

A Proposed International Watershed Research Network

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Abstract

An “International Watershed Research Network” is to be an initial project of the Sino-U. S. Centers for Soil and Water Conservation and Environmental Protection. The Network will provide a fundamental database for research personnel of the Centers, as well as of the global research community, and is viewed as an important resource for their successful operation. Efforts are under way to: (a) identify and select candidate watersheds, (b) develop standards and protocols for data collection and dissemination, and (c) specify other data sources on erosion, sediment transport, hydrology, and ancillary information of probable interest and use to participants of the Centers.

The initial focus of the Network will be on water-deficient areas. Candidate watersheds for the Network are yet to be determined although likely selections include the Ansai Research Station, northern China, and the Walnut Gulch Experimental Watershed, Arizona, USA. The Network is to be patterned after the Vigil Network, an open-ended group of global sites and small drainage basins for which Internet-accessible geomorphic, hydrologic, and biological data are periodically collected or updated. Some types of data, using similar instruments and observation methods, will be collected at all watersheds selected for the Network. Other data from the watersheds that may reflect individual watershed characteristics and research objectives will be collected as well.

Keywords: network, research watersheds, data, monitoring

Introduction

The Sino-U. S. Centers for Soil and Water Conservation and Environmental Protection were established in May 2002, at the Northwest Sci-Tech University for Agriculture and Forestry, Yangling, Shaanxi Province, China (Gray et al., in press). The Centers provide a formal mechanism to enable cooperation between Chinese and American scientists in developing methods and strategies to conserve soil and water and to maintain environmental protection. Scientists participating at the Centers will conduct research and develop techniques to promote education and outreach of common interest to peoples of the two countries, implemented by mutual understanding and in conformity with their policies.

The Centers are at the Northwest Sci-Tech University of Agriculture and Forestry in Yangling, Shaanxi, China, and at the Institute for the Study of Planet Earth, the University of Arizona, Tucson, Arizona, USA. Each Center manages and funds research conducted from that country. A Joint Oversight Committee (JOC) of members from both countries provides independent scientific review and guidance. Because activities of research, education, and outreach within the earth sciences require reliable landscape data, an initial objective of the JOC is to establish an “International Watershed Research Network” (IWRN), from which hydrologic, geomorphic, agronomic, and biological data, actively collected and archived, will be available to staff of the Centers and to the research community at large.

The IWRN will be comprised of gauged (instrumented) sites and small watersheds, generally in, but not limited to, water-deficient areas, where relatively long-term records of reliable (validated) data have been collected. Initial focus is likely to be on established research sites and watersheds in China and the United States. Establishment of an IWRN requires agreement among Chinese and American representatives for criteria used for watershed selection, protocols for the collection of data and the unconstrained availability of data, responsibility for

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data collection, network construction, and testing of protocols at selected watersheds. Information describing the principal worldwide data sets that may assist research conducted under the auspices of the Centers will be compiled, in part to aid in the selection of additional watersheds for the IWRN, and partly to augment databases for research conducted under the auspices of the Centers.

To address these prerequisites for establishing a network of research watersheds, interaction among Chinese and American scientists and representatives from other countries is essential. Thus, the general purposes of this paper are to inform the international watershed-research community of these intentions and to solicit worldwide input from scientists who desire to participate in Network development. The IWRN is to be a source of global information for assessing and mitigating physical, chemical, and biological sediment damages, estimated to exceed 16 billion dollars annually in North America alone (Osterkamp et al. 1998). The principal goal, therefore, is to accumulate consistent, validated (quality-assured) watershed data, both actively collected and archived, for use by researchers of the Centers and by the global research community in general.

An International Watershed Research Network: Description and Implementation

Watersheds comprising the initial Network are expected to be up to approximately 1000 km² in size; data collection at each will be conducted using established standards for observations of change, management and compilation of watershed information, and data access. This approach applies to the strategies of observation, the objectives of ongoing research, the instruments used, and the procedures used, such as frequency of observations in time and space. The intent of these standards is to ensure an ability for intercomparison of watershed data and processes worldwide. Prior to establishment of the Network, efforts will be made to: (1) identify and select candidate watersheds for the Network; (2) identify acceptable, and preferably, consistent instrumentation and techniques for the collection, dissemination, and archival of data; and (3) specify other data sources on erosion, sediment transport, hydrology, climate, vegetation, and other information of probable interest to and use through the Centers. In preparation to implement the IWRN, the following activities must be completed:

- establishment of selection criteria for watersheds that are either presently gauged or to be gauged by representatives of the Centers and their designated points of contact
- assessment of the candidate watershed observation and research plan to represent the watershed processes
- determination of standards for the types and quality of instrumentation to be maintained or installed at the various gauged watersheds
- determination of protocols for data assembly, management, and access, and for designations of responsibility
- selection of a small number of charter watersheds to be included in the Network
- identification of reliable, quality-assured data sets that may contain erosion, sediment-transport, hydrologic, and related information useful to Centers researchers, and that may help guide selection of additional watersheds for the Network
- planning for the testing of protocols at selected watersheds and the development of a consistent means for storage and dissemination of watershed data

Among the criteria to be established for the selection of watersheds in the IWRN will be: a satisfactory watershed research and observation plan; a record of the types, uniqueness, length, amount, and quality of data available at a watershed; documentation of the size (area) of the watershed, its climate, the country(s) involved, the availability of logistical support at or near the watershed, and other relevant information such as presently occurring natural and induced surface processes. Priority will be given to paired, or comparative, watersheds in China and the United States that, for example, are similar in all respects except for land-use practices. Regardless of the criteria established, the intent will be to require that data from the watersheds included are comparable and permit consideration of critical research issues, or questions, of watershed management, especially of arid and semiarid regions in or relevant to China and the United States. These questions include but are not limited to identifying what the water and sediment yields of the representative watersheds are under natural conditions and how land-use practices have altered these yields, how different agricultural practices affect water and sediment movement to stream

channels in landscapes of specified characteristics, how rampant erosion in arid/semiarid watersheds can be reduced by re-vegetation after land-use stresses have caused gully initiation, which dryland crops provide the best resistance to erosion under specified conditions of climate, soil, and topography, and which practices of hillslope modification (such as terracing, construction of levees, contour tillage) are most likely to minimize erosion under specified conditions of climate, soil, and topography, thereby leading to landscape rehabilitation.

Although these questions are basic, the solutions are exceedingly complex; all have been addressed by previous studies, but no question has been answered comprehensively. The development of a global data resource – through a watershed research network -- is necessary if the questions are to be answered satisfactorily.

Implementation of an IWRN must incorporate a means to provide information freely to the watershed-research community. Data compiled from the proposed IWRN are intended principally as a resource for the Centers, but also will be available to all natural scientists via an established USGS web site for the Vigil Network (<http://www.paztcn.wr.usgs.gov/vigil/>) (Orr and Osterkamp 1999). The Vigil Network, which was begun and continues to be managed by the USGS (Leopold 1962, Osterkamp and Emmett 1992), is a system of sites and small drainage basins where long-term geomorphic, hydrologic, and biological data are collected periodically, and the information is added as an update to the accumulating data file. Although data collected for the IWRN will vary with local conditions, as has been the case for Vigil Network records, certain standard data types will be collected at all watersheds of the Network and will likely include measures of climate, geology and soils, topography, vegetation, and land use.

Existing Databases

Databases relevant to the Centers' objectives are available from many countries. For example, as of January, 2000, the NWISWEB database of the USGS (Turcios et al. 2000, Osterkamp and Gray 2001, Turcios and Gray 2001) contained about 15,400 sites in the United States and Puerto Rico for which fluvial-sediment data are available. The most useful databases should be identified and information on their characteristics and availability should be

obtained for selecting IWRN watersheds, and to represent a resource for scientists of the Centers.

Research Watersheds and Network Design

Initially the IWRN will be comprised of established watersheds and sites in semiarid, water-deficient areas where relatively long-term, high-quality data have been collected and compiled. Following this criterion alone, the Ansai Research Station, northern China, the Walnut Gulch Experimental Watershed, at Tombstone, Arizona, USA, and the Eshtemoa Experimental Watershed, northern Negev Desert, Israel, are candidates, as are presently unspecified watersheds in Australia, India, and northern Mexico.

The Ansai Research Station (36° 51' 39"N, 109° 19' 23"E) of the Institute of Soil and Water Conservation, Chinese Academy of Science, and the Ministry of Water Resources was established in 1973 and became a member of the Chinese Ecosystem Research Network in 1991. Isohyetal maps of the area, based on long-term data, suggest that mean annual precipitation at the town of Ansai is about 450mm, but shorter-term records collected at the research station indicate that precipitation averages 498 mm (Guobin Liu, Chinese Academy of Sciences, written communication, 2003). The station is in the highly erodable gullied region of the Loess Plateau (mean annual sediment yield about 13,500 t/km²), has an elevation of 1010 to 1431 m, and, before major anthropogenic modification, had temperate forest-steppe vegetation (Guobin Liu, Chinese Academy of Sciences, written communication, 2003).

The Walnut Gulch Experimental Watershed of the U. S. Department of Agriculture, Agricultural Research Service, was established in 1961 as a research site representative of 600,000 km² of semiarid rangeland in the southwestern United States. The watershed (31° 43' N, 110° 41' W) is 149 km² in area, has an elevation ranging from 1250 to 1585 m, and mean annual precipitation (at Tombstone, Arizona, in the west-central part of the watershed) of 324 mm. Vegetation is mostly shrubs and grasses. Instrumentation includes numerous rain gages and 11 runoff flumes; data are collected intensively in 12 sub-basins in which rainfall, runoff, and sediment yield are related to land use through erosion modeling (Renard et al. 1993; Alonso 1997).

The 112-km² Eshtemoa watershed (31° 22' N, 34° 54' E) in the northern Negev Desert, Israel, has been in

operation 10 years. Native vegetation, which has been altered through land use, consists mainly of herbs, thorny shrubs, and, in the upper parts of the watershed, pines. Mean annual precipitation is 280 mm and the main gravel-bed channel drains soils derived principally from limestone, chalk, and loess exposed on the southwest flank of the Hebron Mountains (Reid et al. 1995). Available information includes event-based bed-load data from sub-basins of the catchment.

The process of site and watershed selection, based on agreed protocols for data collection and the implementation of those protocols by representatives of the JOC, will be extended to include a network design. Watershed monitoring involves repeated observation through time at a site or watershed, generally to facilitate the regulation or control of those operations for which the time-series data are collected. In contrast, a network defines areal variability of the measured properties and, therefore, is designed to identify change in both space and time.

Thus, site and watershed selections and the data collected at the watersheds must be compatible with network objectives, permitting a global analysis for each data type compiled. Descriptions of the various global data sets, and analyses of those data sets, relevant to the Centers' interests will be compiled and entered in the USGS-Vigil Network web site, partly to aid in selection of watersheds for the Network, and partly to add resources for the Centers' research. Information about the Sino-U. S. Centers may be found on the Centers' web site <http://www.ispe.arizona.edu/sino>.

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