

WORLD CLIMATE PROGRAMME

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WORLD CLIMATE PROGRAMME

SECOND PLANNING MEETING ON WORLD CLIMATE PROGRAMME - WATER

(PARIS, 16-19 NOVEMBER 1982)

WCP – 36

UNITED NATIONS EDUCATIONAL
SCIENTIFIC AND CULTURAL
ORGANIZATION

WORLD METEOROLOGICAL
ORGANIZATION

The WCP consists of four major components implemented by WMO in conjunction with other international organizations:

- The World Climate Research Programme (WCRP)
- The World Climate Applications Programme (WCAP)
- The World Climate Impact Studies Programme (WCIP)
- The World Climate Data Programme (WCDP)

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1. OPENING

1.1 The Second Planning Meeting on the World Climate Programme - Water was held at Unesco Headquarters, Paris, from 16 to 19 November 1982. It was organized jointly by WMO and Unesco. The meeting was attended by representatives of UNEP, IIASA and IAHS and by specialists in hydrology and water resources. A full list of participants is given in Annex 1 to this report.

1.2 The meeting was opened at 10.00 a.m. on Tuesday 16 November 1982 by Mr. M. Batisse, Deputy Assistant Director-General for Environmental Sciences of Unesco and by Mr. J. Nemeč, Director of the Hydrology and Water Resources Department of WMO. Mr. Nemeč expressed the gratitude of WMO to Unesco for the offer to host the meeting. He explained that, within the WMO Secretariat, water-related activities under the World Climate Programme (WCP) were handled jointly by himself and Mr. T. Potter as Director of the World Climate Programme Department. He informed the meeting that Mr. Potter greatly regretted being unable to participate personally in its deliberations. In their remarks Mr. Batisse and Mr. Nemeč referred to the special character of World Climate Programme - Water (WCP-Water) in the overall WCP which cuts across the whole field of research, impact, applications and data. They stated that the purpose of the meeting was to offer guidance concerning specific project activities under WCP-Water, in particular within the framework of the areas which are indicated as having priority in the WMO and Unesco planning documents for 1983 and onwards.

1.3 The meeting unanimously elected Mr. J. Rodda as its chairman. The agenda followed by the meeting is given in Annex 2 to this report. The meeting discussed all matters in plenary but the first draft of the material which appears in Annex 3 of this report was prepared by small ad hoc groups.

1.4 A list of abbreviations used in the report is presented in Annex 4.

2. REVIEW OF RECOMMENDATIONS AND DECISIONS OF GOVERNING BODIES

2.1 The meeting was informed of the recommendations and decisions of the various governing bodies of the organizations concerned in the planning of the World Climate Programme. It was recalled that the WCP, as adopted by the Eighth World Meteorological Congress in 1979, has four component programmes. WMO acted as lead agency with overall responsibility for planning and co-ordination; the international organizations responsible for the component programmes being as follows:

- the World Climate Research Programme (WCRP) - WMO/ICSU
- the World Climate Applications Programme (WCAP) - WMO
- the World Climate Impact Studies Programme (WCIP) - UNEP
- the World Climate Data Programme (WCDP) - WMD@

2.2 The objectives of the World Climate Research Programme (WCRP) are to determine to what extent climate can be predicted and the extent of man's influence on climate. This element of the WCP is carried out jointly by WMO and ICSU under the guidance of the Joint Scientific Committee of the two organizations.

2.3 With regard to water, it was noted that specific activities were planned in relation to land-surface and hydrological processes. A study conference had been held on this subject in Greenbelt, U.S.A. in January 1981 to consider the manner in which such processes could be introduced into atmospheric general circulation models.

Thought was being given to the possibility of organizing an international experiment to study land-surface and hydrological processes and their effect on atmospheric circulation as a basis for verifying and, if possible, improving the way in which they were characterized in current general circulation models.

2.4 Major studies using global atmospheric circulation models had been carried out during the First GARP Global Experiment (FGGE) in 1979. Many of the data from FGGE were still being compiled, including those for surface runoff over the globe.

2.5 It was explained that the basic objective of the World Climate Applications Programme (WCAP) was to assist societies in improving their capabilities to carry out various activities and to obtain maximum economic and social benefit under different climatic conditions while maintaining environmental integrity. To this end efforts were being made to promote parallel activities in many applications sectors. Three priority areas had been selected in this regard, namely: food, water and energy,

2.6 The World Climate Impact Studies Programme (WCIP) was introduced as being aimed at the study of the impact of climate on the interrelations between population, resources, environment and development. This component is particularly concerned with the impact of climatic change and variability on the socioeconomic systems of individual countries and of the world as a whole. A Plan of Action for the WCIP which was recommended by the Scientific Advisory Committee (SAC) of UNEP at its first meeting in February 1981 had been approved by the UNEP Governing Council at its ninth session in May 1981. The meeting was informed that a second meeting of the Scientific Advisory Committee is planned for January 1983.

2.7 It was noted that the purpose of the World Climate Data Programme (WCDP) had been defined so as to ensure the availability of reliable climate data which are accessible and exchangeable in an acceptable form and time as required for climate research, applications and impact studies.

2.8 The observation and monitoring of climate and its variations necessitate the sampling of a broad range of elements of the earth-ocean-atmosphere-cryosphere climate system and the WCDP should provide the co-ordination necessary to ensure that WCP requirements are incorporated in the further development of the various data systems. It was recognized that, for the purposes of the WCDP, both hydrological and hydrometeorological data are included in the term "climate data".

2.9 Climate and the world's water-resource system have a special relationship insofar as water resources depend on the hydrological cycle which is itself part of the climate system. Hence there are hydrological and water-resource aspects in all four components of WCP and of WCAP-Food and WCAP-Energy. The meeting was informed that, in order to facilitate the necessary co-ordination, all water related activities in WCP were grouped under the general title: World Climate Programme - Water (WCPWater).

2.10 The basic objective of WCP-Water was stated as being:

- to meet more effectively the socioeconomic needs which depend on water-resource systems, through the improved application of climate data and information,

2.11 It was noted that the broad aim was being pursued along the lines of the following more specific objectives:

- to enhance our understanding of the relationship which exists between climate and water resources and which is based on hydrological processes (this involved placing greater emphasis on the interactions between climate, hydrology and water resources);
- to make more effective use of climate information in water-resource management (intended to cover planning, design and operation of water-resource systems, as well as more general aspects of the water needs of societies);
- to enhance our understanding of the impact of climate variability and change on water resources (including interactions affecting socioeconomic activities related to water-resource management);
- to improve the availability of data required to achieve the objectives of WCP-Water (involves efforts at regional, national and international levels relating to many types of data).

2.12 It was recognized that many international organizations had long-standing programmes of relevance to the objectives of WCP-Water, in particular the Hydrology and Water Resources Programme of WMO and the International Hydrological Programme of Unesco, and that these activities would be strengthened and, where necessary, refocussed so as to contribute significantly to WCP-Water. Certain on-going programmes of UNEP, FAO, IIASA and IAHS (ICSU), amongst others, were also expected to contribute

2.13 The meeting was informed that, at its thirty-fourth session in June 1982, the WMO Executive Committee paid particular attention to the co-ordination of the World Climate Programme. The Committee felt that it was unnecessary at this time to establish permanent interdisciplinary committees to assist in the planning of projects within identified priority problem areas and that specialized inputs to this planning process could be organized through ad hoc committees or expert groups. The planning meetings on WCP-Water were seen as serving this purpose as regards water-related aspects of the WCP,

3. REVIEW OF CURRENT AND PLANNED AGENCY ACTIVITIES

3.1 Planning of WCP-Water had been initiated at the first Informal Planning Meeting on WCP-Water which had been held in Geneva in February 1981. The aims and objectives for WCP-Water proposed by that meeting had subsequently been endorsed by a number of bodies including the Executive Committee of WMO and the Intergovernmental Council of the International Hydrological Programme of Unesco. The specific suggestions for activity areas and projects made by the first meeting had also formed the basis for more detailed planning by both WMO and Unesco.

3.2 As regards WMO, its Executive Committee in June 1982 approved, as a guideline, five of the above areas as those on which the Organization might concentrate its efforts in the medium-term. It identified one or more projects under each area which should receive priority. It was foreseen that a start could be made in 1983 in implementing these projects. In May of that year the Ninth World Meteorological Congress would meet and would consider not only progress in the development of plans for the WCP as a whole, but also proposals for specific action by WMO under WCP Water for the period 1984-1987. A longer-term plan, couched in general terms, might also be adopted extending until 1991.

The relevance of WMO's Operational Hydrology Programme (OHP) to the aims of WCP-Water was noted, together with the fact that the Organization's Commission for Hydrology was expected to meet for its seventh session in the first half of 1984. It was recognized, therefore, that the present meeting was well timed to offer guidance as to the further planning of WMO's activities under WCP-Water.

3.3 The Unesco/WMO International Conference on Hydrology and the Scientific Bases for the Rational Management of Water Resources held in Paris in August 1981 had as one of its tasks the preparation of an outline plan for the third phase of the International Hydrological Programme (IHP) which would be implemented from 1984-1989. On the basis of the recommendations of different WCP planning meetings, the international Conference included as one of the 18 themes in the Outline Plan for IHP-III a Theme 3 "Interaction between climatic variability and change and hydrological processes". This is the first time that particular attention has been given to climate within the IHP, although climatic information was used in many projects under the IHP and its predecessor the International Hydrological Decade, such as those related to water balances, floods and droughts. Three main aspects have been taken into account for the planning of IHP-III: more and better use of climate information by hydrologists in order to improve the design of water projects; the use of existing knowledge on climate variability to determine the impact it may have on water availability, water-resource systems and through these on society under different conditions and the provision of relevant hydrological data and information to climatologists.

3.4 The Unesco Extraordinary General Conference in November 1982 would approve the Medium-Term Programme for the years 1984-1989 of which IHP-III would be an integral part. The Intergovernmental Council of the IHP would then determine, in March 1984, the detailed programme and plan for IHP-III (1984-1989) and consequently determine also the detailed projects of the climate related Theme 3 mentioned above. These detailed projects are to be based on the decisions of the Unesco Extraordinary General Conference of November 1982, the recommendations of the WCP-Water Planning Meeting, the decisions and recommendations of the Ninth World Meteorological Congress in 1983 and the recommendations of the Sixth Session of the Bureau of the Council of the IHP. It was noted that the IHP would thus be able to start its activities contributing to the WCP in April 1984.

3.5 The representative of UNEP informed the meeting that in their Medium-Term Plan (1982-1983) climate aspects are dealt with in the chapter on environmental assessment and earthwatch. The assessment of the environment programme was conceived as an internationally financed and coordinated global system of national facilities and services, which should study the interaction between men and the environment, provide early warning of environmental hazard and determine the status of selected natural resources.

3.6 The World Climate Impact Study Programme (WCIP) and climate change was covered by Decision 7/4 of the UNEP Governing Council which requested UNEP to collaborate with WMO and other organizations concerned with WCP in the implementation of the sub-programme for the study of the impacts of climate on human activities, and, if so requested by WMO, to assume, within the availability of funds, responsibility for the implementation of this sub-programme, under the over-all co-ordination of WMO.

3.7 A draft plan of action for the WCIP was approved by the Governing Council at its Eighth Session in 1980. A Scientific Advisory Committee on WCIP has been established by UNEP to guide the implementation of the Plan of Action.

3.8 The Council also highlighted the problem of carbon dioxide as an emerging global environmental programme. The Council called for the convening of a meeting of appropriate international governmental and non-governmental organizations to review all aspects of the ozone layer. At a meeting held in Washington D.C. in March 1977, a world plan of action on the ozone layer was formulated and a coordinating committee established. This committee had met regularly since,

3.9 It was explained that the System-Wide Medium Term Environment Programme (SWMTEP) was a document which represented the environment programme for the medium term (1984-1989) and which had been prepared with the assistance of all the agencies of the UN system with UNEP playing a key role. Matters relating to the WCP were dealt with in Chapter III of SWMTEP, entitled - atmosphere.

3.10 In SWMTEP it had been proposed that, during the period 1984-1989, UNEP would concentrate on several activities of which two have been given priority:

- (a) co-ordination of the WCIP as part of WCP and support for studies of the impact on natural climate variations on food systems, water resources, energy and other sectors of human activity;
- (b) identification of existing national and international climate impact programmes which may contribute relevant information and, as appropriate, incorporation of these into WCIP.

3.11 Finally the representative of UNEP made a general remark on the documents presented and stated that while emphasis had been given to the impact of climate on water resources more relevance should be given to the second half of the cycle, that is, impact of man's activities on climate. Among man's activities several aspects of water-resource development such as water transfer, irrigation and drainage could have an impact on climate or at least microclimate.

3.12 IIASA had submitted a proposal to UNEP to conduct a two-year exploratory assessment of the potential impacts and policy implications of anthropogenically induced climate change. The primary objective of the assessment would be to integrate and interpret the vast amount of diverse information that exists on the nature, likelihood, and implications of possible human influences on climate such as carbondioxide and trace-gas emissions. Drawing upon such techniques as scenario analysis, risk and decision analysis, and interactive gaming, an interdisciplinary assessment team of natural and social scientists would focus on selected climate impacts and develop practical frameworks for analysing them. The assessment team would include hydrologists and water-resource specialists (either in residence at IIASA or IIASA collaborators) because of the importance of the hydrologic transfer function for evaluation of possible human influences on climate and vice versa. The meeting was informed that IIASA's particular interest was in that component of WCP-Water which was concerned with the study of impacts of climate variability and change on society through water resources. As an international, non-governmental and interdisciplinary research institution, IIASA was uniquely equipped to deal with several key aspects of these problems. Taking into account that this research area had already been included under Theme 3 of the IHP-III it was suggested that a complete proposal for a project "Impact of Climate on Society through Water Resources" be developed jointly by Unesco and IIASA.

3.13 The meeting was informed of the many bodies within the ICSU family which were involved in different activities related to water. It noted that the majority of these were not involved in a direct way in studies relating to climate, although several were concerned with problems relating to the effects of climate on water-resource systems, the effects of climate variability, collection of data that

permit the construction of palaeoclimates and the monitoring of changes in both natural and man-modified ecosystems as a result of climatic change or variation. Others were studying processes, such as the hydrological cycle and land surface and cryosphere processes, which are, or may be, climatologically significant.

3.14 IAHS had been involved extensively in the area of climate and climate variability through its own activities and activities in co-operation with other bodies, for example, at the Canberra Assembly of IUGG (December 1979) IAHS had organized its own symposium on "Areas of Low Precipitation" and, through its International Commission on Snow and Ice (ICSI) with IAMAP and IAPSO, a symposium on "Sea Level, Ice and Climatic Change". Immediately before the Canberra Assembly, IAHS had collaborated with Unesco and WMO in a symposium on drought held in New Delhi, producing a state-of-the-art report for that meeting, IAHS had been one of the co-convenors of the Oxford 1981 Symposium on Variations in the Global Water Budget and several of the Symposia at its Exeter General Assembly (1982) had relevance to WCP-Water. The same applied to symposia involving IAHS at the Hamburg Assembly of IUGG (August 1983). Of particular importance would be those on: Sea Ice Margins, Assessment of Natural Hazards, Polar Meteorology and Climatology, Scientific Procedures Applied to the Planning, Design and Management of Water Resources Systems. There would also be a number of workshops where water would be important in the context of WCP, namely: New approaches in Water Balance Computation, Glacier Mass Balance Studies and others. Through ICSI, the Association was involved with the PSFG and the TTS/WGI at Zurich, both activities being very important to WCP-Water: ICSI was also active in a number of other directions, particularly with Unesco in IHP where snow and ice are important to climate and water.

3.15 The meeting recognized the complexity that arose in the planning of WCP-Water as a result of its inter-disciplinary and inter-organizational character. The close links that existed at both formal and informal levels were warmly welcomed and all concerned were encouraged to maintain and, where possible, strengthen the degree of inter-agency co-ordination in WCP-Water. Particular mention was also made of the need to ensure close co-ordination between the planning and implementation of WCP-Water and activities under the WCP in the fields of food and energy.

4. REVIEW OF NATIONAL ACTIVITIES INCLUDING RESPONSES TO CIRCULAR LETTERS

4.1 In July 1982, the WMO Secretariat sent a letter to all WMO Members seeking information on national activities related to the main subject areas of WCP-Water. The IHP Secretariat sent copies of WMO's letter to all National Committees for the IHP. The meeting was provided with a summary listing of the replies to this letter that had been received to date. It noted that more replies were still expected and that the WMO Secretariat would add these to the list as they were received. Participants expressed an interest in receiving copies of the list once it was complete.

4.2 While recognizing the value of much of the information reported by the countries, the meeting noted that certain of the national activities listed fell somewhat outside the scope of WCP-Water. It was therefore recommended that such activities should not be included in the final list as this might give a false impression of the field of interest covered by WCP-Water. Mr. Beran, in his role as rapporteur to WMO's Commission for Hydrology, kindly offered to assist the WMO Secretariat in the final compilation of the list.

4.3 The information on national activities was taken into account by the meeting when it considered the detailed planning of projects under agenda item 5.

5. IMPLEMENTATION OF INTERNATIONAL PROJECTS

5.0.1 The meeting considered methods for implementing international activities on the basis of the guidelines for action areas and priority projects for WCP-Water approved by the Thirty-Fourth Session of the Executive Committee of WMO, the outline plan for Unesco's IHP-III (1984-1989) as determined by the International Conference held in Paris in August 1981, and on the basis of the recommendations of the first planning meeting of February 1981.

5.0.2 The discussion on each of the seven activity areas is summarized below under 5.1 to 5.7. The principal outcome of these discussions is presented in Annex 3 to this report which records the recommendations of the meeting as regards projects for priority implementation in each area. The specific proposals for each project are presented as project sheets using a standard format.

5.1 Studies of climate variability using hydrological data

5.1.1 The meeting recommended that the compilation and evaluation of glacier fluctuations related to climate variability be included in this activity area. It was noted that this project had been in execution for a long time by the IAHS International Commission for Snow and Ice, although it had been interrupted temporarily by the death of Professor Müller. UNEP, through Unesco, was reported as sponsoring the World Glacier Inventory, executed by the ETH in Zurich, Switzerland. This project would continue until 1985. The organizations concerned would consider, over the next three years, a project to be started after 1985 including observations of variations of reference glaciers selected on the basis of the inventory. It was reported that the Bureau of ICSI would consider at its next meeting the continuation of the ICSI activity of publishing the volume 1975-1980 glacier fluctuation data. It was expected that IAHS/ICSI would, as in the past, request Unesco for financial assistance for the publication of this volume.

5.1.2 It was noted that plans for the IHP-III included a project 6.3 "Establishment of a methodology for distinguishing between man's influence and climate variability". The objective of this project would be to subtract climate variability from observed data in order to determine the influence of man on the hydrological cycle, but it would be useful also in developing a methodology to subtract man's influence to determine the effect of climate variability.

5.1.3 The meeting recommended that this activity area be entitled "Studies of hydrological data in the context of climate variability and change" so as to make it clear that the intention is to study hydrological data as an aid or input to studies of climate and not to study climate variability itself. The importance of proxy-data was emphasized and for this reason a specific project, listed below as I.1, was included in the priority list as a basis for work in this field. A total of four priority projects were identified in this activity area and are described in Annex 3 under the following titles:

- I.1 Analysing historical hydrological and related information with respect to climate change
- I.2 Analysing long time series of hydrological data and indices with respect to climate variability
- I.3 Glacier fluctuations
- I.4 Transfer of hydrological information of stations and basins to grid point or average grid area values.

5.2 Modelling of the hydrological cycle

5.2.1 The meeting noted that this activity area was foreseen as being closely related with the work of those involved in climate modelling under the WCRP, the modelling of the hydrological cycle being undertaken here as a basis for coupling the climate and hydrological systems rather than for purely hydrological or water-resource purposes. Reference was made to the proposals being prepared under the WCRP for an international experiment to study land-surface and hydrological processes and their effects on atmospheric circulation as reported under 2.2 above. The meeting therefore supported the proposal for the convening of a workshop under this activity area of WCP-Water to provide an opportunity for hydrologists and climate modellers to study the questions raised and approaches that might be followed in pursuing this line of investigation.

5.2.2 In view of the above, the meeting developed the proposal referred to as project II.1 below and in Annex 3, noting as it did so the importance of testing various water balance and area! evaporation models as a part of such work. As indicated in the description of project II.1, the proposal included a suggestion that informal discussions be held in Hamburg on the occasion of the IUGG General Assembly in August 1983.

5.2.3 The meeting included one project under this activity area, namely:

II.1 Workshop on approaches to and possibilities for the coupling of physically based climate and hydrological models.

5.3 Application of climate to hydrological forecasts in the operation of water-resource systems

5.3.1 This activity area was seen very much as a contribution from WCP-Water to the aims of the WCAP, the emphasis being on the practical application of methodologies. The set of project proposals under this heading was therefore mainly of a national or regional character, to be undertaken with varying degrees of international support but always with a view to gaining from international collaboration and exchange of experience.

5.3.2 Specific mention was made of the relevance of certain activities foreseen for the IHP-III under its Project 3.2.

5.3.3 The project proposed for implementation in the Sahel, project III below and in Annex 3, was seen as providing a valuable basis for studies of the use of climate dependent factors to foreshadow drought incidence and modelling of the land/ water environment and its management in relation to the process of desertification.

5.3.4 Three projects were recommended for implementation under this activity area, these being:

- III.1 Application of climate information to hydrological forecasts for the Sahel
- III.2 Pilot study for application of climate information to hydrological forecasts in the operation of irrigation, hydropower and flood control systems in India
- III.3 Application of positional climatological information to water supply forecasting in the United States of America.

Mention was made of the possibility of developing, at some time in the future, a project on the application of monthly weather outlooks in water supply operations in the Federal Republic of Germany.

5.4 Inventory of water Resources and their dynamics

5.4.1 The meeting was advised of the ongoing activities of WMO and Unesco with regard to the cataloguing and collection of global sets of hydrological data, as reported for example under 2.4 and 2.8 above.

5.4.2 In order to simplify the presentation of proposals for those projects under WCP-Water which involve the collection and analysis of hydrological data, it was decided to place all such projects under one activity area, namely area I. Consequently, it was proposed that activity area "Inventory of water resources and their dynamics" be deleted and the one project currently listed under that heading be transferred to become project I.4, as listed in Annex 3 and under 5.1.3 above.

5.4.3 Project I.4 was recognized as one specific activity under the WCP through which the hydrological community could offer valuable practical assistance to the climatologist and climate modellers. It was pointed out, however, that the analysis and storage of hydrological information on the basis of grid areas was also of interest to the hydrologist, although here the space scale was an important complicating factor.

5.5 Studies of the influence of climate variations on water resources

5.5.1 Both Unesco and WMO had selected as priority projects the analysis of sensitivity of water-resource systems to climate variations. The meeting felt that the relevant time horizon should be 30 to 100 years and that the purpose of such projects should be to test the sensory water-resource systems on the basis of certain parameters, such as the variations in basin outflow as a result of changes in input, for example, changes in precipitation over the basin, The second purpose would be to study the need for and/or value of long as opposed to short records of climate information as a basis for water-resource system design. A third purpose might be to consider the uncertainty introduced by the error in the hydrologic models used as transfer functions in such studies.

5.5.2 The meeting discussed at some length whether such sensitivity analyses should include aspects of transfer functions between hydrological variables and water-resource decision variables and aspects concerning the impact of a greater or lesser sensitivity on socioeconomic parameters. In general the meeting was of the opinion that it would be preferable to limit the scope of the project to water parameters, but that the relations with socioeconomic parameters could be indicated without going into sociologic and economic studies.

5.5.3 It was noted that included with planning of the third phase of IHP was the proposal for a study of the relationship between sensitivity analysis and to impact on society of any variations or changes.

5.5.4 Four projects were recommended for implementation under this activity area, namely:

IV.1 Sensitivity of water-resource systems to climate variations

IV.2 Use of climate data and information for the study, planning and management of water resources

IV.3 Study of the impact of climate variability and change on the occurrence of droughts and catastrophic floods

IV.4 Study of impact of climate variability and change on the occurrence of floods in urban areas.

5.6 The impact of climate on society through water resources

5.6.1 Climate variability and change have an impact on society directly through changes in the hydrological characteristics of a region, as in the case of floods and droughts, and indirectly through a change in water resources on which depend the satisfaction of societal needs such as food, health and energy.

5.6.2 The impact of climate variability and change manifests itself in two ways. First are the changes which affect the supply of water, and second are those which affect the demand. There is also the question of the interaction between the affected supplies and demands. For instance, climate variability leading to drought, reduces the amount of water supply through the hydrological transfer process and also directly affects the demand for water, as in the case of increased demand for irrigation water for crops.

5.6.3 It was noted that the evolution of the socioeconomic impacts arising from climate variability and change through hydrologic and water-resource transfer functions is of primary importance to other components of the WCP dealing with food, health and energy.

5.6.4 The meeting discussed the difference in scope of activity areas IV and V and for reasons of clarity proposed that area IV should focus primarily on hydrology and water resources and area V should take as a basis the society. When this distinction had been made the meeting felt that area V would relate closely with the aims of the World Climate Impact Programme and suggested that Unesco define a specific project in this field.

5.6.5 The hope was expressed that the UNEP Scientific Advisory Committee for the WCIP would, at its next meeting, consider the above aspects and formulate programmes/projects accordingly. It was noted that Unesco and IIASA both had an interest in these aspects and it was suggested that they might focus on such problems, possibly in collaboration with one another.

5.6.6 In the light of the above, it was felt that it would be preferable for the development of any specific WCP-Water projects to await the outcome of the meeting of the UNEP Scientific Advisory Committee, scheduled for January 1983.

5.7 Influence of man's activities on climate

5.7.1 The first planning meeting identified this area as project 2.3 "Study of the effects on the Climate of Man's Intervention in the Hydrological Cycle". The meeting felt that the importance of the subject warrants the promotion of this project to an activity area. This is included as area VI in Annex 3.

5.7.2 The meeting identified two topics for consideration in this area. The first is the influence of large-scale projects, such as interbasin transfers, on climate at a continental or sub-continental scale, In this regard, it was noted that the general subject of the impact of large-scale water projects was being dealt with in IHP-II and that it was foreseen that a large symposium on the subject, sponsored by UNEP and Unesco, would be held in 1984, probably in the U.S.S.R.

5.7.3 The second activity would be the study of the impact of water-resources work on climate at micro and river basin scale.

5.7.4 No detailed proposals were made for projects under this activity area.

6. IMPLEMENTATION OF NATIONAL PROJECTS

6.1 It was recognized that one of the primary purposes of international projects under WCP-Water would be to compile, compare and synthesize related national activities. Some national activities were seen as being innovative and of such a nature that they could be regarded as pilot or demonstration projects of interest and value to the international community. Where such projects were known to the participants they were included with those described in Annex 3.

6.2 The meeting expressed the hope that the implementation of the World Climate Programme would encourage the development of many activities at national level with the same aims as those of WCP-Water. Although the information on national activities referred to under 4 above was found to be very interesting, the meeting recommended against any attempt to establish a comprehensive inventory of all national activities related to WCP-Water. However, the proposal was made that, within the next year or two, the final list referred to under 4.2 be circulated widely to countries for general information together with a very specific request for summary information on any national activities on the precise topics chosen for international action, as described in Annex 3. This request might be submitted in the form of a questionnaire which, if carefully drafted, would help to ensure that only information relevant to these specific topics would be received.

7. FUTURE DEVELOPMENTS AND MEDIUM- TO LONG-TERM PLANS

7.1 The participants recalled (see paragraph 3.3 above) that the Outline Plan of the Third Phase of the IHP (1984-1989) adopted by the Unesco/WMO International Conference in August 1981 included one major theme (Theme 3) referring to "Interaction between climatic variability and change and hydrological processes". However, the detailed planning of these IHP activities would not be definitely decided before the sixth session of the IHP Council in March 1984. It was also noted that the plan of WMO's activities in the field of water for 1984-1987 would be considered by the Ninth World Meteorological Congress in May 1983 and by the WMO Commission for Hydrology at its seventh session in 1984.

7.2 In view of the current stage of development of the WCP, and WCP-Water in particular, as outlined in 2 and 3 above, the meeting felt that there was little it could say regarding the further planning of the programme at this point in time. The view was expressed, however, that once the WMO Congress and Commission for Hydrology had met and the sixth session of the Intergovernmental Council for the IHP had been held, there might well be a need to again review plans for WCP-Water. It was therefore suggested that a meeting of experts and organization representatives meet in late 1984 or in 1985 to assist in this task, at which time it should be possible to report on the implementation of projects under WCP-Water over the intervening two or three years and take account of the results obtained when making proposals for future activities.

7.3 Two specific points were stressed during this brief consideration of future developments. The first was the need to consider the transfer of knowledge and technology, including education and training, in association with or as an outcome of all WCP--Water projects. The first planning meeting had laid considerable emphasis on this and, although it was not considered appropriate to include a separate activity area for the purpose, the second planning meeting wished to record its encouragement of such supporting activities.

7.4 The second specific point related to the continuing need for close collaboration between WMO and Unesco in the further planning and in the coordinated implementation of WCP-Water projects.

7.5 When developing proposals for specific projects under agenda item 5, the meeting had before it the outline plan for Theme 3 of the third phase of the IHP (see paragraphs 3.3 and 3.4 above). As an aid to the IHP Bureau and Intergovernmental Council in their further consideration of this theme, the meeting offered suggestions to the Unesco Secretariat as to how this outline might be further developed so as to provide a basis for Unesco collaboration in the implementation of WCP-Water.

8. CLOSURE

8.1 The meeting adopted its report in draft form and requested the Secretariat to finalize and complement it as necessary so as to present it in a format more readily usable by readers not present at the meeting. The Chairman closed the meeting on Friday, 19 November 1982.

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AGENDA

1. OPENING
2. REVIEW OF RECOMMENDATIONS AND DECISIONS OF GOVERNING BODIES
3. REVIEW OF CURRENT AND PLANNED AGENCY ACITIVITIES
4. REVIEW OF NATIONAL ACTIVITIES INCLUDNG RESPONSES TO CIRCULAR LETTERS
5. IMPLEMENTATION OF INTERNATIONAL PROJECTS
 - 5.1 Studies of climate variability using hydrological data
 - 5.2 Modelling of the hydrological cycle
 - 5.3 Application of climate information to hydrological forecasts in the operation of water-resource systems
 - 5.4 Inventory of water resources and their dynamics
 - 5.5 Studies of the influence of climate variations on water resources
 - 5.6 Impact of climate on society through water resources
 - 5.7 Influence of man's activities on climate
6. IMPLEMENTATION OF NATIONAL PROJECTS
7. FUTURE DEVELOPMENTS AND MEDIUM- TO LONG-TERM PLANS
8. CLOSURE

WORLD CLIMATE PROGRAMME – WATER (WCP- Water)

ACTIVITY PASS

And

PRIORITY PROJECTS

As proposed by the Second Planning Meeting on WCP-Water
(Paris, November 1982)

Summary Listing of Activity Areas and Priority Projects for WCP-Water

as proposed by the Second Planning Meeting on WCP-Water

(Paris, November 1982)

- I. STUDIES OF HYDROLOGICAL DATA IN THE CONTEXT OF CLIMATE VARIABILITY AND CHANGE
 - I.1 Analyzing historical hydrological and related information with respect to climate change
 - IAHS with co-operation of Unesco, WMO, ICSU and national institutions
 - 1983-90.
 - I.2 Analyzing long time series of hydrological data and indices with respect to climate variability
 - WMO in co-operation with Unesco and interested national bodies
 - 1983-87.
 - I.3 Glacier fluctuations
 - ICSI (IAHS) with the support of UNEP and Unesco
 - 1983-86.
 - I.4 Transfer of hydrological information of stations and basins to grid point or average grid area values
 - WMO in collaboration with national institutions and the Federal Republic of Germany
 - 1982-85.
- II. MODELLING OF HYDROLOGICAL CYCLE
 - II.1 Workshop on approaches to and possibilities for the coupling of physically based climate and hydrological models
 - WMO and ICSU
 - 1983, follow up 1984-87.
- III. APPLICATION OF CLIMATE INFORMATION TO HYDROLOGICAL FORECASTS IN THE OPERATION OF WATER-RESOURCE SYSTEMS
 - III.1 Application of climate information to hydrological forecasts for the Sahel
 - Coordinated by WMO with participation by countries of Sahel region, UNDP and FAO and support from institutions in other countries.
 - Ongoing to 1986.

III.2 Pilot study for application of climate information to hydrological forecasts in the operation of irrigation, hydropower and flood control systems in India

- National agencies, international input coordinated by WMO with participation of UNDP
- Time schedule to be coordinated with those of other projects under WCP-Water.

III.3 Application of positional climatological information to water supply forecasting in the U.S.A.

- National agencies
- 1982-90.

IV. STUDIES OF THE INFLUENCE OF CLIMATE VARIATIONS ON WATER RESOURCES

IV.1 Sensitivity of water-resource systems to climate variations

- WMO with contributions from Unesco, IIASA and IAHS
- 1982-87.

IV.2 Use of climate data and information for the study, planning and management of water resources

- Unesco with co-operation of WMO, UNEP, IIASA, IAHS and UATI
- 1984-89.

IV.3 Study of the impact of climate variability and change on the occurrence of droughts and catastrophic floods

- Unesco in co-operation with WMO and IAHS
- 1984-89.

IV.4 Study of impact of climate variability and change on the occurrence of floods in urban areas

- Unesco in co-operation with WMO, IAHS and UATI
- 1984-89.

V. IMPACT OF CLIMATE ON SOCIETY THROUGH WATER RESOURCES

(Relevant projects may be developed on the basis of the outcome of the meeting of UNEP Scientific Advisory Committee for WCIP in January 1983.)

VI. INFLUENCE OF MAN'S ACTIVITIES ON CLIMATE

(No projects proposed at this stage.)

ACTIVITY AREA I

STUDIES OF HYDROLOGICAL DATA IN THE CONTEXT OF

CLIMATE VARIABILITY AND CHANGE

An analysis of historical hydrological data and information and in particular of long hydrological time series should be undertaken in order to gain fuller knowledge of climate variability and a better understanding of the processes related to climate change.

Due to the close relationship between climate and hydrology, hydrological variables and the water resources are very strongly influenced by climate variations. With respect to these interactions, hydrological variables, such as surface runoff, can be considered as climate variables representing on a large scale the residual of precipitation and evaporation. In the past, hydrological data have not been used as much as they could as a basis for studying climate variability.

In addition, an inventory of water resources, their supply, demands and their dynamics, is needed to provide hydrological data:

- (a) to climate modellers for the validation of predictions;
- (b) to researchers studying climate change and variability;
- (c) for use in sensitivity studies; and
- (d) for the application to food, energy, economy and health problems.

One has to take into account the fact also that in the majority of developing countries elementary hydrological information is scarce and unreliable. For these regions appropriate transfer functions between climate, hydrological processes and water resources have to be derived and applied. The data are important as a basis for the establishment of relationships, therefore the hydrological inventory should be an essential part of the WCDP.

Project I.1 Analysing Historical Hydrological and related Information with respect to Climate Change

1. Background

Historical hydrological and related information concerning for example floods, low flow periods, river ice periods is available in many countries in the form of direct information stored in archives or in the form of indirect information such as proxy-data (i.e. ice core data, dendrochronological data, sediment probes, historical events tied to climatological or hydrological parameters, etc.). This material has been used for specific studies but could be more broadly used for improving the knowledge of temporal variations in hydrological regimes during past centuries. Such information would be useful for analysing climate change.

The methodologies to be used for such studies rarely exist but several bodies, including some working in the framework of the WCP, have undertaken research in these fields, However, there is seldom close co-ordination between the individual research studies.

2. Anticipated output

- (a) Improvement of methodologies and as far as possible unification of them;
- (b) Comparison of results using various approaches for specific climatological or hydrological parameters and for specific periods.

3. Mechanism for implementation

- (a) Round-table discussion at General Assembly of IUGG in Hamburg on topics (a) and (b) above;
- (b) Establishment of an ad hoc and temporary working group for liaison and to some extent co-ordination;
- (c) Workshop in 1987 for analysis of the first results.

4. Organizations/bodies involved

IAHS responsible with co-operation from Unesco, WMO, ICSU and other interested international bodies and national institutions.

5. Tentative time schedule

1983-1990.

6. Comments

This project involves the co-operation of many scientists from very different fields of research, It will begin in 1983 with a relatively small number of individual actions and will become operational only after several years, at which time the project will encompass most of the related action.

Liaison necessary with Project I.2.

Project I.2 Analysing Long Time Series of Hydrological Data and Indices with respect to Climate Variability

1. Background

In many countries long hydrological time series (precipitation, discharges, water levels of rivers, estuaries, lakes, sea, etc.) are available. From these hydrological variables and relevant meteorological variables (air, temperature, etc.) long series of hydrological parameters (annual mean, monthly mean, minimum values, excess for different time periods based on daily values, etc.) and indices (drought-index, etc.) can be obtained. This material should be used for improving knowledge of climate variability by being analysed in that respect, In some countries relevant investigations are currently being undertaken.

2. Anticipated output

Results in analysing such long time series may give more detailed information on the variability of climate in time and space. The results will contribute to a better understanding of the physical processes behind climate variability.

3. Mechanism for implementation

- (a) The round-table discussion in Hamburg referred to under 3(a) of Project I.1 could also aid in development of detailed plans for this project;
- (b) To make the results of such studies in different countries comparable with each other, it is necessary to develop a unified method and to propose guidelines for the use of existing statistical methods. Countries involved with studies analysing long time series in respect to climate variability should be asked for information on their methods and parameters used in such studies, An expert should be appointed to compile, in consultation with some other experts and on the basis of the information obtained recommendations on the use of existing statistical methods suitable for analysing long time series and on the kind of parameters or indices to be used. Related technology might be developed as a component of HOMS. Exchange of existing computer programmes should be considered;
- (c) Member States should be asked to analyse their long time series on the basis of the recommended statistical method;
- (d) Results of these studies should be sent to WMO for a compilation of the results obtained in different countries.

4. Organizations/bodies involved

The project will be executed by the WMO in co-operation with Unesco and with the participation of those countries which have available long hydrological time series.

5. Tentative time schedule Based on (a) to (d) under 3 above:

- (a) 1983
- (b) 1983-1984;
- (c) 1985-1986;
- (d) 1987.

6. Comments

An expert should be asked to review all material published on existing long time series. Countries should be asked for a completion of this information by a questionnaire on their existing long hydrological time series. Data for the studies mentioned should be on a daily or at least monthly basis. Minimum length of records should be about 80 years.

Project I.3 Glacier Fluctuations

1. Background

In some alpine countries, glacier fluctuations have been observed for many decades. Since 1960 glacier observations have been standardized on an international level and published on a five-year basis by the Permanent Service on the Fluctuations of Glaciers (PSFG).

Since 1976, the Temporary Technical Secretariat (TTS) for World Glacier Inventory has assembled national or regional glacier inventories using a computerized data system. This project will be completed by 1985. By then, a joint programme should have been developed. This new programme will combine the TTS and the PSFG. Reference glaciers will be chosen on the basis of the World Glacier Inventory and these glaciers will be monitored in detail (annual mass balance).

2. Anticipated output

- (a) Record of long-time series of glacier variations;
- (b) Monitoring climate variations in all glacierized regions on the basis of mass-balance studies of reference glaciers.

3. Mechanism for implementation

National correspondents (institutions) are invited to participate (these contacts exist already). A central secretariat is to be responsible for collection, publication and pilot studies.

4. Organizations/bodies involved

- (a) ICSI of IAHS with the support of UNEP and Unesco;
- (b) Some institution to furnish the infrastructure of the secretariat (e.g. free use of computer);
- (c) National institutions as correspondents.

5. Tentative time schedule

1983 draft of joint programme PSFG plus TTS
1984 final proposal on new programme
1985 completion of the World Glacier Inventory
1983-1985 TTS to select reference glaciers in collaboration with national correspondents
1986 start of new programme

6. Comments

The activity of the PSFG, suspended after the death of its director, Professor F. Muller, has to be resumed. Means must be found to publish Volume IV of PSFG's "Variations of Glaciers".

Project I.4 Transfer of Hydrological Information of Stations and Basins to Grid Point or Average Grid Area Values

1. Background

General circulation and hydrological models depend on grid values for their parameter inputs. However, station networks and basins are congruent neither to the systematic meshes nor to the heterogeneity of topography, soils, vegetation, etc. This makes it difficult to transform the observed data to the needed forms. The hydrological information must be condensed to grid values on the mesh-width of the models. The methodologies have to be developed and global data sets have to be prepared for the averages and the corresponding real-time operational systems have to be organized.

2. Anticipated output

Methodologies for the transfer of hydrological information from station or basin values to grid point and grid area values. Global hydrological data sets or grid point and grid area bases.

3. Mechanism for implementation

Development of methodology by consultant and review by meeting of experts prior to pilot application.

4. Organizations/bodies involved

WMO in collaboration with national hydrological services and institutes in the Federal Republic of Germany.

5. Tentative time schedule

Development of methodology 1982-83, meeting of experts 1983, pilot application 1983-1985.

ACTIVITY AREA II

MODELLING OF THE HYDROLOGICAL CYCLE

The quantitative coupling of climate, hydrology and water resources can best be achieved within the framework of mathematical models of the hydrological cycle. In principle the types of such models cover a very wide spectrum, ranging from empirical relationships to causal (i.e. physically based) formulations, both subject to greatly varying levels of sophistication and scales in time and space. There is, or should be, no conflict between empirical and causal approaches in the sense that a correct empirical relation cannot be contradicted by the result of a correct causal model; there is, however, a definitive hierarchical relationship between these: the empirical model mostly states the observed facts, while a causal model attempts to explain why they take on the observed states and forms.

The explanatory power of causal models makes them especially attractive to the WCP-Water because it implies the potential of making inferences about events (and their impacts) which are beyond the range of past observations, as well as about the consequences of man's interference in the natural processes involved.

Thus, while recognizing the legitimacy of many categories of models, special emphasis should be put on those which are based on the dynamics of the physical processes involved including the feedbacks between the processes traditionally treated independently of each other. The inclusion of such feedbacks will call for innovative approaches, re-examination of the traditional dividing lines, and may even lead to partial restructuring of the education of climatologists, meteorologists, hydrologists and water-resource specialists, with the aim of providing them with a broader basis of common background.

Project II.1 Workshop on Approaches to and Possibilities for the Coupling of Physically Based Climate and Hydrological Models

1. Background

It is considered that the further development and improvement of physical-mathematical models of the atmosphere would gain greatly from a better understanding of the effect on climate of hydrological processes and an upgrading of the manner in which such processes are incorporated into global climate circulation models.

2. Anticipated output

Discussion and outline of practical ways for bringing together results of physical climate and hydrological modelling in order to accommodate the physical relationships (feedbacks) which are mostly being neglected in the current practice of modelling.

3. Mechanism for implementation

A workshop, of about one week's duration, with attendance limited to scientists and professionals actively working in physically based climate and hydrological modelling. The objective would be to propose specific research projects and approaches that seem promising for coupling physically based climate and hydrological models. Informal discussions might be held on the subject in Hamburg in August 1983 during the IUGG General Assembly as a basis for planning the workshop.

4. Organizations/bodies involved

International organizations with WMO as lead agency in co-operation with

5. Tentative time schedule

Informal discussion mid-1983, workshop late 1983, follow-up action, possibly under WCRP, 1984-1987.

ACTIVITY AREA III

APPLICATION OF CLIMATE INFORMATION TO HYDROLOGICAL FORECASTS

IN THE OPERATION OF WATER-RESOURCE SYSTEMS

Long-range weather outlooks for periods of one to three months are being prepared, but improved methods of formulation and application of climate information are needed to be of significant value in the operation of water-resource systems. Also, improvements in the forecasting technology would be desirable not only for the short term but also for the long term, extending beyond one year. Because of uncertainty in the forecasts, water-resource applications will need to take a probabilistic approach and future enhancements to climate forecast technology should explore the types of probabilistic methods that could be applied in practice,

The results of this activity should include:

- Improved methods for using climate information in hydrological forecasting for monthly and seasonal periods
- Methods for applying climate information in water-resource management
- Evidence of the value of weather and climate information in the operation of water-resource systems.

Project III.1 Application of Climate Information to Hydrological Forecasts for the Sahel

1. Background

Extended forecasts, beyond the anticipated development of synoptic situations, find their basis in the study of variability of climate on a monthly or seasonal basis. Forecasts over a period varying from one to three months have practical applications in the assessment of possible flood magnitudes and drought severities. They also meet the essential requirements of rain-fed agriculture, in the operation of seasonal storage reservoirs and in the management of water supply and other undertakings dependent upon natural streamflow and lake conditions.

The forecasts are evidently the more necessary in those areas which experience considerable interannual variations in monthly and seasonal expectations. Whilst compounding the problem of formulating forecasts, it is considered to be in a region such as the Sahel that a particular study should be undertaken, especially in view of the serious threat to the region of desertification which is linked so closely to the management of water and land resources.

2. Anticipated output

Utilising the available synoptic, agrometeorological, climatological and hydrological data base in the Sahel, the project will provide the potential for:

- (a) producing forecasts of water-resource availability for short-term periods; and
- (b) practical application of such forecasts for rational management and conservation of water resources;
- (c) development of a mathematical model of the land and water environment that will predict the effects of various management policies and of potential climate changes in the Sahel.

3. Mechanism for implementation

The AGRHYMET Centre, Niamey provides an appropriate infrastructure, including the necessary data base and computer facilities. The activity would be a logical extension of an existing responsibility to undertake climate monitoring in the Sahel region.

4. Organizations/bodies involved

The project will be coordinated by WMO with the participation of the countries of the Sahelian region, UNDP and FAO; support from research and operational agencies in developed countries would be sought, in particular as regards output (c) where considerable expertise exists for such work, for example in the U.S.A.

5. Tentative time schedule

Ongoing project with target of achieving full operational status in 1986,

6. Comments

This project will be conducted in close co-operation with ORSTOM, Hydra Niger, ASECNA and is closely related with projects II.2, II.3 and II.4, Liaison to be ensured with activities and follow-up to MONEX for linkage between climate and the sea-surface temperature of the South Atlantic Ocean.

Project III.2 Pilot Study for Application of Climate Information to Hydrological Forecasts in the Operation of Irrigation, Hydropower and Flood Control Systems in India

1. Background

To aid in the improved use of water for specific purposes, accurate forecasts of water volumes with progressive updating at frequent intervals would be required. Models and/or methodologies developed for such forecasts, using climate information, could be tested and evaluated on a pilot study basis in the Yamuna River Basin, India, or any appropriate river basin in the neighbouring region which qualifies from considerations of data availability and status of water-resource development. This would be one of a number of such projects which could be undertaken.

2. Anticipated output

Using only the hydrological data available in the study area, operating plans will be produced to optimize the use of water for specified purposes. Also, using the climate data available as inputs to climate models and/or methodologies, runoff will be estimated and operating plans prepared. The two operations will be compared and the models and/or methodologies evaluated.

3. Mechanism for implementation

Implementation will be accomplished by national agencies (central and state) with consultant support from international organizations. Once the models/methodologies have been developed some training in their use will be required.

4. Organization/bodies involved

In addition to the national agencies, international input to the project will be coordinated by WMO with the participation of UNDP.

5. Tentative time schedule

The project will be initiated and scheduled in co-ordination with other projects under WCP-Water.

6. Comments

Such pilot projects, if undertaken in different regions of the world, would help provide a global understanding of the potential on the application of climate information in hydrologic forecasts for improved use of water resources. Liaison to be ensured with activities as follow-up to MONEX for linkage between climate and the sea-surface temperature of the Indian Ocean.

Project III.3 Application of Positional Climatological Information to Water Supply Forecasting in the United States of America

1. Background

Monthly weather outlooks are made by the U.S. National Weather Service's Climate Analysis Centre. This can lead to a positional* or conditional climatology appropriate to the present state of the climate system. This climatology, together with current and historical time series of hydrometeorological data, can then be used as input to hydrological models to produce an ensemble of possible future streamflow hydrography which can then be analysed in a statistical sense to produce probabilistic Extended Streamflow Predictions (ESP's) for specified time periods in the future. The NWS's Office of Hydrology and related components will produce such forecasts for selected basins and these will be evaluated from the standpoint of their usefulness for water managers who must make decisions on possible operational alternatives for various water-resource systems.

2. Anticipated output

- (a) Prototype for the potential application of climate information in water-resource management;
- (b) Evaluation of improved skill achieved in Extended Streamflow Predictions for monthly and seasonal time periods through the incorporation of positional climatological information;
- (c) Initial formulation of objective procedures for incorporating positional climatological information into hydrologic forecasting methodology to produce probabilistic Extended Streamflow Predictions;
- (d) Report describing results of project, including procedural recommendations and recommendations for future development and research.

3. Mechanism for implementation

The procedures will be implemented in the U.S.A. for selected basins through co-operation between the US National Weather Service and local water authorities who potentially will apply the Extended Streamflow Predictions as inputs to their waterresource operations.

4. Organizations/bodies involved

The principal organization involved in this project will be the US National Weather Service in co-operation with other water and climatological organizations in the U.S.A.

*Positional climatology in this context is that climatological information which allows one to position or weight historical time series of hydrometeorological data in relation to current weather patterns so that they may be used in hydrologic simulations leading to probabilistic Extended Streamflow Predictions.

5. Tentative time schedule

- (a) Development of Data Base of Positional Climatological Information - ongoing;
- (b) Development of initial hydrological prediction procedures incorporating climatological positional information - 1982-1985;
- (c) Implementation of procedures for selected basins - 1985-1987;
- (d) Evaluation of improved skill achieved in probabilistic ESP with incorporation of positional climatological information - 1987-1988;
- (e) Refinement and revision of techniques, and final testing;
- (f) Prepare final report - 1990.

6. Comments

This project will be conducted in close co-operation with other projects under Activity Area III, which are being coordinated internationally by the WMO.

ACTIVITY AREA IV

STUDIES OF THE INFLUENCE OF CLIMATE VARIATIONS ON WATER RESOURCES

The projects under this activity field are divided into three groups each prompted by a major observation about climate's impact on water resources.

Perhaps the most important outcome of any study in this area is a statement of the effect on water-resource decision variables of changes (real or hypothetical) in climate inputs. This activity therefore includes all sensitivity analyses, whether on hydrological variables or on water-resource decision variables.

The second class of projects is inspired by the recent altered perspective on climate, i.e. that it is in continual motion. In reality the scale and direction of this motion is entirely determined by physical forces in the atmosphere, ocean, at the land surface and even astronomic factors. For convenience these motions are thought of as fluctuations about a local average value which in turn may fluctuate, vacillate irregularly, or even behave in a sinusoidal fashion. Movements which occur over a time scale of, say, 30 to 80 years are of particular importance as these are the planning horizons for current human activity in water-resource projects. Movements which occur over a 10-30 year time scale are important in that this is often the order of duration of our data base on which the scheme is designed, Within this time scale we conventionally ignore the possibility that part of the variation is due to movement and we tend to assign the total variability to the single causes of local fluctuation about a locally stable average value.

The final premise on which the projects in this activity field are founded is the idea that there is a distinction between hydrological variables (such as aquifer level, runoff volume, flood frequency distribution), and water-resource decision variables (such as reservoir volume, hundred year flood, crop water use). In some cases the difference is slight, but in general it can be stated that hydrological variables are directly measured or derived from measurements with little intervention, Water-resource decision variables tend to be derived quantities somewhat remote from the basic measurements. Thus it is often the case that the relationship is sufficiently obscured so that one cannot simply estimate the effect of an alteration in the governing hydrological variables on the dreived water-resource variable,

The projects under this activity therefore lie within the following three areas:

- (i) sensitivity analyses of water-resource projects to climate change
- (ii) statistical considerations relating to the possible difference between the climate in the design data period and the planning period
- (iii) transfer functions between water-resource decision variables and the primary hydrological variables.

Project IV.1 Sensitivity of Water-Resource Systems to Climate Variations

1. Background

Hydrologists, water-resource planners and managers are increasingly alerted to the differences in the properties of climate and hydrological quantities as measured over different time periods. This realization, and the need to take action, exist independently of whether the differences are the product of sampling variability or intrinsic non-stationarity due to climate change. The problem is especially acute in arid and semi-arid regions where variability (e.g. in annual runoff) is already high so that stable estimates of design quantities are difficult to achieve but where the need for water-resource schemes to compensate for the uncertainty and shortages of supplies is most vital.

2. Anticipated output

- (a) The enhancement of our understanding of the origin of interannual and seasonal variability and the persistence properties of salient hydrological variables;
- (b) An increase in our application of the performance of different hydrological modelling techniques in replicating the response to climate inputs;
- (c) Estimates of the sensitivity of hydrological outputs due to hypothetical changes in climate inputs;
- (d) Estimates of the sensitivity of water-resource outputs (e.g. the reliability of a reservoir or the value of the 100-year return period flood) to changes in the hydrological input series,

3. Mechanism for implementation

It is felt that the larger part of the effort should be devoted to the problem of hydrological output change expressed as a function of a given change in climate input (mainly precipitation) large basins which illustrate different rainfall and temperature regimes should be selected, a bias to be encouraged to the conditions found in the least developed countries. All forms of modelling and approaches should be encouraged ranging from simple water and energy balance formulations to conceptual models. Full use should be made of regional analogues which expose possible differences that may occur in time by reference to catchments which already experience the altered climate regime.

A sizeable minority of the effort should go further to trace the effect of hydrological changes through to water-resource decisions by either using the previous hydrological outputs as inputs to, for example, an irrigation or water supply project. This may be done directly or by making use of suitably standardized storage yield or flood frequency diagrams.

As a general rule it is felt that the source of the difference will not affect the result. However, if severe climate change is postulated then consideration needs to be given to possible consequences to the model structure or] parameters (e.g. size of storages and the soil moisture deficit versus evapotranspiration relationship) as well as to the climate input series. Also realistically linked assumptions about changes to climate inputs parallel to precipitation such as temperature, wind and radiation should be made in order to complete the picture of change on the demand side as well as on the supply side.

Researchers in the field will need to be sensitive to the type of hydrological data that water-resource system design requires, e.g. streamflow time series, flood peaks, storage yield. They will need to talk to climatological colleagues to know they are not transgressing known climate interrelationship that must operate even after a change,

4. Organizations/bodies involved

University or institutional research at the national level.

WMO with contributions from Unesco, IIASA and IAHS.

5. Tentative time schedule

Workshop within two to three years; conference topic much later.

6. Comments

See Nemeč and Schaake (1982) for example of use of conceptual model to study rainfall runoff sensitivity; Beran (1981) for example of use of storage yield and flood frequency diagrams to answer sensitivity of return period of designs to altered hydrological inputs. Schwartz (1977) for list of water-resource variables and speculations about climate change impact. Standard water-resource economics and decision theory texts for suggestions for a formal framework for inclusion of statistical uncertainty.

References

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- Beran, M. "Climate change and variability - new problems for water-resources and hydrology", presented at International Conference on Hydrology and to Scientific Bases for the National Management of Water Resources, Paris, August, 1981. To be published by Unesco.
- Nemeč, J. and J. Schaake. "Sensitivity of water-resource systems to climate variation", *Hydrological Sciences Journal*, Volume 27, IAHS, 1982.

Project IV.2 Use of Climate Data and Information for the Study, Planning and Management of Water Resources

1. Background

The relationship between climate and the water-resource system on the earth is unique in the sense that parts of the hydrological cycle, namely precipitation and evaporation, are simultaneously inherent parts of the climate and are important characteristics of it. The hydrological cycle is in turn the very basis of availability of water resources. It is possible to consider hydrological processes as a transfer function from the climate system to the water resource system and vice versa, the function being under different circumstances part of either one of the two systems, With the increasing use of water resources the vulnerability of society with regard to fluctuations in supply due to climatic variability is likely to increase. It is, therefore, important to promote more and better use of climate information by hydrologists in order to improve the design of water projects, the use of existing knowledge on climate variability to determine the impact it may have on water availability, water resources systems and through these on society under different conditions.

2. Anticipated outputs

- (a) Promotion of national studies that integrate climatologists, hydrologists, water-resource systems specialists and decision makers;
- (b) Compilation and review of existing information on the sensitivity of water-resource systems to climate variation the transfer functions between hydrological variables and water-resource decision variables and the relative vulnerability of different types of systems in different circumstances with regard to climate variability and change.

This review is primarily meant for information of hydrologists, water-resource systems specialists and decision-makers;

- (c) Introduction of climatology into curricula for the training of water-scientists.

3. Mechanism for implementation

IHP, National Committees for the IHP. The exact method of execution to be decided by the Intergovernmental Council for the IHP.

4. Organizations/bodies involved

Unesco with co-operation of WMO, UNEP, IIASA, IAHS and UATI.

5. Tentative time schedule

1984-1989.

Project IV.3 Study of the Impact of Climate Variability and Change on the Occurrence of Droughts and Catastrophic Floods

1. Background

There is a need to provide hydrologists with advice on how to make better use of climatological and meteorological information in order to enable them to better understand the occurrence of droughts and floods, including associated climate dependant events such as teleconnections and effects of sea-surface temperature. The aim is to improve related risk assessment and planning for the prevention and mitigation of the consequences of the natural hazards concerned.

2. Anticipated output

- (a) Promotion of national studies;
- (b) Convening of a symposium under IHP-III;
- (c) A publication for self-study and use in post-graduate courses.

3. Mechanism for implementation

Through the IHP, the exact method of execution to be determined by the Intergovernmental Council of the IHP.

4. Organizations/bodies involved

Unesco in co-operation with WMO and IAHS.

5. Tentative time schedule

1984-1989.

Project IV.4 Study of Impact of Climate Variability and Change in the Occurrence of Floods in Urban Areas

1. Background

Current design practice for urban drainage systems takes no account of possible climate change due to the effects on climate of the urban area. There is evidence of changes in rainfall rates and the incidence of heavy rainstorms which can cause more severe flood problems than hitherto

2. Anticipated output

Improved awareness amongst urban designers of possible greater vulnerability of current drainage systems to floods and the development of design modifications to overcome the hazard.

3. Mechanisms for implementation

Through the IHP, the exact method of execution to be determined by the Intergovernmental Council of the IHP.

4. Organizations/bodies involved

Unesco in co-operation with WMO, IAHS and UATI.

5. Tentative time schedule

1984-1989.

6. Comments

Liaison should be established with the WMO programme of activities in urban climatology.

ACTIVITY AREA V

IMPACT OF CLIMATE ON SOCIETY

THROUGH WATER RESOURCES

The impact of climate on society through water resources can be considered on several levels.

One is a simple statement of the type of impact that a climate change or variation has on the population of a given region either directly, through significant changes in hydrological characteristics, or indirectly through the projection of these water-regime changes into other areas of vital societal importance such as food, energy and health. It should be noted that the final impact might be positive or negative, not only as a function of the climate change or variation itself but also as a consequence of the effect of the change in hydrological characteristics on societal interests. For example, flooding in moderation can be beneficial to some societies and reduced variability in streamflow could be detrimental.

A higher level involves the study of the adaptability of the given population to such impacts. For example with regard to the impact of droughts and floods, two major hypotheses have been posed (Warrick, 1980; Sugawara, 1978). The first states that persistent and adaptive societies, through their technological and social organization, lessen the impacts upon the resident population of frequent climate fluctuations or climate related events. The second hypothesis states that success in insulating a society from relatively frequent events of climate origin, where the society is becoming increasingly complex both socially and technically, will increase the vulnerability of such a society to natural (climate-related) as well as to social perturbations that occur much less frequently.

ACTIVITY AREA VI

INFLUENCE OF MAN'S ACTIVITIES ON CLIMATE

There is much interest in both scientific and more general circles as to whether man's activities are influencing or will influence the climate. It is proposed that such an influence might be exerted through changes in the hydrological regime. If such a proposition is to be seriously studied, there is need for an improvement of the representation of the climate forcing functions in the modelling of the hydrological cycle under man's intervention. Results of such studies would help to separate man-made changes in the hydrological cycle from natural variability and would also help to reconstruct non-influenced conditions.

LIST OF ABBREVIATIONS

AGRHYMET	Applications in Agrometeorology and Operational Hydrology (Programme for the Sahelion countries)
ASECNA	Agency for Air Safety in Africa and Madagascar
ESP	Extended Streamflow Prediction
ETH	Eidgenbssische Technische Hochschule
FAO	Food and Agriculture Organization of the United Nations
FGGE	First GARP Global Experiment
GARP	Global Atmospheric Research Programme (WMO/ICSU)
IAHS	International Association of Hydrological Sciences
IAMAP	International Association of Meteorology and Atmospheric Physics
IAPSO	International Association of Physical Sciences of the Ocean
ICSI	International Commission on Snow and Ice
ICSU	International Council of Scientific Unions
IHP	International Hydrological Programme (of Unesco)
IIASA	International Institute for Applied Systems Analysis
IUGG	International Union of Geodesy and Geophysics
MONEX	Asian Monsoon Experiment (a regional component of FGGE)
NWS	National Weather Service (of U.S.A.)
ORSTOM	Organization de la Recherche Scientifique et Technique Outre-Mer (of France)
PSFG	Permanent Service on the Fluctuations of Glaciers
SAC	Scientific Advisory Committee (of UNEP)
SWMTEP	System-Wide Medium Term Environment Programme
TTS/WGI	Temporary Technical Secretariat for World Glacier Inventory
UATI	Union of International Engineering Organizations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
Unesco	United Nations Educational, Scientific and Cultural Organization
WCAP	World Climate Applications Programme
WCDP	World Climate Data Programme
WCIP	World Climate Impact Studies Programme
WCP	World Climate Programme
WCRP	World Climate Research Programme
WMO	World Meteorological Organization

REPORTS PUBLISHED IN THE WORLD CLIMATE PROGRAMME SERIES

- WCP - 1 INFORMAL PLANNING MEETING ON '40RLD CLIMATE PROGRAMME (FOOD) (GENEVA, 10-14 NOVEMBER 1980)
- WCP - 2 PRELIMINARY PLAN FOR THE WORLD CLIMATE RESEARCH PROGRAMME (GENEVA, JANUARY 1981)
- WCP - 3 JOINT WMO/ICSU/UNEP MEETING OF EXPERTS ON THE ASSESSMENT OF THE ROLE OF CO₂ ON CLIMATE VARIATIONS AND THEIR IMPACT (VILLACH, AUSTRIA, NOVEMBER 1980)
- WCP - 4 CONFERENCE STATEMENT AND PANEL REPORTS OF THE TECHNICAL CONFERENCE ON CLIMATE FOR ASIA AND THE WESTERN PACIFIC (GUANGZHOU, CHINA, 15-20 DECEMBER 1980) (out of print: has been incorporated into the Report of the Conference which has been published as WMO Publication No. 578)
- WCP - 5 INFORMAL PLANNING MEETING ON WORLD CLIMATE PROGRAMME - WATER (GENEVA, 2-6 FEBRUARY 1981)
- WCP - 6 THE INTERNATIONAL SATELLITE CLOUD, CLIMATOLOGY PROJECT (GENEVA, JANUARY 1981) (out of print)
- WCP - 7 REPORT OF THE THIRD MEETING OF THE JSC WORKING GROUP ON HYDROLOGY AND LAND SURFACE PROCESSES (COLLEGE PARK, MARYLAND, USA, 10 JANUARY 1981)
- WCP - 8 REPORT OF THE MEETING ON THE COORDINATION OF PLANS FOR FUTURE SATELLITE OBSERVING SYSTEMS AND OCEAN EXPERIMENTS TO BE ORGANIZED WITHIN THE WCRP (CHILTON, U.K., 26-31 JANUARY 1981)
- WCP - 9 SUMMARY REPORT OF THE INFORMAL PLANNING MEETING ON THE WEST AFRICAN DATA BANK (GENEVA, 25-27 FEBRUARY 1981)
- WCP - 10 MEETING OF SELECTED EXPERTS ON CLIMATE-RELATED MONITORING (GENEVA, 21-24 APRIL 1981)
- WCP - 11 JSC/CCCO MEETING ON TIME SERIES OF OCEAN MEASUREMENTS (TOKYO, 11-15 MAY 1981)
- WCP - 12 MEETING OF JSC EXPERTS ON AEROSOLS AND CLIMATE (GENEVA, 27-31 OCTOBER 1980)
- WCP - 13 PLAN FOR WCP DEMONSTRATION PROJECTS - FOOD, ARISING FROM INFORMAL FAO/WMO MEETING OF EXPERTS (GENEVA, 27-31 JULY 1981)
- WCP - 14 PAPERS PRESENTED AT THE WMO/ICSU/UNEP SCIENTIFIC CONFERENCE ON ANALYSIS AND INTERPRETATION OF ATMOSPHERIC CO₂ DATA (BERN, 14-18 SEPTEMBER 1981)
- WCP - 15 REPORT OF THE INFORMAL PLANNING MEETING ON WCP DATA REFERRAL SYSTEM (GENEVA, 28 SEPTEMBER - 2 OCTOBER 1981)

- WCP 16 REPORT OF THE INFORMAL PLANNING MEETING ON WCP ENERGY (ROSKILDE, 1-3 DECEMBER 1981)
- WCP - 17 REPORT OF THE WCP DATA MANAGEMENT MEETING (GENEVA, 16-20 NOVEMBER 1981)
- WCP - 18 EXTENDED CLOUDS AND RADIATION, BY C.M.R. PLATT, AUSTRALIA. A REPORT COMPILED FOR THE INTERNATIONAL RADIATION COMMISSION AND PRESENTED AT IAMAP (HAMBURG, AUGUST 1981) (out of print)
- WCP - 19 PLANNING GUIDANCE FOR THE WORLD CLIMATE DATA SYSTEM, BY R.L. JENNE (USA, FEBRUARY 1982)
- WCP - 20 THE INTERNATIONAL SATELLITE CLOUD CLIMATOLOGY PROJECT (ISCCP) PRELIMINARY IMPLEMENTATION PLAN (APRIL 1982)
- WCP - 21 PAPERS PRESENTED AT THE JSC/CCCO MEETING ON TIME SERIES OF OCEAN MEASUREMENTS (TOKYO, 11-15 MAY 1981)
- IAICP - 22 REPORT OF THE JSC/CCCO "CAGE" EXPERIMENT: A FEASIBILITY STUDY (MAY 1982)
- WCP - 23 REPORT OF THE SECOND INFORMAL PLANNING MEETING ON THE WEST AFRICAN DATA BANK (GENEVA, 19-23 APRIL 1982) (also available in French)
- WCP - 24 FORMATS AND QUALITY CONTROL OF CLIMATOLOGICAL DATA FOR WEST AFRICA (also available in French)
- WCP - 25 OPTIMAL CLIMATE DATA UTILIZATION: A CLIMATIC DATA ACQUISITION, ARCHIVING, PROCESSING AND DISSEMINATION SYSTEM FOR RESOURCE MANAGEMENT. Prepared by Amos Eddy, Oklahoma Climatological Survey, September 1982.
- WCP - 26 REPORT OF THE WMO/CAS-JSC-CCCO MEETING OF EXPERTS ON THE ROLE OF SEA ICE IN CLIMATIC VARIATIONS (GENEVA, 24-29 JUNE 1982)
- WCP - 27 REPORT OF THE PLANNING MEETING FOR THE MONSOON CLIMATE PROGRAMME (GENEVA, 28 JUNE - 1 JULY 1982)
- WCP - 28 REPORT OF 'THE PLANNING MEETING ON INTERNATIONAL SATELLITE CLOUD CLIMATOLOGY PROJECT (ISCCP) (GENEVA, 9-12 AUGUST 1982)
- WCP - 29 REPORT OF THE JSC/CAS MEETING OF EXPERTS ON DETECTION OF POSSIBLE CLIMATIC CHANGE, MOSCOW 3-6 OCTOBER 1982
- WCP - 30 CLIMATE / ENERGY GRAPHICS: CLIMATE DATA APPLICATIONS IN ARCHITECTURE. By Vivian Loftness, Institute of Building Sciences in Carnegie-Mellon University, Pittsburgh, Pa, September 1982
- WCP - 31 GUIDELINES ON CLIMATE DATA ORGANIZATION AND FORMATS (PREPARED BY THE INTER-COMMISSION MEETING ON CLIMATE DATA ARCHIVING FORMATS; GENEVA, 20-24 SEPTEMBER 1982) (In preparation]

- WCP - 32 FIRST CO-ORDINATION MEETING OF REGIONAL SOUTH EAST ASIAN CLIMATE DATA MANAGEMENT AND USER SERVICES (BANGKOK, 29 NOVEMBER 3 DECEMBER 1982) [In preparation]
- WCP - 33 BIBLIOGRAPHY ON HEAT RELEASES. By D. Schneiter, January 1983 [In preparation]
- WCP - 34 CLOUD/RADIATION INTERACTION (SCIENTIFIC PAPERS PRESENTED AT JSC-III, DUBLIN, MARCH 1982)
- WCP - 35 THE INTERNATIONAL SATELLITE CLOUD CLIMATOLOGY PROJECT (ISCCP) PRELIMINARY IMPLEMENTATION PLAN (REVISION 1, NOVEMBER 1982) [In preparation]
- WCP - 36 SECOND PLANNING MEETING ON WORLD CLIMATE PROGRAMME - WATER (PARIS, NOVEMBER 1982)