

## Catalog of United States Contributions to the International Hydrological Decade, 1965-1974 (1975)

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# **CATALOG OF UNITED STATES CONTRIBUTIONS TO THE INTERNATIONAL HYDROLOGICAL DECADE 1965-1974**

**Compiled by  
UNITED STATES NATIONAL COMMITTEE  
for the  
INTERNATIONAL HYDROLOGICAL DECADE**

**NATIONAL ACADEMY OF SCIENCES  
Washington, D. C., 1975**

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The members of the committee selected to undertake this project and prepare this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. Responsibility for the detailed aspects of this report rests with that committee.

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## PREFACE

The U.S. National Committee for the International Hydrological Decade (IHD) was established in the National Academy of Sciences-National Research Council in 1965 at the request of the Department of State. Its purpose was to guide United States participation in the IHD Program (1965-1974).

The IHD, a cooperative international program, involved the efforts of more than 100 nations. Its international activities were coordinated by a Council of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). The purposes of the IHD were to strengthen the scientific basis for water use and conservation, to stimulate education and training, and to improve the ability of developing and developed countries alike to cope with their water problems.

This volume presents summaries of projects, undertaken by federal, state, and local agencies, universities, and private organizations as parts of their regular on-going programs, which were considered to fit the objectives of the IHD program. Some projects were selected by the U.S. National Committee and some were accepted or endorsed after being volunteered by their principal investigators or their institutions. It is not suggested that these were the only projects undertaken in the United States that would fit the Decade program. There no doubt were several hundred others that would have fit equally well. Rather, this is a compilation of projects whose investigators were interested in being associated with an international program or were known to be interested by those associated with the Decade program in the United States. Also, to maintain a reasonably low profile in Decade matters,

the U.S. National Committee felt that only a fair representation of U.S. efforts should be listed.

No attempt was made to find U.S. equivalents of all activities proposed by the IHD Coordinating Council, nor were activities whose subject matter was almost uniquely a U.S. development - such as remote sensing - omitted because there was no UNESCO equivalent. The list is arbitrary, uneven, and not necessarily representative of the full scope of water-related work in the United States.

This catalog is one of a series of reports summarizing the activities of the United States and the U.S. National Committee for the IHD in support of the Decade program. Like its predecessor, Catalog of International Hydrological Decade Stations and Networks in the United States (issued by the National Academy of Sciences - National Research Council in 1972), this catalog may be considered as an appendix to the final report of the U.S. National Committee, which will be issued after the completion of all other Decade reports.

H. Garland Hershey  
Chairman,  
U.S. National Committee for the  
International Hydrological Decade

## ACKNOWLEDGEMENT

The U.S. National Committee for the International Hydrological Decade is grateful for the support and cooperation of the numerous agency and individual contributors to the U.S. program of participation in the Decade. Obviously, agencies are composed of people, and it is really the individual investigators and administrators whom we have to thank. Although they are too numerous to list separately, it is their work, their enthusiasm, and their cooperation that really constitute the sum of U.S. contributions to the scientific advances made within the framework of the Decade program.

The U.S. National Committee particularly appreciates the support provided by the National Science Foundation for its activities and those of its Secretariat.

H. Garland Hershey  
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Catalog of United States Contributions  
to the International Hydrological Decade  
1965 - 1974

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<sup>\*/</sup> IHD Resolution Number. Each IHD activity was established and modified by formal resolutions. The Roman numbers indicate the session during which the resolution was passed; the Arabic numbers list the session resolutions in numerical order. Only resolutions in whose activities the U.S. participated are listed.

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## INTRODUCTION

The International Hydrological Decade (1965-1974) was a cooperative international program coordinated by UNESCO and involving the efforts of more than 100 nations. Its purposes were to strengthen the scientific basis for water use and conservation, to stimulate education and training in hydrology, and to improve the ability of developing and developed countries alike to cope with their water problems.

The U.S. National Committee for the International Hydrological Decade (USNC/IHD) was established in 1965 to guide and advise United States participation in the IHD program.

Each country participating in the Decade was responsible for its own program. The U.S. program included some new, distinctively IHD activities, and many projects selected from the ongoing activities of federal, state, and private agencies. Those projects selected from ongoing activities, together with the distinctly IHD activities, are called the U.S. contributions to the International Hydrological Decade, and their results are presented here in summary form.

The information on each listed activity includes project title, agency, principal investigator, objectives, significant results, and reports available publicly. This information was supplied by the individual agency conducting the activity. As such, the material presented in the reports of the individual activities does not necessarily represent the views of the U.S. National Committee or the National Academy of Sciences - National Research Council.

The activities included in this volume have been arranged in the order in which they were established by UNESCO's IHD Coordinating Council. Each activity has been assigned a compound number consisting of roman and arabic numerals. This number identifies a specific type of activity by the number of the session of the IHD Coordinating Council and the individual resolution of the session that established the activity. (Thus, activity IV.13 was established by the 13th resolution of the Fourth Session of the IHD Coordinating Council.) U.S. contributions to each activity are preceded by an abstract of the relevant resolution, and additional background comments as necessary. Where there are two or more U.S. contributions to a single activity, they are listed alphabetically by the name of the first or only principal investigator.

Some gaps exist in the sequence of these identifying numbers. Such gaps indicate either that a resolution has been replaced by, or combined with, a resolution of a later session, or that the United States had no activities in these areas. Because existing expertise in some activities was concentrated in the United States, there were no international equivalents. Nonetheless, these activities were selected as U.S. contributions because other countries were interested in progress in the activity.

This report, however, does not include full descriptions of all U.S. contributions to the Decade. Although noted summarily in this catalog, reports on two large parts of the US/IHD program are issued separately. These are the activities of the International Field Year

for the Great Lakes and the USNC/IHD Work Groups. Not noted in this catalog is the work of the USNC/IHD Panel on post-Decade Procedures.

The International Field Year for the Great Lakes (IFYGL) is (at least through 1977) a cooperative program between the United States and Canada centering on the physical hydrology of Lake Ontario and its drainage basin. The scope of IFYGL is such that it covers nearly all of the project subjects encompassed by the IHD program. Since the data-collection stage of the project has only recently been completed, most of the reports are still in the process of being prepared. When completed, IFYGL will be covered by a series of reports describing the results of the research done under individual components of the IFYGL program, and an additional report integrating the component reports will be issued jointly by U.S. and Canadian agencies during the period 1975-77. A report summarizing U.S. and Canadian activities of the preparatory and planning phases of IFYGL has been published.<sup>1/</sup> This volume concentrates on activities through 1973 and describes the objectives of the program, its organization, its facilities, and its binational data-management system. The 150-odd individual and component IFYGL activities are presented only briefly in this report.

Twelve US/IHD Work Groups were established by the USNC/IHD in support of the activities of international working groups, or their

<sup>1/</sup>Ludwigson, J. O., 1974, "Two Nations, One Lake - Science in Support of Great Lakes Management," Canadian National Committee for the International Hydrological Decade, Ottawa, Ontario, Canada.

equivalents, and in related areas of interest. US/IHD Work Groups were active in the following fields:

- (1) World Water Balance
- \* (2) Snow and Ice Hydrology
- \* (3) Representative and Experimental Basins
- \* (4) Hydrology of Carbonate Terranes
- (5) Hydrology Network Planning and Design
- (6) Floods and their Computation
- \* (7) Nuclear Techniques in Hydrology
- (8) Hydrological Maps
- (9) Remote Sensing in Hydrology
- \* (10) Education and Training
- (11) Exchange of Information
- (12) International Field Year for the Great Lakes (U.S. program)

Work Groups whose names are preceded by an asterisk (\*), will prepare, or have prepared, separate reports on their activities. All Work Groups are briefly described in this report.

The United States also participated in the activities of the following international Working Groups but did not establish equivalent Work Groups at home:

- (1) Groundwater Studies
- (2) Standardization
- (3) Influence of Man on the Hydrological Cycle (with emphasis on agriculture)

<sup>1/</sup>US/IHD, "United States Participation in the International Hydrological Program 1975-," a report of the Panel on post-Decade Procedures, National Academy of Sciences, Washington, D.C.

#### (4) Urbanization Effects on Hydrology

The work of several ad hoc subcommittees also contributed valuable information and guidance in connection with special problems, particularly those concerned with the implementation of U.S. participation in the post-Decade Program. Except for the report on post-Decade activities <sup>1/</sup> which has already been issued, these and related activities of the U.S. National Committee and the US/IHD Secretariat in support of the IHD program will be described in the final report of the U.S. National Committee. This final report will summarize the accomplishments of the U.S. National Committee and present its recommendations for needed research and institutional adjustments to the growing demand for increased activity by the United States in the field of international water resources research, development, and technical assistance. The final report will be issued in 1975 so that it can include a complete summary of Decade activities through 1974.



Coordinating Council Resolution No. I.1 Basic Data Projects

Resolution No. I.1

The Co-ordinating Council,

Considering the paramount importance of the existence of sufficiently precise and reliable basic data for a knowledge of the water resources of a given country, on the one hand, and of a group of countries and the world as a whole, on the other,

1. Deems it essential that all countries should possess, in addition to the more or less temporary stations necessary for the study of any specific project, a basic network of permanent hydrology stations whose equipment and operation should be of good quality; the existence of such a network would be of outstanding value to each of the countries concerned;
2. Recommends that Unesco, other international organizations, and those countries able to do so should assist countries asking for help in planning, equipping and operating these networks.
3. Recommends that all countries should choose, within their basic networks, a certain number of important or characteristic stations, the data from which would be included in international Decade publications needed for different projects and in this number data needed for the world water balance;
4. Considers it desirable that countries able to do so should establish networks of benchmark basins and stations in accordance with the respective proposals so as to permit subsequent research on the influence of human activity on the hydrological cycle;
5. At the same time, the Council requests that the Secretariat, with the assistance of the ICSU Committee for the International Hydrological Decade, present to the next meeting of the Council more complete proposals concerning hydrological requirements in respect of basic networks covering pluviometry, evaporation, groundwater, chemical quality, temperature of water, and other factors.

<b>TITLE</b>	<b>Water Atlas of the United States</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.1 Basic data projects</b>	<b>US/IHD ref: 1.12 (343)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Water Information Center, Inc. Water Research Building Manhasset Isle, Port Washington, N.Y. 11050</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>J. J. Geraghty</b>	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<b>This volume brings together, in a series of 122 maps of the United States, the basic information available regarding the hydrological phenomena and water resources characteristics of the conterminous states, Alaska, and Hawaii. The conterminous United States are shown at a scale of about 1:15,000,000 (86 plates); Alaska, at about 1:20,000,000 (20 plates); and Hawaii, at about 1:5,000,000 (16 plates).</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Geraghty, J. J., and others, 1973, Water Atlas of the United States (2nd edition), Water Information Center, Port Washington, N. Y., 244 p. (unnumbered).</b>	



TITLE	Catalog of Information on Water Data	
Coordinating Council Resolution in force and short title	I.1 Basic Data Projects	US/IHD ref: 5.1(329)
ORGANIZATION IN CHARGE OF ACTIVITY	Office of Water Data Coordination U.S. Geological Survey National Center, MS 417 Reston, Virginia 22092	
PRINCIPAL INVESTIGATOR	<p>R. H. Langford</p> <p>To develop a catalog of information about water data for streams, lakes, reservoirs, estuaries and ground waters, including information about the site, parameters measured, frequency of measurement, mode of data dissemination, and organization acquiring the data. Catalog serves as a basis for coordination of data-acquisition activities and for design and operation of the National Water Data Network.</p> <p>Procedures and mechanisms established to obtain information on water data acquisition activities from acquiring agencies in United States. Catalog of Information on Water Data established and indexes published (see "Reports Available" for latest edition of indexes).</p> <p>Doyel, W. W., W. F. Curtis, and E. B. Chase, 1968, Catalog of information on water data - Index to areal investigations and miscellaneous activities, Ofc. of Water Data Coordination, U.S. Geol. Survey, 161 p.</p> <p>Office of Water Data Coordination, 1972, Catalog of information on water data - Station listings for part a - streamflow and stage, part b - quality of surface water, and part c - quality of ground water, U.S. Geol. Survey, 21 vols.</p> <p>Pauszek, F. H., 1973, Digest of the 1972 catalog of information on water data, Ofc. of Water Data Coordination, U.S. Geol. Survey, December 1973, 83 p.</p> <p>Rapp, J. R., W. W. Doyel, and E. B. Chase, 1968, Catalog of information on water data - Index to ground water stations, Ofc. of Water Data Coordination, U.S. Geol. Survey, 657 p.</p>	

22 maps available for resources Alaska, and shown at a scale, at about 1:5,000,000

as of the National Center,

<b>TITLE</b>	<b>Network Planning and Design</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.1 Basic Data Projects</b>	<b>US/IHD ref: 5.3 (332)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Network Planning and Design U.S. National Committee for the IHD 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	H. E. Lesesne Tennessee Valley Authority Knoxville, Tennessee 37914	A. O. Waananen U.S. Geological Survey WRD 345 Middlefield Rd. Menlo Park, Calif. 94025
<b>OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. Promote development of theoretical approaches to design of hydrological networks consistent with practical constrictions such as availability of trained manpower, funds, and logistical feasibility.</li> <li>2. Cooperate with Working Groups in specific hydrological fields with advice concerning network design.</li> <li>3. Be prepared to identify advisors and experts on network design to developing countries, on their request for assistance.</li> <li>4. Cooperate with related international Working Groups, as practical.</li> </ol>	
<b>SIGNIFICANT RESULTS</b>	The Work Group assisted with the dissemination of the WMO questionnaire that led to the preparation of the WMO casebook on network design and the information contained in the UNESCO report on groundwater studies.	
<b>REPORTS AVAILABLE PUBLICLY</b>	(See Casebook on Hydrological Network Design Practices, WMO Rept. No. 324, and Section 7.1, Location of Observation wells in Ground-water Studies, UNESCO Studies and Reports in Hydrology no. 7. Also see references to publications under US/IHD Work Group on Representative and Experimental Basins.	

Coordinating Council Resolution No. I.3 Hydrological Benchmark Basins  
and Stations

Resolution No. I.3

The Council,

Recommends that the attention of Member States be drawn to the scientific value of establishing benchmark basins and stations for permanent reference purposes;

Suggests that, where national programmes permit, some basins and stations be selected for this purpose as part of the Decade and future programmes, and that they be established in accordance with standards which make them of international as well as national value;

Recognizes that the selection of such basins and stations will be the responsibility and prerogative of national committees, but has offered some suggested general criteria which should be considered in the selection of these basins and stations;

Invites Member States to establish benchmark basins and stations and to inform the Secretariat of their locations, descriptions and type of information being collected.

<b>TITLE</b>	<b>Hydrological Benchmarks</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.3 Hydrological Benchmark Basins and Stations</b>	<b>US/IHD ref: 2.1 (119)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Denver Federal Center Denver, Colo. 80225	
<b>PRINCIPAL INVESTIGATOR</b>	R. F. Hadley	
<b>OBJECTIVES</b>	To provide long records of hydrologic data on basins unchanged by the works of man and to provide a control for estimating the natural flow from developed basins.	
<b>SIGNIFICANT RESULTS</b>	<p>46 Decade benchmark stations have been installed. A continuous streamflow record is being obtained at each of these established benchmarks, except at one which is on a crater lake.</p> <p>Chemical analyses of 4 or 5 water samples per year are being made at each benchmark. Additional data being collected on some of the basins includes precipitation, air and water temperatures, pan evaporation, wind speed and sediment transport.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>U.S. National Committee for the IHD, 1972, Catalog of International Hydrological Decade Stations and Networks in the United States, National Academy of Sciences - National Research Council, Washington, D.C., 66 p.</p> <p>Leopold, L. B., 1962, A National Network of Hydrologic Bench Marks, U.S. Geological Survey Circular 460-B, 4 p.</p> <p>Langbein, W. B., 1968, Hydrological Bench Marks, WMO/IHD Report No. 8, World Meteorological Organization, Geneva, 8 p.</p> <p>Cobb, E. D. and J. E. Biesecker, 1971, The National Hydrologic Bench-Mark Network, U.S. Geological Survey Circular 460-D, 38 p.</p>	

<b>TITLE</b>	<b>Climatological Benchmark Stations</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.3 Hydrological Benchmark Basins and Stations</b>	<b>US/IHD ref: 2.1 (10)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	J. M. Mitchell, Jr. Environmental Data Service, NOAA Silver Spring, MD 20910	
<b>OBJECTIVES</b>	The primary purpose of the network of Reference Climatological Stations is to construct records that will show climatic trends. These stations are selected on the basis of two general criteria. First, they must have made daily observations of temperature and precipitation for an extended period (generally 50 years or more) in a relatively unchanged environment. Second, they must be located where observations in an environment relatively unaffected by man can be continued for a long period. Among the climatological factors to be measured are solar radiation, soil temperature, soil moisture, humidity, pressure, evaporation, wind, radioactive fall-out, and air pollution.	
<b>SIGNIFICANT RESULTS</b>	To date, a network of 17 stations has been established.	
<b>REPORTS AVAILABLE PUBLICLY</b>	U.S. National Committee for the IHD, 1972, Catalog of International Hydrological Decade Stations and Networks in the United States, National Academy of Sciences - National Research Council, Washington, D.C., 66 pp.	

<b>TITLE</b>	<b>IHD Evaporation Network (U.S. Stations)</b>	
<b>Coordinating Council Resolution in force and short title</b>	I.3 Decade Stations VII.2 Water Balances	<b>US/IHD ref:</b> 1.3 (46)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Springs, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	E. L. Peck Hydrologic Research Laboratory	
<b>OBJECTIVES</b>	To establish a network of the minimum number of stations required to represent adequately the evaporation regimes of the United States.	
<b>SIGNIFICANT RESULTS</b>	<p>Forty of the existing 500 Class-A Pan-evaporation Stations have been selected to form the U. S. Decade Network of Evaporation Stations. Of these, two are in Alaska, three in Hawaii, one in Puerto Rico, one on Johnson Island in the Pacific Ocean; the other 33 stations are distributed throughout the conterminous United States.</p> <p>The IHD Evaporation Network is made up of the minimum number of stations required to represent adequately the evaporation regimes of the United States. Sites are chosen to illustrate variations across the U. S. of 1.) annual evaporation; 2.) physiographical, hydrological, climatological, and soil characteristics, and 3.) length and continuity of record.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Basic precipitation, pan-evaporation, and climatological data is compiled and published on a monthly and annual basis in chronological data, and hourly precipitation data, by the NOAA-National Weather Service. These compilations are available from the NOAA-National Climatic Center, Asheville, North Carolina.</p> <p>U.S. National Committee for the IHD, 1972, Catalog of International Hydrological Decade Stations and Networks in the United States, National Academy of Sciences - National Resource Council, Washington, D.C., 66 p.</p>	

Coordinating Council Resolution No. I.9 Hydrogeological Map  
of the Arid Zones

V.3.1. The problem and expected results

On the proposal of the International Association of Hydrogeologists (IAH), of the International Union of Geological Sciences (IUGS), it is intended to establish a synthesis, at the international level, of present knowledge concerning groundwater in the arid zones. For this purpose it is proposed to draw up small scale hydrogeological maps of arid zones. Each map would be accompanied by an explanatory note and annexed cartographical documents. The latter, arranged by major regions (on a scale of 1/2,000,000 for instance), would chart the basic features of groundwater tables from the standpoint of scientific knowledge and exploitation possibilities.

Resolution No. I.9

The Council,

Recommends that a hydrogeological map of the arid zones be drawn up, providing a simplified representation of the basic features of groundwater tables from the standpoint of scientific knowledge and exploitation possibilities;

Suggests that all surface hydrological data worth recording at the scale selected should also be given; these data might possibly be combined with those relating to various mineral resources, which the IUGS proposes to prepare;

Recommends that the IUGS and the Secretariat co-ordinate their activities to this end.

<b>TITLE</b>	<b>Deserts of the World: An Appraisal of Research into Their Physical and Biological Environments</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.9 Hydrogeological Map of the Arid Zones</b>	<b>US/IHD ref: 2.3(158)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Office of the Arid Lands Studies 1242 East Speedway University of Arizona Tucson, Arizona 85719</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>W. G. McGinnies</b>	
<b>OBJECTIVES</b>	<b>To determine in detail what topics have been or are being investigated for the world's deserts, to appraise the reported work, and to disclose areas of study where further work is needed.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Rather than recapitulate all information known about the deserts of the world, the results comprise a compendium-guidebook to past and present research based upon critical review of published literature augmented by consultations with specialists and a series of reports concentrating on individual desert terranes and the specific problems of food and fiber production in arid lands.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Paylore, Patricia, 1967, Arid Lands Research Institutions: A world directory, University of Arizona Press, Tucson, 268 p.</b></p> <p><b>McGinnies, W. G., B. J. Goldman, and Patricia Paylore (Editors), 1968, Deserts of the world - An appraisal of research into their physical and biological environments, University of Arizona Press, Tucson, 788 p.</b></p> <p><b>McGinnies, W. G., and B. J. Goldman (Editors), 1969, Arid Lands in Perspective, University of Arizona Press, Tucson, 421 p.</b></p> <p><b>McGinnies, W. G., B. J. Goldman, and Patricia Paylore (Editors), 1971, Food, Fiber, and the Arid Lands, University of Arizona Press, Tucson, 437 p.</b></p> <p><b>Amiran, D. H. K., and A. H. Wilson (Editors), 1973, Coastal Deserts: Their Natural and Human Environments, University of Arizona Press, Tucson, 207 p.</b></p> <p><b>Smiley, T. L., and J. H. Zumberge (Editors), 1974, Polar Deserts and Modern Man, University of Arizona Press, Tucson, 173 p.</b></p>	



<b>TITLE</b>	Groundwater in Australia	
<b>Coordinating Council Resolution in force and short title</b>	I.9 Hydrological Maps of Arid Zones III.15 Regional Cooperation VII.3 Groundwater Studies	US/IHD ref: 2.3(174)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Army Natic Laboratories Natic, Massachusetts 01760	
<b>PRINCIPAL INVESTIGATOR</b>	E. S. Simpson Office of Arid Lands Studies University of Arizona Tucson, Arizona 85721	
<b>OBJECTIVES</b>	To provide information on the status of groundwater investigations in Australia.	
<b>SIGNIFICANT RESULTS</b>	<p>Essentially all exploitable ground water of the Australian arid zone is contained in the pore spaces of relatively flat-lying sandstones and limestones, which occur within the major sedimentary basins and cover about half of the arid-zone land surface. In each basin the aggregate thickness of the porous rocks is hundreds to thousands of feet, and they are inter-layered with various rocks not bearing water, thus producing artesian or semiartesian conditions in many places. Although the quantity of stored water is immense, most of it accumulated during the past tens to hundreds of thousands of years; at least half of it is too mineralized for use in irrigation. The annual recharge from rainfall, though unknown in amount, is undoubtedly only a very small fraction of the amount in storage, and perhaps even less than the annual amount currently pumped from wells.</p> <p>Outside the sedimentary basins, small to moderate supplies of ground water may be obtained from fissures in the older crystalline rocks, or from relatively thin surficial deposits of unconsolidated sand, if the local water table is not deeper than the depth of fissures or the bottom of the sand.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Simpson, E. S., 1969, Contributions on the Status of Aridlands Research: Groundwater in Australia, Technical Report 70-5-ES, U.S. Army Natic Laboratories, 22 p.	

Coordinating Council Resolution Nos. I.12, I.13, I.14  
Snow and Ice Hydrology

V.6 WORLD INVENTORY OF PERENNIAL AND ANNUAL ICE AND SNOW MASSES

1. Problem and expected results

Snow and ice masses constitute a tremendous amount of stored water. In effect, about 80 percent of all the water on the land areas of the world exists as ice and snow. Some of this circulates rapidly in the hydrologic cycle (mean residence time in the solid phase measured in hours, days, or months); some circulates so slowly that it may be considered "permanently" stored (mean residence times of the order to  $10^3$  to  $10^6$  years). All snow and ice, however, has an effect on the global environment. Much has been learned during and since the IGY about the volume of the two major ice caps (Antarctica and Greenland) but knowledge of the time and space variations in volume of ephemeral snow cover, ice on and in water, ground ice (permafrost), and mountain glaciers is most unsatisfactory. The regimes of alpine glaciers, for example, have a great deal to do with the downstream supply of fresh water.

Resolution No. I.12 World Inventory of Perennial and Annual  
Ice and Snow Masses

The Council,

Considers the world inventory of perennial and annual ice and snow masses as a long-term objective of the Decade;

Recommends that the scope of this activity be limited in the first years to the mapping of permanent snow and ice;

Urges interested Member States to compile and assemble for publication, data on all significant areas of permanent snow, glaciers, ice caps, shelf ice, etc., in order to obtain the elements to establish the regional distribution of permanent snow and ice in their territories and the degree of accuracy in each area;

Invites the IASH (through its ICSI) to act as scientific adviser in this activity; ICSI would prepare a list of observations to be made for this inventory which the Secretariat would distribute among interested Member States;

Urges participating Member States to provide available data to ICSI for the preparation of a preliminary global survey;

Encourages Member States to continue the mapping of permanent snow and ice areas and to keep the Secretariat and IASH informed.

## V.7 MEASUREMENTS OF GLACIER VARIATIONS ON A WORLD-WIDE BASIS

### 1. Problem and expected results

Glaciers may be the most sensitive climatic indicators in nature, both of current climate and of secular changes. However, quantitative climatic data cannot be obtained directly from glaciers because of complicating local influences such as micro-climatic effects and dynamic response characteristics. Some difficulties can be circumvented by obtaining a large statistical sampling. Although glacier variations have been observed for more than four centuries, no quantitative theory linking glacier variations to climatic change emerged until 1963. Measurements of glacier variations have new meaning because of this. In recognition of the importance of measurements, the International Commission of Snow and Ice (ICSI) of IASH has progressed from simple photographic records of glacier termini to detailed photogrammetric volume-change measurements and net-budget studies.

#### Resolution No. I.13 Measurements of Glacier Variations on a World Basis

The Council,

Having considered proposals for measurements of glacier variations on a world-wide basis,

Encourages all interested Member States to participate actively in this project and to provide available data to the Secretariat;

Suggests that the Technical Secretariat for this activity be supplied by the ICSI of IASH which has been carrying out the pilot study on recent fluctuations of glaciers;

Urges Unesco to continue to assist the ICSI of IASH in the implementation of this activity;

Recommends as a guide to National Committees for the organization of their national programmes of measurements, the checklist of glacier variations, observations and measurements prepared by the ICSI of IASH;

Directs the Secretariat to maintain close contact with IASH, SCAR and other international organizations and groups engaged in snow and ice observations and studies.

V.8 COMBINED WATER-, ICE-, AND HEAT-BALANCE MEASUREMENTS AT SELECTED REPRESENTATIVE GLACIER BASINS (N-S, E-W Chain of Glacier Stations)

1. Problem and expected results

The Council considers that full understanding of the relations between glaciers and climate cannot be achieved until co-ordinated data are available on heat-, water-, and ice-budgets for representative glaciers and their drainage basins, extending over a period of years. These data will have to be combined with flow dynamics and glacier variation data in order to complete the picture, but the latter data are easier to obtain and the problem with them, is, therefore, less pressing. Budget data are needed from glaciers in widely different geographic areas.

2. Work to be undertaken

2.1 A north-south chain of stations might extend from Arctic America to the Antarctic Peninsula, a west-east chain could extend from the Pyrenees through Europe and Asia to the Pacific. A minimum number of stations should be established where mass-budgets and meteorological, climatological and hydrological measurements would be made at least yearly.

Resolution No. I.14 Combined Water, Ice and Heat Balance Measurements at Selected Representative Glacier Basins

The Council,

Having considered the proposal for combined water-, ice-, and heat-balance measurements at selected representative glacier basins along a north-south and east-west chain of glacier stations,

Encourages all Member States whose territory is located in the proposed chains to participate actively in this research,

Invites the International Commission of Snow and Ice of the International Association of Scientific Hydrology to prepare, in consultation with the Secretariat, the international programme of co-operation in this activity,

Encourages Member States in which this type of investigation is highly developed to join with other countries in order to obtain glacial-meteorological observations and co-operate in measurements by providing some personnel, instruments, and possibly financial support.

<b>TITLE</b>	<b>Snow and Ice Hydrology - Current Status and Future Directions</b>	
<b>Coordinating Council Resolution in force and short title</b>	I.12, I.13, and I.14 Snow and Ice Studies	<b>US/IHD ref:</b> 1.7(315)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Snow and Ice National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	Andrew Assur, Chairman	
<b>OBJECTIVES</b>	Within the field of snow and ice hydrology the Work Group's objectives were 1) identification of research needs and accomplishments, 2) improvement of the fragmented communications within the field, 3) elimination, wherever possible, of the duplication of effort and 4) translation of research results into applications and management techniques.	
<b>SIGNIFICANT RESULTS</b>	The Work Group promoted regional cooperation on snow and ice hydrology and coordinated with Canada the scheduling of a series of workshops and symposia on the topic sponsored by both the U.S. and Canada. The two U.S. sponsored symposia resulted in publications dealing with the state-of-the art as listed below. The Work Group also promoted many other U.S. projects as contributions to the IHD including a glacier survey and the establishment of U.S. glacier monitoring stations in the world network. An analysis was made of the status of snow and ice hydrology and recommendations were made for improvement in the U.S. snow and ice research and data collection efforts.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Meiman, J. R., Ed., 1969, Proceedings of the Workshop on Snow and Ice Hydrology, duplicated report, College of Forestry and Natural Resources, Colorado State University, Fort Collins, 142 p.</p> <p>Santeford, H. S. and J. L. Smith, Ed., 1974, Advanced Concepts and Techniques in the Study of Snow and Ice Resources-an Interdisciplinary Symposium, National Academy of Sciences, Washington, D.C., 789 p.</p> <p>Work Group on Snow and Ice Hydrology of the U.S. National Committee for the IHD, 1975, Snow and Ice Hydrology-Current Status and Future Directions, National Academy of Sciences, Washington, D.C. (in preparation).</p>	

TITLE	Snow Management - Watersheds in Transition - A Symposium	
Coordinating Council Resolution in force and short title	Related to: I.12, I.13, and I.14 Snow and Ice Studies	US/IHD ref: 1.7(276)
ORGANIZATION IN CHARGE OF ACTIVITY	US/IHD Work Group on Snow and Ice National Academy of Sciences 2101 Constitution Avenue N.W. Washington, D.C. 20418	
PRINCIPAL INVESTIGATOR	Andrew Assur, Chairman	
OBJECTIVES AND SIGNIFICANT RESULTS	<p>A symposium entitled Watersheds in transition was organized by the American Water Resources Association to examine the effect of "changes" on the hydrological response of watersheds. One session of the Symposium was organized by the US/IHD Work Group on Snow and Ice and centered on the effects of snow management. The papers included:</p> <p style="padding-left: 40px;">Development of Management for Increasing Snowpack Water Yields from Ponderosa Pine Forests in Arizona.</p> <p style="padding-left: 40px;">Snowpack Management Potential in Alaska.</p> <p style="padding-left: 40px;">Simulating Effects of Harvest Cutting on Snowmelt in Colorado Subalpine Forests.</p> <p style="padding-left: 40px;">Snowmelt Peak Flows and Antecedent Precipitation and Melt in the Northern Rocky Mountains.</p> <p style="padding-left: 40px;">Vegetation Management to Control Snow Accumulation and Melt in the Northern Rocky Mountains.</p> <p style="padding-left: 40px;">Status of Cloud Seeding.</p> <p style="padding-left: 40px;">Snow Management seems unlikely in the Northeast.</p>	
REPORTS AVAILABLE PUBLICLY	Csallany, S.C., T. G. McLaughlin, and W. D. Stiffler, Compilers, 1972, Watersheds in Transition, Proceedings of a Symposium held at Fort Collins, Colorado, June 19-22, 1972, American Water Resources Association, 405 p.	

<b>TITLE</b>	<b>Prediction of Winter Surface Conditions in Cold Regions Using Meteorological Parameters</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.12 Inventory of Perennial and Annual Ice and Snow Masses</b>	<b>US/IHD ref: 2.6(162)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Army Cold Regions Research and Engineering Laboratory Hanover, New Hampshire 03755</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>M. A. Bilello and R. E. Bates</b>	
<b>OBJECTIVES</b>	<b>To develop methods to predict ice formation and growth and to estimate the properties of a snow cover.</b>	
<b>SIGNIFICANT RESULTS</b>	<p><b>In cooperation with the National Weather Service, NOAA, the Atmospheric Environment Service, Canada; and the Air Weather Service, U.S. Air Force, a network of snow cover property and ice thickness observing stations throughout Canada and part of the northern United States, including Alaska, have been established.</b></p> <p><b>USA/CRREL provides the form and measurement equipment and maintains a quality control on the weekly and/or bi-monthly receipt of measurements on snow cover density, hardness, and temperature and on river, lake, and sea ice conditions and thicknesses.</b></p> <p><b>The regional and seasonal variations in snow and ice conditions are then associated with concurrent local weather observations. The relationships found are subsequently used to develop methods to predict ice formation and growth and to estimate the properties of a snow cover.</b></p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Bilello, M. A., 1964, Ice prediction curves for lake and river locations in Canada, US Army CRREL Research Report 129.</b></p> <p><b>Bilello, M. A., 1966, Survey of Arctic and Subarctic temperature inversions, US Army CRREL Technical Report 161.</b></p> <p><b>Bilello, M. A., 1967, Water temperatures in a shallow lake during ice formation, growth and decay, US Army CRREL Research Report 213.</b></p> <p><b>Bilello, M. A., 1969, Surface measurements of snow and ice for correlation with aircraft and satellite observations, US Army CRREL Special Report 127.</b></p> <p><b>Bilello, M. A. and R. E. Bates, 1972, Ice thickness observations, North American Arctic and Subarctic, 1968-1969 and 1969-70, US Army CRREL Special Report 43, Part VI.</b></p>	

TITLE	Measurement of Snowfall and Snowpack Characteristics	
Coordinating Council Resolution in force and short title	I.12 Perennial and Seasonal Snow and Ice Masses IV.8 Measurement of precipitation, including Snow and Snowpack	US/IHD ref: 1.7(323)
ORGANIZATION IN CHARGE OF ACTIVITY	U.S. Geological Survey Water Resources Division Tacoma, Washington 98402	
PRINCIPAL INVESTIGATOR	Mark F. Meier	
OBJECTIVES	Existing methods of measuring snowfall and snowpacks are notably inaccurate, expensive, and/or dangerous. No operational methods exist for measurement of snow-covered area or for obtaining synoptic data on water equivalent, snowpack thickness, or snow wetness. Geological Survey research is directed towards improvement in point measurements and development of remote sensing systems.	
SIGNIFICANT RESULTS	Methods were developed for measuring snow wetness, mass, and movement of liquid water using electromagnetic and conventional techniques. Micro-wave emission from snow was measured on ground and from aircraft at 7 frequencies, and results compared with theory. Volume scattering was shown to have a strong effect on microwave emission. Snow mapping by use of ERTS imagery was shown to be feasible; snow-covered area measurements were made for basins as small as 6 km <sup>2</sup> . Snow-covered area in specific drainage basins or equivalent snowline altitudes were measured rapidly from ERTS images with an electronic image analysis console.	
REPORTS AVAILABLE PUBLICLY	<p>Edgerton, A. T., A. Stogryn, and G. Poe, 1971, Microwave radiometric investigations of Snowpacks: Aerojet-Gen. Corp. Microwave Div., Final Rep. 1285R-4, Cont. 14-08-001-11828, 82 p.</p> <p>Linlor, W. I., 1972, Snowpack water content by remote sensing: Proc. Internat. Symposia on the Role of Snow and Ice in Hydrology, Banff, UNESCO.</p> <p>Linlor, W. I., Remote Sensing and snowpack management: Proc. Amer. Water Works Association, 1973 Ann. Mtg., May 1973. <u>In press.</u></p> <p>Linlor, W. I., and J. L. Smith, 1973, Electronic measurements of snow sample wetness: Proc. Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, USNC/IHD, National Academy of Sciences.</p> <p>Linlor, W. I., M. F. Meier, and J. L. Smith, 1973, Microwave profiling of snowpack free-water content: Proc. Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, USNC/IHD, National Academy of Sciences.</p>	



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Meier, M. F., 1970, Present status of snow and ice in hydrology: Proc. Workshop on Snow and Ice Hydrology, Ft. Collins, Colo., 1969, J. R. Meiman (ed.), p. 1-10.

Meier, M. F., 1970, Research on snow and ice hydrology in the Water Resources Division, U.S. Geological Survey: Proc. Workshop on Snow and Ice Hydrology, Ft. Collins, Colo., 1969, J. R. Meiman (ed.), p. 124-125.

Meier, M. F., 1969, Evaluation of South Cascade Glacier test site results: NASA Earth Resources Aircraft Program Status Review 1968, v. 3, Hydrology, Oceanography, and Sensor Studies, Sec. 20, 17 p.

Meier, M. F., 1970, Glaciers and snowpacks: some common problems in nonpolar glaciology: in The Progress of Hydrology, v. 2, Specialized hydrologic subjects, p. 729-736, Proc. First Internat. Seminar for Hydrology Professors, Urbana, 1969, Univ. Illinois.

Meier, M. F., and A. T. Edgerton, 1971, Emission characteristics of snow and ice in the microwave range: NASA Third Ann. Earth Resources Pr. Rev., v. 3, Hydrology and Oceanography, Sec. 51, 14 p.

Meier, M. F., and A. T. Edgerton, 1971, Microwave emission from snow - a progress report: Proc. Seventh Internat. Symposium on Remote Sensing of Environment, 1971, Ann Arbor, p. 1155-1163.

Meier, M. F., 1972, Measurement of snow cover using passive microwave radiation: Proc. Internat. Symposia on the Role of Snow and Ice in Hydrology, Banff, UNESCO.

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Meier, M. F., 1973, Evaluation of ERTS imagery for mapping and detection of changes of snowcover on land and on glaciers: NASA Symposium on Significant Results Obtained from ERTS-1, v. 1, Tech. Presentations Sec. A, Paper W-19, p. 863-875.

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Schmugge, T., T. T. Wilheit, P. Gloersen, M. F. Meier, D. Frank, and I. Dirmhirn, Microwave signatures of snow and fresh water ice: Proc. Symposium on Advanced Concepts in the Study of Snow and Ice Resources, USNC/IHD, National Academy of Sciences.

<b>TITLE</b>	<b>Workshop on Snow and Ice Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.12, I.13, and I.14 Snow and Ice Studies</b>	<b>US/IHD ref: 3.1 (185)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. National Committee for the IHD National Academy of Sciences 2101 Constitution Avenue N.W. Washington, D.C. 20418</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>James R. Meiman, Colorado State University, Ft. Collins, CO</b>	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<p>To improve communications among those from various professional backgrounds and geographical regions having a common interest in snow and ice. During the workshop, a state of the art of snow and ice hydrology was explored and an attempt was made to identify and define some of the major problems and possible solutions. Major workshop sessions were devoted to: (1) distribution and measurement of the snow cover; (2) physics of metamorphism and melt; (3) snow and ice management of water yields; (4) standardization of snow observations; (5) measurement of snowfall and its redistribution; and (6) research cooperation and improvement of communications among those working in the field of snow and ice.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Meiman, J.R., (ed.), 1969, Proceedings of the Workshop on Snow and Ice Hydrology, held at Colorado State University, Fort Collins, Colorado, Aug. 18-22.</p>	

<b>TITLE</b>	<b>Alaskan Glaciers</b>	
<b>Coordinating Council Resolution in force and short title</b>	I.12 Inventory of Perennial and Annual Snow and Ice Masses	<b>US/IHD ref:</b> 1.7(325)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Water Resources Division Tacoma, Washington 98402	
<b>PRINCIPAL INVESTIGATOR</b>	Austin Post	
<b>objectives</b>	To determine the number, location, and characteristics of normal, surging, and tidal glaciers, and glacier dammed lakes in Alaska.	
<b>SIGNIFICANT RESULTS</b>	Data have been obtained on about 1,000 glaciers in Alaska. New maps showing the extent of glaciers have been prepared. These indicate that the total area of glacier ice, about 73,800 km <sup>2</sup> , is about 40% more than previous estimates. A special study was made of dangerous situations caused by glaciers, including an inventory of 750 glacier dammed lakes. More than 200 surging glaciers in Alaska and adjacent Canada were located, their unusual distribution noted, and features described. A classification of surging glaciers was also attempted. Data collection continues with a definitive inventory of surging glaciers of this area planned. The asynchronous behavior of Alaska's 30 tidal glaciers is being investigated and a new hypothesis has been devised to account for their peculiar behavior. Preparing an inventory of the world's larger surging glaciers by means of ERTS imagery is shown to be feasible.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Krimmel, R. M., and M. F. Meier, 1974, Glacier applications of ERTS images: paper accepted for Symposium on Remote Sensing in Glaciology, Cambridge, England.</p> <p>Meier, M. F., and Austin Post, 1969: What are glacier surges?: Canadian Jour. Earth Sciences, 6:4, p. 807-817.</p> <p>Post, Austin, 1969, Distribution of surging glaciers in western North America: Jour. Glaciology, 8:53, p. 229-240.</p> <p>Post, Austin, and L. R. Mayo, 1971, Glacier dammed lakes and outburst floods in Alaska: U.S. Geol. Survey. Hyd. Atlas 455, 3 sheets, 10 p.</p> <p>Post, Austin, 1972, Periodic surge origin of folded medial moraines on Bering piedmont glacier, Alaska: Jour. Glaciology, 11:62, p. 219-226.</p> <p>Post, Austin, and George Plafker, Nonsynchronous Neoglacial advances and retreats of the Hubbard, Guyot, and Malaspina Glaciers, Alaska: U.S. Geol. Survey Prof. Paper. <u>In preparation.</u></p>	

<b>TITLE</b>	<b>Glacier Inventory in Conterminous U.S.</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.12 Inventory of Perennial and Annual Snow and Ice Masses</b>	<b>US/IHD ref: 1.7(326)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Geological Survey Water Resources Division Tacoma Washington 98402</b>	<b>San Jose State College San Jose, California 95192</b>
<b>PRINCIPAL INVESTIGATOR</b>	<b>Austin Post William H. Raub</b>	
<b>OBJECTIVES</b>	<b>To measure the area, volume, and characteristics of glaciers and their contribution to the world water balance.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>An inventory of 756 glaciers covering 267 km<sup>2</sup> in the North Cascades, Washington, about one-half of the glacier area of the U.S. south of Alaska, was published in 1971. A similar inventory of an estimated 500 glaciers of the Sierra Nevada, California, most of which are very small, is nearing completion. Glacier locations, sizes, areas, volumes, and characteristics are compiled. The glacier outlines shown on new topographic maps is being checked and revised where necessary to assure that the glacier information shown conforms to internationally adopted standards. This will greatly aid in compiling future inventories of glaciers in Oregon, Montana, and Wyoming.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Krimmel, R. M., 1970, Gravimetric ice thickness determination, South Cascade Glacier, Washington: Northwest Science, v. 44, no. 3, p. 147-153.</b></p> <p><b>Post, Austin, Don Richardson, W. V. Tangborn, and F. L. Rosselot, 1971, Inventory of glaciers in the North Cascades, Washington; U.S. Geol. Survey Prof. Paper 705-A, 26 p.</b></p> <p><b>Raub, William, and Austin Post, Inventory of glaciers and perennial ice masses of the Sierra Nevada, California: U.S. Geol. Survey Prof. Paper 705-B. <u>in preparation.</u></b></p>	

<b>TITLE</b>	<b>Advanced Concepts and Techniques in the Study of Snow and Ice Resources - An Interdisciplinary Symposium</b>	
<b>Coordinating Council Resolution in force and short title</b>	I.12, I.13, and I.14 Snow and Ice Studies	<b>US/IHD ref:</b> 1.7(314)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Snow and Ice National Academy of Sciences 2101 Constitution Avenue N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	H. S. Santeford and J. L. Smith	
<b>OBJECTIVES</b>	<p>To explore the possible impact of new technology on the study and management of snow and ice resources, especially in the area of measurement, data accumulation, and information dissemination.</p> <p>To explore the application of those techniques that may benefit the study and management of snow and ice resources.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>An interdisciplinary symposium was held at Monterey, California on December 2-6, 1973. The program contained 76 papers on the following topics: Snow - Information Needs and Distinguishing Characteristics, Snow and Ice - Distinguishing Characteristics, Information Systems, Radar Techniques, Remote Sensing Techniques, Nuclear Techniques, and Miscellaneous Techniques.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Santeford, H.S. and J. L. Smith, Compilers, 1974, Advanced Concepts and Techniques in the Study of Snow and Ice Resources, National Academy of Sciences, Washington, D.C., 900 p.</p>	

<b>TITLE</b>	<b>Compilation of Data on Variations of U.S. Glaciers</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.13 Measurement of Glacier Variation on a World Basis</b>	<b>US/IHD ref: 1.7(324)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>American Geographical Society and U.S. Geological Survey New York, New York                      Tacoma, Washington (MFM)</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>W. O. Field, Jr. and M. F. Meier</b>	
<b>OBJECTIVES</b>	<b>To assemble data on variations in length, thickness, mass balance, and hydrometeorological data for as many U.S. glaciers as possible for years 1965-70.</b>	
<b>SIGNIFICANT RESULTS</b>	<p><b>Data for this period were assembled on American glaciers as follows:</b></p> <ol style="list-style-type: none"> <li><b>1. Changes in length: 135 glaciers (112 in Alaska)</b></li> <li><b>2. Changes in thickness: 7 glaciers (2 in Alaska)</b></li> <li><b>3. Mass balance: 10 glaciers (4 in Alaska)</b></li> <li><b>4. Hydrometeorological data: 5 glaciers</b></li> </ol>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Kasser, Peter, 1967, Fluctuations of glaciers 1965-70, IAHS (ICSJ)-UNESCO, Paris, 52 p., 23 tables, 7 figs., 1 map. [U.S. data on tables 2.1, 2.2, 9.1.3, 9.2.4, 9.2.5, 9.3.1 and 9.5.1]</b>	

TITLE	Glacier Variations in Washington State	
Coordinating Council Resolution in force and short title	I.13 Measurements of Glacier Variations on a World Basis	US/IHD ref: 1.7(327)
ORGANIZATION IN CHARGE OF ACTIVITY	U.S. Geological Survey Water Resources Division Tacoma, Washington 98402	
PRINCIPAL INVESTIGATOR	Austin Post M. F. Meier S. M. Hodge F. M. Veatch R. S. Sigafos E. L. Hendricks Arthur Johnson	
OBJECTIVES	Measure or map terminus positions or variations, changes in thickness, and rate of flow of selected glaciers in Washington State.	
SIGNIFICANT RESULTS	A large number of related investigations on the glaciers of Mount Rainier have been undertaken including measurement of late Neoglacial changes of a selection of the larger glaciers using dendrochronology, use of a 24-year photographic record of Nisqually Glacier to derive variation data, ground surveys to measure changes coupled with a detailed analysis of the flow of Nisqually Glacier, use of annual aerial photography to measure variations in terminus position of the major glaciers, study of outburst floods, and revision of glacier information on topographic maps. Other studies of glacier variations have been conducted on Mount Baker, Mount Adams, the Olympic Mountains, and the North Cascades.	
REPORTS AVAILABLE PUBLICLY	<p>Hodge, S. M., Variations in the sliding of a temperate glacier: Jour. Glaciology. <u>In press.</u></p> <p>Hodge, S. M., 1972, The movement and basal sliding of the Nisqually Glacier, Mount Rainier: Univ. Washington Dept. Atmospheric Sci., Sci. Rep., 409 p.</p> <p>Johnson, Arthur, Nisqually Glacier 1857-1970. <u>In preparation.</u></p> <p>Meier, M. F., 1966, Some glaciological interpretations of re-mapping programs on South Cascade, Nisqually, and Klawatti Glaciers, Washington: Canadian Jour. Earth Sciences, 3:6, p. 811-818.</p> <p>Meier, M. F., Barclay Kamb, C. R. Allen, and R. P. Sharp, Flow of Blue Glacier, Olympic Mountains, Washington: Jour. Glaciology. <u>In press.</u></p> <p>Meier, M. F., 1968, Calculations of slip of Nisqually Glacier on its bed: no simple relation of sliding velocity to shear stress: Internat. Assoc. Sci. Hyd., Bern Gen. Assembly, 1967, Pub. 79, p. 49-57.</p> <p>Post, Austin, Variations of glaciers in the North Cascades, Washington. <u>In preparation.</u></p>	



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Richardson, Donald, 1968, Glacier outburst floods in the Pacific Northwest: U.S. Geol. Survey Prof. Paper 600-D, p. D79-D86.

Richardson, D., 1973, Effect of snow and ice on runoff at Mount Rainier, Washington: Proc. Internat. Symposia on the Role of Snow and Ice in Hydrology, Banff 1972, UNESCO.

Sigafoos, R. S., and E. L. Hendricks, 1972, Recent activity of glaciers of Mount Rainier, Washington: U.S. Geol. Survey Prof. Paper 387-B, 24 p.

Veatch, F. M., 1969, Analysis of a 24-year photographic record of Nisqually Glacier, Mount Rainier National Park: U.S. Geol. Survey Prof. Paper 631, 52 p.

<b>TITLE</b>	<b>Analysis of a 24-year Photographic Record of Nisqually Glacier, Mt. Rainier National Park, Washington</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.13 Measurements of Glacier Variations</b>	<b>US/IHD ref: 1.7 (188)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Geological Survey Water Resources Division 1305 Tacoma Avenue South Tacoma, WA 98402</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>F. M. Veatch</b>	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<b>To describe and demonstrate by means of examples what kind of data usable in analyzing glacier characteristics can be obtained from a simple program of long-term photographic coverage from stations on the ground.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Veatch, F. M., 1969, Analysis of a 24-year photographic record of Nisqually Glacier, Mt. Rainier National Park, Washington: U.S. Geol. Survey Prof. Paper 631.</b>	

<b>TITLE</b>	<b>Snowmelt Investigations</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.14 Combined water, ice and heat balance measurements at selected representative glacier basins</b>	<b>US/IHD ref: 2.3 (278)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	Eric A. Anderson Hydrologic Research Laboratory	
<b>OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To develop techniques to estimate the energy exchange across the snow-air interface. The techniques must be applicable for use in estimating areal energy-exchange.</li> <li>2. To develop a conceptual model of the snow accumulation and ablation process over an area for use in river forecasting.</li> </ol>	
<b>SIGNIFICANT RESULTS</b>	<ol style="list-style-type: none"> <li>1. A technique for estimating point energy exchange across the snow-air interface was developed. This technique is based on the combination method (combination of aerodynamic and energy balance equations).</li> <li>2. The combination method technique for snow cover energy exchange was modified for use over an area. The resulting model was applied to two research watersheds with reasonable success.</li> <li>3. Because of the lack of radiation data for most watersheds, a model of the snow accumulation and ablation process was developed which uses air temperature as the only index to energy exchange across the snow-air interface. This model has been applied to 10 watersheds with good success.</li> </ol>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Anderson, E. A., 1968, Development and Testing of Snow Pack Energy Balance Equations, Water Resources Research; 4:1, 19-37.</p> <p>Anderson, E. A., 1973, National Weather Service River Forecast System - Snow Accumulation and Ablation Model, NOAA Technical Memorandum NWS HYDRO-17, U.S. Dept. of Commerce, Silver Spring, MD.</p>	

TITLE	Combined Heat, Ice, and Water Balances at Representative Glacier Basins	
Coordinating Council Resolution in force and short title	I.14 Combined water, ice, and heat balance measurements at selected representative glacier basins	US/IHD ref: 1.7(69)
ORGANIZATION IN CHARGE OF ACTIVITY	U.S. Geological Survey Water Resources Division Tacoma, Washington 98402 Fairbanks, Alaska 99701	
PRINCIPAL INVESTIGATOR	M. F. Meier, W. V. Tangborn, R. M. Krimmel, L. R. Mayo	
OBJECTIVES	To obtain a broad understanding of snow and ice accumulation, melt, and runoff in many different climatic regimes, and the relation of these processes to meteorologic elements at all scales.	
SIGNIFICANT RESULTS	Final selection was made of the 4 stations in the United States; involved in this was a series of measurements of snow accumulation on glaciers across the Chugach Range in Alaska. Detailed water and mass balance measurements were made on Gulkana and Wolverine (Alaska), South Cascade (Washington), and Maclure (California) Glaciers. Mass balance stations and personnel shelters have been installed at all stations, as have recording streamflow, precipitation, and temperature gages. Ten years of record were obtained at South Cascade Glacier, 9 at Gulkana and Wolverine Glaciers, and 6 years at Maclure Glacier. More sophisticated instruments were tested at South Cascade Glacier, including heat balance instrumentation. Thermal IR data was obtained from the air and ground to assist in heat balance determinations at South Cascade Glacier.	
REPORTS AVAILABLE PUBLICLY	<p>Dean, W. W., 1974, Maclure Glacier, California: Small glaciers provide summer streamflow in the Sierra Nevadas: Western Snow Conf., 1974 Ann. Mtg., Anchorage. <u>In press.</u></p> <p>Krimmel, R. M., and W. V. Tangborn, 1974, South Cascade Glacier: The moderating effect of glaciers and runoff: Western Snow Conf., 1974 Ann. Mtg., Anchorage. <u>In press.</u></p> <p>Mayo, L. R., 1972, Self-mixing antifreeze solution for precipitation gages: Jour. App. Meteorology, 11:2, p. 400-404.</p> <p>Mayo, L. R., M. F. Meier, and W. V. Tangborn, 1972, A system to combine stratigraphic and annual mass-balance systems: A contribution to the International Hydrological Decade: Jour. Glaciology, 11:61, p. 3-14.</p> <p>Mayo, L. R., and D. C. Trabant, 1972, Gulkana and Wolverine Glaciers, Alaska: Comparison of high altitude with low altitude snowpacks in central and southern Alaska: Western Snow Conf., 1974 Ann. Mtg., Anchorage. <u>In press.</u></p>	

Meier, M. F., and W. V. Tangborn, 1965, Net budget and flow of South Cascade Glacier, Washington: Jour. Glaciology, 5:41, p. 547-566.

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Meier, M. F., 1966, The U.S. program for the IHD with special reference to snow and ice: Proc. Western Snow Conf., Seattle, Wash., April 1966, p. 13-16.

Meier, M. F., 1970, UNESCO/IASH technical papers in hydrology, 1970: Jour. Glaciology, 9:57, p. 405-406.

Meier, M. F., W. V. Tangborn, L. R. Mayo, and Austin Post, 1971, Combined ice and water balances of Gulkana and Wolverine Glaciers, Alaska, and South Cascade Glacier, Washington, 1965 and 1966 hydrologic years: U.S. Geol. Survey Prof. Paper 715-A, 23 p.

Meier, M. F., 1974, Presidential address, International Commission of Snow and Ice: Proc. IUGG Gen. Assbly., Moscow 1971. In press.

Tangborn, W. V., R. M. Krimmel, and M. F. Meier, 1974, A comparison of glacier mass balance measurements by glaciologic, hydrologic, and mapping methods, South Cascade Glacier, Washington: Proc. IUGG Gen. Assbly. Moscow 1971. In press.

Tangborn, W. V., L. R. Mayo, D. R. Scully, and R. M. Krimmel, Combined ice and water balances of Gulkana and Wolverine Glaciers, Alaska, South Cascade Glacier, Washington, and Maclure Glacier, California, 1967 hydrologic year: U.S. Geol. Survey Prof. Paper 715-B. In preparation.

Coordinating Council Resolution No. I.15 Gross Sediment Transport into the Oceans

Resolution No. I.15

The Council recommends

1. that the evaluation of gross sediment transport into the oceans be considered in conjunction with the world-wide measurement of runoff;
2. that Member States participate in the programme by reviewing data already collected and by establishing stations to measure solid transports at the mouths of great rivers, coastal points and streams representative of the major climatic and ecological zones of the world;
3. that measurements of solid transports be of reasonable precision and be comparable from region to region which may necessitate the holding of periodical meetings of specialists;

Invites the Secretariat to take into consideration the efforts of IASH in this direction and to develop this activity in close co-operation with that organization;

Requests the Secretariat to prepare, in co-operation with IASH, for consideration by the National Committees, the criteria for selection of streams where observations should be made.

<b>TITLE</b>	<b>Fluvial-Sediment Discharge to the Oceans from the Conterminous United States</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.15 Gross Sediment Transport to the Oceans</b>	<b>US/IHD ref: 3.4(316)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U. S. Geological Survey National Center Reston, Virginia 22092</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>W. F. Curtis</b>	
<b>OBJECTIVES</b>	<b>To summarize the quantity of fluvial sediment discharged to the Atlantic and Pacific Oceans and the Gulf of Mexico from the conterminous United States.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Annual fluvial-sediment discharge from the conterminous United States averages 491,449,600 short tons, of which 14,204,000 is discharged to the Atlantic Ocean, 378,179,000 to the Gulf of Mexico, and 99,066,600 to the Pacific Ocean.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Curtis, W.F., J. K. Culbertson, and E. B. Chase, 1973, Fluvial-sediment discharge to the oceans from the conterminous United States: U.S. Geol. Survey Circular 670, 15 p.</b>	

<b>TITLE</b>	<b>Inventory of Sediments and Solutes Transported to the Sea</b>	
<b>Coordinating Council Resolution in force and short title</b>	I.15 Gross Sediment Transport into Oceans III.2 World Water Balance	<b>US/IHD ref:</b> 1.11(74)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	W. R. Curtis D. K. Leifeste	
<b>OBJECTIVES</b>	The purpose of this project is to measure the dissolved and suspended loads contributed to the oceans in surface drainage from the United States and to provide data on the general distribution of water and water quality in principal river basins.	
<b>SIGNIFICANT RESULTS</b>	<p>Fifty-one stream gaging stations on major rivers were selected for the collection of chemical quality sediment and temperature data. Data observations were made in 21 of the 51 stations. Six sediment stations were activated under the IHD Program to give baseline data for the Great Lakes drainage. Monthly samples were collected for minor elements analysis. Five water quality monitors were purchased to upgrade the expanded capacities at strategic river sites.</p> <p>Annual fluvial-sediment discharge from the conterminous United States averages 491,449,600 short tons, of which 14,204,000 is discharged to the Atlantic Ocean, 378,179,000 to the Gulf of Mexico, and 99,066,600 to the Pacific Ocean. Data from 27 drainage areas were used to estimate the average annual discharge, yield and concentration of fluvial sediment. The data may be used to extrapolate part of the total world sediment yield to the marine environment.</p> <p>Dissolved-solids data from 54 river basins for 1966-69 were used to compute the amount of dissolved material contributed to the oceans from the conterminous United States. The computations show that about 264,000,000 tons are discharged annually. The Gulf of Mexico receives the largest load, about 183,000,000 tons, of which about 157,000,000 tons are contributed by the Mississippi River. The Atlantic Ocean received about 37,500,000 tons, and the Pacific Ocean about 43,400,000 tons. Average yearly yields range from 26 to 231 tons per square mile and average about 100 tons per square mile.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	U.S. Geological Survey, 1969, Summary of Water Quality Data for International Hydrological Decade Stations in the United States; U.S. Geol. Survey duplicated report, 351 p.	



**Curtis, W. F., J. K. Culbertson, and E. B. Chase, 1973, Fluvial-Sediment Discharge to the Oceans from the Conterminous United States; U.S. Geol. Survey Circular 670, 17 p.**

**Leifeste, D. K., 1974, Dissolved-Solids Discharge to the Oceans from the Conterminous United States; U.S. Geol. Survey Circular 685, 8 p.**

<b>TITLE</b>	<b>Sediment Yield of Major Rivers of the World</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.15 - Gross Sediment Transport into Oceans</b>	<b>US/IHD ref: 1.11(161)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Soil Conservation Service U.S. Department of Agriculture Hyattsville, Maryland 20782	
<b>PRINCIPAL INVESTIGATOR</b>	John N. Holeman Engineering Division	
<b>OBJECTIVES</b>	To compile a listing of the sediment yields of the major rivers of the world.	
<b>SIGNIFICANT RESULTS</b>	The amount of suspended sediment transported by rivers to the seas each year is tabulated. The major rivers are ranked in order of sediment transported per year and drainage area and water discharge data are included. The rivers are listed by continents in subsequent tables with data on drainage area, annual sediment yields in tons, sediment production rates in tons per square mile per year, the years of sediment measurements, and the sources of data. This sample represents more than one-third of the land contributing water-borne sediment to the seas and, if representative, indicates an annual world sediment yield of 20 billion tons. The data suggests that Africa, Europe, and Australia have very low sediment yields, South America is low, North America is moderate, and Asia's is high to the degree of yielding up to 80% of the sediment reaching the oceans annually.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Holeman, J. H., 1968, Sediment Yield of Major Rivers of the World, Water Resources Research, 4:4, 737-747.	

Coordinating Council Resolution No. I.16 The Discharge of Tritium  
to the Oceans by Major Rivers

V.10.1. Problem and expected results

In order to achieve optimum application to hydrological problems, of the present high concentration of tritium in precipitation, it is necessary to complement the existing global survey of precipitation with the measurement of tritium in the major rivers of the world. It is hoped that the data can be applied to the analysis of turnover time in major river basins, the estimation of tritium remaining in the continents for recharge and analysis of the annual river flow cycle, particularly with regard to the contributions of groundwater.

2. Work to be undertaken

2.1 The major rivers of the world are to be sampled on a scheduled basis and the tritium concentration is to be determined. Details of the sampling procedure are available from IAEA, which is willing to provide analysis to those countries which may so desire.

2.2 The choice of rivers will rest with National Committees which will also decide whether to submit samples to IAEA or to make the analyses themselves.

Resolution No. I.16 The Discharge of Tritium  
to the Oceans by Major Rivers

The Council,

Bearing in mind the potential use of environmental tritium to hydrological studies,

Invites Member States to

- (1) Consider their participation in the programme and inform the IAEA and the Secretariat of their decisions;
- (2) Inform the IAEA and the Secretariat of the rivers to be sampled and the dates when the monthly samples will be taken, and indicate whether analysis by IAEA is required.
- (3) Provide IAEA and the Secretariat with information on related hydrological data available at the sampling site.

<b>TITLE</b>	<b>Bibliography of Tritium Studies Related to Hydrology through 1966</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.16 Discharge of Tritium to the Oceans</b>	<b>US/IHD ref: 1.1 (86)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	E. C. Rhodehamel	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	To provide improved access to information on use of tritium in hydrological studies.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Rhodehamel, E. C., V. B. Kron, and V. M. Dougherty, 1971, Bibliography of Tritium Studies Related to Hydrology Through 1966, U. S. Geol. Survey Water-Supply Paper 1900.	

<b>TITLE</b>	Tritium Discharge to the Oceans	
<b>Coordinating Council Resolution in force and short title</b>	I.16 Discharge of Tritium to Oceans	<b>US/IHD ref:</b> 1.11 (114)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	(Address inquiries to National Center in Reston, Virginia)	
<b>OBJECTIVES</b>	To develop the fundamental information concerning the global distribution of the tritium water tracer to be applied to basic problems of hydrology, meteorology, and oceanography.	
<b>SIGNIFICANT RESULTS</b>	Monthly stream water samples are routinely collected for tritium analyses on 20 major streams in the United States. Tritium concentrations and total tritium loads in streams have declined appreciably since reaching a maximum in 1963 and 1964.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Stewart, G. L. and C. M. Hoffman, 1966, Tritium Rainout Over the United States in 1962 and 1963: U.S. Geological Survey Circular 520.</p> <p>Stewart, G. L. and R. K. Farnsworth, 1968, United States tritium rainout and its hydrologic implications, Water Resources Research, 4:2, 273-289.</p> <p>Stewart, G. L. and T. A. Wyerman, 1970, Tritium rainout in the United States during 1966, 1967, 1968, Water Resources Research, 6:1, 77-87.</p> <p>Wyerman, T. A., R. K. Farnsworth, and G. L. Stewart, 1970, Tritium studies in the United States, 1961-1968, Radiological Health Data and Reports, 11:9, 421-439.</p> <p>Carlston, C. W., L. L. Thatcher and E. C. Rhodehamel, Tritium as a hydrological tool: The Wharton Tract study, I.A.S.H. publication no. 52, Commission on Subterranean Waters, 503-512.</p>	

Coordinating Council Resolution No. I.21 Chronological Hydrology

VI.1.2.1. Problem and expected results

1.1. The use of carbon-14 and tritium as dating tools in the study of groundwater and rain water movements has in the opinion of some hydrologists, already indicated a high potential in chronological hydrology. Isotopic measurements on water from deep levels give indications that the radioactive carbon contents can be used to compute a true residence time for that water. The age of water from shallow depths can be deduced from the content of tritium. The deuterium and oxygen 18 ratios in dated waters may give clues to the original isotopic composition of the precipitation from which the water was derived and might be correlated with specific climatic changes.

1.2 Non-nuclear techniques such as dendrochronology, the chronology of alluvial terraces, the study of varve deposits, glacier observations, pollen analysis and historical research should be combined in an endeavour to establish correlations for particular basins or zones between the fragmentary information obtained from different sources and the observed hydrological and climatological data, and to compare the results obtained on a world-wide scale.

Resolution No. I.21

The Council,

Recognizing the importance of chronological hydrology investigations;

Directs the Secretariat

1. to inform Member States of this proposed activity;
2. to foster co-operation of participating Member States for the co-ordination of methods used and modes of interpretation and for correlation of data from different places;
3. Invites IAEA to participate actively in this activity with its tritium laboratory and with the C-14 laboratory which will be in operation within a year and other interested agencies to participate with their facilities;
4. recommends to those countries wishing to participate in this activity that they contact the Secretariat and send in detailed information on the proposed research, for co-ordinating purposes.

<b>TITLE</b>	Application of Dendrochronology to Paleohydrology	
<b>Coordinating Council Resolution in force and short title</b>	I.21 Chronological Hydrology - Non-nuclear	US/IHD ref: 3.2 (7)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Geochronology Laboratories University of Arizona Tucson, Arizona 85721	
<b>PRINCIPAL INVESTIGATOR</b>	Charles W. Stockton and Harold C. Fritts	
<b>OBJECTIVES</b>	To analyze the joint occurrence of climate and relative width of tree rings for the state of Arizona, and to then use the results to make probability estimates of climate for the period 1650-1899.	
<b>SIGNIFICANT RESULTS</b>	<p>The analysis presented in the study outlines several objective methods leading to quantitative evaluations of past climates by employing the relative width of annual rings in trees. Climatic data for the state including both precipitation and temperature for each of four seasons are placed into three equally probable classes. Several ring width chronologies from the state are standardized and normalized before combining them into a single state-wide series. Analyses of high-frequency and low-frequency variance components in the several chronologies are employed to evaluate intervals of heterogeneity in ring-width patterns throughout the state for 20-year interval of time.</p> <p>The joint occurrence of 3 precipitation and 3 temperature classes produced a multi-normal population with 9 categories which are combined with 9 equally probable ring-width classes. Climatic probabilities associated with the ring-width classes for 1950-1890 are applied to write probability statements regarding the occurrence of seasonal climatic classes prior to the 1900-1947 record.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Stockton, C. W. and H. C. Fritts, 1968, Conditional Probability of Occurrence of Variations in Climate Based on Width of Annual Tree Rings in Arizona, Laboratory of Tree-Ring Research Annual Report Grant No. E-88-67 (G), Tucson, Ariz., 24 p.	

**Coordinating Council Resolution No. I.22 Incidence and Spread of Continental Drought**

**VI.1.3. Droughts still remain one of the major calamities to people around the world. Some climatic data have been interpreted to indicate that drought begets drought. Extensive information on drought incidence is essential, as is study of the physics of atmospheric transport of undissipated radiant energy. This will require a study of data on past droughts and establishment of instrumentation to study major droughts in the future.**

**This project will help to explain the effect as some of the drought caused imbalance in the heat budget of the atmosphere, and the effect of the transport to other areas of heat generated by this process. Success in analysing this phenomena will clearly depend upon development of an adequate model of the behaviour of the atmosphere. Standardization of methods is paramount, and an international symposium or seminar may be required to establish operational plans for the project.**

**Resolution No. I.22**

**The Council,**

**Requests the Secretariat to inform all the Member States of this proposed activity;**

**Recommends to those which wish to participate therein to notify the Secretariat and to send in detailed information on the proposed research, for co-ordinating purposes.**



<b>TITLE</b>	Dendroclimatic History of the United States	
<b>Coordinating Council Resolution in force and short title</b>	I.22 Incidence and Spread of Continental Drought	US/IHD ref: 2.6(156)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Laboratory of Tree-ring Research University of Arizona Tucson, Arizona 85721	
<b>PRINCIPAL INVESTIGATOR</b>	H. C. Fritts	
<b>OBJECTIVES</b>	To extend the climatological history of the southwestern United States through the use of dendrochronological and dendroclimatological techniques.	
<b>SIGNIFICANT RESULTS</b>	The necessary technology, with accompanying computer programming, has been developed which allows the researcher to relate tree-ring data to past climatological events. Maps depicting the mean, percent departure of mean, and percent departure of standard deviation of tree-ring growth are used to infer climate changes spanning the past 200 to 300 years.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Julian, P. R. and H. C. Fritts, 1968, On the possibility of quantitatively extending climatic records by means of dendroclimatological analyses. Proceedings of the First Statistical Meteorological Conf., Hartford, Conn., p. 76-82.</p> <p>Fritts, H. C., 1969, Tree-ring analyses: a tool for water resources research. Transactions AGU, 59(1): 22-27.</p> <p>Fritts, H. C., 1966, Growth Rings of trees: Their correlation with climate, Science, 154, 973-979.</p> <p>Fritts, H. C., 1965, Tree-ring evidence for climatic changes in western North America, Monthly Weather Rev., 93, 421-443.</p> <p>LaMarche, V. C., Jr., 1966, An 800-year history of stream erosion as indicated by botanical evidence: U. S. Geol. Survey Prof. Paper 550-D, p. 83-86.</p> <p>Fritts, H. C., 1971, Dendroclimatology and dendroecology: Quat. Research, 1:4, p. 419-449.</p> <p>Fritts, H. C., T. J. Blasing, B. P. Hayden, J. E. Kutzbach, 1971, Multivariate techniques for specifying tree-growth and climatic relationships and for reconstructing anomalies in paleoclimate: J. of App. Meteor. 10:5, p. 845-864.</p> <p>LaMarche, V. C., Jr. and H. C. Fritts, 1971, Anomaly patterns of climate over the western United States, 1700-1930, derived from principal component analysis of tree-ring data: Monthly Weather Rev., 99:2, p. 138-142.</p> <p>Stockton, C. W. and H. C. Fritts, 1971, Augmenting annual runoff records using tree-ring data: In proceedings of the 1971 meetings of the Arizona Section American Water Resources Association, Hydrology and Water Resources in Arizona and the Southwest, 1, p. 1-12.</p>	

Stockton, C. W. and H. C. Fritts, 1971, Conditional probability of occurrence for variation in climate based on width of annual tree-rings in Arizona: *Tree-Ring Bull.*, 31, p. 3-24.

Fritts, H. C., 1972, Tree-rings and climate: *Sci. American*, 226:5, p. 2-10.

Fritts, H. C., 1973, Paleoclimatology: In Daniel N. Lapedes, Ed. 1973 McGraw-Hill Yearbook of science and technology, McGraw-Hill, New York.

Helley, E. J., and V. C. LaMarche, Jr., 1973, Historic flood information for northern California streams from geological and botanical evidence: *U. S. Geol. Survey Prof. Paper 485-E*, p. 16.

Stockton, C. W. and H. C. Fritts, 1973, Long term reconstruction of water level changes for Lake Athabasca by analysis of tree-rings: *Water Resources Bull.*, 9:5, p. 1006-1027.

Stockton, C. W., 1974, Long-Term streamflow records reconstructed from tree-rings: *Univ. of Arizona Press*, in press.

<b>TITLE</b>	<b>Incidence and Spread of Continental Drought</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.22 Incidence and Spread of Continental Drought</b>	<b>US/IHD ref: 2.6 (128)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Agricultural Research Service                  U.S. Dept. of Agriculture                  Soil and Water Conservation Research Division                  Beltsville, Maryland 20705</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>H. N. Holtan</b>	
<b>OBJECTIVES</b>	<b>To investigate the incidence and spread of continental drought in the United States.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Measurement of various parameters of climate, primarily in connection with research on conservation of moisture for agricultural production but amendable to analyses and interpretation on the incidence and spread of drought have been made at: Sydney, Montana; Mandan, North Dakota; Morris, Minnesota; Newell and Brookings, South Dakota; Ames, Iowa; Manhattan, Kansas; and Bushland, Big Springs, and Temple, Texas. The variety of problems and spectrum of results precludes ready summation and the reader is referred to individual reports listed below.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Army, P. J., J. J. Bond, and C. E. van Doren, 1959, Precipitation-yield relationships in dry land wheat production on medium to fine textured soils of the southern high plains, Agronomy J., 51, 721-724.</b>  <b>Weakly, H. E., 1962, History of drought in Nebraska, J. Soil &amp; Water Conservation, 17, 271-275.</b>  <b>Hershfield, D. M., 1970, Generalizing dry-day frequency data, Am. Water Works Assoc. J., 62:1, 51-54.</b>  <b>Hershfield, D. M., 1970, Dry periods in the Eastern United States, J. Soil &amp; Water Conservation, 25:6, 242-243.</b>	

Coordinating Council Resolution No. I.24 Relations Between Soil Moisture and Runoff

VI.1.5.1. Problem and expected results

It is generally accepted that the moisture condition of the upper soil layer is one of the primary factors controlling the amount of runoff from a given storm rainfall. The effect of this factor is readily demonstrated and understood at any given point, but the practical utility of this knowledge depends on ability to integrate the effects of a wide range of soil types and soil moisture conditions throughout a drainage basin. For the analysis of these relations, for basins where little or no runoff data are available, it will be necessary to evaluate the soil complex of a drainage basin and derive a relation that would permit computation of runoff from rainfall data.

2. Work to be undertaken

The study would include refinement of rainfall-runoff-relations, using soil moisture as one of the important parameters for typical basins throughout large areas for which adequate data on rainfall and runoff are available. Data on soil characteristics could be obtained by field surveys and sampling. Correlations of the field data and the empirically derived soil moisture functions would then be made. If successful, rainfall-runoff relations could be synthesized for basins without runoff records. Such procedures could then be used to compute runoff data for river basins in similar areas of the earth where only rainfall data are available. The Council noted that many other factors are just as important.

Resolution No. I.24

The Council,

Requests the Secretariat to inform Member States of this activity.

Recommends that Member States who wish to participate inform the Secretariat and send in detailed information on the proposed research for co-ordinating purposes.

<b>TITLE</b>	<b>Generalized Soil Moisture-Runoff Relationships</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.24 Relation between Soil Moisture and Runoff</b>	<b>US/IHD ref: 3.3(1)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	North Pacific Division U.S. Army Corps of Engineers 210 Custom House Portland, Oregon 97209	
<b>PRINCIPAL INVESTIGATOR</b>	James A. Anderson	
<b>OBJECTIVES</b>	The refinement of rainfall-runoff relationships using soil moisture as the primary parameter for typical basins throughout the United States where adequate data on rainfall and runoff are available.	
<b>SIGNIFICANT RESULTS</b>	A report entitled "Runoff Evaluation and Streamflow Simulation by Computer" has been prepared. This report describes a mathematical model developed in this office in which soil moisture-runoff relationships in the form of continuously varying relationships and variable evapotranspiration indexes account for the water balance of a watershed area.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Anderson, J.A., 1971, Runoff Evaluation of Streamflow Simulated by Computer, North Pacific Engineering Division, U.S. Army Corps of Engineers, Portland, Oregon.</p> <p>U.S. Army Engr. Div. North Pacific, 1972, User Manual for COSSARR Model Streamflow Synthesis &amp; Reservoir Regulation, Portland, Oregon.</p> <p>U.S. Army Engr. Div. North Pacific, 1972, Application of the SSARR Model to the Upper Paraguay River Basin (prepared for the UNDP/UNESCO Project: Hydrological Studies of the Upper Paraguay River Basin, Brazil), Portland, Oregon.</p> <p>U.S. Army Engr. Div. North Pacific, 1972, Program Description &amp; User Manual for SSARR Model Streamflow Synthesis &amp; Reservoir Regulation, Program 724-K5-G0010, Portland, Oregon.</p>	

Coordinating Council Resolution No. I.26 Genesis and Physical Chemistry of Natural Waters

VI.1.7.1. Problem and expected results

Little is known of the genesis of the chemical composition of natural waters. Data have been accumulating on the composition of rain, but the areal distribution of rain compositions, as well as the oceanic and terrestrial components of their composition, are poorly known. Soil waters and soil gases have hardly been sampled; consequently, the inter-connections of rain and soil minerals, which control the composition of the water that enters aquifers, cannot be interpreted.

Millions of water analyses are available, and there have been tens of thousands of detailed studies of the mineralogy of rocks, but studies including both kinds of information for a given rock and coexisting water are few and scattered.

2. Work to be undertaken

A major programme is needed on the stability relation of minerals in aqueous solutions, on the kinetics of reaction of minerals and waters, and on the physical chemistry of natural solutions. Only after a major effort will it be possible to understand the genesis of water quality, and to take the steps possible for its control and modifications.

Resolution No. I.26

The Council,

Requests the Secretariat to inform all Member States of the proposals for research on the genesis and physical chemistry of natural waters;

Recommends to those countries which wish to participate therein to inform the Secretariat and to send in detailed information on the proposed research, for co-ordinating purposes.

<b>TITLE</b>	Chemistry of Atmospheric Precipitation	
<b>Coordinating Council Resolution in force and short title</b>	I.26 Genesis and physical chemistry of natural waters	US/IHD ref: 3.6(75)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	D. W. Fisher	
<b>OBJECTIVES</b>	To discover the controls on the chemistry of atmospheric precipitation and to determine the effects of precipitation on the quality of surface and ground water.	
<b>SIGNIFICANT RESULTS</b>	<p>Atmospheric precipitation on the northeastern U.S. is distinctly acidic, with relatively high concentrations of nitrate and sulfate. Much of this acidity, nitrate and sulfate are of anthropogenic origin. Smaller concentrations of industry and population in the Middle Atlantic states result in lower contents of acid, nitrate and sulfate in precipitation over much of eastern North Carolina and southeastern Virginia.</p> <p>In the tropical marine environment of St. Thomas, rainfall is typically slightly alkaline and contains little nitrate and little more sulfate than would be expected from sea salts. The alkalinity is associated with calcium and sodium, indicating an aerosol component which may be localized in character. Calcium-sodium bicarbonates also provide a significant part of the mineral content of precipitation near the coasts of North Carolina and southern Virginia.</p> <p>Throughout the eastern U.S., atmospheric precipitation supplies nearly all of the chloride, sulfate, and fixed nitrogen carried by uncontaminated streams and fresh water aquifers.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Gambell, A. W. and D. W. Fisher, 1966, Chemical Composition of Rainfall, Eastern North Carolina and Southeastern Virginia: U.S. Geological Survey Water Supply Paper 1535-K.</p> <p>Fisher, D. W., 1968, Annual variations in chemical composition of atmospheric precipitation, eastern North Carolina and southeastern Virginia: U.S. Geological Survey Water Supply Paper 1535-M.</p> <p>Pearson, F. J., Jr., and D. W. Fisher, 1971, Chemical composition of atmospheric precipitation in the Northeastern United States: U.S. Geological Survey Water Supply Paper 1535-P, 23 p.</p> <p>Davis, G. H., 1961, Geological Control of Mineral Composition of Stream Water of the Eastern Slope of the Southern Coast Ranges, California, U.S. Geological Survey Water Supply Paper 1535-B, 30 p.</p> <p>Carroll, Dorothy, 1962, Rainwater as a Chemical Agent of Geologic Processes - A Review, U.S. Geological Survey Water Supply Paper 1535-G, 18 p.</p>	

**Fisher, D. W., A. W. Gambell, G. E. Likens and F. H. Bormann,  
1968, Atmospheric contributions to water quality of streams in  
the Hubbard Brook Experimental Forest, New Hampshire: Water  
Resources Res., 4:5, 1115-1126.**



<b>TITLE</b>	<b>Rate of Chemical Weathering of Silicate Minerals in New Hampshire</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.26 Genesis and Physical Chemistry of Natural Waters</b>	<b>US/IHD ref: 3.6(146)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Dartmouth College Hanover, New Hampshire</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>N. M. Johnson</b>	
<b>OBJECTIVES</b>	<b>To analyze the cation budgets in terms of their significance on chemical weathering rates.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>The losses of dissolved Ca, Na, Mg, and K have been deter- mined for six watersheds in New Hampshire during the period 1963-1967. From the rate at which Ca and Na are lost, the steady-state chemical weathering rate is calculated at 800 kg of bedrock-till per hectare per year. Under podzol weathering conditions, a major part of the K and Mg released by the breakdown of primary minerals is apparently retained in peodogenic clays.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Johnson, N. M., et al., 1968, Rate of chemical weathering of silicate minerals in New Hampshire, Geochimica et Cosmo- chimica Acta, 32, 531-545.</b>	

<b>TITLE</b>	<b>Water load of Uranium, Radium, and Gross Beta Activity at Selected Gaging Stations, Water Year 1960-61</b>	
<b>Coordinating Council Resolution in force and short title</b>	I.26 Genesis and Physical Chemistry of Natural Waters	US/IHD ref: 1.11(168)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Denver Federal Center Denver, Colorado 80225	
<b>PRINCIPAL INVESTIGATOR</b>	E. C. Mallory	
<b>OBJECTIVES</b>	<p>To determine the amounts of uranium, radium, and gross beta activity in major streams of the U.S. during the water year 1960-61.</p> <p>To establish the amount of uranium and radium being transported in solution to the oceans.</p> <p>To furnish background data for future geochemical studies of the naturally occurring radioelements and radioactivity.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>Water samples were collected from 36 rivers during low, medium, and high flows. The drainage areas above the sampling sites represented about 55 percent of continental United States (including 86,000 square miles of Alaska) and 155,000 square miles of Canada. During the 1960-61 water year the total uranium-solute load ranged from about 100 pounds contributed by the Nezinscot River to 695,000 pounds contributed by the Mississippi River. The calculated total uranium-solute load of the rivers sampled was used to estimate that about 2 million pounds of uranium were carried in solution from the continental United States to the oceans during this water year. The calculated radium-solute load for the sampling period ranged from about <math>2.5 \times 10^{-5}</math> pounds for the Nezinscot River to <math>25,000 \times 10^{-5}</math> pounds for the Mississippi River. The gross solute load of radium from the conterminous United States to the oceans for the water year 1960-61 was estimated to be about <math>67,000 \times 10^{-5}</math> pounds.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Mallory, E. C., J. O. Johnson, and R. C. Scott, 1969, Water Load of Uranium, Radium, and Gross Beta Activity at Selected Gaging Stations, Water Year 1960-61: U.S. Geol. Survey Water-Supply Paper 1535-0, 31 p.	

Coordinating Council Resolution No. I.28 Effects of Physiographic Features on  
Precipitation

VI.1.9.1. Problem and expected results

Effects of physiographic features on precipitation have been studied from time to time, but primarily on a local basis. Some types of storms tend to give high rainfall at high elevations, while others do not. Further study is required to develop procedures for systematic evaluation of the effects of physiographic features on rainfall amounts and distribution by climatic provinces. The results would be applicable to regions for which rainfall data are inadequate.

2. Work to be undertaken

The scope would include study of several typical climatic provinces to evaluate effects of physiographic features on rainfall amounts and distribution. Efforts would be made to generalize the results to make them applicable to similar climatic provinces elsewhere. Verification of the procedures for similar climatic provinces of the earth would be attempted where appropriate data are available.

In order to evolve reliable procedures for interpolating precipitation on the basis of physiography, extensive observation and analysis of data for all parts of the world will be necessary.

Resolution No. I.28

The Council,

Requests the Secretariat to:

1. inform all Member States of the proposals for research on effects of physiographic features on precipitation;
2. inform the ad hoc working group on representative and experimental basins of this activity for co-ordination purposes;
3. draw the attention of the International Association of Meteorology and Atmospheric Physics to this activity.

Recommends to interested Member States that they inform the Secretariat of their proposed activities for purposes of co-ordination.

<b>TITLE</b>	<b>Effects of Physiographic Factors on Precipitation: Reynolds Creek Experimental Watershed, Boise, Idaho</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.28 Effects of Physiographic Features</b>	<b>US/IHD ref: 2.2(122)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<p>Agricultural Research Service                  U.S. Dept. of Agriculture                  Soil and Water Conservation Research Division                  Beltsville, MD 20705</p>	
<b>PRINCIPAL INVESTIGATOR</b>	C. W. Carlson	
<b>OBJECTIVES</b>	To investigate the effect of physiographic factors on precipitation.	
<b>SIGNIFICANT RESULTS</b>	<p>In 1961, the Reynolds Creek watershed was instrumented with nearly 100 recording rain gages spaced approximately 1.6 km apart in and surrounding the 240 km<sup>2</sup> tract. The experimental area is about 28.8 km long with elevations ranging from about 1,070 to 2,200 meters msl. The gage network is supplemented by snow courses in the headwaters area.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Neff, E. L., 1965, Principles of precipitation network design for intensive hydrologic investigations, International Association of Scientific Hydrology Symposium on the Design of Hydrological Networks: 1966, pp. 49-55.</p> <p>Cooper, C. F., 1966, Sampling characteristics of neutron probe measurements in a mountain snowpack: Journal of Glaciology: 6(4): 289-298.</p> <p>Hershfield, D. M., G. H. Comer, and B. Levy, 1972, Spectra of Precipitation in Mountainous Regions. Symp. on Distribution of Precipitation in Mountainous Areas Proc., Geilio, Norway, Vol. II (WMO/OMM No. 326): 432-447.</p> <p>Hamon, W. R., 1972, Computing Actual Precipitation. Symp. on Distribution of Precipitation in Mountainous Areas Proc., Geilio, Norway, Vol. II (WMO/OMM No. 326): 159-174.</p>	

<b>TITLE</b>	<b>Effects of Physiographic Factors on Precipitation and Evaporation</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.28 Effects of Physiographic Features</b>	<b>US/IHD ref: 2.2(48)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	E. L. Peck Hydrologic Research Laboratory	
<b>OBJECTIVES</b>	To determine the effects of physiographic factors on precipitation and evaporation.	
<b>SIGNIFICANT RESULTS</b>	<p>1. A study of physiographic factors on evaporation was conducted during the summers of a four-year period in northern Utah. Full scale evaporation data were collected at 17 high elevation stations from 17 sites ranging from 1319 meters to 2731 meters in elevation. All data are on punch cards.</p> <p>2. Hydrometeorological data have been collected for stations on the western slopes of the Wasatch Mountains in northern Utah. These data coupled with radiosonde information have been used to investigate the relation of meteorological parameters to precipitation distribution.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Peck, E. L. and D. Pfannkuch, 1963, Evaporation Rates in Mountainous Terrain, Pub. No. 62, Inter. Assoc. of Sci. Hydro., Comm. of Evap., p. 267-278.</p> <p>Peck, E. L., 1967, Influences of Exposure on Pan Evaporation in a Mountainous Area, Ph.D. Dissertation, Utah State University.</p> <p>Peck, E. L., 1973, Relation of Orographic Winter Precipitation Patterns to Meteorological Parameters, Symposium on the Distribution of Precipitation in Mountainous Areas, Geilo, Norway, August 1972, vol. II, Technical Papers, WMO/OMM no. 326, Geneva, Switzerland.</p> <p>Peck, E. L., 1973, Discussion of Problems in Measuring Precipitation in Mountainous Areas, Symposium on the Distribution of Precipitation in Mountainous Areas, Geilo, Norway, August 1972, vol. 1, WMO/OMM no. 326, Geneva, Switzerland.</p> <p>Not listed separately are twelve papers by U.S. authors in WMO, 1972, Distribution of Precipitation in Mountainous Areas, Geilo Symposium, Norway, 21 July-5 August 1972, vols. I and II, WMO Rept. no. 326, WMO, Geneva, 815 p.</p>	

<b>TITLE</b>	<b>Effects of Physiographic Features on Precipitation, Arizona</b>	
<b>Coordinating Council Resolution in force and short title</b>	I.28 Effects of Physiographic Features I.57 Radar Measurement of Rainfall	<b>US/IHD ref:</b> 2.2(143)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey P.O. Box 2367 Prescott, Arizona 86301	
<b>PRINCIPAL INVESTIGATOR</b>	H. E. Skibitzke	
<b>OBJECTIVES</b>	The use of radar to measure the variation of rainfall patterns in space and time. The techniques so derived to be applied to streamflow measurements.	
<b>SIGNIFICANT RESULTS</b>	Maps and correlation plots to analyze data collected on the Harquahala Plains area in Arizona. These data showed a significant correlation of summer thunderstorm activity with geology; the reason being the difference in heat absorption of various rock types.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Copies of data can be obtained through the U.S. Geological Survey, P.O. Box 2367, Prescott, Arizona.	

Coordinating Council Resolution No. I.30 Forest Hydrology

VI.1.11.1. Problem and expected results

The main objective of this activity is the study of the changes of water balance elements on watersheds in connexion with the execution of forestry and forest reclamation measures. As a result of this investigation, it is hoped that recommendations on the water-regulating role of forests and their influence on changes of water balance could be elaborated.

2. Work to be undertaken

The principal items to be covered by this activity are:

- (1) the research of water balance elements on open and forested watersheds;
- (2) the study of water balance of watersheds covered by different types of forest and by different stands;
- (3) the investigations of water balance elements of watersheds on which forestry reclamative measures are carried out.

There has already been much work in this field and it would be useful to have a summary of the available information on this subject. In this connexion, the Council was made aware of an international symposium on forest hydrology to be held in September 1965 in the United States.

Resolution No. I.30

The Council,

Requests the Secretariat to inform all Member States of the study of water balance in connexion with the evaluation of water-regulating and water-conserving role of forests;

Recommends to those countries which wish to participate in this activity to contact the Secretariat and to send in detailed information on the proposed research for co-ordinating purposes.

<b>TITLE</b>	<b>An Outline of Forest Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.30 Forest Hydrology</b>	<b>US/IHD ref: 5.1 (167)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	School of Forest Resources University of Georgia Athens, Georgia 30601	
<b>PRINCIPAL INVESTIGATOR</b>	J. D. Hewlett and W. L. Nutter	
<b>OBJECTIVES</b>	To prepare a text that is designed to introduce forest hydrology to forest resource students and future land managers.	
<b>SIGNIFICANT RESULTS</b>	<p>The text, <i>An Outline of Forest Hydrology</i>, extends from a review of hydrological processes to illustrations of the application of hydrology to management. It deals adequately with soil and vegetation phases of the hydrologic cycle. At the same time it presents equally well the principal elements of surface and groundwater hydrology and engineering practices.</p> <p>The chapter headings are: Introduction (including definitions which are relevant rather than comprehensive and explicit rather than discursive, and a short history of the development of forest hydrology); Water and Energy Cycles; Drainage Basin Morphology; Atmospheric Moisture and Precipitation; Surface Water; Evapotranspiration; Surface Water, Streamflow, and the Hydrograph; Erosion and Sedimentation in Relation to Forests; Forests and Floods; and Forests and Water Quality.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Hewlett, J. D. and W. L. Nutter, 1969, <i>An Outline of Forest Hydrology</i> , University of Georgia, Athens.	



<b>TITLE</b>	<b>International Symposium on Forest Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.30 Forest Hydrology</b>	<b>US/IHD ref: 5.1 (342)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	School of Forest Resources Pennsylvania State University University Park, PA.	
<b>PRINCIPAL INVESTIGATOR</b>	William E. Sopper and Howard W. Lull	
<b>OBJECTIVES</b>	To provide an opportunity for scientists engaged in the field of forest hydrology research to get together to determine our present state of knowledge, current research needs and trends, and to provide a bench mark which might serve as a point of departure for anticipated future studies.	
<b>SIGNIFICANT RESULTS</b>	<p>The symposium was held at the Pennsylvania State University 29 August-10 September 1965. It brought together 87 scientists from 22 countries to listen to and discuss the contents of 86 reports under the following main headings:</p> <ul style="list-style-type: none"> <li>Resumes of Forest Hydrology Research (country reports)</li> <li>Forests and Precipitation</li> <li>Forests and Soil Water</li> <li>Forests and Evapotranspiration</li> <li>Forests and Runoff</li> <li>Forests and Soil Stabilization</li> <li>Research Techniques and Instrumentation</li> <li>Panel Discussion of New Instruments</li> </ul>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Sopper, W. E., and H. W. Lull (eds.), 1967, International Symposium on Forest Hydrology, Proceedings of a National Science Foundation Seminar, 29 August-10 September 1965, Pennsylvania State University; Pergamon Press, Oxford, 813 p.	

**Coordinating Council Resolution No. I.31 Relations Between Sediment Transport,  
Streamflow and Channel Morphology**

**VI.1.12.1. Problem and expected results**

The behaviour of natural stream channels poses fundamental problems in virtually every region of the world. Continuing laboratory studies, essential to understanding channel stability and sediment and water transport, should be supplemented by field measurements over a broad range of conditions to verify theoretical and laboratory studies.

**2. Work to be undertaken**

Research includes the mechanics of aqueous flow in both rigid and alluvial channels, resistance to flow, sediment transport, channel stability, and the design of stable channels and conveyance systems. Current research also seeks to learn the cause and dimensions of scour-and-fill features. An international programme should lead to find measurements at frequent intervals in selected reaches of selected rivers to establish relations between cohesive soil properties, flow regimes and vegetation. Co-ordinated effort may reduce the number of measurements and help in developing new instrumentation.

**Resolution No. I.31**

The Council,

Requests the Secretariat to inform all the Member States of the research proposals on the relations between sediment transport, streamflow and channel morphology;

Recommends to those countries who wish to participate therein to contact the Secretariat and to send in detailed information on the proposed research, for co-ordinating purposes.

<b>TITLE</b>	<b>Sediment Water Interaction in Some Georgia Rivers and Estuaries.</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.31 Relation Between Sediment Transport, Stream and Channel Morphology</b>	<b>US/IHD ref: 1.11(215)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	School of Geophysical Sciences Georgia Institute of Technology Atlanta, Georgia 30332	
<b>PRINCIPAL INVESTIGATOR</b>	K. C. Beck	
<b>OBJECTIVES</b>	To study the sediment properties of some Georgia rivers and estuaries.	
<b>SIGNIFICANT RESULTS</b>	<p>Georgia lower Coastal Plain streams are characterized by low suspended load, low ionic strength, low pH, high <math>PCO_2</math>, high proportions of <math>SiO_2</math>, Al, and Fe and high dissolved organic content. These characteristics become less pronounced in streams heading in the Piedmont and Fall Line. The chemistry of the streams is controlled by atmospheric input, weathering of the already strongly leached soils, and by the organic compounds produced on decay of vegetation in the low gradient, swampy terrain. Hydrologic conditions, largely flushing of swamp waters into the streams after rains, control the relative importance of these factors.</p> <p>The relatively high Cl content and constant ratios of Na, K, Mg, Ca, and <math>SO_4</math> to Cl at values not far removed from sea water suggests that these species are derived from rain and atmospheric aerosals, and that mineral weathering contribution is minor.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Beck, K. C., 1972, Sediment Water Interactions in Some Georgia Rivers and Estuaries, School of Geophysical Sciences in cooperation with Environmental Resources Center, Georgia Institute of Technology, Atlanta, Georgia, 97 p.	

<b>TITLE</b>	<b>Movement of Radionuclides in Water and Sediment in Rivers and Estuaries</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.31 Relation Between Sediment Transport, Streamflow, and Channel Morphology</b>	<b>US/IHD ref: 3.4 (8)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Battelle Memorial Institute P.O. Box 999 Richland, Washington 99352</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>D. R. Kalkwarf</b>	
<b>OBJECTIVES</b>	<p>The purpose of the study is to develop an extensive and useful understanding of the mechanisms involved in the transport, absorption, sedimentation, and translocation of radionuclides in the Columbia River and its estuaries, and thus those that might be expected in other river systems. The first phase of the project is a reconnaissance study of radionuclide inventories in the Columbia River and a preliminary analysis and correlation of their major physical form and location. The second phase is a laboratory study of the reaction mechanism of radionuclides with constituents of the river together with refined river sampling in order to explain the results of phase 1 and to predict radionuclide behavior under other conditions.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>Methods and techniques developed are used routinely by several agencies and Universities to evaluate radiological status of the Columbia River and its estuary.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Nelson, J. L., R. W. Perkins and W. L. Haushild, 1966, Determination of Columbia River Flow Times Using Radioactive Tracers Introduced by the Hanford Reactors. Water Resources Research 2, 31-39.</p> <p>Perkins, R. W., J. L. Nelson &amp; W. L. Haushild, 1966, Behavior and Transport of Radionuclides in the Columbia River Between Hanford and Vancouver, Washington. Limnology and Oceanography 11, 235-248.</p> <p>Gross, M. G., &amp; J. L. Nelson, 1966, Movement of Radioactive Sediment on the Continental Shelf Near Washington &amp; Oregon. Science 154, 879-885.</p>	

<b>TITLE</b>	Behavior of Radionuclides in the Columbia River and its Estuary below Hanford, Washington	
<b>Coordinating Council Resolution in force and short title</b>	I.31 Relation between Sediment Transport, Streamflow, and Channel Morphology	<b>US/IHD ref:</b> 3.6 (94)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Atomic Energy Commission Washington, DC 20545 (in cooperation with General Electric Corp., U.S. Geol. Survey, Oregon State Univ., U.S. Army Corps of Engr.)	
<b>PRINCIPAL INVESTIGATOR</b>	E. Robertson, Battelle-Northwest, Richland, Washington	
<b>OBJECTIVES</b>	<p>1) To describe the bottom sediment distribution, in time and space along the river, major tributaries, and estuary, including size, distribution and mineralogy.</p> <p>2) To determine the quantities of various radionuclides deposited in reservoirs, and study the conditions leading to scour and retransport.</p> <p>3) To develop a mathematical model to describe flow in the estuary as related to transport of water sediment and biota.</p> <p>4) To study the physico-chemical nature of sorption-desorption mechanisms.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>The most significant event in the radio-ecology of the Columbia River during this decade has been the closure of the last of the original plutonium production reactors in January of 1971. Since that time the radionuclide concentrations in Columbia River water, suspended matter, sediments and biota has decreased to near background level. Three main mechanisms have accounted for this decrease: 1) radioactive decay; 2) scouring and flushing of radioactive surface sediments during spring freshets; and 3) burial of radioactive sediment deposits by fresh, relatively uncontaminated sediments. Continuing studies are in progress with the purpose of characterizing the long-range behavior of the radionuclides remaining in the river sediments and biota.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Robertson, D. E., et al., 1973, Transport and Depletion of Radionuclides in the Columbia River, in: Radioactive Contamination of the Marine Environment, IAEA, Vienna.</p> <p>Becker, C. D., 1973, Aqueous Bioenvironmental Studies in the Columbia River at Hanford 1945-1971, A Bibliography with Abstracts, BNWL-1734, UC-48, Battelle Pacific Northwest Laboratory, Richland, Washington. (this Bibliography contains all pertinent publications up to 1972).</p>	

Coordinating Council Resolution No. I.37 Evapo-Transpiration Processes

VI.1.18.1. Problem and expected results

On a long-term basis, the difference between precipitation and evapotranspiration over an area is a measure of available water supply; evaporation from a reservoir is a drain on this supply, and the difference between precipitation and potential evapotranspiration is a major factor in estimating the irrigation needs for a proposed project. The requirements for evaporation observations are more complex than those for precipitation because evaporation is strongly affected by the nature and condition of the land surface and underlying soil. In addition to the need for improved instrumentation, there remains the problem of developing techniques for converting standard evaporation observations to those required for water resources purposes (free-water evaporation, potential evapotranspiration, actual evapotranspiration, etc.). Geographic variations in evaporation are large in many areas of the world, and the variations cannot be delineated accurately without improved knowledge of physiographic and other effects. Investigations of this nature will lead to improved generalized maps of free-water evaporation, actual evapotranspiration and other phenomena, as elements of the water cycle.

2. Work to be undertaken

Further research is needed on the theoretical aspects of evaporation phenomena, and on practical aspects as well, so that this major element in the hydrologic cycle can be better evaluated under specified circumstances.

Resolution No. I.37

The Council,

Requests the Secretariat to inform all the Member States of this proposed activity;

Recommends to those which wish to participate therein to notify the Secretariat and to send in detailed information on the proposed research, for co-ordinating purposes.

<b>TITLE</b>	<b>Water Transfer by Evapotranspiration: Mechanism and Amounts</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.37 Evapotranspiration Processes</b>	<b>US/IHD ref: 3.1 (127)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Agricultural Research Service U.S. Dept. of Agriculture Soil and Water Conservation Research Division Beltsville, MD 20705	
<b>PRINCIPAL INVESTIGATOR</b>	C. W. Carlson	
<b>OBJECTIVES</b>	To investigate evapotranspiration under the following agricultural conditions: Energy exchange in croplands; Ithaca, New York Coastal influences on climatic gradients; Lompoc, California Evaporation in semi-arid areas; Ft. Collins, Colorado Evaporation from irrigated field crops in dry land areas; Kimberly, Idaho and Tempe, Arizona.	
<b>SIGNIFICANT RESULTS</b>	The variety of problems and spectrum of results precludes ready summation and the reader is referred to individual reports listed below.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Wright, J. L. and E. R. Lemon, 1966, Photosynthesis under field conditions, VIII, Analyses of wind speed fluctuation data to evaluate turbulent exchange within a crop, <i>Agronomy J.</i>, 58:3, 255-261.</p> <p>Gardner, H. R. and R. J. Hanks, 1966, Evaluation of the evaporation zone in soil by measurement of heat flux, <i>Soil Science Society of America Proceedings</i>, 30:4, 425-428.</p> <p>van Bavel, C. H. M., J. E. Newman, and R. H. Kilgeman, 1967, Climate and estimated water use by an orange orchard, <i>Agricultural Meteorology</i>, 4, 27-37.</p> <p>McGuinness, J. L. and L. H. Parmele, 1972, Maximum potential evapotranspiration frequency - east central United States, <i>Amer. Soc. Civ. Engin. Proc., Irrig. &amp; Drain. Div. J.</i>, 98: IR 2, 207-214.</p> <p>Nixon, P. R., G. P. Lawless, and G. V. Richardson, 1972, Coastal California evapotranspiration frequencies, <i>Amer. Soc. Civ. Engin. Proc., Irrig. &amp; Drain. Div. J.</i>, 98: IR 2, 185-191.</p> <p>Ritchie, J. T., 1972, Model for predicting evaporation from a row crop with incomplete cover, <i>Water Resources Research</i>, 8:5, 120-1213.</p> <p>McGuinness, J. L. and E. F. Bordne, 1972, A comparison of lysimeter-derived potential evapotranspiration with computed values, <i>USDA Tech. Bul.</i> 1452, 71 p.</p>	

<b>TITLE</b>	Gila River Phreatophyte Project	
<b>Coordinating Council Resolution in force and short title</b>	I.37 Evapotranspiration processes	<b>US/IHD ref:</b> 3.1(63)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Room 4J, Federal Bldg. 301 West Congress Tucson, Arizona 85701	
<b>PRINCIPAL INVESTIGATOR</b>	R. C. Culler, R. L. Hanson, and others	
<b>OBJECTIVES</b>	To evaluate water salvage by phreatophyte control on a flood plain typical of the areas of existing and proposed application.	
<b>SIGNIFICANT RESULTS</b>	<p>A 16-mile reach of the Gila River flood plain in southeastern Arizona was used to determine water salvage by the removal of phreatophytes consisting primarily of saltcedar (<i>Tamarix pentandra</i>). Water-budget data collected during the 9-year study (1963-71) defined evapotranspiration rates for various amounts of vegetative cover. These evapotranspiration rates were used to determine a consumptive use coefficient expressed in terms of plant cover and macro-climatic conditions, thus enabling extrapolation of the results to other areas of a similar environment.</p> <p>Included in the study is a comprehensive error analysis of the 12 components comprising the water budget, an evaluation of the application of infrared-color aerial photography used to develop a spectral signature of the vegetative cover, and an evaluation of evapotranspiration from up to 20,000 acres of exposed areas on San Carlos Reservoir located immediately downstream from the study reach.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Burkham, D. E., 1970, Precipitation, streamflow, and major floods at selected sites in the Gila River drainage basin above Coolidge Dam, Arizona: U.S. Geol. Survey Prof. Paper 655-B, 33 p.</p> <p>Burkham, D. E., and D. R. Dawdy, 1970, Error analysis of streamflow data for an alluvial stream: U.S. Geol. Survey Prof. Paper 655-C, 13 p.</p> <p>Burkham, D. E., 1972, Channel changes of the Gila River in Safford Valley, Arizona, 1846-1970: U.S. Geol. Survey Prof. Paper 655-G, 24 p.</p> <p>Culler, R. C., 1965, The Gila River Phreatophyte Project: Proceedings 9th Annual Arizona Watershed Symposium, p. 33-38.</p> <p>_____, 1970, Application of infrared color photography to the description of flood plain vegetation: Proceedings of the workshop on aerial color photography in the plant sciences, Gainesville, Florida Dept. of Agr., p. 159-164.</p> <p>_____, 1970, Water conservation by removal of phreatophytes: EOS Trans. American Geophys. Union, 51:10, p. 684-689.</p>	



\_\_\_\_\_, 1970, Application of remote sensing to hydrology in the Arizona regional ecological test site: Proc. Arizona Regional Ecological Test Site Workshop, October 29, 1970, p. 53-55.

Culler, R. C., and others, 1970, Objectives, methods, and environment - Gila River Phreatophyte Project, Graham County, Arizona: U.S. Geol. Survey Prof. Paper 655-A, 25 p.

Culler, R. C., and R. M. Turner, 1970, Relation of remote sensing to transpiration of flood plain vegetation: Second Annual Earth Resources Aircraft Program Status Review, National Aeronautics and Space Administration, v. 3, p. 37-1 to 37-8.

Culler, R. C., 1971, Application of remote sensing on the Gila River Phreatophyte Project, San Carlos Indian Reservation, Arizona: Applied Remote Sensing of Earth Resources in Arizona, Proc. 2nd Arizona Regional Ecological Test Site Symposium, November 2-4, 1971, p. 65-72.

Culler, R. C., J. E. Jones, and R. M. Turner, 1972, Quantitative relationship between reflectance and transpiration of phreatophytes - Gila River Test Site: 4th Annual Earth Resources Aircraft Program Status Review, National Aeronautics and Space Administration, p. 83-1 to 83-9.

Hanson, R. L., F. P. Kipple, and R. C. Culler, 1972, Changing the consumptive use on the Gila River flood plain, southeastern Arizona, in Age of changing priorities for land and water: Proceedings ASCE Irr. and Drain. Div. Specialties Conf., Sept. 1972, p. 309-330.

Hanson, R. L., 1972, Subsurface hydraulics in the area of the Gila River Phreatophyte Project: U.S. Geol. Survey Prof. Paper 655-F, 27 p.

\_\_\_\_\_, 1973, Evaluating the reliability of specific-yield determinations: U.S. Geol. Survey Jour. Research, 1:3, p. 371-376.

McQueen, I. S., 1972, Soil-moisture and energy relationships associated with riparian vegetation near San Carlos, Ariz.: U.S. Geol. Survey Prof. Paper 655-E, 51 p.

Turner, R. M., 1970, Measuring vegetation from Ektachrome infrared aerial photographs: Proc. Arizona Regional Ecological Test Site Workshop, October 29, 1970, p. 56-59.

\_\_\_\_\_, 1971, Measurement of plant community cover from aerial photographs: Third Annual Earth Resources Aircraft Program Status Review, National Aeronautics and Space Administration, v.3, p. 50-1 to 50-8.

\_\_\_\_\_, 1971, Measurement of spatial and temporal changes in vegetation from color IR film: Proceedings, International Workshop on Earth Resources Survey Systems, Ann Arbor, Mich., May 3-15, 1971, p. 513-525 and Proceedings, Am. Soc. of Photogramm., ACSM Fall Convention, September 1971, 16 p.

\_\_\_\_\_, 1973, Quantitative and historical evidence of vegetation changes along the upper Gila River, Arizona: U.S. Geol. Survey Prof. Paper 655-H. (In press.)

Weist, W. G., Jr., 1971, Geology and ground-water system, Gila River Phreatophyte Project: U.S. Geol. Survey Prof. Paper 655-D, 22 p.

Culler, R. C., R. M. Turner, and J. E. Jones, Evapotranspiration and transpiration, in Manual of remote sensing, R. G. Reeves, ed.: Am. Soc. of Photogramm., chap. 8, v. 2, In press.

Culler, R. C., R. L. Hanson, and J. E. Jones, Relation of consumptive use coefficient to the description of vegetation: Special symposium on Evaporation and Transpiration from Natural Terrain, Am. Geophys. Union, San Francisco, Calif., in preparation.

Jones, J. E., Evapotranspiration calculated using color infrared photography as a vegetation measurement - Techniques and applications: U.S. Geol. Survey Prof. Paper 655 - in preparation.

\_\_\_\_\_, Interception, in Manual of remote sensing, R. G. Reeves, ed.: Am. Soc. of Photogramm., chap. 8, v. 2., In press.

\_\_\_\_\_, Application of color-infrared photography to evapotranspiration research, in Proceedings Fourth Annual Conference on Remote Sensing in Arid Lands: Tucson, Arizona. In press.

**Coordinating Council Resolution No. I.43 Evaporation Reduction From Open Surfaces**

**VI.1.24.1. Problem and expected results**

Conservation of water stored in surface reservoirs is especially important in arid areas, where water losses through evaporation may amount to as much as 2.5 metres per year. In addition to water loss, evaporation causes some reduction in the quality of stored water because of the increased concentration of dissolved salts in the residual water. Various reports on experimental evaporation suppression indicate savings of 10 to 30 per cent. The whole field needs further study and possibly some new approaches.

**2. Work to be undertaken**

Much work remains to be done, not only on seeking and testing monomolecular chemical films which cause no damage to the quality of water or to the aquatic biota, but also the effects of size and shape of the reservoir and its location in regard to the local micro-climate and the prevailing winds. In view of the extensive research already under way in several countries, wider exchange of current information and ideas in this field are suggested.

**Resolution No. I.43**

The Council,

Requests the Secretariat to inform all the Member States of this proposed activity;

Recommends to those which wish to participate therein to notify the Secretariat and to send in detailed information on the proposed research, for co-ordinating purposes.

<b>TITLE</b>	<b>Evaporation Reduction from Open Surfaces - Air Bubbling Technique Studies in California</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.43 Evaporation Reduction from Open Surfaces</b>	<b>US/IHD ref: 3.1(76)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Building 25 Denver Federal Center Lakewood, Colorado	
<b>PRINCIPAL INVESTIGATOR</b>	G. E. Koberg	
<b>OBJECTIVES</b>	Studies will be made on the problem of trying to maintain a degree of stratification throughout the summer heating period.	
<b>SIGNIFICANT RESULTS</b>	The experiment to de-stratify El Capitan reservoir near Escondido, California by the air bubbling technique was started in June, 1965. The contents of the reservoir at that time were 15,000 acre-feet. The time required to reach a nearly stratified condition was one week, but continuous operation of the equipment through the summer was required to maintain the dissolved concentration in the hypolimnion near 60 percent of saturation. The net savings in evaporation was estimated at 140 acre-feet or 5 percent of the annual evaporation.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Koberg, G. E., A demonstration of thermal destratification by an air-bubbling technique: U.S. Geol. Survey Water-Supply Paper, in preparation.</p> <p>Koberg, G. E. and M. E. Ford, Jr., 1965, Elimination of thermal stratification in reservoirs and the resulting benefits: U.S. Geol. Survey Water-Supply Paper 1809-M, 28 p.</p> <p>Fast, A. W., 1968, Artificial destratification of El Capitan Reservoir by aeration, Part I, effects on chemical and physical parameters: Calif. Dept. of Fish and Game, Fish Bulletin 141, 97 p.</p> <p>Busby, M. W., 1973, Air injection at Lake Cachuma, California: U.S. Geol. Survey open-file report, 31 p.</p>	

<b>TITLE</b>	<b>Mechanics of Evaporation</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.43 Evaporation Reduction from Open Surfaces</b>	<b>US/IHD ref: 1.3(322)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Bldg. 25, Denver Federal Center Lakewood, Colorado 80225	
<b>PRINCIPAL INVESTIGATOR</b>	G. E. Koberg	
<b>OBJECTIVES</b>	<p>To develop a relation to measure evaporation using the mass-transfer approach which will apply to any open water surface.</p> <p>To develop a technique to reduce evaporation losses from stock ponds utilizing plastic films.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>A mass-transfer equation has been developed based on the measurement of wind at 2 and 4 meters, the air temperature and humidity at 2 meters, and the temperature of the water surface. All measurements are made at the same location over water and only represent the evaporation rate at that location. The equation utilizes the ratio of the wind between 2 and 4 meters and requires a correction for atmospheric stability. Using Lake Hefner data, the results by the relationship were generally within 5 percent or less of the monthly evaporation results by the water budget. Although the relationship has not been used extensively in other investigations, where it has been used the results were in good agreement with other methods of measuring evaporation.</p> <p>Floating covers of plastic film have been tested on stock ponds for the purpose of reducing evaporation. The problems of using plastic covers are the degradation of the plastic by ultraviolet radiation and anchoring the cover such that the wind will not remove it from the water surface. The most successful covers were fabricated from polyethylene foam having a thickness of 3 millimeters. By bonding a white acrylic film (0.08 millimeter in thickness) to the foam to protect it from ultraviolet radiation, a cover was maintained in place on a stock pond for two years. At the end of two years the bond between the film and foam deteriorated and the wind removed the film from the foam.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	None	

**Coordinating Council Resolution No. I.44 Dynamics of Lakes and Reservoirs**

**VI.1.25.** The purpose of this research is to understand the processes, both thermodynamic and hydrodynamic, which occur in natural and artificial lakes. Included in the research are such themes as:

- (a) thermodynamic regimes of lakes and reservoirs, including thermal stratification and circulation;
- (b) wind-driven circulations;
- (c) movement and deposition of sediments;
- (d) time-dependent changes in lakes and reservoirs through sedimentary, biological and chemical processes.

**Resolution No. I.44**

**The Council,**

**Requests the Secretariat to inform all the Member States of the proposals for research on dynamics of lakes and reservoirs;**

**Recommends to those countries who wish to participate therein to contact the Secretariat and to send in detailed information on the proposed research, for co-ordinating purposes;**

**Requests the Secretariat to draw the attention of Member States to the forthcoming symposium on lakes which will be organized in Garda (Italy) in 1966 by the IASH and the University of Padua in co-operation with Unesco.**

TITLE	International Field Year for the Great Lakes	
Coordinating Council Resolution in force and short title	I.44 Dynamics of Lakes and Reservoirs III.15 Regional Cooperation	US/IHD ref: 2.7 (79)
ORGANIZATION IN CHARGE OF ACTIVITY	US/Canadian Joint Steering Committee for IFYGL (JSC/IFYGL) US/Canadian Joint Management Team for IFYGL (JMT/IFYGL)	
PRINCIPAL INVESTIGATOR	<p>U.S. Co-chairman of JSC/IFYGL: W. J. Drescher                  U.S. Geological Survey                  University of Wisconsin                  1815 University Avenue                  Madison, Wisconsin 53706</p> <p>U.S. Co-chairman of JMT/IFYGL: E. J. Aubert                  Great Lakes Environmental                  Research Laboratory                  2300 Washtenaw Avenue                  Ann Arbor, Michigan 48104</p> <p>U.S. part, Biological/Chemical Component:                  T. T. Davies                  Grosse Ile Field Station                  9311 Groh Road                  Grosse Ile, Michigan 48138</p> <p>A full list of participating organizations is given here to indicate the broad involvement of the IFYGL program.</p> <p>GOVERNMENT -- NATIONAL</p> <p style="text-align: center;"><u>Canada</u></p> <p><u>Department of Energy, Mines and Resources</u>                  Canada Centre for Remote Sensing                  Great Lakes Research Division                  Geological Survey of Canada</p> <p><u>Department of the Environment (Environment Canada)</u>                  Atmospheric Environment Service                  Central Services Directorate                  Hydrometeorology and Marine Applications Division                  Environmental Management Service                  Inland Waters Directorate                  Canada Centre for Inland Waters                  Great Lakes - St. Lawrence Study Office                  Water Survey of Canada                  Tides and Water Levels Section                  Canadian Wildlife Service                  Fisheries and Marine Service                  Marine Sciences Directorate                  Canadian Hydrographic Service                  Atlantic Oceanographic Laboratory                  Fisheries Research Board</p> <p><u>National Museum of Canada</u></p>	

National Research Council of Canada  
Canadian National Committee for the International  
Hydrological Decade  
National Aeronautical Establishment

Ministry of Transport  
Canadian Marine Transportation Agency  
Prescott Marine Agency

GOVERNMENT -- STATE/PROVINCIAL

Ontario Department of Health  
Air Pollution Control Service

Ontario Ministry of the Environment  
Division of Laboratories and Research  
Division of Water Resources  
Water Quality Branch  
Water Quantity Management Branch  
River Basin Research Section

Ontario Ministry of Natural Resources  
Glenora Fisheries Station  
Lake Erie Fisheries Research Station

Royal Ontario Museum

NON-GOVERNMENTAL -- ACADEMIC

Dalhousie University

McGill University

McMaster University  
Centre for Applied Research and Engineering Design  
Department of Geography

Queen's University

Trent University

University of British Columbia  
Institute of Oceanography

University of Guelph

University of Toronto  
Great Lakes Institute  
Institute of Environmental Sciences and Engineering

University of Waterloo

University of Windsor

Denmark  
University of Copenhagen



GOVERNMENT -- NATIONAL

United States

Department of Commerce

National Oceanic and Atmospheric Administration  
Atlantic Oceanographic and Meteorological Laboratory  
Center for Experiment Design and Data Analysis  
Environmental Research Laboratories  
Environmental Satellite Service  
Lake Survey Center  
National Weather Service  
Research Flight Facility

Department of Defense

U.S. Army: Corps of Engineers (Detroit District)  
U.S. Air Force: Air Weather Service

Department of the Interior

Bureau of Sport Fisheries and Wildlife  
Great Lakes Fisheries Laboratory  
U.S. Geological Survey

Department of Transportation

U.S. Coast Guard  
Federal Aviation Agency

Environmental Protection Agency

Rochester Field Office of Region II  
Grosse Ile Field Station of the National Environmental  
Research Center, Corvallis, Oregon  
(Office of Research and Development)

National Aeronautics and Space Administration

Lewis Research Center  
Environmental Research Laboratories

National Science Foundation

Illinois State Water Survey

New York State Department of Environmental Conservation

NON-GOVERNMENT -- ACADEMIC

Cape Fear Technical Institute

Colorado State University

Cornell University

Cornell Aeronautical Laboratory

Manhattan College

Northwestern University

Pennsylvania State University

State University of New York

Buffalo  
Albany  
Oswego

University of Miami (Florida)

University of Michigan  
Great Lakes Research Division  
Willow Run Laboratory

University of Nevada  
Desert Research Institute

University of Washington

University of Wisconsin  
Great Lakes Center  
University of Wisconsin-Milwaukee

Woods Hole Oceanographic Institution

NON-GOVERNMENTAL - PRIVATE

Canada

ERA Instruments

NON-GOVERNMENTAL - PRIVATE

United States

Calspan Corporation

Center for the Environment and Man

General Electric, Inc.

National Academy of Sciences-National Research Council  
United States National Committee for the International  
Hydrological Decade

OBJECTIVES

To investigate in depth, through an integrated and fully coordinated group of research programs, a number of basic unsolved, or only partially solved, physical problems associated with the hydrology, meteorology, physical limnology and geology of one of the Great Lakes and its drainage basin. In brief, these programs although fundamental in nature, will seek to improve man's knowledge of the available fresh water supply for such widely diverse purposes as domestic and industrial usages, navigation, power, recreation and sewage disposal. In connection with the last named, studies will be directed at obtaining a better understanding of the physical factors which affect the dispersal of pollutants in the lake.

The decision to concentrate on the physical processes of Lake Ontario and its basin was taken deliberately and with full recognition of the immediate importance of ecological and pollution problems. It was felt that a detailed understanding of the physical processes in Lake Ontario and its basin was basic to any understanding of its chemical, biological, and nutrient cycles. A Biology-Chemistry Program was added as a major component to satisfy the growing interest of scientists and water managers in both countries.

#### SIGNIFICANT RESULTS

Up to through 1974, the principal significant result of planning, which began in 1966, was the successful completion of the data collection phase - the Field Year - which continued from April 1972 through March 1973.

The major research subjects included -

- 1) Causes of lake-level variations as related to precipitation, evaporation and surface - and ground-water supply.
- 2) The relative accuracy and utility of various methods of measuring evaporation.
- 3) The nature of modification of climate by large water masses.
- 4) The formation and dissipation of lake ice.
- 5) The movement of water in the lake, including its circulation, diffusion properties and waves (both surface and internal).
- 6) The physical factors affecting the chemical, biological and materials balance of a large body of water, including consideration of eutrophication, pollution and sedimentation.

These major objectives were undertaken through 151 tasks, or projects, 72 of which were done by the United States and 79 of which were done by Canada. A list of these tasks, too long to be itemized here, is given in the report entitled *Two Nations, One Lake-Science in Support of Great Lakes Management* (see below). Hundreds of scientists and researchers participated from federal and state and provincial agencies and from academic and private organizations.

As one result, literally millions of bits of information were collected. They are now being analyzed and computer-stored. Many publications have been published and more are in preparation. The publication and data archival plan consists of the following items:

1. Official Publications
  - a. Technical Plan (See below)
  - b. IFYGL Bulletin (See below)
  - c. Technical Manuals (See below)
    - i. summaries of available techniques
    - ii. evaluation of IFYGL systems
  - d. Scientific reports (scheduled for publication 1975-1977)
    - i. Terrestrial Water Budget Report
    - ii. Lake Meteorology Report
    - iii. Energy Balance Report

- iv. Evaporation Synthesis
- v. Biology and Chemistry Report (3 vols.)
- vi. Water Movement Report
- vii. Atmospheric Boundary Layer Report
- viii. IFYGL Program Report
- e. Summary Reports of the Program
  - i. Objectives and Activities-1965-1973-  
(See below)
  - ii. IFYGL Symposia (See below)
  - iii. IFYGL Atlas
- 2. Scientific papers in journals and in proceedings volumes (listed in part in IFYGL Bulletins; q.v.; complete list available eventually from data archives.)
- 3. Data Archives (including summaries, an inventory of collected data, a catalog of archival contents, and a description of the data collected.)

**REPORTS AVAILABLE  
PUBLICLY**

Canadian and U.S. Joint Management Team, 1972, International Field Year for the Great Lake - IFYGL Technical Plan, duplicated report,  
volume 1 - Scientific Program, 439 p.  
volume 2 - Data Acquisition Systems, 461 p.  
volume 3 - Field Operations Plan, 269 p.  
volume 4 - Data Management Plan, 110 p.  
plus 604 pages of annexes.

Hansen, A. L., J. W. Wilson, L. F. Jenkins, and L. A. Weaver, 1973, IFYGL Tech Manual Series No. 4, United States IFYGL Office, National Oceanic and Atmospheric Administration, Rockville, Maryland, 48 p.

International Field Year for the Great Lakes, IFYGL Bulletin, published at intervals by the National Oceanic and Atmospheric Administration, Rockville, Maryland

No. 1,	January	1972,	37 p.
2,	March	1972,	38 p.
3,	May	1972,	86 p.
4,	September	1972,	120 p.
5,	December	1972,	120 p.
6,	April	1973,	67 p.
7,	July	1973,	91 p.
8,	October	1973,	78 p.
9,	February	1974,	82 p.
10,	May	1974,	95 p.
11,	July	1974,	113 p.
12,	October	1974,	66 p.
13,			

International Field Year for the Great Lakes, 1974, Proceedings of the IFYGL Symposium, 55th Annual Meeting of American Geophysical Union, April 8-12, 1974; National Oceanic and Atmospheric Administration, Rockville, Maryland, 169 p.

Latimer, J. R., 1972, Radiation Measurement, IFYGL Tech. Manual Series No. 2, Canadian National Committee for IHD, Ottawa, Canada, 53 p.

Ludwigson, J. O. (ed.), 1974, Two Nations, One Lake-Science in Support of Great Lakes Management-Objectives and Activities of the International Field Year for the Great Lakes 1965-1973, [a report of the Canadian and U.S. National Committees for the IHD], IFYGL Centre, Atmospheric Environment Service, Environment Canada, Downsview, Ontario, 145 p.

\_\_\_\_\_, Heindl, L. A., and Brown, I. C., 1974, International Field Year for the Great Lakes - Objectives, Scientific Programme and Organization, Nature and Resources, vol. 10, no. 2, p. 2-9.

Palmer, M. D., 1972, Measurement of Currents on the Great Lakes, IFYGL Tech. Manual Series No. 3, Canadian National Committee for IHD, Ottawa, Canada, 32 p.

Robertson, Andrew, 1974, U.S. IFYGL Shipboard Data Acquisition System, United States IFYGL Office, National Oceanic and Atmospheric Administration, Rockville, Maryland, 39 p.

Wilson, R. G., 1971, Methods of Measuring Soil Moisture, IFYGL Tech. Manual Series No. 1, Canadian National Committee for IHD, Ottawa, Canada, 19 p.

<b>TITLE</b>	<b>Stratified Flow in Lakes, Reservoirs, and Large Rivers</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.44 Dynamics of Lakes and Reservoirs</b>	<b>US/IHD ref: 3.1(164)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Tennessee Valley Authority Engineering Lab. Knoxville, TN 37902</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>E. H. Lesesne</b>	
<b>OBJECTIVES</b>	<b>To develop methods for predicting water movements and temperature changes in flowing streams and reservoirs that result from both natural and man-induced influences.</b>	
<b>SIGNIFICANT RESULTS</b>	<p><b>Advancement was made in the development of computation methods for the mathematical representation of the thermo-hydrromechanics of reservoirs.</b></p> <p><b>In addition, laboratory studies were made to determine the effect that various discharge structures at stream power plants had on the mixing of heated water at the discharge point.</b></p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>TVA Engineering Laboratory, 1972, Heat and Mass Transfer between the Water Surface and the Atmosphere, Water Resources Research Lab Report No. 14, Norris, Tennessee.</b></p> <p><b>TVA Engineering Laboratory, 1969, Evaluation of Fontana Reservoir Field Measurements, Water Resources Research Report No. 18, Norris, Tennessee.</b></p> <p><b>Wunderlich, W. O. and R. A. Elder, The Mechanics of Stratified Flow in Reservoirs, Reservoir Fishery Resources Symposium, University of Georgia, Athens, published by the American Fisheries Society, Washington, D.C.</b></p> <p><b>Wunderlich, W. O., 1971, The Dynamics of Density Stratified Reservoirs, Reservoir Fisheries and Limnology, G. E. Hall, ed., Special Publication No. 8, American Fisheries Society, Washington, D.C.</b></p>	

<b>TITLE</b>	<b>Changes in the Biota of Lakes Erie and Ontario</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.44 Dynamics of Lakes and Reservoirs</b>	<b>US/IHD ref: 3.10(213)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Buffalo Society of Natural Sciences Research Foundation of the State University of New York Buffalo, New York</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>R. A. Sweeney</b>	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<p>During the period 1955-1965 there has been an increased concern with the changes that have occurred in Lakes Erie and Ontario. Of particular alarm to the general public has been the rapid decline of game and commercial fish, and the marked increase in the less desirable species. Likewise, the flora has altered both in quantity and quality. As a result, several programs to study the biota of these lakes are being developed and intensified.</p> <p>Believing that all scientific investigators could gain through mutual cooperation and coordination a conference was held on the changes in the biota of Lakes Erie and Ontario. The program dealt with three topics: results of previous investigations, technical problems associated with such studies, and areas in which additional research would be of most value.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Sweeney, R. A. (editor), 1969, Proceedings of a Conference on Changes in the Biota of Lakes Erie and Ontario, Bulletin of the Buffalo Society of Natural Sciences, Buffalo, New York, 25:1, 84 p.</p>	

TITLE	Changes in the Chemistry of Lakes Erie and Ontario	
Coordinating Council Resolution in force and short title	I.44 Dynamics of Lakes and Reservoirs	US/IHD ref: 3.10(214)
ORGANIZATION IN CHARGE OF ACTIVITY	Buffalo Society of Natural Sciences Research Foundation of the State University of New York Buffalo, New York	
PRINCIPAL INVESTIGATOR	R. A. Sweeney	
OBJECTIVES AND SIGNIFICANT RESULTS	<p>During the period 1955-1970 there has been increasing concern with changes that have occurred on Lakes Erie and Ontario. Of particular alarm to the general public has been the rapid decline of game and commercial fish, closing of beaches and deterioration in the quality of drinking water from these lakes. In 1968 a conference was held at the State University College at Buffalo on changes in the biology of Lakes Erie and Ontario.</p> <p>Among the comments received on the first conference was a request for a similar conference on the chemical aspects of these lakes. Thus, this second conference was organized.</p> <p>The program dealt with three topics - results of previous investigations, technical problems associated with such studies, and areas in which additional research would be of value.</p>	
REPORTS AVAILABLE PUBLICLY	Sweeney, R. A. (editor), 1971, Proceedings of the Conference on Changes in the Chemistry of Lakes Erie and Ontario, Bulletin of the Buffalo Society of Natural Sciences, Buffalo, New York, 25:2, 85 p.	



**Coordinating Council Resolution No. I.48 Application of Mathematical Models for Run-Off Prediction in Various Climatic and Physiographic Regimes**

**VI.2.2.1. Problem and expected results**

Hydrological models which synthesize the hydrological cycle from the ground until it leaves the watershed as streamflow or evapotranspiration can complement process-oriented hydrological research. An effective model will permit evaluation of the importance of specific processes and the testing of results or hypotheses derived from other research. In addition to their role in basic hydrological research, hydrological models offer promise as research auxiliaries for evaluating natural and artificial changes in hydrological regimes.

**2. Work to be undertaken**

Existing models require further testing on data representing a variety of hydrological regimes from all parts of the world. Such testing will lead to refinements in some models, elimination of others as unrealistic, and possibly to development of new models. It will also provide data necessary to relate model parameters with physical characteristics of the watersheds. In order to carry out this programme, the necessary input data must be collected on a continuous basis from selected representative watersheds around the world.

**Resolution No. I.48**

**The Council**

**Requests the Secretariat to inform all Member States of the proposals for research on the application of mathematical models for run-off prediction in various climatic and physiographic regimes and to envisage the organization of a symposium on this matter;**

**Recommends to those which wish to participate therein to notify the Secretariat and to send in detailed information on the proposed research, for co-ordinating purposes.**

<b>TITLE</b>	<b>Runoff Evaluation and Streamflow Simulation by Computer</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.48 Application of Mathematical Models for Runoff Prediction in Various Climatic and Physiographic Regimes</b>	<b>US/IHD ref: 3.3 (201)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>North Pacific Engineering Division U.S. Army Corps of Engineers Portland, Oregon</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>James A. Anderson</b>	
<b>OBJECTIVES</b>	<b>To develop a mathematical model of basin runoff resulting from rainfall and snowmelt which incorporates varying soil moisture and evapo-transpiration indices.</b>	
<b>SIGNIFICANT RESULTS</b>	<p><b>The Streamflow Synthesis and Reservoir Regulation (SSARR) Program is designed to create a mathematical hydrologic model of a river system through the use of an electronic digital computer. Streamflows can be synthesized by evaluating the entire hydrological process of snowmelt and/or rainfall runoff for all significant points throughout a river system.</b></p> <p><b>Drainage basins can be separated into homogeneous hydrologic units of a size and character which can be used as a logical delineation of major drainage into its component subdrainages. Channel storage can be specified for channel reaches to present the natural delay to be encountered in a complex river system. Storage effects of lakes and man-made reservoirs can be evaluated in accordance with free-flow conditions or specified conditions of reservoir storage or withdrawn. Streamflows can be thus developed for all key locations on the main system and tributary rivers.</b></p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Anderson, J. A., 1971, Runoff Evaluation and Streamflow Simulated by Computer, North Pacific Engineering Division, U.S. Army Corps of Engineers, Portland, Oregon.</b></p> <p><b>U.S. Army Engr Div., North Pacific, 1972, User Manual for COSSARR Model Streamflow Synthesis &amp; Reservoir Regulation, Portland, Oregon.</b></p> <p><b>U.S. Army Engr Div., North Pacific, 1972, Application of the SSARR Model to the Upper Paraguay River Basin (prepared for the UNDP/UNESCO Project: Hydrological Studies of the Upper Paraguay River Basin, Brazil), Portland, Oregon.</b></p> <p><b>U.S. Army Engr Div., North Pacific, 1972, Program Description &amp; Use Manual for SSARR Model Streamflow Synthesis &amp; Reservoir Regulation, Program 724-K5-G0010, Portland, Oregon (Revised Dec 72).</b></p>	

<b>TITLE</b>	<b>Deterministic Hydrologic Systems Modeling</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.48 Application of Mathematical Models for Runoff Prediction in Various Climatic and Physiographic Regimes</b>	<b>US/IHD ref: 2.4(166)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Dept. of Civil Engineering University of Illinois at Urbana-Champaign Urbana, Illinois 61801</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>V. T. Chow University of Illinois at Urbana - Champaign Urbana, Illinois 61801</b>	
<b>OBJECTIVES</b>	<b>To develop deterministic mathematical models for hydrologic systems.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>A general lumped deterministic model has been developed to simulate hydrologic systems.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Chow, V.T. and V.C. Kulandaiswamy, 1971, General hydrologic systems model, Journal of the Hydraulics Division, ASCE, 97: HY6, 791-804.</b></p> <p><b>Chow, V.T., 1972, Hydrologic modeling - The Seventh John R. Freeman Memorial Lecture, Proceedings, Boston Society of Civil Engineers, 60: 5, 1-27.</b></p> <p><b>Chow, V.T. and V.C. Kulandaiswamy, 1972, Discussion on general hydrologic system model, Journal of the Hydraulics Division, ASCE, 98: HY10, 1873-1874.</b></p> <p><b>Chow V.T. and V.C. Kulaidaiswamy, 1972, General hydrologic system model, Transactions, ASCE, 137, 704.</b></p>	

<b>TITLE</b>	<b>Hydrodynamic Modeling of Watersheds</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>1.48 Application of Mathematical Models for Runoff Prediction in Various Climatic and Physiographic Regimes</b>	<b>US/IHD ref: 2.1 (116)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Dept. of Civil Engineering University of Illinois at Urbana-Champaign Urbana, Illinois 61801	
<b>PRINCIPAL INVESTIGATOR</b>	Dr. Ven Te Chow Hydrosystems Laboratory	
<b>OBJECTIVES</b>	<p>(1) To develop laboratory instrumentation for controlled experiments on rainfall and runoff relationship of watersheds.</p> <p>(2) To investigate the hydrodynamics of flow of surface water on watersheds.</p> <p>(3) To develop hydrodynamic models of watersheds.</p>	
<b>SIGNIFICANT RESULTS</b>	A Watershed Experimentation System (WES) was developed for the project and can produce an artificial storm for runoff studies under laboratory controlled conditions. It was used to verify the theories that were proposed for determining the effect on runoff due to moving rainstorms. Also, several hydrodynamic watershed models (Illinois Hydrodynamic Watershed Models [IHMM] I, II, III, and IV) were developed and tested by the WES.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Chow, V. T., 1964, Artificial Raindrops for Laboratory Watershed Experimentation, Transactions, American Geophysical Union, 45:4, 611.</p> <p>Harbaugh, T. E. and V. T. Chow, 1965, Raindrop Production for Laboratory Watershed Experimentation, Journal of Geophysical Research, 70:24, 6111-6119.</p> <p>Harbaugh, T. E. and V. T. Chow, 1966, Raindrop Production for Laboratory Watershed Experimentation, Civil Engineering Studies, Hydraulic Engineering Series, No. 12, University of Illinois, 9 p.</p> <p>Chow, V. T., 1967, Laboratory Study of Watershed Hydrology, Proceedings, the International Hydrology Symposium, Fort Collins, Colorado, Paper no. 26, vol. 1, 194-202.</p> <p>Harbaugh, T. E. and V. T. Chow, 1967, A Study of the Roughness of Conceptual River Systems or Watersheds, Proceedings, XII Congress of the International Association for Hydraulic Research, Paper no. A2, vol. 1, 9-17, Fort Collins, Colorado.</p> <p>Chow, V. T., 1967, Laboratory Study of Watershed Hydrology, Civil Engineering Studies, Hydraulic Engineering Series no. 14, University of Illinois, 9 p.</p>	

Harbaugh, T. E. and V. T. Chow, 1967, A Study of the Roughness of Conceptual River Systems on Watersheds, Civil Engineering Studies, Hydraulic Engineering Series no. 15, University of Illinois, 9 p.

Chow, V. T. and B. C. Yen, 1974, A Laboratory Watershed Experimentation System, Civil Engineering Studies, Hydraulic Engineering Series no. 27, University of Illinois, 196 p.

Hsie, C. H., V. T. Chow, and B. C. Yen, 1974, The Evaluation of a Hydrodynamic Watershed Model (IHW Model IV), Civil Engineering Studies, Hydraulic Engineering Series no. 28, University of Illinois, 143 p.

Shen, Y. Y., B. C. Yen, and V. T. Chow, 1974, Experimental Investigation of Watershed Surface Runoff, Civil Engineering Studies, Hydraulic Engineering Series no. 29, University of Illinois, 197 p.

<b>TITLE</b>	<b>Water Resources Systems Analysis</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.48 Application of Mathematical Models for Runoff Prediction in Various Climatic and Physiographic Regimes</b>	<b>US/IHD ref: 5.1(173)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Dept. of Civil Engineering University of Illinois at Urbana - Champaign Urbana, Illinois 61801</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>Dr. Ven Te Chow, Hydrosystems Laboratory University of Illinois at Urbana-Champaign, Urbana, Illinois 61801</b>	
<b>OBJECTIVES</b>	<b>To develop advanced methodologies for the analysis of water resources systems.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Several advance techniques for the optimization of water resources systems have been developed, and are discussed in the report listed below.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Chow, V.T. 1968, Hydrologic Systems for water resources management, Conference Proceedings, Water Resources Institute Report No. 4, Clemson University, Clemson, South Carolina, 8-22.</b></p> <p><b>Chow, V.T. and D.D. Meredith, 1969, Water resources systems analysis - Part I. Annotated Bibliography on Stochastic Processes, Civil Engineering Studies, Hydraulic Engineering Series No. 19, University of Illinois, 80 p.</b></p> <p><b>Chow, V.T. and D.D. Meredith, 1969, Water resources systems analysis - Part II. Annotated Bibliography on Programming Techniques, Civil Engineering Studies, Hydraulic Engineering Series No. 20, University of Illinois, 45;., July 1969.</b></p> <p><b>Chow, V.T. and D.D. Meredith, 1969, Water resources systems analysis - Part III. Review of Stochastic Processes, Civil Engineering Studies, Hydraulic Engineering Series No. 21, University of Illinois, 100 p.</b></p> <p><b>Chow, V.T. and D.D. Meredith, 1961, Water resources systems analysis - Part IV. Review of Programming Techniques, Civil Engineering Studies, Hydraulic Engineering Series No. 22, University of Illinois, 70 p.</b></p> <p><b>Chow, V.T. and B.B. Ewing, 1969, Advanced Civil Engineering Planning Technology, Proceedings of a Short Course, Department of Civil Engineering, College of Engineering, The University of Illinois at Urbana-Champaign, 204 p.</b></p> <p><b>Windsor, J.S. and Chow V.T., 1970, A Programming Model for Farm Irrigation Systems, "Civil Engineering Studies, Hydraulic Engineering Series No. 23, University of Illinois at Urbana-Champaign, 95 p.</b></p>	

**Chow, V.T. 1970, Systems Approaches in hydrology and water resources, In The Progress in Hydrology, Proceedings, The First International Seminar for Hydrology Professors, Vol. 1, 490-509.**

**Heidari, M., V.T. Chow and D.D. Meredith, 1971, Water Resources Systems Analysis by Discrete Differential Dynamic Programming, Civil Engineering Series No. 24, University of Illinois at Urbana-Champaign, 118 p.**

**Heidari, M., Chow V.T., Kokotovic P. V. and D. D. Meredith, 1971, The discrete differential dynamic programming approach to water resources systems optimization, Water Resources Research, 7:2, 273-282.**

**Chow, V.T., 1971, General report on optimal operation of water resources system, Proceedings, International Symposium on Mathematical Models in Hydrology, Warsaw, Poland, Separate Volume, p. 1-9.**

**Windsor J.S. and V.T. Chow, 1971, Model for farm irrigation in humid areas, Journal of the Irrigation and Drainage Division, ASCE, 97: IR3, 369-285.**

**Chow, V.T., 1971, Methodologies for Water Resources Planning: DDDP and MLOM(TLOM), Water Resources Center, Research Report No. 47, University of Illinois at Urbana-Champaign, 50 p.**

**Windsor J.S. and V.T. Chow, 1972, Multireservoir optimization model, Journal of the Hydraulics Division, 98: HY10, 1827-1845, October 1972.**

<b>TITLE</b>	<b>Mathematical Models for Streamflow Prediction</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.48 Application of Mathematical Models for Runoff Prediction in Various Climatic and Physiographic Regimes</b>	<b>US/IHD ref: 3.8 (49)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	D. L. Fread Hydrologic Research Laboratory	
<b>OBJECTIVES</b>	<p>To investigate and develop a feasible streamflow routing model which can provide stages and discharges when: (1) the flow is affected by backwater conditions due to tributaries, reservoirs, tides, mild bottom slopes, (2) the river is a complex system interconnected with diversion channels, and (3) the stream is subject to significant transmission losses.</p> <p>To investigate the feasibility of modeling stage-discharge relations affected by: (1) transient flow dynamics and (2) changes to the elevation and shape of alluvial channel bottoms due to sediment transport.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>A mathematical model to predict stages and discharges has been developed and is currently being tested. The model is based on an implicit finite difference solution of the St. Venant equations of continuity and motion. This model is capable of simulating transient backwater conditions caused by downstream reservoir operations and tributary discharge. Also, wave propagation in an up-stream direction due to tides and storm surges can be simulated with the model. The implicit solution technique enables the use of relatively large time steps which makes the model economically feasible for long duration transients.</p> <p>A mathematical model based on the St. Venant equations has been developed to determine stage-discharge relations affected by transient flow conditions. The model has been demonstrated on "loop" relations using data pertaining only to the location of the stage-discharge relation. Using known (observed or predicted) discharges or stages, the model determines the associated stage or discharge respectively.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Amein, M., 1972, Numerical Simulation of Unsteady Flows in Rivers and Reservoirs, Contract No. O-3528 Report, 72 p.</p> <p>Fread; D. L., 1973, Effects of Time Step Size in Implicit Dynamic Routing, Water Resources Bulletin, American Water Resources Association, 9:2, 338-351.</p>	



**Fread, D. L., 1973, A Technique for Implicit Dynamic Flood Routing in River with Major Tributaries, Water Resources Research, American Geophysical Union 9:4, 918-926.**

**Fread, D. L., 1973, A Dynamic Model for Stage-Discharge Relations Affected by Changing Discharge, NOAA Technical Memorandum NWS Hydro-16, U.S. Department of Commerce, NWS, NOAA.**

<b>TITLE</b>	<b>USDAHL-70 Model of Watershed Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.48 Application of Mathematical Models for Runoff Prediction in Various Climatic and Physiographic Regimes</b>	<b>US/IHD ref: 2.4 (274)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Agricultural Research Service, U.S. Dept. of Agriculture Soil and Water Conservation Research Division, Beltsville, MD 20705</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>H. N. Holtan</b>	
<b>OBJECTIVES</b>	<b>To develop a hydrologic model applicable to 4 ARS experimental watersheds representing a diversity of climate and physiography.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>A mathematical model of watershed hydrology has been designed to serve the purposes of agricultural watershed engineering. The model is currently a series of empiricisms selected to provide a mathematical continuum from ridge top to watershed outlet in terms of input information readily available to the analyst. The model is intended to help bridge the gap between theory and practice by providing a framework in which basic knowledge can be applied to watershed engineering.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Holtan, H. N., and N. C. Lopez, 1971, USDAHL-70 model of watershed hydrology, Technical Bulletin No. 1435, Agricultural Research Service, U.S. Dept. of Agriculture, Washington, D.C.</b></p> <p><b>Revision of USDAHL-70 completed. Snowmelt program included. Also routines for calculating movement of agricultural chemicals programmed.</b></p> <p><b>Yen, C. L., G. H. Comer, and H. N. Holtan, 1973, USDAHL-74 Flood Routing Method, Plant Physiology Institute Report No. 7, Agricultural Research Service, U.S. Dept. of Agriculture, Washington, D.C.</b></p>	

<b>TITLE</b>	<b>Hydrological Models</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.48 Application of Mathematical Models for Runoff Prediction in Various Climatic and Physiographic Regimes</b>	<b>US/IHD ref: 3.8 (14)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	Walt Sittner John Monro Eric Anderson Hydrologic Research Laboratory	
<b>OBJECTIVES</b>	The Weather Service has a continuing research program directed toward the derivation of improved hydrological models for deriving streamflow from observations of precipitation, snowcover and other meteorological factors influencing evaporation and taking into account the physical characteristics of the area.	
<b>SIGNIFICANT RESULTS</b>	A program of model testing, involving four hydrological models developed in the U.S., has been completed. As a result of this program, one conceptual model, a modification of the Stanford Watershed Model, has been adopted for use in river forecasting by the National Weather Service. A second testing program, similar to the first but international in scope, is now under way. It is being sponsored by the World Meteorological Organization.	
<b>REPORTS AVAILABLE PUBLICLY</b>	National Weather Service River Forecast System, Forecast Procedures, NOAA Technical Memorandum NWS Hydro-14, U.S. Department of Commerce, Silver Spring, Md., Dec., 1972.  Sittner, W. T., C. E. Schauss, & J. C. Monro, 1969, Continuous Hydrograph Synthesis with an API Type Hydrologic Model, Water Resources Research, 5:5.  Sittner, W. T., 1973, Modernization of National Weather Service River Forecasting Techniques, 1973, Water Resources Bulletin, Am. Water Resources Assoc., 9:4.  Monro, J. C., and E. A. Anderson, National Weather Service River Forecasting System, (submitted for publication) ASCE, Journal of the Hydraulics Division.  Monro, J. C., 1971, Direct Search Optimization in Mathematical Modeling and a Watershed Model Application, NOAA Technical Memorandum NWS Hydro-12, U.S. Department of Commerce, Washington, D.C.	

<b>TITLE</b>	<b>Mountain Snow and Ice Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.48 Application of Mathematical Models for Runoff Prediction in Various Climatic and Physiographic Regimes</b>	<b>US/IHD ref: 1.7 (328)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Geological Survey Water Resources Division 1305 Tacoma Avenue South Tacoma, Washington 98402</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>Wendell V. Tangborn Lowell A. Rasmussen</b>	
<b>OBJECTIVES</b>	<ol style="list-style-type: none"><li>1. To construct rational models of the processes that comprise the hydrologic cycle in mountain areas where snow is an important element. Input is presently limited to synoptic meteorological and hydrological data currently collected in the areas of interest.</li><li>2. Ultimately to develop a real time, operational model of the water balance of mountain watersheds using the theories and techniques found in (1) One purpose of this model would be to forecast streamflow on a daily or seasonal basis.</li></ol>	
<b>SIGNIFICANT RESULTS</b>	Utilizing standard precipitation and runoff data in the North Cascades of Washington, a first stage, simplified model of mountain water balance was developed which produces snowmelt streamflow forecasts with accuracy comparable to current snow survey methods. The altitude and time (which are interrelated) distribution of potential streamflow (total water storage) is determined with this model, thus making it possible in the spring to forecast summer and fall streamflow with reasonable accuracy.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Rasmussen, L. A., and W. V. Tangborn, Runoff and precipitation characteristics of the North Cascade Range and a proposed hydrometeorological streamflow forecasting method. <u>In preparation.</u>	

Coordinating Council Resolution No. I.49 Automatic Processing of Hydrological Data

VI.2.3.1. Problems and expected results

This investigation proposes to improve on methods of processing and publication of hydrological information, as well as the use of such methods for forecast operations and dissemination of this information by the use of data processing equipment and computers. As a result new methods of collection, processing and publication as well as transmission of observational data must be elaborated and introduced.

2. Work to be undertaken

2.1 Mechanization of the initial processing of observations received from automatic and semi-automatic stations.

2.2 Mechanization and partial automation of the processing of data for preparation and publication of hydrological yearbooks.

2.3 Elaboration of methods for automatic processing of hydrological data, including the analysis of such data, standardization of forms for presenting this information.

2.4 Investigation by digital computer of the laws of statistical distribution of the fundamental characteristic of the hydrological regime.

2.5 Solution of hydrological and hydraulic problems by digital and analogue computers.

Resolution No. I.49

The Council,

Requests the Secretariat to inform all the Member States of this proposed activity;

Recommends to those which wish to participate therein to notify the Secretariat and to send in detailed information on the proposed research, for co-ordinating purposes.

<b>TITLE</b>	<b>Design Characteristics for a National System to Store, Retrieve and Disseminate Water Data</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.49 Automatic Processing of Hydrological Data</b> <b>V.6 Standardization</b>	<b>US/IHD ref:</b> <b>5.2(318)</b> <b>5.1(330)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Office of Water Data Coordination</b> <b>U.S. Geological Survey</b> <b>National Center, MS 417</b> <b>Reston, Va. 22092</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>G. W. Whetstone</b>	
<b>OBJECTIVES</b>	<b>To develop a national system of water data management which would facilitate the exchange of water data between collector and user organizations in both the Federal and non-Federal community.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>(1) The development of design characteristics for the system by the Federal Interagency Advisory Committee on Water Data;</b>  <b>(2) Detailed design of the National Water Data Exchange (NAWDEX).</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Federal Interagency Water Data Handling Work Group, 1971, Design Characteristics for a National System to Store, Retrieve and Disseminate Water Data, U.S. Geological Survey, Office of Water Data Coordination, 31 p.</b>  <b>Doyel, W. W., and S. M. Lang, 1972, NAWDEX - A system for improving accessibility to water data, Proceedings of Symposium on Watersheds in Transition, Amer. Water Resources Assoc., p. 91-97.</b>	

**Coordinating Council Resolution No. I.50 Mathematical Analysis of Streamflow and Precipitation Sequences**

**VI.2.4.1. Problem and expected results**

Most hydrological variables and processes are stochastic. Therefore, the theories of probability, of stochastic processes, and mathematical statistics are the main mathematical methods for analysis of hydrological processes. The gap between modern accomplishments in the theories of probability, stochastic processes, and mathematical statistics, on the one hand, and their application to hydrological processes, on the other is about 25 years.

**2. Work to be undertaken**

Without limiting the scope of work under this activity, the following are some of the topics to be studied:

- (1) methods of determining probabilities in hydrology;
- (2) application of stochastic processes and time-series analysis to hydrological processes;
- (3) use of mathematical statistics in describing hydrological processes, as well as in drawing maximum information from a given amount of basic hydrological data;
- (4) use of theory of errors and control methods in analysing reliability and quality of hydrological data;
- (5) use of mathematical statistics in generalization and description of hydrological characteristics of an environment.

**Resolution No. I.50**

**The Council,**

**Requests the Secretariat to inform all Member States of the Mathematical Analysis of Streamflow and Precipitation Sequences;**

**Recommends to interested Member States who wish to participate therein to notify the Secretariat and to provide detailed information on the proposed research for co-ordinating purposes.**

<b>TITLE</b>	<b>Application of Remote Sensing to Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.50 Mathematical Analysis of Streamflow and Precipitation Sequences</b>	<b>US/IHD ref: 2.4(308)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	International Business Machines Corporation Federal Systems Division 150 Sparkman Drive Huntsville, Alabama	
<b>PRINCIPAL INVESTIGATOR</b>	Reuben Ambaruch Principal Investigator	J. W. Simmons Study Manager
<b>OBJECTIVES</b>	To assess the feasibility of using data produced by remote observations from space and/or aircraft to reduce the time and expense normally involved in achieving the ability to predict the hydrological behavior of an ungaged watershed.	
<b>SIGNIFICANT RESULTS</b>	<p>The study was conducted in three phases, calibration, correlation, and validation, aimed at devising a set of widely applicable observable characteristics (such as climatology, areas, elevation, and land use) and inferable characteristics (such as soil depth and porosity).</p> <p>The five validation runs produced simulated streamflows which correlated remarkably well with observed streamflow. Daily correlation coefficients ranged from 0.83 to 0.87; monthly, from 0.92 to 0.97. Many major storms were reasonably well matched with respect to peak flows and timing of peaks. For a multi-year open-loop simulation, this is adequate for most applications, and it strongly indicates the feasibility of using remotely sensed data to forecast the hydrologic performance of an ungaged watershed.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>IBM Federal Systems Division, 1973, Application of remote sensing to hydrology: Final technical report: IBM No. 73W 00387, Huntsville, Alabama, 112 p.</p> <p>_____, 1972, Application of remote sensing to hydrology; Technical progress report: IBM NO. 73W-00089, Huntsville, Alabama, 100 p.</p> <p>_____, 1971, Earth Resources Evaluation Study (Series H-1): Progress report: IBM No. 71W-00375, Huntsville, Alabama, 150 p.</p> <p>_____, 1974, A Study of remote sensing as applied to regional and small watersheds; Final summary report, vol 1: IBM No. 74W-00175, Huntsville, Alabama, 40 p.</p>	



<b>TITLE</b>	<b>Stochastic Hydrologic Systems Modeling</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.50 Mathematical Analysis of Streamflow and Precipitation Sequences</b>	<b>US/IHD ref: 2.4(311)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Dept. of Civil Engineering University of Illinois at Urbana-Champaign Urbana, Illinois 61801	
<b>PRINCIPAL INVESTIGATOR</b>	Dr. Ven Te Chow, Hydrosystems Laboratory University of Illinois at Urbana-Champaign Urbana, Illinois 61801	
<b>OBJECTIVES</b>	To develop stochastic mathematical models for hydraulic systems.	
<b>SIGNIFICANT RESULTS</b>	Various stochastic hydrologic systems models have been developed, and are discussed in the reports listed below.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Chow, V.T. and S. Ramaseshan, 1965, Sequential generation of rainfall and runoff data. Journal of Hydraulics Division, ASCE, 91: HY4, Pt. 1, 205-23.</p> <p>Chow, V.T. and S. Ramaseshan, 1965, Sequential generation of rainfall and runoff data. Civil Engineering Studies, Hydraulic Engineering Series, No. 11, University of Illinois, 19 p.</p> <p>Chow, V.T. and S. Ramaseshan, 1966, Discussion of sequential generation of rainfall and runoff data, Journal of the Hydraulics Division, ASCE, 92, HY4, 162-165.</p> <p>Chow, V.T. and S. Ramaseshan, 1966, Sequential generation of rainfall and runoff data, Transactions, ASCE, 131, 696-697.</p> <p>Chow, V.T. 1969, Stochastic analysis of hydrologic systems, Research Report No. 26, Water Resources Center, University of Illinois at Urbana-Champaign, 34 p.</p> <p>Chow, V.T. and S.J. Kareliotis, 1970, Analysis of stochastic hydrologic systems, Water Resources Research, 6: 6, 1569-1582.</p> <p>Chow, V.T. Stochastic hydrologic systems, In Systems Approach to Hydrology, Proceedings, U.S.-Japan Bi-Lateral Seminar in Hydrology, Honolulu, Hawaii, Water Resources Publications, Fort Collins, Colorado, p 1.1-1.19; discussion, p. 1.22-1.23.</p>	

**Chow, V.T. 1971, Stochastic approach in hydraulics, Hydraulic Engineering, Chinese Institute of Hydraulic Engineers, 13, 199-201.**

**Chow, V.T. 1971, Stochastic analysis of hydraulic systems, Proceedings, Fourteenth Congress of the International Association for Hydraulic Research, 5, 265-271.**

**Chow, V.T. Stochastic hydraulics - a challenging field of study, In Stochastic Hydraulics, Proceedings, International Symposium on Stochastic Hydraulics, University of Pittsburgh, 3-8.**

**Chow, V.T. and S.J. Kareliotis, 1972, Reply to comments on analysis of stochastic hydrologic systems, Water Resources Research, 8; 163-165.**

**Kareliotis, S.J. and V.T. Chow, 1972, Analysis of residual hydrologic stochastic processes, Journal of Hydrology, 15: 2, 133-140.**

**Chow, V.T. and T. Prasad, 1972, Theory of stochastic modeling of watershed systems, Journal of Hydrology, 15; 4, 261-284.**

**Torelli, L. and V.T. Chow, 1972, Tests of stationarity of hydrologic time series, Proceedings, International Symposium on Uncertainties in Hydrologic and Water Resources Systems, Vol. 1, University of Arizona, Tucson, Arizona, 254-72.**

**Chow, V.T. 1973, Analysis of multiple-input stochastic hydrologic systems, Research Report No. 67, Water Resources Center, University of Illinois at Urbana-Champaign, Urbana, Illinois, 66p.**

<b>TITLE</b>	<b>Mathematical Analysis of Streamflow and Precipitation Sequences</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.50 Mathematical Analysis of Streamflow and Precipitation Sequences</b>	<b>US/IHD ref: 2.4 (152)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Dept. of Civil Engineering Stanford University Stanford, CA 94305	
<b>PRINCIPAL INVESTIGATOR</b>	R. K. Linsley N. H. Crawford	
<b>OBJECTIVES</b>	To develop a procedure for the generation of stochastic hourly rainfall data at several stations.  To develop a procedure to simulate monthly rainfall by stochastic methods and the generation of equivalent monthly streamflow.	
<b>SIGNIFICANT RESULTS</b>	The Stanford Watershed Model - a digital simulation model - has been developed and tested on watersheds with varying hydrologic regimens. The simulated streamflow was shown to correlate well with the observed streamflow and an average correlation coefficient of 0.99 was obtained for the basins tested.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Crawford, N. H. and R. K. Linsley, 1966, Digital Simulation in Hydrology: Stanford Watershed Model IV, Technical Report No. 39, Dept. of Civil Engr., Stanford University, Stanford, CA, 210 p.	

Coordinating Council Resolution No. I.57 Radar Measurement of Rainfall

VI.2.11.1. Problem and expected results

Information about rainfall within large areas while the event is in progress is difficult and expensive to obtain by conventional methods, especially during thunderstorm activity. Work already accomplished shows that radar has considerable potential use for this purpose.

2. Work to be undertaken

Current research on methods should be continued and accelerated in order to increase the amount of hydrological information than can be routinely obtained by radar, and to improve its applicability to specific events.

Resolution No. I.57

The Council,

Requests the Secretariat in consultation with WMO to inform all Member States of this proposed activity - Radar Measurement of Rainfall;

Recommends that those countries who wish to participate therein notify the Secretariat and send in detailed information on the proposed research, for co-ordinating purposes.

<b>TITLE</b>	<b>Evaluation of Radar and Raingage Systems for Flood Forecasting</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.57 Radar Measurement of Rainfall</b>	<b>US/IHD ref: 3.8 (287)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	Walter M. Grayman                      Massachusetts Institute of Technology Peter S. Eagleson                      Cambridge, Massachusetts 02139	
<b>OBJECTIVES</b>	The objective of this study is to determine some of the requirements of the information collections system for real time hydrologic forecasting. More specifically, the determination of the optimal precipitation measuring systems for use in hydrologic forecasting is studied. This includes the design of the network and the determination of the best methodology for operating the system. The following results are based on hypothetical, but representative physical and economic data.	
<b>SIGNIFICANT RESULTS</b>	<ol style="list-style-type: none"> <li>1) Both raingage and radar systems are economically feasible over a wide range of economic situations.</li> <li>2) The optimal configuration consists of raingages only. Considering only the single network purpose of flood forecasting, the use of radar is not justified.</li> <li>3) The optimal density of raingages ranges from one raingage per 200 square miles to one raingage per 400 square miles depending on the level of economic development within the flood plain.</li> <li>4) The use of radar must be justified by its application in other fields such as weather prediction in addition to its use in flood warning systems.</li> </ol>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Grayman, W. M., and P. S. Eagleson, 1971, Evaluation of Radar and Raingage Systems for Flood Forecasting, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, No. 138, M.I.T., Cambridge, Mass.</p> <p>Mejía, J. M., and Ignacio Rodríguez-Iturbe, 1973, Multi-dimensional Characterization of the Rainfall Process, Part I: Synthetic Generation of Hydrologic Spatial Processes, Part II: On the Transformation of Point Rainfall to Areal Rainfall, No. 177, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, M.I.T., Cambridge, Mass.</p> <p>Rodríguez-Iturbe, Ignacio, and J. M. Mejía, 1973, The Design of Rainfall Networks in Time and Space, No. 176, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, M.I.T., Cambridge, Mass.</p>	

<b>TITLE</b>	<b>Areal Rainfall Measurements by Radar</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>I.57 Radar Measurement of Rainfall</b>	<b>US/IHD ref: 3.8 (16)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 3060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	D. R. Greene	
<b>OBJECTIVES</b>	To derive reliable areal quantitative precipitation patterns from digital radar data for operational river and flood forecasting purposes.	
<b>SIGNIFICANT RESULTS</b>	An automated system has been developed and is being tested under operational conditions at four stations to derive areal quantitative precipitation estimates based on digital radar data and to communicate these data to the user in a timely mode. It has been shown that the areal estimates can be improved by integrating the radar data with data obtained from a network of raingages. Also, it has been shown feasible to automatically collect rain gage data in the real-time by use of Devices for Automatic Remote Data Collection (DARDC's). Procedures are under development to improve the quality of areal precipitation estimates for operational purposes through the automated integration of digital radar data with rain gage data collected by use of the DARDC's.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Braatz, T., and R. A. Clark, 1972, Comparative Analyses for the Prediction of Streamflow from Small Watersheds by Use of Digitized Radar Data, Texas A&amp;M, College Station, Texas.</p> <p>Clark, R. A., Y. T. Canipe, and D. R. Greene, 1972, Applications of Digital Radar Data in Both Meteorology and Hydrology, 15th Radar Meteor. Conf., American Met. Society.</p> <p>Greene, R., 1971, Numerical Techniques for the Analysis of Digital Radar Data with Applications to Meteorology and Hydrology, Texas A&amp;M, College Station, Texas.</p> <p>Hudlow, D., 1972, Use of Radar Data from D/RADEX for Operational Hydrology, 15th Radar Meteor. Conf., American Met. Society.</p> <p>Hudlow, D., 1973, Use of Digital Radar Data in Operational Hydrology, National Meeting, ASCE, Washington, D.C.</p>	

Peck, E. L., Larson, L. W., Wilson, J. W., 1974,  
Lake Ontario Snowfall Observational Network for  
Calibrating Radar Measurements, US/IHD Symposium,  
Monterey, Calif., Dec. 1973.

Wilson, J. W., 1971, Use of Rain Gages to Adjust  
Radar Estimates of Rainfall, CEM, Hartford, Conn.

Coordinating Council Resolution No. III.1 Decade Stations

Resolution No. III.1<sup>(1)</sup>

The Council,

1. Recalling resolutions I.1, I.2, I.3 of its first session and II.6 of its second session;
2. Considering the reports of the working group on exchange of information and world water balance;
3. Notes with appreciation that the majority of countries have forwarded to the IHD Secretariat some information for publication of standard observations at selected Decade stations but recognizes that the information received is still incomplete and not uniform;
4. Urges national committees who have not already done so to send all information required by the Secretariat in the forms concerning basic information on Decade stations in accordance with the letter of the IHD Secretariat of 26 April 1967, as follows: river, lake, pan evaporimeter, lysimeter and groundwater stations, giving priority to river stations;
5. Requests the IHD Secretariat to publish the Introductory Volume to publications on the standard observational data from international hydrological decade stations of the world before the end of 1967. Publication should be in loose leaf or similar form to permit additions and changes of information which will be received at a later date.

(1) This resolution supersedes resolution 1.2.



<b>TITLE</b>	<b>Decade Lysimeter Stations - Compilation of Data</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>III.1 Decade Stations</b>	<b>US/IHD ref: 1.3 (139)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Agricultural Research Service U.S. Dept. of Agriculture Beltsville, Maryland 20705</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>H. N. Holtan</b>	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<b>Compiled descriptive data for U.S. network of Decade lysimeter stations.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>U.S. National Committee for the IHD, 1972, Catalog of International Hydrological Decade stations and networks in the United States, National Academy of Sciences - National Research Council, Washington, D.C., 5 p., 2 tables, and 1 fig.</b>	

<b>TITLE</b>	<b>Catalog of IHD Stations and Networks in the United States</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>III.1 Decade Stations</b>	<b>US/IHD ref: 1.3 (337)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. National Committee for IHD National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	R. L. Nace	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	To provide an index of hydrological fluctuations and trends on regional and national scales in the United States as a contribution to IHD compilation of such data on a worldwide basis. Suitable stations were selected from existing national networks and these have been combined into international networks. Suitable stations of the following types were provided: Precipitation (no index stations selected); Pan-evaporation (40); lysimeter (12); river-discharge gages (82); lake-level gages (23); groundwater observation wells (34); water-quality measuring sites (94); representative and experimental basins (60); hydrological bench marks (46); glacier basins (5); vigil stations (58); and reference climatological sites (17).	
<b>REPORTS AVAILABLE PUBLICLY</b>	U.S. National Committee for the IHD, 1972, Catalog of International Hydrological Decade Stations and Networks in the United States, National Academy of Sciences-National Research Council, Washington, D.C., 66 p.	

<b>TITLE</b>	<b>Discharge of Decade River Stations (U.S. Stations)</b>	
<b>Coordinating Council Resolution in force and short title</b>	III.1 Decade Stations	US/IHD ref: 1.6(99)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	(Address inquiries to Branch of Surface Water)	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	Routine data collection on 82 selected stations on major rivers, usually near their mouth, provides baseline data on discharge, chemical quality, sediment, and temperature for UNESCO/IHD compilations of discharge and related data of selected rivers of the world. The U.S. Stations provide an integral part of an international network which may be used to establish indices of river-flow fluctuations and trends on a worldwide basis.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>U.S. National Committee for the IHD, 1972, Catalog of International Hydrological Decade Stations and Networks in the United States, National Academy of Sciences-National Research Council, Washington, D.C., p. 6-7, table 3, and fig. 2.</p> <p>Discharge and related records for the 82 selected stations are indicated in publications of the U.S. Geological Survey in the series of Water-Supply Papers entitled "Surface Water Supply of the United States." Inquiries regarding data for specific stations should be addressed as indicated above. Abstracts of these records are contained in the following UNESCO/IHD publications:</p> <p>UNESCO, 1969, List of International Hydrological Decade Stations of the World, UNESCO Studies and Reports in Hydrology no. 6, p. 35-36.</p> <p>UNESCO, 1969-71, Discharge of Selected Rivers of the World, UNESCO Studies and Reports in Hydrology no. 5, part I, General and regime characteristics of stations selected, p. 28-30; part II, Monthly and annual discharges recorded at selected stations (from start of observations up to 1964), p. 61-90; and part III, Mean monthly and extreme discharges (1965-1969), p. 37-50.</p>	

**Coordinating Council Resolution No. III.15 Regional Cooperation**

**Resolution No. III.15<sup>(1)</sup>**

**The Council,**

- 1. Recalling resolutions I.66 and II.15 of its previous sessions;**
- 2. Stressing the importance of close co-operation between countries sharing common basins or situated in regions with similar hydrologic conditions;**
- 3. Noting with satisfaction progresses achieved in various regions in the development of common projects related to the IHD programme;**
- 4. Invites national committees to continue their efforts to promote regional scientific co-operation in the framework of IHD activities and to make necessary arrangements for those basins or areas where such co-operation has not been already established.**

(1) This resolution supersedes resolutions nos. I.66 and II.15.

<b>TITLE</b>	<b>Directory of Hydrological, Hydrometeorological, and Water Resources Agencies in the Caribbean Area</b>	
<b>Coordinating Council Resolution in force and short title</b>	III.15 Regional co-operation	<b>US/IHD ref:</b> 5.3 (160)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. National Committee for the IHD National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	L. A. Heindl	
<b>OBJECTIVES</b>	To improve communication between the various hydrological, hydrometeorological, and water resources agencies in the Caribbean area.	
<b>SIGNIFICANT RESULTS</b>	A directory, organized by Country and State, was prepared which lists pertinent information on hydrological, hydro-meteorological, and water resources agencies in the Caribbean area. For each entry, the agency name, person to contact, address, and statement of function is given.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Directory of Hydrological, Hydrometeorological, and Water Resources Agencies in the Caribbean Area. Prepared for distribution at the Hydrology Session of the 5th Caribbean Geology Conference, St. Thomas, U.S. Virgin Islands, July 1-7, 1968.	

<b>TITLE</b>	<b>Aerial Photography of Chilean Glaciers</b>	
<b>Coordinating Council Resolution in force and short title</b>	III.15 Regional Cooperation I.13 Glacial Variations I.14 Mass-balance Measurements	<b>US/IHD ref:</b> 5.3(134)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Water Resources Division Tacoma, Washington 98402	
<b>PRINCIPAL INVESTIGATOR</b>	Austin Post	
<b>OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. Establish an annual glacier aerial photographic program, the work to be done by the Chilean Air Force. The U.S. Geological Survey planned the proposed photography, recommended equipment, and trained Air Force personnel.</li> <li>2. Investigate likely sites for future, detailed mass and heat balance studies on individual glaciers and make recommendations.</li> </ol>	
<b>SIGNIFICANT RESULTS</b>	The severe droughts in recent years in Central Chile focused attention on the importance of glaciers as a water resource at critical times. Glacier inventories of portions of the central and northern areas of the country are being prepared on the basis of the UNESCO guidelines. In cooperation with the U.S. Geological Survey special aerial photography missions were flown in Central Chilean Andes, far southern Andes, and Tierra del Fuego.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Post, Austin, 1970, Glaciers in the central Chilean Andes and their importance to water resources: U.S. Geol. Survey, Tacoma, Wash., open-file report.  Muller, F., and C. S. L. Ommanney, The contribution of glacier ice to the World Water Balance. Proc. Symposium on World Water Balance, IAHS Pub. 94, v. 3, 1970, p. 539-552.	

Coordinating Council Resolution No. IV.8 Measurement of Precipitation Including  
Snow and Snow Pack

Resolution IV.8 (1)

The Council,

1. Recalling resolution I.52 of its first session, which recognizes that the methods and instrumentation for measuring snow fall and snow pack are inadequate under adverse conditions;
2. Considering that deficiencies in precipitation measurements represent an important source of error in the establishment of water balances, and that knowledge of areal distribution of precipitation is needed in most hydrological problems;
3. Recognizing that broadening of current research is necessary and that more research should be undertaken to overcome these deficiencies;
4. Recognizes the responsibility of WMO to produce guidance material on the measurement of precipitation (including snow fall and snow on the ground) and particularly to improve the accuracy of measurements;
5. Suggests that WMO consider acting as the technical secretariat for these projects and offer the means of promoting these activities;
6. Invites the WMO to supply countries with the outline of the research which is to be undertaken at experimental installations including those in experimental and representative basins;
7. Recommends, in order to broaden the participation, that those national committees that wish to participate in these activities inform the Secretariat and send in detailed information on the proposed research;
8. Invites the IASH to provide counsel to WMO on these projects.

(1) This resolution supersedes resolution I.52.

<b>TITLE</b>	<b>Measurement of Snowfall-Snowpack Characteristics</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>IV.8 Measurement of Precipitation Including Snow and Snowpack</b>	<b>US/IHD ref: 3.8(11)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	E. L. Peck L. W. Larson V. C. Bissell	
<b>OBJECTIVES</b>	Existing methods of measuring snowfall and water equivalent of snowpacks are notably inaccurate under adverse climate conditions and there has been endless discussion at international meetings of the need for research to overcome these difficulties. National Weather Service research is directed towards improvement in point measurements and development of airborne remote sensing system for water equivalent measurement.	
<b>SIGNIFICANT RESULTS</b>	<p>Considerable improvement in solid precipitation measurements has been achieved through proper site selection and gage shielding. Analytical techniques for improving point measurements of precipitation have been investigated and found to be quite useful at times.</p> <p>The airborne measurement of natural gamma radiation shows considerable promise for improving areal estimates of snow cover water equivalent.</p> <p>The use of natural gamma radiation measurement techniques have been tested for ground based sensors.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Barnes, J. C. and C. J. Bowley, 1969, Satellite Surveillance of Mountain Snow in the Western United States, Allied Research Associates, Inc., Baltimore, Md.</p> <p>Larson, L. W., 1972, Approaches to Measuring 'True Snowfall', 29th Annual Meeting, Eastern Snow Conference, Oswego, N.Y.</p> <p>Johnson, M. L. and E. Anderson, 1968, The Cooperative Snow Hydrology Project - ESSA Weather Bureau and ARS Sleepers River Watershed, Eastern Snow Conference, Boston.</p> <p>Peck, E. L., et al., 1971, Evaluation of Snow-Water Equivalent by Airborne Measurement of Passive Gamma Radiation, Water Resources Research, 7:5, 1151-1159.</p> <p>Peck, E. L. and V. C. Bissell, 1973, Aerial Measurement of Snow Water Equivalent by Terrestrial Gamma Radiation Survey, Bull. International Assoc. Hydro Sciences, XVIII:1.</p>	



Bissell, V. C. and E. L. Peck, 1973, Measurement of Snow at a Remote Site: Natural Radioactive Technique, Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, US/IHD, Monterey, Calif.

Bissell, V. C., 1973, Natural Gamma Spectra Peak Method for Snow Measurement from Aircraft, Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, US/IHD, Monterey, Calif.

Peck, E. L., L. W. Larson, and J. W. Wilson, 1973, Lake Ontario Snowfall Observational Network for Calibrating Radar Measurements, Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, US/IHD, Monterey, Calif.

Peck, E. L., 1973, Review of Methods of Measuring Snow Cover, Snowmelt, and Streamflow Under Winter Conditions, presented at International Symposia on the Role of Snow and Ice in Hydrology, Banff, Canada.

Peck, E. L., 1972, Snow Measurement Predicament, Water Resources Research, 8:1.

Fritzsche, A. E. and Z. G. Burson, 1972, Aerial Snow Gauging Using National Terrestrial Gamma Radiation, E G & G, 1183-1557, Las Vegas Division, Las Vegas, Nevada.

Coordinating Council Resolution No. IV.13 Technical Assistance

Resolution No. IV.13<sup>\*</sup>

The Council,

1. Recalling resolution III.16 of the third session of the Co-ordinating Council;
2. Reaffirms the recommendations in that resolution;
3. Noting the direct appeal in the speech of the Director-General of Unesco to the Council on 6 May 1968; for positive recommendations;
4. Suggests that the Director-General bring to the attention of Member States and of the UNDP, the necessity of hydrological studies prior to development projects to improve the basis for planning and construction; and toward that end;
5. Recommends establishment of;
  - (a) demonstration or pilot projects to verify and demonstrate the use of modern scientific methods and equipment in hydrological studies;
  - (b) bilateral or multilateral international co-operative studies of important rivers, groundwater basins, or other units or phenomena having mutual interest;
6. Recommends consideration of the UNDP for financing of such projects;
7. Requests national committees to recommend to universities that they develop a system whereby a university or institution in an advanced country, and a comparable one in a developing country, establish and maintain mutually beneficial relations, such as exchange of professors, joint research on common problems, improvement of curricular, teaching aids and laboratory facilities, etc.;
8. Requests the Secretariat to prepare for the next session of the Council a plan of action for carrying out these and other related recommendations of the Council.

\* Ed. Note: Resolution No. IV.13 is a little more emphatic and specific rewording of No. III.16.

<b>TITLE</b>	<b>Cooperative Studies in Peru</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>IV.13 Technical Assistance</b>	<b>US/IHD ref: 3.9(285)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Army Corps of Engineers The Hydrologic Engineering Center Davis, California 95616</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>E. F. Hawkins</b>	
<b>OBJECTIVES</b>	<p>The primary objective of this study was to develop stream-flow estimation techniques for the coastal basins of Peru. Streamflow could then be estimated for ungaged basins and their potential yield determined. The project faced several data problems which had to be resolved in order to accomplish the objective. First, the existing data base of monthly streamflows was either non-existent or unorganized. Second, most of the existing streamflow measurements included the effects of regulation. Third, there were few data on the hydrologic and physiographic characteristics of the basins where streamflow measurements existed.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>Preliminary results have been submitted to ONERN, Peru for their review. These results include the complete series of analyses and computations from the development of the raw data base to the equations for estimating streamflow for ungaged streams. The estimating equations were derived from a multiple linear regression analysis of the average monthly streamflows and the physiographic characteristics of the watersheds. The physiographic data were collected by Peru for 15 typical watersheds. A 50 year data base of average monthly flows was derived by estimating missing values for 100 stream stations from rather sparse raw daily flow data. This was accomplished in four steps: first, translation of raw data to punched cards; second, editing for consistency and computation of average monthly flows; third, removal of regulation effects; and fourth, estimation of missing monthly streamflows. Missing flows were determined by statistical analyses using the Corps of Engineers "Generalized Computer Program, HEC-4, Monthly Streamflow Simulation."</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>A formal report on this project and other aspects of Peru's natural resources will be available from the Oficina Nacional de Evaluacion de Recursos Naturales (ONERN). No final results are available at this time.</p> <p>An interim technical paper entitled, "Estimating Monthly Streamflows Within a Region" by Leo R. Beard, et al., is available from The Hydrologic Engineering Center.</p>	

<b>TITLE</b>	<b>Cooperative Studies in Guatemala</b>	
<b>Coordinating Council Resolution in force and short title</b>	IV.13 Technical Assistance I.22 Continental Drought	<b>US/IHD ref:</b> 3.9(209)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Army Corps of Engineers The Hydrologic Engineering Center Davis, California 95616	
<b>PRINCIPAL INVESTIGATOR</b>	E. F. Hawkins A. D. Feldman	
<b>OBJECTIVES</b>	<p>The primary objective of this study was a hydrologic analysis of the potential hydropower development of Lake Atitlan in Guatemala. The Corps of Engineers streamflow and reservoir operation simulation models were used to evaluate the hydrologic feasibility of the project. Lake Atitlan is a sink for a watershed that was cut off by volcanic activity from its natural drainage to the Pacific Ocean. Hydropower is to be generated by tunneling through the volcanic rim on the Pacific side of the lake and running a penstock down the steep slope to the coastal plain. There are very few years of rainfall and runoff records for the watersheds whose rivers will be diverted to the lake.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>The HEC produced a report showing the feasibility for the hydropower operation of the lake under different demand projections for electrical power. Because of the lack of data with which to do the simulation study, it was necessary to perform statistical analyses of the existing rainfall, runoff, and lake surface elevation data in order to reconstruct a continuous historical record. The statistical analyses were accomplished by the "Generalized Computer Program, HEC-4, Monthly Streamflow Simulation", computer program. The recorded and reconstructed streamflows and lake surface elevations were input to the generalized computer program, "Reservoir Yield" to simulate the operation of the lake under different power demand curves. The lake operation was simulated over a 25 year period. Results showed the lake to remain in long-term equilibrium at 90 to 100 percent of the projected power demand depending upon the scheme of development.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>A formal report was submitted to the Guatemalan Government in 1972.</p> <p>Feldman, A. D., 1973, Evaluation of Drought Effects at Lake Atitlan [Guatemala] in Decisions with Inadequate Hydrologic Data, Proceedings of the 2d International Hydrology Symposium, Water Res. Publ., Ft. Collins, Colo., p. 238-251.</p>	

<b>TITLE</b>	<b>Activities with Developing Countries</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>IV.13 Technical Assistance</b>	<b>US/IHD ref: 5.3 (54)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	Eugene L. Peck Hydrologic Research Laboratory	
<b>OBJECTIVES</b>	<p>Working through the Meteorological Service of the respective countries research contracts supported by PL-480 funds have been made with Israel and Yugoslavia. The Israel projects are: (1) statistical, meteorological and depth-area analysis of rainfall by the Israel Meteorological Service; (2) determination of evapotranspiration for short intervals on a karst benchmark basin by the Soil Conservation Service; and (3) precipitation, streamflow and sediment conveyance in a small and arid watershed by Hebrew University.</p> <p>The contract with Yugoslavia involves an experimental representative watershed study with major emphasis on application to river forecasting.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>The following Israeli investigators are working on the various projects: No reports have been received to date.</p> <p>(1) Mr. Rosenan, Israeli Meteorological Service                  (2) Mr. Rosenzweig, Israeli Soil Conservation Service                  (3) Dr. Schick, Hebrew University, Jerusalem</p> <p>Professor Muskatirovic, Jaroslav Cerni Institute, Belgrade, is the Principal Investigator for the Yugoslavia study.</p>	

<b>TITLE</b>	<b>Techniques for Assessing Hydrological Potentials in Developing Countries</b>	
<b>Coordinating Council Resolution in force and short title</b>	IV.13 Technical Assistance	<b>US/IHD ref:</b> 5.3(319)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Office of Science and Technology Agency for International Development Washington, D.C.	
<b>PRINCIPAL INVESTIGATOR</b>	G. C. Taylor, Jr., U.S. Geological Survey	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<p>This report was prepared in connection with the activities of the Planning Group on Science, Technology, and Development established by the Organization for Economic Cooperation and Development. It is intended to serve as a basis for evaluation the current state of the art and research priorities with respect to techniques for assessing hydrological potentials in developing countries. This activity area was selected for analysis due to (1) its importance in the development context, (2) the relative neglect of research in the area by donor countries and international agencies; and (3) the likelihood that additional research will make major contributions to the solution of critical problems.</p> <p>The report describes current capabilities and future needs for assessing hydrological potentials under the following topical headings: Streamflow, Erosion, and Sediment Transport, Water Movement in Unsaturated Soils, Groundwater, Precipitation, Evaporation, and Hydrologic Applications of Remote Sensing.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Techniques for Assessing Hydrological Potentials in Developing Countries (State of the Art and Research Priorities), Office of Science and Technology, Agency for International Development Rept. No. TA/OST 73-17, Washington, D.C., 1973, 66 p.	

Coordinating Council Resolution No. V.2 Hydrology of Carbonate Rocks

Resolution No. V.2<sup>(1)</sup> \*

The Council,

1. Recalling resolutions I.17, II.4, III.4 of its first and third sessions;
- ⋮
5. Notes the difficulties encountered in preparing the map of the hydrology of the carbonate rocks of the Mediterranean Basin and the danger of unjustifiable overlapping with hydrogeological maps in preparation or proposed for Europe and Africa north of the Sahara;
6. Instructs the Working Group to concentrate on fields of carbonate rocks mapping not yet covered;
7. Notes also that the work on the preparation of a guide to the hydrology of carbonate rocks is making good progress;
8. Instructs the working group to avoid duplications in this matter, particularly with those bodies of the Council dealing with ground-water investigations;
9. Expresses its satisfaction with the results achieved and the programme for the future activities of the Working Group on the Hydrology of Carbonate Rocks of the Mediterranean Basin;
10. Thanks the Food and Agriculture Organization for the support so far provided;
11. Invites the FAO to continue to provide the technical secretariat and support for the working group.

(1) This resolution supersedes resolution III.4.

\* Ed. Note: Under this resolution the U.S. National Committee for the International Hydrological Decade established its Work Group on Hydrology of Carbonate Terranes to conduct a program of activities in the United States and adjacent areas as appropriate.

<b>TITLE</b>	<b>Comparison of Chemical Hydrogeology of the Carbonate Peninsula of Florida and Yucatan</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 2.8(197)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	William Back and B. B. Hanshaw	
<b>OBJECTIVES</b>	<p>1) To describe the geochemistry of water in two carbonate terranes, and</p> <p>2) To identify and interpret the effects of various geologic controls on the groundwater flow pattern and on the resulting chemical character of the water.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>Aquifers of the peninsulas of Florida and northern Yucatan are Tertiary marine carbonate formations showing lithologic and faunal similarities. In addition, the tropical to subtropical climates of the two areas are similar, each having annual rainfall of about 1000 to 1500 mm.</p> <p>Despite similarities in these fundamental controls, contrasts in the hydrologic and geochemical systems are numerous and striking. For example, Florida has many rivers; Yucatan has none. Maximum thickness of fresh ground water in Florida is about 700 meters; in the Yucatan it is less than 70 meters. In Florida the gradient of the potentiometric surface averages about 1 meter per kilometer; in the Yucatan it is exceedingly low, averaging about 0.02 meter per kilometer. In Florida the chemical character of water changes systematically downgradient, owing to solution of minerals of the aquifer and corresponding increases in total dissolved solids, sulfate, calcium, and Mg-Ca ratio; in the Yucatan no downgradient change exists, and dominant processes controlling the chemical character of the water are solution of minerals and simple mixing of the fresh water and the body of salt water that underlies the peninsula at shallow depth.</p> <p>Hydrologic and chemical differences are caused in part by the lower altitude of the Yucatan plain. More important, however, these differences are due to the lack of an upper confining bed in Yucatan that is hydrologically equivalent to the Hawthorn Formation in Florida. The Hawthorn cover prevents recharge and confines the artesian water except where it is punctured by sinkholes, but sands and other unconsolidated sediments fill sinkholes and cavities and impede circulation. In the Yucatan the permeability of the entire section is so enormous that rainfall immediately infiltrates to the water table and then moves laterally to discharge areas along the coasts.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Back, William and B. B. Hanshaw, 1970, Comparison of chemical hydrogeology of the carbonate peninsulas of Florida and Yucatan, J. of Hydrology, 10:4, 330-368.	



<b>TITLE</b>	<b>Hydrology in Limestone Areas: Lowrey Draw Watershed, Sonora Texas</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 2.8 (126)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Agricultural Research Service U.S. Dept. of Agriculture Soil and Water Conservation Research Division Beltsville, MD 20705	
<b>PRINCIPAL INVESTIGATOR</b>	C. W. Carlson	
<b>OBJECTIVES</b>	Continue investigations of rainfall-runoff relationships and correlation of changes in groundwater levels with water losses from porous and/or cavernous reservoir basins.	
<b>SIGNIFICANT RESULTS</b>	Beginning in 1961, surveys of geology, soils, topography, and land use and installations of instrumentation for measurements of precipitation, streamflow, groundwater, and seepage of water from 5 reservoirs in an area of 124 square kilometers within the Edwards Plateau region.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Knisel, W. G., 1965, Groundwater studies in the Edwards Plateau of Texas, U.S. Dept. of Agriculture ARS, 41-100.  Blank, H. R., W. G. Knisel, and R. W. Baird, 1966, Geology and groundwater studies in part of the Edwards Plateau of Texas including Sutton and adjacent counties, U.S. Dept. of Agriculture ARS, 41-103.  Knisel, W. G., 1972, Response of Karst Aquifers to Recharge, Colo. State Univ. Hydrology Papers, Number 60: 1-48.	

<b>TITLE</b>	A Losing Drainage Basin in the Missouri Ozarks Identified on Side-Looking Radar Imagery	
<b>Coordinating Council Resolution in force and short title</b>	V.2 Hydrology of Carbonate Rocks	US/IHD ref: 2.8(320)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey 103 W. 10th Street Rolla, Missouri 65401	
<b>PRINCIPAL INVESTIGATOR</b>	G. L. Feder J. H. Barks	
<b>OBJECTIVES</b>	To describe the character of Logan Creek basin, a losing stream basin, on side-looking radar imagery and trace the water lost from the basin to its outlet in an adjoining basin.	
<b>SIGNIFICANT RESULTS</b>	<p>Logan Creek basin, a losing drainage basin in the Missouri Ozarks, is identified on side-looking radar imagery. Owing to the rapid infiltration of precipitation in the Logan Creek basin, erosion and dissection are greatly reduced in comparison with rates of these processes in the surrounding normal or gaining basins. Thus the Logan Creek basin has a more uniform tone and a smoother texture on the side-looking radar imagery than the highly dissected surrounding basins. This distinctive tonal and textural contrast may be useful in identifying other losing drainage basins in carbonate terranes.</p> <p>Rhodamine WT dye, injected in Logan Creek during a low-flow period in October, 1969, was recovered between 3 and 10 days later at Blue Spring in the Current River basin, 10 miles (16 km) to the South.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Feder, G. L. and J. H. Barks, 1972, A Losing Drainage Basin in the Missouri Ozarks Identified on Side-Looking Radar Imagery, U.S. Geol. Survey Prof. Paper 800-C, 249-252.	

<b>TITLE</b>	Hydrologic Study of a Waste-Disposal Problem in a Karst Area at Springfield, Missouri	
<b>Coordinating Council Resolution in force and short title</b>	V.2 Hydrology of Carbonate Rocks VII.9 Hydrological Problems Related to Water Quality	<b>US/IHD ref:</b>  2.8(289)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey 103 W. 10th Street Rolla, Missouri 65401	
<b>PRINCIPAL INVESTIGATOR</b>	E. J. Harvey John Skelton	
<b>OBJECTIVES</b>	To investigate the problems associated with the disposal of municipal and industrial wastes at Springfield, Missouri.	
<b>SIGNIFICANT RESULTS</b>	In a study of a pollution problem in the Springfield area, dye tests, seismic studies, and discharge measurements have proved the existence of a complex naturally developed underground drainage system. Effluent from a sewage plant with secondary treatment travels underground, where it cannot be aerated, and reappears in a downstream spring. Efforts to restrict the effluent to the stream into which it is originally discharged have been only partly successful. Measurements of streamflow and spring discharge show that the natural inflow of water to the spring is large and that it helps to dilute the sewage effluent to a more acceptable level. The primary area of groundwater recharge is agricultural land west of Springfield. Preservation of this area in its present land use and the carrying out of simple corrective measures on the creek carrying the effluent would help alleviate the pollution problem.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Harvey, E. J. and John Skelton, 1968, Hydrologic Study of a Waste-Disposal Problem in a Karst Area at Springfield, Missouri, U.S. Geol. Survey Prof. Paper 600-C, 217-220.	

<b>TITLE</b>	<b>Evaluation of Anomalous Streamflow Patterns by Seepage Runs and Radar Imagery in the Missouri Ozarks</b>	
<b>Coordinating Council Resolution in force and short title</b>	V.2 Hydrology of Carbonate Rocks	US/IHD ref: 2.8(321)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey 103 W. 10th Street Rolla, Missouri 65401	
<b>PRINCIPAL INVESTIGATOR</b>	E. J. Harvey John Skelton	
<b>OBJECTIVES</b>	Relate characteristics of topography as shown on K-band radar imagery to anomalous streamflow patterns in karst.	
<b>SIGNIFICANT RESULTS</b>	Seepage runs and streamflow records are used to locate losing areas in stream basins in the Missouri Ozarks. The karst terrane consists of dolomitic limestone and sandstone of Ordovician and Cambrian age. Side-looking radar imagery emphasizes variations in topography and reveals two types of drainage basin topography, rough and smooth (deeply dissected and slightly dissected basins). In the deeply dissected basins (rough ones) main streams and tributaries generally gain. In the slightly dissected basins (smooth ones), the streams lose a part or all of their flow. On radar imagery the gaining stream basin has a dark tone and rough texture in contrast to the light uniform tone and smooth texture of the losing stream basin. The contrast is due to the difference in degree of dissection.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Harvey, E. J. and John Skelton, 1972, Evaluation of Anomalous Streamflow Patterns by Seepage Runs and Radar Imagery in the Missouri Ozarks, Soc. Mining Engrs. AIME Trans. 252, 113-118.	

<b>TITLE</b>	<b>Hydrology of Limestone Terranes - Geophysical Investigations</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 3.1 (283)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Geological Survey of Alabama P.O. Drawer 0 University, Alabama 35486</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>T. J. Joiner and W. L. Scarbrough</b>	
<b>OBJECTIVES</b>	<b>To determine the effectiveness of geophysical methods in the interpretation of groundwater occurrence and movement in limestone terranes.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Geophysical methods were successful in assisting in the location, definition, and projection of general trends of solution development in limestone terranes.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Joiner, T. J., and Scarbrough, W. L., 1969, Hydrology of limestone terranes - geophysical investigations, Geological Survey of Alabama Bull. 94, Part D, University, Alabama.</b>	

<b>TITLE</b>	<b>Annotated Bibliography of the Hydrology of Limestone Terranes - and Supplement</b>	
<b>Coordinating Council Resolution in force and short title</b>	V.2 Hydrology of Carbonate Rocks	US/IHD ref: 2.3, 5.1(192) and 3.1(281)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Geological Survey of Alabama P.O. Drawer 0 University, AL 35486	
<b>PRINCIPAL INVESTIGATOR</b>	Philip E. LaMoreaux	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<p>No extensive study of the hydrology of an area is possible without a careful review of the existing literature. This became obvious in connection with a study to determine the effectiveness of geochemical and geophysical techniques of determining the location, quantity and quality of groundwater in the massive limestone beds underlying the Tennessee Valley area of north Alabama. As a result, an early and continuing phase of the study was the preparation of an annotated bibliography of the hydrology of limestone terranes. As the study continued, the bibliography grew to include literature from well outside the immediate study area. In cooperation with the US/IHD Work Group on the Hydrology of Carbonate Terranes, the bibliography was extended to include references from abroad. This annotated bibliography will now provide information regarding the base of knowledge from which the present study and others can move forward with greater facility than before.</p> <p>The compilation of annotated material continued after the publication of the first volume, particularly of references from the international literature. The supplement will provide annotations on materials published since 1967, the cutoff for material in the initial bibliography.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>LaMoreaux, Philip E., Dorothy Raymond, and Thomas J. Joiner, 1970, Annotated bibliography of carbonate rocks. Geological Survey of Alabama Bull. 94, Part A, University, Alabama.</p> <p>Warren, W. M., J. D. Moore, and P. E. LaMoreaux, <u>in press</u>, Annotated bibliography of carbonate rocks - Supplement I, Geological Survey of Alabama, University, Alabama.</p>	

<b>TITLE</b>	<b>Hydrology of Limestone Terrane Symposium</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 3.1 (282)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Geological Survey of Alabama P.O. Drawer 0 University, Alabama 35486	
<b>PRINCIPAL INVESTIGATOR</b>	P. E. LaMoreaux (Editor)	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	A collection of four papers on limestone hydrology presented at the Southeast Section meeting of the Geological Society of America held in March, 1972. The following reports are included: Stringfield, V. T., LeGrand, H. E., and LaMoreaux, P. E.; Development of Karst and its Effects on the Permeability and Circulation of Water in Carbonate Rocks, with Special Reference to the Southeastern States.  Moser, P. H.; Environmental Geology of Madison County - Making Geology Pertinent to the Layman.  Hyde, L. W.; Roberts Industrial Subdivision Problem, Post-Study Evaluation.  Thayer, P. A., and Textoris, D. A., Faunal and Diagenetic Controls of Porosity and Permeability in Tertiary Aquifer Carbonates, North Carolina.	
<b>REPORTS AVAILABLE PUBLICLY</b>	This report to be published in 1975 as a Bulletin by the Geological Survey of Alabama.	

<b>TITLE</b>	<b>Effects of Karst Features on Circulation of Water in Carbonate Rocks in Coastal Areas</b>	
<b>Coordinating Council Resolution in force and short title</b>	V.2 Hydrology of Carbonate Rocks I.23 Hydrology of Deltaic and Coastal Areas, Estuaries and Coastal Marine Waters	<b>US/IHD ref:</b> 2.8(303)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey P.O. Box 2857 Raleigh, North Carolina 27602	
<b>PRINCIPAL INVESTIGATOR</b>	H. E. LeGrand	
<b>OBJECTIVES</b>	To discuss the relation of sea water to fresh water and the circulation of water in carbonate rocks in the coastal areas of Andros Island, Bahamas, W.I., and the Adriatic Coast near Split, Yugoslavia.	
<b>SIGNIFICANT RESULTS</b>	<p>Where sinkholes and (or) vertical solution shafts below sea level penetrate the aquifer, the fresh ground water may discharge through these karst features if the fresh-water head is greater than that of the salt water. However, under some conditions the salt-water head may exceed that of the fresh water, and the direction of movement is reversed as sea water flows into the aquifer. This sea-water flow into the aquifer occurs (1) where sinkholes, acting as "cased wells," penetrate less permeable rock before reaching a lateral solution channel and (2) where (or when) the fresh-water head is less than that required to balance the salt water. On Andros Island, Bahamas, the range in tide (as much as 5 feet) from low tide to high tide is sufficient to cause such a reversal locally. During low tide the salt-water head becomes sufficiently low that the ground-water head exceeds that of the sea water, and the ground water flows through the sinkholes to the ocean floor; during high tide sea water flows in the sinkholes. In the Adriatic Sea along the coast of Yugoslavia, apparently the fresh-water head is sufficient to produce perennial springs in some localities, but in other areas, as in the Bay of Kastela near Split, the fresh-water head becomes low enough during some seasons that the flow is reversed and salt water enters the aquifer through the karst features.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Stringfield, V. T., and H. E. LeGrand, 1971, Effects of karst features on circulation of water in carbonate rocks in coastal areas, <i>J. Hydrology</i> , 14:2, 139-157.	



<b>TITLE</b>	<b>Differential Erosion of Carbonate Rock Terranes</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 2.8(304)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey P.O. Box 2857 Raleigh, North Carolina 27602	
<b>PRINCIPAL INVESTIGATOR</b>	H. E. LeGrand	
<b>OBJECTIVES</b>	To evaluate the large topographic features of carbonate formations and to emphasize the factors that are involved in differential erosion where carbonate formations occur.	
<b>SIGNIFICANT RESULTS</b>	<p>Differential erosion results from a combination of physical and chemical processes. There are prerequisites for both physical and solutinal erosion. Rock must be decomposed or disintegrated before it can be physically removed; a permeable soil cover is necessary for effective solution of carbonate rocks.</p> <p>Erosion in carbonate terranes is favorable under moderate rather than under extreme conditions of cover, purity of the carbonate rock, topographic relief, and precipitation. Denuded carbonate rocks are much more resistant to physical and chemical erosion than are carbonate rocks with a moderately thin soil and vegetal cover; where the soil and rock cover is very thick, physical erosion of the covered bed is impossible and chemical erosion may be retarded because of retarded water circulation. Further analysis indicates that some of these extremes are in turn related to extremes in cover. Pure carbonate rocks yield no insoluble residue to form a cover; also, intense precipitation tends to strip off a thin cover and to keep the rock denuded; also, if the carbonate rocks are relatively impermeable, water cannot easily penetrate the rock to encourage soil development. Thus, the degree of cover on a carbonate terrane is an important key to differential erosion and to much of the topographic relief.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	LeGrand, H. E. and V. T. Stringfield, 1971, Differential erosion of carbonate rock terranes, <i>Southern Geology</i> , 13:1, 17 p.	

<b>TITLE</b>	<b>Water Levels in Carbonate Rock Terranes</b>	
<b>Coordinating Council Resolution in force and short title</b>	V.2 Hydrology of Carbonate Rocks	<b>US/IHD ref:</b> 2.8(305)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey P.O. Box 2857 Raleigh, North Carolina 27602	
<b>PRINCIPAL INVESTIGATOR</b>	H. E. LeGrand	
<b>OBJECTIVES</b>	To indicate some ranges of conditions of the water level in carbonate rocks and to highlight some interpretations of water-level conditions.	
<b>SIGNIFICANT RESULTS</b>	<p>Many subtle aspects of water levels in carbonate rocks need to be put in perspective even though hydrologists have recognized the fundamental value of characteristics of ground-water levels. The depth to the water table in carbonate rocks is controlled by local factors such as permeability and topography and by the regional factor of climate; both permeability and topography are dynamically developed according to the degree of preferential circulation of sub-surface water and of solution of the rock, and the water table responds by lying deep beneath hilly permeable karstlands and shallow beneath flat and poorly permeable carbonate rocks. The uneven distribution of permeability and of topographic conditions is responsible for the intriguing karst phenomena of disappearing and reappearing surface streams. Great infiltration capacities of some karst regions result in large local fluctuations of the water table and in some cases to local reversals in direction of ground-water flow between wet and dry seasons. Water-level behavior in space and time is a primary consideration for interpreting the hydrology of carbonate terranes.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	LeGrand, H. E. and V. T. Stringfield, 1971, Water levels in carbonate rock terranes, Ground Water, 9:3, p. 4-10.	

<b>TITLE</b>	<b>Delineation of Groundwater Flow Systems in Nevada</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 2.8 (290)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Center for Water Resources Research Desert Research Institute University of Nevada System Reno, Nevada</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>M. D. Mifflin</b>	
<b>OBJECTIVES</b>	<b>To delineate groundwater flow systems in Nevada</b>	
<b>SIGNIFICANT RESULTS</b>	<p>Available hydrologic and geologic information has been considered with flow system theory in an attempt to delineate groundwater flow systems in Nevada. Definition of sink areas, source areas and configuration of flow within the flow system has been the primary objective of the study. Source areas and configuration of flow have been approximated in most areas, whereas sink areas have been confidently located for nearly all of the systems. The one hundred and thirty-six recognized flow systems in Nevada have been separated into two groups based upon configuration of flow. Presence or absence of important interbasin flow has been used as a criteria.</p> <p>Several types of fluid potential measurements are demonstrated to be optimal methods of delineating groundwater flow systems. Changes in fluid potential in the vertical direction establish source areas, zones of lateral flow, sink areas and boundaries of circulation cells.</p> <p>A concept of flow capacity of terrane for groundwater flux has aided in the recognition and understanding of environmental influences on the configuration of groundwater flow systems. Interbasin flow is closely related to bedrock permeability and availability of moisture for recharge. In nearly every area where interbasin flow has been recognized, there is also relatively permeable bedrock. In most areas of interbasin flow, only limited moisture is available for recharge.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Mifflin, M. D., 1968, Delineation of Ground-Water Flow Systems in Nevada, Technical Report Series H-W, Desert Research Institute, University of Nevada, Reno, 111 p.</b>	

<b>TITLE</b>	<b>A Glossary of Karst Terminology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 5.1(179)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	W. H. Monroe	
<b>OBJECTIVES</b>	To compile a glossary on the terms used in describing karst geomorphologic features and processes.	
<b>SIGNIFICANT RESULTS</b>	This glossary includes most terms used in describing karst geomorphologic features and processes. The terms are primarily those used in the literature of English-speaking countries, but a few of the more common terms in French, German, and Spanish are included, with references to the corresponding English terms where they are available. The glossary also includes simple definitions of the more common rocks and minerals found in karst terrain, common terms of hydrology, and a number of the descriptive terms used by speleologists. The glossary does not include definitions of most biospelological terms, geologic structure terms, varieties of carbonate rock that require microscopic techniques for identification, or names describing tools and techniques of cave exploration.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Monroe, W. H. (compiler), 1970, A Glossary of Karst Terminology, U.S. Geol. Survey Water-Supply Paper 1899-K, 26 p.	

<b>TITLE</b>	<b>Structural Controls on Streamflow in the North Fork River and Bryant Creek Basins, Missouri</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 2.8(297)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Geological Survey 103 W. 10th Street Rolla, Missouri 65401</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>John Skelton E. J. Harvey</b>	
<b>OBJECTIVES</b>	<b>To study the causes for the different hydrological response of the North Fork River and Bryant Creek basins.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>North Fork River and Bryant Creek, which drain adjacent basins in southern Missouri, have practically the same size drainage areas (561 sq. mi. and 570 sq. mi., respectively) and similar basin shape, climate, and surface geology. However, the groundwater runoff of North Fork River basin, where karst topography is much better developed, is twice that of Bryant Creek. Structure is the major factor influencing groundwater outflow. Jointing and perhaps faulting with NW-SE and NE-SW trends have pronounced effect on the alignment of sinkholes and orientation of ridges and valleys. Large springs occur where these trends intersect, and the flow from these springs accounts for most of the difference in groundwater runoff between the two basins.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Skelton, John and E. J. Harvey, 1968, Structural controls on streamflow in the North Fork River and Bryant Creek basins, Missouri, U.S. Geological Survey Prof. Paper 600-C, 153-157.</b>	

<b>TITLE</b>	<b>Hydrology of Limestone Terranes, Photogeologic Investigations</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 3.1 (279)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Geological Survey of Alabama P.O. Drawer 0 University, Alabama 35486</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>J. L. Sonderegger</b>	
<b>OBJECTIVES</b>	<b>To interpret the occurrence and movement of groundwater in a limestone area of Alabama by the use of panchromatic, color, and infrared films.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Wells drilled along fracture trace detected on aerial photographs yielded substantially more water than the average randomly located wells.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Sonderegger, J. L., 1970, Hydrology of limestone terranes, photogeologic investigations, Geological Survey of Alabama Bull. 94, Part C, University, Alabama.</b>	

<b>TITLE</b>	<b>Hydrology of Limestone Terranes - Geologic Investigations</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 3.1(284)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Geological Survey of Alabama P.O. Drawer O University, Alabama 35486</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>J. L. Sonderegger and J. C. Kelley</b>	
<b>OBJECTIVES</b>	<b>The geology of a limestone terrane was studied to aid in the interpretation of the occurrence and movement of groundwater in limestones.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Solution activity was shown to be the major factor causing "deformation" structures in the Highland Rim section of the Arka. Tectonic structure has been modified by ground-water solution.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Sonderegger, J. L., and J. C. Kelley, 1970, Hydrology of limestone terranes - geologic investigations, Geological Survey of Alabama, Bull. 94, Part B, University, Alabama.</b>	

<b>TITLE</b>	<b>Hydrology of Carbonate Terranes</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 2.8 (331)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Hydrology of Carbonate Terranes c/o U.S. National Committee for IHD 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	V. T. Stringfield and P. E. LaMoreaux	
<b>OBJECTIVES</b>	To promote the improvement of understanding of the hydrology of carbonate terranes in this country and adjoining areas; 2) to cooperate and maintain liaison with the international FAO/IHD Working Group on the Hydrology of Carbonate Rocks in the Mediterranean Basin; and 3) to promote, in whatever way possible within its means, a better understanding of the hydrology of carbonate terranes in the western hemisphere.	
<b>SIGNIFICANT RESULTS</b>	<p>To carry out these objectives, the Work Group sponsored symposia, organized field seminars, encouraged preparation of review articles, glossaries, bibliographies, and other reports, and in general provided liaison to encourage advancement in this field of hydrological studies.</p> <p>Several individual projects under this program are described separately in this volume. Here it is useful to summarize the Work Group's field seminars.</p> <p>Ten seminars were held and two - a second one in Jamaica and one in Egypt - were planned but could not be implemented because of conditions beyond the control of the Work Group. The seminars gave local hydrogeologists an opportunity to observe and discuss their local and regional conditions and problems of carbonate hydrology with members of the Work Group and its occasional guest. At the same time, the seminars broadened the base of understanding of the Work Group. The following list provides some measure of the scope of the Work Group's accomplishments:</p> <p>Jamaica, 9-13 October 1967 - Carbonate hydrology under predominantly humid conditions                  Nevada, 25-28 March 1968 - Local and regional flow patterns in an arid to semi-arid climate and a basin-and-range terrain                  Puerto Rico, 14-16 October 1968 - Carbonate hydrology in another humid environment - providing a base for a comparative study                  Alabama, 21-23 January 1969 - Temperate-climate conditions at south end of Appalachian Mountains                  Missouri, 19-23 May 1969 - Temperate-climate conditions around southern margin of Ozark Mountains                  West Virginia and Pennsylvania, 21-22 May 1970 - Temperate-climate conditions of north-central Appalachian region                  Florida, 21-24 October 1970 - Semi-tropical conditions; carbonate hydrology under stress of intensive development                  Texas, 30 November-2 December 1970 - Semi-arid conditions - water quality and flow changes across a wide expanse of</p>	



one of the most productive aquifer systems in the U.S.  
Pennsylvania and Central Appalachian Region, 30-31 October  
1971 - Modification of May 1970 trip conducted as a  
field conference of the annual meeting of the Geological  
Society of America  
Mexico, 24-28 April 1972 - Highly deformed carbonate rocks  
in a humid climate.

**REPORTS AVAILABLE  
PUBLICLY**

See other activities of this Work Group described in this  
report.

US/IHD Work Group on Hydrology of Carbonate Terranes, Final  
Report, in review, scheduled for publication in 1975.

<b>TITLE</b>	<b>Karst and Paleohydrology of Carbonate Rock Terranes in Semiarid and Arid Regions</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 3.1 (280)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Geological Survey of Alabama P.O. Drawer 0 University, Alabama 35486</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>V. T. Stringfield, P. E. LaMoreaux, and H. E. LeGrand</b>	
<b>OBJECTIVES</b>	<p>This investigation compares the degree of karstification in humid and arid zones as a function of precipitation. Three carbonate-rock terranes are described in arid and semiarid regions (Kaibab Plateau in Arizona, Nullarbor Plain on the South Coast of Australia, and the Western Desert of Egypt) and compared with more humid regions of the United States and the Northern Yucatan Peninsula, Mexico.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>Results of this study indicate that the reconstruction of the geologic and hydrologic history of each arid carbonate region reveals that karstification has been preserved from earlier times when the climate was less arid. A review of the history provides insight for evaluating the hydrology of active karst systems.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>This report has been completed and will be published by the Geological Survey of Alabama as Bulletin 105, Karst and Paleohydrology of Carbonate Rock Terranes in Semiarid and Arid Regions, with Comparison to the Humid Karst of Alabama, by V. T. Stringfield, P. E. LaMoreaux, and H. E. LeGrand.</p>	

<b>TITLE</b>	Relation of Sea Water to Fresh Water in Carbonate Rocks in Coastal Areas.	
<b>Coordinating Council Resolution in force and short title</b>	V.2 Hydrology of Carbonate Rocks	US/IHD ref: 2.8(302)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	V. T. Stringfield and H. E. LeGrand	
<b>OBJECTIVES</b>	To briefly state the results of some of the recent studies of the relation of sea water to fresh water in carbonate rocks in coastal areas of Florida and to show how vertical solution channels or shafts in relatively impervious parts of carbonate rocks may affect the relation of salt water to fresh water under certain conditions in coastal areas as at Tarpon Springs, Florida, and Cephalonia, Greece.	
<b>SIGNIFICANT RESULTS</b>	<p>The principles controlling the equilibrium between the denser salty water and the lighter fresh water in coastal aquifers apply to carbonate as well as sand systems. However, under certain equilibrium conditions of fresh and salt water in parts of some carbonate aquifers unusual hydrologic phenomena result. Hydrologic conditions at Tarpon Springs, Florida, and Cephalonia, Greece, include deep vertical openings as sinkholes through a relatively impervious part of the aquifer system. In both cases the tops of the sinkholes or natural wells are exposed to sea water. At Tarpon Springs the dynamic equilibrium between salt water and fresh water fluctuates so that the flow of salt water from the spring to a lake 2 miles away is sometimes reversed. At Cephalonia, the head of fresh water does not exceed the head of salty water in the sinkholes; the flow of sea water into the aquifer, aided by a shallow channel from the sea, is continuous, and the water level in the sinkhole is continuously depressed below sea level. Both cases represent a partially confined U-tube system where water at the seaward, sinkhole end is denser than at the other end and where a low fresh-water head is less than the salt-water head.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Stringfield, V.T., and H.E. LeGrand, 1969, Relation of sea water to fresh water in carbonate rocks in coastal areas, with special reference to Florida, USA., and Cephalonia, Greece, J. Hydrology, 9, 387-404.	

<b>TITLE</b>	<b>Conceptual Models for Carbonate Aquifers</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 2.8 (191)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Minerals Research Laboratory Dept. of Geochemistry and Mineralogy Penn State University University Park, PA 16802	
<b>PRINCIPAL INVESTIGATOR</b>	W. B. White	
<b>OBJECTIVES</b>	To provide idealize endmember aquifer types with which the more complicated real aquifers may be compared.	
<b>SIGNIFICANT RESULTS</b>	Carbonate aquifers have been subdivided into 3 major types with a number of subtypes. The classification of a particular aquifer into one of these types can be made on the basis of easily observed hydrogeological conditions. Each type has associated with it a particular flow pattern and a characteristic pattern for the fragments of cave that are left behind as the water table is lowered. The usual controls of structure, lithology, and position of base level are shown to act mainly to perturb the gross pattern and to determine some of the detailed morphology of the resulting drainage network.	
<b>REPORTS AVAILABLE PUBLICLY</b>	White, B., 1969, Conceptual models for carbonate aquifers, Groundwater, vol. 7, no. 3.	

<b>TITLE</b>	<b>Hydrologic Studies of the Limestone Aquifer of the Central Kentucky Karst</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.2 Hydrology of Carbonate Rocks</b>	<b>US/IHD ref: 2.8 (190)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Minerals Research Laboratory                  Pennsylvania State University                  University Park, PA 16802</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>William B. White</b>	
<b>OBJECTIVES</b>	<p>1) To complete basic survey and reconnaissance studies of the central Kentucky karst.</p> <p>2) Interpretative studies based on the knowledge assembled in the basic survey and reconnaissance will seek to describe the dynamics of the limestone aquifer system.</p> <p>3) Quantitative hydrology - to quantitatively describe the behavior of the limestone aquifer.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>The following major studies have been completed on the Central Kentucky Karst Aquifer:</p> <p>1) Hydrogeology of aquifer including the role of vertical shafts in transmitting vadose water and the role of horizontal conduits associated with main throughput drains, and shaft drains.</p> <p>2) Chemical hydrology showing characterization of different water types and the seasonal variations in the chemistry of limestone springs.</p> <p>3) Measurement of continuous hydrographs of karst springs showing short time period fine structure related to aquifer response and to precipitation events.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Deike, H., III, and W. B. White, 1969, Sinuosity in limestone solution conduits, <i>Am. J. of Science</i>, 267, p. 230-241.</p> <p>White, W. B., A. Watson, E. R. Pohl, and Roger Brucker, 1970, The Central Kentucky Karst, <i>The Geographical Review</i>, 60, p. 88-115.</p> <p>White, W. B. and L. White, 1970, Channel hydraulics of free-surface streams in caves, <i>Caves and Karst</i>, 12, p. 41-48.</p> <p>Brucker, R. W., J. W. Hess, and W. B. White, 1972, Role of vertical shafts in the movement of ground water in carbonate aquifers, <i>Ground Water</i>, 10:6.</p>	

Coordinating Council Resolution No. V.3 Floods and their Computation

Resolution No. V.3

The Council,

2. Recognizing that the problem of floods and their computation is one of the major long-term objectives of the International Hydrological Decade;
5. Directs the working group [on Floods and their Computation] to finish a methodological guide on the collection and processing of data for the study of floods in 1970;
6. Requests the IHD Secretariat to assist, by all means at its disposal, the working group in the preparation of the above guide and suggests that it be published by Unesco as soon as possible;
7. Considers the preparation of a world catalogue of very large floods on rivers as timely;
8. Requests the working group to finish a form for the world catalogue of very large floods on rivers with necessary explanatory notes for compilation, and suggests that it be distributed by Unesco in early 1970 before the next session of the Council;
9. Adopts in principle a proposal concerning the necessity to broaden the terms of reference of the Working Group on Floods which is as follows:
  - (i) Study and generalization of world experience on computation of the major characteristics of stream flow.
  - (ii) Preparation of scientific material and recommendations on methods of computation of maximum and minimum stream flow, as well as other parameters with different levels of hydrological knowledge of the territory and for various physical and geographical zones.
  - (iii) Guidance for compiling and up-dating the catalogue of outstanding hydrological phenomena.
10. Requests the working group to examine these recommendations and to prepare concrete proposals and a plan for possible carrying out of the tasks mentioned in point 9 above during the second half of the Decade.

<b>TITLE</b>	<b>Floods and Their Computation</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.3 Floods and their Computation</b>	<b>US/IHD ref: 2.6 (334)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Floods and their Computation U.S. National Committee for IHD 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	F. F. Snyder 1516 Laburnum Street McLean, Virginia 22101	
<b>OBJECTIVES:</b>	To cooperate with the UNESCO/IHD Working Group on Floods and their Computation (which later had its scope of activities broadened to Floods and Low Flow) by providing data and materials from the United States on request and as available.	
<b>SIGNIFICANT RESULTS</b>	With the cooperation of the U.S. Geological Survey, the Corps of Engineers, and the Water Resources Council, the US/IHD Work Group operated to provide data and information as feasible. The data will be published in UNESCO reports on floods and low flows in the near future.	

Coordinating Council Resolution No. V.6 Standardization

Resolution No. V.6<sup>(1)</sup>

The Council,

1. Recalling its resolution I.61 and relevant discussions at its second and third sessions;
2. Noting that at its recommendation an inter-agency meeting was held in the WMO Headquarters with the participation of ISO, WHO, Unesco and WMO;
3. Noting further the report of this meeting;
4. Considering that standardization of instruments and techniques in hydrology may considerably contribute to the success of the IHD programme;
5. Agrees with the proposals for further action outlined in the above-mentioned report;
6. Recommends to all interested international organizations, in particular to ISO, WMO, Unesco, WHO, FAO, IAEA, IASH and IAH, the formation of inter-agency panel on standardization in hydrology, and calls upon them for their co-operation in the activities of this panel;
7. Further recommends that the terms of reference of this panel should include:
  - (i) To review and place in evidence the work of participating international organizations engaged in the standardization of instruments, methods of observation and techniques for elements of the hydrological cycle;
  - (ii) to advise on the possible co-ordination of such activities;
  - (iii) to identify gaps in the programme of standardization and suggest action to be taken.
8. Invites WMO, taking into account its activities in standardization, to provide the technical secretariat for the above inter-agency panel;
9. Requests the Panel to inform the Council by progress reports on the work accomplished in this field and advise the Council in the field of standardization problems in hydrology;
10. Recommends that this Panel should take into account the work of the Working Group on Ground Water established by the Coordinating Council as far as ground-water observation methods are concerned.

(1) This resolution supersedes resolution I.61.



<b>TITLE</b>	<b>Standardization Intercomparisons</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.6 Standardization</b>	<b>US/IHD ref: 5.2 (333)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Standardization Problems U.S. National Committee for IHD 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	V. T. Chow Department of Civil Engineering University of Illinois Urbana, Illinois 61801	
<b>OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. To encourage the recognition of the activities in the fields of comparison and standardization of many existing organizations, and to encourage their adoption in hydrological practices in so far as it is appropriate.</li> <li>2. To promote the development of standards and intercomparison where none exist or are inadequate, compatibly with existing local and domestic constrictions and practices.</li> <li>3. To encourage the domestic adoption of appropriate international standards.</li> <li>4. To respond to UNESCO-WMO/IHD requests for information regarding U.S. practices.</li> </ol>	
<b>SIGNIFICANT RESULTS</b>	Materials regarding standardization and intercomparison were submitted by the Work Group, or through affiliated groups, not matters of instrumentation comparison (See International Field Year for Great Lakes), terminology (See Glossaries), and operational hydrology (Under the WMO Commission of Hydrology).	
<b>REPORTS AVAILABLE PUBLICLY</b>	(See reports listed under headings above.)	

<b>TITLE</b>	<b>Standardization of Instruments</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.6 Standardization</b>	<b>US/IHD ref: 5.2 (12)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	Charles Hoffeditz and Lee Larson Hydrologic Research Laboratory	
<b>OBJECTIVES</b>	To cooperate with the World Meteorological Organization (WMO) on projects for intercomparison of hydrometeorological instruments.	
<b>SIGNIFICANT RESULTS</b>	Participated in intercomparison studies conducted by WMO's Commission on Instrumentation and Methods of Operation (CIMO) Working Groups on: <ol style="list-style-type: none"> <li>1. Intercomparison of Precipitation Gages</li> <li>2. Intercomparison of Evaporation Gages</li> </ol>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Reports of CIMO Working Groups, World Meteorological Organization, Geneva, Switzerland.	

<b>TITLE</b>	<b>Recommended Methods for Water-Data Acquisition</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.6 Standardization</b>	<b>US/IHD ref: 5.2(294)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Office of Water Data Coordination U.S. Geological Survey National Center, MS 417 Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	A. I. Johnson, Methods Coordinator	
<b>OBJECTIVES</b>	To designate methods recommended by Federal agencies for the acquisition of water data.	
<b>SIGNIFICANT RESULTS</b>	Under Federal interagency working groups recommended methods are being proposed for acquisition of data on all phases of the hydrologic cycle. Includes quantity and quality of surface waters and subsurface waters, snow and ice, evaporation and transpiration, and hydrometeorological methods. A handbook of methodology is planned.	
<b>REPORTS AVAILABLE PUBLICILY</b>	Federal Interagency Work Group on Designation of Standards for Water Data Acquisition, 1972, Recommended Methods for Water-Data Acquisition - Preliminary Report; Duplicated report, U.S. Geological Survey Office of Water Data Coordination, Reston, Virginia, 417 p.	

<b>TITLE</b>	<b>Multilingual Glossary of Hydrological Terms</b>	
<b>Coordinating Council Resolution in force and short title</b>	V.6 Standardization I.65 International Glossary of Hydrology	US/IHD ref: 5.2 (336)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<u>ad hoc</u> US/IHD Panel on Multilingual Glossary of Hydrological Terms U.S. National Committee for IHD 2101 Constitution Avenue, N.W., Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	R. F. Kresge National Weather Service - NOAA Rockville, Maryland 20910	
<b>OBJECTIVES</b>	To assist the WMO/UNESCO Joint Project on Terminology to complete and revise the Multilingual Glossary of Hydrological Terms.	
<b>SIGNIFICANT RESULTS</b>	The Panel, working as a unit, and its members, reviewed and revised the first and second drafts of the multilingual glossary, submitting a large number of emendations to the list of multilingual terms and many recommendations regarding definitions.	
<b>REPORTS AVAILABLE PUBLICLY</b>	(See UNESCO/WMO International Glossary of Hydrology, published as WMO/OMM/BMO Report no. 385, 393 p.)	

Coordinating Council Resolution No. V.9 Design of Water Resources Projects with  
Inadequate Data

Resolution No. V.9<sup>(1)</sup>

The Council,

:

2. Noting that the Panel [of Experts on DEWARPID] has identified the most important problems within this field;
3. Noting that these problems fall in a general way under three groups, namely;
  - (i) Methodologies of computation of design data with inadequate basic observations, mainly on the basis of hydrometeorological elements;
  - (ii) training of specialists in hydrological engineering, a field centered on provision of design data to projects;
  - (iii) preparation of concrete regional studies of hydrological elements for direct use in the computation of design data by specialists of countries in the region;
4. Noting
  - (i) that the WMO has already established a working group, the terms of reference of which concern the problems in 3 (i) above;
  - (ii) that problems in 3(iii) above are already pursued in the field of interest of many international and regional organizations;
5. Invites
  - (i) WMO to take the responsibility for the problems connected with this IHD project mentioned under 3 (i) above;
  - (ii) Unesco to take responsibility for the problems mentioned under 3 (ii) above;
6. Recommends to all Member States and international governmental and non-governmental organizations to increase the work on regional, sub-regional and national syntheetical studies of all hydrological elements needed for project design data, in particular within the UNDP projects and through bi-or multilateral agreements between countries;
7. Decides to terminate the activities of the Panel expressing appreciation for its work.

(1) This resolution supersedes resolution II.5

<b>TITLE</b>	<b>Hydrologic Engineering Methods for Water Resources Development</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>V.9 Design of Water Resources Projects with Inadequate Data</b>	<b>US/IHD ref: 3.9 (2)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Army Corps of Engineers The Hydrologic Engineering Center Davis, California 95616</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>B. S. Eichert and L. R. Beard The Hydrologic Engineering Center</b>	
<b>OBJECTIVES</b>	Develop a report on hydrologic procedures that can be applied in regions of sparse data. The 12-volume report contains detailed discussions of hydrologic engineering methods and procedures, as well as descriptions of computer programs, that can be used in the application of these methods and procedures.	
<b>SIGNIFICANT RESULTS</b>	Work on the 12 volume set is proceeding. Volumes 1, 2, 4, 8, 10, and 11 are published and distributed. Remaining volumes are in various stages of completion.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Hydrologic Engineering Methods for Water Resources Development, HEC, U.S. Army Corps of Engineers, Davis, California.</p> <p>Vol. I Requirements and General Procedures, 1971                      Vol. II Hydrologic Data Management, 1972                      Vol. III Hydrologic Probabilities                      Vol. IV Hydrograph Analysis, 1973                      Vol. V Hypothetical Floods                      Vol. VI Water Surface Profiles                      Vol. VII Reservoir Operation for Flood Control                      Vol. VIII Reservoir Yield                      Vol. IX Reservoir System Analysis                      Vol. X Principles of Groundwater Hydrology, 1972                      Vol. XI Water Quality Determinations, 1972                      Vol. XII Sediment Transport</p> <p>(These reports will also be available through the                      National Technical Information Service                      U.S. Department of Commerce                      5258 Port Royal Road                      Springfield, Virginia 22151 )</p>	

Coordinating Council Resolution No. VI.5 Influence of Man on the Hydrological Cycle

Resolution No. VI.5<sup>(1)</sup>

**The Council**

1. Having considered that the scientific scope of the problem on the Influence of Man on the Hydrological Cycle comprises many different aspects of man's activity both in the field of agriculture and forestry and in that of urbanization and industrial and water management;
2. Decides to continue the working group on the Influence of Man on the Hydrological Cycle dealing with both the agricultural and urbanization aspects;
3. Approves the terms of reference for the working group as indicated in Annex IV to the present report;
4. Requests FAO to continue to provide the technical secretariat and support for this working group as a whole;
5. Requests Unesco to provide the technical secretariat and support for the sub-working group which will be established to deal with the urbanization and related effects as set out in section 3 of the terms of reference. This sub-working group will be expected to report to the main working group in due time for its findings to be incorporated in the overall report.

(1) This resolution supersedes resolution V.4

<b>TITLE</b>	<b>Hydrology of Agricultural Watersheds</b>													
<b>Coordinating Council Resolution in force and short title</b>	<b>VI.5 Influence of Man on the Hydrological Cycle</b>	<b>US/IHD ref: 2.5 (202)</b>												
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Soil and Water Conservation Research Division Agricultural Research Service (ARS) U.S. Department of Agriculture Beltsville, Maryland 20705													
<b>PRINCIPAL INVESTIGATOR</b>	C. W. Carlson													
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<p>Investigations concerning a wide variety of watershed problems related to the influence of man on the hydrological cycle were conducted at 10 ARS watersheds. These were:</p> <table border="0"> <tr> <td>Danville, VT</td> <td>Coshocton, OH</td> <td>Columbia, MO</td> </tr> <tr> <td>Riesel, TX</td> <td>Oxford, MS</td> <td>Boise, ID</td> </tr> <tr> <td>Chickasha, OK</td> <td>Santa Rosa, NM</td> <td>Watkinsville, GA</td> </tr> <tr> <td>Tucson, AZ</td> <td></td> <td></td> </tr> </table> <p>The variety of problems and spectrum of results precludes ready summation and the reader is referred to individual reports listed below.</p>		Danville, VT	Coshocton, OH	Columbia, MO	Riesel, TX	Oxford, MS	Boise, ID	Chickasha, OK	Santa Rosa, NM	Watkinsville, GA	Tucson, AZ		
Danville, VT	Coshocton, OH	Columbia, MO												
Riesel, TX	Oxford, MS	Boise, ID												
Chickasha, OK	Santa Rosa, NM	Watkinsville, GA												
Tucson, AZ														
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Osborn, H. B., L. J. Lane, and J. F. Hundley, 1972, Optimum gaging of thunderstorm rainfall in southeastern Arizona, <i>Water Resources Research</i>, 8:1, 259-265.</p> <p>Williams, J. R. and R. W. Hann, 1972, HYMO, A problem-oriented computer language for building hydrologic models, <i>Water Resources Research</i> 8:1, 79-86.</p> <p>Lane, L. J. and K. G. Renard, 1972, Evaluation of a basin-wide stochastic model for ephemeral runoff from semiarid watersheds, <i>Amer. Soc. Agr. Engin. Trans.</i>, 15:2, 280-283.</p> <p>Smith, R. E., 1972, Border irrigation and ephemeral flood waves, <i>Amer. Soc. Civ. Engin. Proc., Irrig. &amp; Drain. Div. J.</i>, 98:IR 2, 289-307.</p> <p>Snyder, W. H. and L. E. Asmussen, 1972, Subsurface hydrograph analysis by convolution, <i>Amer. Soc. Civ. Engin. Proc., Irrig. &amp; Drain. Div. J.</i>, 98:IR 3, 405-418.</p> <p>Richardson, C. W., 1972, Changes in water yield of small watersheds by agricultural practices, <i>Amer. Soc. Agr. Engin. Trans.</i>, 15:3, 591-593.</p> <p>Dunne, Thomas, 1970, <i>Runoff Production in a Humid Area</i>, USDA ARS 41-160, 108 p.</p> <p>Kibler, D. F. and D. A. Woolhiser, 1970, <i>The Kinematic Cascade as a Hydrologic Model</i>, Colo. State Univ. Hydrol. Paper No. 39, Fort Collins, Colorado, 27 p.</p> <p>Onstad, C. A. and D. G. Jamieson, 1970, Modeling the effect of land use modification on runoff, <i>Water Resources Research</i>, 6:5, 1287-1295.</p>													



England, C. B. and G. R. Stephenson, 1970, Response units for evaluating the hydrologic performance of rangeland watersheds, *J. Hydrol.*, 11, 89-97.

Smith, R. E. and D. A. Woolhiser, 1971, *Mathematical Simulation of Infiltrating Watersheds*, Colo. State Univ. Hydrol. Paper No. 47, Fort Collins, Colorado, 44 p.

McGuinness, J. L. and L. L. Harrold, 1971, Reforestation influences on small watershed streamflow, *Water Resources Research*, 7:4, 845-852.

Saxton, K. E. et al., 1971, Hydrology and erosion of loessial watersheds, *Amer. Soc. Civ. Engin. Proc., Hydraul. Div. J.*, 97, HY 11, 1835-1851.

Brakensiek, D. L. and C. A. Onstad, 1968, The synthesis of distributed inputs for hydrograph predictions, *Water Resources Research*, 4:1, 79-85.

Dendy, F. E. and W. A. Champion, 1973, *Summary of reservoir sediment deposition surveys made in the United States through 1970*, USDA Misc. Pub. 1266, 82 p.

Foster, G. R. and L. D. Meyer, 1972, Transport of soil particles by shallow flow, *Am. Soc. Agr. Engin. Trans.*, 15:1, 99-102.

Young, R. A. and R. E. Burwell, 1972, Prediction of runoff and erosion from natural rainfall using a rainfall simulator. *Soil Sci. Soc. Amer. Proc.*, 36:5, 827-830.

<b>TITLE</b>	Effects of Thermal Pollution on River Temperatures and Ice Condition	
<b>Coordinating Council Resolution in force and short title</b>	VI.5 Influence of Man on the Hydrological Cycle	US/IHD ref: 2.5(153)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Army Cold Regions Research and Engineering Laboratory Hanover, New Hampshire 03755	
<b>PRINCIPAL INVESTIGATOR</b>	S. L. Dingman, W. F. Weeks, Y. C. Yen, and Andrew Assur	
<b>OBJECTIVES</b>	<ol style="list-style-type: none"> <li>1. Formulation of a one-dimensional steady state equation for heat balance of a river.</li> <li>2. Development of digital computer programs which incorporate previously established semi-empirical equations for heat loss rates due to evaporation, long- and short-wave radiation, and convection in numerically evaluating downstream temperature changes in a cooling river.</li> <li>3. Development of a simplified computational method which utilizes data generated in the computer program to establish coefficients under varying meteorological conditions.</li> <li>4. Test of methods against available field data from the literature as well as against new field observations collected in this program.</li> <li>5. Application of results to keeping portions of navigable waterways ice free in winter.</li> </ol>	
<b>SIGNIFICANT RESULTS</b>	<p>We have been able to accomplish all of the above objectives. Our theoretical results have been shown to be in good agreement with field observations. Also our calculations indicate that it is possible to use waste heat from nuclear power plants to greatly alleviate ice problems along selected stretches of navigable waterways.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Dingman, S. L., W. F. Weeks, and Y. C. Yen, 1966, The Effects of thermal pollution on river ice conditions, Part I, General method of calculation. US Army CRREL Research Report 206.</p> <p>Assur, Andrew and S. L. Dingman, 1966, The effects of thermal pollution on river ice conditions, Part II, Simplified method of calculation. US Army CRREL Research Report 206.</p> <p>Dingman, S. L., W. F. Weeks, and Y. C. Yen, 1968, The effects of thermal pollution on river ice conditions. Water Resources Research 4:2, p. 349-362. Also in Hearings before the Subcommittee on Air and Water Pollution. Committee on Public Works, U. S. Senate, 90th Congress, 2nd Session, p. 445-467.</p> <p>Dingman, S. L., 1968, Some effects of thermal pollution. Forest Notes 98, p. 12-14.</p> <p>Dingman, S. L. and W. F. Weeks, 1970, Observations of temperature and ice distribution in the North Saskatchewan River below the Edmonton Generating Plant. CRREL Special Report 152, 33 pp.</p> <p>Weeks, W. F., C. M. Keeler, W. Parrot, and D. LeVine, 1971, Wintertime dissipation of heat from a thermally polluted river, Water Resources Research, 7:6, p. 1529-1537.</p>	

**Weeks, W. F. and S. L. Dingman, 1973, Thermal modification of river ice covers: progress and problems. In The Role of Snow and Ice in Hydrology (Proceed. Banff Symposium, Sept. 1972), Vol. 2, p. 1427-1435, UNESCO-WMO-IASH, Geneva - Budapest - Paris.**

<b>TITLE</b>	Urban Water Resources Research Program	
<b>Coordinating Council Resolution in force and short title</b>	VI.5 Influence of Man on the Hydrological Cycle	US/IHD ref: 2.5 (346)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	American Society of Civil Engineers Urban Water Resources Research Program 23 Watson Street Marblehead, Massachusetts 01945	
<b>PRINCIPAL INVESTIGATOR</b>	M. B. McPherson, Program Director	
<b>OBJECTIVES</b>	<p>The basic purpose of the Program is to help establish coordinated long range research in urban water resources on a national scale. During the Decade the program was divided into three phases. The theme of Phase I was research needs assessment and that of Phase II was urban water management. Phase III emphasized translation of research findings into practice, facilitation of urban runoff research, and collaboration and participation in research of municipalities and other organizations. Another phase begun in late 1974 will address international urban hydrology research capabilities and include development of two urban hydrology state-of-the-art reports, on "urban catchment studies" and on "mathematical models".</p>	
<b>SIGNIFICANT RESULTS</b>	<p>This program produced many reports and technical memoranda dealing with problems of urban hydrology and the influence of man on this environment. Importantly the Program Director was the U.S. representative to and Chairman of the IHD/UNESCO Subgroup on the Effects of Urbanization on the Hydrological Environment. In this capacity the Program had significant international interaction. This Program was also the U.S. Co-operating Institution for the International Workshop on the Hydrological Effects of Urbanization held in Warsaw Poland 8-10 November 1973.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>American Society of Civil Engineers, New York, N.Y., 1968, Urban Water Resources Research, First Year Report to the Office of Water Resources Research, avail. NTIS, PB 184 318, W69-03506.</p> <p>American Society of Civil Engineers, New York, N.Y., 1969, Basic Information Needs in Urban Hydrology, a Report to the Geological Survey, avail. NTIS, PB 185 442, W69-06770.</p> <p>Schaake, J. C. Jr., 1968, T. M. No. 3, "Response Characteristics of Urban Water Resources Data Systems," avail. NTIS, PB 182 788, W69-03509.</p> <p>Wenzel, H. G. Jr., 1968, T. M. No. 4, "A Critical Review of Methods of Measuring Discharge Within a Sewer Pipe," avail. NTIS, Pb 182 789, W69-03510.</p>	

McPherson, M. B., 1968, T.M. No. 5, "The Nature of Changes in Urban Watersheds and Their Importance in the Decades Ahead," avail. NTIS, PB 182 790, W69-03511.

McPherson, M. B., 1969, T. M. No. 6, "Some Notes on the Rational Method of Storm Drainage Design," avail. NTIS, PB 184 701, W69-07482.

McPherson, M. B., 1970, ASCE, New York, N. Y., Prospects for Metropolitan Water Management, avail. ASCE, 345 East 47th Street, New York, N. Y. 10017.

ASCE Urban Water Resources Research Program, 1970, "Systems Analysis for Urban Water Management," a report by Water Resources Engineers, Inc., avail. NTIS, PB 197 677, W71-04755.

Prawdzik, T. B., 1970, T.M. No. 12, "Environmental and Technical Factors for Open Drainage Channels in Milwaukee," avail. NTIS, PB 191 710, W70-06318.

McPherson, M. B., 1971, T. M. No. 14, "Management Problems in Metropolitan Water Resource Operations," avail. NTIS, PB 206 087, W72-03553.

McPherson, M. B., 1971, T. M. No. 15, "Feasibility of the Metropolitan Water Intelligence System Concept (Integrated Automatic Operational Control)," avail. NTIS, PB 207 301, W72-05328.

McPherson, M. B., 1972, T.M. No. 17, "Hydrological Effects of Urbanization in the United States," avail. NTIS, PB 212 579.

McPherson, M. B., 1972, T.M. No. 18, "Urban Runoff," avail. NTIS, PB 212 580.

Bigler, A. B., 1973, T.M. No. 19, "Urban Ecosystems: A Water Resources Perspective," (Draft), avail. NTIS.

Goddard, J. E., 1973, T.M. No. 20, "An Evaluation of Urban Flood Plains," (Draft), avail. NTIS.

<b>TITLE</b>	<b>Role of Water in Urban Planning and Management</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VI.5 Influence of Man on the Hydrological Cycle</b>	<b>US/IHD ref: 2.6 (288)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	W. J. Schneider D. A. Rickert A. M. Spieker	
<b>OBJECTIVES</b>	To develop the capabilities of supplying hydrologic information in a form readily usable by urban officials. This project deals with one major aspect of the program - the adaptation of water-resources information to urban planning and management.	
<b>SIGNIFICANT RESULTS</b>	Types of hydrologic data and information needed for urban planning and management have been identified. Basic data have been synthesized into third and fourth generation products directly applicable to urban planning and management problems. Experience indicates that the most useful products are maps or atlases compatible in scale and detail the hydrologic system compatible with and linkable to overall management models.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Schneider, W. J., et. al., 1973, Role of Water in Urban Planning and Management, U.S. Geological Survey Circular 601-H, 10 p.</p> <p>Schneider, W. J. and A. M. Spieker, Water for the Cities-The Outlook, 1969, U.S. Geological Survey Circular 601-A, 6 p.</p> <p>Leopold, L. B., 1968, Hydrology for Urban Land Planning - A Guidebook on the Hydrologic Effects of Urban Land Use, U.S. Geological Survey Circular 554, 18 p.</p> <p>Feth, J. H., 1973, Water Facts and Figures for Planners and Managers, U.S. Geological Survey Circular 601-I, 30 p.</p> <p>Sheaffer, J. R., D. W. Ellis, and A. M. Spieker, 1970, Flood Hazard Mapping in Metropolitan Chicago, U.S. Geological Survey Circular 601-C, 14 p.</p> <p>Rantz, S. E., 1970, Urban Sprawl and Flooding in Southern California, U.S. Geological Survey Circular 601-B, 11 p.</p>	

<b>TITLE</b>	<b>Willamette River Basin Water Quality Studies</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VI.5 Influence of Man on the Hydrological Cycle</b>	<b>US/IHD ref: 2.5 (135)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Battelle-Northwest P.O. Box 999 Richland, Washington 99352</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>W. W. Waddel</b>	
<b>OBJECTIVES</b>	<b>Set up, calibrate and verify a water quality model for the Willamette River Basin. The model included 22 parameters which could interact with each other to realistically simulate the water quality.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>The water quality model was successfully applied to the basin and predicted water quality levels satisfactorily.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Baca, R. C., et al., 1973, EXPLORE-I: A River Basin Water Quality Model, Battelle, Pacific Northwest Laboratories, Richland, Washington.</b>	

Coordinating Council Resolution No. VI.9 Ecology and Control of Water-Loving Vegetation

Resolution No. VI.9<sup>(1)</sup>

The Council,

1. Recalling its resolution III.11;
2. Considering the nuisance effects of water plants in waterways;
3. Considering the increasing practical value of the study of ecology of aquatic plants and of their control;
4. Accepts the report and recommendations of the ad hoc panel of experts;
5. Notes with appreciation the efforts of the IHD Secretariat and the IBP to implement this activity;
6. Invites the IBP to continue its activities on studies of aquatic vegetation in co-operation with the Secretariat;
7. Requests the IHD Secretariat in co-operation with IBP to carry out the following programme in the field of ecology of water-loving vegetation:
  - (a) promotion of regional and international studies on the ecology of water-loving plants;
  - (b) preparation of a technical paper on the development of improved means for controlling and monitoring the spread of water-loving plants;
  - (c) preparation of a technical paper on preliminary studies needed before changes can be made in the hydrological regimes of basins, and on research practices to obtain improved understanding of the ecology of water-loving plants under both natural and experimental conditions and in different climatic regions.
8. Requests the IHD Secretariat to prepare a progress report on these activities for the next session of the Council.

(1) This resolution supersedes resolution III.11



<b>TITLE</b>	<b>Aquatic Weeds</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VI.9 Ecology and Control of Water-loving Vegetation</b>	<b>US/IHD ref: 1.10 (182)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Agricultural Research Service and U.S. Dept. of Agriculture Soil and Water Conservation Beltsville, MD 20705</b>	<b>College of Agriculture University of Wisconsin Madison, WI</b>
<b>PRINCIPAL INVESTIGATOR</b>	<b>L.W. Weldon R.D. Blackburn ARS, USDA Fort Lauderdale, Florida</b>	<b>L.G. Holm University of Wisconsin</b>
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<b>To provide a state of the art summary on aquatic weeds.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Holm, L. G., L. W. Welden, and R. D. Blackburn, 1969, Aquatic weeds. Science, V. 166, 7 Nov. 1969, p. 699-709.</b>	

Coordinating Council Resolution No. VII.2 Water Balance

2.3.1 Working Group on Water Balances

The Council noted some progress on international co-operation in this field: a technical paper on the Scientific framework of world water balance was published; a fundamental contribution on the theory and practices of water balance research was made by the Reading Symposium (July 1970) on Water Balance, and preparation of the Guide on hydrological mapping has started. The Council also noted that the on methods of computation of elements of water balance, without which it is impossible to carry out any co-ordinated studies of regional, large-scale, continental and global balances, and the compilation of an annotated bibliography on water balances has not yet been completed.

As the guide on the computation of water balances should summarize the experience of as many countries as possible, the Council invited national committees to forward to the IHD Secretariat any significant material which they have on this subject.

With regard to the guide on hydrological mapping, the Council agreed with the recommendation of the sub-group on hydrological maps that the question of practical mapping of generalized data and parameters with reference to engineering computation of runoff of water bodies inadequately studies is especially important for developing countries.

Resolution No. VII.2

The Council,

:

2. Considering the importance of a guide on the computation of water balance for the study of large-scale, regional and global water balances;

:

4. Recommends that, in the period up until the end of the Decade, the Working Group should concentrate its attention mainly on the preparation of a guide on the computation of water balance for the study of large-scale, regional and world water balances, and take all necessary measures to ensure its publication in 1972;

5. Requests that, in the preparation of an international guide on the preparation of hydrological maps, attention should be given to reflecting in this guide, alongside scientific and methodological questions, the problems of hydrological mapping which are especially important for developing countries.

<b>TITLE</b>	<b>Physical and Geological Oceanography of the Great Bay, New Hampshire, Estuarine System</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.2 Water Balances</b>	<b>US/IHD ref: 2.3 (154)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Dept. of Earth Sciences University of New Hampshire Durham, NH 03824</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>Franz E. Anderson</b>	
<b>OBJECTIVES</b>	<p>There were two main objectives of this study: (1) a thorough study of the physical oceanography of the bay on a annual basis; and (2) its relation to the present and past depositional regime. Because the project was not funded, only part of the proposed research was conducted. The study mainly concentrated on the transport of suspended sediments through the estuarine system.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>Samples of estuarine water were collected from the Bellamy River estuary, a tributary to Great Bay. Surface and near bottom water samples were analyzed for total suspended matter and organic carbon. These data were compared with the current velocity, temperature, and salinity structure of the estuary to understand the seasonal flux of suspended sediment in the estuary. Samples were collected on a bi-monthly basis for one year.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Anderson, Franz E., 1968, Factors affecting the concentration of particulate matter in estuarine waters. Paper presented to the Geological Society of America, 1968 Annual Meeting in Mexico City.</p> <p>Anderson, F. E., 1970, The periodic cycle of particulate matter in a shallow, temperate estuary: Jour. Sed. Petrology, 40, 1128-1135</p>	

<b>TITLE</b>	Hydrological Maps	
<b>Coordinating Council Resolution in force and short title</b>	VII.2 Water Balances (Hydrologic Maps)	US/IHD ref: 3.1(279)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Hydrological Maps c/o U.S. National Committee for IHD 2101 Constitution Avenue, N.W. Washington, D.C. 20418 in cooperation with  Committee on Ground Water American Geophysical Union 1909 K St., N.W. Washington, D.C. 20006	
<b>PRINCIPAL INVESTIGATOR</b>	E. S. Asselstine and A. I. Johnson	
<b>OBJECTIVES</b>	To foster the improvement of practical and conceptual aspects of hydrological mapping; to foster appreciation for the unity of the hydrological cycle through preparation of hydrological maps of atmospheric, surface, vadose-zone, and saturated underground water; and to cooperate with and assist the UNESCO/IHD Working Group on Hydrological Maps, subsequently incorporated with the UNESCO/IHD Working Group on Water Balances.	
<b>SIGNIFICANT RESULTS</b>	<p>Preparation of the UNESCO/IHD Traveling Exhibit of Hydrological Maps, which included 61 maps from 23 countries, presenting a broad spectrum of hydrological subjects and different ways of presenting hydrological phenomena. After being shown at universities and conferences in the United States for about one year, the exhibit was sent to Canada, Cuba, and South America.</p> <p>In preparation for the exhibit, the Work Group examined about 300 hydrological maps made in the United States and selected about 75 for the UNESCO type collection. To expedite the selection, the Work Group developed a map classification system that later was adapted to UNESCO's broader needs.</p> <p>The Work Group also cooperated with the AGU Committee on Ground Water to prepare two chapters for the proposed UNESCO Guidebook on the Preparation of Hydrological Maps, scheduled for issue in 1975. This guidebook represents the first attempt to treat the preparation of all types of hydrological maps in a congruent fashion.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Heindl, L. A., 1970, Proposal for a U.S. National Water Atlas, Am. Water Resources Assoc. Water Resources Bull., 6:1, p. 1-6.  _____, 1970, An Approach to the Rational Classification of Hydrological Maps (abstract), Geol. Soc. America Abstracts with Program, 2:7, p.  _____, 1971, Hydrological Mapping and the IHD, Nature and Resources, 7:1, p. 15-19.  _____, in review, Chapter I - Introduction in Guidebook on Preparation of Hydrological Maps, UNESCO publication scheduled for 1975.	

**Johnson, A. I., and others, in review, Contributions to  
Chapter VII - Groundwater Maps in Guidebook on Preparation  
of Hydrological Maps, UNESCO publication scheduled for 1975.**

<b>TITLE</b>	<b>Water Stored in Lakes, Reservoirs, and Swamps</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.2 Water Balances</b>	<b>US/IHD ref: 1.5(33)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Forest Service U.S. Department of Agriculture North Central Forest Experiment Station Grand Rapids, Minnesota 55744	
<b>PRINCIPAL INVESTIGATOR</b>	Don H. Boelter	
<b>OBJECTIVES</b>	To obtain data on water in swamps, inflow and outflow, and turnover time, and to develop methods of making reliable estimates over vast areas of swampland by extension of results from gauged areas.	
<b>SIGNIFICANT RESULTS</b>	<p>About three-fourths of the 15 million acres of organic soils in the United States is in the northern forest zone. Water balance measurements on experimental bog watersheds show that nearly 20 inches of water are lost each year by evapotranspiration. Heaviest losses occur in midsummer, although over 40 percent of annual rainfall also occurs during the 3 summer months. Hydrographs from recording wells indicate that evapotranspiration may be reduced when bog water tables recede only slightly below the surface. Management techniques which lower wetland water tables should reduce evaporation loss and make more water available for summer streamflow. Knowledge of the streamflow leaving wetland forest watersheds is vital to woodland managers planning drainage systems; to engineers planning bridges, culverts, and water control structures; and to water managers in agriculture, industry, municipalities, and the wildlife field. New knowledge developed in the Southeast shows that engineers who use a common drainage formula without correction for soil moisture storage capacity can underestimate peak flows by 60% during wet periods. Such a large underestimation can result in underdesign of bridges, culverts, ditches &amp; other water control structures.</p> <p>Recent evidence shows that runoff is not evenly distributed from northern bogs and swamps. Flow in the spring months accounts for two-thirds or more of the total annual water yield. Summer and fall flows are low. Annual peak rates of discharge were low and recessions were long, indicating that bogs were effective as storage areas for short-term runoff. However, they were not effective as long-term storage areas or regulation of streamflow.</p> <p>Laboratory and field studies of organic soils measured large and significant differences in physical properties of various peat materials. Water storage and yield, as well as rates of water movement, were related to degree of decomposition of the organic material.</p>	

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- Boelter, D. H., 1972, Preliminary results of water level control on small plots in a peat bog. Fourth Int. Peat Cong. Proc., Otaniemi, Finland, June 25-30, 1972, Vol.3, 347-354.

**Brown, J. M., 1972, The effect of overstory removal upon surface wind in a black spruce bog. USDA, Forest Service, Res. Note NC-137, 2 p.**

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<b>TITLE</b>	Streamflow from the United States into the Atlantic Ocean during 1931-1960.	
<b>Coordinating Council Resolution in force and short title</b>	VII.2 Water Balances	US/IHD ref: 1.6(306)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	C. D. Bue	
<b>OBJECTIVES</b>	To furnish data on streamflow into the Atlantic Ocean. The data consisted of the following: Discharge by years from specified segments of coastline for a 10-year period (the period not specified), discharge of the Charles River at mouth for the period 1920-1960, and the mean discharge of the Hudson River at mouth for the period 1890-1960, and mean monthly discharge of the Penobscot and James Rivers at mouth for a 10-year period (the period not specified).	
<b>SIGNIFICANT RESULTS</b>	<p>Streamflow from the United States into the Atlantic Ocean, between the international stream St. Croix River, inclusive, and Cape Sable, Fla., averaged about 355,000 cfs (cubic feet per second) during the 30-year period 1941-60, or roughly 20 percent of the water that, on the average flows out of the conterminous United States. The area drained by streams flowing into the Atlantic Ocean is about 288,000 square miles, including the Canadian part of the St. Croix and Connecticut River basins, or a little less than 10 percent of the area of the conterminous United States. Hence, the average streamflow into the Atlantic Ocean, in terms of cubic feet per second per square mile, is about twice the national average of the flow that leaves the conterminous United States. Flow from about three-fourths of the area draining into the Atlantic Ocean is gaged at streamflow measuring stations of the U.S. Geological Survey. The remaining one-fourth of the drainage area consists mostly of low-lying coastal areas from which the flow was estimated, largely on the basis of nearby gaging stations.</p> <p>Streamflow, in terms of cubic feet per second per square mile, decreases rather progressively from north to south. It averages nearly 2 cfs along the Maine coast, about 1 cfs along the North Carolina coast, and about 0.9 cfs along the Florida coast.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Bue, C. D., 1970, Streamflow from the United States into the Atlantic Ocean during 1931-1960: U.s. Geol. Survey Water-Supply Paper 1899-I, 36 p.	

<b>TITLE</b>	<b>Hydrology of Prairie Potholes</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.2 Water Balances</b>	<b>US/IHD ref: 2.3(84)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Denver Federal Center Denver, Colorado 80225	
<b>PRINCIPAL INVESTIGATOR</b>	W. S. Eisenlohr, Jr.	
<b>OBJECTIVES</b>	To determine the general hydrologic characteristics of the prairie potholes and the corresponding influence on the ecology of the area (primarily migratory waterfowl).	
<b>SIGNIFICANT RESULTS</b>	<p>The prairie pothole region provides the best breeding grounds for migratory waterfowl, yet much of that region has already been drained for agriculture and the drainage of more potholes is in progress. It is important that the prairie potholes most desired by waterfowl for breeding, feeding, and resting be preserved for their use. To select the potholes to be preserved requires a thorough understanding of their hydrology.</p> <p>The usefulness of a prairie pothole to waterfowl depends on the length of time it contains enough water to benefit the waterfowl. The principal gain of water in a pothole comes from snowmelt runoff in the spring. There are additional gains in some years as a result of rains and the runoff from torrential rainstorms. As a very few potholes overflow, evapotranspiration and seepage are the only loss from most potholes. By evaluating these losses one obtains a measure of the usefulness of a prairie pothole and the gain in amount of water that could be required to keep it useful.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Eisenlohr, W. S., Jr., and C. E. Sloan, 1968, Generalized hydrology of prairie potholes on the Coteau du Missouri, North Dakota: U.S. Geol. Survey Circular 558.</p> <p>Eisenlohr, W. S., Jr., 1965, Hydrology of prairie potholes in Northcentral United States: Bull. of the International Association of Scientific Hydrology, Sept., p. 49-50.</p> <p>Eisenlohr, W. S., Jr., and others, 197 , Hydrologic investigations of prairie potholes in North Dakota, 1959-68: U.S. Geol. Survey Prof. Paper 585-A (in press).</p> <p>Sloan, C. E., 1972, Groundwater hydrology of prairie potholes in North Dakota: U.S. Geol. Survey Prof. Paper 585-C, 29 p.</p> <p>Eisenlohr, W. S., Jr., 1966, Determining the water balance of a lake containing vegetation, International Association of Scientific Hydrology Publication 70, p. 91-99.</p>	

<b>TITLE</b>	<b>Precipitation Data for the United States</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.2 Water Balances</b>	<b>US/IHD ref: 1.2 (45)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	Ralph F. Kresge Office of Hydrology National Weather Service, NOAA Silver Spring, MD 20910	
<b>OBJECTIVES</b>	To provide accurate knowledge about how much water exists, where it occurs, and how much actually is available for use.	
<b>SIGNIFICANT RESULTS</b>	Published data from all precipitation observation stations, over 13,000 in number, are available for appraisal and investigation of the water resources of the nation. Many of these stations have been and are being used in connection with other Decade projects. Among these projects are representative and experimental basins, reference climatological stations, and evaporation stations. Further to assist in the international exchange of precipitation data from the IHD, data from a network of 143 stations in the contiguous U.S. are available in World Weather Records for North America, 1951-60.	
<b>REPORTS AVILABLE PUBLICLY</b>	Basic precipitation, pan-evaporation, and climatological data are compiled and published on a monthly and annual basis in Climatological Data, and Hourly Precipitation Data, by the NOAA Environmental Data Service. These compilations are available from the NOAA - National Climatic Center, Asheville, North Carolina.	

<b>TITLE</b>	<b>World Water Balance</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.2 Water Balance</b>	<b>US/IHD ref: 1.12 (348)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on the World Water Balance National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	R. L. Nace, Chairman	
<b>OBJECTIVES</b>	The objectives of this Work Group were to promote activities within the U.S. leading to better understanding of the world and regional water balances and to provide information for international compilations regarding the various parameters of the hydrological cycle in the United States.	
<b>SIGNIFICANT RESULTS</b>	The Chairman of this U.S. Work Group was also the U.S. Representative to the corresponding UNESCO International Working Group on World Water Balance. Through this liaison the U.S. Work Group was able to contribute to the overall direction of the IHD on this subject. Further, the Chairman served as the Coordinator for U.S. participation in the International Symposium on World Water Balance held in Reading, England in July 1970. In addition to assuring presentation of several U.S. contributions the Work Group provided suggestions on the symposium program. Other activities included the preparation of a catalog of U.S. hydrological networks, provision of U.S. data on floods, lakes, and water quality to UNESCO, securing the translation of a pertinent Russian paper, and the promotion of a U.S. Water Atlas.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>U.S. National Committee for the IHD, 1972, Catalog of International Hydrological Decade Stations and Networks in the United States, National Academy of Sciences-National Research Council, Washington, D.C., 66 p.</p> <p>Kudelin, B. I., I. S. Zektser, A. V. Meskheteli, and S. A. Brusilovsky, The Problem of Groundwater Discharge into the Seas, U.S. IHD Bulletin, No. 19, Reprinted from EOS, Transactions American Geophysical Union, 52:10, 1971, translation by F. W. Trainer, 6 p.</p> <p>Nace, R. L., 1969, Water and man: a world view, UNESCO and its programme series, UNESCO, Paris, France, 46 p.</p> <p>Nace, R. L., 1967, Water Resources: A Global Problem with Local Roots, <u>in</u> Environmental Science and Technology, 1:7, pp. 550-560.</p> <p>Geraghty, J. J., and others, 1973, Water Atlas of the United States (2nd edition), Water Information Center, Port Washington, N.Y., 244 p. (unnumbered).</p> <p>Nace, R. L., 1970, World hydrology: status and prospects, <u>in</u> Proceedings of Symposium on world water balance, Reading, England 1970, IAHS Publication no. 92, vol. I, 10 p.</p>	

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Simpson, E. S., D. B. Thorud, and Irving Friedman, 1970, Distinguishing winter from summer recharge to groundwater in southern Arizona by deuterium analysis, in Proceedings of Symposium on world water balance, Reading, England 1970, IAHS Publication no. 92, vol. I, 2 p.

<b>TITLE</b>	<b>Discharge of Surface Water to the Sea</b>																	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.2 Water Balances</b>	<b>US/IHD ref: 1.6 (66)</b>																
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Va. 22092																	
<b>PRINCIPAL INVESTIGATOR</b>	Alfonso Wilson; Kathleen T. Iseri																	
<b>OBJECTIVES</b>	To compile data, in atlas form, on the surface water component of discharge of water to the sea from the United States, Alaska and Puerto Rico.																	
<b>SIGNIFICANT RESULTS</b>	<p>Displays maps showing discharge to the sea from the United States and Alaska in 1966 and 1967, totalled as follows:</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td style="text-align: right;"><math>M^3 S^{-1}</math></td> </tr> <tr> <td></td> <td style="text-align: right;">(rounded)</td> </tr> <tr> <td><b>From conterminous United States</b></td> <td></td> </tr> <tr> <td style="padding-left: 20px;">To Atlantic Ocean</td> <td style="text-align: right;">10,180</td> </tr> <tr> <td style="padding-left: 20px;">To Pacific Ocean</td> <td style="text-align: right;">14,140</td> </tr> <tr> <td style="padding-left: 20px;">To Gulf of Mexico</td> <td style="text-align: right;">25,120</td> </tr> <tr> <td><b>From Alaska to Pacific Ocean</b></td> <td style="text-align: right;"><u>42,800</u></td> </tr> <tr> <td style="padding-left: 40px;"><b>Total (rounded)</b></td> <td style="text-align: right;"><b>92,000</b></td> </tr> </table>			$M^3 S^{-1}$		(rounded)	<b>From conterminous United States</b>		To Atlantic Ocean	10,180	To Pacific Ocean	14,140	To Gulf of Mexico	25,120	<b>From Alaska to Pacific Ocean</b>	<u>42,800</u>	<b>Total (rounded)</b>	<b>92,000</b>
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<b>REPORTS AVAILABLE PUBLICLY</b>	Wilson, Alfonso, and K. T. Iseri, 1969, River discharge to the sea from the shores of the conterminous United States, Alaska, and Puerto Rico: U.S. Geol. Survey Hydrol. Atlas 282.																	

Coordinating Council Resolution No. VII.3 Groundwater Studies

Resolution No. VII.3

The Council,

:

2. Recognizing the great complexity of tasks facing the Working Group [on Groundwater Studies];

:

4. Accepts the work plan of the Working Group up until the end of the Decade, which was adopted at its first session in Paris and includes the compilation of international guides on:

the design and planning of networks of observation wells;

hydrogeological mapping;

the use of geophysical methods in exploration of groundwaters;

the hydrogeological studies in areas with fissured and carbonate rocks;

the exploration of quality of groundwaters;

the methods of exploration and forecasting of groundwater resources in large areas;

the international glossary of hydrogeological terms for the second edition of the "International Guide on Groundwater studies";

5. Decides that the Working Group should continue its activities in the framework of the terms of reference established by the Council at its sixth session in resolution VI.4;

6. Directs the Working Group to give priority in its plan for 1972-1974 to:

(a) compilation of an international guide on the methods of exploration and estimation of various types of deposits of fresh groundwater, and the organization in 1973 of an international seminar on this subject;

(b) compilation of an international guide on hydrogeological work with a view to land use;

(c) compilation of an international guide on hydrogeological mapping;

7. Requests the Working Group, at its next session, to define the priority tasks of the long-term programme of international co-operation for the exploration of groundwater in accordance with resolution VII.13 of this session.

<b>TITLE</b>	<b>Significance of Groundwater Chemistry in Performance of North Sahara Tube Wells in Algeria and Tunisia</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.3 Groundwater Studies III.15 Regional Co-operation</b>	<b>US/IHD ref: 3.6(301)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Geological Survey National Center Reston, Virginia</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>F. A. Clarke and B. F. Jones</b>	
<b>OBJECTIVES</b>	<b>To determine if the waters from the principal North Sahara aquifers of Algeria and Tunisia are likely to cause corrosion and mineral encrustation on well casings and filter pipes and thus contribute to observed reductions in discharge and quality changes in irrigation wells.</b>	
<b>SIGNIFICANT RESULTS</b>	<p><b>Although the shallow and deep waters differ significantly in certain quality factors, all are sulfochloride types with corrosion potentials ranging from moderate to extreme. None appear to be sufficiently supersaturated with troublesome mineral species to cause rapid or severe encrustation of filter pipes or other well parts. However, calcium carbonate encrustation of deep-well cooling towers and related irrigation pipes can be expected because of loss of carbon dioxide and water during evaporative cooling.</b></p> <p><b>Corrosion products, particularly iron sulfide, can be expected to deposit in wells producing water from the deep aquifer.</b></p> <p><b>Both the shallow waters and the deep waters examined in this study will tend to cause soil salinization because their salt content are relatively high, and both have sodium absorption ratios which are unfavorable to sodium-sensitive soils and vegetation.</b></p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Clark, F.E. and B.F. Jones, 1972, Significance of Groundwater Chemistry in Performance of North Sahara Tube Wells in Algeria and Tunisia. U.S. Geol. Survey Water-Supply Paper 1757-M, 39 p.</b>	



<b>TITLE</b>	<b>International Glossary of Hydrogeology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.3 Groundwater Studies</b>	<b>US/IHD ref: 3.5 (288)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>US/IHD Work Group on Groundwater Studies National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>George H. Davis, Chairman; Seymour Subitzky, Principal Reviewer</b>	
<b>OBJECTIVES</b>	<b>To review the English language version of the UNESCO report, "International Glossary of Hydrogeology," prepared under the direction of Jean Margat.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>The review was completed and appropriate revisions and suggestions were made. The report is scheduled for publication in 1975 and will satisfy a long felt need for an authoritative multilingual glossary on the subject of hydrogeology.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Margat, Jean (ed.), <u>in preparation</u>, International Glossary of Hydrogeology, UNESCO, Paris, France.</b>	

<b>TITLE</b>	Application of Geophysical Logging to Groundwater Studies in Southern Saskatchewan	
<b>Coordinating Council Resolution in force and short title</b>	VII.3 Groundwater Studies III.15 Regional Co-operation	<b>US/IHD ref:</b> 1.8(317)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Saskatchewan Research Council Saskatoon, Saskatchewan Canada	U.S. Geological Survey Denver Federal Center Denver, Colorado 80225
<b>PRINCIPAL INVESTIGATOR</b>	J. H. Dyck	W. S. Keys
<b>OBJECTIVES</b>	To evaluate various logging methods under field conditions in Saskatchewan.	
<b>SIGNIFICANT RESULTS</b>	<p>Single-point resistance and spontaneous potential logs in fresh-water filled rotary-drilled test-holes provide data useful in geohydrologic studies in Saskatchewan. These geophysical logs are made by many of the water well drilling contractors in Saskatchewan on a routine basis. The logs provide good resolution of various lithologic units and provide data required to estimate the salinity of water in sand beds prior to constructing a well.</p> <p>Caliper logging offers a potentially useful method for evaluating hole conditions and the effect of drilling techniques on the formation in completion zones. The casing collar locator log run in a previously constructed well near Estevan demonstrates that this device can provide an accurate and objective measurement of the position and length of each joint of casing, the position of the screen assembly, and the location of screened and blanked intervals within the screen assembly. This tool should find general application in water well construction and maintenance practice.</p> <p>The neutron-epithermal neutron log provides a method of measuring the porosity of sand and gravel beds. The response of the gamma log is similar to that of the spontaneous potential log and the neutron-epithermal neutron log deflects in a fashion similar to the resistance and resistivity logs. Nuclear logs offer the advantage that they can be run in cased or uncased boreholes which may be filled with any type of fluid. They require more complicated and expensive instrumentation and slow-speed logging to obtain the required resolution. The normal resistivity logs offer the possibility of determining the concentration of dissolved solids in the formation water. The gamma-gamma log is a poor alternative to the natural gamma and neutron log for stratigraphic correlations.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Dyck, J. H., W. S. Keys, and W. A. Meneley, 1972, Application of geophysical logging to groundwater studies in southern Saskatchewan, Canadian Journal of Earth Sciences, 9,78-94.	

<b>TITLE</b>	Qualitative and Quantitative Evaluation of Infra-red Imagery	
<b>Coordinating Council Resolution in force and short title</b>	VII.3 Groundwater Studies	<b>US/IHD ref:</b> 3.8 (159)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Battelle-Northwest P.O. Box 999 Richland, Washington 99352	
<b>PRINCIPAL INVESTIGATOR</b>	J. R. Eliason	
<b>OBJECTIVES</b>	To provide digital computer compatible IR scanning systems to enhance qualitative and quantitative evaluation of Infra Red Imagery.	
<b>SIGNIFICANT RESULTS</b>	<p>Techniques were developed for the analysis and display of surface temperature data obtained by means of an aerial infra-red scanner. The output of the scanner is initially recorded in analog form on magnetic tape, then is subsequently digitized and processed in a digital computer. The processing program applies the necessary geometric and temperature corrections, calibrates the signals, and produces the final output. An editing capability is provided whereby land area can be deleted and areas of particular interest can be isolated and expanded. Output is available in several forms:</p> <p>(1) Temperature levels represented by distinctive patterns or by numbers or letters, (2) Contour plots and stereo pairs of contour plots, (3) Oblique projections of the thermal surface, (4) Intensity modulated pictures. The temperature sensitivity of the system is about .2°C.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Eliason, J. R. et al, 1968, Techniques for Qualitative and Quantitative Evaluation of Infra-red Imagery. U.S. AEC Report BNWL-SA-1698.	

<b>TITLE</b>	<b>Sodium Sulphate Studies</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.3 Groundwater Studies</b>	<b>US/IHD ref: 2.11(203)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Va. 22092	
<b>PRINCIPAL INVESTIGATOR</b>	I. G. Grossman	
<b>OBJECTIVES</b>	To explain the origin of the sodium sulphate deposits of the northern Great Plains of Canada and the United States.	
<b>SIGNIFICANT RESULTS</b>	Widespread surficial deposits of sodium sulphate in the Northern Great Plains may have been derived from deeply buried evaporates of the Prairie Formation of Devonian Age. Groundwater from the Rocky Mountain area presumably circulated eastward into the large structural basin underlying in the Great Plains in Canada and northern United States, dissolving the evaporates at great depths from late Devonian time onward. In late Pleistocene time, ascending mineralized groundwater discharged into melt-water channels in stratified drift overlying buried bedrock valleys. Freezing segregated pure crystals of sodium sulphate which accumulated in meromictic lakes. The residual brines discharged into streams draining southward into the Missouri River system. Rising temperatures and increasing aridity gradually disintegrated the drainage pattern in an area where the deposits were reserved beneath existing or shrunken lakes.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Grossman, I. G., 1968, Origin of the sodium sulphate deposits of the northern Great Plains of Canada and the United States, U.S. Geological Survey Professional Paper 600B, p. B104-B109.	

<b>TITLE</b>	<b>Investigation of Methods for the In-place Measurement of Vadose Zone Hydraulic Parameters</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.3 Groundwater Studies</b>	<b>US/IHD ref: 3.3 (92)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Atomic Energy Commission Washington, D.C. 20545</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>R. E. Isaacson, Atlantic Richfield Hanford Co. Richland, Wash. 99352</b>	
<b>OBJECTIVES</b>	<b>To perfect techniques for measuring hydraulic characteristics of partially-saturated soils in situ. (to examine recently developed instrumentation and equipment and to apply the advances in electronic component design, minimization, pressure-sensing equipment, and soil moisture probes to in situ soil measurements.)</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Moisture migration in arid soil is dominated by gaseous phase diffusion parameters. Maximum depth of penetration of fallout tritium relates to barometric cycling.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Hsieh, J. J. C., L. E. Brownell and A. E. Reisenauer, 1972, Lysimeter Experiment Description and Progress Report on Neutron Measurements. Battelle-Northwest, Richland, Washington, BNWL-1711.</b></p> <p><b>Hsieh, J. J. C., A. E. Reisenauer and L. E. Brownell, 1972, A Study of Soil Water Potential and Temperature in Hanford Soils, Battelle-Northwest, Richland, Washington, BNWL-1712.</b></p> <p><b>McHenry, J. R. and A. C. Gill, 1970, Measurement of Soil Moisture with a Portable Gamma Ray Scintillation Spectrometer, Water Resources Res., 6:3, p. 989-992.</b></p> <p><b>Wiebe, H. H., et al, 1971, Measurement of Plant and Soil Water Status. Bulletin 484, Utah State University.</b></p>	

<b>TITLE</b>	<b>Soil Moisture Transport in Arid Site Vadose Zones</b>	
<b>Coordinating Council Resolution in force and short title</b>	VII.3 Groundwater Studies	<b>US/IHD ref:</b> 3.3(300)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Atlantic Richfield Hanford Company Richland, Washington 99352	
<b>PRINCIPAL INVESTIGATOR</b>	R. E. Isaacson	
<b>OBJECTIVES</b>	To thoroughly study the movement of water, both upward and downward, under various conditions of wetting in the zone of aeration with particular reference to questions about percolation of rain water and snow melt to the water table.	
<b>SIGNIFICANT RESULTS</b>	<p>Soil-moisture relationships are being studied for selected soils on the Hanford reservation to determine the rate and direction of soil moisture movement in the vadose zone high above the deep water tables. The purpose is to establish with greater certainty the fate of radionuclides stored in the sediments on the Hanford reservation. Observations to date indicate that the annual precipitation of meteoric water does not percolate to the water table but apparently moves downward only a few meters during the fall and winter months and is removed by evaporation and evapotranspiration during the summer.</p> <p>The movement of soil water downward is influenced by the soil temperature. A decrease in temperature during autumn and winter increases the surface tension of water in the capillaries of the soil thus providing a holding system that prevents transport of water downward. Lower temperatures increase the radius of curvature and, therefore, the volume of the menisci of water held at the points of soil-particle contact. This is one reason for the increase in soil moisture as temperature decreases.</p> <p>Temperature gradients in autumn and winter tend to move water from depths toward the surface except for a short period during February and possibly March. During late spring and summer the temperature gradients in the soil near the surface reverse but upward transport of water by surface evaporation, evapotranspiration, and diffusion negates the mechanisms for downward percolation.</p> <p>Work has shown that there is a critical rainfall that is required to cause moisture to migrate to the water table. Further studies are showing that commonly accepted equations in hydrology that assume isothermal conditions are not generally applicable in arid or semiarid regions having a deep water table, and conservation of momentum expressions must be developed and evaluated. It has become apparent that temperature, not gravity, is the primary driving force for moisture transport in the more arid soils.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Isaacson, R. E., et al., 1974, Soil Moisture Transport in Arid Site Vadose Zones, ARH-SA-169 (SM-182/6), Atlantic Richfield Hanford Co., Richland, Washington, 25 p. (See also report ARH-2983, 1974.)	

<b>TITLE</b>	<b>Digital Computer Methods for Evaluating Groundwater Recharge</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.3 Groundwater Studies</b>	<b>US/IHD ref: 3.8(91)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Atomic Energy Commission Washington, D.C. 20545	
<b>PRINCIPAL INVESTIGATOR</b>	R. E. Isaacson, Atlantic Richfield & Hanford Co. D. B. Cearlock, Battelle Northwest Laboratory	
<b>OBJECTIVES</b>	To determine the effects of size and configuration of these facilities on groundwater recharge capacities. Also to determine the effect of soil heterogeneities and depth to water tables on recharge rates will be evaluated.	
<b>SIGNIFICANT RESULTS</b>	Significant advancement in computer technology has made digital modeling of groundwater systems practical. Realistic stimulations of transient heterogeneous grounded water systems have been developed by several investigators. Both local and basin wide modeling can be routinely made.  Several significant reports are listed below.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Kipp, K. L., D. B. Cearlock and A. E. Reisenauer, 1973, Mathematical Modeling of a Large, Transient, Unconfined Aquifer with Heterogeneous Permeability Distribution, Transactions AGU 53:4.</p> <p>Kipp, K. L., D. B. Cearlock, A. E. Reisenauer and C. A. Bryan, 1972, Variable Thickness Transient Groundwater Flow Model Theory and Numerical Implementation, Battelle-Northwest, Richland, Washington, BNWL-1703.</p> <p>Kipp, K. L. and D. B. Cearlock, 1972, The Transmissivity Iterative Calculation Routine - Theory and Numerical Implementation, Battelle-Northwest, Richland, Washington, BNWL-1706.</p> <p>Addison, L. E., D. R. Friedrichs and K. L. Kipp, 1972, The Transmissivity Iterative Programs on the PDP-9 Computer - A Man-Machine Interactive System, Battelle-Northwest, Richland, Washington, BNWL-1707.</p> <p>DeMier, W. V., A. E. Reisenauer and K. L. Kipp, 1972, Variable Thickness Transient Groundwater Model Program-User's Manual, Battelle-Northwest, Richland Washington, BNWL-1704.</p> <p>Freeze, R. A., 1971, Three-Dimensional, Transient, Saturated-Unsaturated Flow in a Groundwater Basin, Water Resources Res. 7:2, 347-366.</p>	

Bredehoeft, J. D. and G. F. Pinder, 1970, Digital Analysis of Areal Flow in Multiaquifer Groundwater Systems: A Quasi-Three Dimensional Model, Water Resources Research 6:3, 883-888.

Cearlock, D. B. and A. E. Reisenauer, 1971, Sitewide Groundwater Flow Studies for Brookhaven National Laboratory, Upton, L. I., New York, Pacific Northwest Laboratories, Undocumented Report, Battelle Memorial Institute.

D. L. Schrieber, A. E. Reisenauer, K. L. Kipp and R. T. Jaske, 1973, Anticipated Effects of an Unlined Brackish-Water Canal on a Confined Multiple-Aquifer System, Battelle-Northwest, Richland, Washington, BNWL-1800.

Friedrichs, D. R., 1973, A Graphic Digitizer Program to Interpolate Matrix Grid Values: Users Manual, Battelle-Northwest, Richland, Washington, BNWL-1652.

Friedrichs, D. R., 1972, Graphic Display of Three-Dimensional Surfaces-User's Manual, Battelle-Northwest, Richland, Washington, BNWL-1722.

Ahlstrom, S. W. and R. G. Baca, 1974, Transport Model-User's Manual, Battelle-Northwest, Richland, Washington, BNWL-1716.

Routson, R. C. and R. J. Serne, 1972, Experimental Support Studies for the Percol and Transport Models, Battelle-Northwest, Richland, Washington, BNWL-1719.

Routson, R. C. and R. J. Serne, 1972, One-Dimensional Model of the Movement of Trace Radioactive Solute Through Soil Columns: The Percol Model, Battelle-Northwest, Richland, Washington, BNWL-1718.

Serne, R. J., R. C. Routson and D. A. Cochran, 1973, Experimental Methods for Obtaining Percol Model Input and Verification Data, Battelle-Northwest, Richland, Washington, BNWL-1721.

Friedrichs, D. R., 1972, Information Storage and Retrieval System for Well Hydrograph Data-User's Manual, Battelle-Northwest, Richland, Washington, BNWL-1705.

Addison, L. E., D. R. Friedrichs and K. L. Kipp, 1972, Transmissivity Iterative Program-User's Manual, Battelle-Northwest, Richland, Washington, BNWL-1708.

Kipp, K. L. and R. D. Mudd, 1973, Collection and Analysis of Pump Test Data for Transmissivity Values, Battelle-Northwest, Richland, Washington, BNWL-1709.



<b>TITLE</b>	<b>Study of Depression in Groundwater and Moisture Flow in the Vadose Zone</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.3 Groundwater Studies</b>	<b>US/IHD ref: 3.5 (09)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Battelle Memorial Institute P.O. Box 999 Richland, Washington 99352</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>D. R. Kalkwarf A. E. Reisenauer</b>	
<b>OBJECTIVES</b>	<b>To develop accurate methods to mathematical models and associated digital computer programs for describing hydrologic depressions and transient moisture movements in the vadose zone.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Several digital computer models have been developed for describing hydrologic depressions and transient moisture movements in the vadose zone. Expansion into multidimensional heterogeneous, unsaturated-transient systems has been achieved.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Cearlock, D.C., 1966, Transport Analysis - Basic Predictive Approach to the Movement of Pollutants Through Soils, Proceedings of the 21st Annual Purdue Industrial Waste Conf., Lafayette, Indiana, May 3-5, 1966.</b></p> <p><b>King, L.G., 1965, Description of Soil Characteristics of Partially Saturated Flow, Soil Science Society of American Proceedings, 29:4, 359-362.</b></p> <p><b>Nelson, R.W., 1966, A Sequence for Predicting Waste Transport by Ground Water, 1966 Water &amp; Sewage Works Ref. Vol. (Scranton Publishing Co., Chicago, Illinois).</b></p> <p><b>Reisenauer, A.E., 1973, D.B. Cearlock and C.A. Bryan, Numerical Solution of the Richard's Equation and Application to Unsaturated Flow Problems, Transactions AGU 53:4.</b></p> <p><b>Reisenauer, A.E., D.B. Cearlock and C.A. Bryan, 1972, Partially-Saturated Transient Groundwater Flow Model Theory and Numerical Implementation, Battelle-Northwest, Richland, Washington, BNWL-1713.</b></p> <p><b>Reisenauer, A. E., 1973, Calculation of Soil Hydraulic Conductivity from Soil-Water Retention Relationships, Battelle-Northwest, Richland, Washington, BNWL-1710.</b></p>	

Bredehoeft, J. D. and G. F. Pinder, 1970, Digital Analysis of Areal Flow in Multiaquifer Groundwater Systems: A Quasi-Three Dimensional Model, Water Resources Research 6(3), pp. 883-888.

Cearlock, D. B. and A. E. Reisenauer, 1971, Sitewide Groundwater Flow Studies for Brookhaven National Laboratory, Upton, L. I., New York, Pacific Northwest Laboratories, Undocumented Report, Battelle Memorial Institute.

Schrieber, D. L., A. E. Reisenauer, K. L. Kipp and R. T. Jaske, 1973, Anticipated Effects of an Unlined Brackish-Water Canal on a Confined Multiple-Aquifer System, Battelle-Northwest, Richland, WA., Report BNWL-1800.

Ahlstrom, S. W., R. J. Serne, R. C. Rouston, and D. B. Cearlock, 1974, Methods for Estimating Transport Model Parameters for Regional Groundwater Systems, Battelle-Northwest, Richland, WA., Report BNWL-1717, 23 p.

<b>TITLE</b>	<b>Salt Water Intrusion into Coastal Aquifers - Miami Area, Florida</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.3 Groundwater Studies</b>	<b>US/IHD ref: 2.8 (339)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Geological Survey National Center Reston, Virginia 22092</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>F. A. Kohout</b>	
<b>OBJECTIVES</b>	<b>To investigate the dynamics of the salt-water front of the Biscayne aquifer.</b>	
<b>SIGNIFICANT RESULTS</b>	<p>Investigations in the coastal part of the Biscayne aquifer, a highly productive aquifer of limestone and sand in the Miami area, Florida, show that the dynamically stable salt-water front is as much as 8 miles seaward of the position computed according to the Ghyben-Herzberg principle. This discrepancy results largely from the fact that the salt water in the Biscayne aquifer is not static, as explanations of the balance between fresh water and salt water commonly assume. Equipotential lines in terms of equivalent fresh-water head in wells shows that, when the fresh-water head is high, water in all parts of the aquifer moves seaward, but that when the head is low, salt water circulates from the floor of the sea through the lower part of the aquifer into the zone of diffusion, and thence back to the sea.</p> <p>By use of horizontal gradients derived from the low-head equipotential diagrams, a flow net has been constructed to show the movement of fresh and salt water in the aquifer. About seven-eighths of the total discharge at the shoreline originates as fresh water in inland parts of the aquifer. The remaining one-eighth represents a return of sea water entering the aquifer through the floor of the sea.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Cooper, H. H., F. A. Kohout, H. R. Henry, and R. E. Glover, 1964, Sea water in coastal aquifers, U.S. Geol. Survey Water-Supply Paper 1613-C, 84 p.</p> <p>Kohout, F. A., and Howard Klein, 1967, Effect of pulse recharge on the zone of diffusion in the Biscayne aquifer, Haifa Symposium on Artificial Recharge and Management of Aquifers, International Assoc. of Hydrological Sciences Public. no. 72, p. 252-270.</p> <p>Kohout, F. A., and M. C. Kolipinski, 1967, Biological Zonation related to groundwater discharge along the shore of Biscayne Bay, Miami, Florida, in Estuaries, Am. Assoc. Advancement of Science Public. no. 83, p. 488-499.</p>	

<b>TITLE</b>	Submarine Springs	
<b>Coordinating Council Resolution in force and short title</b>	VII.3 Groundwater Studies	US/IHD ref: 2.3 (338)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey National Center Reston, Virginia 22092	
<b>PRINCIPAL INVESTIGATOR</b>	F. A. Kohout	
<b>OBJECTIVES</b>	To investigate the nature, origin, and dynamics of submarine springs.	
<b>SIGNIFICANT RESULTS</b>	Fresh-water submarine springs imply that the landward segment of an aquifer is underdeveloped because unutilized fresh water continues to be lost in the sea. Cessation of flow indicates that safe yield of an aquifer has been exceeded. If the landward head falls too far below that of sea level, the conduit to the submarine provides a path of ingress for salt water. Remote sensing of temperature anomalies between spring and sea water appear to provide a basis for estimating discharge.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Kohout, F. A., 1966, Submarine springs: A neglected phenomena of coastal hydrology, Ankara Symposium on Hydrology and Water Resources Development; Central Treaty Organization (CENTO), Ankara, Turkey, p. 391-413.</p> <p>Kohout, F. A., M. C. Kolipinski, and A. L. Higer, 1973, Remote sensing of submarine springs: Florida Platform and Jamaica, West Indies, Second Palermo Symposium on Ground Water - Hydrology of Fractured Rocks, Palermo, Sicily (Italy). <u>In press.</u></p>	

TITLE	Ground Water Pollution - The Authoritative Primer	
Coordinating Council Resolution in force and short title	VII.3 Groundwater Studies VII.9 Hydrological problems related to Water Quality	US/IHD ref: 2.5 (178)
ORGANIZATION IN CHARGE OF ACTIVITY	National Water Well Association 88 Broad Street Columbus, Ohio 43215	
PRINCIPAL INVESTIGATOR	<p>J. H. Lehr</p> <p>To present a comprehensive overview of groundwater pollution in lay terms suitable for use by water well drillers, their clients, and the general public.</p> <p>The material was presented under the following section headings:</p> <ul style="list-style-type: none"> <li>The Protection of Ground Water Resources</li> <li>The Availability and Use of Ground Water</li> <li>The Classification of Ground Water Pollutants</li> <li>Ground Water Pollution from Surface Sources</li> <li>Ground Water Pollution from Production Wells</li> <li>Ground Water Pollution from Injection Wells</li> <li>The Purification of Polluted Ground Water</li> <li>The Role of Federal Legislation</li> <li>Governmental Responsibilities in Ground Water Management</li> <li>Sharing the Responsibility</li> <li>Survey of the States</li> <li>The Model Law</li> <li>Acknowledgements and References</li> </ul> <p>Lehr, J. H. (ed.), 1970, Ground Water Pollution - the Authoritative Primer, Water Well Journal Special Issue 24:7, p. 31-67.</p>	

<b>TITLE</b>	<b>Infrared Exploration for Coastal and Shoreline Springs</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.3 Groundwater Studies</b>	<b>US/IHD ref: 1.8 (157)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>School of Earth Sciences Stanford University Stanford, CA 94305</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>Ronald J. P. Lyon Keenan Lee</b>	
<b>OBJECTIVES</b>	<b>To determine the ability of an infrared scanning system to detect and delineate shore line fresh water springs and to develop methods for the quantitative (volumetric) evaluation of discharge from resulting imagery.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>Development of techniques using air-borne infrared scanners (3-5 micron and 8-14 micron) to explore for shoreline springs. Non-classified scanners have the demonstrated capability of locating a shoreline and sublacustrine fresh water springs at a primary test site - Monolake, California, a sailing water body. The discharge from these springs can be delineated on imagery and their aerial temperature distribution mapped.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Lyon, R.J.P. and K. Lee, 1968, Infrared exploration for coastal and shoreline springs: Stanford Remote Sensing Lab. Technical Report, 68-1, 68 p.</b>	

<b>TITLE</b>	Land subsidence and hydrogeology	
<b>Coordinating Council Resolution in force and short title</b>	VII.3 Groundwater Studies	US/IHD ref: 1.8(73)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Room W-2528, Federal Bldg. 2800 Cottage Way Sacramento, California 95825	
<b>PRINCIPAL INVESTIGATOR</b>	J. F. Poland	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<p>To examine mechanics of compaction of fine-grained sediments as related to land-subsidence. Field installations recording compaction and artesian-head change in California and Arizona were maintained.</p> <p>Near Pixley, California, recording of artesian heads of 6 piezometers was extended to include recording of heads in 6 additional piezometers (3 of these tap aquifers and 3 tap aquitards).</p> <p>A second liquid-level tiltmeter was set up on the site of the future California Aqueduct pumping plant at the base of Wheeler Ridge. This provides continuous recording of tilt of the land surface in two directions, and is also coupled to highly sensitive compaction recorders monitoring the thickness of deposits between land surfaces and a depth of 150 feet.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Meade, R. H., Petrology of sediments underlying areas of land subsidence in central California. Prof. Paper 497-C. <u>In press.</u></p> <p>Poland, J. F. and G. H. Davis, Land Subsidence due to withdrawal of fluids: GSA Engineering Geology Review, v. 11. <u>In press.</u></p> <p>Poland, J. F., Remarks on land subsidence studies in California: State Publication, Proceedings of the Geologic Hazards Conf. on Landslides and Subsidence. <u>In press.</u></p> <p>Lofgren, B. E., Hydrogeology and land subsidence Great Central Valley, California: Calif. Div. Mines and Geology Bull. 190, Geology of Northern California; GSA Guidebook. <u>In press.</u></p>	

<b>TITLE</b>	Land Subsidence in the San Joaquin Valley, California, and its Effect on Estimates of Groundwater Resources	
<b>Coordinating Council Resolution in force and short title</b>	VII.3 Groundwater Studies	US/IHD ref: 3.9(298)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Room W-2528 Federal Bldg. 2800 Cottage Way Sacramento, California 95825	
<b>PRINCIPAL INVESTIGATOR</b>	J. F. Poland	
<b>OBJECTIVES</b>	To determine the principles controlling the deformation of aquifer systems resulting from change in effective stress; to determine parameters of aquifer systems and aquitards, including the storage coefficients, under both virgin and elastic stress ranges. To determine causes of subsidence, methods for decreasing or alleviating subsidence, and what part of subsidence is reversible.	
<b>SIGNIFICANT RESULTS</b>	<p>Land subsidence due to the withdrawal of fluids has been occurring with increasing frequency worldwide. In the United States, the maximum subsidence has been in California: 9 m and 13,500 km<sup>2</sup> in the San Joaquin Valley; 4 m and 800 km<sup>2</sup> in the Santa Clara Valley; and 9 m at the Wilmington oil field. This latter subsidence is now under complete control, due to injection of more than 1 million barrels of water per day for repressuring. Subsidence in Texas has now (1973) reached 8 feet and affected at least 7,800 km<sup>2</sup> and the inundation of shore lines has become very serious. Subsidence in central Arizona also is on the order of 2.5 m and many scores of fissures have developed. Principal problems caused by the subsidence are (1) changes of elevation and gradient of natural drainages and water-transport structures, (2) failure of water wells from compressive rupture of casings, due to the compaction, and (3) tidal encroachment in lowland coastal areas.</p> <p>Methods of investigation have included establishment and releveing of bench-mark networks, measurement of compaction or expansion of aquifer systems by depth bench marks (taut cable and anchor or free-pipe extensometers); measurement of correlative change in applied stress (water-level fluctuation); making laboratory tests of cored samples to obtain physical and hydrologic properties and consolidation and rebound characteristics, and petrologic studies, including clay mineralogy; relating the areal variation in subsidence per unit of head change to the controlling geologic parameters; and development of a mathematical model to evaluate aquitard parameters by simulation of field measurements of compaction and change in applied stress.</p> <p>Studies indicate that the subsidence due to ground-water overdraft in central California is chiefly the result of compaction of highly compressible aquitards in the virgin range of stressing, due to large declines of artesian head. Field measurements of compaction or expansion of these multiaquifer systems and the correlative change in fluid pressure have been utilized to construct stress-strain curves and to derive storage and compressibility parameters. These data have shown that the values of the average compressibility and (storage) parameters for the aquifer system may be 50 to 100 times greater when total applied stresses are in the virgin range of stressing than when they are in the elastic range. These field measurements defining response of the</p>	



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aquifer systems in the elastic range of stress show that at one site the restoration of the artesian head to its initial position would result in rebound of the land surface equal to 2 percent of the overall subsidence.

X-ray diffraction studies show that montmorillonite composes 6 to 8 parts in 10 of the clay minerals in these aquifer systems.

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Bull, W. B., 1972, Prehistoric near-surface subsidence cracks in western Fresno County, California: U.S. Geol. Survey Prof. Paper 437-C, 85 p.

Lofgren, B. E., 1973, Land subsidence due to ground-water withdrawal, Arvin-Maricopa area, California: U.S. Geol. Survey open-file report, 182 p. (Prof. Paper 437-D in press)

Bull, W. B. and R. E. Miller, 1972, Land subsidence due to ground-water withdrawal in the Los Banos-Kettleman City area, California. Part 1, Changes in the hydrologic environment conducive to subsidence: U.S. Geol. Survey open-file report, 164 p. (Prof. Paper 437-E in press)

Bull, W. B., 1972, Land subsidence due to ground-water withdrawal in the Los Banos-Kettleman City area, California. Part 2, Subsidence and compaction of deposits: U.S. Geol. Survey open-file report, 262 p. (Prof. Paper 437-F in press)

Bull, W. B. and J. F. Poland, 1972, Land subsidence due to ground-water withdrawal in the Los Banos-Kettleman City area, California. Part 3, Interrelations of water-level change, change in aquifer-system thickness, and subsidence: U.S. Geol. Survey open-file report, 198 p. (Prof. Paper 437-G in press)

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Meade, R. H., 1968, Compaction of sediments underlying areas of land subsidence in central California: U.S. Geol. Survey Prof. Paper 497-D, 39 p.

Miller, R. E., J. H. Green and G. H. Davis, 1971, Geology of the compacting deposits in the Los Banos-Kettleman City subsidence area, California: U.S. Geol. Survey Prof. Paper 497-E, 46 p.

Riley, F. S., 1970, Land surface tilting near Wheeler Ridge, southern San Joaquin Valley, California: U.S. Geol. Survey Prof. Paper 497-G, 29 p.

Riley, F. S. and E. J. McClelland, 1972, Application of the modified theory of leaky aquifers to a compressible multiple-aquifer system: U.S. Geol. Survey open-file report, 96 p. (Approved for publication as Prof. Paper 497-H)

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Riley, F. S., 1969, Analysis of borehole extensometer data from central California, in Tison, L. J., ed., Land Subsidence, v. 2: Internat. Assoc. Sci. Hydrology, Pub. 89, p. 423-431.

<b>TITLE</b>	<b>Use of Water Levels in Estimating Aquifer Constants in a Finite Aquifer</b>	
<b>Coordinating Council Resolution in force and short title</b>	VII.3 Groundwater studies	US/IHD ref: 1.8(292)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey 903 W. Tennessee St. Tallahassee, Florida 32304	
<b>PRINCIPAL INVESTIGATOR</b>	M. I. Rorabaugh	
<b>OBJECTIVES</b>	To develop a simple field technique for appraising groundwater supplies in aquifers of limited extent.	
<b>SIGNIFICANT RESULTS</b>	<p>Methods of estimating the aquifer constant <math>T/S</math> (transmissibility coefficient divided by storage coefficient) from natural fluctuations of water levels in observation wells were first developed for the case of a finite aquifer having parallel boundaries. Reservoir stage fluctuations were analyzed subsequently using similar methods. Equations adapted from heat-flow theory indicate that water levels fall exponentially with time, but only after sufficient time has elapsed for the profile shape to stabilize. After this critical time, <math>T/S</math> may be computed from the slope of the recession at any well. In applying the method to a field problem, the effects of vertical components of flow in the discharge area were eliminated by the use of an imaginary boundary. An analysis by finite differences on a profile may be applied to aquifers where repetitive recharge makes the use of the recession method impractical. The method was successfully applied to Hungry Horse Reservoir, Montana, in computation and prediction of useable amounts of bank storage responding to reservoir stage fluctuations. Water budget and model analyses resulted in a wide range of results when used separately, but when used in conjunction, the range was reduced and a most probable solution inferred. The study concluded that a change in ground water storage was a useful, but not major, factor in calculating the water balance of the reservoir and should be included as a factor in predicting volumes of water available for power production.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Simons, W. D., and M. I. Rorabaugh, 1971, Hydrology of Hungry Horse Reservoir, Northwestern Montana, U.S. Geol. Survey Prof. Paper 682, 66 p.	

TITLE	Annotated Bibliography on Artificial Recharge of Groundwater, 1955-1967.	
Coordinating Council Resolution in force and short title	VII.3 Groundwater Studies	US/IHD ref: 1.8(307)
ORGANIZATION IN CHARGE OF ACTIVITY	U.S. Geological Survey National Center Reston, Virginia 22092	
PRINCIPAL INVESTIGATOR	D. C. Signor	
OBJECTIVES AND SIGNIFICANT RESULTS	Because of the worldwide interest in the field of artificial recharge and the need for a single source of references to the literature published since 1954, an annotated bibliography was prepared. The bibliography is arranged alphabetically by author. The indexing is by subject and geographic location.	
REPORTS AVAILABLE PUBLICLY	Signor, D. C., D. J. Growitz, and William Kam, 1970, Annotated bibliography on artificial recharge of groundwater, 1955-1967: U.S. Geol. Survey Water-Supply Paper 1990 (a sequel to Water-Supply Paper 1477), 141 p.	

<b>TITLE</b>	Ground water in the United States; Ground water in Puerto Rico and the [U.S.] Virgin Islands	
<b>Coordinating Council Resolution in force and short title</b>	VII.3 Groundwater Studies	US/IHD ref: 1.8 (72)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey P.O. Box 2415 Trenton, New Jersey 08607	
<b>PRINCIPAL INVESTIGATOR</b>	Allen Sinnott	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	To summarize the occurrence and availability of ground water in 1) the conterminous United States, Alaska, and Hawaii; and 2) Puerto Rico and the [U.S.] Virgin Islands for inclusion in a volume, "Ground Water in the Western Hemisphere," being prepared by the Water Resources Section, Resources and Transport Division of the United Nations.	
<b>REPORTS AVAILABLE PUBLICLY</b>	McGuinness, C. L., and Allen Sinnott (ed.), in review, 1) United States, and 2) Puerto Rico and [U.S.] Virgin Islands, in Ground Water in the Western Hemisphere, United Nations Department of Economic and Social Affairs. (Scheduled for publication in English and Spanish in 1975.)	

TITLE	Hydrology and Hydrodynamics of the Zone of Vadose Water	
Coordinating Council Resolution in force and short title	VII.3 Groundwater Studies	US/IHD ref: 3.3(82)
ORGANIZATION IN CHARGE OF ACTIVITY	U.S. Geological Survey Water Resources Division Denver Federal Center Denver, Colorado 80225	
PRINCIPAL INVESTIGATOR	R. W. Stallman	
OBJECTIVES	The work for this project was divided into four phases: 1) devise and test field methods of measuring flow in the hydraulic properties of the unsaturated zone; 2) measure velocities of fluids underground by analysis of temperature profile; 3) develop and test methods of predicting the nature of flow in the unsaturated zone; 4) improve and develop new techniques for field measurement of evapotranspiration.	
REPORTS AVAILABLE PUBLICLY	<p>Stallman, R. W., 1972, Data needs for predicting problems caused by use of subsurface reservoirs: Water Resources Research, 8:1, p. 238-241.</p> <p>Stallman, R. W., and E. A. Sammel, 1972, Ground-water studies - an international guide for research and practice: UNESCO, Paris, Chapter 5.5, 12 p.</p> <p>Lohman, S. W., and others, 1972, Definitions of selected ground-water terms - revisions and conceptual refinements: U.S. Geol. Survey Water Supply Paper 1988, 21 p.</p> <p>Stallman, R. W., 1971, Waste-storage - the earth scientist's dilemma: American Assoc. Petrol. Geol., Symposium on Underground Waste Management and Environmental Implications, Houston, Texas, December 6, 1971.</p> <p>_____, 1970, Problems caused by use of subsurface reservoirs: Paper presented at Am. Geophys. Union Symposium on Planning and Design of Ground Water Data Programs, December 1970, San Francisco.</p> <p>Stallman, R. W., and E. P. Weeks, 1969, The use of atmospherically induced gas pressure fluctuations for computing hydraulic conductivity of the unsaturated zone: Paper presented by Weeks at November 1969 Annual Meeting, GSA, Atlantic City; abstract published in GSA meeting proceedings.</p> <p>Stallman, R. W., and J. E. Reed, 1969, Steady flow in the zone of aeration: Proc. Symposium Water in the unsaturated zone, Wageningen, The Netherlands, June 1966, Internat. Assoc. Sci. Hydrol., p. 564-575.</p> <p>Stallman, R. W., and C. T. Jenkins, 1969, Computing transmissivity and accretion by analyzing water-table altitudes from unconfined aquifers: (Revised and published by U.S. Geol. Survey Water Supply Paper 2029C by E. P. Weeks, 1973).</p>	

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Stallman, R. W., and I. S. Papadopoulos, 1966, Measurement of hydraulic diffusivity of wedge-shaped aquifers drained by streams: U.S. Geol. Survey Prof. Paper 514, 50 p.

Stallman, R. W., 1965, Effects of water-table conditions on water-level changes near pumping wells: Water Res. Research, 1:2, p. 295-312.

Weaver, Richard A., 1971, MS Thesis, Compilation of response function for flow in underground reservoirs: Colorado School of Mines.

Weeks, E. P., and M. L. Sorey, 1973, Use of finite-difference arrays of observation wells to estimate evapotranspiration from ground water in the Arkansas River Valley, Colorado: U.S. Geol. Survey, Water Supply Paper 2029-C, C1-C27.

Coordinating Council Resolution No. VII.5 Representative and Experimental Basins

Resolution No. VII.5

The Council,

1. Recalling resolution VI.6 and the terms of reference of the Working Group on Representative and Experimental Basins (Annex IV of the report of the sixth session of the Co-ordinating Council); \*
2. Considering the amount of research already carried out or still to be carried out on representative and experimental basins, the scientific work that has been and is being accomplished during the Decade on such basins in a great many countries, and the need for methods of evaluating the influence of man on the hydrological cycle, particularly as they have emerged in the light of the Wellington symposium;
3. Accepts the report of the sixth session of the Working Group and its work plan for the remainder of the Decade;
4. Recommends that from now until the end of the Decade, the Working Group concentrate its activities on:
  - (i) problems relating to the results of research on experimental and representative basins considered as exceptionally useful instruments of study for the evaluation of man's influence on the hydrological cycle;
  - (ii) the development of systems of classifying basins that will enable the interpretation, comparison and extrapolation of results;
5. Requests once again that the co-operation between this Working Group and the other working groups of the Co-ordinating Council and the corresponding working group of the WMO be strengthened in order to avoid any duplication of effort.

\* Ed. Note: Resolution VI.6 reaffirmed support of the Working Group and requested more extensive coordination with other working groups.



<b>TITLE</b>	<b>Experimental Basin: Central Great Plains Experimental Watershed, Hastings, Nebraska</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.5 Representative and Experimental Basins</b>	<b>US/IHD ref: 2.1(118)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Agricultural Research Service U.S. Dept. of Agriculture 101 Administration Bldg. Beltsville, MD 20705</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>C. W. Carlson</b>	
<b>OBJECTIVES</b>	<b>To continue investigations of the effects of land use and agricultural practices upon streamflow, with emphasis on analysis of accumulated records.</b>	
<b>SIGNIFICANT RESULTS</b>	<p><b>Beginning in 1938, surveys of geology, soil, land use, and agricultural practices and establishment of instrumentation for measurement of precipitation, soil moisture, and streamflow regimes on watersheds ranging in size from 1.6 to 1415 hectares in size.</b></p> <p><b>Project closed; data are available from: Hydrologic Data Laboratory Room 216, Bldg. 001 Agricultural Research Center-West Beltsville, Maryland 20705</b></p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Allis, J. A., F. J. Dragoun, and A. L. Sharp, 1964, Transmission losses of loessial watersheds, American Society of Agricultural Engineers Transactions, 7(3): 209-212, 217.</b></p> <p><b>Effects of runoff volume from perennial prairie seeded on cultivated land. Journal of Soil and Water Conservation, 20: 63-64, 1965.</b></p>	

<b>TITLE</b>	Chemical Weathering of an Ultramafic Rock in a Humid-sub-tropical Environment	
<b>Coordinating Council Resolution in force and short title</b>	VII.5 Representative and Experimental Basins	US/IHD ref: 2.1(198)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Maryland Geological Survey Johns Hopkins University Baltimore, Maryland 21218	
<b>PRINCIPAL INVESTIGATOR</b>	Emery T. Cleaves Donald Fisher Owen Bricker	
<b>OBJECTIVES</b>	To determine the geochemical balance and rate of chemical weathering of the serpentine.	
<b>SIGNIFICANT RESULTS</b>	<p>Weathering processes in a small watershed underlain by serpentinite in the Piedmont of Maryland were studied by means of a mass balance technique and were compared with the processes operative in a watershed underlain by schist. The two terranes are downwasting at a rate of 2.4 m per m.y. but chemical weathering much more strongly affects the serpentinite (2.2 m per m.y.) than the schist (1.2 m per m.y.).</p> <p>The serpentinite lacks a saprolite cover because resistate minerals are absent and alumina in the bedrock is scarce. In contrast, the schist contains both quartz and a source of alumina in the alumino-silicate minerals, and, as a result, has a thick saprolite mantle. Relatively small amounts of secondary quartz, chalcedony, and 14A clay minerals are synthesized in the serpentinite watershed, but relatively large amounts of gibbsite and clay minerals (kaolinite and vermiculite) are formed during the weathering of the schist. The hydrologic consequences in the serpentinite terrane compared with the schist watershed are increased flood-flow discharge, greater fluctuation in seasonal instantaneous base-flow discharge, and pronounced seasonal fluctuations in total discharge. The serpentinite stream water averaged 205 ppm of total dissolved solids in the base flow compared to 25 ppm in the schist. Stream water from the serpentinite is of the magnesium bicarbonate type; that from the schist is sodium-calcium bicarbonate type.</p> <p>On the serpentinite, substantial land-surface reduction (denudation) is effect by chemical weathering; mechanical weathering is secondary. On the schist terrane mechanical weathering is the primary agent that lowers the land surface, even though chemical weathering reduced the rock mass by almost one-half.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Cleaves, E. T., A. E. Godfrey, and O. P. Bricker, 1970, Geochemical balance of a small watershed and its geomorphic implications, Geological Society of America Bulletin, 81, 3015-3032.</p> <p>Cleaves, E. T., D. W. Fisher, and O. P. Bricker, Chemical weathering of serpentinite in the Eastern Piedmont of Maryland, Geological Society of America, (in press).</p>	

TITLE	IHD Representative and Experimental Research Basins in the United States	
Coordinating Council Resolution in force and short title	VII.5 Representative and Experimental Basins	US/IHD ref: 2.1 (172)
ORGANIZATION IN CHARGE OF ACTIVITY	US/IHD Work Group on Representative and Experimental Basins National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C.	
PRINCIPAL INVESTIGATOR	R. F. Hadley, Chairman	
OBJECTIVES	To compile basic information on the extent of use of instrumented watersheds in the U.S. for hydrologic research; to formulate a network of representative and experimental basins to serve as a basis for participation in the IHD; to facilitate exchange of representative and experimental basin data, techniques and results to other nations and to assess and comment on the success of the U.S. Program.	
SIGNIFICANT RESULTS	In 1969 the Work Group compiled a catalog of the 60 U.S. Representative and Experimental Basins which agreed to be part of the world-wide IHD network of research watersheds. This catalog provided maps, location, types of instrumentation, objectives of studies, sponsoring organization, type of data being collected and available published reports for each of the basins. This report was followed up by one published in 1974 that provided additional information on each basin, the results achieved in the interim and the cost and availability of data. The final report of the Work Group (now in press) serves to assess the effectiveness of the overall U.S. Representative and Experimental Basins program and make recommendations for improvement. The Work Group's program also contributed to the international exchange of scientists, information, data and techniques pertinent to the establishment and operation of representative and experimental basins.	
REPORTS AVAILABLE PUBLICLY	<p>Work Group on Representative and Experimental Basins, U.S. National Committee for the International Hydrological Decade, 1969, Representative and Experimental Research Basins in the United States: National Research Council, Washington, D.C., 267 p., 68 maps, 1 foldout explanation.</p> <p>_____, 1974, International Hydrological Decade Representative and Experimental Basins in the United States: Catalog of Available Data and Results 1965-1972, National Academy of Sciences, Washington, D.C., 149 p.</p> <p>_____, in review, U.S. Programs in Representative and Experimental Basins-An Assessment with Recommendations (tentative title).</p>	

<b>TITLE</b>	<b>Vigil Network</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.5 Representative and Experimental Basins</b>	<b>US/IHD ref: 2.1(140)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	U.S. Geological Survey Denver Federal Center Denver, Colorado 80225	
<b>PRINCIPAL INVESTIGATOR</b>	R. F. Hadley	
<b>OBJECTIVES</b>	<p>Vigil Stations are located where observations can be made over long periods of time to record changes in landscape features. Sites are selected to represent typical environments that will be affected by nearby cultural influences. Vigil stations differ from benchmark stations in that the latter are located in areas protected from man's influences.</p> <p>Types of data collected at these stations vary and the same observations are not necessarily made or recorded at every site. In effect, each vigil station could be the site for different investigations.</p>	
<b>SIGNIFICANT RESULTS</b>	To date 58 vigil stations have been installed.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><u>Sources of data:</u> Both the original description and the periodic surveys are filed in permanent repositories in the Library, U.S. Geological Survey, Washington, D.C., U.S.A., and the Library Laboratory of Geomorphology, University of Uppsala, Sweden.</p> <p>U.S. National Committee for the IHD, 1972, Catalog of International Hydrological Decade Stations and Networks in the United States, National Academy of Sciences - National Research Council, Washington, D.C.</p> <p>Leopold, L. B., 1962, The Vigil Network, J. Intl. Assoc. Sci. Hydrology, VII Annee, n.2, 5-9.</p> <p>Emmett, W. W. and R. F. Hadley, 1968, The Vigil Network: Preservation and Access of Data, U.S. Geo. Survey Circular 460-C, 21 p.</p>	

<b>TITLE</b>	<b>Watershed Research in Western North Carolina</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VII.5 Representative and Experimental Watersheds</b>	<b>US/IHD ref: 2.1(199)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Tennessee Valley Authority 350 Evans Bldg. Knoxville, TE 37902	
<b>PRINCIPAL INVESTIGATOR</b>	C. H. Smith	
<b>OBJECTIVES</b>	To study the effects of agricultural covers upon the hydrology of small watersheds.	
<b>SIGNIFICANT RESULTS</b>	<ol style="list-style-type: none"> <li>1. Well managed agricultural covers were found to have some surprising effects on streamflow. These responses were found to vary considerably among watersheds.</li> <li>2. Soil surface crusting and cover management can markedly change the cover-streamflow relationship.</li> <li>3. Overland flow was found to occur infrequently on most of the watershed soils.</li> <li>4. The concept of partial-area contribution to watershed runoff was major finding of the project.</li> </ol>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Tennessee Valley Authority, 1953-1970, Watershed Research in Western North Carolina, Annual Reports, Tennessee Valley Authority, Knoxville, Tennessee.</p> <p>Tennessee Valley Authority, 1970, A Study of the Effects of Agricultural Covers Upon the Hydrology of Small Watersheds, Tennessee Valley Authority, Knoxville, Tennessee.</p>	

Coordinating Council Resolution No. VII.7 Information and Publications

Resolution No. VII.7

The Council,

2. Considering the necessity of the continuation of the publication of "Discharge of selected rivers of the world" beyond the Decade period, and of guides on various hydrological subjects;
3. Noting the concern shown by the Working Group for wider dissemination of research carried out by Member States and results thereof;
4. Noting that the Group stresses the continued need for symposia and seminars and early publication of the main results of their deliberations;
5. Accepts the report of the fourth session of the Working Group;
6. Decides that the Group should continue its work in accordance with the work plan;
7. Reiterates that Member States should send urgently the data for the publication on "Discharge of selected rivers of the world";
8. Urges Member States to supply the IHD Secretariat with:
  - (a) summary reports on the main results of the IHD achieved at national level;
  - (b) scientific reports on selected IHD projects in the forms suggested by the Working Group;
9. Recommends Member States to prepare their national catalogues of IHD research projects and of other pertinent research, and to publish them, if this has not been already done, using whenever possible, the model prepared by the Working Group on Information and Publications;
10. Suggests that the IHD Secretariat deputise scientists to cover symposia on hydrological subjects held under the auspices of United Nations bodies for preparing repertoire of salient features to be published in the Unesco Bulletin "Nature and Resources";
11. Requests Unesco to accept the responsibility for publication of material according to the priorities established by the Council (Annex XVII of the present report);
12. Recognizes the activities of international governmental and non-governmental organizations in exchange of information (particularly United Nations, FAO, WMO, IAEA, IAHS and IAH).

TITLE	Exchange of Information	
Coordinating Council Resolution in force and short title	VII.7 Information and Publications	US/IHD ref: 5.1 (335)
ORGANIZATION IN CHARGE OF ACTIVITY	US/IHD Work Group on Exchange of Information U.S. National Committee for IHD 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
PRINCIPAL INVESTIGATOR	R. F. Kresge National Weather Service - NOAA Rockville, Maryland 20910	
OBJECTIVES:	<ol style="list-style-type: none"> <li>1. To promote domestic exchange of information regarding international hydrological activities.</li> <li>2. To assist with compiling information from the United States for use in UNESCO publications.</li> <li>3. To cooperate with the equivalent UNESCO/IHD Working Group.</li> </ol>	
SIGNIFICANT RESULTS	The US/IHD Work Group, operating through ad hoc Panels and individually, and in cooperation with Federal and non-federal organizations, contributed information and data to UNESCO publications on discharge of the main rivers of the world and the international glossary of hydrological terms (q.v.). The Work Group also responded to numerous inquiries regarding water information in the United States.	
REPORTS AVAILABLE PUBLICLY	(See UNESCO Studies and Reports in Hydrology no. 5, (Vols. I, II, and III) and no. 6, and UNESCO/WMO International Glossary of Hydrology, published in WMO Report no. 385.)	

Coordinating Council Resolution No. VIII.1 Application of Nuclear Techniques in Hydrology

Resolution No. VIII.1

The Council,

1. Recalling resolution VII.6; \*
2. Accepts the report submitted by the sixth session of the Working Group (on Nuclear Techniques in Hydrology);
3. Emphasizes the need for a revised edition of the Guidebook on Nuclear Techniques in Hydrology;
4. Endorses the Working Group's approval of the synopsis of the publication programme and invites the Working Group to make final arrangements for the publication;
5. Draws the attention of other working groups concerned to the application of tracer methods to water movement and pollution problems and invites the Working Group to continue its efforts in regard to application of these techniques in hydrology;
6. Decides that the Working Group continue its activities as outlined in its proposed programme;
7. Invites the IAEA to continue to provide the Technical Secretariat of the Working Group and encourages IAEA to continue to assist and advise Member States in applying nuclear techniques to hydrological problems;
8. Expresses the need to further international exchange of information on the application of these new techniques through symposia, seminars, training courses and related activities;
9. Invites interested countries with experience in nuclear techniques and related fields to continue to forward information to the Secretariat.

\* Ed. Note: Resolution VII.6 recommended and urged that the Guidebook on Nuclear Techniques in Hydrology, published earlier by the Working Group, be revised and published again.



<b>TITLE</b>	<b>Neutron Meter use in Soil-moisture Measurements</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VIII.1 Nuclear Techniques in Hydrology</b>	<b>US/IHD ref: 3.5(187)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Nuclear Techniques in Hydrology National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	Wilford R. Gardner Dept. of Soil Science University of Wisconsin Madison, Wisconsin 53706	
<b>OBJECTIVES</b>	To provide up-to-date information on the use of neutron meters in soil-moisture measurements.	
<b>SIGNIFICANT RESULTS</b>	In response to a request from the International Atomic Energy Agency, the Work Group on Nuclear Techniques in Hydrology of the U.S. National Committee for the IHD sent out a questionnaire concerning the use of neutron moisture meters to several hundred scientists and engineers believed to have interest in neutron moisture measurements. The answers to the questionnaire (sent to 350 persons from which 200 responded) have been correlated and the results summarized in the report, Neutron Meter Use in Soil-Moisture Measurements. Commercial instruments are used chiefly, and the number in use increases steadily. Field calibration remains a difficult problem. The method is in use for every hydrological problem that requires a soil-moisture measurement. A real need exists for research and development to increase the reliability of the meters in field use. Two bibliographic lists are appended to the report to illustrate the scope of present work.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Gardner, W. R., 1970, Neutron meter use in soil-moisture measurements, <i>Isotopes and Radiation Technology</i> , 7:3, 297-305.	

TITLE	Nuclear Techniques in Hydrology - Current Status and Prospective Uses	
Coordinating Council Resolution in force and short title	VIII.1 Nuclear Techniques in Hydrology	US/IHD ref: 3.8 (345)
ORGANIZATION IN CHARGE OF ACTIVITY	US/IHD Work Group on Nuclear Techniques in Hydrology National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
PRINCIPAL INVESTIGATOR	F. J. Pearson, Chairman	
OBJECTIVES	This Work Group was established to support U.S. participation in the IAEA/IHD Working Groups and to further the general understanding and application of nuclear techniques to hydrologic problems.	
SIGNIFICANT RESULTS	In addition to providing requested and voluntary papers for IAEA publications, symposia, and related meetings the Work Group; a) assisted in the preparation of two papers on application of nuclear techniques by W. R. Gardner and by L. L. Thatcher; b) promoted the U.S. translation of the Russian text by V. I. Ferronskiy and others on nuclear techniques; c) sponsored, in cooperation with the Canadian National Committee for IHD and others, joint well logging activities in Saskatchewan, Canada; and d) cooperated with the US/IHD Work Group on Snow and Ice Hydrology in sponsoring the Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources. The final report of the Work Group on Nuclear Techniques in Hydrology (now in press) summarized its activities during the Decade; provides an assessment of the state-of-the-art; identifies needed areas of research; and makes several recommendations necessary to further the understanding and application of nuclear techniques in hydrology.	
REPORTS AVAILABLE PUBLICLY	<p>Gardner, W. R., 1970, Neutron Meter Use in Soil Moisture Measurements, Published in Isotopes and Radiation Technology, Vol. 7, No. 3, pp. 297-310.</p> <p>Thatcher, L. L., 1969, Principles of the Application of Nuclear Techniques to Hydrologic Investigations, Published in the Progress of Hydrology, Proceedings of the First International Seminar for Hydrology Professors, Urbana, Illinois.</p> <p>Ferronskiy, V. I. (ed.), 1971, Radioisotope Investigative Methods in Engineering Geology and Hydrogeology, Translation Series, AEC-tr-7230, avail. NTIS, 254 p.</p> <p>US/IHD Work Group on Nuclear Techniques in Hydrology, Nuclear Techniques in Hydrology - Current Status and Prospective Uses, Final report, <u>in press</u>.</p> <p>Dyck, J. H., W. S. Keys, and W. A. Meneley, 1972, Application of Geophysical Logging to Groundwater Studies in Southern Saskatchewan, Reprinted from Canadian Journal of Earth Sciences, Vol. 9, No. 1, pp. 78-94.</p>	

<b>TITLE</b>	<b>Water Management and Avalanche Control</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VIII.1 Application of Nuclear Techniques in Hydrology</b>	<b>US/IHD ref: 3.9 (88)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Atomic Energy Commission Idaho Falls, ID 83401</b>	<b>U.S. Forest Service P.O. Box 245 Berkley, CA 94701</b>
<b>PRINCIPAL INVESTIGATOR</b>	<b>Dr. Peter D. Randolph</b>	<b>Dr. James L. Smith</b>
<b>OBJECTIVES</b>	<b>To develop an automatic snow forecasting system based upon a nuclear device which has been previously developed and field tested by the U.S. Forest Service.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>From one to five remotely operated telemetered gages have been operated successfully since the winter of 1970-1971. Five gages are located in: the Sierra Nevada of California; Mt. Hood, Oregon; Alyeska, Alaska; Sun Valley, Idaho and Red Mountain Pass, Colorado. The base station is located in Idaho Falls, Idaho. Gages have been used in a study for development of avalanche predictive operations for snow fed stream flow forecasting by soil conservation services and BPA, and for snow hydrology studies.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>D. C. Shreve and A. J. Brown, 1974, Development and Field Testing of a Remote Radioisotopic Snow Gage, Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Asilomar, CA, December 2-6, 1973, U.S. Committee for the IHD, National Academy of Sciences.</b></p> <p><b>P. D. Randolph, R. A. Coates, E. W. Killian, 1973, Telemetered Profiling Isotopics Snow Gage - Final Report and Publications, ANCR-1105 Radioisotope and Radiation Application, TID-4500, (Available from National Technical Information Services, Dept. of Commerce Springfield, VA 22151.)</b></p> <p><b>Smith, J. L., H. G. Halverson, R. A. Jones, 1972, Central Sierra Profiling Snow Gage: A Guide to Fabrication and Operation, United States Atomic Energy Commission Radioisotope and Radiation Applications (TID-4500) TID-25986, (available from NTIS.)</b></p> <p><b>Smith, J. L., H. G. Halverson, R. A. Jones, 1970, The Profiling Radioactive Snow Gage in Proceedings International Symposium on Snow Removal and Ice Control Research, Highway Research Board, National Academy of Science Special Report 115, Washington, DC.</b></p> <p><b>Smith, J. L. and H. G. Halverson, 1969, Hydrology of Snow Profiles Obtained with the Profiling Snow Gage in Proceedings 37th Annual Western Snow Conf. pp. 41-48, Colorado State University Press, Fort Collins, Colorado.</b></p>	

**Limpert, F. A., and J. L. Smith, 1974, Utility of Isotope Profiling for Water Management, in Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Asilomar, CA, December 2-6, 1973, U.S. Committee for the International Hydrological Decade, National Academy of Science.**

<b>TITLE</b>	<b>Gamma Ray Attenuation for Soil Water Content Measurements</b>	
<b>Coordinating Council Resolution in force and short title</b>	VIII.1 Nuclear Techniques in Hydrology	US/IHD ref: 2.6(177)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Battelle Memorial Institute Pacific Northwest Laboratories Richland, Washington	
<b>PRINCIPAL INVESTIGATOR</b>	A. E. Reisenauer S. J. Phillips	
<b>OBJECTIVES</b>	(1) Measurement of soil moisture content by gamma ray attenuation using 241 Am. (2) Gamma ray attenuation measurements for obtaining non-destructive soil moisture and bulk density determinations between pressures of 0 and 2 bars using 137 Cs.	
<b>SIGNIFICANT RESULTS</b>	<p>The measurement of soil moisture of laboratory samples by attenuation of gamma rays is described with particular reference to the use of 241 Am as a source of protons. With the 241 Am is compared with 137 Cs, and some advantages of 241 Am over 137 Cs are that less biological shielding is required; the apparatus may be made smaller and lighter; there is greater sensitivity for small soil thicknesses (4.5 to 6 cm). Disadvantages of 241 Am are that special pre-amplification of the 60 keV signal is needed and 241 Am is limited to small columns because of the soft gamma rays emitted. There is a practical limit to strength of source which may be obtained with 241 Am because of self-absorption. However, source strengths entirely adequate for most studies should be obtainable. Moisture determinations of laboratory soil columns subjected to gamma ray attenuation with 137 Cs as a proton source at pressures between 0 and 2 bars is investigated. Soil desorption values are obtained by applying increasing pressure and simultaneously taking successive measurements of soil moisture in the same column. This method increases the accuracy of soil desorption measurements as opposed to multi-component measuring systems.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>King, L. S., 1967, Gamma Ray Attenuation for Soil Water Content Measurements Using 241 Am, Battelle Memorial Institute, Pacific Northwest Laboratories, Richland, Washington.</p> <p>Gardner, W. H. and C. Calissendorff, 1967, Gamma Ray and Neutron Attenuation in Measurement of Soil Bulk Density and Water Content, Isotope and Radiation Techniques in Soil Physics and Irrigation Studies. International Atomic Energy Agency, Vienna.</p> <p>Gardner, W. H., G. S. Campbell and C. Callissendorff, 1972, Systematic and Random Errors in Dual Gamma Energy Soil Bulk Density and Water Content Measurements, Soil Sci. Soc. Amer. Proc., 36:393-398.</p>	

<b>TITLE</b>	<b>Radioisotope Investigative Methods in Engineering Geology and Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VIII.1 Nuclear Techniques in Hydrology</b>	<b>US/IHD ref: 5.1(309)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Atomic Energy Commission Division of Technical Information Washington, D.C.</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>US/IHD Work Group on Nuclear Techniques in Hydrology</b>	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<b>To make the material presented in the U.S.S.R. text, Radioizotopnyye metody issledovaniya v inzhenernoy geologii i gidrogeologii, more readily available to the scientific, educational, and professional communities in the United States.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Ferronskiy, V. I. (ed.), 1968, Radioisotope Investigative Methods in Engineering Geology and Hydrology; translated from Radioizotopnyye metody issledovaniya v inzhenernoy geologii i gidrogeologii, ATOMIZDAT, Moscow (1968), 304 p.; U.S. Atomic Energy Commission rept. AEC-tr-7230, 254 p. (Available also through National Technical Information Service U.S. Department of Commerce 5285 Port Royal Road Springfield, Virginia 22151)</b>	

Coordinating Council Resolution No. VIII.2 Education and Training of Hydrologists

Resolution No. VIII.2

- The Council,  
:
2. Considering that the training of hydrologists at all levels is one of the most important features of the IHD programme;
  3. Taking into account the growing need in developing countries for the training of technicians, engineers and research scientists in the field of scientific and technical hydrology and water resources management;  
:
  5. Asks all National Committees of developed countries to continue to supply regularly to the Secretariat information on:
    - (a) fellowships in hydrology which would be offered to candidates from other countries;
    - (b) the general and practical training of hydrologists in their country and in particular in courses, publications and films;
  6. Recommends that Unesco and other organizations of the United Nations system continue to sponsor and organize international higher courses in hydrology, technician training courses and on-the-job training courses, and that they increase the number of fellowships for hydrological studies;  
:
  8. Recommends that Unesco publish the technical papers "Analysis of Textbooks in Hydrology" and "Teaching Hydrology";
  9. Suggests that the Unesco publications "Teaching Hydrology", "Curricula and Syllabi", "Textbooks in Hydrology" and "Teaching Aids" be revised and published as a set;
  10. Reiterates the need for a succinct study on the progress in hydrological education since the inception of the IHD, and requests the Secretariat to plan for early publication of the report;
  11. Agrees that hydrological education is one of the most important activities within the long-term programme in hydrology and appreciates the suggestions for a programme for future international activities as foreseen by the Working Group, and invites the National Committees to provide adequate means for execution of educational activities within their countries.

<b>TITLE</b>	<b>International Seminars for Hydrology Professors, First - Progress of Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	VIII.2 Education and Training	US/IHD ref: 4.2(183)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Dept. of Civil Engineering University of Illinois at Urbana-Champaign Urbana, Illinois 61801	
<b>PRINCIPAL INVESTIGATOR</b>	Ven Te Chow, Seminar Director	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<p>The Seminar, held at Urbana, Illinois, July 13-25, 1969, was aimed at an advanced level of discussion and exploration in hydrologic education. Because of the wide scope of the science of hydrology, the theme of the Seminar was limited to new developments in the field of hydrology, to hydrologic teaching and research at colleges and universities, and to the relation of hydrology with government, society, and professions.</p> <p>More than 7,000 copies of the Proceedings have been distributed around the world.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Chow, V. T. (ed.), 1969, The Progress of Hydrology, Proceedings of the First International Seminar for Hydrology Professors, University of Illinois, Urbana, Illinois, Vol. I-III, 1295 p.	



<b>TITLE</b>	<b>On-the-Job Training</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VIII.2 Education and Training of Hydrologists</b>	<b>US/IHD ref: 4.2 (53)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Weather Service, NOAA Gramax Building 8060 Thirteenth Street Silver Spring, Maryland 20910	
<b>PRINCIPAL INVESTIGATOR</b>	Robert A. Clark Office of Hydrology	
<b>OBJECTIVES</b>	To raise the hydrologic competence of the participating IHD countries by providing on-the-job training to foreign nationals.	
<b>SIGNIFICANT RESULTS</b>	To date, four courses in Hydrologic Analysis and Forecasting have been given. Thirty foreign national students from 17 countries have been involved. The classroom portion of the course is of 8-12 weeks duration. It includes basic hydrology, river forecasting techniques, and some meteorology. It is followed by an on-the-job assignment to a River Forecast Center.	
<b>REPORTS AVAILABLE PUBLICLY</b>	None	

TITLE	International Workshops in Hydrologic Engineering	
Coordinating Council Resolution in force and short title	VIII.2 Education and Training I.50 Mathematical Analysis	US/IHD ref: 3.9(286)
ORGANIZATION IN CHARGE OF ACTIVITY	U.S. Army Corps of Engineers The Hydrologic Engineering Center Davis, California 95616	
PRINCIPAL INVESTIGATOR	E. F. Hawkins J. C. Peters	
OBJECTIVES	Provide training courses for foreign nationals in a comprehensive variety of hydrologic engineering techniques with emphasis on computer applications of the techniques.	
SIGNIFICANT RESULTS	<p>Two 4-week International Workshops were conducted at The Hydrologic Engineering Center in August 1972 and August 1974. The two workshops were attended by 53 participants from 26 countries.</p> <p>The Workshop provided engineers engaged in the planning, design, and operation of water resources projects with a practical knowledge of a comprehensive variety of hydrological engineering techniques. Considerable emphasis was placed on the use of computers in applying the techniques to real-world problems, and a high-speed computer was available to the students as part of the course of instruction.</p>	
REPORTS AVAILABLE PUBLICLY	See also Hydrologic Engineering Methods for Water Resources Development.	

<b>TITLE</b>	<b>The Water We Live By</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VIII.2 Education and Training</b>	<b>US/IHD ref: 5.1 (341)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	L. A. Heindl 3577 N. Powhatan Street Arlington, Virginia 22213	
<b>PRINCIPAL INVESTIGATOR</b>	L. A. Heindl	
<b>OBJECTIVES</b>	To provide a supplementary textbook at the junior high to high school level (or juveniles 12-16 years of age) regarding water resources in the United States and their problems, use, management, and conservation.	
<b>SIGNIFICANT RESULTS</b>	<p>The text describes the development of the use of water and gives case histories of selected problems or regions under the following chapter tables</p> <p>That's All There Is (Availability of Water)                  Before Water Management (Hydrological Cycle under natural stresses)                  Our Problems Begin (Effects of water use prior to c.1900)                  Water Management Becomes Necessary (Objectives of Management)                  Management and Conflicting Interests                  Droughts in a Tradition of Plenty (New York and Florida)                  What Price the Blooming Desert? (Arizona)                  A River Fights Up Hill (Ohio River)                  The Making of a National Showpiece (Potomac River)                  The Great Lakes - A Case for International Management                  The Future is You.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Heindl, L. A., 1970, The Water We Live By, Coward-McCann, New York, 127 p.	

<b>TITLE</b>	Hydrologic and Water Resource Education and Training in the U.S. - A Review and Recommendations	
<b>Coordinating Council Resolution in force and short title</b>	VIII.2 Education and Training of Hydrologists III.15 Regional Cooperation IV. 13 Technical Assistance	US/IHD ref: 4.2 (340)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Education and Training National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	M. L. Johnson, Chairman	
<b>OBJECTIVES</b>	The education and training program objectives were twofold: First, to further understanding and appreciation of the physical basis of the hydrological regime and of the stresses on it by man's activities and demands; and second, to promote and encourage the study of water sciences and applied practices by foreign experts and students in the United States and by U.S. students and experts abroad.	
<b>SIGNIFICANT RESULTS</b>	The Highlights of the Work Group's accomplishments were 1) the establishment in cooperation with Universities Council on Water Resources of the UCOWR/IHD Fellowships and Assistantships in Hydrology Program which supported graduate training for about 125 foreign students at U.S. Universities; 2) the sponsorship of three International Seminars for Hydrology Professors in which there was participation by 168 foreign experts from 29 countries and 146 domestic experts; and 3) the preparation and distribution of 6000 copies of a syllabus of detailed topical studies and references on hydrology and the water resources fields for use by instructors teaching environmental studies at the college undergraduate level. A final significant achievement of the Work Group was the preparation of its final report. This document: a) summarizes all of the Work Group's activities, b) presents a survey of the current state of affairs in the U.S. education of water resource specialists and the public and c) makes a series of recommendations to improve the status of education and fulfill future manpower and educational needs.	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Chow, V. T. (ed.), 1969, The Progress of Hydrology, Proceedings of the First International Seminar for Hydrology Professors, University of Illinois, Urbana, Illinois, Vol. I-III, 1295 p.</p> <p>Systems Analysis of Hydrologic Problems, Proceedings of the Second International Seminar for Hydrology Professors, Utah State University, Logan, Utah, 1973, 452 p.</p> <p>Monke, E. J. (ed.), 1974, Biological Effects in the Hydrological Cycle - Terrestrial Phase, Proceedings of the Third International Seminar for Hydrology Professors, Purdue University, West Lafayette, Indiana, 391 p.</p>	

Work Group on Education and Training of the U.S. National Committee for the IHD, 1972, Hydrology and Water Resources: A Syllabus of References for Teaching Introductory Courses in the Water Environment, National Academy of Sciences, Washington, D.C., 73 p.

US/IHD Work Group on Education and Training, Hydrologic and Water Resource Education and Training in the U.S. - A Review and Recommendations, Final report, in press.

<b>TITLE</b>	<b>Hydrology and Water Resources - A Syllabus of References</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VIII.2 Education and Training of Hydrologists</b>	<b>US/IHD ref: 5.1(312)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>US/IHD Work Group on Education and Training National Academy of Sciences 2101 Constitution Avenue N.W. Washington, D.C. 20418</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>M. L. Johnson, Chairman</b>	
<b>OBJECTIVES AND SIGNIFICANT RESULTS</b>	<b>The recent surge of concern over man's impact on his environment has resulted - for one thing - in a multiplicity of courses intended to introduce the undergraduate student to the complexity of the interrelationships of man's activities with those of the physical forces modeling the world in which he lives. Many of these courses are of necessity taught by instructors who are not fully aware of hydrological and water-related aspects of man's problems. This Syllabus was prepared for use by such instructors. To date nearly 6,000 copies have been distributed by the USNC/IHD.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Work Group on Education and Training of the U.S. National Committee for the IHD, 1972, Hydrology and Water Resources: A Syllabus of References for Teaching Introductory Courses in the Water Environment, National Academy of Sciences, Washington, D. C., 73 p.</b>	

<b>TITLE</b>	International Seminars for Hydrology Professors, Third - Biological Effects in the Hydrological Cycle-Terrestrial Phase	
<b>Coordinating Council Resolution in force and short title</b>	VIII.2 Education and Training VI.9 Ecology	US/IHD ref: 4.3 (340)
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Dept. of Agricultural Engineering Agricultural Experiment Station Purdue University West Lafayette, Indiana 47907	
<b>PRINCIPAL INVESTIGATOR</b>	E. J. Monke, Seminar Director	
<b>OBJECTIVES</b>	<p>To broaden the understanding of biological-physical interactions within the terrestrial phase of the hydrological cycle. Specific objectives of the seminar were:</p> <ol style="list-style-type: none"> <li>1. To establish the role of biology in the hydrological cycle, to stress the subordinate nature of the hydrological cycle with respect to the ecosystem, and to present the philosophy that the ecological system might well be the policy criterion base for future planning and development of our water resources.</li> <li>2. To re-examine the biological-physical interactions in the hydrological cycle at least where the biological input is significant.</li> <li>3. To discuss problems in identifying and quantifying the biologically-affected hydrological variable particularly with regard to hydrologic systems analysis, and to acquaint participants of recent developments in assessing the effect of vegetative cover by remote sensing.</li> <li>4. To examine case studies of management schemes in which the biological component is altered to obtain select watershed response, and to discuss decision-making with respect to alternatives.</li> </ol>	
<b>SIGNIFICANT RESULTS</b>	<p>This seminar was held at Purdue University, July 18-30, 1971. The hydrological cycle was assumed to be a subset of the ecological system although actually the reverse is true because it is the relative abundance of water which largely establishes the ecology of particular land areas. This assumption, however unrealistic, forced the participants to broaden their concepts of hydrology and its interactions with the biological environment. Discussions were limited generally to terrestrial habitats and the biological-hydrological interactions of large inland lakes, estuaries, and bays - as well as the oceans - were not included. Thirty invited papers covered the following major topic headings:</p> <ol style="list-style-type: none"> <li>1. Role of Biology in Hydrological Cycle - the Ecological System and the Influence of Man.</li> <li>2. Biological-Physical Relationships of Hydrological Processes.</li> <li>3. Identification and Measurement Techniques</li> </ol>	

**4. Management of the Biological Component for Select Watershed Response.**

**REPORTS AVAILABLE  
PUBLICLY**

**Monke, E. J. (ed.), 1974, Biological Effects in the Hydrological Cycle - Terrestrial Phase, Proceedings of the Third International Seminar for Hydrology Professors, Purdue University, West Lafayette, Indiana, 391 p.**

**This report also available from:  
National Technical Information Service  
U.S. Department of Commerce  
5285 Port Royal Road  
Springfield, Virginia 22151**



<b>TITLE</b>	<b>Education in Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>VIII.2 Education and Training of Hydrologists</b>	<b>US/IHD ref: 5.1 (176)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Universities Council on Water Resources Water Resources Center University of California Los Angeles, California 90024	
<b>PRINCIPAL INVESTIGATOR</b>	Walter L. Moore, University of Texas, Austin, Texas	
<b>OBJECTIVES</b>	<p>To evaluate the current status of education in hydrology in the United States,</p> <p>To evaluate the potential for education in hydrology in the United States, and</p> <p>To obtain information on the characteristics of various programs of education in hydrology.</p>	
<b>SIGNIFICANT RESULTS</b>	<p>The Survey of Education Programs in Hydrology was initiated by the Universities Council on Hydrology, the organization which predated the present Universities Council on Water Resources. The survey was undertaken to obtain the most reliable information possible on the status of hydrology education in the United States at the time of the survey (1966). An important feature of this survey was the effort devoted to communicate the objective and scope of the survey and the meaning of terms to the participants.</p> <p>The report presents information on four aspects of hydrology programs which the Committee felt were of primary significance in determining the effectiveness of education in hydrology: Faculty, Courses Offered, Degree Programs, and Financial Support. A chapter of the report is devoted to the presentation of information obtained on each of these topics and one to a brief summary.</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	Universities Council on Water Resources, 1967, Education in Hydrology, United States Universities - Early 1966, The University of Texas Press, Austin, Texas, 44 p.	

<b>TITLE</b>	<b>International Seminars for Hydrology Professors, Second - Systems Analysis of Hydrologic Problems</b>	
<b>Coordinating Council Resolution in force and short title</b>	VIII.2 Education and Training I.50 Mathematical Analysis	<b>US/IHD ref: 5.1(313)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	Utah Water Research Laboratory College of Engineering Utah State University Logan, Utah 84322	
<b>PRINCIPAL INVESTIGATOR</b>	J. P. Riley, Seminar Director	
<b>OBJECTIVES</b>	To emphasize the system approach as applied to hydrology, in which the various fundamental hydrologic processes and their interrelationships were studied and examined.	
<b>SIGNIFICANT RESULTS</b>	The Second International Seminar for Hydrology Professors was held at Utah State University on August 2-14, 1970. The program consisted of 25 invited papers covering the following topics: Nature of Hydrologic Systems, Description of Hydrologic Systems, Hydrologic Systems Modeling Techniques and Devices, and Applications.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Systems Analysis of Hydrologic Problems, Proceedings of the Second International Seminar for Hydrology Professors, Utah State University, Logan, Utah, 1973, 452 p.	

TITLE	Universities Council on Water Resources/IHD Fellowship and Assistantship Program in Hydrology	
Coordinating Council Resolution in force and short title	VIII.2 Education and Training	US/IHD ref: 4.1(22)
ORGANIZATION IN CHARGE OF ACTIVITY	Universities Council on Water Resources and U.S. National Committee for IHD c/o USNC/IHD 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
PRINCIPAL INVESTIGATOR	Executive Secretary USNC/IHD	
OBJECTIVES	To assist foreign nationals wishing to do graduate studies in the field of water resources at universities in the United States.	
SIGNIFICANT RESULTS	The program began with the academic year 1968-69 during which 49 scholarships were offered. By academic year 1973-74 the number of scholarships available had increased to 55. During this five-year period approximately 150 scholarships were utilized by foreign nationals doing graduate studies in the U.S.	
REPORTS AVAILABLE PUBLICLY	US/IHD Work Group on Education and Training, Hydrologic and Water Resource Education and Training in the U.S. - A Review and Recommendations, <u>in preparation.</u>  U.S. National Committee for International Hydrological Decade, Accomplishments and Recommendations - part 3 of the Final Report of the U.S. National Committee for the International Hydrological Decade, <u>in preparation.</u>	

**No Equivalent IHD Coordinating Council Resolution**

**The contributions described in this section represent work undertaken in the U.S. for which there was no Coordinating Council Resolution. It is included in the catalog because of expressed foreign interests in the subject matters.**

<b>TITLE</b>	<b>Precipitation Scavenging of Pollutants</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>No Equivalent</b>	<b>US/IHD ref: 1.11 (93)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>Atomic Energy Commission Pacific Northwest Laboratory Richland, Washington 99352</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>J. M. Hales, Battelle-Northwest, Pacific Northwest Laboratories, Richland, Washington 99352</b>	
<b>OBJECTIVES</b>	<b>To develop a practical quantitative theory for predicting the rate of collection of atmospheric pollutants by rain.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>The washout of reactive gases can be predicted using the theory of molecular diffusion to water drops. Newly calculated washout coefficients based on measured rain spectra rather than on fitted spectral equations have been recommended.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p><b>Hales, J. M., 1972, Scavenging of Gaseous Tritium Compounds by Rain, BNWL - 1659, Battelle, Pacific Northwest Laboratories, Richland, Washington.</b></p> <p><b>Hales, J. M., Precipitation Washout of Gaseous Tritium Compounds in BNWL - 1651 PTI p. 33-36.</b></p> <p><b>Hales, J. M., and L. C. Schwendiman, 1971, Precipitation Scavenging of Tritium and Tritiated Water, USAEC Division of Biology and Medicine Annual Report, Vol. II, Part I p. 82.</b></p> <p><b>Precipitation Scavenging (1970); AEC Symposium Series 22 Proceedings of a symposium held at Richland, Washington, June 2 - 4, 1970 (38 papers), U.S. Atomic Energy Commission Division of Technical Information.</b></p> <p><b>Engelman, R. J., 1968, 5-4 The Calculation of Precipitation in Scavenging pp. 208 - 221 in Meteorology and Atomic Energy 1968, D. S. Slade, Editor, U.S. Atomic Energy Commission Office of Information Services.</b></p>	

<b>TITLE</b>	<b>Scavenging of Pollutants by Snow</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>No equivalent</b>	<b>US/IHD ref: 1.11 (87)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	<b>U.S. Atomic Energy Commission Washington, D.C. 20545</b>	
<b>PRINCIPAL INVESTIGATOR</b>	<b>S. K. Sood, Illinois Institute of Technology Research Institute, Chicago, Ill.</b>	
<b>OBJECTIVES</b>	<b>To develop a practical quantitative theory for predicting the rate of collection of atmospheric pollutants by snow and ice.</b>	
<b>SIGNIFICANT RESULTS</b>	<b>The scavenging efficiency of naturally precipitating snow and ice crystals was determined for submicron polystyrene latex and sodium chloride aerosols. The effect of crystal habit, crystal dimensions, and particle size on scavenging efficiency was established. Experimental results show that scavenging efficiency is a function of both the crystal diameter and the particle diameter.</b>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<b>Sood, S. K., and M. R. Jackson, 1970, Scavenging by Snow and Ice Crystals <u>in</u> Precipitation Scavenging Atomic Energy Commission Symposium Series 22. Proceedings of a symposium held at Richland, Washington, June 2-4, 1970 U. S. Atomic Energy Commission Division of Technical Information.</b>	

<b>TITLE</b>	<b>Remote Sensing Applied to Hydrology</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>No Equivalent</b>	<b>US/IHD ref: 3.8 (344)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	US/IHD Work Group on Remote Sensing Applied to Hydrology National Academy of Sciences 2101 Constitution Avenue, N.W. Washington, D.C. 20418	
<b>PRINCIPAL INVESTIGATOR</b>	Morris Tepper, Chairman	
<b>OBJECTIVES</b>	To evaluate the current program of work within the area of remote sensing applied to hydrology and to prepare a state-of-the-art and/or informational documents regarding the subject.	
<b>SIGNIFICANT RESULTS</b>	This Work Group co-sponsored the Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources. Also it provided through its members remote sensing data to several UNESCO/IHD programs such as for the inventory of lakes greater than 100 KM <sup>2</sup> . The Work Group prepared a working paper for use in planning post-Decade Remote Sensing programs. This working paper has been transmitted to the USNC for Scientific Hydrology, which has responsibility for guiding U.S. participation in the International Hydrological Program. This document will assist in formulation of the US/IHP program dealing with remote sensing and its application to all IHP task areas.	
<b>REPORTS AVAILABLE PUBLICLY</b>	Rango, A., D. F. McGinnis, V. V. Salomonson, and D. R. Wiesnet, New Dimensions in Satellite Hydrology, U.S. IHD Bulletin, No. 30, Reprinted from EOS, Transactions American Geophysical Union, Vol. 55:7, 1974, 9 p.	

<b>TITLE</b>	<b>Use of Satellites</b>	
<b>Coordinating Council Resolution in force and short title</b>	<b>No Equivalent</b>	<b>US/IHD ref: 3.8(15)</b>
<b>ORGANIZATION IN CHARGE OF ACTIVITY</b>	National Environmental Satellite Service/NOAA Suite 300 3737 Branch Avenue, S.E. Washington, D.C. 20031	
<b>PRINCIPAL INVESTIGATOR</b>	D. R. Wiesnet D. F. McGinnis	
<b>OBJECTIVES</b>	To investigate the application of information from weather satellites to hydrology.	
<b>SIGNIFICANT RESULTS</b>	<p>Briefly, the significant findings of studies in remote sensing (mainly satellite) applications to hydrology are:</p> <ol style="list-style-type: none"> <li>1. Useful measurements can be made of the extent of snow cover. (1), (2)</li> <li>2. There are correlations between microwave brightness temperatures and useful snow parameters, such as water equivalent, wetness, temperature, etc.</li> <li>3. Areas of melting or areas which have melted and re-frozen can be detected from a comparison of visible and near infrared imagery. (4)</li> <li>4. There are correlations between microwave brightness temperatures and soil moisture. (5)</li> <li>5. Extent of flooding. (6)</li> <li>6. That snowfield measurement from satellites can be correlated with runoff. (7)</li> <li>7. That snowlines may be delineated. (8) (7)</li> <li>8. Basin parameters for hydrologic models can be measured. (9)</li> <li>9. Precipitation can be estimated in some cases. (10) (12)</li> </ol> <p>Satellite data gathering (11) (12)</p>	
<b>REPORTS AVAILABLE PUBLICLY</b>	<p>Baker, D. R., 1972, Remote Sensing of Snow Fields from Earth Satellites, International Workshop on Earth Resources Survey System, v. II, Ann Arbor, Michigan, May 3-14, 1971, pp. 431-435.</p> <p>Cooper, C. F., 1969, Snow Cover Measurement, Photogrammetric Engineering, 31:4, pp. 611-619.</p> <p>McGinnis, D. F., 1973, Detecting Melting Snow and Ice by Visible and Near-Infrared Measurements from Satellites, International Symposia on the Role of Snow and Ice in Hydrology - Symposium on Measurement and Forecasting, WMO-1, 10 pp.</p> <p>Merritt, E. S. and C. Hall, Soil Moisture Estimation Applications of Nimbus-3 HRIR (.7-1.3 <math>\mu</math>m) Observations, Final Report Contract 2-37098 Earth Satellite Corporation, (prepared for NOAA) no date.</p>	



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