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CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA
TOPICAL REPORT NO. 91

INTERNATIONAL HYDROLOGICAL DECADE

Report and Comments on the Intergovernmental Meeting of Experts held in Paris, UNESCO House, April 7-17, 1964.

P. MEYBOOM

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1. Introduction

In accordance with resolution 2-2212(b), adopted by the General Conference of Unesco at its 12th session, the purpose of the intergovernmental meeting of experts on hydrology was to prepare the final draft of the programme for the International Hydrological Decade and to specify the procedures for its execution.

The meeting which was formally opened by Mr. R. Maheu, Director General of Unesco, was attended by 157 scientists,* representing 57 states and various international organizations. The Canadian delegation was made up of:

Mr. R.H. Clark,	Water Resources Branch, Department of Northern Affairs and National Resources.
Dr. P. Meyboom,	Geological Survey of Canada, Department of Mines and Technical Surveys.
Mr. J.P. Bruce,	Meteorological Service, Department of Transport.
Mr. M.S. Slivitzky,	Services Hydrologiques du Quebec.

The meeting elected the following officers:

Chairman:	Mr. A. Volker (Netherlands)
Vice-Chairmen:	Prof. E. Mosonyi (Hungary)
	Prof. J.S. Gandolfo (Argentina)
	Dr. Nour-Ed-Dine Rifai (Syria)
Rapporteur:	Mr. L.C. Faboumy (Dahomey)

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* 92 engineers, 22 meteorologists, 24 physicists and agricultural scientists, 13 geologists, 6 permanent Unesco delegates.

The following comments have been prepared on the basis of notes made during the meeting and on the draft report of the proceedings (Document 106). These comments are the personal opinion of one member of the Canadian delegation and do not necessarily represent the opinion of the entire delegation.

2. The revised outline of the scientific programme of the Decade

It should be remembered that the International Hydrological Decade will be concerned primarily with water in the land areas of the globe, attention being paid to oceanic waters only in relation to specific problems in land areas. Similarly, as far as meteorology is concerned the programme will include only those aspects closely related to the land-phase of the hydrologic cycle. The programme outline that was originally proposed by Unesco included seven basic components:

(a) appraisal of the state of our knowledge of the hydrology of the world, and identification of the principal gaps in that knowledge,

(b) standardization of the instruments, observations, techniques and terminologies used for the collection, compilation and reporting of data,

(c) establishment of basic networks and improvement of existing networks to provide fundamental data on hydrologic systems,

(d) research on hydrological systems in selected environments, constituting what may be called "representative basins",

(e) research on specific hydrologic problems, the nature of which calls for international cooperation,

(f) theoretical and practical training in hydrology,

(g) systematic exchanges of information.

The first draft of a detailed scientific programme, based on these seven points of orientation was presented in Unesco Document 22, which was subsequently revised and presented in a different format in Annex I of Unesco Document 181. In the light of comments received from Member States, a new annex was drafted, called: "Revised outline of the programme for the Decade". The new draft, which is based entirely on a classification of the elements of the water cycle (i.e. precipitation, evaporation, etc.) was attached as Annex I to Unesco Document 100 and served as a working paper for the 1964 meeting.

The first point of the agenda called for a review of all national programmes with particular reference to Document 100 Annex I. While commenting on their national programmes, all delegates made it clear that Annex I had been the blue-print for their plans. Many delegates emphasized, however, that their programme had not yet received budgetary approval and had therefore to be considered merely as a statement of good intentions. This situation was somewhat of a vicious circle, in that the governments of participating states required Unesco approval of the national programme before allotting any funds and in that Unesco could not formulate any firm plans without budgetary commitments of the participating states. Dr. Nace (U.S.A.) summarized this situation very clearly by saying: "There is no use stating what is desirable, participants to this meeting should state what they are willing to do".

It became obvious however, that the meeting could not fulfil its first purpose: the final draft of a Decade programme. All it could do - and all it actually did - was to re-emphasize the list of subjects that should receive particular attention during the Decade. Seen in this light, the meeting achieved little more than the meeting of May, 1963.

For these reasons, and with a view to preparing the work of the first session of the Coordinating Council, the meeting requested the Director General to invite all Member States to present their programme or their revised programme, before 31st December, 1964. These programmes will then be compiled by the Unesco Secretariat and the resulting Document will be distributed to all National Decade Committees and to all interested organizations.

Without elaborating on all national proposals, some of the points that were raised can be summarized as follows:

For many countries the chief aim during the Decade will be the construction of basic hydrometric and meteorological networks, and it will certainly be in the spirit of the Decade to accelerate this type of activity. On the other hand, those countries that have already basic networks and in which advanced hydrologic research is already being carried out, do not count on accelerating their activities because of the great lack of trained personnel (United Kingdom, Germany, Netherlands, Israel). It follows that the hydrological awareness that is being aroused by the Hydrological Decade will greatly benefit the developing countries but perhaps we should not expect too much from it in terms of faster advancement in the science of hydrology.

The U.S.A. delegation which had presented a national programme under the title: "Contribution to the Hydrological Basis for Human Welfare", pointed out that Annex I did not provide a proper framework for inter-disciplinary research projects (Example: "Interrelation among hydrologic regimes and ecological systems"). Following this line of thought the meeting was divided into three working groups, corresponding to a simplified set of categories of projects: basic data; inventories and balances; and

special research. The three categories were compared with three concentric rings, of which in each country the inner circle consists of basic data. Depending on the state of knowledge in a country, inventories and balances would constitute a second circle, whereas research would make up the third circle.

3. Discussions and recommendations of the working groups

The meeting discussed at some length the purpose of the working groups and a résumé of these discussions was meant to provide adequate guidance for the operation of each working group.

To educate administrations of developing countries, the working group on the collection of basic data was to make a clear statement about the necessity of collecting basic data. Furthermore, the working group was asked to decide on the requirements for groundwater observation networks to decide whether a basic data programme should include chemical data and to decide whether or not there existed a priority of investigations in a hydrological survey.

The report that was issued by the working group included the following recommendations, none of which bore much relation to the terms of reference set out above:

(a) It is requested that the Coordinating Council for the hydrological Decade takes the necessary action to establish definite standards for Decade stations. These should include standards for groundwater measurements.

(b) It is recommended that the meeting encourages the activities of the World Meteorological Organization dealing with the comparison of evaporation measurement methods.

(c) It is recommended that the Coordinating Council arranges to provide guidance on analysis techniques for the study of chemistry of water.

(d) It is recommended that the Coordinating Council takes steps to arrange for evaluation of gross sediment transport into the oceans.

(e) It is recommended that the Coordinating Council takes action to promote development of methods of measuring sediment transport and of instruments for measuring hydrologic parameters in remote areas.

(f) It is recommended that the Coordinating Council encourages dissemination of information about automatic techniques of data collection and computer techniques of data processing.

The second working group, dealing with inventories and balances was requested to state that the Hydrological Decade should not deal with a confrontation of required water resources, but rather with a scientific assessment of the available resources. In other words: that the Hydrological Decade should not deal with the management aspects of water and water planning, but with the study of water as it occurs in nature. Among the recommendations put forth in the final report of the second working group, the following points were presented as a minimum programme for 1965-1966:

National activities:

Every country should assemble all available hydrological data pertaining to: precipitation, run-off, groundwater, soil moisture, evaporation, lakes, snow, ice and glaciers, sediment transport and soil erosion, and also on water chemistry. These data should be published in reference books, yearbooks or maps. Where figures are already available

for these elements of the hydrologic cycle, an attempt should be made to arrive at a first estimate of the overall water balance. Wherever more detailed information is available, it is recommended that this should be written up in the form of monographs.

Each participating country should be encouraged to establish at least one representative basin in the period 1965-1966, keeping in mind that one well-equipped representative basin will be of greater value than several equipped to inferior standards.

International activities:

Interested countries should make arrangements to study problems concerning the water balance of international river basins and groundwater aquifers.

The second working group recommended furthermore that the Coordinating Council should review the proposals from the different countries with regard to representative basins in order to ensure their most effective distribution with respect to climate, topography and geology.

The third working group, dealing with hydrological research, was requested to limit itself to research which really requires international cooperation. The working group described the concept of international cooperation in research as follows:

International scientific cooperation does not require one project or one area, but rather one problem. Problems that lend themselves to solution by international cooperation can be twofold. They can either be of such a universal nature that they delay the advancement of hydrology everywhere, or they are inherent in the peculiar geographical distribution of hydrologic phenomena. In the first case international scientific cooperation may take the form of an international awareness of the problem, which may lead to an accelerated effort to solve it; whereas in the second case

international cooperation consists of a study of analogous environments in different geographic regions, by using the same methods of investigation. In both instances scientists are aware of one another and the summation of their individual studies leads to larger systems of generalizations than could have been achieved if their work had been carried out in isolation. The working group emphasized that the principle of international scientific cooperation is based on individual awareness of activities elsewhere in the world.

After establishing this criterion the working group stated that research on any topic within the scope of the Decade is relevant to the advancement of hydrology and that the working group endorses all planned research programmes as an essential contribution to the Decade programme.

Additional to this resolution and applying the criterion of international cooperation the working group tried to find subjects in all phases of hydrology in which research would be particularly useful. With regard to a concerted attack on a universal problem, Canada proposed specifically to search for fast and cheap methods to determine the spatial distribution of permeability and hydraulic head in order to facilitate studies of groundwater flow systems. In a joint statement Canada and the United States presented two typical examples of the second type of international cooperation:

1. Dendochronology and alluvial terrace chronology of post-Pleistocene river development,

2. Hydrology of prairie "potholes".

The final product of this search for suitable subjects was a long list of headings, vague in their generality and applicable to every possible situation. The following paragraphs occurred under the heading "groundwater".

(a) Occurrence and movement

1. physics of flow in the unsaturated zone,
2. measurement of directional permeability in various lithologic materials,
3. determination of places and amounts of recharge and factors that control them,
4. direction and rates of groundwater discharge in various environments,
5. geophysical and electric prospecting for groundwater.

Such research includes new methods of study of samples of lithologic materials obtained from wells and outcrops. Spatial distribution of hydraulic heads in basins or regional flow systems is important and techniques are needed to determine them quickly and cheaply. The use of isotope techniques should be encouraged.

Salt water intrusion is a problem in which such knowledge can be applied, but in addition involves knowledge of mixing and flushing at interfaces and boundaries in flow systems.

Much work is needed on the interrelations among surface water and groundwater, including relations of rivers to adjacent groundwater bodies.

(b) Hydrology of calcareous terrains and karst topography

1. determination of dynamics and direction of flow in solution channels, volumes of rates of flow,
2. environmental controls and processes of formation of solution channels and erosion,

3. determinants and rates of solution and formation of cavities.

Because of the unavoidable vagueness of such a general list of items, the working group decided that certain activities deserved special attention early in the Decade. These activities include:

Regional and intercountry discussions of specific problems common to them,

Selection of appropriate research areas, environments or basins,

Agreements on terminology and form of data where necessary to promote joint planning and unified direction.

In the final report of the working group, five topics were selected for special attention during the early stages of the Decade. It should be noted that none of these topics had been emphasized during sessions of the working group. They appeared more or less as personal conclusions of the officers of the working group;

1. Determination of time trends in hydrological phenomena.
2. Studies of the effects of urbanization and changing land management on hydrologic parameters.
3. Management techniques in groundwater, with emphasis on artificial recharge.
4. Study of the variation of glaciers and ice fields.
5. Studies of channels and rills, with special regard to comparison between regions ranging from humid to arid.

The third recommendation seemed in contradiction with the terms of reference of the second working group, which was asked to state specifically that water management would not constitute part of the Decade programme.

4. Basic operations necessary for the execution of the projects and further comments on research

The bulk of the basic data will be furnished by networks of observation stations, the most developed of which are those dealing with precipitation and streamflow. One of the purposes of the Decade is to promote a programme of standardized observations. The following arrangement and types of observation stations are being considered.

(a) Decade observation station. (standardized observation station) Decade stations will comply with certain quality standards so as to improve the quality of ordinary rain-gauge networks and hydrometric stations.

(b) Benchmark stations. These stations provide data from basins which are essentially in their natural state. They would be the reference base for determining normal stream flow and groundwater regimens, sediment behaviour, chemical characteristics and other properties. The meeting noted that an international network of hydrologic benchmark stations (or Vigil network) would be a noteworthy accomplishment.

(c) Experimental basins. Experimental basins are small basins (less than hundreds of square kilometers) where one would measure temperature, precipitation, streamflow etc., and how these parameters would be affected by changes in land use (urbanization, reforestation etc.)

(d) Representative basins. Representative basins would be chosen in areas where there is standard observation work in progress which might be supplemented by short-term special data. The aim would be to understand the hydrology of a number of well-defined environments throughout the world.

A number of interesting points with regard to basins were brought up during the sessions of the working group on research. France commented that in their selection of experimental basins 4 conditions had to be satisfied:

(1) exact congruence between surface basin and groundwater basins,

(2) simple and homogeneous geology,

(3) no human influence at the outset of the experiment,

(4) the basin must be measurable.

The Hungarian delegate commented that Hungarian scientists had found it very difficult to find areas where these conditions are satisfied.

Asked about the difference between an experimental basin and a representative basin, the French delegate explained that deliberate human influence on the environment under study was the criterion of an experimental basin.

There was strong opposition against the concept of experimental basins, particularly from the United States and the United Kingdom. It was explained that in American experimental basins 10,000 station years' of information had been collected, of which less than 25% had ever been interpreted. In all these costly and lengthy observations groundwater was virtually neglected. Germany and the U.S.S.R. expressed more optimistic views by stating that experimental basins should be regarded as the best free-air laboratories available. It was stressed by all participants, however, that experimental basins are a tool and not a research project.

The same is true for representative basins. Their purpose is the description of an environment; they are not primarily meant to offer opportunity for research. This explains why no mention was made of the sort of research that can be carried out in a representative basin, with the exception of Mr. Volker's proposal to study the role of subsurface storage in run-off. For instance, it was not realized that basins may be the ideal framework in which to study groundwater flow-systems. Indeed, it was not specified for any of the suggested subjects for groundwater research that the subject could only be studied properly in the context of a flow-system. It thus seems that the "research potential" of representative basins as far as groundwater studies are concerned, was highly underestimated.

This is strange. Particularly if seen in the light of a recent article in Science by H.E. Thomas and L.B. Leopold, called "Groundwater in North America". In this article the authors conclude that research on natural and artificial recharge, on unsaturated flow, on hydrochemistry and on aquifer characteristics should all be considered as supporting activities to the overall objectives of defining numerically the hydrologic system and of analyzing the regional flow patterns and the superimposed chemical systems.

Mr. Leopold who was chairman of the working group on research, did list all the "supporting activities" in groundwater research, but the final report of the working group does not include the overall objective of analyzing the flow systems.

5. Supporting activities

In a joint session of the three working groups considerable time was spent discussing the supporting activities of the Decade, which strictly speaking, do not form part of the scientific programme but are nevertheless essential for its implementation. These activities include education and training, and exchange of information

a. Education and training. In the final report of the meeting the present status of scientists working in hydrology was summarized as follows: "Although many scientists today are working in and on the fringes of hydrology, relatively few call themselves hydrologists, and this for several reasons. Hydrology is an interdisciplinary science. That is, some aspects of hydrology are included in civil engineering, others are in soil science, in geology or in meteorology, but the whole of hydrology is not within any one of these sciences. Moreover, until recently, few academic institutions offered degree curricula in hydrology at either the undergraduate or graduate levels. Consequently, many hydrologists today are such by personal choice and have become hydrologists through on-the-job training and experience".

It is interesting to recall the report of the working group on "education and training" of the 1963-meeting. This working group distinguished among five levels of education:

(1) Observer
(2) Professional Aid
(3) Hydrometrist
(4) Hydrologist (Hydrogeologist)
(5) Research Hydrologist

In one of the developing countries the relevant ratio of the different classes was found to be as follows: 30 : 6 : 2 : 1 for the classes 1 to 4.

Various delegates commented on the present status of education in hydrology in their countries. It was mentioned that the U.S.A. has already prepared a "Handbook for Hydrologists" and that there are now 30 universities in the United States offering graduate courses in hydrology. These universities have grouped themselves into the "Universities Council on Hydrology", which has issued a little booklet on the various programmes that are offered by its members.

Israel believes that the best training is "on-the-job" and it therefore offers stipendia to people from abroad who then participate in a current hydrological project in Israel. France offers also fellowships in hydrology. These courses contain 20 trainees, who receive instruction in subjects dealing with the entire hydrologic cycle. Special courses in hydrology are now given at the Universities of Montpellier, Paris and Bordeaux, and approximately 60 students have received degrees in hydrology from these universities. As far as South America is concerned, the University of Sao Palo, in Brazil, has a "Basin School" for middle and upper level education, where hydrology and hydrogeology are being taught.

It was generally felt that the training of groups 1 to 3 should be local, whereas training of hydrologists and research hydrologists would be independent of location. It was also felt that a split between "surface hydrologist" and "hydrogeologist" should come after a joint general training, but the existence of the two different directions was recognized. The 1963-working group on education formulated the difference thus: "Formal instruction in the field of hydrology must cover hydrogeology as well as hydrometeorology to be fully effective. As with most professions, the experience gained in practical work determines whether a hydrologist operates on surface water principally or on groundwater principally."

b. Exchange of information. With respect to the national programmes the meeting agreed that the content, extent, system of data acquisition and dissemination, including publications, are determined by the countries themselves.

The meeting considered it desirable that as regards hydrometeorology the content of the national publications should correspond to the recommendations of the Commisssion on Hydrometeorology of WMO.

The meeting also accepted Canada's proposal that editorial directors of existing hydrologic journals should be encouraged to undertake special Decade issues on appropriate topics. The publication of scientific papers and reports arising from the Decade should be accomplished as much as possible through established publishing channels.

With respect to international aspects of the programmes, exchange of information should be determined by the countries concerned on the basis of mutual agreement.

6. Advisory and coordinating bodies

(a) Role and composition of National Committees.

The meeting recommended that National Committees should ensure the collection and circulation of data obtained before or during the Decade, if necessary through a national data collection centre. National Committees should draw up the national programmes and describe the local situation and needs in terms of staff and instruments. From the 35 National Committees that are already in existence, it could be concluded that "they are generally made up of persons-of-importance with direct responsibilities in the execution of the research programmes and that their special fields of study provided a balanced coverage of the different branches of hydrology".

The meeting recommended also that in order to play their role as a national coordinating agency, National Committees should be able to sustain a direct role in the execution of the Decade programme.

(b) The Coordinating Council of the Decade

According to the draft statutes of the Coordinating Council, it shall be composed of eighteen Member States of Unesco, selected by the general conference at each of its ordinary sessions, taking due account of

equitable geographic distribution, and of the need to ensure appropriate rotation. The experts appointed by Member States as their representatives on the Council shall preferably be chosen from among those persons who are playing a major part in their national Decade programme.

The Council shall be responsible for supervising from the organizational and scientific point of view the implementation of the whole Decade programme, for recommending scientific projects and for coordinating international cooperation.

The International Council of Scientific Unions may give advice to the Council on matters of scientific character. ICSU, as well as representatives of the brotherhood of other United Nations organizations may take part in all meetings of the council, without the right to vote. The Secretariat of the Council shall be provided by the Director-General of Unesco.

The international programmes of hydrological investigations, recommended by the Council to Member States for concerted action on their part, shall be financed by the participating Member States according to the commitments which each State is willing to make.

(c) Role of international non-governmental scientific organizations

The meeting noted with satisfaction the statements made by the representatives of the International Council of Scientific Unions (ICSU), International Association of Scientific Hydrology (IASH), the International Association of Hydrogeologists (IAH), the International Council of Irrigation and Drainage (ICID) and the International Association of Hydraulic Research (IAHR). Briefly, these statements were as follows:

ICSU: Professor Wilson, speaking for ICSU, stated that ICSU appreciates its role as a scientific adviser to the Coordinating Council of the Decade

and that a special committee will be set up within ICSU to carry out this advisory task. In the meantime, the IASH has been asked to advise ICSU on matters of hydrology.

In spite of the recognition of the important role of hydrology, ICSU feels that the field of water resources is much wider than simple hydrology and that the Decade should include study of such matters as pollution and re-use of water.

In his reply to Professor Wilson, the Chairman emphasized that specific advice should be within the scope of the Decade, as it is determined by this meeting.

IASH: On behalf of the IASH, Professor Tison pledged full support to the Hydrological Decade. Reference was made to a standing committee on hydrogeological maps, which, in cooperation with the International Association of Hydrogeologists, has prepared an international legend for hydrogeological maps. The first hydrogeological map that has been made using the new legend is available from Unesco, which also distributes copies of the legend.

ICID: Expressed great interest in the Decade.

IAH: Speaking for the IAH, Dr. Dubertret stated that the Association will center its attention on small-scale hydrogeological maps, the first one of which is now in preparation for Western Europe.

IAHR: Expressed great interest in the Decade and attention was drawn to a symposium in Leningrad (1965) dealing with hydraulic research.

7. Unesco's proposed programme for 1965-1966

Unesco's proposal is made up as follows:

(a) Secretariat for the Decade ($70,000); which will be provided by the Director-General of Unesco to the Coordinating Council.

(b) Exchange of information ($80,000); Unesco's publication programme includes a review on research on important hydrological problems. Preparation of hydrological and hydrogeological maps will be undertaken and one map has already been published (Hydrogeology of Meknes Fes).

The meeting recommended that Unesco should publish a periodical newsletter, summarizing significant Decade activities and activities of the Coordinating Council. Canada proposed that the newsletter be in the form of a Hydrological Yearbook, containing abstracts and literature references of all national programmes. The meeting also felt that the Decade would be substantially aided by the preparation of an international glossary on hydrology.

During the discussions on this subject Israel made the very pertinent remark that it was necessary to have a decimal classification of hydrological subjects. The idea was endorsed by Italy, and it was said that particularly in groundwater a more precise terminology was highly desirable.

(c) Training of hydrologists ($95,000); Unesco will investigate where hydrologists can be trained and it will advise on how the existing training facilities can be expanded. It is generally felt that hydrology is too much scattered among several branches of natural science, the boundaries of which are determined by tradition. Unesco therefore plans to draw up a proper curriculum for the training in hydrology and to prepare certain text-books, in which the various disciplines are properly blended.

As far as training proper is concerned Unesco plans on giving scholarships, technical assistance and on requesting countries to give scholarships in the field of hydrology. Furthermore, Unesco plans on 4 regional courses in hydrology in 1965, one in each of the following areas: Africa, Latin America, Asia and Arabia.

(d) Assistance to Member States ($55,000). While most of the expense involved in the implementation of the Decade will be borne by the participating countries, Unesco assistance will be provided to Member States, on advice of the Coordinating Council, to support certain national or regional research projects within the framework of the programme. This assistance will include provisions for standard measuring equipment as well as for short-term expert missions.

8. Role of the other organizations of the United Nations

Representatives of three UN organizations made statements with regard to the International Hydrological Decade.

(a) World Meteorological Organization (WMO). It was generally understood that WMO has an important role to play in the Decade, particularly with regard to standardization of instruments and methods of meteorological observation. The representative of WMO explained that his organization will assist countries in setting up basic hydrometeorological networks to at least the minimum density standards. WMO is preparing a hydrometeorological glossary in four languages and the organization has set up a special "Commission for Hydrometeorology" whose terms of reference do not only cover precipitation and evaporation but all other elements involved in the study of the water balance (except groundwater).

The WMO representative proposed that certain aspects of the Decade programme would be given to WMO for implementation. (In connection herewith it is interesting to note that a member of the U.S. delegation in the working group on basic data stated that the International Hydrological Decade was to be a scientific affair, in which there was no place for either basic network construction or for WMO). Nevertheless, the meeting recommended

that the Coordinating Council should give due attention to the existing machinery within WMO for dealing with hydrometeorological matters.

The meeting took note of the symposium on network design, to be organized by WMO and IASH in Canada (1965).

(b) Food and Agricultural Organization of the United Nations (FAO)

FAO is primarily interested in three aspects of hydrology: (1) influence of man on the hydrologic cycle; (2) groundwater; (3) soil moisture. FAO feels that the Decade should not embark on an endless path of subsidiary sciences, such as rural economy and its relation to water availability, but that it should be kept within reasonable limits. At present FAO employs 300 experts, 50 of which are hydrogeologists. FAO already has established seven experimental basins (Morocco, Tunisia, Israel, Togo, Nigeria, Sudan and Rhodesia), and intends to expand this work, possibly in cooperation with WMO.

(c) International Atomic Energy Agency (IAEA). The IAEA is glad to review national programmes in order to judge whether isotope studies can be applied to certain aspects of the programme. IAEA will provide for the exchange of information on the use of isotope techniques and for the dissemination of data from such projects. Laboratory facilities of the Agency may be used to provide analysis for isotope hydrology studies.

9. Miscellaneous comments

International Association of Hydrogeologists The IAH has been organized as part of the International Geological Congress during the congress in Mexico. The association was organized by French geologists and 80 per cent of the present 500 members are French. The association has been very active, judging from the proceedings of its international meetings in Paris (1957), in Leige (1958), in Madrid (1959) and in Beograd (1962). During the Decade the Association intends to play an important role in preparing hydrogeological maps.

It is very likely that the IAH will become one of the Associations of the International Union of Geological Sciences which is to be formed in New Delhi in December of this year. Comparable to the International Union of Geodesy and Geophysics, the Union of Geological Sciences may instigate national committees and national subcommittees in the earth sciences. Assuming a vivid response to this new international grouping of geologists, Canada may be wise to organize a subcommittee on hydrogeology as one of the subcommittees to its national committee on Geological Sciences. This subcommittee could play an active role in Canada's Decade programme.

Hydrogeological maps Dr. Buchan invited me to attend an informal joint meeting of the standing committees on hydrogeological maps of the IASH and the IAH. The meeting was attended by:

Dr. S. Buchan (U.K.)	Dr. G. Castany (France)
Dr. K. Ubell (Hungary)	Dr. L. Dubertret (France)
Dr. W. Richter (Germany)	Mr. J. Margat (France)
Dr. G. Santing (Netherlands)	Mr. D. Costa (U.S.A.)

The participants were asked to comment on their preliminary experiences with the new international legend for hydrogeological maps which was published by Unesco on behalf of the two committees. The general opinion was that the legend is useful for small-scale maps, but that it is impractical for scales exceeding 1:250.000 (which is the scale of the G.S.C. water probability maps). All participants mentioned two obstacles in preparing hydrogeological maps; how to depict the hydrodynamic conditions and how to show the three dimensional framework of geology.

Mr. Margat explained that in order to do justice to the three dimensions one may have to produce several sheets for one area, each one showing the conditions at a particular depth or for a particular stratigraphic unit.

Such an atlas is now in preparation for the basin of Paris. Additional to such atlases France has started a systematic hydrogeological map series on 1:50,000, according to the existing topographic grid. The next day, when I visited the Bureau des Recherches Géologiques et Minières, Mr. Margat showed me the first sheet of this series, the sheet Douai.

In Germany, the first country to publish a national hydrogeological map scale 1:1,000,000, geologists are not clear about the purpose of detailed groundwater maps, and Germany does not intend to publish maps on scales larger than 1:250,000.

Hungary has published a beautiful national atlas, containing hydrogeological and hydrological maps on scales 1:500,000 and 1:100,000.

With regard to the purpose of small-scale maps, such as the 1:1,000,000 German map, it was said that they constitute scientific documentation that is easily accessible to engineers and town-planners. The relation between hydrogeological maps and geological maps was compared to the relation between the new tectonic maps and geological maps, in that they both present a new synthesis.

None of the authors had considered the difference between water probability maps and water availability maps. From the Canadian standpoint all maps that were shown at the meeting were water probability maps.

Piezometers Dr. S. Mandel (Israel) told me about the experience of Israelian hydrogeologists with piezometers. Piezometers have been used extensively in Israel, also in conjunction with automatic recorders and small-hole attachments. The experience was not altogether favourable. Although the results were generally good, the installations were vulnerable, difficult to maintain, expensive to service and very expensive to install. In Israel, piezometer sets are also read by local observers, who are generally

unable to judge whether the installation is still functioning properly. To prevent loss of valuable information, one technician has to be assigned to such work in a certain area, for which work he requires an instrument repair-shop equipped with tools and material. The entire operation becomes thus excessively expensive.

Israel is therefore looking for other techniques to study flow-systems and particular attention is being paid to tracer studies. Israel has also established an extensive "library of natural waters" which serves as a standard for chemical and tracer studies.

Groundwater in crystalline rocks I learned from discussions with Dr. Hagemann that the Norwegian Geological Survey has been very successful in obtaining groundwater from crystalline rocks. Prospecting for groundwater in crystalline areas involves mapping of tectonic features, since fracture zones and joint systems constitute the aquifers. Dr. Hagemann gave me half a dozen reprints form the Norwegian Geological Yearbook in which some of the results are reported. From these I learned that several large Norwegian waterworks utilize groundwater from plutonic rocks. Dr. Hagemann was surprised to learn that so little work of this nature was done on the Canadian Shield.

10. Summary and Conclusions

(1) Despite the vague and elusive character of a meeting of this kind, it has clarified the principle of "international scientific cooperation", which is simply based on individual awareness of activities elsewhere in the world and on the desire of the individual scientist to communicate about these activities.

(2) Agreement has been reached that the basic execution of the Decade programme shall be carried out by means of Decade observation stations, Benchmark stations, Experimental basins and Representative basins, emphasis being placed on quality rather than quantity.

(3) It can be deduced from the reports of the working groups that a minimum national programme for 1965-66 should contain:

(a) a preliminary estimate of the overall national water balance,

(b) establishment of one well-equipped representative basin,

(c) determination of time trends in national hydrologic phenomena.

OTTAWA, April 30, 1964.