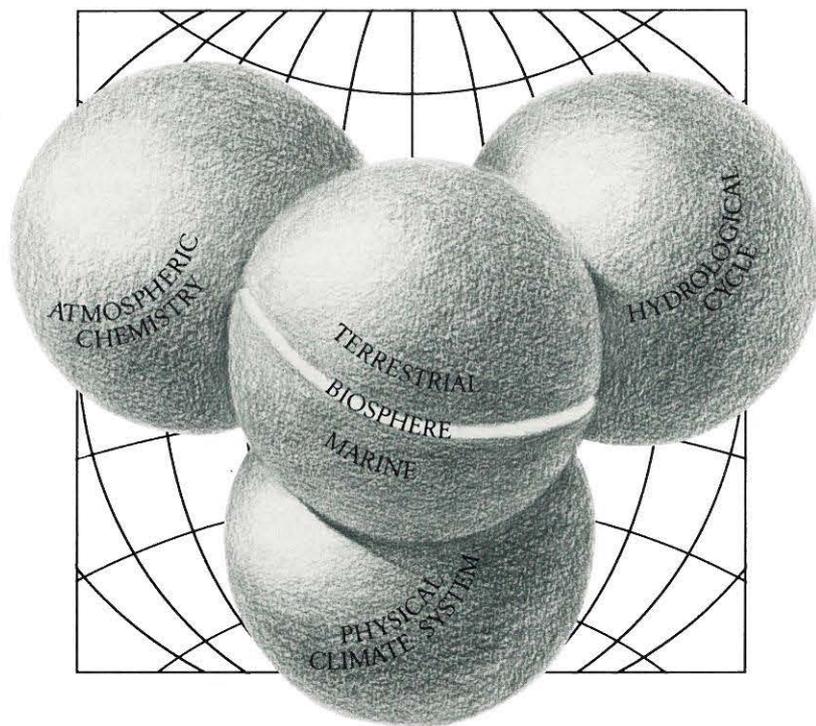


GLOBAL I G B P CHANGE

REPORT No. 7:1



The International Geosphere-Biosphere Programme: A Study of Global Change (IGBP)

A Report from the First Meeting of
the Scientific Advisory Council for the IGBP

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held at The Royal Swedish Academy of Sciences
Stockholm, Sweden
24–28 October, 1988

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FOREWORD

The Special Committee for the IGBP met for the first time in Paris at ICSU Headquarters in July 1987, with the charge from ICSU to plan the International Geosphere-Biosphere Programme: A Study of Global Change. During the next thirteen months the SC-IGBP developed "A Plan for Action" (IGBP Report No. 4), which was published in August 1988. This document outlines the priorities for a global, international research programme to be conducted in the 1990s and beyond.

In developing an international programme of such a magnitude and complexity, it is essential that the Special Committee for the IGBP, charged with programme formulation, has excellent communication links to the international scientific community. During the preparation of the "Plan for Action" report, the SC-IGBP arranged 11 international planning meetings with participation of more than 200 scientists. Close contacts were also developed with a number of other ICSU bodies, UN organizations and other international research efforts.

In order to allow for a scientific assessment of the scientific priorities suggested by the SC-IGBP, the IGBP Constitution calls for the convening of an IGBP Scientific Advisory Council. The SAC-IGBP "shall advise on the scientific contents of the Programme, assess its results and make recommendations for the general policies of the Special Committee". The First Meeting of the IGBP Scientific Advisory Committee was held at the Royal Swedish Academy of Sciences from 24 to 28 October 1988. The meeting was attended by 174 participants representing 37 countries, 34 ICSU bodies and 16 other organizations. This IGBP Report No. 7, which is published in two parts, represents the report from that meeting and will serve as an important document for the preparation of detailed plans for the implementation phase of the IGBP.

The Second Meeting of the SAC-IGBP will be held in Paris 3-7 September 1990 and a report describing the details of IGBP research projects and implementation strategies will be ready for distribution in June 1990. The world scientific community is faced with a tremendous challenge in developing a strong IGBP and the SC-IGBP will call on a large number of individual scientists as well as national and international organizations to help in this work.

Stockholm May 1989

Thomas Rosswall
Executive Director, IGBP

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**First Meeting of the Scientific Advisory Council
of the ICSU International Geosphere-Biosphere Programme:
A Study of Global Change**

at the Royal Swedish Academy of Sciences
Stockholm, 24-28 October, 1988

SUMMARY REPORT

The IGBP Scientific Advisory Council, SAC, held its first meeting in Stockholm, 24-28 October, 1988 to consider in detail the "Plan for Action" of the Special Committee for the IGBP (SC-IGBP) Report No.4, (August 1988). The Council also considered the various reports that were submitted to the first meeting of the SAC from ICSU Bodies and Associates, from various National Committees for the IGBP, and from organizations outside of ICSU. The SC-IGBP will study these reports in detail at ensuing meetings of the SAC to derive recommendations for its general policies, in accordance with the IGBP Constitution.

During the two years that have elapsed since ICSU decided to launch the Global Change Programme it has become ever more obvious that a joint international effort of the kind that is being considered is of fundamental importance for the future habitability of the planet. It will document changes of world concern in the global environment, both as these occur in real time and as they have transpired in the past. To many, the IGBP is now seen as an essential element in making prudent plans for managing the common natural resources of the Earth, as recognized in the United Nations Report "Our Common Future, A Plan for Sustainable Development" and the resolution adopted by the U.N. General Assembly in 1987. A Global Change Programme directed at a better understanding of the Earth system will reduce the uncertainty in analyses and predictions of how the environment will be altered in the future and, through this understanding, can lead to more prudent policy decisions on the part of all the governments of the world.

General Conclusions

1. The Council reaffirmed the programme focus and general scientific priorities that formed the basis for the ICSU decision, in 1986 to undertake the IGBP. Moreover, it found the general plan outlined in Report No.4 to be basically sound and appropriate as the basis for more detailed development of programme components in the future. During this first meeting, the Council examined many of the features of the plan and provided specific recommendations and advice concerning virtually all elements of the plan. These are included as working group reports.
2. The Council noted that the concept of predictability is currently not applied with equal confidence among the disciplinary components of the planned programme. Moreover, application of predictability becomes more uncertain as disciplinary studies are combined in new ways. Since some measures of the eventual success of the programme will be based on the improvement of predictability, attention must be given to a more rigorous definition of predictability and its application in a programme of this complexity.
3. Success of the programme will depend on collaboration among disciplines to study global processes, but also on the development of new approaches and techniques within disciplines. As an example, historical and prehistorical data derived from natural archives will be used to document past global conditions and as tests for models. In addition, techniques for extracting environmental data of the past will of necessity be made more quantitative.
4. Development of the IGBP will demand a thoughtful balance between an organizational structure to support interdisciplinary research at the global scale and the need to foster new creative ideas that will arise from single investigators and teams of researchers.

5. There is an apparent paradox between the need for a bounded research programme and the need to understand global processes. Resolution of this paradox requires that the programme be defined to address issues which meet the priority criteria laid out in the original charge: "those areas of each of the fields involved that deal with key interactions and significant change on time scales of decades to centuries, that most affect the biosphere, that are most susceptible to human perturbation, and that will most likely lead to practical, predictive capability." Toward this end, the SC-IGBP must resist the inevitable pressure to broaden the programme beyond what can be done and done well in these areas. The Council affirmed the selection of the general research areas named in the four coordinating panels and four working groups as appropriate first steps in the iterative process of programme definition and recommended that further refinement continue, including the establishment of realistic goals in all areas.

6. Although the IGBP is a new and unprecedented endeavour, its success depends on close collaboration with many related scientific programmes. These collaborative connections must be explicitly identified and delineated as the IGBP develops and as funding strategies are put in place.

7. The ultimate success of the IGBP will depend upon the imagination and dedication of top-flight scientific talent and also on the availability of adequate resources. As much attention must be paid to organizing financial support as is paid to organizing experiments. The Council recognized the need to establish a mechanism for coordinating the financial support of the programme, including the means through which participating nations will commit resources to joint efforts. Toward this end it expected that specific proposals be made for consideration at the second meeting of the Scientific Advisory Council in mid-1990. Some preliminary considerations were developed in the course of the SAC meeting by one of the working groups.

8. From its inception, the IGBP has recognized the importance of the human dimensions of global change. At the same time the programme has also recognized the practical need to focus on a limited set of central interactions that fall within the traditional disciplinary expertise of ICSU. Towards this end the Council affirmed the decision of the SC-IGBP to encourage studies of the human dimensions of global change in close communication with the social sciences and with endeavours now underway in this area. To accomplish this the SAC recommended (a) that a new staff position reflecting the human dimensions be established in the IGBP secretariat in Stockholm; (b) that Scientific Steering Committees, when they are established, include representation from the social sciences as appropriate; and (c) that a collaborative project be set up in the foreseeable future involving some aspects of human/natural science interaction.

9. While the IGBP is international in scope and global in focus, its success will depend largely on national efforts. Thus, the programme must recognize that it will be endorsed and eventually judged to some degree through perceptions of how it contributes to various national priorities. Toward this end, the design of the programme must be built with the aid of national programmes and in the light of national and regional interests.

10. The IGBP was first proposed as an ICSU programme in Stockholm in January 1983; it has been under study and definition, in one form or another, since that time. The Council felt that implementation of the Global Change Programme should commence as soon as possible in areas that are clearly central to its aims and which are at this time sufficiently defined to proceed as pilot activities. Toward this end the Council suggested that the SC-IGBP designate core programme elements and define specific pilot activities accordingly. The Council endorsed the proposal of the SC-IGBP that further elaboration of the Global Change Programme and specific project plans for core elements be developed during the next 18 months, to be discussed at a second meeting of the Scientific Advisory Council in mid-1990.

11. The Council recognized the fundamental importance of developing a rational schedule for data exchange and information analysis and the urgency to identify and to begin long-term measurements of a critical set of fundamental physical, chemical and biological parameters that will document the future course of significant global change. Toward this end it emphasizes the need to establish mechanisms for data and information exchange early in the programme

development. The offer of the WG/WDC to prepare and distribute selected world data sets as an immediate pilot project was heartily endorsed.

12. The Council recognized the fundamental role of the World Climate Programme in the development of the Global Change Programme and urges the SC-IGBP to establish a structure for cooperation that will work to the common good of both programmes.

13. It is clearly in the best interests of the IGBP to involve as many nations as possible in the scientific activities of the programme, both in developed and in developing countries. Along this line the Council urged the SC-IGBP to consider the offer of Professor Salam, on behalf of the Third World Academy of Sciences to institute a new IGBP focus within the organized, Third World scientific establishment.

14. The Council expressed a firm statement of commitment to initiate as soon as possible major new international research projects dealing with (a) the role of biota in the cycles of chemicals in the atmosphere which give rise to the greenhouse gas effect; (b) the role of oceanic organisms in the global carbon dioxide cycle; (c) the role of land plants in the exchange of energy and moisture between the land and the atmosphere; and (d) a coordinated effort to recover information from natural archives that will illuminate connections between atmospheric composition, global temperature, ice extent, solar history, and the distribution of land and oceanic organisms.

**Minutes of the Third Meeting of the Special Committee for
the International Geosphere-Biosphere Programme:
A Study of Global Change (IGBP)**

**The Royal Swedish Academy of Sciences, Stockholm, Sweden
23, 29-30 October, 1988**

Present:

J. J. McCarthy	Chairman
B. Bolin	
M.-L. Chanin	
P. J. Crutzen	
S. Dyck	
J. A. Eddy	
W. S. Fyfe	Treasurer
R. Herrera	Vice-Chairman
V. M. Kotlyakov	
T. Nemoto	Only 23 October
H. Oeschger	
S. I. Rasool	
T. Rosswall	Executive Director
J. S. Singh	
V. A. Troitskaya	
B. H. Walker	
J. D. Woods	
D. Ye	
F. W. G. Baker	Executive Secretary, ICSU
J. Marton-Lefèvre	Deputy Executive Secretary, ICSU
G. Björklund	Programme Officer, IGBP
D. Ojima	Post-doctoral fellow, IGBP
H. Virji	National Science Foundation, Washington, DC

1. Opening

The Chairman opened the meeting and the Executive Director welcomed the participants to the Royal Swedish Academy of Sciences. Regrets from Dr. Diop were noted. It was decided

to invite Dr. H. Virji to attend the meeting on 29-30 October. It is anticipated that Dr. Virji will join the IGBP secretariat for at least one year starting in April 1989.

2. Adoption of the agenda

The draft agenda was approved as circulated. It was noted that further items under "Other business" might be added at the next session after the SAC meeting.

3. Minutes of the Second SC-IGBP Meeting

The minutes from the second meeting of the SC-IGBP held at Harvard University, Cambridge, MA, USA 8-11 February 1988 were approved as circulated.

4. Minutes from the Second EC-IGBP Meeting

The draft minutes from the second meeting of the EC-IGBP at the Hungarian Academy of Sciences, Budapest 4-5 June have been circulated to the members of the SC-IGBP. The draft minutes were noted.

5. Review of Programme for SAC-IGBP

The draft programme for the SAC-IGBP was approved.

6. Proposal for a Three Tier Structure for IGBP Planning and Implementation

The proposal in the "Plan for Action" that the IGBP should develop a three-tier structure for planning and implementation was reviewed in light of discussions during SAC-IGBP. Although it was not the intention, the three tier structure had been interpreted as a priority list. It was pointed out during the SAC-IGBP that many activities considered as supporting activities in the proposal are just as essential to the overall "Global Change" programme as the IGBP core projects themselves. It was decided to designate core "Global Change" projects in two categories with equal priorities: (i) Core "Global Change" projects coordinated by the IGBP itself or in collaboration with another body and (ii) core "Global Change" projects coordinated by another body. In addition, there will be supporting activities, which are clearly related to the overall goals of the "Global Change" effort, but which require no formal designation by the SC-IGBP. It was further decided that core IGBP projects should be planned and supervised by Scientific Steering Committees under the

guidance of the SC-IGBP. Note was taken of a number of national initiatives and it is hoped that these can later form the basis for regional and international collaboration, which may lead to the development of additional research areas for core IGBP projects.

7. Extended Membership for Coordinating Panels and Working Groups

The present Coordinating Panels and Working Groups were reviewed. The first phase of the IGBP planning was considered ended by the publication of the "Plan for Action" and the second planning phase will now start and continue until the Second SAC-IGBP meeting. The need to involve first rate scientists in these planning endeavours cannot be overemphasized.

The original charges of the Coordinating Panels and Working Groups were reassessed in the light of the SAC discussions. In view of the overarching role of modelling in the IGBP, it was decided to set up a fifth Coordinating Panel on "Global Analysis, Interpretation and Modelling" and to dissolve the present Working Group on "Global Modelling". The possible combination of the Working Groups on "Data and Information Systems" and "Geosphere-Biosphere Observatories" was discussed, but it was decided that such a merge is premature at the present time. With regard to the Working Group on "Techniques for Extracting Environmental Data of the Past, see agenda item 8.

Based on recommendations from the Chairmen of the Coordinating Panels and Working Groups, the composition of the expanded groups was discussed. It was decided that a member of the SC-IGBP should continue to chair each of the groups. In view of the increasing importance for the SC-IGBP to concentrate on integrative aspects and long-term planning, it was considered essential that the members of the SC-IGBP focus their efforts on the work of the Special Committee in taking responsibility for an overall coherent development of the programme and that they should not to the same extent as previously be members of the IGBP sub-groups. It was decided that any SC-IGBP member, however, can take part in any meeting of the Coordinating Panels and Working Groups.

It was decided to invite the following persons to be members of the Coordinating Panels and Working Groups until 1 July, 1990 (certain modifications are included in the list as per EC-IGBP decisions):

CP 1:

P. J. Crutzen (FRG) (Chairman, Member SC-IGBP)

M.-L. Chanin (France) (Member SC-IGBP)

R. J. Cicerone (USA)

J. Freney (Australia)

(Contd.)

(CP1 contd.)

R. C. Harriss (USA)
J.-P. Malingreau (Italy)
P. Matson (USA)
R. Prinn (USA)
W. S. Reeburgh (USA)
H. Rodhe (Sweden)
H. I. Schiff (Canada)
A. Tuck (USA)
G. A. Zavarzin (USSR)

CP 2, no change in present composition:

T. Nemoto (Japan) (Chairman, Member SC-IGBP)
B. Bolin (Sweden) (Member SC-IGBP)
S. I. Rasool (USA) (Member SC-IGBP)
J. D. Woods (UK) (Member SC-IGBP)

CP 3:

S. Dyck (GDR) (Chairman, Member SC-IGBP)
J. C. André (France)
H.-J. Bolle (FRG)
M. Chahine (USA)
R. Dickinson (USA)
G. Farquhar (Australia)
S. Harrison (Sweden)
M. G. Khublaryan (USSR)
G. Kienitz (Hungary)
C. Kömer (Austria)
L. C. Molion (Brazil)
S. W. Running (USA)
V. Targulian (USSR)

CP 4:

B. H. Walker (Australia) (Chairman, Member SC-IGBP)
Congbin Fu (China)
J. MacMahon (USA)
E. Medina (Venezuela)
H. Nix (Australia)
(contd.)

(CP4 contd.)

I. Noy-Meir (Israel)
C. Prentice (Sweden)
W. A. Reiners (USA)
P. Sellers (USA)
H. Tiessen (Canada)
P. M. Vitousek (USA)
I. Woodward (UK)
R. Zlotin (USSR)

CP 5:

B. Bolin (Sweden) (Chairman, Member SC-IGBP)
P. J. Crutzen (FRG) (Member SC-IGBP)
J. D. Woods (UK) (Member SC-IGBP)
F. Bretherton (USA)
K. Hasselmann (FRG)
K. Ya. Kondratjev (USSR)
J. E. Kutzbach (USA)
C. Nobre (Brazil)
G. Pearman (Australia)
M. Prather (USA)
J. Sarmiento (USA)
D. S. Schimel (USA)
U. Siegenthaler (Switzerland)

WG 1:

S. I. Rasool (USA) (Chairman, Member SC-IGBP)
F. Becker (France)
V. Boldirev (WMO)
J. Cihlar (Canada)
H. Croze (UNEP)
R. da Cunha (Brazil)
G. Kullenberg (UNESCO)
A. P. Metalnikov (USSR)
S. Ruttenberg (USA)
D. Skole (USA)
W. Sombroek (The Netherlands)
G. Withee (USA)

WG 2, no change in present composition:

R. Herrera (Venezuela) (Chairman, Member SC-IGBP)
E. S. Diop (Senegal) (Member SC-IGBP)
W. S. Fyfe (Canada) (Member SC-IGBP)
V. M. Kotlyakov (USSR) (Member SC-IGBP)

It was decided that the Coordinating Panels and Working Groups should submit reports on their work to the 2nd SAC-IGBP meeting and that interim reports should be available for discussion by the SC-IGBP at its 5th meeting (see agenda item 18). The reports from the Coordinating Panels should consist of a review of the crucial issues that need to be addressed by the IGBP and detailed core project proposals, which could be proposed as candidates for implementation immediately after the 2nd SAC-IGBP.

8. Scientific Steering Committee on "Global Changes of the Past"

The Working Group on "Techniques for Extracting Environmental Data of the Past" has recommended in their report from the Berne meeting (July 1988) that a core IGBP project should be developed in the area of "Global Changes of the Past". During the discussions it was stressed that this is a general area of high priority for understanding "Global Change". There are many ongoing activities, but a lack of coordination between various approaches to retrieve data of the past exists which is needed for an overall understanding. It was decided to establish the first IGBP Scientific Steering Committee (SSC) on "Global Changes of the Past" and to ask the SSC to develop a proposal for a multi-technique research programme for discussion at the 5th meeting of the SC-IGBP, and to develop plans for how this programme can be initiated in 1990. It was noted that the SSC should assess the possible contributions of planned or existing national and international efforts.

It was decided to invite the following individuals to serve on the SSC until the Second SAC-IGBP:

H. Oeschger (Switzerland) (Chairman, Member SC-IGBP)
J. A. Eddy (USA) (Member SC-IGBP)
A. Berger (Belgium)
B. Berglund (Sweden)
B. Frenzel (FRG)
T. van der Hammen (the Netherlands)
(contd.)

(SSC contd.)
J. Imbrie (USA)
Tungshen Liu (China)
C. Lorius (France)
C. Pfister (Switzerland)
N. Rutter (Canada)
F. Schweingruber (Switzerland)
N. J. Shackleton (UK)
M. Stuiver (USA)
A. A. Velitchko (USSR)

9. Review of Specific Proposals from Coordinating Panels and Working Groups

The proposals in the "Plan for Action" were reviewed on the basis of the discussions during the SAC-IGBP as well as the national and other written reports presented to that meeting.

Coordinating Panel 1: Terrestrial Biosphere-Atmospheric Chemistry Interactions

It was decided to work towards the development of a core IGBP project on "Biological, Chemical and Meteorological Processes that Regulate the Composition of the Atmosphere".

It was decided to suggest to the CACGP (IAMAP/IUGG) that the "International Atmospheric Chemistry" (IGAC) Programme is designated as a core "Global Change" project. It was noted that Crutzen is a member of the IGAC committee.

A meeting of the Panel immediately after a SCOPE/Dahlem Conference on "Biological Processes Leading to the Release and Uptake of Photochemically or Climatically Important Trace Gases" was approved.

It was decided to co-sponsor a meeting with SCOPE on "Trace Gas Exchange Between Ecosystems and the Atmosphere" (Sweden 19-23 February 1990) and to appoint Crutzen, Chanin and P. Matson as members of the joint Planning Committee in addition to the members appointed by SCOPE.

The Committee approved the suggestion that the Panel should organize a meeting on "Effects of Landuse Changes and Biomass Burning on Trace Gas Release from Terrestrial Ecosystems" in 1990 or 1991.

The meeting on "Soils and the Greenhouse Effect" organized by the International Soil Reference and Information Centre (ISRIC) in Wageningen, the Netherlands 14-18 August, 1989 was noted.

The Committee noted the development of an International Programme on the Middle Atmosphere to be implemented through IUGG (MARC) and SCOSTEP (as part of STEP) and asked the Panel to review progress and report back to the SC-IGBP on possible needs for action by the Committee.

The Committee noted the potential importance of increased UV-B radiation on biological systems and welcomed the initiative by SCOPE to invite IUPAB to join in the development of a state-of-the art report on this issue. The interest of SCAR was also noted. It was decided to discuss needs for IGBP action after the SCOPE/IUPAB report has become available.

Coordinating Panel 2: Marine Biosphere-Atmosphere Interactions

It was decided to suggest to SCOR that the "Joint Global Ocean Flux Study" (JGOFS) be designated as a core "Global Change" project. It was noted that McCarthy and Nemoto are corresponding members of the JGOFS Committee.

The Committee approved the plan to organize, jointly with JGOFS, a study conference on "Modelling Ocean-Atmosphere Interactions, Including the Effects of Primary Production in the Oceans" (tentative title) as a step towards the definition of an IGBP core project on marine biogeochemical cycles and physical climate linkages as a complement to JGOFS. The meeting will be held at the Royal Society (London) in January or February 1990 with Woods responsible, on behalf of the SC-IGBP, for the meeting in consultation with the Panel and the Panel on "Global Analysis, Interpretation and Modelling". It was noted that M. Fasham will be responsible for the practical matters related to the organization.

The Committee approved the plans to arrange a meeting of the Panel in the second half of 1989 to address especially questions related to coastal seas.

Coordinating Panel 3: Biospheric Aspects of the Hydrological Cycle

It was decided that the Panel should develop a specific proposal for a core IGBP project on "Biospheric Aspects of the Hydrological Cycle". The developments of such a project plan

should fully utilize the experiences from ISLSCP and take into account the proposed LAVIP programme. COSPAR, IAMAP and IAHS should be invited to take part in the planning.

The Committee decided that discussions should be initiated with WCRP (GEWEX) regarding the possibility of establishing a joint Scientific Steering Committee for a core IGBP project and to ask CP 4 to take part in the development of the project plans. Initial coordination should be discussed at the next JSC Study Group on GEWEX (Pasadena, CA, USA 7-10 February, 1989).

The Committee approved the proposal to invite Unesco (IHP), WCP/Water and IIASA (LIR) to a joint discussion on how energy and water cycle studies of large river basins can be promoted within the framework of ongoing or planned programmes to further our understanding of the hydrological processes leading to global changes.

The Committee approved the plans to organize a meeting of the Panel during the first half of 1989.

It was decided that a joint meeting between CP3, CP4 and CP5 should be organized to consider problems related to CO₂ to consider inputs needed to global modelling efforts.

Coordinating Panel 4: Effects of Climate Change on Terrestrial Ecosystems

The Committee noted that the research requirements cover a very wide array of necessary activities. Present decisions relate to a minimum programme for urgent development of clearly defined IGBP objectives. Other equally important issues, such as the effect of elevated CO₂ levels on plant water use efficiency at the community level, will be addressed later.

The Committee noted with great interest the SCOPE workshop on "Effects of Climate Change on Production and Decomposition", Woods Hole, MA (9-14 April 1989), which will involve representation by the SC-IGBP, and approved the proposal to immediately follow this workshop with a meeting of the Panel. The objective of that meeting is to establish the requirements for and appropriate structure of a set of models for predicting ecosystem dynamics (especially vegetation change) in response to climate and atmospheric change. This would include biome-level and regional models as well as a model of global vegetation change, developed in conjunction with IIASA.

The Committee approved the proposal to arrange a workshop in 1989 to explore the development of a core IGBP project on modelling ecosystem dynamics in response to climatic and atmospheric change.

The Committee approved the proposal that the further development of appropriate generic models, for IGBP purposes, for agricultural crops and managed forests should be addressed in consultation with appropriate organizations, such as FAO, IBSRAM and IBSNAT and decided that Rosswall should initiate discussions with FAO to clarify the interests of FAO in the IGBP in general and the development of generic models in particular.

The Committee noted the essential requirement for a better map of current landuse patterns and for estimates of future changes in landuse patterns due to demographic, economic and technological factors. Consideration should also be given to past landuse changes. It was decided that the development of plans for a meeting on this topic should be investigated by Walker and Rosswall through contacts with appropriate bodies.

Coordinating Panel 5: Global Analysis, Interpretation and Modelling

The Committee noted that many approaches to the analysis and interpretation of IGBP research will be of importance, and modelling is an essential component of these. A fundamental understanding of the geosphere-biosphere system, particularly the development of an integrated view, cannot be arrived at without the development of global models. It is, however, essential to recognize the major difficulties and limitations of modelling. The problems of uncertainty and predictability should therefore be kept in focus.

The Committee decided to ask the Panel to develop a strategy for global modelling and requests a draft report to be available at the 5th meeting of the SC-IGBP. It was noted that scientific groups active in different fields of modelling need to be involved. The Committee decided to ask the Panel to consider the need for establishing a group on numerical experimentation.

The Committee approved the proposal to arrange a workshop on "Modelling the Global Carbon Cycle" in Sweden 14-18 August, 1989 (meeting later changed to Heidelberg, FRG, 18-20 October, 1989) as a first step towards a more complete programme for global modelling and that the first meeting of the Panel will be held in conjunction with this workshop.

Working Group 1: Data and Information Systems

The Committee approved plans to develop inventories of relevant global data bases in collaboration with appropriate organizations such as WDC and UNEP and decided to ask the Panel to also include data bases on past global changes and to prepare a strategy for how to assess the quality of the data.

The Committee decided that discussions should be initiated with ISY regarding the possibility to initiate a joint pilot study on end-to-end performance of existing observations and data systems for long-term measurements.

The Committee approved the plans to develop a pilot data assembly project on land cover changes and asked the Working Group to consult with CP 4 in the development of detailed plans for such a project.

The Committee approved that the next meeting of the Working Group together with a few additional experts be convened in Geneva in January 1989.

The Committee noted with great interest the plans of the WDC to develop a pilot programme for the distribution of global vegetation index data to a number of scientists around the world and asks the WG to develop a plan for the implementation of such a project in consultation with WDC, GRID and CP4. It was also decided to ask the WG to look into the possibility of expanding this to other remotely sensed data, such as ocean colour.

Working Group 2: Geosphere-Biosphere Observatories

The Committee noted with some concern that the report to the SAC had not received the anticipated enthusiastic response. It was probably mainly a communication problem and alternative names to "Global Observatories" were considered, as the report had given the impression of a global set of highly centralized monitoring institutes. The Committee stressed that the top tier GBOs were designed as regional research and training centres, and it is not realistic to establish many such centres. The Committee decided to ask the WG to consider this matter carefully at the next meeting and to prepare a revised outline of a plan for GBOs taking the discussions during SAC-IGBP into account. The Committee approved the plan to have a meeting of the WG in Thailand 17-21 April 1989 in conjunction with a workshop on GBOs (this meeting has later been postponed). In order to achieve a more precise definition of the goals, structure and the scientific questions pertaining to the GBOs, the Committee further decided that the Chairmen of all Coordinating Panels and the Working Group on "Data and Information Systems" should be represented at the meeting of WG 2.

The Committee approved the plans to arrange, jointly with IIASA, a meeting on GBOs in Warsaw 25-27 September and a meeting of the WG 28-30 September 1989.

The Committee decided that the WG should prepare a project document to be used for approaching various funding agencies for support of a feasibility study. The document should be available at the 5th meeting of the SC-IGBP.

10. Establishment of an IGBP Interagency Coordinating Committee

It was noted that the EC-IGBP had discussed the need to formalize contacts with a few key UN bodies to ensure an efficient coordination mechanism for planning and implementing the IGBP and related research projects. The Committee approved the decision of the EC-IGBP to invite UNEP, Unesco and WMO to designate one person each as members of an IGBP Interagency Coordinating Committee and that the other members of the ICC-IGBP should be the members of the EC-IGBP. It was noted that the ICC-IGBP will meet for one day in direct connection with regular EC-IGBP meetings for discussion of areas of mutual interest, to strengthen collaboration and increase communication among the four bodies. It was also noted that the first meeting was scheduled for London (UK) 11 January 1989.

11. Policy Discussion on Financing the IGBP

The Committee discussed various strategies for the international funding of the planning and implementation phases for the IGBP. In particular, it noted the presentation by Dr. R. Corell to the SAC meeting and the discussion group report from that meeting. It was decided to ask Rosswall to prepare a project document for the second phase of the IGBP, the planning until 1 July 1990, as a basis for approaching funding bodies and asked him to explore the possibility of arranging a meeting with these in early 1989. It was also decided to ask the President of ICSU, Professor M. G. K. Menon, to write to all national ICSU members not presently contributing to the financing of the IGBP, asking them for financial contributions. This letter should be followed-up by a letter from McCarthy and Fyfe. Rosswall should prepare a document based on the discussions at the SAC for discussion at the first ICC meeting in London outlining various options for involving international and national funding agencies in a dialogue for the long-term financing of the IGBP operational phase.

12. General Plan for Action 1989-1990 and Possible Cooperation with Wissenschaftskolleg zu Berlin

The extended Coordinating Panels and the new Scientific Steering Committees have been charged with developing core IGBP projects and the Committee discussed how this might best be achieved. It was considered essential that the Chairmen of the Coordinating Panels and the Scientific Steering Committee be given additional staff support to enable them to act vigorously over the next 18 months. In principle, the IGBP planning effort would best be served by attracting as experienced scientists as possible to work with the SC-IGBP and its sub-groups. Discussions have been held with Wissenschaftskolleg zu Berlin, and there is interest in supporting scientists as fellows to the centre and that they would work on integrative aspects of the planning phase in Berlin. It was decided to suggest to the Wissenschaftskolleg that six IGBP fellows be appointed for six months each starting 1 October 1989; each scientist would work with the Chairman and IGBP group in reviewing present knowledge in the particular field of interest and to help develop specific IGBP core projects. If possible, the scientists would spend another six months at the home institution of the Chairmen.

In addition to the Wissenschaftskolleg zu Berlin fellows, the Committee discussed the needs for postdoctoral fellows to work from the office of the Chairmen of the IGBP groups and decided to advertise for such positions with appointments soonest and until 1 July, 1990.

The SC-IGBP decided that detailed reports from all Coordinating Panels, Working Groups and Scientific Steering Committee should be available no later than 1 March 1990 and that the second meeting of the SAC-IGBP should be held in May-June 1990 (later postponed until 3-7 September by the EC-IGBP).

13. Financial Report and Budget for 1989

The Committee noted the financial statement for income and expenditure from the Stockholm office. The Committee also noted the revised budget for 1988 as prepared by the Executive Committee. The draft budget for 1989 was discussed and after certain revisions, it was decided to approve a draft budget for 1989.

14. Interactions with ICSU Scientific Members

The SC-IGBP noted that there had been many expression of great interest in the IGBP from ICSU members at the ICSU General Assembly in Beijing. There was, however, also some concern about the modalities for efficient communication between the IGBP and the ICSU

Unions, Scientific Committees and other bodies. The Committee discussed how this could best be achieved and noted that if the IGBP is to succeed, it is essential that all members of ICSU with an interest in the IGBP also can contribute to the planning and implementation of the IGBP. The Committee decided to invite each ICSU scientific member, and a selected group of other bodies, to nominate a correspondent to the IGBP, if they so wish. The correspondents, and the organizations they represent, will be listed in the ICSU yearbook and the appointment of a correspondent will define the body as an IGBP adhering body as given by the IGBP Constitution (para 25a).

15. Rotation of SC-IGBP Membership

The Committee noted the decision by the ICSU Executive Board at its meeting in September 1988 to establish a rotation scheme for the membership of the Special Committee as per the IGBP Constitution. The terms of appointment are as follows:

J. J. McCarthy	Appointed until 1990 (eligible for reappointment)
B. Bolin	Reappointed until 1992
M.-L. Chanin	Appointed until 1990 (eligible for reappointment)
P. J. Crutzen	Reappointed until 1992
E. H. S. Diop	Appointed until 1990 (eligible for reappointment)
S. Dyck	Reappointed until 1992
J. A. Eddy	Reappointed until 1992
W. S. Fyfe	Reappointed until 1991
R. Herrera	Reappointed until 1992
V. M. Kotlyakov	Appointed until 1990 (eligible for reappointment)
T. Nemoto	Reappointed until 1991
H. Oeschger	Reappointed until 1991
S. I. Rasool	Reappointed until 1991
T. Rosswall	Appointed for a three-year term (1986-1989); renewable
J. S. Singh	Appointed until 1990 (eligible for reappointment)
V. A. Troitskaya	Appointed until 1990 (eligible for reappointment)
B. H. Walker	Appointed until 1990 (eligible for reappointment)
J. D. Woods	Reappointed until 1992
D. Ye	Reappointed until 1991

16. Personnel

It was noted that Dr. Gunilla Björklund has been appointed by the Royal Swedish Academy of Sciences as Programme Officer at the IGBP Secretariat and that the position is funded

through grants from the Swedish government. It was also noted that the activities at the Secretariat have increased considerably and that the draft budget for 1989 includes an additional position as secretary at the Secretariat. The Committee decided to ask the Royal Swedish Academy of Sciences to employ a secretary full-time as of 1 January 1989 and noted that the cost for this additional post is included in the budget for 1989.

The Committee noted that the tasks of Mrs. Hildburg Berglund have developed beyond those originally foreseen. In view of this, the Committee decided to ask the Royal Swedish Academy of Sciences to employ Hildburg Berglund as Administrative Assistant to the Executive Director from 1 November 1988 at a present salary grade of N20:6. The Committee noted that the increased salary is covered by the budgets for 1988 and 1989.

17. IGBP Constitution

The Committee noted comments from the China Association for Science and Technology on the IGBP constitution and the suggestions from ICSU and IGBP officers. The Committee decided to propose certain revisions of the present constitution (Annex 1) to the ICSU Executive Board for approval.

18. Future Meetings

The Committee decided that the 4th meeting of the Special Committee shall be held in Brussels (Belgium) 13-17 June, 1989 and that the 5th meeting shall be held in Berlin (FRG) 6-10 November 1989. The Committee noted that the 3rd meeting of the EC-IGBP will be held in London (UK) 12-13 January 1989 and the 4th meeting in Bogota (Colombia) 20-22 October 1989 (later changed to Lisbon, Portugal, 14-16 October 1989).

19. Other Business

a. Relationships to SAFISY

The Committee discussed the International Space Year and the report from the planning conference held in Durham (NH, USA) earlier this year. The establishment of a Space Agency Forum on International Space Year (SAFISY) was noted with great interest. The Committee expressed a keen interest in developing appropriate links with SAFISY and decided to ask Rasool to discuss this further with them and report back to the IGBP. It was noted that the next meeting of SAFISY would be held in Frascati (Italy) in May 1989, and it decided that if the IGBP is invited, it should be represented apart from Rasool by McCarthy and/or Rosswall.

b. Report from SAC-IGBP

It was decided to publish a report from the SAC meeting in the series of IGBP reports and that it should include the conference summary, the introductory presentations in the plenary sessions (except the ones from the Coordinating Panel and Working Group chairmen, which summarized the contents of IGBP Report), reports from the discussion groups and the minutes from the 3rd SC-IGBP meeting.

c. TWAS

The proposal by Professor A. Salam at the SAC meeting that the planned International Centre for Earth and Environmental Sciences could play a major role in the IGBP was noted with great interest, and it was decided to ask Rosswall to discuss this further with TWAS and report back to the Committee. The TWAS/ICSU lectureship scheme was also noted with great interest.

d. Staff person in the social sciences

The suggestion during the SAC that a staff person representing the social sciences should be located at the IGBP secretariat to serve as a node for links between the developments of the IGBP and related international programmes in the social sciences (e.g., UNU/ISSC/IFIAS Human Dimensions of Global Change) was noted with great interest. It was decided that if the social sciences community considers such a staff person (at a post-doctoral level) at the IGBP secretariat would serve an important function and if the financial implication can be solved, the IGBP would welcome such an addition to the secretariat and provide necessary office space and services.

e. Proposal for Working Group on "Anthropogenic Forcing"

Oeschger brought forward a proposal from Fyfe that a Coordinating Panel or Working Group on "Anthropogenic Forcing" should be established. The Committee discussed the proposal and noted that anthropogenic forcing is a key part of the underlying themes of the IGBP, which is stressed in the "Plan for Action" report. This should be taken note of by all existing Coordinating Panels and Working Groups as well as the Scientific Steering Committee. It was decided to ask the Executive Committee to discuss this further and report back to the Special Committee.

Stockholm, 30 October, 1988

Thomas Rosswall
Executive Director

OPENING ADDRESSES AND BRIEF MESSAGES

INTRODUCTORY WELCOME

Thomas Rosswall

Executive Director, IGBP

Your Majesty, Ms Birgitta Dahl, Minister of Environment and Energy, Excellencies, Professor Menon, Ladies and Gentlemen.

In 1972, the United Nations Conference on Human Environment was held in Stockholm. This very important meeting led to the establishment of the United Nations Environment Programme and focused world attention on environmental problems. The focus at that time was on pollution and pollution control with emphasis on national and regional problems.

In 1988, we assemble in Stockholm for another important meeting on international environmental problems. The picture that emerges today is different from that of 1972. Many of the issues that concerned those assembled in 1972 have now taken on truly global dimensions. We are now confronted by reports of major reductions in the protective ozone layer over the Antarctica. Emissions of so called "greenhouse gases" are expected to drastically change the global climate with sea-level rise as one of the consequences. The destruction of rain forests in the tropics may have dramatic effects also on climate and precipitation patterns. These, and other, threats to our global environment has led to an international, political awareness, which is exemplified by a statement from a meeting on "The Changing Atmosphere: Implications for Global Security" last summer in Canada. The following citation from the first paragraph of the conference statement sums up some of the major concerns in a forceful manner: "Humanity is conducting an uncontrolled, globally pervasive experiment, whose ultimate consequences could be second only to a global nuclear war. The Earth's atmosphere is being changed at an unprecedented rate by pollutant resulting from human activities, inefficient and wasteful fossil fuel use and the effects of rapid population growth in many regions. These changes represent a major threat to international security and are already having harmful consequences over many parts of the globe".

In 1979, during the SCOPE General Assembly, which met in this very hall, Professor Gilbert F. White, then President of SCOPE, and Dr. Mostafa K. Tolba, Executive Director of UNEP, issued a joint statement in which they said: "The time is ripe to expand current efforts to understand the great interlocking systems of air, water, and minerals nourishing the earth". What they called for was an integrated view of Earth as life-sustaining system. A system which cannot be understood if one does not address the interactions between its physical, chemical and biological components. Nine years later the world's scientific community meets again in Stockholm to address the issue of an integrated study of linkages among geospheric and biospheric processes, and to discuss a research programme, which aims at a better understanding of the global system and the underlying interactive processes in order to supply some of the knowledge needed for a proper evaluation of the future fate of our Earth. We are discussing the first steps in the planning of a major new international research programme on a new science, but one which is not only created from scientific curiosity but also from necessity. Science and technology have gone hand in hand to develop modern society. The force of scientific discoveries is yearly being recognized by the Royal Swedish Academy of Sciences through its Nobel prizes in chemistry and physics. The scientific discoveries have, however, also led to the development of technologies, which have not considered the effects on our environment. It is now time that science takes a big step forward in order to help solve some of the major global environmental issue.

The impact of scientific understanding in providing the necessary impetus for needed international agreements is clearly seen by the concern over the ozone reduction in the Antarctica. There has been discussions about the fate of the protective ozone shield for several decades, and early 1980s it was estimated that the global tropospheric ozone content would decrease by a few per cent in the not too distant future. But we did not understand the global system, and both direct measurements and satellite observations showed that the ozone content

over one specific region, the Antarctica, had decreased drastically over parts of the year. Our scientific understanding of the functioning of the global system was not sufficient for anyone to predict this. Still, only a few years later there is consensus in the scientific community about the cause-effect relationship after a massive scientific effort. There are at least two lessons from this example. Our present understanding is totally insufficient to predict the effect of human activities on the Earth system, but with proper resources, scientific investigations can clarify the issue to such an extent that proper political action can be taken at the international level. The UN World Commission on Environment and Development report "Our Common Future" clearly states that environmental considerations are paramount for development. Sustainable development in all parts of the world is threatened by the global environmental problems we are going to address at this meeting. Changing climate and sea-level rise are two examples. We are very pleased to welcome several scientific colleagues from developing countries to this meeting and we are looking forward to involving the scientific community in many more countries. The President of the Maldives, in his statement to last year's General Conference of the UN, pointed out that predicted sea-level rises would wipe out his country and called for international action. The President of Brazil recently made a statement that an embargo on export of timber will be introduced and that, together with legislation to limit the agricultural developments in the region, should drastically limit deforestation rates. These are just two examples of a new awareness in the developing world that environmental problems, and especially those with a long-term and sometimes global effect, will have to be addressed in a forceful manner.

The scientific community is faced with a very difficult task. Because of the complexity of the Earth system we must develop a research programme of a magnitude never before attempted. The best scientific brains and the most enthusiastic young scientists must be enrolled in this effort, if we are to succeed. The funding agencies and politicians must be made aware of the necessity of this effort, the ICSU national and scientific members, the UN system and a large number of other international organizations must join force in developing a strong "International Geosphere-Biosphere Programme: A Study of Global Change". This meeting is a major step towards achieving this goal.

The IGBP secretariat, which is based at the Royal Swedish Academy of Sciences with financial support from the Swedish Government, is proud to host this first meeting of the Scientific Advisory Council of the IGBP. On behalf of the Special Committee for the IGBP I welcome you to this important event. We are looking forward to frank and constructive discussions of the planning report prepared by the Special Committee. Your participation in this meeting should ensure that the detailed planning of the programme will have strong international support. We welcome representatives of national IGBP Committees. We encourage representatives from countries where such committees do not exist to help establish them. We welcome representatives from ICSU Unions, Scientific Committees and Scientific Associates to take part in the discussions. Your knowledge and experience will be prerequisite for the development of the IGBP. We welcome representatives from the United Nations family, with which we need to work closely in both the development and implementation of the Global Change Programme, and we welcome representatives of other organizations, who have taken the time to come to Stockholm.

Although the number of participants poses some practical problems, we are gratified by the response to our invitation to this meeting. Let us work to ensure that by the conclusion of the first SAC meeting we will all share in the knowledge that we have made substantial progress in our collective effort to develop the IGBP.

Thank you.

OPENING ADDRESS

H. M. the King Carl XVI Gustaf

Minister Dahl, Mr. Chairman, Mr. President, Ladies and Gentlemen.

It is of vital importance to mankind that matters of Environment and conservation are discussed on an international level, especially those with global effects.

I am personally very interested in conservation. Therefore I am proud to be able to say that my country is well known around the world for being in the forefront when it comes to such questions.

When the United Nations Environment Conference was held in Stockholm, in 1972, I attended some of its sessions. This conference, in many ways served as the starting point for the international awareness and cooperation in the field of conservation which ever since have continued to grow.

An excellent proof of the increased, global awareness of the need of conservation is the fact that almost 40 nations are represented here today. I find this most encouraging and I am very pleased to wish you all welcome.

Nature, water and air must be preserved so that our children and coming generations will have the chance to enjoy them as much as we do. International agreements, of the kind you have gathered here to discuss and hopefully decide on, later this week, are important instruments in our fight for the environment.

Therefore I wish you a successful meeting, with an inspiring exchange of ideas and knowledge. I look forward to seeing the result as a decision on the International Geosphere-Biosphere Programme.

But meetings of this kind are not just good for academic reasons. They also serve the cause of creating personal ties and new friendships, which make future cooperation so much easier. I wish you a happy stay in Sweden and in Stockholm with many fine memories and experiences to bring back home.

Good luck and thank you.

OPENING ADDRESS

M. G. K. Menon

President, ICSU

Your Majesty; Your Excellency Ms. Birgitta Dahl, Minister of Environment and Energy; Professor Lindqvist, President of the Royal Swedish Academy of Sciences, Ladies and Gentlemen.

This is the first meeting of the Scientific Advisory Council of the "International Geosphere-Biosphere Programme: A Study of Global Change". It is a very important event for the International Council of Scientific Unions. All of us at ICSU regard the IGBP as the most significant and intellectually challenging international cooperative undertaking of our time, not only for the International Council of the Scientific Unions (ICSU), but for all of mankind.

Since its creation 1931, nearly 60 years ago, ICSU has been dedicated to encouraging international scientific cooperation for the benefit of all of humanity. ICSU has gone about meeting this ambitious objective in a number of ways, including the initiation of international interdisciplinary scientific programmes. These include, for example; the International Geophysical Year in the mid-1950s; the International Biological Programme, which lasted a decade from 1964 to 1974 and which was the direct predecessor of the UNESCO's "Man and the Biosphere" Programme; and the Global Atmospheric Research Programme followed by the World Climate Research Programme, carried out in partnership with another UN agency, the World Meteorological Organization.

ICSU carries out its mission across the world with the help of all of its participating members. The Royal Swedish Academy of Sciences has been a most active and creative National Member of ICSU from the first year of ICSU's existence, 1931; and has helped us in the many areas of our work, including providing the Secretariat for our very important Committee on the Free Circulation of Scientists; and as of 1987, in generously housing the Secretariat of the Global Change Programme. May I take this opportunity to express ICSU's gratitude to the Government of Sweden for the most gracious financial and moral support received for this Programme. Without such help from our members, our task would be much more difficult, if not impossible, to carry out.

Much of ICSU's work is carried out on a day-to-day basis by its various members: the discipline-based Scientific Unions, and national scientific academies or research councils located in all parts of the world. ICSU itself is the umbrella organization, bringing all of these together in an interactive, interdisciplinary and coherent system. In addition to launching the major global programmes I have just referred to, ICSU has also been responsible for setting up important mechanisms to carry out a variety of inter-disciplinary activities. Examples of these include the Scientific Committees on the Problems of the Environment, Oceanic, Antarctic and Space Research, and Solar Terrestrial Physics: there are over 20 of these, many of which are represented in this meeting and will along with the Scientific Union members of ICSU and other organizations be working closely with the Special Committee for the IGBP in the development of the Global Change Programme.

The idea of embarking upon a study of the interactions between the Earth's geosphere and biosphere was first brought to the attention of ICSU in a scientific lecture by Professor George Garland of Canada, presented to ICSU's 19th General Assembly commemorating the 25th anniversary of the IGY. A document proposing a project on the study of global change or global habitability was first submitted to the Executive Board of ICSU in January of 1983. As it happens, that particular meeting of the Board took place in this very building. When the members of ICSU are enthusiastic about an idea, they are able to move rapidly, and by August of that same year a first colloquium on the topic was organized at the same time of ICSU's General Committee meeting in Warsaw. Following this colloquium, an ad-hoc committee was established by ICSU to study the way in which ICSU could organize such an ambitious

programme. By September 1984, at ICSU's 20th General Assembly in Ottawa, a half-day symposium was held which was well received by the international scientific community attending that Assembly. The Symposium's publication entitled "Global Change" and published by our ICSU Press has been our first best seller. The General Assembly adopted a resolution requesting ICSU to explore the possibility of launching a major new research programme on the study of Global Change. As a result, a planning mechanism was set up by ICSU, which presented the results of its work to the 21st General Assembly of ICSU, held on Berne in September 1986, through a Symposium on Global Change. This Symposium and the International Geosphere-Biosphere Programme: A Study of Global Change.

Environment and development

It may be useful to briefly go over the rationale for undertaking such a programme. The population of the world has grown significantly, largely because of reduced death rates and improved conditions of living resulting from application of science. Many parts of the world, referred to as the developed industrialized countries, have reached unprecedented levels of prosperity - again principally through the development of science and technology. There is an expanding spiral of human aspirations; and efforts to meet these, particularly using the ever increasing capabilities of science and technology. The general feeling most people have is that one can proceed with the fulfillment of the aspirations of the already large and increasing number, following the approaches followed in the most developed areas of the world, without any consequences to the environment - as though this constitutes an infinite resources. This no longer is the case. The concept that has clearly dawned on us now is that we need development; but it has to be sustainable. For this to be possible it is necessary for us to understand what our inheritance is, in terms of the natural resources and of the environment that sustains us; only then can we put these to good use. We need to plan, so that the interests of humanity as a whole take precedence over those of nations and pressure groups concerned only with short term gains and narrow considerations. We need to appreciate the vision of a one world of interdependence that science and technology has brought about.

Even a decade and a half ago when the famous Conference was held in 1972 in Stockholm on Human Environment, the principal focus was on the problems of pollution in the industrialized countries. It was Mrs. Indira Gandhi, the late Prime Minister of India who focussed attention at that a large part of the developing world was faced with problems of poverty; and that poverty was the worst form of pollution. As a result of the Stockholm Conference, the United Nations Environment Programme (UNEP) was set up. But its focus has still very little to do with development or removal poverty. What we face now is the challenge: how to bring about development and ensure that it is sustainable.

In earlier periods of human history, populations were small; aspirations were largely related to aspects of survival; lifestyles were defined in terms of fulfilling basic needs; and human capabilities were limited. Humankind has no doubt been altering the environment in the process of living and development for at least 2 million years, but during most of this time, human influence on the environment has been local in scale and small in magnitude. It is only over the last half a century that humankind has developed the ability to alter the environment on a global scale, and not just in terms of local effects such as due to pollution. And these changes and their consequences can occur in a time period as short as a life span. We are, therefore, now faced with observing and understanding global change, and particularly its anthropogenic causes - hence IGBP.

International Geosphere Biosphere Programme of ICSU

The key objective of this programme is "to describe and understand the interactive physical, chemical, and biological processes that regulate the earth system, the unique environment that it provides for life, the changes that are occurring in this system, and the manner in which they are influenced by human actions". In particular, "the priority will be on key interactions, and significant changes on time scales of decades to centuries, that most affect the biosphere, that are most susceptible to human perturbation, and that will most likely lead to practical, predictive capability".

It will thus be seen that the primary goal of IGBP is to advance our ability to predict changes of the global environment so that society can be fore-warned about the consequences of pathways being currently pursued, and changes that need to be introduced, if catastrophe is to be avoided and sustainable development assured.

It is clear that a programme of this nature has by definition to be global in character. One cannot understand the ecology of the globe other than by measurements over a whole range of latitudes and longitudes on the earth's surface, as well as at various altitudes in the atmosphere and depths in the oceans - namely data from many sources and locations. Three-fifths of the land area of the earth is covered by developing countries, who must therefore be participants in this programme. Scientists from different disciplines and areas of experience and expertise have to work on this programme; therefore, a large number of discipline-oriented Unions, who are members of ICSU, have all to play an important role in this activity.

A programme of this nature has become possible only now, with the availability of global observation systems based on satellites with advanced sensors, and large scale computational capabilities for analyses and development of models. We also know much more now on how to extract palaeo-information on environmental parameters from the distant past which are indicators of global change.

One is concerned with time scales ranging from seconds to thousands of years and with space scales from a micron to thousands of kms. It will involve the development of complex two and three dimensional global models. IGBP will need a new global data and communication system.

This is a programme which will continue over several decades. It is the most ambitious and most wide-ranging global scientific programme ever taken up. Developing countries will be able to participate in this, in terms of making observations on land, sea and in the air. They will be able to obtain equipment and learn about maintenance, accuracies, and production of data which can be put together on a global scale. They will be participants in the analysis of one of the most complex problems that we have ever tackled - the global eco-system, involving all the disciplines of mathematics, computer modelling, physical processes, chemistry, biology, oceanography, extracting information from the past, non-linear system relationships and the like. There are immense intellectual challenges and rewards, IGBP can be a significant engine for scientific development in the third world countries. I am very happy that we have in our midst one of the most distinguished scientists from the Third World, Prof. Abdus Salam, Nobel Laureate in Physics, who is President of the Third World Academy of Sciences (TWAS) ICSU has many collaborative programme with TWAS; and I hope that IGBP will turn out to be a major one.

A programme of this nature must of necessity involve free availability and exchange of data and information. Therefore, it demands a system of "openness" which is at the very heart of scientific endeavour, as opposed to the secrecy of commercial, defence and national approaches to technology. I cannot think of a better way in which to bring the global scientific community together, not only in terms of scientific effort, but ultimately in the self interest of human society as a whole. It is my belief and my hope that, through this type of cooperative effort, science can indeed become a beacon and a trail blazer for the world to come together.

By January of the following year, after a series of consultations with scientific community world-wide, the Executive Board of ICSU appointed the 19-member Special Committee for the IGBP. The work accomplished by this Special Committee of scientists, who are also fully occupied in their professional lives in their home institutions, is indeed an impressive one. Three full meetings of the Special Committee have all of the Coordinating Panels and Working Groups. Last month, at ICSU's 22nd General Assembly in Beijing, after completing the document entitled "A Plan for Action", the Special Committee once again organized a successful scientific symposium for the members of ICSU as well as for the members of China's scientific community.

We in ICSU are well aware of the fact that a complex programme such as the IGBP cannot be carried out by our Special Committee on its own, and that a number of other international programmes or projects already exist or are being planned by the scientific members of ICSU as well as by sister organizations from within and outside of the UN system. We

wholeheartedly welcome all of these initiatives. ICSU is committed to ensure that all of our efforts are undertaken in a manner which avoids duplications and which leads to the development of complementary Programme components. The Scientific Advisory Council meetings provide an ideal opportunity to bring together the different organizations involved in working on the various aspects of the IGBP.

We are also aware of the need to consider the social context in which global change occurs and are grateful that those international organizations with more expertise than ICSU in this area, namely UNU, IFIAS, ISSC, etc. have proposed a Programme on the human Dimensions of Global Change which we have been following; and intend to continue to follow closely. We look to some of ICSU's Scientific Unions, notably the Geographers and the Psychologists, to help us in bridging the gap between the natural and social sciences in this important area. Finally, we are also aware of the development of numerous national IGBP committees and programmes, and are happy to note that many of these are represented here at this meeting. We realize that we will need much more national involvement in the IGBP, and are fully committed to helping IGBP communities develop in all parts of the world: North and South, and East and West. All of these will make up the truly international programme ICSU had in mind when it launched the IGBP.

In closing, your Majesty, your excellencies, ladies and gentlemen, I wish to assure you once again of ICSU's total commitment to the IGBP which we consider as our most significant undertaking, and the greatest of scientific challenges. As President of ICSU I have the pleasant task not only of chairing this Scientific Advisory Council but also of following almost daily the development of this Programme; and I wish all of us the best of success in this undertaking.

OPENING ADDRESS

Birgitta Dahl

Swedish Minister of the Environment and Energy

Your Majesty, Mr Chairman and conference delegates, ladies and gentlemen...

It gives me great pleasure to introduce this highly important conference. What you discuss and the conclusions you arrive at in due course will be of immense importance to further scientific and political endeavours where the global climate is concerned.

Each and every day, information on imminent environmental disasters reaches us. In a completely unprecedented manner, we must take heed of these warning signals and act promptly to reverse the trends. We must change our way of formulating the problems so as to look into the future more easily.

In the last few years, we have experienced the natural repercussions that occur when environmental destruction goes too far. We perceive certain threats to the environment directly, through our senses; others we see only through remote analyses and reworked computer models. But they spell out the same message: trends must be reversed.

In Europe during the 1970s and '80s, we have witnessed the profound effects of air pollution and acidification. Human influence has caused severe deterioration in forest land and groundwater. The land will take a very long time to recover. Problems of acidification are now increasingly apparent in other continents too - Asia and North America.

In the continent of Africa, crop failures and famine have been the outcome of an increasingly dry climate. The United States are experiencing the worst drought for fifty years. These warning signals may give great cause for concern, and we must take them seriously.

Environmental-policy decisions demand great responsibility on the part of us as politicians and scientists. Impatient citizens are calling for swift measures. But there are no short cuts to good results. Patience, a long-term view and an ability to assign priorities are required. It will take time to turn complex structures in an environmentally sound direction. That is why the insight that we must initiate or intensify the work must be very strong.

Swedish commitments and those of other European countries concerning sulphur emissions are having the effect of greatly reducing the deposition of sulphur. The reduction does not go far enough, it is true, but it will still enable us to see improvements in severely acidified lakes, without artificial respiration, in the foreseeable future.

Before I proceed, I would like to lay down certain starting points for our work. They may perhaps be self-evident to us - I believe they are - but they have not sufficiently come to permeate practical policy in many countries, or international agreements.

The first starting point is, of course, that the earth, with its natural resources, its beauty and its riches - everything we can base our livelihood on - is our joint responsibility. The human race must, in some respects, influence nature in order to be able to survive.

We in the industrial nations belong to the first generation that no longer perceives poverty and famine as the greatest threats to health and survival. Today, the greatest threat to humankind - second, of course, to military armament and the threat of nuclear war - is damage to the environment instead.

The human race represents something quite unique. That is our capacity for love and compassion and our insight, at least if one lives by the laws of humanism, that the physically weak also have a right to live. Our right to influence nature is connected with these human

traits. We must create living conditions that enable all human beings to survive and live a full and rich life, but we must do it without carrying on with our ruthless poisoning, destruction and over-exploitation of natural resources.

Threats to the global climate are nothing new, it is true, but indications of changes are coming ever more frequently and are a great deal clearer than they used to be. The situation calls for massive efforts. In purely general terms, I would like to emphasise that when it comes to suspected environmental problems we must act before they arise. All our experience to date indicates that we cannot wait for complete certainty about the severity of the problems before proceeding to act.

We know that climatic changes take place slowly and very sluggishly. When a rise in temperature has been clearly ascertained, we will irrevocably be faced by a substantial temperature rise. We must therefore act without being certain what the future is going to be like.

I can also affirm that we are currently beginning to get a consensus on efforts to prevent a rapid change in the climate. The message of the recommendations from the Toronto climate conference last summer is clear. Another encouraging fact is that questions of climate were a topic in the important detente discussions between the superpowers and the economic summit meeting in the summer.

Let me now turn the strategy of how we should tackle these problems. It is not mere politeness that prompts me to stress the importance of research here today. It is still true that we are genuinely uncertain about how the problems are interconnected, and about the various effects we fear. We must have greater clarity in these matters. Clear scenarios must be worked out, showing what various alternatives may involve. These, in turn, must lead to the right measures being taken.

Secondly, we must work for a global agreement on the reduction of greenhouse gases. Just over a year ago, an agreement was signed in Montreal on cuts in emissions of gases with a damaging effect on the ozone layer. In Sweden's view, it was gratifying that the agreement secured such wide support, and so quickly. It shows that the international community can act. But the agreement does not go far enough if we are to prevent the depletion of the ozone layer and the accompanying effect on the climate. Sweden - and I know that other countries are doing so too - is working to speed up the reduction plan. We ourselves have adopted a phase-out plan according to which all use of freon should have ceased by 1995, and most of this phasing out will already take place at the beginning of the 1990s.

But we must start now to work out strategies for how a change in the global climate can be prevented. I would like to identify some strategic issues.

The first is that, with varying degrees of difficulty, we can tackle different greenhouse gases. They cannot all be treated alike. Research in the past few years has indicated the importance of gases other than carbon dioxide. We have reasonably certain grounds for estimating that chlorofluorocarbons, CFCs, are responsible for one-quarter of the greenhouse effect, although the overall quantities are small in relation to other gases. What is more, the CFCs play a major role in the depletion of the ozone layer. A more rapid phase-out plan than that determined at the Montreal conference would therefore be of crucial importance to the climate as well. The Swedish government is therefore working for a tightening-up of the Montreal Convention.

The second issue is the rate of increase in carbon-dioxide emissions. Researchers have done some outstanding work in showing that the rate of increase and, by the same token, the oceans capacity to absorb carbon dioxide are of paramount importance to the pace of climate change. Greater energy efficiency and the use of fuels other than coal and oil are therefore strategic factors in decreasing the impact on the climate. We must therefore give priority to these fuels, such as natural gas and wood fuels. Obviously, the introduction of new, energy-saving technology is the best means of promoting the strategy of not changing the climate. But this development must also be stimulated. We must, especially in the industrial nations, configure our energy pricing in such a way that energy-saving processes and fuels with lower carbon-dioxide emissions are favored. This is particularly important at times of low international oil prices. In opening the Swedish Parliament recently, the Prime Minister declared that a charge

on carbon-dioxide emissions would be introduced for this very reason.

The third issue is that of the conditions of human development in the countries of the Third World. We know that poverty in these countries is leading to overexploitation of forest and other land, with deforestation as one consequence. This, combined with the ruthless felling of the world's rainforests by multinationals, also involves a major threat to the climate.

The fourth question is about the paths of development we can discern in the long term. The transport sector, which is expanding rapidly worldwide, runs almost exclusively on fossil fuels. Pollutants from the transport sector not only affect the climate but also contribute to regional pollution, such as acidification and eutrophication, and are among the major reasons for human ill-health. Today, techniques are being introduced that give us a certain breathing space. Harmful pollution is diminishing. But if motor transport is to be permitted in future, completely different transport systems, engine designs and types of fuel are called for. Already now, we must identify the requirements to apply at the beginning of the twenty-first century, so that an environmentally sound change-over stimulated and planned.

The energy system is facing the same challenge. For a number of years, the energy system has been becoming cleaner where traditional pollutants are concerned, at least in many Western countries. This is a development we have welcomed and should make the most of. But it does not go far enough in the long term. We must, to a greater extent than before, concentrate our efforts on the long-term conversion problems - how to get away from the systems that entail unacceptable risks. This is one of the crucial points in the Swedish strategy for converting the energy system. Neither nuclear power nor fossil fuels are a tenable solution to our energy problems in the long term. We must retreat from the cul-de-sacs that previous strategies for solving energy problems have involved.

Global agriculture also needs reforming. At present, our agriculture contributes to our unsound use of our economic resources and the environment. Agriculture, too, affects the climate by its intensive production methods.

Industrial production must be modified so that we avoid waste arising, both the actual process and in the final use of the products. Synthetic substances must be examined in a considerably more stringent way than has hitherto been the case.

I am basically an optimist. I believe that, with a combination of determination, boldness, the will to embark on the new, practical, day-to-day work of reform and the perseverance to stick at it, we can perform our tasks. Research is important not only to our ability to detect problems at an early stage. Research also has a major bearing on our capacity to meet the challenges entailed by the requisite changes. We must, quite simply, enlist research and technology in the service of humankind and the environment. In my view, this approach must from now on permeate work in all sectors of society, and at all levels in the community.

We in Sweden, as I said before, will intensify our efforts in international negotiations. As a practical contribution to this work, we have also set up an international institute of environmentally sound technology. This institute will have 25 million kronor at its disposal annually for the first five years. It is intended to be a place where knowledge of optimal technology can be compiled and evaluated, and from where it can be disseminated so as to be put into practice.

We are also working to initiate a new global environmental conference as a follow-up to the Brundtland Commission's report, which is now being discussed 20 years after the first. I think it should be possible to use it as a sort of lever to make international efforts more intense and far-reaching. But it must be a conference that convenes people to implement practical commitments in strategically important areas.

Your Majesty, Mr. Chairman, ladies and gentlemen!

In this address, I have underlined the need of vigorous and concerted commitments to prevent a deterioration in the climate. The world's nations must join to carry out large scale joint commitments. The Swedish Government therefore welcomes initiatives of this kind from various countries. We are prepared, in every way we can, to participate in international bodies

and other organizations in order to push development in the right direction. We are also prepared to make contributions ourselves, by practical actions to reversing the negative trend.

We are also prepared to support international research actively in order for the problems to be clarified. It is our hope that your work will succeed in promoting a more profound understanding among decision-makers in various parts of the world. It will take time to reverse current developments, and that is why we need to start now.

OPENING ADDRESS

Ingvar Lindqvist

President of the Royal Swedish Academy of Sciences

It goes without saying that this is indeed a great day for the Royal Swedish Academy of Sciences. It is a great day because we are honored to be hosting the first International Geosphere-Biosphere Programme (IGBP) Scientific Advisory Council meeting, and also because we are honored to have Professor Thomas Rosswall and the IGBP Secretariat permanently established on these premises.

It is also an important day for those Academicians who at an early date pointed to the importance of environmental issues and suggested that the Royal Swedish Academy of Sciences should play an active role in discussing, critising, and promoting research into these issues.

I dare suggest that these efforts have, at least indirectly, contributed to the formation of the present IGBP programme. This active interest in environmental issues is also manifested in the establishment of a special committee for environmental research at the Academy as well as in the publication of AMBIO: A Journal of the Human Environment.

Why then, among all the scientific issues to choose from, should the Academy take a special interest in environmental problems? I think the answer to this question is that environmental research is the most obviously multidisciplinary enterprise in natural science. This Academy has the competence and experience to cover the whole field of natural sciences. We also collaborate with some of the very bright young scientists who are as yet too young to become members of the Academy. Fortunately, this competence is connected with a genuine interest in the problems dealt with in the IGBP Programme.

Let me again express the honour and privilege we of the Academy feel in seeing and hearing you all at this very important meeting.

THE CONTRIBUTIONS TO AND THE ROLE OF THIRD WORLD SCIENTISTS IN THE PLANNING AND IMPLEMENTATION OF THE IGBP

Abdus Salam

Third World Academy of Sciences.

I am deeply privileged and feel honoured to have been asked to speak on behalf of the Third World. We are here today to consider global change - particularly the changes which can be attributed to human actions. One aspect of this is the Third World involvement - representing 3/4 of humanity and 3/5 of the land area of the globe - in the basic research which is needed. For my part - and speaking as a stark outsider to this subject (I am a humble Particle Physicist) - I am here to remind our colleagues from the North, that we - the scientists from South - will need all their moral assistance in this most exciting and intellectually challenging task of studying global change. Like the proverbial hungry man in the fable, who was asked what 2 + 2 makes, and could only say "four loaves of bread", I have come to suggest that we shall indeed need those loaves of bread.

Let us make no mistake about it. It appears today that the political climate, at least so far as the environmental part of our subject is concerned, has become a politically important issue in the North. Starting with Sweden's first commitment which dates from before the 1972 United Nations Conference and symbolised by His Majesty's presence here today, there is the growing perception by the leaders of the industrialised North, of the necessity to "befriend the earth". Mrs Thatcher, the British Prime Minister, for example, has recently spoken at her Party's Conference in Brighton confirming that "green" issues were now high on her political agenda. Her Government will take steps to clean up the industrial rivers of North and the Midlands and to diminish British reliance on fossil fuels (which have been blamed for acid rain and the greenhouse effect). She has also promised to cooperate with other countries to protect the ozone layer and to try to end the destruction of the world's forests by directing British overseas aid to help poor countries plant more trees. Likewise, during the US elections, both candidates have spoken about their earnest desire to protect the environment and to get the future government of the US actively engaged in this endeavour.

So far as the Third World is concerned, there was the response from the Norwegian Prime Minister, Gro Harlem Brundtland - of jointly chairing with the United Nations Secretary General, a meeting in Oslo in early July. Called at the suggestion of Mrs. Brundtland, the heads of 22 UN development agencies were asked to review the environmental constraints on development in the Third World. This indirect involvement of the developing countries together with the perception that without their full support no real long-term global change is likely to be meaningful in the environmental area is the second thing which I wish to emphasise. The reason for this interest is simple. The lungs of the earth - the tropical forests - are situated in the Third World.

In the same context, the London "Economist" of last week has connected the possibility of debt reduction with the protection of the environment since the debtor countries of the world are mostly the countries which happen to own the forests, like Brazil and Central America. It may be good to recall that some ten days ago an electric utility in Connecticut has contributed to the planting of 52 million trees over 1 000 square kilometers in Guatemala in order to combat carbon dioxide. A total sum of \$2 million from the World Bank. If we extrapolate this pricing mechanism to the 15m square kilometers of forests over the entire globe, we arrive at the colossal figure of around \$200 billion for the developing countries. This sum may seem large, though it is no more than 25% of the world's yearly global military expenditures. It would not make a big dent to the debt burden which currently runs to \$1.2 trillion. (It would just about look after 18 months interest on this loan). In Third World terms, however, it totals nearly six times the monies provided yearly by all Aid Organisations put together.

But talking of these shallow economics, I have stayed away from my real topic - the unique inter-disciplinary mix of Basic Science and Science in Application, in respect of studying the

phenomenon of life in its setting of the sun, the land, the oceans, the underground waters, the rivers and the atmosphere. I repeat what I read in your brochures - that theoretical models will be differentiated, using data bases and observation systems, to be located in all parts of the globe, linked with observatories and satellite data processed by large computers. This approach to global science certainly satisfies one of my personal cravings, that is for an organisation to be created which would directly worry about the global aspect of the earth as a whole, for example, whether its axis is in danger of tilting next year or whether the sun is going to shine with equal or enhanced intensity over the next one hundred years. Even the most obtuse ones of our planners may be able to understand the humility with which you - the real scientists - view the subject when you say quite bluntly that you need more of basic theoretical understanding before you can pronounce on any of the world's environmental-developmental problems.

"One of the great failings of past studies of large scale environment-development issues (and, indeed, of "systems" studies in general) has been their inability to foster a critical capacity for reflecting on the quality and credibility of their work. One result has been a deep distrust of such studies by other scholars. Another has been their virtual neglect by the policy community, at least in part because policy makers had no way to assess the substantive strengths and limitations of alternative studies and their recommendations". ("Sustainable Development of the Biosphere: Human Activities and Global Change" by William C. Clark and C. S. Holling, from Global change: Proceedings of the Symposium sponsored by ICSU during its 20th General Assembly in Ottawa, Canada on 25 September 1984, edited by T. F. Malone and J. G. Roederer, Cambridge University Press, page 474).

And even the most obtuse of our planners can understand that "while remote sensing in the broader concept is still in proof stage, there have been fine applications to specific regional problems, for example, the United Nations Food and Agriculture Organisation's (FAO) desert locust control programme. If desert rains come early, abundant vegetation appears and locust swarm to eat the food supply of a hundred thousand people per day.

"In what would be described as a modest infestation in 1980, to locust swarm covered 6000.000 square km, of the southern Sahara and cost more than a quarter million dollars to control. With hindsight it now seems clear that the outbreak could have been prevented. A satellite image of Mali in June 1980 revealed the source of the locust swarm as in an 800 square km growth of vegetation. An area that small could easily have been sprayed and the locusts wiped out. Unfortunately, the image processing was then a year too late". ("The Science of Global Change - An Overview" by Herbert Friedman, from Global Change: Proceedings of the Symposium sponsored by ICSU during its 20th General Assembly in Ottawa, Canada on 25 September 1984, edited by T. F. Malone and J. G. Roederer, Cambridge University Press, page 474).

But what do the leaders in the Third World really think at present? Apart from the devastation caused by forests being cut and the consequent recurrent floods, as in Bangladesh - and apart from the rapidly increasing pollution in our cities - so far our leaders in the Third world have not recognized that the environmental problems are also their problems. Dumping of the Northern chemical wastes in the Third World has not helped, nor have the newspaper murmurings of the greenhouse effect nor the distant destruction of the ozone layer. These are all supposed to be problems which have been brought about by the actions of those in the North.

The first thing for our governments is to realise that even if historically this may be the case, we are all parts of the same global ecosystem and the devastation of one component of the globe is going to affect us all equally. Like the nuclear winter problem, there are going to be victims, no tigers - not even paper tigers. In this respect, the Third World Academy of Sciences and its political arm which was constituted two weeks ago - the Third World Network of Scientific Organisations (TWNSO) could perhaps help.

The Third World Academy of Sciences was founded by a group of scientists from the developing countries who belonged, in their personal capacities, to the prestigious Academies of the North, such as the Royal Swedish Academy of Sciences, the Royal Society of the United Kingdom, the Pontifical Academy of Sciences in Vatican, the Accademia Nazionale dei Lincei of Italy, the Soviet Academy of Sciences, the National Academy of Sciences of the

United States of America, the French Academy of Sciences and the like. Among them were nine Science Nobel Prize Winners then living, who were born in the Third World. The founding meeting of the Academy took place in November 1983 and the Academy itself was officially inaugurated by the Secretary General of the United Nations in July 1985. We have at present around 132 Fellows, 49 Associate Fellows and 20 Corresponding Fellows from 46 countries. Through a generous grant from the Italian Government and the Government of Canada, we have been able to award 240 Research Grants (of the order of \$5 000 each), to researchers in the Third World plus 123 South-South Fellowships to facilitate visits of scientists within the Third world, plus 86 Fellowships of the order of \$15 000 each - to those wanting to pursue their research work in collaboration with Italian Laboratories. In this respect, we are acting as the Basic Sciences counterpart of the International Science Foundation located here in Stockholm.

One of the political projects we have spawned, in concert with the African Academy of Sciences - which itself was the outcome of the African scientists coming together for the first time in Trieste in July 1985 - is the Drought, Decertification and Food Deficit Project (DDFD) which - in concert with your thinking - starts with the premise that what the Sahel region needs is the basic study of the interaction of the Sahel - its atmosphere, the sun and its underground waters. There is need to create a network of institutions around Africa which should carry these researches, and we are trying to help build up such institutes.

As I said above, the meeting of the Third World Network of Scientific Organisations which was held two weeks ago, brought together 15 Ministers of Science, Technology and Higher Education, 12 Presidents of Academies of Science plus 17 Chairmen of Research Councils from 38 Third World countries. We decided to create a scientific organisation for looking after global science - and also, inter alia, act as a pressure group for Science within the Third World - on the pattern of the Group of '77. The current membership of the Network consists of 89 Ministers of Science, Technology and Higher Education plus Academies plus National Science Research Councils from 60 Third World countries. One of our first speakers at the establishment meeting of the Network two weeks ago was ICSU's President, Professor M.G.K. Menon, who spoke about the possibilities offered to the Third World by the International Geosphere-Biosphere Programme (IGBP). Thus, today's ICSU initiative has come to be well-known in the Third World and I am sure that when the organisation you are setting up needs to, it will get first-class representatives from the organisations which were represented at the Trieste meeting.

Where are we lacking in the Third World? We suffer - most of all from lack of recognition of Science as a valid profession in our countries. Because of this, we are seldom asked to take care of the development projects in our own countries. We lack scientific manpower, we lack international contacts, we suffer from isolation, we lack scientific literature. In fact, the Third World Academy of Sciences is hosting a meeting next Monday and Tuesday where leading publishers from the North are meeting with some of the aid agencies and where we would like them all to sign a Trieste Convention which says that it is the "birthright of a scientific community in every country to be provided with at least one copy of every scientific journal and every scientific book". We shall appreciate any help you can give us in this endeavour.

What should be our priorities? Our first priority should be to educate our leaders (as those from the North have succeeded in educating their leaders).

Secondly, I have personally always believed that increasing the scientific manpower and increasing the awareness among the scientific manpower which is already available, should always be one of our first priorities and that international centres of the type which I have had the privilege of leading for the last 25 years, is one of the important modalities in getting this done. I am speaking about the IAEA-UNESCO-run International Centre for Theoretical Physics which has trained (for research) 18 000 men and women from the Third World in Higher Physics - including some aspects of the subject of this Conference, like the Physics of the Decertification Process, the Physics of Soils, the Physics of the Ionosphere, and the Physics of Earth, the Atmosphere and the Oceans - taken as high-level Research courses and workshops at regular intervals of two years, to which around 100 Third World scientists come to participate. We are just now involved in the exercise of setting up three more centers for the Third World (like the International Centre for Theoretical Physics). One of these Centres will be on Earth Sciences and the Environment, the second on pure and Applied Chemistry and the third on

High Technology and New Materials, on behalf of the Government of Italy. May I request that your international committee should act as the Scientific Committee of the Centre for Environment, that it should house itself in Trieste permanently, and that the new Centre on Earth Sciences and the Environment - as soon as it comes into being next year - shall be devoted to the problem of training more high-level people, both from the developed and the developing countries, in the inter-disciplinary areas which your Conference is looking at. What I would like your Conference to do is to give us a pledge in return (on behalf of the organisation which you will create) that we shall be helped in this endeavour, particularly by providing us with directors for our activities and lecturers.

We hope this new Centre will be a United Nations Centre like the International Centre for Theoretical Physics. It will then be an international Centre - not belonging to one country but to the whole of mankind. It will be your Centre. It may be founded to the extent of \$10 million a year when it is fully operational through the generosity of the Italian Government. I shall, of course, be seeking more funds for all these three Centres while I am in Sweden.

I have been authorised to make the pledge that from the Third World Academy of Sciences side, funds will be made available each year for twenty grants of \$5 000 for research work in developing countries on Environmental Studies. On the side of this conference, I would like you, when you set up your organisation and budget funds for it, always to add an additional 10% for the Third World. Half of these funds will go to the four giants of Science in the Third World, Argentina, Brazil, China and India. The other half will go to the rest of the Third World countries.

Perhaps I should speak of the fifth giant of Science - South Korea - which is fast coming up in terms of numbers of scientists and technologists supported by its 3% of GNP spending on Science and Technology research and development - the same as Japan.

You may have noticed that I have always used the words Basic Sciences in all my references to the work of this conference. The words Basic Science have a pejorative meaning in the Third World. I would like to eradicate that impression as much as possible by aligning it with your work. You are the successors to the nuclear physics community which was in the ascendant in the days of yore. The world has decided - quite rightly - that protection of the environment is its major concern after nuclear detente is signed and I pray that work here in the next five days is blessed with the success it deserves.

**WMO PROGRAMMES AND THE IGBP
A PROPOSAL FOR A PARTNERSHIP**

G.O.P. Obasi

Secretary-General
World Meteorological Organization

Introduction

The World Meteorological Organization has followed with great interest the initiative taken by the International Council of Scientific Unions (ICSU) to develop the International Geosphere-Biosphere Programme (IGBP), and also the progress made by the scientific community in defining the main scientific thrusts of this programme. WMO has recognized that on the one hand it could contribute substantially to IGBP and on the other, co-operation with IGBP would help to put WMO activities in broader context.

There are, of course, many important connections between the dynamics of the atmosphere-ocean-ice-land surface system, the main focus of WMO activities, and the bio-geochemical problems which have been identified as aiming to acquire, analyze and interpret worldwide observations of the atmosphere, hydrosphere and oceans, can provide a fundamental global information base required for the development of IGBP studies. Assessments of scientific progress in connection with changes in the framework of WMO programmes. We believe that there is both the need and the goodwill, for mutually beneficial participation of WMO in IGBP activities, and for ensuring that the IGBP enhances the value of WMO programmes.

More specifically, one can see that ICSU is ideally suited to muster the wide range of scientific expertise needed to approach the essentially multi-disciplinary problems of global environmental change. Scientific progress in these fields must often rely upon global observing and data management systems, well beyond the normal resources of an individual scientific team or a grouping of laboratories. It is a main *raison d'être* of an intergovernmental organization like WMO, to work with its 100 National Members to attend to these operational tasks and produce the systematic observations necessary to understand the changing atmosphere, as well as for applications in weather forecasting, climatology and water resources management.

Allow me to outline in a little more detail the WMO programmes which are closely related to the IGBP.

WMO programmes of interest to IGBP

1. The world Weather Watch

The IGBP Report No. 1, 1986, provides a clear rationale for the importance of a global data and communication system which will provide rapid communication between organizations and scientists.

The report states in connection with a "Global Data and Communication System":

"The IGBP will require a new global data and communication system to handle and disseminate the vast amount of information that will be generated and obtained;

A comprehensive data system employing modern techniques of data storage and worldwide access is a task of great magnitude - and perhaps the largest single challenge of the IGBP".

The WMO World Weather Watch Programme is a successful existing system upon which the IGBP can build to meet its needs for a global data and communication system.

The Production, collection, processing and distribution of meteorological and other environmental data is the role of the World Weather Watch (WWW) which is the core programme of the Organization. The WWW is an integrated system composed of national facilities and services owned and operated according to an agreed global scheme by individual Member countries of WMO. It is unique in the field of international co-operation. In no other field, particularly in science and technology, is there such a truly world-wide operational system to which virtually every country contributes for the common good.

It has three basic components: the Global Observing System (GOS) comprising some 10,000 observing sites on land, 7,000 ships at sea, as well as upper air stations and 9 weather satellites for observation and measurement of meteorological and related elements; the Global Telecommunication System (GTS), a world-wide system for the rapid real-time exchange of observational data, as well as of analysed and processed information, including forecasts. These analyses and forecasts are produced by the third main component, the Global Data Processing System, a network of three world and 26 regional computerized analysis centres. The implementation of the WWW does, of course, require constant attention to the standardization of observing and measuring techniques, to the development of common telecommunication procedures and protocols and to the presentation of both observational data and processed information in a manner understood by all, regardless of language.

Data from all of the collection systems are transmitted by the GTS which currently conveys over 15 million characters of alpha numeric data and 2000 weather charts daily. The GTS comprises a Main Telecommunication Network (MTN) which has 21 point-to-point circuits connecting the three World Meteorological Centres, 14 Regional Telecommunication Hubs (RTH) and a regional network which serves a further 16 RTHs and 149 national centres. This makes in all, a planned 259 circuits. At last count, 220 are operating effectively. Almost all centres on powerful computers allowing the collection, sorting, selection and retransmission of vast amounts of data exchanged at speeds of 9,600 bits per second.

In the Global Data Processing System, the three World Meteorological Centres undertake analysis and forecasts on a global scale making available about 350 analyzed products daily to the Regional Centres, which, in turn have an output of over 2000 products for use by National Meteorological Centres. Some of the Regional Centres have become highly specialized - such as the European Centre for Medium-Range Weather Forecasting, and the Typhoon Centre in Tokyo.

The main benefit to IGBP of making maximum use of WWW as a building block is that it provides a set of standardized procedures to observe and disseminate geophysical information in real time to users around the globe. The telecommunication system ranges from advanced satellite-computer links to ordinary telegraph/telephone lines in developing countries, all merged into a single integrated system based on the ISO Open System Architecture. This permits the incorporation of very different levels of technology into one integrated system. A further advantage of the WWW for the IGBP to build upon is that it is an existing system which has operated in a progressively more advanced manner for the past twenty-five years.

The World Weather Watch, originally developed for immediate applications to weather warning and forecasting, has already shown a capability to handle other kinds of environmental information, including oceanographic data, through the Integrated Global Ocean Services System (jointly organized by IOC and WMO). Other examples of broader uses include transmission of information concerning the accidental release of radioactive substances and their long-distance transport in the atmosphere, and level one seismic data. This was a brief overview of WMO's largest programme, but other WMO activities can also make major contributions to the goals of IGBP.

2. Hydrology and Water Resources

The WMO Hydrology and Water Resources Programme is concerned with the supporting, standardization, collection and use of hydrological data at national and international levels. There are close links with the World Climate Programme in the joint monitoring of atmospheric and hydrologic variables, including the modelling of evapotranspiration and runoff processes.

3. Environmental Pollution Monitoring and Research

Two well-established global observation networks co-ordinated by WMO have assumed greatly increased importance because of concerns over the changing composition of the earth's atmosphere. One is the Background Air Pollution Monitoring Network (BAPMoN) with more than 200 stations world-wide, located away from cities or major pollution sources. This network began officially nearly 20 years ago, and some developed countries designated stations established earlier, as part of the network. Trends in global and regional concentrations of carbon dioxide, sulphur and other contaminants in rain water, and in dry fallout and suspended particulates, as well as turbidity measurements, are assessed by means of BAPMoN data. Similarly, the Global Ozone Observing System initiated over 25 years ago has provided the foundation for much of the recent assessment of depletion of stratospheric ozone layer.

4. World Climate Programme

Probably the best documented global environmental changes are those associated with natural or man-induced variations in background air pollution, ozone and the global climate. WMO, in co-operation with ICSU and UNEP, has long recognized these problems and has undertaken to carry out the World Climate Programme with four main components: (1) data collection and management, (2) applications of climatic data, (3) economic and societal impacts of climate change, and (4) research problems.

a) World Climate Data

The World Climate Data Programme (WCDP) consists of a number of major projects for transfer of technology in climate data management and applications of data (CLICOM), implementation of the Climate Data Referral System (INFOCLIMA), development of global and regional climate data sets, and a Climate System Monitoring (CSM) capability.

CLICOM (Climate data management using microcomputers) has provided a basis for developing climate data sets that were not accessible earlier for many scientists and other users, especially from developing countries. More than 50 developing countries are being assisted to install this standard system and set of software packages. The INFOCLIMA project involves preparation of a computerized catalogue on the availability of climatic data world-wide.

The Climate System Monitoring (CSM) project was initiated in 1984. CSM is designed to provide Meteorological Services and other national and international organizations with analyzed information on the state of earth's climate system, and diagnostic insights into significant large-scale anomalies of regional and global consequence. A CSM Monthly Bulletin has been issued since July 1984.

b) Research on Global Climate Change

You are undoubtedly familiar with the activities of the World Climate Research Programme (WCRP), undertaken by WMO in co-operation with ICSU and guided by the WMO/ICSU Joint Scientific Committee. This Programme aims to develop the understanding of climate dynamics, that is to say establish quantitative formulations of the physical processes which control the time-dependent behaviour of global geo-physical fields, over periods of months, year and decades. Some facets of this Programme are intimately connected with the practical problems of extended-range seasonal weather forecasting, which are of major concern to WMO Members. Some of you may feel that these activities are not really relevant to the geo and biosciences. Indeed, it has long been a common view in parts of the scientific community that weather, and seasonal or interannual variations of the atmospheric circulation due to fast-coupled ocean-atmosphere dynamics, such as observed in El-Niño-Southern Oscillation events, could be lumped into some form of "meteorological noise". The hope was that these events could be conveniently ignored when considering the more exciting problem of "global change".

On the contrary, it is a basic scientific assumption of the World Climate Research Programme

that the distinction between "weather" and "climate", although convenient at times, cannot be made in principle. In the first place, climate is nothing but the cumulative effect of weather. Models and sensitivity studies can only be trusted insofar as the mathematical tool used is able to simulate realistically the presently observed weather and climate. Furthermore, there is no easy way to separate the "climatic signal" which may be the manifestation of a long-term trend caused by changes in specific forcing factors, from the "noise" generated by the internal dynamics of the Earth System on practically all time-scales accessible to our observations

The main WCRP projects are: the Global Energy and Water Cycle Experiment (GEWEX), the Tropical Oceans and Global Atmosphere (TOGA) and the World Ocean Circulation Experiment (WOCE), as well as projects on Sea-Ice Research, Land Surface Hydrological Processes, Cloud-Radiation Feedback and on the effects of the Radiatively Active (greenhouse) Gases. These all directly contribute to the solution of the scientific problems of global environmental change.

c) Intergovernmental Panel on Climate Change

The goal of IGBP is to describe and understand the Earth system and the manner in which it is influenced by human actions. One of the prime current concerns is the human role in bringing about a change in the planet's climate. In order to assess the results of scientific studies and data, and to generate and debate ideas on how humanity can meet the challenge of climate change, WMO, jointly with UNEP, is establishing the Intergovernmental Panel on Climate Change. The Panel consisting of national representatives drawn from scientific environmental and policy agencies will have its first session in Geneva from 9 to 11 November 1988. The review of the scientific knowledge and its interpretation, in terms of public policy both national and international, will be the vital tasks of the Panel.

Conclusion

The significance of the basic scientific research which will be undertaken under the IGBP is well recognized by all. Studies of global environmental change and the collection exchange and analyses of essential global data sets are vital parts of WMO activities and we are willing to work as an active partner, through our existing programmes, to help ensure the success of IGBP. In doing this, WMO would also be helping to discharge its own responsibility in the face of growing concern of our Members about changes in earth's atmosphere and climate by human activities.

BRIEF MESSAGE

Genady Golubev

Assistant Executive Director, UNEP

Mr Chairman, Excellencies, Distinguished Colleagues, Ladies and Gentlemen:

On behalf of the Executive Director of the United Nations Environment Programme, Dr Mostafa Tolba I bring you greetings and very best wishes for a successful, productive meeting.

Introduction

UNEP is extremely interested in the activities of IGBP for two overriding reasons. The first is that we attempt to base all of our activities in monitoring, assessing and managing the environment on the best scientific information available. IGBP clearly represents a constellation of the world's best scientific brainpower which could be assembled to deal with the complexities involved in global changes. We anticipate that the results from the work of IGBP will contribute substantially to the scientific basis of the UN Environment Programme. The second reason is that a major preoccupation of UNEP over the next few years will focus on the impacts of climate change. Once again, we hope that many of the vast array of scientific gaps in this field will be filled by IGBP.

We observe impressive progress to date, and let me pass on UNEP'S congratulations to the Special Committee, the Panels and Working Groups. In a relatively short time you have gone quite far and produced an orderly, scholarly and thoughtful plan concerning what may after all be Man's most ambitious enquiry so far into our fundamental life-support system. I will return to Man (and Woman)-related issues at the end of my remarks.

While we recognise and support the need for the four Panels to coordinate work in major scientific arenas and the four Working Groups to perfect methodologies, we would encourage the Special Committee to accelerate the development of a global workplan, in particular addressing the practicalities of implementation.

UNEP'S potential contribution to global change activities is unique. Although our role is well-known to be coordinating and catalytic, we often sail quite close to the edge of being operational, particularly when there is a gap in knowledge or methodology to be filled. In such a case, our relative flexibility and ability to act quickly, compared to many international agencies, allows us to step in until one of our agency partners can pick up the thread. In particular, UNEP has a special position as translator of scientific results into policy, of helping to bridge the gaps between the scientists and the decision makers.

Potential areas of cooperation

I wish to touch very briefly on a number of UNEP'S mandated activities which we feel will be able to contribute directly and concretely to the studies of global change over the next decade and beyond. And since I am in your territory, so to speak, I will refer to UNEP activities using IGBP organisational nomenclature. I stress that I will at this stage just list areas, and hope to have the opportunity during the meetings over the next few days to provide more substantive interventions.

1. Biosphere-atmosphere interactions

a) Biogeochemical cycles

Concerning the field of biosphere-atmosphere interactions, UNEP has and will continue to support the investigations of SCOPE into the biogeochemical cycles, particularly sulphur and

carbon. Clearly such studies are crucial to the IGBP investigations of global change.

b) Ocean studies

Intensive research and monitoring programmes involving hundreds of national institutions are being organized and supported by UNEP. In the framework of GEMS, the Global Environment Monitoring System, the monitoring of sources, levels and effects of contaminants follow similar masterplans and, using standardized methodology, yield globally comparable results. In addition, for example through GESAMP, the Group of Experts on Scientific Aspects of Marine Pollution, UNEP sponsors studies relevant to IGBP, notably studies on the global oceanic cycle of selected contaminants, including their exchange and transport through the oceans and other biosphere components. We offer the results of such studies as a concrete contribution to IGBP.

c) Biospheric aspects of the hydrological cycle

I feel very strongly that IGBP has a special opportunity to steer the classical hydrological approach towards an integrative perspective which will help us to examine and understand the hydrology of ecosystems. I will have much to say about this in the next few days.

d) Effects of Climate Change on Terrestrial Ecosystems

UNEP affords the highest priority to the concerns of climate change. In the field of Effects of Climate Change on Terrestrial Ecosystems, UNEP is contributing to the global effort in several ways.

We attempt to improve the knowledge base of climate scenarios by assembling scientists and supporting the World Climate Programme together with WMO. We hope that this will lead to refinement of the general information provided by global circulation models, and in particular to more accurate regional scenarios.

Since it is almost impossible to consider climate change impacts on the land without reference to processes and effects in the oceans (sea-level rise being an obvious one) we have launched a broad enquiry into the impact of expected climate changes on coastal ecosystems and would encourage the relevant Coordinating Panel to consider ocean-related effects as well in the first instance.

We contribute to the assessment of likely impacts on sea-level and production systems, through, for example, the work of GEMS-Atmosphere, the Regional Seas Task Teams on Implications of Climate Change, and some case study modelling with GRID.

We are also attempting to help governments develop policy options - largely limitation or adaption strategies - to likely climate change impacts, through the work of GEMS-Atmosphere and the Advisory Group on Greenhouse Gases, the Intergovernmental Panel on Climate Change with WMO, the activities of the Beijer Institute, and through the mechanisms offered by the Regional Seas Programme.

We hope the facts and predications marshalled by the foregoing will provide the ammunition for an international convention and with its associated science-based protocols for controlling the anthropogenic contributions to climate change.

We would urge the Coordinating Panel to address in the context of climate change, the question of impacts of change on biological diversity, drawing as appropriate on the experience and information sources available in such bodies as the International Bureau of Plant Genetic Resources and IUCN's World Conservation Monitoring Centre.

e) Geosphere-Biosphere Observatories

Concerning the proposed Geosphere-Biosphere Observatories, I believe there are two areas in particular in which we can cooperate. One is through the potential combining of efforts of our current "Integrated monitoring" activities with the proposed "Cooperating GBOs", Geosphere-Biosphere Observatories. We can discuss this in detail later, but at this stage permit me to flag

my concern with the practical ways and means for establishing and financing such Cooperating GBOs.

Similarly, the functions of the planned IGBP Research and Training Centres overlap in a number of respects with those of UNEP's GRID Regional Nodes of which there are currently three, in Nairobi, Geneva and Bangkok. Here again, we should explore the practicalities of merging our efforts for the most cost-effective results.

f) Methodology development

The tasks of the IGBP Working Groups clearly cut across sectors and deal with the methodology of global change studies: modelling, data management, retrospective analyses and data capture. I have already noted our experience in monitoring related to GBOs, and would like at this juncture simply to name a few areas in which UNEP has something specific to contribute to IGBP.

These areas are: ecological monitoring, remote sensing, the development of quality assurance techniques and reference standards for environmental monitoring, and the application of geographic information system - GIS - technology for data management and integration. Concerning the latter, we feel that UNEP's Global Resource Information Database, GRID, has much to offer IGBP.

Some conceptual concerns

Mr Chairman, permit me to finish by raising some questions concerning not the sciences involved in what we are trying to achieve with IGBP, but with the concept and administration of the Programme. I regret I cannot supply you with ready answers to the questions, but feel very strongly that if the studies of IGBP are to have real impact we - the Scientific Advisory Committee - must address them.

There is, we all know, a perennial gap between science and application. The answer is not just to gather more information, and let us be realistic, those funding our efforts will not accept such a proposal on its own. My question is: how do we close the gap?

The Plan for Action is comprehensive and thoughtful, as I have said. But do we need to wait for the next biennium for action? How do we accelerate our studies and understanding and thereby the necessary management actions?

The question of data management we will discuss later this week, and I believe that geographic information system technology will loom large. However, over and above the tools we use, how can we ensure that the world at large has free access to the world heritage of data?

We are all here it seems as earth or atmosphere scientists, but do we not need to consider bridging the gap between our sciences and the social sciences? There are two attendant questions: how do we account for the effect of man-made perturbations and assess the relative importance between natural and anthropogenic changes? Secondly, can IGBP avoid the responsibility for ensuring that its scientific results are relevant and directly applicable to the dependant social, economic and human welfare consequences? It is not so that we are really only concerned with global change because of the ultimate impacts on ourselves? In other words, the human dimension of global change is of the utmost importance and UNEP therefore intends to play a major role in translating the knowledge gained by IGBP into policy action.

Closing remarks

For these reasons, UNEP is, and will continue to be, one of the major supporters of and contributors to the core IGBP project, both financially as well as intellectually by introducing you to and nominating both our staff and associated experts to assist on the Panels and Working Groups. We also hope we will be able to assist in defining needs in terms of information required for policy and decision making.

Mr. Chairman, Colleagues, once again please accept UNEP's very best wishes for a successful and productive meeting.

BRIEF MESSAGE

Mario Ruivo

Secretary,
Intergovernmental Oceanographic Commission (IOC), Unesco

Your Majesty, Madam Minister, Mr. President of ICSU, Mr. President of the Academy of Sciences, Conference Participants, Colleagues:

The Director-General very much regrets not being here today but, as you know, he is involved at present in the Session of Unesco Executive Board, and has asked me to represent him here. He takes a personal interest in ICSU/IGBP activities and has asked me to convey his best wishes to you for fruitful work. The fact that he has designated several senior colleagues of Unesco's Science Sector to attend this first meeting of the Scientific Advisory Council of the IGBP is more than a mere expression of interest: our presence here today - and we are grateful to you for having arranged it - bears witness to the spirit of partnership in Unesco-ICSU relations.

The Director-General has stated the importance he attached to IGBP on several occasions, such as when he visited the US National Academy of Sciences on 14 April this year. He has also emphasized his intention to develop the required arrangements with a view to maximizing the results for ICSU, Unesco and Member States.

Having closely followed the various stages leading to the creation of IGBP, Unesco has already contributed to some of the preparatory activities.

Unesco has several scientific programmes active in the field of global change, and looks forward to continuing to co-operate with ICSU and the scientific community on the International Geosphere-Biosphere Programme (IGBP).

Unesco at the present time is undergoing a major evolutionary step. The Director-General of Unesco has presented his vision for this evolution in the outline of the draft third medium-term plan for 1990-1995 (document 130 EX/4). In order "to do better" by "doing less" (para. 51), he proposes "the strengthening of co-operation with international non-governmental organizations with a view to making the Organization's action more effective and more wide ranging" (para. 19).

It is further proposed in the draft plan to contribute "to the study of the changes and risks affecting the earth's environment, in co-operation with the Programme on Global Change of the International Council of Scientific Unions" (para. 35), as well as to promote "international scientific co-operation in the study of global change at both regional and national levels (in particular in the developing countries)" (para. 36)

This contribution would be "to the gradual establishment, under the main programmes on environmental protection and natural resources management for sustainable development, of networks for research, dissemination of data and monitoring of the changes in and the risks threatening the global environment (in conjunction with the Global Change Programme of...ICSU)" and the "preparation of studies, models and scenarios concerning the impact of global changes on societies" (para. 134) (in interface with Unesco's Major Programme Area on Man and Society in a Changing World and with the International Federation of Institutes for Advanced Study).

Since ICSU has decided to concentrate in the IGBP on the interactive physical, chemical and biological processes that regulate the total earth system, the social science contribution of Unesco as described in the latter part of the above paragraph represents one of Unesco's complementary roles to ICSU.

The Unesco programmes, which contribute to the study of global change, do so through direct co-operation with the scientific community at the national, regional and global levels, through co-operation with ICSU bodies, and through intergovernmental co-operation. These programmes concern principally terrestrial ecology (through the Man and Biosphere Programme), freshwater and hydrology (mainly through the International Hydrological Programme), geology (especially through the International Geological Correlation Programme), marine science and ocean observing systems (especially through the inter-regional Project on Coastal Marine systems and the Intergovernmental Oceanographic Commission). The programmes dealing with climatic change and the hydrological cycle have strong research components on relevant atmospheric processes, in co-operation with the World Meteorological Organization and certain bodies of the ICSU system.

Unesco has collaborated with the International Council of Scientific Unions (ICSU) during Unesco's entire 42 years of existence to promote scientific research and co-operation. That collaboration has significantly benefitted the scientific community, as well as being mutually beneficial to both organizations. The International Geosphere-Biosphere Programme (IGBP) offers a new opportunity to continue that fruitful co-operation.

Most of the Unesco scientific programmes which are active in the field of global change are closely associated with various ICSU bodies. Some of the scientists involved in these programmes have been active in the planning phase of IGBP. They and many of the others will be active in the IGBP research programme. Everyone would benefit by linking these Unesco programmes in some way to the IGBP, which should include interactions between terrestrial, freshwater, oceanic and atmospheric systems.

Unesco, an intergovernmental body, and ICSU, a non-governmental body, both promote science and have complementary and mutually supportive roles. By working together, they can produce more than the sum of their individual outputs. The possible co-operation with respect to the IGBP between ICSU and Unesco should depend on the needs of the scientific community concerning the IGBP research programme.

Unesco has already formally consulted with its Member States through its governing bodies, and those of its scientific programmes, on how to facilitate potential co-operation with the IGBP, as stated in the reports of the relevant bodies. Unesco has also undertaken informal discussions with some of its scientific constituency on how the Organization could co-operate with ICSU in the IGBP. Many scientists, particularly those in the Third World, would like to see strong programmatic linkages, since they expect to be active in both IGBP and in Unesco programmes. Examples here concern research in marine coastal processes, on marine-terrestrial interactive processes, and on the coupling between coastal and open ocean processes, as well as on the interchange of substances between the terrestrial, freshwater and marine environments. All of these areas are covered by the Unesco science programmes. IGBP recommendations for research have already been incorporated into the draft plan for the fourth phase of the International Hydrological Programme and are under study by IOC. Other examples concern co-operation on establishment of the geosphere-biosphere observatory infrastructure, and collaboration with the existing ocean observing and monitoring systems established in the framework of IOC. Other scientists, particularly those active in well-organized global programmes, prefer a looser arrangement until the research plan of the IGBP is clear.

Exchange between ICSU and Unesco has already been close in the planning phase of the IGBP. Future possible co-operation can take many forms. For example, Unesco might provide an intergovernmental mechanism to mobilize required governmental support to the programme which is planned by the scientists through ICSU. Unesco could provide the active support of and interaction with its scientific programmes and observing systems already in operation. In addition, specific joint or closely co-ordinated projects could be organized, particularly in areas where Unesco already involves scientists in strong relevant programmes, such as in the Third World. It might be useful to have a joint co-ordinating committee.

Unesco already provides substantial input to the question of global change and IGBP-related matters through its on-going programmes. Because of this and the existing momentum of Unesco's research programmes which require the planning of activities well in advance of the adoption of the IGBP research programme, Unesco is already committing some resources for the initiation of possible collaborative activities.

At present, major contributions to IGBP can be expected to materialize through Unesco's intergovernmental programmes such as IGPC, IHP, MAB, the programmes of IOC and newly developed activities in the field of energy. These programmes, while they rely on scientific research and services and on the strong participation of national scientific communities, provide a coherent framework of action at the regional and international levels, with the active involvement of governments.

If environmental matters have been a major aspect of Unesco's science programmes, they are likely to become one of the priorities within the third Medium-Term Plan of the Organization for the years 1990-1995, which is just now being elaborated. In fact, in his introduction to the Annotated Outline of this Plan, the Director-General puts the protection of the earth's environment as one of the three major challenges for the future, the other two being "peace" and "development". Unesco's interaction with IGBP will, no doubt, receive a prominent place in the final version of the Medium-Term Plan. Already concrete references to IGBP appear under a heading called "Global changes in the environment" which will bring together the "contribution(s) to the gradual establishment, under the main programmes on environmental protection and natural resources management for sustainable development, of networks for research, dissemination of data and monitoring of the changes in and risks threatening the global environment". Unesco is in a unique position to contribute also to societal aspects of Global Change through its activities in the field of education and the social sciences.

Unesco is committed to continued support to ICSU, and is ready to establish a close relationship between the IGBP and the Unesco specialized programmes related to global change. It is up to ICSU and the IGBP Scientific Advisory Council to decide on how they might wish to co-operate with Unesco.

We look forward to the results of your meeting to provide guidance for the elaboration of our own complementary interdisciplinary programmes in various fields relating to the geosphere-biosphere and, we hope, joint ventures in areas of mutual interest.

BRIEF MESSAGE

Roland J. Fuchs

Vice-Rector, United Nations University

Your Majesty, Yours Excellency Minister Dahl, President Lindqvist, President Menon, Colleagues and Friends:

On behalf of the United Nations University and its Rector, Dr. Heitor Gurgulino de Souza, may I add our greetings to those of the participants in the First Meeting of the IGBP Scientific Advisory Council. As an institution mandated to study pressing global issues of human survival, development and welfare, the University is keenly aware of the threat to human habitability of the earth, and thus of human survival, posed by global environmental change. We wish to congratulate ICSU for its initiative in undertaking this timely international and interdisciplinary programme, and your Government for its generosity in funding the Secretariat.

Serving in another capacity as a member of a delegation at the Berne ICSU General Assembly, which authorized the Programme, I was but dimly aware of the audacity of ICSU in contemplating such an ambitious programme - a programme that involves harnessing many disciplines, institutions and individuals and, also, raising substantial resources. The planning of such a long-term programme is by itself an enormous and time-consuming task and we are all in the debt of Dr. McCarthy and his colleagues on the IGBP Steering Committee and in the various Working Groups who have devoted so much time and effort to formulate the impressive plans that are being reported at this meeting.

The UN University, since its earliest years, has had a major programmatic concern with global environmental and related resource issues. Under a programme entitled "Global Life Support Systems", we are currently engaged in studies of the climatic, biotic and human interactions in the humid tropics; sustainable use of fragile environments, such as mountain and highland systems; and of renewable energy sources and planning.

The University's most recent activity in this field is a joint venture with IFIAS and ISSC to develop an international programme entitled "Human Dimensions of Global Change", intended as a human and social science effort to complement ICSU/IGBP. The status of this programme will be reported upon in some detail later at this meeting, but I am pleased to tell you that at a symposium held at the UN University in Tokyo immediately following the Beijing ICSU General Assembly, a group of nearly 100 human, social and natural scientists urged the early initiation of an international research programme to investigate both the humancauses and consequences of global change. Specifically, the purposes of the programme would be:

- to improve scientific understanding and increase awareness of the complex dynamics governing human interaction with the total earth system;
- to strengthen efforts to predict and anticipate social change affecting the global environment;
- to analyse options for practical policy and management initiatives for dealing with global environmental change; and
- to identify broad social strategies to prevent or mitigate undesirable impacts of global change, or to adapt changes already unavoidable.

The Interim Steering Committee for this new programme will continue, here in Stockholm, discussions that began in Tokyo of ways to implement this new programme, and we will shortly announce initial plans. In developing the programme, the Committee will consider carefully mechanisms for interacting with ICSU's IGBP. Speaking on behalf of the UN University, rather than the Steering Committee, let me assure this audience of our commitment

at the UN University to both IGBP and HDGCP, i.e. to the natural, human and policy science aspects of global change, and our intention to make this a major thrust in our future UNU programmes. The UN University, through its research, training and dissemination programmes, is prepared to do its share in mobilizing an international community of scholars and scientists in a collaborative effort aimed at seeking enhanced understanding of the natural, human and social dimensions of the changing global environment.

We wish you well not only this week, but also in the implementation of your bold programme.

BRIEF MESSAGE

Sergio C. Trindade

Executive Director, CSTD United Nations

Your Majesty

Ms. Birgitta Dahl, Swedish Minister of the Environment/Energy

Prof. M.K.G. Menon, President of ICSU and Chairman of SAC of IGBP

Prof. I. Lindqvist, President, Royal Swedish Academy of Sciences

Prof. J.J. McCarthy, Chairman, SC-1988

Prof. Abdus Salam, President, TWAS

Prof. Thomas Rosswall, Executive Director, UGBP

My colleagues from the United Nations system, Obasi (WMO), Golubev

(UNEP), Ruivo (UNESCO), Fuchs (UNU)

IGBP participants

Ladies and Gentlemen

It is an honor and a pleasure to address the first meeting of the scientific advisory council of the International Geosphere-Biosphere Programme-IGBP here in this beautiful city of Stockholm and under the historic roof of the Royal Swedish Academy of Sciences and exactly on United Nations day. I thank you for the opportunity.

I believe that, despite the pressing immediate problems that it must attend, the United Nations should spend some of its energies and resources on longer term issues.

It is true that many United Nations programmes have 10 years as their time frame of reference. This is fine. But there are issues of global concern such as the outer space, climate, the environment, communicable diseases, etc. which clearly require a pluri-decade approach. In some of these issues the UN CSTD is trying, in co-operation with the United Nations system agencies, to encourage this longer term view.

One example is the international discussion on technology assessment of space technologies over the next 50 years which we plan to hold in Japan in November 1989 in co-operation with UNU, among others.

I, therefore, welcome this splendid and opportune initiative, the ICSU Programme of Global change, whose focus is on "the key interactions of physical, chemical and biological processes that regulate the total earth system, and whose impacts take on time scales of decades to centuries".

The Global Change Programme, as I understand it, is interested in "the significant interactions most sensitive to human perturbations". Yet it appears that man is subsumed in all Global Change studies. I do acknowledge that "developing predictive capabilities in relation to future changes in our global live support system" is a formidable scientific task, extremely complex and colossal in magnitude. Hence, all I want to suggest is that, if you agree that the human connection of Global Change is important, we all make an effort to establish the appropriate linkages with institutions and activities that share this concern.

In my view, there are at least two angles of observation of the human dimension of Global Change. First, man as an anthropogenic factor functioning according to real incentives and disincentives that shape the behavior of societies and individuals.

Second, man as scientist, engineer, intellectual in general, curious about Nature, striving to add to universal knowledge, capable of learning.

When looking at man as human society, it is reasonable to consider that human behavior is determined, at least in part, by decision-makers, political and otherwise.

This feature is of particular interest to UN CSTD. Our work is primarily concerned with helping, together with the United Nations system and others, interested countries acquire and maintain a home-grown capability to make reasonable and relatively independent decisions in the use of technology and science for sustainable development, in the context of "Our Common Future" report, or development in peace with Nature.

Basically we try to help interested countries help themselves by stimulating national policy dialogues of social and economic life. This is a new approach that we began this year with pilot projects in Nepal and Jordan. Others will follow soon in Tanzania, Colombia and Thailand. We hope that one of the concrete results of this process is the identification by the countries themselves of portfolios of priority actions, and provide sustained and adequate policy direction into the future.

Back to ICSU's Global Change and its human connection, I believe it would be desirable to establish, through whatever appropriate means, linkages that would make the findings of the Global Change Programme over time useful to political decision-making. The United Nations system is well suited to this task and could help in many ways. In this process the international and national media in all countries could play a key role. Political decision making at the global level could bring about, among other things, an international agreement on greenhouse gases.

Man, seen as scientist, is not evenly distributed on the face of earth. Prof. Abdus Salam has just addressed the contribution to and the role of Third World scientists in the planning and implementation of the Global Change Program. The task of mobilizing scientific talent for IGBP constitutes a challenge even for developed societies.

Nevertheless, it seems to me that IGBP offers a unique opportunity for many countries to build up relevant indigenous scientific capabilities. Here I would like to note the benefits of the 1957 international geophysical year and similar initiatives, in promoting the growth of scientific capabilities in many developing countries.

This opportunity now provided by IGBP should interest, in particular, those developing countries who suffer from time to time, or even progressively, the local consequences of global changes in regards to desertification and drought and a variety of natural disasters.

Political decision-makers could have a decisive influence in encouraging the growth of such scientific capabilities in the interested countries. Somehow the message of ICSU's Global Change Programme must get to them. Again, the United Nations system could help through its multitude of activities and connections with decision-makers in the developing world. National and international media could again help particularly if they are in regular contact with the progress of IGBP.

I would like to conclude this note with two pieces of information:

First, on 7-10 November 1988, that is, in three weeks, UN CSTD is co-sponsoring with the University of Dortmund and the support of the Senate of Hamburg, a World conference on climate and development. Prof. Rosswall is apprised of this initiative, and colleagues from the United Nations, e.g. Dr. M. Tolba, UNEP's Executive Director, will be participating.

Second, the year of 1989 marks the 10th anniversary of the United Nations Conference on Science and Technology for Development which took place in Vienna. Together with the United Nations system, government leaders will participate in an intergovernmental discussion in August 1989 on the future approaches to help interested countries pursue autonomous courses in science and technology for development.

In this context, ICSU's Global Change Programme constitutes a welcome challenge and affirmative incentive. We at the UN CSTD are ready to support it to the limit of our resources in the future as we have in the past.

Thank you.

OPENING ADDRESS

James J. McCarthy

Chairman, Special Committee for the IGBP

Your Majesty, Minister Dahl, Professor Lindqvist, President of the Royal Academy of Sciences, Professor Menon, President of ICSU, and Fellow Scientists:

I wish to join Professors Rosswall and Menon in expressing my gratitude to the government of Sweden and the Royal Swedish Academy of Sciences for their support of the Secretariat for the IGBP and for hosting this first meeting of the IGBP Scientific Advisory Council.

I would also like to express my appreciation to our colleagues from WMO, UNEP, UNESCLCO, UNCSTD, and the social sciences who are with us this week for their expressions of support and interest in working with ICSU as partners in the Study of Global Change.

It is indeed a great pleasure to initiate the discussions that will engage this assembly for week-long review of IGBP Report No.4 of the Special Committee, entitled "A Plan for Action". The Special Committee consists of 18 members (list attached). Also listed are these individuals' disciplinary identity, at least it was my sense of their fields from the background information available when the Committee was appointed by the ICSU Executive Board. In my experiences with these individuals over the past two years, I have been continually surprised by their extraordinary range of interests. I am, in fact, quite personally delighted by the effectiveness of this committee in formulating the transdisciplinary research focus that was so clearly called for in the ICSU charter for this programme.

I prefer to show a list of this Committee's membership without indicating nationalities so as to emphasize that the members of the Special Committee serve as representatives of disciplines rather than as representatives of nations.

This is not to suggest that national perspectives are unimportant. Quite the contrary. The IGBP cannot be brought to fruition without the active involvement of the National Adherents as well as the Unions of ICSU. Even before the first meeting of the Special Committee, the concept of the Scientific Advisory Council was identified as a means whereby the National Adherents and the Unions could actively participate in the planning and implementation of the IGBP. We are, therefore, delighted that nearly 40 nations and several unions are represented here this week.

Argentina	France	Poland
Australia	Germany (GDR)	South Africa
Austria	Germany (Federal Republic of)	Spain
Bangladesh	Hungary	Sri Lanka
Belgium	India	Sweden
Brazil	Ireland	Switzerland
Canada	Israel	Tanzania
Chile	Jamaica	United Kingdom
China (Beijing)	Japan	USA
China (Taipei)	Netherlands	USSR
Czechoslovakia	New Zealand	Venezuela
Denmark	Norway	Zambia
Finland		Zimbabwe

I would like to briefly review the organization of the IGBP planning efforts to date.

At the Berne ICSU General Assembly two years ago, an ad hoc planning committee for the IGBP submitted its report of a two years study. It recommended and the General Assembly concurred that the IGBP be launched with the following statement of objective:

To describe and understand the interactive physical, chemical and biological processes that regulate the total Earth system, the unique environment it provides for life, the changes that are occurring in this system and the manner in which they are influenced by human actions.

Although a sound and laudable objective, the planning committee had the wisdom and foresight to further recommend the following priority statement for the programme:

Those areas of each of the fields involved that deal with key interactions and significant change on the time scales of decades to centuries, that most affect the biosphere, that are most susceptible to human perturbation, and that will most likely lead to practical, predictive capability.

Prior to its first meeting the Special Committee diligently reviewed the several planning document reports, and endorsed both of these statements.

In its first week-long meeting the Special Committee diligently reviewed a broad range of candidate research areas for the IGBP, and reached the conclusion that a set of underlying themes should characterize the research of the IGBP:

- Documenting and predicting global change;
- Observing and improving our understanding of dominant forcing functions;
- Improving our understanding of transient phenomena in the total Earth system; and
- Assessing the effects of global change that would cause large scale and important modifications affecting the availability of renewable and non-renewable resources.

Taken together they should serve to define the character of the IGBP research, and thus set it apart from that of other interdisciplinary and international science programmes.

In order to proceed with the planning of discrete research projects for the IGBP, the Special Committee identified four initial areas in which this programme could make substantial contributions. For each a coordinating Panel was appointed, with a chairman and members selected entirely from the Special Committee:

- Terrestrial Biosphere - Atmospheric Chemistry Interactions
- Marine Biosphere - Atmosphere Interactions
- Biospheric Aspects of the Hydrological Cycle
- Effects of Climate Change on Terrestrial Ecosystems

Since the chairmen of each of these will be making presentations later today and tomorrow on behalf of his Panel, I won't at this time comment further on the findings of these groups.

The linkages among the panels and the points at which external forcing functions must be considered are shown diagrammatically on page 89.

The domain of a coordinating panel links the biosphere to the physical climate system via either the chemical composition of the atmosphere or the hydrological cycle. A change in these relationships that might be suitable for an IGBP research focus could originate at either end or at any point along one of the transfer arrows. For example, a change in the linkage between the terrestrial biosphere and physical properties of climate via atmospheric chemistry could result from natural climate effects on the biosphere, the effects of land use changes on the biosphere, or via anthropogenic effects on atmospheric chemistry.

There are certain common problems relating to each of these research areas and Working Groups were formed to address the following:

- Global Geosphere - Biosphere Modelling
- Data and Information Systems
- Techniques for Extracting Environmental Data from the Past
- Geosphere-Biosphere Observatories

The chairmen and members of these Groups were also drawn from the Special Committee, and tomorrow the chairman will be reporting on their progress.

During the last two years nearly 200 scientists have gathered in meetings convened by the chairmen of these groups, and the products of these efforts served as input for the writing teams that produced IGBP Report No.4, "A Plan for Actions."

In this report, a strategy for organizing the research effort of the IGBP is introduced, which will be important for us to consider during the course of this week.

IGBP Three Tier Structure:

1. **Core Projects**
Essential to the IGBP and under direct supervision of the Special Committee.
2. **Supporting Activities**
Essential to the IGBP but under the supervision of other organizations.
3. **Affiliated Activities**
Related to Global Change research but outside the priority statement of the IGBP.

To date the primary emphasis of the Special Committee has been to define the highly interactive "core" projects of the IGBP. Report #4 identifies areas that appear to be the most promising, and during this week we need your responses to these suggestions.

In addition, the Special Committee recognizes that some research absolutely essential to the IGBP is either already underway or is likely to be developed by bodies other than the Special Committee. In such cases, these other groups can more appropriately offer direct supervision that will be required as the research strategy for particular projects is specified. In this regard we acknowledge the essential nature of "Supporting Activities."

We realize as well the potential relevance of still other efforts to study and understand Global Change that fall outside the realm of the IGBP priority statement by virtue of their time scale for significant change, their interaction with the biosphere, or their susceptibility to human perturbation.

The IGBP Constitution defines the role of the Scientific Advisory Council as follows:

- Gives advice on scientific content of the Programme;
- Reviews scientific activities of the Special Committee;
- Provides a forum and mechanism for cooperation among participating Adhering Bodies;
- Reviews recommendations on the range of dues for National Adherents.

These are our marching orders for the week, and you will see that in this first meeting of the Scientific Advisory Council most of the time has been allocated to the first three of these.

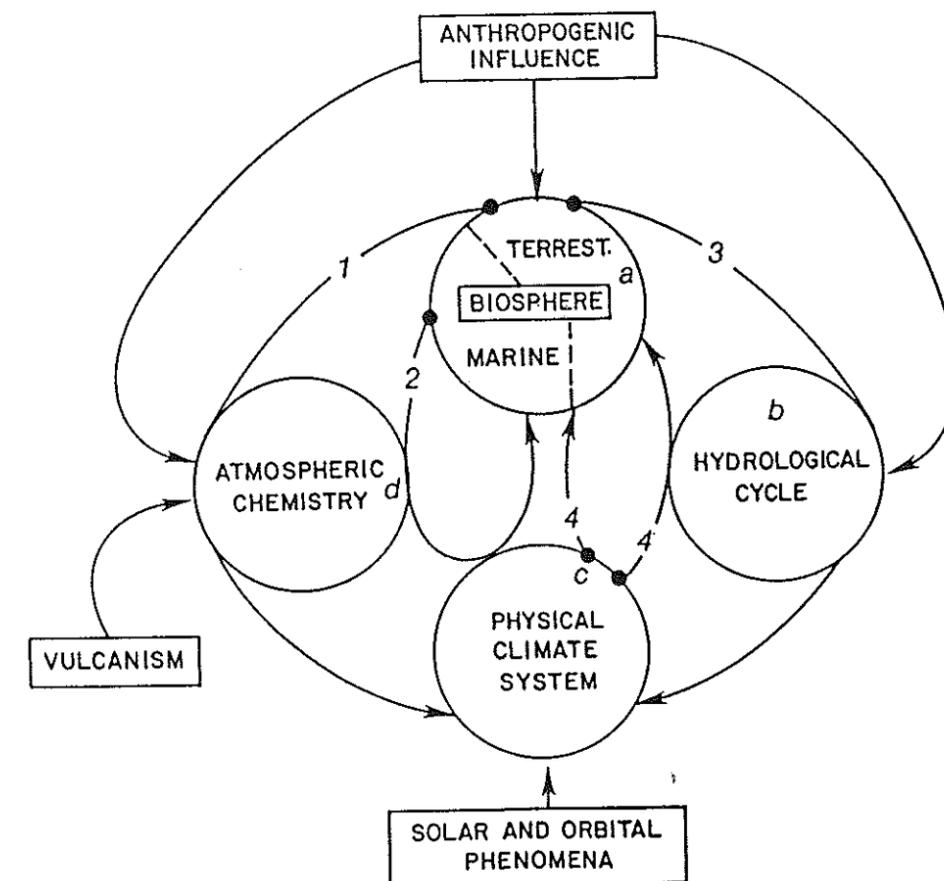
We will depart somewhat from the intent of the fourth point, and will instead devote time to discussing possibilities for international arrangements to finance the IGBP projects.

Before The Chairman of this meeting, Professor Menon, opens the general discussion, I would

like to remind you of a set of concerns that the Special Committee shares as we look towards the implementation of IGBP projects. Success of this programme requires:

- Long term commitments to a research programme that is not expected to yield practical applications for several years;
- Access to all national territories and exclusive economic zones, a policy that is clearly consistent with the self interest of each nation that is to benefit from the global perspective that this programme will provide;
- Unprecedented sharing of data among all participating scientists and governmental bodies.

On this note, again I bid you welcome, and I conclude my remarks. Thank you.



The Special Committee for the IGBP

James J. McCARTHY
(Chairman)

Oceanographer

Rafael HERRERA
(Vice-Chairman)

Ecologist

William S. FYFE
(Treasurer)

Geologist

Bert BOLIN

Meteorologist

Marie-Lise CHANIN

Meteorologist

Paul J. CRUTZEN

Atmospheric Chemist

El Hadji Salif DIOP

Geologist

Siegfried DYCK

Hydrologist

John A. EDDY

Solar Physicist

Vladimir M. KOTLYAKOV

Glaciologist

Takahisa NEMOTO

Oceanographer

Hans OESCHGER

Geochemist

S. Ichtiaque RASOOL

Atmospheric Chemist

Thomas ROSSWALL
(Executive Director)

Biogeochemist

Jai S. SINGH

Ecologist

Valeria A. TROITSKAYA

Solar Physicist

Brain H. WALKER

Ecologist

John D. WOODS

Oceanographer

Duzheng YE

Meteorologist

**PLENARY PRESENTATIONS OF TOPICS OF
GENERAL INTEREST TO THE IGBP**

THE ROLE OF NATIONAL COMMITTEES

Hans-Jürgen Bolle

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Introduction

The broad view of the modern earth sciences taken by the International Geosphere - Biosphere Programme requires exceptional efforts in regard to stimulation, integration, training and funding if a successful research programme is to be accomplished. It is obviously necessary to involve as many countries as possible in this research initiative. The research itself may be biased by national, geographical, climatic, and economical peculiarities according to the scientific approach used. It seems mandatory therefore to support the work of the IGBP by means of a network of national points of contact. In what follows we reflect on the different roles these points of contact may play in the overall system. Since they have different status in different countries it may not be valid to use the term "National Committees" we will, however, retain this term for practical reasons. Different status levels may also cause problems for national points of contact in addressing the tasks to be discussed here. However, since we are only in the initial stages of a process of convergence, a hypothetical situation may be conjectured.

The position of the National Committee among scientists and other groups involved in the IGBP is sketched in Figure 1, which shows some of the communication links discussed below. While the Special Committee for the IGBP is responsible for designing a complete worldwide programme, the major role of the National Committee is to outline feasible action and the sequence in which this action is implemented.

Theoretical possibilities for the competence level of National IGBP Committees

The different points of contact for IGBP may have different levels of status in different countries. These can be described as follows:

Category 1. Groups of individual scientists, who meet and elaborate on research programmes by the consent of national scientific bodies, e.g. Academies or National Science Foundations. The groups meet to form international agreements on financial and other resource commitments, excluding the commitments that are the responsibility of the individual scientist.

Category 2. Committees that act as advisory bodies and are established by sponsoring organizations, and that can influence expenditure of funds allocated for IGBP research.

Category 3. Committees, established under the directive of supporting national agencies to promote activities of global geosphere - biosphere concern that are of major national interest.

Accordingly, the IGBP Special Committee should receive not only the necessary funds from the participating nation, but also moral support, direct or indirect support with the respect to resources, and scientific support for the activities to be carried out. The ideal National Committee would fall within the second category. The possible contributions of these National Committees toward making the IGBP a success are outlined below.

Advisory functions

National Committees may be established by governmental institutions to advise sponsoring

organizations on the following issues.

- Clarification of the significance of IGBP research for the solution of national research needs and of the impact which global change may have on national environmental and economic conditions.
- Evaluation of the impact that international research initiatives may have on national research issues.
- Evaluation of the national research potential in the field and of the impact national contributions will have on IGBP.
- Identification of the most effective and most desirable ways to direct national resources into international research efforts.
- Definition of the main emphasis of national research activities in the context of global change (including the participation of highly specialized small groups that are essential for research work in international cooperation and innovative research approaches not initially foreseen).
- Evaluation and merging of research reports; encouraging submission of reports for publication.
- Mediation between scientists/scientific groups and sponsoring bodies; stimulation of the submission of coordinated research proposals to national sponsoring agencies.
- Maintaining contact with national ICSU and UN committees and with national representatives to coordinate activities in all IGBP-related areas on the national level including the WCRP.

National Committees may also be involved in evaluating and selecting scientific proposals for funding. It may be useful to agree on some fundamental criteria for the selection of projects essential for the success of the IGBP.

Some general criteria:

- relevant for studies of global change;
- interdisciplinary;
- international cooperation established;
- willingness of scientists to participate in joint research with groups from other countries, and if necessary to communicate their results in IGBP publications and register the data in international data bases.

It must be ensured that innovative individual research approaches are not prevented by these general criteria.

Coordinating functions for national research groups

On the national level the Committees can foster IGBP by stimulating and integrating the research and services that are necessary for the progress of the programme. Necessary activities include the following:

- Survey of outgoing national research and assessment of its relevance for IGBP;
- Improving the availability of research results by the comprehensive organization and compilation of data and results relevant for IGBP;
- Establishing structures that will enable easy coordination between the participating

scientists from different disciplines;

- Support to scientists and scientific groups in obtaining the necessary research funds for participation in IGBP;
- Supporting identification of the necessary research partners and bringing together researchers from the different disciplines.

Coordination with IGBP Special Committee COMMITTEE

Coordination with the IGBP Special Committee is extremely important for two reasons. First, the IGBP has to rely upon national support to achieve its goal of global research and not all nations or scientific groups will understand the term "global" in the same way. Second, some contributions to global research clearly call for coordinated regional activities. However, research needs and research potential differs for the different regions.

The IGBP Special Committee may have difficulty in identifying all regional peculiarities and National Committees can advise the Special Committee when necessary. Coordination will include the following areas.

- Identification of regional research needs;
- Support in defining research projects either by own studies or by seconding members to study groups, project preparation, steering groups, etc.;
- Local arrangement for meetings of the Special Committee or its sub-groups;
- Assistance to the Special Committee in evaluating the feasibility of research projects, e.g. by
 - a. Advising IGBP groups about available national experts and research potential, and/or
 - b. Investigating possibilities of supporting IGBP with facilities such as observatories, aircraft, ships, satellite data, data banks, or special instruments.
- Mediation between the Special Committee and national sponsoring organizations in financial matters.

Coordination with other National Committees

A number of case studies under the supervision of IGBP will be carried out in specific critical areas of the world and this will require a good deal of **regionalization**. It is therefore crucial that in such cases the regional research potential be activated. Although coordination between different national IGBP committees should normally be channelled through the IGBP Secretariat a few exceptions may be essential, e.g.

- If the feasibility of a regional activity (with impact on global change studies) is being discussed, the National Committees involved may first clarify the situation in common and then evaluate the available research potential.
- National IGBP Committees may contact each other with respect to training facilities and curricula in order to improve training in the area under study.
- Geosphere-Biosphere observatories may need the close cooperation of groups from two or more nations. The IGBP Committees of the nations involved should take joint responsibility for the establishment, instrumentation, and operation of these observatories.
- Joint evaluation from time to time of the IGBP and discussion on how to distribute the workload among the nations.

- Search for research partners in different countries.
- Exchange of experiences between the countries, e.g. in regard to financial matters.
- Mutual information on national activities. A short annual report listing national activities should be circulated among the National Committees either directly or via the IGBP Secretariat. The Secretariat should also be kept informed of regional activities not channelled through it.

Education and training

In view of the need for the exchange of scientific results and the stimulation of the young generation of scientists, National IGBP Committees can lend substantial support to the Special Committee by:

- I. Preparing the ground for hosting IGBP-related scientific meetings and acting as local organizer or delegating this function to a national institution;
- II. Promoting the establishment of multidisciplinary training courses and centers at universities and research institutions;
- III. Promoting the extension of curricula at universities towards multidisciplinary;
- IV. Disseminating, by means of publications and other information sources, the basic ideas of the IGBP, i.e.;
 - multidisciplinary earth-oriented research, with focus on the role of the biosphere in the global system,
 - commencement of major research issues of global relevance by coordinated multinational efforts,
 - training of a new generation of scientists to deal efficiently with the large and multidisciplinary environmental research issues of the future.

Conclusions

The National Committees are a vital component of the IGBP. The major role of the National Committees is support to the IGBP Special Committee in its efforts to organize truly global and international research. Since they constitute that part of the Scientific Advisory Committee that primarily influences the raising of additional national funds for IGBP, they should maintain close contact with the IGBP Secretariat and with each other. They may even be encouraged to form regional groupings such as those under the auspices of the Commission of the European Communities.

At the next SAC meeting ICSU should make provision for representatives of the National Committees or similar bodies to meet at an earlier stage in order to exchange experiences and present status of national or regional preparations for IGBP. This would provide an improved means for interaction between planning for global IGBP activities and the mobilization of national resources.

Since various governmental and nongovernmental organizations have an interest in IGBP, the SAC essentially consists of three groupings: National Committee, ICSU bodies, and UN bodies. All nations send representatives from different organizations that act as advisors to the IGBP. This may lead to a certain amount of conflict even between representatives from the same nation serving on the IGBP Committees and other scientific bodies. In order to avoid time consuming clarification of viewpoints between the concerned parties at SAC meetings, coordination of the various organizations must be initiated at the national level. The National IGBP Committees should therefore act in the closest possible cooperation with the national representatives of other organizations who are in anyway concerned with the work of the IGBP.

INTERACTION OF IGBP WITH ICSU BODIES AND WITH OTHER INTERNATIONAL PROGRAMMES

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President, Royal Irish Academy

Introduction

My task is to place the IGBP in context against the background of the activities of the activities of the large number of ICSU bodies and of the relevant work which has been undertaken under various international scientific programmes, both non-governmental and inter-governmental. These are two separate but related topics. Both must be taken into account and any problems arising overcome if the IGBP is to attain its full potential of effectiveness. The working group session arranged for this topic should enable us to identify the key problems and suggest possible solutions. This presentation is intended to provide background information for the working group discussion and to suggest some questions of importance.

The ICSU family

ICSU has a dual membership, consisting of both scientific members representing individual disciplines and national members representing regions of organised scientific activity. At present there are 20 scientific members (and 26 scientific associates) and there are 59 national members (and 15 national associates). In the past two decades ICSU has established a number of scientific committees and special committees to promote interdisciplinary scientific programmes on an international basis. The Special Committee for the IGBP is one of these. At present, there are 12 scientific and special committees and there are 6 inter-Union Commissions and Panels. Further details in relation to these various components of ICSU can be found in the Yearbook (ICSU, 1988).

There are many analogies between an organisation such as ICSU and an extended human family. In the latter, as in the former, each member has their own individual personality which tends to become more distinctive with time. The interplay of personalities is bound to produce tensions from time to time. In most human families the bonds, both formal and informal, that link individual family members are sufficiently strong to counteract these tensions. Within the ICSU family, tensions also arise from time to time. When the question of an increase in dues comes up at the General Assembly, there is a natural tension between scientific members who wish to see more money available for scientific programmes and national members who face the task of persuading their own funding authorities to provide the extra money involved. However, such tensions do not give rise to serious difficulty because of the sense of identity within the General Assembly. The question of importance for this meeting is to identify whether the IGBP will result in any additional tensions within the ICSU family and whether the structures for the planning of the IGBP are adequate to absorb such tensions. In considering this question, it is important to recall that there are several levels of organization within ICSU and that there will be interactions with IGBP at all levels. Mention is made in IGBP Report No. 4 of the contribution by the Commission on Atmospheric Chemistry and Global Pollution to the planning of a possible IGBP core project on atmospheric aspects of global change. This Commission is one of many Commissions of the International Association for Meteorology and Atmospheric Physics (IAMAP) which is one of the seven member associations of the International Union for Geodesy and Geophysics (IUGG) which in turn is one of the twenty scientific members of ICSU. Interaction at various levels (Union, Association, Commission, Working Group) is beneficial to both parties but involves a potential for misunderstandings and tensions within both the Union and the IGBP structures and also between levels of the two organisations other than the level at which direct cooperation is taking place. Care must be taken to minimise such effects.

Background of international scientific cooperation:

International cooperation on interdisciplinary scientific programmes first emerged in geophysics where there is a long history of such endeavours (Baker, 1982). The first Polar Year of 1882-83 was followed fifty years later by second Polar Year of 1932-33 which was broader in scope. The proposed third Polar Year of 1957-58 was broadened greatly to become the International Geophysical Year which ushered in the Space Age and set the stage for a great expansion in geophysical research in the following decades. Of particular relevance to the IGBP are the developments flowing from the International Geophysical Year that resulted in the World Weather Watch of WMO (1960), the Global Atmospheric Research Programme (GARP) of ICSU and WMO (1967) and the World Climate Programme (WCP) of ICSU, WMO and UNEP (1980). Widely based international and interdisciplinary programmes on a similar scale in relation to the biosphere emerged later but have also become a feature of present day research (di Castri, 1984).

One of the first large scale projects of UNESCO was the Arid Zone Programme begun 1950. A decade later ICSU organised the International Biological Programme (1964-74) which performed for the Biosphere a key catalytic role equivalent to the International Geophysical year. There followed the establishment by ICSU in 1969 of the Scientific Committee of Problems of the Environment (SCOPE) and the launching by UNESCO in 1971 of the Man and the Biosphere Programme (MAB). Both of the latter programmes are still continuing.

A feature of many of these international interdisciplinary programmes has been a flexibility in structure and a willingness to combine non-governmental and inter-governmental resources (Baker, 1982, Dooge and Baker, 1984). In particular ICSU and its component bodies have cooperated with UNESCO on a number of programmes (Baker, 1986). This cooperation has sometimes been with ICSU itself, sometimes with a constituent union, and sometimes with a scientific committee of ICSU. Examples of different forms of cooperation are the International Geological Correlation Programme (UNESCO and IUGS, 1969) International Biological Networks (ICSU and UNESCO, 1979), and the International Decade of the Tropics (IUBS and MAB, 1982).

The collaboration of ICSU with WMO on GARP and with WMO and UNEP on WCP has already been mentioned. An example of ICSU collaboration with FAO is the Biological Investigations of Marine Antarctic Systems and Stocks (SCOR, SCAR and FAO, 1981). An interesting example of genetic mixing is the Committee on Climatic Changes and the Ocean (CCCCO), which is a joint body under SCOR (a scientific committee of ICSU) and IOC (an Intergovernmental Council under UNESCO) and which contributes significantly to the World Climate Research Programme (WCRP) which is itself a joint programme of ICSU and WMO.

IGBP interfaces with other programmes:

Because of its wide scope the IGBP must consider its relationship to a number of ongoing international programmes. To discuss all the interfaces involved would clearly be beyond the scope of this short presentation. To attempt to list and classify them would probably only lead to sterile discussion involving the definitions and the taxonomy of such programmes. Instead, the time will be used to discuss the relationship of the IGBP to two important international programmes, one relating to the geosphere and one to the biosphere. The programmes chosen for discussion are the SCOPE Programme established by ICSU in 1969 and the World Climate Research Programme established by ICSU and WMO in 1980. If solutions can be found for the optimal relationship between IGBP and these two important programmes, then it should not be too difficult to handle the interfaces with other international programmes.

The objectives of SCOPE have been defined as (SCOPE, 1988, p.1)

- "To advance knowledge of the influence of humans on their environment, as well as the effects of these environmental changes upon people, their health and their welfare - with particular attention to those influences and effects which are either global or shared by several nations;
- To serve as a non-governmental, interdisciplinary and international council of scientists

and as a source of advice for the benefit of governments and intergovernmental and non-governmental bodies with respect to environmental problems".

Many similarities and points of contact are apparent if these objectives are compared with those of the IGBP (IGBP, 1988, p.3).

"To describe and understand the interactive physical, chemical and biological processes that regulate the total earth system, the unique environment that it provides for life, the changes that are occurring in this system, and the manner in which they are influenced by human actions".

SCOPE emphasises the stimulation of new approaches and the synthesis of existing information on an international, non-governmental and interdisciplinary basis in relation to environmental problems which offer some hope of manageable action within a reasonable period. Again this resembles the accepted priorities within the IGBP. An examination of the major SCOPE projects reveals a combination of projects of limited duration and long term interest with some changes of emphasis from time to time. Thus the 1974 mid-term programme of SCOPE contained six major projects:

1. Biogeochemical cycles
2. Human Impact on Renewable Natural Resources
3. Environmental Aspects of Human Settlements
4. Ecotoxicology
5. Simulation Modelling of Environmental Systems
6. Communication of Environmental Information and Societal Assessment and Response.

The latest programme (SCOPE, 1988, p.3) contains two of these projects and five new projects, namely:

1. Biogeochemical Cycles
2. Ecotoxicology
3. Genetically Designed Organisms in the Environment
4. Subsiding Coastal Areas
5. Global Change
6. Groundwater Contamination
7. Use of Scientific Information Towards Sustainable Development

In all of these areas, the effort of SCOPE to synthesize information from relevant fields and to identify knowledge gaps is of significance for the IGBP. A close working relationship between the two programmes is essential if both are to reach their full potential. The World Climate Research Programme (WCRP) continued the work under the second objective of the Global Atmospheric Research Programme (1967-1979) organised jointly by ICSU and WMO. The WCRP is the subject of specific agreement between ICSU and WMO and its scientific policy is formulated by a Joint Scientific Committee (JSC) nominated jointly by ICSU and WMO. The objectives of the Programme are (WCRP, 1984, p.1-2):

1. Establishing the physical basis of long-range weather prediction
2. Understanding the predictable aspects of global climate variations over periods of several months to several years
3. Assessing the response of climate to natural or man-made influences over periods of several years

While a comparison of these objectives with those of the IGBP already indicates an appreciable interface, a further comparison of the implementation plan for the WCRP with the priorities established for the IGBP indicated that there will be many points of contact and a need for a understanding of the relationship between the two programmes. In the case of the WCRP the programme is considered as operating on three successive time scales described as follows (WCRP, 1984):

- "The first stream aims at establishing the physical basis for and feasibility of predicting large-scale weather patterns or time-averaged meteorological fields over periods of one to two months, for which the surface temperature of the ocean and the sea ice cover may

be taken as specified boundary conditions determined from initial observations, climatology or both.

- The second stream aims at understanding and, eventually, predicting the variations in the heat transport by ocean currents and the corresponding variations of the atmospheric general circulation, over periods ranging between several months and several years, on the basis of interactive models of the coupled system constituted by the upper tropical oceans, sea ice, the land surface and the global atmosphere.
- Finally, the third stream aims at understanding the causes of long term climate trends and assessing the potential response of climate to natural or human influences over periods of several decades. This last objective requires a vastly improved knowledge of the circulation of the world ocean as well as the ability to model the global oceanic circulation as part of an interactive treatment of the whole climate system".

In the case of the IGBP the priorities have been established as (IGBP, 1988, p.3):

"In concentrating on interactive biological, chemical, and physical processes the IGBP will of necessity put less emphasis on studies that, though they have great strengths and momentum of their own, are already being addressed in existing initiatives, or that will less clearly contribute to our understanding of the changing environment for life in time scales of decades to centuries. Priority in the IGBP will therefore fall on those areas of each of the fields involved that deal with key interactions and significant change on time scales of decades to centuries, that most affect the biosphere, that are most susceptible to human perturbations, and that will most likely lead to practical, predictive capability".

It is clear that in the next few years the two programmes will be tackling scientific problems relating to the human environment on essentially the same global spatial scale, and the same decadal time scale. It is vitally necessary that the relationship between these two ICSU programmes be adequately defined in unambiguous terms so that misunderstanding can be avoided. Such misunderstanding could result in unnecessary friction between two groups whose ability and energy could be combined to promote a healthy synergism between the two programmes.

Conclusion:

Everyone concerned with the implementation of the IGBP must take care to appreciate the extent of activity within the ICSU family and the profusion of existing international interdisciplinary scientific programmes. ICSU established the IGBP because it was thought that there was a specific task to be tackled that was not within the ambit of the existing programmes. But the role of the IGBP cannot be isolated from that of other ICSU bodies or the activities of other international programmes. This meeting provides an excellent forum for discussing what structures and what lines of communication are required in the IGBP to promote cooperation and avoid misunderstanding. By discharging this task the Scientific Advisory Council can make a substantial contribution to the effectiveness of the whole IGBP.

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THE HUMAN DIMENSIONS OF GLOBAL CHANGE: AN INTERNATIONAL
PROGRAMME ON HUMAN INTERACTIONS WITH THE EARTH

Ian Burton

IFIAS
Steering Committee for
Human Dimensions of Global Change

It is a great pleasure for me to be in Stockholm and at this distinguished Academy. Stockholm is the birthplace of IFIAS and was the home of the IFIAS Secretariat from 1972-1986. For me, therefore it is like coming home.

I speak today not so much as Director of IFIAS, but more as the Chairman of the three part Steering Committee for the programme Human Dimensions of Global Change. Also present at this meeting are Professor Roland Fuchs, Vice-Rector of the United Nations University and President of the International Geographical Union (a member-union of ICSU), and Dr Luis Ramallo, Secretary-General of the International Social Sciences Council and also a member of the UNESCO Executive Board.

These three organizations - UNU, ISSC, and IFIAS have been working together as a troika for 16 months to establish the programme Human Dimensions of Global Change. We find it helpful that ICSU has now recognized this Programme as the counterpart programme to IGBP in the social sciences. In this capacity we have participated by invitation in the ICSU General Assembly in Beijing in September 1988, and are here present to describe the work of the Steering Committee and the status of the Human Dimensions Programme.

For the past year IGBP and Human Dimensions have been working successfully together simply by exchanging invitations to symposia and other meetings. We were delighted that Professor Ye (a member of the Special Committee for the IGBP) could attend our recent symposium in Tokyo. That symposium also got off to an excellent start with a lecture from Professor James McCarthy (Chairman SC-IGBP), who described the present level of understanding in the natural sciences of "Global Change" and the approach that is being developed by IGBP.

Perhaps the challenge of Global Change for the social sciences can be captured in a short quotation from Bertrand de Jouvenal, The Art of the Conjecture:

"The future state of society would be perfectly known only in a perfect static society - a society whose structure would always be identical and whose map of the present would remain valid for all time!... But as soon as a society is in movement the familiar traits are perishable: they disappear, some more rapidly than others... To say the movement is accelerating is to say that the length of time for which our Map of the Present remains more or less valid grows shorter. Thus our knowledge of the future is inversely proportional to the rate of the progress."

Society is indeed changing very rapidly not only in the industrially-developed North, but also in the so-called developing countries of the South. Rapid changes in population, agriculture, urbanization, industrial development, trade, macro-economic patterns and so forth, complicate the task of the social scientist in understanding where the present processes of change are leading. Among these variables the changes in the global environment, actual and potential, seem relatively important to many social scientists. In classical economics the three factors of production were defined as land, labor, and capital. All the variations and endowments of environment and natural resources were subsumed under that single term "land". The history of economic thought up to the present day, in both market or capitalist economies, and centrally planned or Marxist economies has been marked by a heavy emphasis on labor and capital to the relative neglect of "land". Economists and social scientists have not in their main schools of thought, identified environment and natural resources as key driving variables or forcing

functions. Problems of resource scarcity are assumed to be avoidable by infinite substitution. Problems of pollution and environmental damage are reduced to "externalities".

It is the hope of the initiators of the Human Dimensions programme that the issues of Global Change will in the future draw the attention of more social scientists. In any event it is clear that without the establishment of the International Geosphere-Biosphere Programme, there would be no Human Dimensions of Global Change programme. In this respect the social sciences owe ICSU and IGBP a great debt.

It is only 16 months since the first ad hoc meeting, called to discuss the creation of a social sciences programme on global change, was held in Toronto at the invitation of IFIAS. The programme is still therefore in a very early stage of development, and the focus and structure are still being formulated. In this process the words used are extremely important. A debate about the name has resulted in a decision to drop the word response from the title (Human Response to Global Change) and to adopt the word dimensions instead.

Words and the concepts they represent are to the social scientist what atoms and molecules are to the natural sciences. How you take them apart and put them back together makes all the difference. Thus, whether we chose to say we have a CO₂ problem, or a climate change problem, or an energy problem, or a problem of sustainability will change the substantive research agenda, the human subjects and social processes on which attention is focussed and also the mix of social scientists and social sciences involved.

Since that first meeting in Toronto such questions have received attention in a series of national, regional, and bilateral meetings. These are listed below:

- "Managing Global Change" Workshop, sponsored by the Royal Society of Canada, held at: Hamilton, Ontario, Canada, June 1987.
- Meeting to consider an International Research Programme in the Social Sciences, sponsored by the U.S. National Science Foundation and the Institute for Social Research, University of Michigan, held at: Ann Arbor, Michigan, September 1987.
- Interim Steering Committee Meetings, held at: Paris, France, and Milan, Italy, November, January, March 1987.
- Human Response to Global Change Programme Meeting, sponsored by Swedish Council for Planning and Co-ordination of Research, held at: Stockholm, Sweden, February, 1988.
- International Political Science Association Meeting, held at: Moscow, U.S.S.R., March 1988.
- Human Response to Global Change Meeting, sponsored by IFIAS, Center for Advanced Studies, Bariloche, CEUR, and IDRC, held at: Buenos Aires, Argentina, April 1988.
- "Man-Society-Global Change" Meeting, sponsored by Polish Academy of Sciences, IFIAS, and IIASA, held at: Mragowa, Poland, May 1988.
- "Human Dimensions of Global Change": A Chinese-U.S. Workshop, sponsored by Chinese State Education Commission and U.S. National Science Foundation, held at: Beijing, China, May 1988.
- Resources for the Future meeting on Controlling and Adapting to Greenhouse Warming, sponsored by RFF, IFIAS, and others, held at: Washington, D.C., June 1988.

They culminated in the Tokyo Symposium of 19-23 September 1988 hosted by U.N.U. for the Steering Committee. Over 80 scientists participated mostly from the social sciences, and also including specialists from the policy, engineering, legal, and health fields. The participants come from all regions of the world and included Dr. James McCarthy, Chairman of SC-IGBP who gave an opening keynote address, and also included five other persons present at this First Meeting of the Special Advisory Council for IGBP, namely Dr Ye Duzheng (China, and a Member of SC-IGBP), Dr. Bernt von Droste (UNESCO-MAB), Dr Hans Landberg of the

Swedish Council for Research Coordination, Professor K.G. Mäler, economist, University of Stockholm, and Walter Manshard, University of Freiburg, and formerly with UNESCO and United Nations University.

The complete report for the Tokyo meeting is not yet finalized and approved. It will be available as soon as it has been approved by the co-chairman Professor Gilbert F. White, and Minister Emil Salim, Indonesian Minister for Population and Environment.

Nevertheless some initial results for the Tokyo Symposium can be presented. First there is a sense that it was a wise decision of ICSU/IGBP to keep the two programmes initially separate, at the international level, but working together in a spirit of close cooperation. There is everything to be gained by a united front. The recognition of the need for both natural and social sciences research can be mutually helpful.

There are at least two reasons for having two programmes at the international level. First the task of bringing together the geosciences and the biosciences is a complicated enough task for IGBP. This would not be helped by having to grapple with the human dimensions at the same time. The same applies *mutatis mutandis* to the social sciences. The development of an integrated, international, interdisciplinary programme on the human dimensions of global change is difficult enough. Even if a shot-gun marriage were to be arranged it is likely that a first cut would be to divide the integrated "all sciences" programme into social and natural components.

This points to the second reason for separation at this time. Namely that the intellectual basis for cooperation in the shape of shared models, concepts, methods of research and analysis is not sufficiently strong to permit the overall integration of the two domains.

Three steps could be taken, however, to open up a path to closer integration in the longer term. Firstly, a few "link" scientists could be appointed to the committees in either programme. There would thus be some shared or overlapping membership and this would certainly facilitate convergence if that is to happen. Secondly, the Secretariats themselves could be attached to the IGBP Secretariat and vice-versa. Thirdly, a joint study group could be established to examine ideas for the closer integration of the natural and social sciences in research on global environmental change.

At the national level the case for separate programmes is less compelling, and there are somewhat greater prospects that IGBP Committees can be enlarged to include social scientists. There is a danger in such an approach for the Human Dimensions programme. This is that the social sciences will become merely a small add-on to a natural science driven agenda. Something similar happened in the early days of the evolution of the UNESCO Man and the Biosphere Programme (MAB) with the result that MAB never has been able to deal as fully as adequately with social and human dimensions of the biosphere as was the original intention.

The development of the Human Dimensions programme will not be possible without the establishment of focal points at the national level. For this purpose National IGBP Committees may serve the need in some countries. Where they do not, other institutional arrangements will have to be invented. The IFIAS network and the UNU network can be helpful in this regard. Eventually, however, some national reference point seems likely to be essential at least in those countries that play a leading role in HDGC.

In addition to the IFIAS and UNU networks it is expected that the member union of ISSC will wish to contribute activities to the programme.

Another achievement of the Tokyo Symposium was the drafting and adoption of programme objectives as follows:

"Dramatic, potentially threatening, and possible irreversible change in the global environment results from past and present human activities. Such change leads to serious impacts on human conditions, with the risk of compromising prospects for life in the future. This body was therefore resolved to initiate an international research programme to investigate both the human causes and consequences of global environmental change. The objectives of the research

programme are:

- to improve scientific understanding and increased awareness of the complex dynamics governing human interaction with the total Earth system;
- to strengthen efforts to study, explore, and anticipate social change affecting the global environment;
- to identify broad social strategies to prevent or mitigate undesirable impacts of global change, or to adapt to changes that are already unavoidable;
- to analyze policy options for dealing with global environmental change and promoting the goal of sustainable development.

In pursuit of these goals, the research programme will undertake several activities, including initiatives

- to foster a global network of scientists and other concerned parties, and to encourage this network - in collaboration with other relevant research initiatives - to engage in research directed towards the dynamics of human interactions with the global ecosystem;
- to undertake selected core research projects central to the purposes of the programme;
- to develop appropriate information systems and methodologies that will enable the execution of a research programme of this scope;

The Tokyo Symposium also agreed that HDGC should develop a core programme of research centered around a few selected themes, and that national groups, international unions and research institutes should be invited to develop contributing programmes without seeking international endorsement.

It is intended that the core programme will be overseen by a Scientific Advisory Committee (SAC) to be established by the Steering Committee. The SAC will start as a small group of five or six persons and will be expanded as need arises and as circumstances permit. Nominations are now invited for suitable senior and independent persons to serve in the initial interim Scientific Advisory Committee.

Development of the core programme can now be started on the basis of advice from regional meetings and the Tokyo Symposium itself. Approval of the core programme awaits the establishment of the Scientific Advisory Committee, but four initial topics have been identified as pilot projects for which planning can be started in detail. These are:

- The stabilization of atmospheric CO₂;
- Vulnerable peoples and places;
- Industrial metabolism;
- Models, data and concepts.

Carbon dioxide stabilization

The Toronto Conference of June 28-30, 1988 on The Changing Atmosphere: Implications for Global Security, adopted the following as part of the Conference Statement:

"Stabilizing the atmosphere concentrations of CO₂ is an imperative goal....Reduce CO₂ emissions by approximately 20 per cent of 1988 levels by the year 2005 as an initial global goal." (Conference Statement p.5)

Accepting for the moment the Toronto Target of -20% we propose an exercise in what is sometimes called back casting. By what routes can the emissions of CO₂ be reduced by 20% by 2005? The Human Dimensions programme is starting now to assemble a group to identify and describe alternative ways and means of reaching Minus 20. A workshop will be held in Budapest in April 1989 and the aim is to produce an authoritative report on paths towards

Minus 20 using different mixes of energy sources, technologies and energy conservation and efficiency. An attempt will also be made to disaggregate the global choices into choices for nations or major world regions.

For this purpose information will be needed from natural scientists within the IGBP, including best available estimates of the contributions of biomass changes to atmospheric carbon; rates of ocean absorption of CO₂ and climate warming. We shall try to move towards disaggregated quantitative expressions of how much change in atmospheric CO₂ levels can be achieved by 2005 and the consequences for achieving or not achieving the 20% target.

Vulnerable peoples and places

The terms "vulnerability", "resilience", "sustainability" and the like, come to the fore because they identify process characteristics of interacting human and natural systems. The purpose is to identify geographically vulnerable localities in the light of global environmental change, and socially vulnerable people in the light of global socio-economic change. It is hypothesized that greatest vulnerability will be found at the interaction of extreme natural changes and extreme social processes resulting in impoverishment.

Two approaches are possible. 1) Examination of vulnerability to a single threat (e.g. sea-level rise, shift of rainfall regime) over a wide area; or 2) examination of all threats at a place (e.g. the Great Lakes Basin or the prairies in North America and elsewhere).

Already considerable work has been achieved in the Soviet Union and there is considerable interest and record of past relevant work in the International Geographical Union. It is proposed to bring these together with other interests to develop the proposed study. Here again inputs from IGBP scientists would be helpful, especially in the disaggregation of the effects of climate change to the regional level.

Industrial metabolism

The focus is on the changing materials and energy balance of industrial sectors. In the advanced industrial nations industrial restructuring is occurring away from the traditional materials - crunching industries towards a new economy based on information, the growth of services, and the knowledge-industries.

The potential contribution of changing industrial metabolism to the achievement of more sustainable development warrants further exploration, and a project in this direction is under consideration.

Models, data, and concepts

The convergence of the Human Dimensions programme around a set of common themes will be greatly aided by and will in turn require convergence on a set of common ideas about data, models and concepts. It is proposed that a group be formed to explore and report on these issues. An invitation has been received from the USSR Academy of Sciences to hold an initial meeting in Moscow in 1989.

In summary

There will be a Human Dimensions of Global Change Programme closely linked to IGBP, and the IGBP Special Committee has already recognized HDGC as a complimentary sister programme.

A Scientific Advisory Committee will be established and nominations are invited.

The programme HDGC will work as closely as possible with IGBP in the exchange of ideas, invitations and personnel. Eventually, it is the intention to develop one more joint project.

Closer ties between IGBP and HDGC will be developed at the national level, with one committee for both programmes in some countries.

A core programme will be developed internationally and a contributory programme will be developed by national groups, scientific unions, academies and institutes.

For an initial set of pilot activities four projects are being considered:

- Paths to a 20% reduction of atmospheric CO₂;
- Identification of vulnerable peoples and places;
- Industrial metabolism;
- Models, data, and concepts.

For the international community of social scientists the Human Dimensions programme if it succeeds will be a pioneer programme. There is no track record of accomplishment in international programmes like those of ICSU and the natural sciences.

All this is exciting and dangerous for social science because social scientists can only pretend to be objective analysts of Global Change, indifferent to the decisions that people make, and neutral about their fate as though they were rats in some global psychological experiment.

The inescapable truth of social science is that, like it or not, we help to create the societies we study. Now we are helping to create a new global consciousness and a stronger sense of our common humanity. ICSU and IGBP are powerful forces in bringing humanity to a sense of shared responsibility for our planet.

In social sciences, our powers of prediction are limited indeed. So much is a matter of human choice. The best way to predict the future is to create it. It is a happy circumstance that the very threat of global environmental change identified through IGBP may be an important element in helping social scientists to help those who would create a better world.

DISCUSSION GROUP REPORTS
FROM THE SAC-MEETING 24-28 OCTOBER, 1988

TERRESTRIAL BIOSPHERE - ATMOSPHERIC CHEMISTRY INTERACTION

Chairman: H. Rodhe
Rapporteur: T. Schneider

In the general introduction it was emphasized by the working group members that IGBP action should be based upon international projects. The projects should consist of joint efforts in well-designed experiments aimed at answering the questions that relate to atmospheric chemistry processes and their interactions with the terrestrial biosphere.

The following tasks were discussed:

- The stratospheric part of the programme is weak.
- The "middle" atmospheric programme (up to 100-km altitude) is part of the IGBP but should be a joint IUGG/IGBP responsibility.
- Emphasis on UV-radiation/ozone depletion problems is important. In this discussion the anticipated SCOPE/IUPAB project on the effects of UV-B radiation was mentioned, as well as the possible contributions by other ICSU Unions. (Prediction of biological changes due to increase in UV-B skin cancer, immunological responses, selection of biological response systems etc.) IGBP activities in this field will have to be specified once the feasibility of the above mentioned project has been explored and defined.
- Monitoring activities are of great importance for the work of this Panel. Further specifications on siting (stratospheric/tropospheric measurements), species to be measured, frequency, etc. have to be worked out together with the working group for Geosphere-Biosphere Observatories.
- The action plan in the IGBP Report No.4 should be further elaborated in expert working groups taking due account of the results of the following important meetings: the IGAC programme planning meeting, Melbourne 1988, and the SCOPE project (Trace Gas Exchange between Terrestrial Ecosystems and the Atmosphere) that will be discussed during conferences in Dahlem, 1989 and in Stockholm 1990.
- The possibility of regional workshops in other parts of the world (e.g. developing countries) should be investigated through the Third World Academy of Sciences or other relevant organisations.
- Major subjects should also take account of high latitude studies (Polar Stations), the tropics, the Pacific region, etc.
- The sulphur compounds (both SO₂ from anthropogenic activities and DMS from biological processes, DMS) and particulates should be incorporated in the programme.
- Information on landuse changes (both historical as well as projections), biomass burning, and other major "man-made" influences, is essential for the analysis and evaluation of the IGBP activities to be carried out within CP1. The activities of the National Committees are essential for this purpose.

MARINE BIOSPHERE - GEOSPHERE INTERACTIONS

Chairman: B. Zeitzschel
Rapporteur: E. Tidmarsh

The working group identified some aspects of this part of the IGBP that require further detailed development. The working group also wished to propose several topics for further consideration by the Coordinating Panel and for possible inclusion in future planning documents.

The following important tasks merit special attention:

- The effects of changing temperature and sea level on marine populations, particularly on productivity and recruitment processes are of great importance for many nations, and study of these effects should not be limited to special populations. It is possible that changes in other types of marine populations might serve as readily observable "indicators" of global change.
- The question of input of nutrients to the ocean via rivers and the consequent eutrophication of the coastal zone deserves attention together with the occurrence of exceptional algal blooms and the resultant mortality in marine biota. Blooms in the open ocean, the factors controlling them, and their patchiness both in time and space, should also be considered. These blooms are intimately linked to the carbon, nitrogen, and sulphur cycles and the effects of global change on these relationships need to be considered.
- No part of the IGBP addresses issues relating to the effects of climate change on pelagic and benthic marine ecosystems, analogous to those proposed for the terrestrial and limnic systems. Such ocean studies should focus on the dominant feedback processes (via the biogenic gases) and their effects upon the plankton community structure.
- The fluxes of energy and matter in coastal and estuarine ecosystems are not being adequately approached in the Joint Global Ocean Flux Study (JGOFS), which has strong connections with the work of the IGBP (CP2) although open ocean biogeochemical cycles, especially carbon, are adequately covered, the fluxes of energy and matter in coastal and estuarine ecosystems are not being adequately approached in the JGOFS. These fluxes are strongly related to the diversity of marine ecosystems and a better understanding of the structure of various ecosystem types is required in order to assess the effects of global change on them.
- It is also essential to study the effects of increased UV radiation on the plankton populations of the surface layer, since these communities form the basis of the food chains that include many economically important marine populations. The SC-IGBP intends to await the results of a relevant SCOPE-IUPAB effort before developing this topic further.
- It is important to stress the roles of IGBP, JGOFS and WOCE in the study of nutrient cycles, oceanic productivity, population dynamics, and their links to the global hydrological cycles as well as the links between coastal and offshore marine ecosystems.
- Significant oceanic studies are undertaken in the countries represented in the IGBP and it is important to consider this fact in the preparation of the programme.
- The necessity for new technologies and instrumentation for the success of large-scale programmes was noted. Remote sensing provides an exciting synoptic view of the ocean and meets the needs of many aspects of oceanic programmes, while satellite sensors provide a largely two dimensional view of the ocean. The interior of the ocean can only be observed using in situ techniques and the scientific projects being considered will require the development of a new generation of self-contained in situ instrument packages. The instrumentation for large-scale oceanic research programmes might include satellite-tracked drifting instruments providing data in near-real time over satellite

communication systems.

- The discussion group recommended that, as a next step in planning the marine component of the IGBP the basic parameters, which must be measured in order to quantify rates of change in the ocean, should be identified. The existence of such a set of core measurements would provide a useful focus for the planning of oceanographic contributions to the IGBP.

BIOSPHERIC ASPECTS OF THE HYDROLOGICAL CYCLE

Chairman: G. McBean
Rapporteur: M. Falkenmark

it was noted that IAHS had particularly stressed the need for close cooperation between hydrologists and ecologists in the IGBP. The absence of water quality aspects in the proposal from CP3 was also noted.

The Global Energy and Water Cycle Experiment (GEWEX) of the ICSU/WMO World Climate Research Programme (WCRP) has been initiated in order to observe, understand, and eventually predict all components of the global water cycle (i.e., precipitation, evaporation, transport, runoff, storage). The GEWEX primarily addresses the physical aspects of the hydrological cycle, as part of the physical climate system. A Scientific Steering Group for GEWEX has been established and includes specialists in remote sensing, atmospheric processes and modelling, oceanography, and hydrology. The chairman of the Working Group for CP3 is a member of the GEWEX SSG.

After the IUGG General Assembly in Vancouver, two hydrological IUGS-contributions had been proposed jointly by IAMS and IAMAP:

- LAVIP, addressing the interaction of human activities with the atmosphere and land-surface processes.
- Hydrological pathways, addressing flow paths of water in the ecosystems and the streamflow generation process.

The working group concluded:

- Whereas the global water cycle in its entirety - a continuous system linking the world ocean, the atmosphere, and the continents - is crucial to the planet's ability to sustain life, the terms of reference of CP3 had been restricted to the hydrological aspects of the terrestrial biosphere.

The research programme presented by CP3 primarily addresses activities aimed at a better understanding of water-related interactions between atmosphere/soil/vegetation, necessary to quantify the role of vegetation in the water cycle.

In order to be able to quantify even the atmospheric and oceanic parts of the water cycle, the IGBP should benefit as much as possible from programmes such as GEWEX(WCRP).

- In a longer term perspective, the hydrological part of the IGBP-programme will serve three main purposes:

I. Provide hydrological ground truth to validate GCMs, based on a subdivision of the global grid into subareas from which hydrological information can be made available;

II. Provide a basis for predictions - driven by climatic scenarios from GCM-simulations - of changes in the wetting of the land and consequential changes in terrestrial hydrological phenomena;

III. Develop concepts of hydrological and vegetative parameters on how to monitor global change. It is important to decide in the near future the parameters to be observed. Particular attention should be paid to sensitive indicators in transition zones. Examination of the past record will assist in this regard.

- With the emerging interest in the functioning of the total Earth System follows the need to stimulate the development of a new field in the hydrological sciences, i.e., hydrology of ecosystems. This is an interdisciplinary field to be developed in close cooperation with

ecologists. There is in particular a need to bridge the gap between two complementary conceptual visions of the main function of water in biomass production: a) water as a conditional factor, basically controlling the length of the growing season; b) water flux through the plant as a fundamental phenomenon in biomass production.

- Climate induced changes in aquatic ecosystems is an issue of considerable human relevance that is presently absent in the overall IGBP programme. It might be useful to ascertain how far the IGBP might benefit from ongoing activities within MAB.
- The special vulnerability of coastal and estuarine environments to man-induced or climate-related changes from the delivery of sediments and dissolved nutrient material via the rivers.
- The International Hydrological Programme of Unesco in its phase IV (1990-1995) is concerned with the following relevant areas: interface processes of water transport through the atmosphere-vegetation-soil system; natural and man-made induced erosion, river-bed deformation and sediment transport; climate variability and hydrologic regimes; effects of sea-bed changes, large-scale snow and ice covers; and related projects.
- Detailed field experiments will serve to provide data for the vegetative-hydrological interactions in GCMs.
- The action plans of the different Panels are not altogether consistent in terms of the level of detail. The action plan of CP3 should accordingly be expanded by encompassing the necessary information on linked activities within GEWEX, WCRP, and IHP IV.

It was recommended that the future IGBP planning should consider the following points:

Linkages to existing international programmes

WCRP/GEWEX. It is recommended that the IGBP and the WCRP work together to integrate GEWEX and the study of the role of vegetation in the water and energy exchange between soil and atmosphere. A task team should be established to identify the key vegetation studies that should be integrated with GEWEX.

ISLSCP, as part of the proposed joint WCRP-IGBP effort on GEWEX and the biospheric aspects of the hydrological cycle, should be requested to develop further the use of satellite data for the land-surface component of the programme and to organize an initial joint (WCRP-IGBP) field experiment:

to validate satellite data, and
to generate data sets which can be used for model parameterizations.

The proposed experiment should be developed within the framework of a HAPEX of the WCRP, integrating the studies of hydrologists, biologists, meteorologists, and others.

This joint activity should also address the task of combining the grid-based GCMs and hydrological-based models for terrestrial ecosystems.

WCP/Water. The IGBP should establish a link to the programme in order to facilitate the incorporation of runoff information in studies of the terrestrial aspects of the water cycle.

UNESCO: IGBP should create a link to the IHP IV programme of UNESCO in order to benefit from their activities.

Linkages to other Panels

The Special Committee should ensure close cooperation between CP 3 and 4. In view of the numerous problems of joint concern, the two Panels should work in close cooperation. Preferably, the programmes of the two Panels should be carefully revised and fully integrated.

The Special Committee should ensure the necessary cooperation between CP 3 and 1 on the issue of water-related coupling between atmospheric chemical cycling and the biosphere.

Linkages to other ICSU-bodies

A link should be established to IAMAP/IAHS in order to incorporate the proposal for the LAVIP-project.

A link should be established to IAMAP/IAHS as a follow-up to the ICSU-proposal on hydrological pathways. More specifically, IAHS might be invited to organize, as a supporting activity, a workshop on the interface between ecohydrology and landscape ecology, an area which is of joint concern to CP 3 and 4.

Global Biosphere Observatories

In order to facilitate long-term funding efforts, the GBOs should be developed primarily around already existing field stations.

One GBO should benefit from the existence in the Amazon Basin of the multi-institute research project involving CENA, INPA and IAEA and organized around the EMBRAPA Amazon research station for the humid sub-tropics.

The proposed training component of GBOs is strongly supported as an essential component of IGBP in view of the considerable lack of qualified scientists in the interdisciplinary field of geosphere-biosphere interactions.

EFFECTS OF CLIMATE CHANGE ON TERRESTRIAL ECOSYSTEMS

Chairman: F. di Castri
Rapporteur: D.O. Hall

There is a great lack of basic information on vegetation and ecosystem responses to atmospheric constituents and climatic changes because of insufficient attention to plant-based research in this area. This was part of the background for the discussions in the group.

Recommendations concluded from the discussion

- For the feedback effect of terrestrial ecosystems on the atmosphere, the following parameters must be measured to drive GCM over annual (seasonal) and long-term time courses at both the biome and regional level:
 - evapotranspiration
 - CO₂ fluxes (and C storage)
 - albedo (short wavelength)
 - long wavelength emission (net energy balance)
 - surface roughness (also seasonal)
- There is a need for increased interactions with GCM modellers to determine what we can provide and what they need.
- Major biomes were identified, which might form a starting point for understanding how the above five parameters might change as one biome changes to another, and especially, as changes within biomes occur, in response to atmospheric constituents and climate changes.
- Agriculture (arable and silvicultural) crops must be considered as a sub-component of this group, and given high-priority.
- The term "ecosystem types" rather than "vegetation types" should be used. The study includes soil, as stated in the main report, but needs emphasis.
- There is great demand for regional and local models and forecasting, which may be difficult to meet over the short term. Important data on extremes and variance rather than means are required.
- The lack of basic information on vegetation and ecosystem responses to atmospheric constituents and climatic changes must be clearly explained to GCM modellers.
- The forthcoming workshops should consider the requirement for an appropriate structure of models to predict major changes in ecosystems. The models are not fixed and thus iterative approaches with models may be the most practical mechanism for implementing the programme, where complete data cannot be obtained within the next five years or so.
- Problems of land-use changes, in response to economic, demographic, and technological changes, need to be included in the IGBP groups, since they involve important interactions with the Human Dimensions of Global Change, and also feedback on climate.
- It was emphasized that this is the planning phase only, but that the initial actions must be decided soon. It is important to understand the previous attempts of modelling strategies and what their limitations were.

GLOBAL GEOSPHERE-BIOSPHERE MODELLING

Chairman: F. Bretherton
Rapporteur: J. Perry

It is highly important for the SC-IGBP to present a clear and realistic assessment of the current state-of-the-art in modelling of the complex Earth system. While models perform an essential integrative function, it must be borne in mind that they are simplified representations of reality, not reality itself.

The predictability of the Earth system is not known, and is in itself a major issue for research. The notion of predictability, the characteristics of the Earth system, and the complications of including human activities need to be dealt with. It is unrealistic to hold out hope for detailed prediction of the unfolding of the one-time global geophysical experiment which mankind is currently conducting. The aim should be to establish the limits of predictability of appropriate statistical characteristics of the Earth system.

The development and employment of models is a central activity within a comprehensive Earth system science program such as the IGBP. Models permit experiments with altered boundary conditions, varying forcing, varied observing systems, etc.; experiments that could not be conducted in the real world. Finally, models may in fact provide some useful degree of at least predictability of the implications of changes in the Earth system.

The following model hierarchy should be considered:

- The top level models that could be used for the global system would be analogous to the General Circulation Models employed in meteorology -- comprehensive, full-resolution models in which all relevant processes are represented in explicit form, albeit perhaps parameterized.
- More realistically, IGBP will need to develop sophisticated process models of various subsystems, e.g., ecosystems.
- Finally, and most immediately, one can employ simple conceptual models based on first principles, insights from empirical studies, and scale analysis, to provide preliminary answers.

Guidance for development of models will come from carefully designed process experiments and studies of the past.

Two approaches for modelling within the IGBP were identified:

- First, IGBP might restrict itself to modelling only those subsystems, e.g. chemical and biological, not being currently studied under the WCRP.
- Alternatively, the IGBP could from the outset address the complete coupled system, including the climate system.

The working group believed strongly that the latter course would in the long run prove to be the only productive option. Thus, one must expect that there will be rapidly growing requirements for ever-stronger interactions between IGBP and WCRP modelling programmes, especially concerning the extensive modelling of the climate system. These might be met at the outset by establishing liaison linkages, e.g., by overlapping membership, between IGBP and WCRP groups, notably the WCRP Working Group on Numerical Experimentation. However, some participants felt that eventual merger of modelling efforts might be the most productive course.

The following tasks are important for the IGBP:

- As noted above, data from the past will play an exceedingly important role in validating and calibrating models, and in suggesting unsuspected modes of behaviour to be studied.
- As in GARP, models will play an important role in designing observational networks and intensive field observational programs.
- Designing models for different levels in the model hierarchy with different computer capacity will be an important task. This might need establishment of entirely new centers for integrated systems modelling.

DATA AND INFORMATION SYSTEMS

Chairman: **P.J. Melchior**
Rapporteur: **S. Ruttenberg**

It was noted that the Commonwealth Science Council plans to hold a workshop on Chemistry, and the Environment, emphasizing techniques for monitoring trace chemicals in the environment and to discuss whether current analytical techniques are adequate enough to obtain useful measurements. This CSC effort may be of interest for the IGBP.

The group also noted the International Geochemical Mapping project, endorsed by the IUGS/Unesco International Geological Correlation Programme. Maps of as many regions as possible will be prepared to document natural radioactivity backgrounds and the occurrence of trace elements important to or deleterious to life. The project could also respond to IGBP input to map specified elements or compounds. This effort was endorsed as a contribution to IGBP.

The group also endorsed the proposal to collect and/or collate global data sets of wide interest and to promote their distribution.

As one study, it was proposed that data set of global "vegetation cover" should be prepared, in collaboration of the ICSU WDC Panel, for at least two seasons of the year, during the El Niño period 1981-85.

The following tasks were identified:

- Prepare datasets of Leaf Area Index, with display software, an IBM-PC compatible 5 1/4" diskettes, with resolution of 25 x 25 km. If possible, include related meteorological and CO₂ information.
- Distribute about 100 sets to scientific groups, especially in developing countries, for use and analysis.
- Organize a workshop to compare results and discuss application software, additional data sets, and the possibility of producing higher-resolution, longer-time series data on CD-ROMS.
- The time scale anticipated is to have a master set ready for discussion for the land-surface workshop in January 1989, distribution shortly thereafter, and the workshop in late 1989.

The group invites the four SC- IGBP Coordinating Panels to suggest additional pilot data sets, on inexpensive computer media, for wide distribution, use, and feedback to the IGBP.

- The group recognizes the need to evaluate the quality of existing data sets that are useful to the IGBP. The WG invites the collaboration of CODATA, FAGS, and the WDC Panel in making such assessments.
- The group proposes to request the IGBP National Committee to submit information on national data sets of potential IGBP interest.
- The group supports collaboration with other groups, within ICSU, e.g. FAGS, CODATA, and the WDC Panel.

TECHNIQUES FOR EXTRACTING ENVIRONMENTAL DATA OF THE PAST

Chairman: N. Rutter
Rapporteur: N. Rutter

Scientists from many disciplines met to discuss the report by the Working Group on Techniques for Extracting Environmental Data of the Past. The Group unanimously agreed that paleoenvironmental data are an important and necessary component of the IGBP, if the programme is to be successful in meeting its objectives. Further, the report was endorsed with only minor changes in structure and content with a strong recommendation that a Scientific Steering Committee be appointed as soon as possible with the mandate to assess the national and international efforts in this area, to develop a multi-technique programme of field activities and to initiate pilot projects.

The following observations and suggestions were agreed upon:

- In that the programme, among other things, calls for numerical data of the past over short time periods, it is imperative that the Steering Committee links with programme modelers to ensure that the correct type of information and data are collected and supplied. Along the same vein, in that paleomodelling is a research emphasis in techniques for extracting data from the past, the Group questions if this should be an independent effort or carried out in cooperation with modellers involved in other aspects of the research programme.
- The Steering Committee should address the problem, at an early stage, on the best method of ensuring that out of the hundreds of projects dealing with paleoenvironments, that the pertinent information is transferred into a unified system and utilized. It is emphasized that it is important that only accurate, consistent proxy data are used and interpreted. The Group also sees the merit of encouraging research into dating methods to improve their accuracy and resolution.
- The Group noted that all four of the proposed IGBP research activities can benefit from most activities and initiatives outlined by the WG 1.
- It is suggested that more emphasis be placed on studies of human impact on the environment and how this may affect the predictions of global change. For instance, industrial development has led, and is leading, to significant changes in the chemistry (trace elements, phosphates, nitrates, oxygen) and biology (algal blooms, elimination of certain species of organisms) of water bodies in many areas. In addition, Man's activities are leading to significant terrestrial modification through degradation of vegetation, soil, and water resources.
- It was suggested again that it is imperative that scientists from developing countries be involved in the activities outlined by the Working Group and that the density of information be increased in key areas, many of which are in developing countries. If transects for data accumulation are to be made in these areas by scientists involved in various components of the research programme, an effort should be made to ensure that there is cooperation and coordination with scientists that may be involved with transects for paleodata.
- It is suggested that added attention should be placed on developments in isotope geochemistry and its implications on paleoenvironmental research, and that attention be paid to the causes and manifestations of the termination of the Pleistocene, and to rapid and extreme changes of past events.
- Further, the group would like to stress that global change may not always be negative as is often advocated.

GEOSPHERE - BIOSPHERE OBSERVATORIES

Chairman: W.G. Sombroek
Rapporteur: R. Herrera

The concept of geosphere-biosphere observatories recognizes that the scientific issues of global change dictate the establishment of a long-term co-ordinated network of marine and land-based measurements of geosphere-biosphere processes. Specifications for the quantity and quality of the necessary data depend upon measurements required for the assessment of global environmental change and for conducting experiments designed to understand global environmental processes.

Geosphere-Biosphere Observatories (GBOs) are proposed as the first level in a hierarchic structure of a few strategically placed GBO Research and Training Centers that are multinationally supported, interdisciplinary in operation, and which serve the needs of experimentation and observation. The second level comprises cooperating GBOs. These will be more numerous (about 100), will consist of a network of existing sites, each supported by one nation, and will participate in both experiments and observations. The third level of the hierarchic structure will be composed of affiliated networks, perhaps as many as 1000 sites, that are parts of several existing networks used to measure one or more variables. Finally, the GBO concept specifically incorporates "tents and rowboats" as a fourth level consisting of transect research and monitoring sites.

As proposed, these GBOs would consist of a hierarchic structure of sites, with the higher level sites designed to be more comprehensive, with greater integration, and representing a long-term commitment. Examples of the major features of the GBOs are described more fully in IGBP Report No. 4.

In consideration of the establishment of GBOs, several cautions can be indicated:

- Establishment of sites will be expensive;
- Research and Training Centers represent yet another organizational structure over existing networks;
- Location of these sites will not be equally effective for answering all research questions or for monitoring all variables; and
- Political issues, the change of parochial ownership, and the danger of loss of continuous support all represent possible sources of jeopardy.

Funding for new programmes, especially in developing countries, is limited and thus starting new programmes is difficult. Agencies are reluctant to create new structures and nomenclatures, since their programmes and budgets are already in place. Arguments for establishing new sites, or materially enhancing existing sites, will need to demonstrate that, as a participant, the agency will acquire many more data on a global basis, and that these global data will be useful in solving local and regional problems.

The ultimate decision about the GBO concept depends upon whether this structure is necessary to support the types of measurements required in the Global Change programme and whether the proposed structure provides data information and data that is not already available from existing networks and sites.

Because of these cautions, it will be necessary to implement GBOs on an experimental basis, using existing sites as much as possible. A few prototype, strategically located, sites with a history of successful relevant research should be selected for initial development. Then it should be determined if these GBOs can provide data, information, and services that cannot be provided by existing networks, whether these sites can provide an effective aggregated scale for global measurements, whether these sites are successful in developing new philosophies and practices of data sharing and the interdisciplinary experimental approaches necessary for

addressing the changing global environment, and whether this GBO system can actually function and fulfill the roles described earlier in this report.

Instituting these GBOs might conflict with other organizations that would participate in the IGBP programme. Thus, attention should be paid to the criteria needed to select the initial Research and Training Centers and the Cooperating Observatories. IGBP Report No. 4 provides some of these criteria, e.g., value for scientific issues, scientific capability, assurance of continuity, openness to scientists of all nations, and location in regard to environmental variables likely to be efficient in documenting global change. Location decisions should include on-site variation to measure spatial variation and transitions to other ecosystems, where responses to changing global climate are rapid, and where episodic events are likely to have major impacts. Agricultural and human-dominated land-use types may be particularly important components in these sites because of their relatively rapid response to changing climate, and because the connections between changing climate and human support systems are more obvious compared to natural systems. Furthermore, data collection designs should take into account human behavioral characteristics in the use of and influence on these natural resources.

The deployment and development of Research and Training Centers and Cooperating Observatories may be made more effective with orientation along transects. These transects could involve more countries as participants and would explicitly address spatial variability across environmental gradients at the regional micro-transects, or continental (mega-transect) scales. While these transects would not provide all the data, information and services of Research and Training Centers, they would be relatively convenient and inexpensive to establish.

GBOs will serve several roles within the Global Change Programme:

- Provide a permanent site where scientists can participate in long-term experiments, where continuation of research is a characteristic of the site and not dependent upon continuity of investigators;
- Provide sites which do not already exist now, namely, sites where multidisciplinary data sets are collected simultaneously to study the changing global environment;
- Ensure that all nations can understand and participate in the research efforts to measure and predict global environmental changes;
- Exert a scientific leadership role in the biome or region represented by the site;
- Operate as a regional data storage and dissemination center, where the data are handled by individuals familiar with the regional geosphere and biosphere characteristics;
- Provide logistically supported sites for the development of specialized instrumentation and for calibration of instruments;
- Offer training with the appropriate instruments under local field conditions;
- Assist in creating a capable scientific community in all countries; and
- Contribute to the education of a cadre of scientists familiar with the approaches and techniques of integrated global science.

These Research and Training Centers and the Cooperating Observatories are not envisioned as one point in space, but rather as a whole landscape that represents both spatial variability and long-term temporal variability.

THE CONTRIBUTIONS TO AND THE ROLE OF NATIONAL IGBP COMMITTEES IN THE PLANNING AND IMPLEMENTATION OF THE IGBP

Chairman: **H.J. Bolle**
Rapporteur: **R. DeFries**

The discussions in the group led to the conclusion that the IGBP National Committees have three major responsibilities:

Coordination of national participation in international research projects of the IGBP

At the planning stage of the IGBP, the National Committees can assist the Special Committee in defining those research projects that require international collaboration. For example, the National Committees should:

- Advise the Special Committee on national experts and available resources for carrying out planned research projects;
- Identify scientific gaps in the plans and communicate this information to the Special Committee;
- Assess and synthesize national participation in related programs (e.g., WCRP);
- Suggest members for international Steering Groups to develop research plans.

As the programme becomes operational an additional responsibility of the National Committees will be to coordinate national participation in international projects (e.g., coordinate facilities such as observatories, aircraft, ships, satellite data banks, and special instruments; stimulate partnerships between scientists in different countries and disciplines). An early field experiment could investigate tropospheric chemistry and the impact of vegetation on the hydrologic cycle, possibly combined with measurements of biogenic sources of trace gases. Such a pilot project would establish mechanisms for the National Committees to coordinate participation in other IGBP projects.

In addition, it was suggested that National Committee representatives meet prior to the next SAC meeting to compare and summarize national priorities. These views could then be concisely presented to the Special Committee.

Identification and implementation of national and regional level activities related to the IGBP

Individual national and regional interests and conditions will diverge from the international research projects defined by the Special Committee. For example, many National Committees have indicated that the human dimensions of global change will be included in their national plans. Such national level activities should be encouraged, particularly as innovative research approaches may emerge from efforts of individual scientists or National Committees. Likewise, joint activities of National Committees to address regional issues should be encouraged.

National and regional activities include:

- Clarifying the significance of the IGBP for national research efforts and for national policies;
- Defining national contributions to the IGBP (e.g., establishing plans for interdisciplinary research relevant to the IGBP, but appropriately conducted within national boundaries; organizing workshops and symposia to synthesize research results);
- Identifying regional research needs and coordinating with other National Committees to plan and implement joint research projects relevant to the IGBP (with proper

coordination through the Special Committee). For example, some European National Committees can coordinate activities through the Commission of European Communities.

- Coordinating plans to establish GBOs and assisting other National Committees to establish GBOs when necessary;
- Supporting (i.e., helping to obtain funds, identifying research partners, etc.) scientists and research groups engaged in activities related to the IGBP;
- Carrying out educational and training activities by promoting interdisciplinary training courses and centers at research institutions and extension of curricula at universities, and publicizing the concepts of IGBP through publications and presentations.

An unresolved issue is the degree to which the Special Committee should be involved in or endorse national and regional level activities.

Assistance in logistical and managerial aspects of the IGBP

- By organizing workshops in cooperation with the Special Committee.
- By suggesting participants for workshops and panels established by the Special Committee.
- By maintaining coordination with other national efforts related to the IGBP and with other National Committees for ICSU bodies.
- By communicating plans for national activities (in a few pages) and other relevant documentation to other National Committees and the Special Committee.

It was also noted that National Committees should maintain membership from a balance of disciplines in order to carry out the interdisciplinary mandate of the IGBP.

INTERACTION BETWEEN THE IGBP AND OTHER SCIENTIFIC BODIES AS WELL AS OTHER INTERNATIONAL RESEARCH PROGRAMMES

Chairman: J.C.I. Dooge

The discussion in the group led to the following conclusions:

Duties and responsibilities of the SAC-IGBP

Article 21 of the Constitution of the SC-IGBP (Appendix 9 of IGBP Report No. 4) stipulates that among its functions, SAC will "provide a forum and mechanism for cooperation between the participating Adhering Bodies". This meeting of the SAC did provide a useful forum for exchange of information and suggestions, but there remains the question of a suitable mechanism for discussing and facilitating such cooperation in the intervals between the meetings of the SAC.

The working group agreed that a mechanism for cooperation to realize the IGBP should have the following characteristics:

- It should be uncomplicated even in view of the fact that there will be many bodies within and outside ICSU that will have valuable contributions to make;
- It should retain flexibility to accommodate the many kinds of cooperation and contributions that may be useful, and also to allow for evaluation of the structure of the IGBP programme;
- It should allow for and encourage collaboration of many ICSU, UN, and other international and specialized bodies; and
- It should allow for experimentation to develop new terms of partnership as appropriate.

The group calls to the attention of the SC-IGBP, as one possible model of collaborative mechanisms, that the closely-related WCRP has adopted the use of Steering Committees for WCRP projects that involve active representation, as appropriate to each project, from each body contributing to the implementation of the project in question. Such direct involvement has been effective in evaluating the detailed plan and implementation of such WCRP projects as ISCCP, TOGA, WOCE and is being used for projects now in the formative stage.

ICSU Coordination

The working group noted that many ICSU Unions, which have expressed interest in the IGBP have established committees to coordinate Union IGBP activities and to serve as a communication path to the SC-IGBP. The working group recommends that other interested Unions, Scientific Committees, and other bodies might do the same, or at least designate an IGBP contact or liaison representative.

To facilitate further the communication and coordination of IGBP programmes of ICSU bodies, the working group recommends that at the time of the meetings of the General Committee of ICSU a special half-day meeting be held by the Presidents of Unions and Scientific Committees or their representatives to discuss the IGBP. ICSU bodies interested in IGBP should be requested to submit brief reports in advance for distribution with other working papers before these meetings.

Cooperation with intergovernmental organization

The working group was pleased to note that a coordinating committee has been established to facilitate collaboration of several UN bodies (WMO, UNEP, Unesco). It was also noted with appreciation that the remarks in opening presentation at this meeting of offers of collaboration,

and during the session noted with especial appreciation the reiteration of offers of broad collaboration by agencies such as Unesco.

Relation to other international programmes

There is a need to establish an understanding and lines of communication with the thirty international programmes (nongovernmental, intergovernmental, and combined) listed in Appendix 2 to IGBP Report No. 4. It is obvious that there can be no fixed uniform system of collaboration and that each case must be considered separately and an appropriate system arrived at by agreement. It is particularly urgent and important that the relationship between IGBP and WCRP be clarified and procedures for recognizing their complementarity devised. This should be done as soon as possible and reported to the Executive Board of ICSU.

Broad communication of IGBP progress

To facilitate communication within the ICSU family as well as the UN and other agencies, and broadly to the international scientific community, the working group recommends to the SC-IGBP that an IGBP Newsletter be established. Announcements and news items should be disseminated not only in an IGBP Newsletter but supplied, as appropriate, to other groups which publish relevant newsletters, as well as to general scientific journals and information newsletters.

Programme structure

The Discussion Group feels it is important that the SC-IGBP define as quickly as possible some important temporal and structural elements of the programme, such as:

- Early definition of some initial projects with, as appropriate, establishment of steering committees and organization of planning workshops;
- A clear statement as to the expected time schedule, outlining planning phases, implementation phases, timing and duration of expected pilot and long-term projects, and analysis phases. It is recognized that projects will encompass a variety of time periods and that some will lead to definition of routine long-term monitoring efforts;
- Some guidelines on level of detail desired in proposed projects by Adhering Bodies for incorporation in the IGBP;
- Guidelines for the SC-IGBP itself for timely responses to Adhering Bodies on project proposals, which is needed for approaches to funding organizations so that endorsed projects can be implemented in a timely fashion.

Moreover, the working group calls the attention of the SC-IGBP to the strong desirability of revising the three tier nomenclature described in IGBP Report No. 4, in as much as the present nomenclature can be misinterpreted by funding agencies and could do harm to the status of important closely-related programmes needed by the IGBP, but organized and implemented by Adhering Bodies.

Finally, the group calls attention to the possible desirability of considering some kind of federated programme structure that provides for a variety of management auspices of research as well as routine monitoring, programmes needed to meet the long-term objectives of the IGBP.

THIRD WORLD COOPERATION IN THE IGBP

Chairman: R. R. Daniel
Rapporteur: J. Cihlar

The discussion within the group focused on several aspects and led to the following suggestions and conclusions:

IGBP activities in Less Developed Countries (LDCs) (not in priority order)

- IGBP should involve LDCs to the greatest possible extent.
- IGBP must find a suitable mechanism/mechanisms to involve LDC scientists in the IGBP, including ways of overcoming occasional reluctance/difficulty in becoming involved in large programmes.
- Developing countries generally cannot afford to allocate large amounts of money to environmental research, but they do have scientists who are prepared to devote their careers to this subject.
- LDC scientists should be involved in data analysis and integration of results, not just in data collection; both processes and monitoring research of high quality should be included.
- IGBP should aim at creation of new scientific expertise and scientific groups in LDCs.
- IGBP should aim at creating a focus (IGBP committee or even only a contact) for activities in as many LDCs as possible.
- IGBP should place emphasis on issues relevant to the country/region concerned, wherever possible, in addition to relevance to the IGBP itself.
- IGBP should identify and take advantage of relevant (a) data already collected, and (b) projects/activities currently underway (sometimes haphazardly) in individual countries.
- Collaboration on projects is needed between developed countries and LDCs; e.g., to provide specialized equipment.
- Each LDC may have a different set of problems that the IGBP will be faced with, and these may vary with time. Therefore, each country may have to be dealt with differently. However, three issues which are generally common are lack of interdisciplinary research, lack of standards for data quality, and difficulty in obtaining commitment for a long-term programme support.
- Although regional cooperation is desirable, practical constraints (e.g., across-the-border travel) often make it difficult.
- A "catalogue of resources" (data available, projects underway, scientific manpower) would be very helpful in planning the IGBP in LDCs.
- In "selling" the IGBP, it would be most helpful to have a product - or a set of products - expected from the programme.
- IGBP provides an opportunity to strengthen the gathering and use of baseline information.
- IGBP should aim to emphasize/spread the idea of new vision, global perspective at all levels including universities, general public, etc.
- Long-term bilateral cooperation is an excellent mechanism for LDCs involvement in the

IGBP. Joint experiments from formulation to analysis and interpretation were stressed.

- The long-term nature of the programme dictates that research programmes in LDCs be associated with well-established groups or groups that are parts of well-established institutions and free from political influences.

Funding

- LDCs must express their resolve and intention to participate in the IGBP by providing funds for the program nationally and internationally.
- There may be numerous LDCs where funding will have to be contributed by external sources such as international organizations, foundations, regional organizations, and donor countries. Mechanisms will have to be found that will ensure that funds will reach the research groups at the right time and for the period of duration of the research. These mechanisms may vary from one country to another. The need for long-term commitment will meet a special challenge in the developing countries.

Organization issues

- In many LDCs where the concept, objectives, plans, and programmes of the IGBP are not adequately known, it is essential that steps are taken to produce the necessary awareness among both the scientific community and decision makers. A brief on IGBP in this connection can be very valuable.
- National programmes will have to obtain the support of the government as a whole. The IGBP will have to take advantage of available opportunities to obtain this support. This will also solve the scientist's loyalty issues.
- The programme must be integrated (data collection to analysis and interpretation) at the national as well as regional and global levels.
- To stimulate creation of National Committees, initial contact points can be identified using ICSU lists, a list of the African Academy of Sciences, the IUCN, the Third World Academy, the International Society of Soil Science, and others.
- The exact approach to stimulating the establishment of National Committees should be examined in view of experiences with the MAB in Africa and the Unesco coastal ecosystems project in South America.
- Potential target agencies in individual countries are Ministries, National Research Councils, and Academies.

Training local scientists

- The proposed linkage with the Earth Sciences Institute of the Third World Academy is attractive and should be taken advantage of. It should be noted that it will require a level of expertise from the members representing LDCs, thus presupposing a prior training programme. It was also emphasized that training opportunities in GBOs for scientists from LDCs should be given special consideration.
- Training could be combined with research in LDCs.
- Training needs should affect university curricula (including transdisciplinary approaches).
- Where local "critical mass" is not available, training can be done abroad, e.g., in the same region.

Communications

- There is a need to promote awareness and importance of the IGBP among scientists and decision makers, nationally and regionally.
- Regional forums for exchanging information would be helpful, as would local seminars/information exchange meetings.
- Timely access to scientific literature (results) and IGBP news is essential.
- IGBP Newsletter and GC updates in journals are potentially powerful vehicles for communication.

The group also raised, but did not discuss, the issues on important scientific problems for LDCs, the needs of scientific infrastructure, building, and instrumentation, and the participation in the GBOs.

INTERNATIONAL COOPERATIVE SUPPORT TOWARD THE IMPLEMENTATION OF THE IGBP RESEARCH PROJECTS

Chairman: R Corell
Rapporteur: S.G. Tilford

The group centered its discussions on matters concerned with the implementation of IGBP research activities, both from a perspective of national research program interests and from the perspective of intergovernmental arrangements. The participants were from these two communities, and hence the group was able to develop a proposal for discussions with a SAC participants. The discussions included a review of existing support and implementation strategies for programmes such as the WCRP, i.e. WOCE, TOGA, JGOFS, IGAC, etc... These provided a helpful frame of reference to "reality" test ideas for the IGBP. Further, the group reviewed such historical perspectives as the International Geophysical Year (IGY), and GARP. These discussions focussed attention on the fact that the implementation and support strategies for the IGBP needs to address these interests and existing infrastructures:

- ISCU, the various bodies of ICSU, the National Committee structure of the IGBP, and the IGBP itself;
- National Programs and Activities related to the IGBP, from the highly focussed and structure programmes of IGBP/GLOBAL CHANGE such as the U.S., to more unstructured but equally important perspectives as those held in some of the developing parts of the world;
- Intergovernmental Organizations and their IGBP-related/like program interests. The WMO, Unesco/IOC, and UNEP play an important role in the implementation of such programs as the IGBP, and can contribute significantly to its successful implementation; and
- Foundations and Private Funding organizations can and should play a significant role in the support and implementation strategy for the IGBP.

The group addresses both long and short term support and implementation strategies for the IGBP, but focussed most of its attention on the long-term funding (i.e. over the next decade or so).

Working group observations

The Working Group discussed the issues and perspectives to underline the needs for support and for developing an implementation strategy for the IGBP.

A number of questions characterized and summarize the discussions, and served as the basis for the development of a "strawman" strategy or conceptual framework for a proposed implementation approach for the IGBP. These included:

1. The IGBP is a long-term research programme, the funding and support of which will most likely include:
 - National Support from Agencies of Government, including funding and support of the principles and needs of the Programme (i.e. Countries working more or less alone on important IGBP research;
 - Support through bilateral and multilateral arrangements, either formal intergovernmental or cooperative science programmes, or more informal arrangements;
 - Centralized funding mechanisms, where resources are centralized and managed by some international body, or by a body on behalf of an international interests;

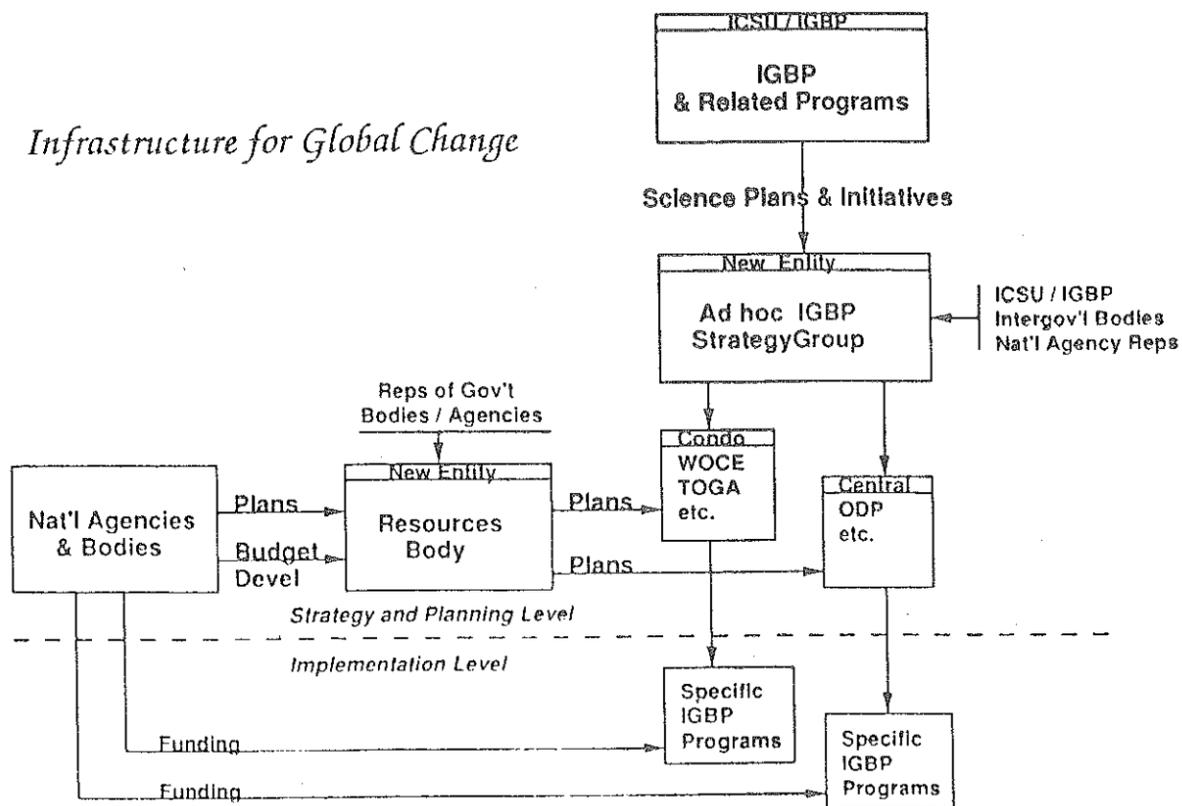
- Countries and organizations with regional interests have critical interests in the IGBP, how do they become partners and players, contributing people, access to important research sites, and other forms of support.
2. Two basic funding arrangements were discussed, the first being the historically most used method of decentralized funding, or "condo" approach, where each party contributing/brings their own resources to the programme and agrees to work within a common framework. Most of WCRP is handled this way. The second approach for funding is to centralize the management of the programme and centralize the funding through funds being supplied by nations to the central management authority. The international Ocean Drilling Program works in this fashion.
 3. Education, training, and technical assistance is a vital component of any implementation strategy, particularly to maintain participation of all the countries of the world, developed and developing a like. The Group discussed the use of short-term workshops, dedicated and long-term institutes, and regional research centers to facilitate these issues as well as the research programme.
 4. A sense of ownership, shared participation in all phases of the planning, strategy development, and implementation planning and execution seemed to be a critical element of any approach to implementation of the IGBP.
 5. The Group explored the experiences with other kinds of "global" research programmes, such as the Agriculture Research Institutes, used for "crop" development,
 6. The group reviewed the need to get started, and proposed that the IGBP consider, seriously, the possibility of joining forces with on-going and established global research programmes, such as the WCRP, JGOFS, IGAC and others.

Important tasks and recommendations from the working group

The group focussed on three main recommendation:

1. The IGBP/Global Change Projects should be categorized as follows:
 - Core IGBP projects essential to the IGBP and under direct supervision of the Special Committee;
 - Supporting activities essential to the IGBP but under supervision of other organizations;
 - Affiliated activities related to Global Change research but outside the priority statement of the IGBP.
2. The IGBP should develop a planning format, well understood by all, so that nations and organizations can plan their nations and organizations can plan their activities in coordination with the IGBP.
3. The group felt strongly that the Third World Countries should be included in the planning of the IGBP, at the earliest possible time.
4. The Group developed a "strawman" infrastructure, outlined in the figure below. The two key components of which are the Strategy Group, where strategic decisions of the directions and implementation approaches can be made in partnership with "key" international bodies, and the Resources Group, where effective resource development and planning can be made in partnership with those countries, bodies, and entities who can provide the needed resources (resources is more than funding, it includes, people, access to vital research areas, etc.)

Infrastructure for Global Change



HUMAN DIMENSIONS OF GLOBAL CHANGE

Chairman: W. Clark

The group noted :

- The substantial and growing interest in the human causes and implications of global environmental change now being expressed by politicians, scholars, and citizens around the world;
- The central role of the IGBP in the international scientific study of global change; and
- The determination of the IGBP, as expressed in its initial "Plan for Action" (IGBP Report No.4), to pursue "discussions on how future cooperation between the IGBP and the social sciences should be developed".

The activities of the working group centered on a preliminary review of activities relating to the human dimensions of global change that have been undertaken or are planned by national IGBP committees, other national efforts, ICSU Unions, other nongovernmental associations and organizations, and international governmental organizations. It also conducted a preliminary review of needs expressed by other SAC working groups for research results that might be provided through collaboration with social scientists and other scholars of the human dimensions of global change. While no in-depth assessment was possible in the time available, the group reports the following tentative findings:

- Reports of national groups: The formal national reports on the IGBP tabled at the first SAC meeting reflect a great range of approaches to the human dimensions of global change. In several countries there have developed significant activities focussed on the human dimensions of global change that appear to be relatively independent of, but proceeding in parallel with, formal national IGBP committee activities. Some countries have developed both strong human components within their national plans for IGBP and active parallel programmes on the human dimensions of global change. Overall, approximately half of the national reports tabled at the SAC meeting address the question of the human dimension of global change.
- Reports of international organizations, unions, and other associations: At least a dozen efforts are underway at the international level that are relevant to understanding the human dimensions of global change.
- Reports of multinational programmes on the human dimensions of global change: The most inclusive and advanced multinational programme on the human dimensions of global change is clearly the IFIAS/ISSC/UNU initiative described by Dr. Burton in his plenary address. A more recent initiative by the European Science Foundation was also described to the group, and documented. Finally, members of the SC-IGBP reported on bilateral activities on the human dimensions of global change involving China, the USA, and the USSR. One of the most fruitful near-term avenues for research on the human dimensions of global change may be tightly focussed bi- and multilateral initiatives.
- Needs expressed by other SAC working groups: There is a strong demand for studies on land use change and changing patterns of industrial emissions.
- The overall goal of creating a useful, predictive understanding of global change per se cannot be realized without significant new research on the nature of human interactions with the geosphere-biosphere system.
- Clearly neither premature merging of the natural science and social science programmes, nor their development in eternal isolation is likely to be effective. In addition to ICSU's IGBP itself, these include the IFIAS/UNU/ISSC international programme on the Human Dimensions of Global Change, several bi- and multilateral efforts, a number of national

IGBP committees and other bodies, many international unions and other nongovernmental international organizations, and the international intergovernmental community as represented by UNEP and Unesco. The enthusiasm, energy, and contributions of these groups are to be commended and encouraged. Additional organizations, national groups, and international bodies should be encouraged to follow their lead.

The development of specific mechanisms for promoting communication, exchange, and cooperation between the IGBP and the various groups interested in the human dimensions of global change should be encouraged. In particular:

- A regular exchange of invitations to participate in key meetings has already developed between IGBP and the HDGCP, many national committees, and some international organizations. Such exchanges should be commended and encouraged.
- Several of the Action Plans proposed in the IGBP Report Number 4 call for the formation of expanded scientific steering committees to help guide the evolution of IGBP research ventures. Several of the plans also call for use or acquisition of understanding (e.g., on land-use change) to which social scientists have made significant contributions. The group recommends that the SC explicitly consider qualified social scientists as candidates for membership on the relevant steering committees. The group members, and the programmes and organizations they represent, expressed their willingness to help in the identification of such candidates if requested to do so by the SC.
- The Executive Director of the SC-IGBP suggested to the group that a demonstration project involving human and environmental dimensions of global change should be organized in the foreseeable future. This offer should be commended and accepted. Initially, the SC-IGBP, as part of its continuing programme planning effort, should indicate any areas in which it feels that contributions from studies of the human system would be especially useful, e.g., patterns of land-use change and industrial emissions. Groups concerned with the human dimensions of global change should strive to develop a few specific, broadly supported proposals for collaborative studies that would be most desirable from their perspective. As thinking within the IGBP and the community of social scholars matures, mechanisms should be sought for bringing about an integration of views in a specific project proposal.
- The Chairman of the SC-IGBP has outlined the SC's programme of building communication links with the National Committees, international organizations, and funding councils. The group emphasized that real cooperation on the human dimensions of global change is unlikely to develop unless effective communication links can be forged between IGBP and the social science community. The group believes that a necessary step in establishing such communication links will be the creation of committed staff positions in key organizational positions, ideally to serve both the IGBP Secretariat and the relevant programs concerned with the human dimensions of global change. Several participants suggested that one particularly useful step would be the placement of a junior staff person charged with promoting links between IGBP and the relevant programs concerned with the human dimensions of global change in or near the SC-IGBP Secretariat. Such an individual could ensure that relevant material produced by national IGBP committees, other organizations, and by the SC itself would reach all groups active in research on the human dimensions of global change. Reciprocally, the staff person could provide a contact point for communication among scholars and programmes working on the human dimensions of global change, and between these individuals and the IGBP Secretariat itself.

If such a position were viewed by SC-IGBP as a useful means to facilitate the future cooperation with the social sciences that it has called for in its Report No. 4, the group felt that requisite funding could almost certainly be provided through the social science community.

IGBP Reports

- No. 1. The International Geosphere-Biosphere Programme: A Study of Global Change. Final Report of the Ad Hoc Planning Group, ICSU 21st General Assembly, Berne, Switzerland 14-19 September, 1986 (1986)
- No. 2. A Document Prepared by the First Meeting of the Special Committee, ICSU Secretariat, Paris 16-19 July, 1987 (1987)
- No. 3. A Report from the Second Meeting of the Special Committee, Harvard University, Cambridge, MA, USA 8-11 February, 1988 (1988)
- No. 4. The International Geosphere-Biosphere Programme. A Study of Global Change (IGBP). A Plan for Action. A Report Prepared by the Special Committee for the IGBP for Discussion at the First Meeting of the Scientific Advisory Council for the IGBP, Stockholm, Sweden 24-28 October, 1988 (1988)
- No. 5. Effects of Atmospheric and Climate Change on Terrestrial Ecosystems. Report of a Workshop Organized by the IGBP Coordinating Panel on Effects of Climate Change on Terrestrial Ecosystems at CSIRO, Division of Wildlife and Ecology, Canberra, Australia 29 February - 2 March, 1988. Compiled by B. H. Walker and R. D. Graetz (1989)
- No. 6. Global Changes of the Past. Report of a Meeting of the IGBP Working Group on Techniques for Extracting Environmental Data of the Past held at the University of Berne, Switzerland 6-8 July, 1988. Compiled by H. Oeschger and J. A. Eddy (1989)