recent water legislation in New Zealand, which defines natural water as "*all forms of water, including fresh water, ground water, artesian water, sea water, geothermal steam, water vapour, ice and snow. . . .* "

The use of environmental studies in hydrology, as referred to in the definition above, has caused hydrology to be tagged as an inter-disciplinary science. The establishment of hydrology as a separate course of learning, and thus as a discipline, is overdue. That this has not taken place is considered by many to be due to its long and fixed association with engineering.

Yevjevich, himself an engineer by training, states (1968) "*It would not be difficult to convince a large percentage of the hydraulic engineers that theirs is the primary discipline and hydrology only a part of it. The reasons are simple. Professional education has presented the facts to engineers in such a way that physical processes of the movement of water through, above, or below various structures is the primary problem of water resources, whereas methods of determining the availability and properties of water in nature are of secondary importance. . . . A down-grading of hydrology from a natural science to an appendage of hydraulic engineering is responsible for these two developments:*

(1) *the development and acceptance of hydrology as an independent science has been retarded;*

(2) *the vacuum thus created by engineers has been filled only partly by scientists from various disciplines.*"

Practitioners in water-environmental sciences (climatology, botany, geomorphology, pedology and geology) have inevitably dabbled in hydrology from time to time. Because of the non-recognition of hydrology as a separate discipline, such studies have been approached from the other (water-environmental) science point of view rather than from a hydrological one. As a consequence, one has virtually to start from scratch in environmental studies when considering relations to water as the central feature.

For instance, in interception and overland-flow studies vegetation form is the prime interest rather than its botanical classification, and the mapping of soils as to their hydrological characteristics of various horizons is more important than a *ceteris paribus* system of classification. However, the literature is notably silent on phytomorphological research or 'single-value' soil mapping.

Because of the absence of creative scientists in the hydrological discipline, engineers considered hydrology as their own domain — leaving those who appreciate hydrology as a science to use the term 'engineering hydrology', meaning to say, hydrology as applied by engineers. Similar terms such as 'agricultural hydrology', 'forest hydrology' and 'medical hydrology' have been used — terms used by the principal applied sciences, Engineering, Agriculture, Forestry and Medicine.

This is not abnormal or inappropriate; terms such as 'engineering geology', 'agricultural meteorology', 'forest biology' or 'medical statistics' have defined meanings also. The important point is that terms such as 'engineering hydrology', 'agricultural hydrology', etc., should be used only if one is concerned with the application of hydrological data or principles to design, cultivation or healing.

The syntactic approach in defining apparent branches of a science has developed in hydrology also. Some of these are valid and helpful, such as dividing hydrology into physical, parametric and stochastic hydrology (Amorocho, 1964).

Those words which combine hydrology with a related science are not realistic but exhibit an apparent lack on the part of the definer to consider hydrology as a discipline in its own right. For instance, 'hydrogeology' has been defined as the study of ground water with particular emphasis given to its chemistry, mode of migration, and relation to the geological environment, and 'geo-hydrology' as the study of ground water with emphasis on the fluid-flow aspects of ground water. The difficulty of considering the two in isolation is increasing, and modern hydrological studies will often find it impossible to separate ground-water studies from other aspects of hydrology, except when ground water is investigated from and for a geological point of view or for direct engineering purposes.

The prize for the greatest terminological monstrosity must surely go to 'hydrometeorology'.

Hydrometeorology in its original and narrow sense has been defined as "*storm studies pertaining to the design of hydraulic structures*" (WMO, 1965). Yevjevich (1968) destroys much of the basis of this 'science' by doubting the use or validity of such storm studies.

Hydrometeorology has sometimes been defined as meteorology plus hydrology; in such a case the study of water in relation to its environment is not included. The World Meteorological Organization inclines to the use of the word 'hydrometeorology' in this sense since, until the establishment of the Office of Hydrology in UNESCO, no other international governmental organization had the responsibility for hydrology. The subject is still somewhat controversial and is unresolved because of organizational squabbles in some countries.

The term 'Hydrometeorological Service' used in some eastern European countries, where hydrology and meteorology are linked organizationally under one Minister, makes some sense.

The search for the correct base on which to set the science of hydrology resulted, in many countries, in organizational and institutional fragmentation. As referred to above, some eastern European countries have a satisfactory organizational pattern, and New Zealand is at least fortunate in having hydrology practised largely in a central organization.

A pertinent question may be asked here: "Which is the ideal place of hydrology, institutionally and organizationally?"

Linguistically, geology should be defined as the science of the earth and if this is acceptable, hydrology would be a natural subdivision. Because geology has normally a much narrower connotation, the term 'earth sciences' has developed which purportedly includes at least meteorology, hydrology, pedology and geology. Sometimes the term 'geological sciences' is used, or even 'geosciences'.

An alternative approach is that followed by the American Geophysical Union and some universities. Geophysics, the science of the physics of the earth, is regarded as the principal science with meteorology, hydrology, volcanology, oceanography and suchlike as sub-branches. The difficulty in accepting this lies in the fact that geophysics has also a much-used and narrower meaning, and it could be argued that the study of the physics of the earth is restrictive.

Geography also has been used as the mother science; a main branch, physical geography, is then subdivided into sciences as listed above under earth or geophysical sciences. In the USSR, schools of hydrology are well established in geography departments of universities — a line followed somewhat tentatively by such departments in New Zealand universities.

More recently the term 'environmental sciences' has appeared. One definition aims at including climatology, hydrology, geomorphology, pedology and ecology, but different interpretations are given also.

The earlier statement that, in hydrology, water-environmental studies should be recast and be considered from a hydrological point of view, undercuts any support for the placing of hydrology in an earth-geophysical, geographical or environmental-sciences context.

Considering natural water as the central feature, an institutional and organizational combination of climatology, hydrology and oceanology (excluding oceanic life) should deserve consideration.

To sum up, hydrologists should not be confounded by the complexity and divergency in the definitions of their science. Similar confusion exists in other sciences and it is easy to find a collection of definitions for almost any discipline. It is nevertheless wise in these formative times to adhere to one definition of a fairly rigid nature, and the one drawn up by the Ad Hoc Panel is as appropriate as any.

Following this strict course, it is of first importance that scientists who work in some aspect falling within this definition should dare to call themselves hydrologists, while in consequence applied scientists applying hydrological data to design, cultivation or healing should refrain from using this word.

Hydrologists should also insist upon a separate course of learning at universities, and professionally associate themselves with groups who are willing to study water-environmental aspects from a hydrological point of view.

The above has been a strict view and some may even argue, a narrow one. It is obvious that sciences will in future merge more and more, and that distinctions between them will become blurred.

However, it is essential that we start from a normal condition and that we put our own house in order first — only then can we be sure that associated sciences respect us, welcome us, and that — when mergers become the order of the day — the essential feature of hydrology to consider matters from a water point of view does not get lost. And this of course is in the interests of hydrology.

— Cornelis Toebes

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