

II. PARTIE SCIENTIFIQUE II. SCIENTIFIC PART

THE VIGIL NETWORK ⁽¹⁾

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Those of us who seek to explain the variations in hydrologic phenomena such as may be observed in the occurrence in floods or in changes in the shape of river channels are painfully aware of the lack of adequate data. Our existing data, collected mainly to serve immediate practical needs for water-resources development, usually are deficient in providing information useful for many kinds of scientific inquiry. Hydrologic records are usually obtained on streams that are highly regulated or otherwise put to use, to the neglect of headwater streams better suited to studies of the details of hydrologic processes.

What the regular programs of hydrologic measurement overlook is the need to identify causes of given observed effects; the chain of events — the linkage of interrelated factors — needs to be known in far more detail than is possible at present. Specifically, the hydrologist as well as the ecologist, the geologist, the botanist, the sociologist, and a host of other natural scientists find themselves unable to link cause and effect because they cannot dissociate the direct and indirect effects of man's use from the similar effects which are brought about by the natural variations in climatic factors.

The nature and causes of climatic variation are not abstruse and impractical exercises of the intellect. On the contrary, water management is becoming increasingly dependent on an improved basic understanding of the interrelations between the atmosphere, the biota, and the land as they affect the hydrologic cycles. To gain a workable understanding of these interrelations it is imperative that we know more than we do at present about the nature of and the effects emanating from hydrologic changes.

The problem is of greater concern in the arid areas of the earth than it is in the more humid ones. First, the arid areas are characterized by an inherent variability, particularly in climatic factors. This variability is reflected in the biota. Secondly, in an arid climate the climatic controls are somewhat more direct than they are in areas where water is not a limiting factor. The hydrologic responses, even to relatively minor climatic variations, are more specific and more prompt. The problem of the arid regions is sharpened because these are just the areas that are commonly overlooked in establishing the existing hydrologic networks.

There is vitally needed now an international system of observations on small watersheds of the principal hydrologic and landscape factors. Field observations of the same kind in many places would improve our understanding of the hydrologic and the biologic aspects of natural interrelations. I propose, therefore, the establishment of an international network of observation points to collect data on some of the basic parameters governing the relation between man and the landscape. The network of observation areas I visualize might consist of the following.

A small watershed would be chosen, the size of which might be from 1 to 10 square miles. It would be chosen to represent a typical area in the general region that is, typical in its general

⁽¹⁾ Based on the author's paper "The Man and the Hill" presented to the Symposium on Climatic Change, sponsored by UNESCO and WMO, Rome, October 1961.

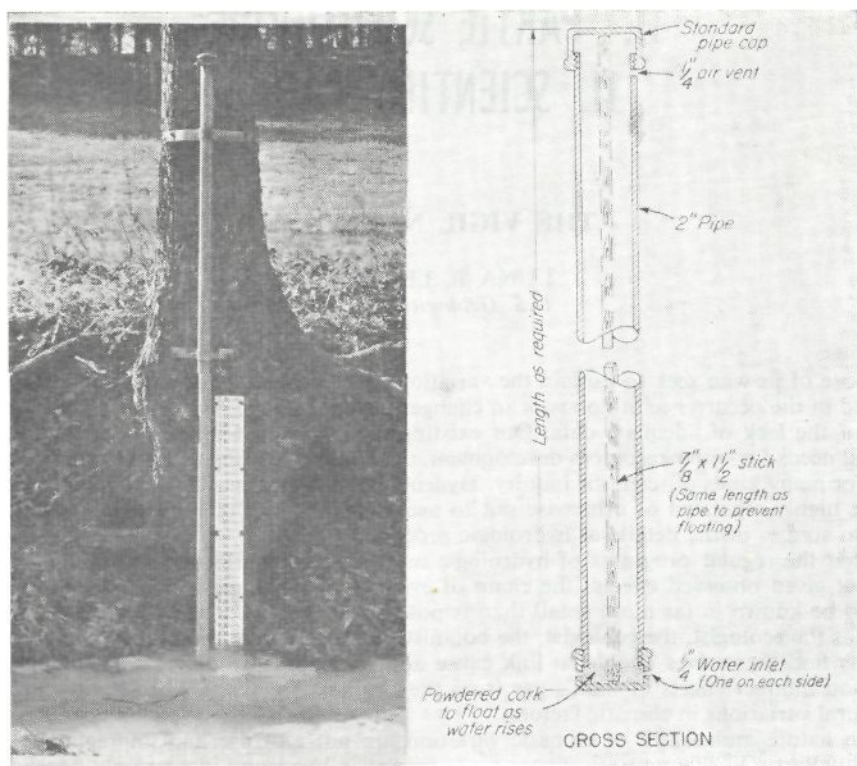


Figure 1. — Crest-stage gage.

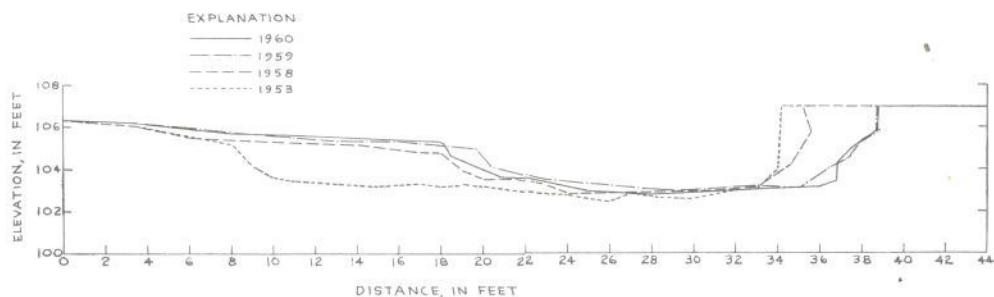


Figure 2. — Cross section of channel of Watts Branch, near Rockville, Maryland, resurveyed successively to study changes with time. Permanent iron pins driven flush with ground surface provide reference points at each end of survey line.

geology, vegetation, slopes, topography, and land use. At the mouth of the drainage basin some very simple observations would be made intermittently. The major flow in the stream channel would be observed by means of an extremely simple crest stage gage. As shown (fig. 1), this is merely a perforated pipe standing near the stream channel within which is contained a wooden measuring stick and at the bottom of which is placed some granulated burnt cork.

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When the water rises in the channel the cork floats up and clings as a high-water mark to the stick inside the pipe. At some later time the observer comes to the crest-stage gage, pulls the stick out of the pipe, observes the position of the cork which is the high-water mark of the most recent flow and records its vertical position.

Another observation which can be made very easily is the cross-sectional shape of the channel at the point of observation. A cross section can be surveyed, tying it at each end to permanent monuments. These monuments or markers might be as simple as a cross chipped in local rock at each end of the channel. Where rock is not available, an iron pipe can be driven into the ground, which will not be disturbed by ordinary activities of man or beast. Such cross sections could be resurveyed seasonally, or even once a year. The changing cross section over a period of years would give a quantitative idea of whether the channel is aggrading or degrading. Figure 2 presents the results of such surveys of a channel cross section over a period of 9 years. If such measurements were continued over many decades, the results should be unusually interesting.

Obviously, in the measurement locality there should be a longterm storage rain gage. These instruments are now available cheaply and have been shown to give good results. A gage buried in the ground and containing a few drops of oil or other material to reduce evaporation can give a very usable record of the seasonal precipitation. Rain gages do require some sort of a fence or barricade to protect them from passing stock, but such protection can be furnished at very low cost. If a small enclosure is built to hold a rain gage, there is then the possibility of having a trap for obtaining samples of windblown pollen and windblown dust. At the same place one may collect samples of rain to measure its content of dissolved chemical salts. Re-photography from a fixed point provides a visual picture of changes with time (see fig. 3).

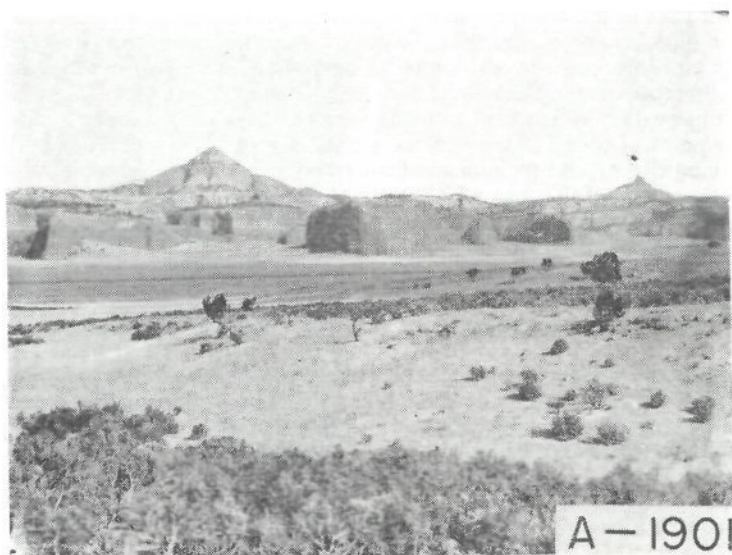
Apart from these measurements which are made seasonally or annually at the mouth of the watershed, each watershed should have cursory but quantitative description of its soil, geology, topography, and vegetation. Quadrants, transects, or some other simple means of describing the vegetation are necessary in order to give quantitative estimates of the gradual change, if any, in plant growth or species distribution.

As an initial step in our part of the suggested network, we in the United States are proposing that a series of small watersheds be chosen along a line or transect stretching in an east-west direction between the major mountain masses in the North American continent. Later we hope to have a similar series of watersheds in a north-south line through the central part of the United States where the topography is relatively flat. The north-south transect, then, would give a representation of the effect of latitude uninfluenced by major differences in topography.

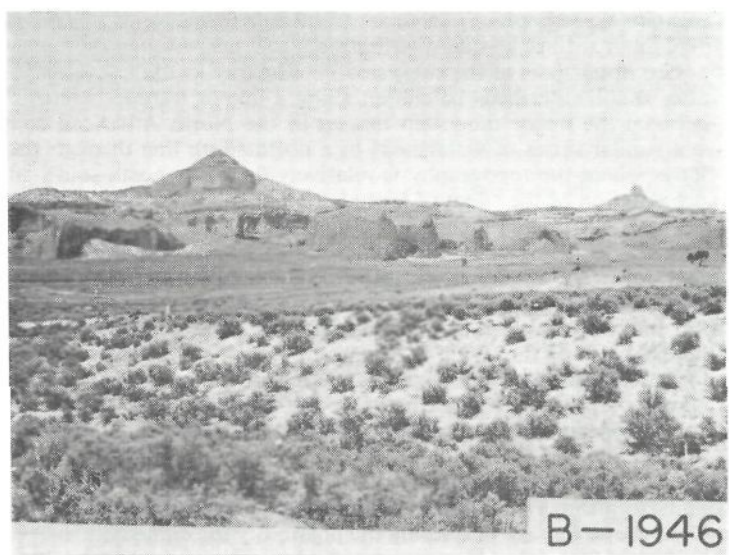
One might ask why it is necessary to suggest that this hydrologic network be formulated on an international basis. The answer seems quite clear. Not all the possible conditions of vegetation, soils, climate, and use are represented even in a very large country. The first purpose of having such an international network is, therefore, to get a sampling of diverse types of landscape in different parts of the world. The second reason why this program should be of an international nature is that many of the climatic and use factors have a distribution dependent partly on continentality, relation to major bodies of water, and other characteristics of aspect and position. To obtain such a range in conditions, the observations should be on various continents.

What I suggest is practical in terms of the types of instruments and observations which are required. Standardization, even of simple observations, can give a large amount of useful information, and has the advantage of offering the possibility for immediate installation. Observations that require very specialized equipment, highly trained manpower, or considerable cash outlay are difficult to initiate. The suggestion made here, on the contrary, has actually been tested in the field, the instruments are of the simplest sort, the time schedule for observations is not critical, and the long-term results of such observations have already proven their usefulness.

It is proposed that this network of simple observational areas be called the *Vigil Network*.



A.—N.H. Darton, 1901.



B.—L.B. Leopold, 1946. The former open spaces show an encroachment by sage. Grass between sage of low density, 2-10 percent, and consisted of *Mullenbergia porteri*, with lesser amounts of *Aristida fendleriana*, *Sporobolus airoides*, *Hilaria jamesii*. Sage in foreground obscures gullies 3-4 feet deep. Sage heavily grazed, some bushes nearly dead.

Fig. 3 — Two views near Navajo Church, 2 miles northeast of Fort Wingate, N. Mex., looking N. 20°E

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A vigil is a watch, an observation over time, if you will. We will watch the changes that occur with time in the vegetation, the channels, the biota, and the overall landscape.

In proposing, then, an international network of landscape observations on small drainage basins, I hope we will begin a trend toward true international cooperation even of relatively simple nature, within the practical limitations of manpower and money. What I am here suggesting is within the reach of even the smallest countries; the amount of initial effort for installation is very small; the possibility of having uniform methods adopted by various countries is good; and the program can be started by nearly any scientist regardless of his particular background or training.

The kinds of observations proposed should also be of interest to such scientists as botanists, ecologists, anthropologists, and others who need information on changes in the natural environment. It is an axiom in ecology that the climatic factors, soil, and the biota interact in such a way as to promote a quasi-equilibrium, notwithstanding the long-term geologic effects of gradual degradation of the continents by solution and by the processes of erosion. Variations in climate produce new conditions of natural equilibrium. The balance between the erosive effects of water and gravity and the ability of the vegetation to hold the soil and to mitigate the erosive effects of running water is particularly sensitive in arid climates; but changes in the quasi-equilibrium everywhere have important effects on man in the past and in the future.

Because the suggested observations have an increasing value with passage of time, it is imperative that the descriptions of the site, directions for locating it, and the basic data resulting from the observations be preserved and not lost. Many observational programs have been lost to science because the data and descriptions were not preserved. It is proposed, therefore, that *thieS* repositories be established where copies of these basic data are stored. The data would be made available on request to interested scientists.

The suggested locations of these repositories are Washington, Geneva, and Ghent. The addresses are:

Chief Hydraulic Engineer
U.S. Geological Survey
Washington 25, D. C.

Headquarters, World Meteorological Organization
Palace of Nations,
Geneva, Switzerland

General Secretary
International Association of
Scientific Hydrology
Ghent, Belgium

As for the first of these, the U.S. Geological Survey is pledged to keep such a file for the International Vigil Network, and is now prepared to receive and file data or descriptions from observation sites

I would welcome discussion of this proposal for a Vigil network either through the pages of this Bulletin or directly. I should particularly appreciate suggestions on kinds and techniques of observations, standardization and publication of results. The latter seems especially important because each participant in exchange for his own contribution should be assured ready access to all other data. If the Vigil network seems to have merit, perhaps it might well be included in the program for international cooperation in scientific hydrology, recently authorized for study by UNESCO.