GLOBAL CHANGE

IGBP

REPORT No. 22

Report from the START Regional Meeting for Southeast Asia

The International Geosphere-Biosphere Programme: A Study of Global Change (IGBP)
of The International Council of Scientific Unions (ICSU)
Stockholm, 1992

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Report from the START Regional Meeting for Southeast Asia

Arranged by

The International Geosphere-Biosphere Programme:
A Study of Global Change (IGBP)
in collaboration with the
Human Dimensions of Global Environmental Change
(HDGEC) Programme

under the auspices of the
Thai Minister of Science, Technology and Energy
His Excellency Professor Sanga Sabhasri

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

The Southeast Asian START workshop spearheaded by ASEAN countries, also attended by representatives from Australia, Japan, USA, and the Academy of Sciences (Taipei) as well as IGBP, WCRP, HDGEC, Unesco, and UNEP/GRID, meeting in Chiang Mai, Thailand on 13-17 January 1992 makes the following recommendations:

1. The workshop stresses the need for the scientific communities in the region to be fully involved in all aspects of global change research. It further notes that the International Geosphere-Biosphere Programme (IGBP), the World Climate Research Programme (WCRP), and the Human Dimensions of Global Environmental Change Programme (HDGEC) provide the international framework for this research. Countries in the region are encouraged to take active part in these international programmes as appropriate taking national priorities and available scientific expertise into account.

2. The workshop endorses the initiatives of the IGBP to address regional research needs in relation to global change, in particular the proposal for START. In the furtherance of these initiatives, the workshop recommends the formation of National Committees for IGBP in all countries of the region. All national committees should preferably be interdisciplinary, including both natural and social scientists. In order for regional activities to be coherent and properly articulated, it is further recommended that there be a regional IGBP coordinator.

3. The workshop recognizes the need for continuity and sustainability of planned activities in order for the programmes to be meaningful and attain their objectives. Therefore, it recommends that the countries involved commit themselves to the programmes through funding support and identification of appropriate individuals and institutions that can follow through the activities.

4. The workshop recognizes the need for substantial funding to carry out the various activities proposed. It recommends that international and bilateral donors, and individual countries and institutions in the region, support the regional programmes on global change through financial assistance.

   In particular, the workshop strongly endorses the IGBP proposal for START to the Global Environmental Facility (GEF), especially with reference to the Tropical Asian Monsoon Region with an initial focus on the ASEAN countries. The workshop notes with interest the proposals from the Thai and Indonesian IGBP committees in relation to START and requests the START Standing Committee to continue discussing these proposals with countries in the region as a priority.

5. In the eventuality that START is successfully launched with the needed initial seed money, the meeting invites the participation of countries from the broader Southeast Asian region. In addition, the meeting notes and welcomes Japan's interest in collaboration with the region, and notes the possible Japanese invitation to host a regional meeting to further address regional aspects of global change research including possible support for the START initiative.

6. The workshop identified, the need for appropriate linkages and interactions among scientists and institutions both within and outside the region. In this context, it recommends the following:

   - training of manpower for global change research to maximize the use of indigenous expertise.
   - periodic experts meetings in the region focused on IGBP Core Projects.
   - compilation of a directory of individuals and institutions with active interest in global change research. Establishment of appropriate regional data bases to serve the specific global change projects.
   - information exchange making use of existing mechanisms where possible. Data generated through IGBP/WCRP/HDGEC projects should be accessible to participating countries.
   - access of participating countries to each other's Exclusive Economic Zones in the context of IGBP and WCRP activities.

7. The workshop recommends the improvement of existing infrastructure that can be mobilized to address global change research. Hence, projects in the region should give due regard for enhancing capacities of existing institutions.

8. The workshop recognized that Southeast Asia has natural phenomena peculiar to it such as the monsoon regime, the pronounced land-ocean interaction due to the archipelagic nature of the region, and the incidence of volcanic eruptions that can affect global change. In addition to global change concerns that are common to many regions (e.g., ENSO events), the meeting recommends, among other issues, that some attention be focused on episodic events likely to have global implications, especially the monsoon influence on land-ocean interactions in the region and physical and socio-economic impacts of volcanic eruptions.

9. As a follow-up to the workshop, the participants recommend the formation of an Ad Hoc START Regional Committee to carry forward the above recommendations in particular and IGBP concerns in general. It is suggested that the committee consist of the Chairs of the IGBP National Committee in the region plus representatives from Brunei Darussalam, Malaysia, the Philippines, and Singapore. The workshop also welcomed the tentative invitation from the Indonesian IGBP Committee to host a follow-up meeting in mid-1992.

Introductory Comments

Professor Sanga Sabhasri, Minister of Science, Technology and Energy

The Chairman of the Thai National Committee on IGBP,
Vice-President of Academic Affairs, Chiang Mai University,
Executive Director of the International Geosphere-Biosphere Programme,
Deputy Executive Director HDGEC Programme,
Distinguished participants,
Ladies and Gentleman,

It is my great privilege to be here among the well known global and regional scientists, old friends from many countries, for this important event as part of the series of important workshops convened by the IGBP. I feel very honoured to address this distinguished gathering of scholars and policy-makers today.

Let me first begin with a profile of our global environment and the IGBP's endeavour to describe this system and the manner in which it is influenced by human activities.

We are very well aware that all regions of the world are being faced with many serious problems caused by changes in the global environment, for example, climate change, and stratospheric ozone depletion, as well as deforestation and acid rain, which create negative effects for life on Earth.

There is a critical need to stimulate and to facilitate regional aspects of the global research programmes. In this regard, we have been impressed by the efforts being made by the IGBP to approach the global environmental problems of all regions, which are different in biogeography, climate and also socio-economic systems. In spite of these differences, the environments and related issues of various nations and regions have been studied and the global change researchers and policies have continuously been developed.

I am very pleased that the workshop has acknowledged the need to discuss regional collaboration as part of the agenda of the international scientific research effort on global change. In particular, it is important to discuss the implementation of a set of Regional Research Sites and establishment of a Regional Research Centre as components of the START effort.

Mr Chairman, distinguished participants, I am certain you will freely express your experience, and share your ideas in this workshop and finally come up with the effective solutions and recommendations which are valuable to our region.

I would like to take this opportunity to express my profound thanks to Professor Thomas Rosswall, Executive Director of the IGBP, Professor Twesukdi Piyakarnchana, Chairman of the National Committee for IGBP, as well as, WCRP and HDGEC for their kind support and the provision of resource persons, and to the local organisers and all participants for making the workshop possible. Many thanks are also extended to the Rector of Chiang Mai University. At this auspicious moment, I would like to declare open the START Regional Workshop. I wish this workshop a great success in its objectives and may all participants have both an enjoyable and a fruitful participation.

Professor Kittichai Wattananikorn, Vice-President of Academic Affairs, Chiang Mai University

Minister of Science, Technology and Energy,
Executive Director, International Geosphere-Biosphere Programme,
Distinguished Participants,
Ladies and Gentlemen,

On behalf of Professor Kasem Watanachai, President of Chiang Mai University, may I extend our warmest welcome to all of you to Chiang Mai, the second largest city in Thailand.

As you may have noticed, the weather in Chiang Mai is much different from Bangkok. I reckon that you will find it more pleasant here. Since it is an old city (about 700 years old), it is therefore rich in tradition and culture. Chiang Mai is also famous for varieties of cottage industries and handicrafts, such as silverware, lacquerware, wood carvings, ornamental flowers, cotton and Thai silk designs. I know that your academic programme is very tight, but I would like to suggest you take some time off to tour our beautiful city.

But like other big cities, Chiang Mai is also affected by environmental problems, and some of our staff members are actively involved in solving those. With this workshop I hope that there will be more collaboration in environmental studies between Chiang Mai University and those of you who are attending.

As for our friendship, the President asked me to inform you that he is very honoured to invite all of you to dinner tomorrow night. I would like once again, to welcome all of you and wish you great success in this workshop.

Thank you and have a nice stay in Chiang Mai.

Professor Twesukdi Piyakarnachana, Chairman IGBP National Committee of Thailand

Your Excellency Professor Dr. Sanga Sabhasri, Minister of Science, Technology, and Energy,
Vice-President of Academic Affairs, Chiang Mai University,
Executive Director of the International Geosphere-Biosphere Programme Professor Thomas Rosswall,
Distinguished Participants,
Ladies and Gentleman,

It is my great pleasure and honour on behalf of the IGBP National Committee of Thailand to welcome you to this historical gathering. Above all, I would like to cordially thank His Excellency, Professor Sanga Sabhasri, who kindly found time to come to the opening ceremony and present a keynote address.

Mr. Chairman, may I take this opportunity to tell you briefly about the developments and the activities of the Thai IGBP Committee.

As you may know, Thailand is one of the countries in Southeast Asia which has been an early participant in the IGBP, since 1989. This is due to the farsighted and good leadership of His Excellency Prof. Sanga Sabhasri, who at the time was the chairman of Thai National ICSU Committee. He recognized that Thai scientists have been working in certain aspects of the changing environment but also needed to address global aspects of change and to join the IGBP.

With strong support from the Ministry of Science, Technology and Energy, the First National Workshop on IGBP was convened in Bangkok in September 1990. The objectives, conclusion and recommendations of that workshop are summarised and published in the IGBP Global Change NewsLetter No. 8, (December 1991). However, in order to actively participate in the IGBP Core Projects, the National IGBP Committee has expanded its membership to cover all relevant areas of research, and at the November 1991 meeting, the National Committee added two more members; one of them in the field of geology and the other in the social sciences. In the present workshop, nearly all members of the IGBP National Committee are participating. We hope that we can learn a great deal from this Workshop and we hope it to be a nucleus for the further development of the IGBP in this country.

We have continuously received support from the Executive Director of the IGBP, Professor Thomas Rosswall and the secretariat staff in Stockholm, Sweden. The Thai National Committee would like to take this opportunity to thank them all and to hope for cooperation in the future.

We are looking forward to the results from this Regional Workshop and prepare to join with all of you as well. We wish you a great success.

Professor Thomas Rosswall, Executive Director, IGBP, and Dr. Richard Moss, Deputy Executive Director, HDGEC

Your Excellency, Professor Sanga Sabhasri,
Professor Kittichai Wattananikorn, Vice-President of Academic Affairs, University of Chiang Mai,
Professor Twesukdi Piyakarnchana, Chairman, Thai National Committee for the IGBP,
Ladies and Gentleman,
Dear Colleagues,

It is with great pleasure that we welcome you to this regional START workshop. It was only in October that His Excellency, Professor Sanga Sabhasri invited the IGBP to convene a regional workshop for Southeast Asia in Thailand. Although we had very limited time to organise the meeting, we were pleased to accept the generous invitation.

The major reason for this meeting is to develop the outline for regional priorities for global change research. The IGBP has recently proposed the development of a Global Change System for Analysis, Research and Training (START). Together with the World Climate Research Programme (WCRP) and the HDGEC, the IGBP is now developing preliminary plans for regional activities in three START priority regions: Equatorial South America, Northern Africa and the Tropical Asian Monsoon Region. Following recommendations from the IGBP Regional Workshop for Asia held in New Delhi early last year (IGBP Report 18:1,1991), it has been decided to focus initially on the Southeast Asia within the Tropical Asian Monsoon Region.

START is a system of interconnected regional research networks being developed by the IGBP of the International Council of Scientific Unions (ICSU), in association with the WCRP, (ICSU and the World Meteorological Organisation, WMO) and HDGEC of the International Social Science Council (ISSC). The fundamental purpose of this system of regional research centres and sites is to promote needed research on the regional origins and impacts of global environmental changes, such as global warming, and to integrate these regional networks into a global system for analysis, research and training.

The START initiative has identified a need for focusing research on global environmental changes, including global warming, in a regional context based on the following priority questions (IGBP Report 15, 1991):

(i) How do regional changes in, for example, land use, industrial practices, energy production and urbanization alter regional atmospheric composition, the regional water cycle and local ecosystem structure and function?

(ii) How can such changes within a region or in combination with those from other regions affect biogeochemical cycles and physical aspects of climate on a global scale?

(iii) How will the ensemble of global change, acting through either direct effects or through altered feedback loops, lead to further change in the biospheric life support system?

Addressing these questions will require interdisciplinary research, with the involvement of both natural and social scientists. START is explicitly interdisciplinary and is being designed to encourage the collaborative research needed to understand the complex interactions of human and environmental systems embodied in global warming and other environmental changes.

The IGBP has recently submitted a proposal to the Global Environmental Facility (GEF) of the World Bank, the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP), which proposes financial support for initial activities in the three priority regions of START. The objectives of the GEF proposal are:

- To create the institutional framework necessary for the scientific community from the three highest priority START regions to participate in all aspects of the internationally agreed upon agenda for global change research with particular emphasis on global warming.

- To enable scientists in these regions to improve understanding of national and regional environmental changes which may cause and be caused by global warming, and thus to provide the necessary scientific assessments upon which policy options for mitigating or adapting to global warming can be developed.

- To build or augment national and regional capabilities to develop geo-referenced compatible data bases on variables relevant to global warming, such as the natural and anthropogenic emissions and uptakes of greenhouse gases; to develop a network within each region which links together national data bases of relevance for regional modelling.

Governments will face decisions about whether the risks posed by global change processes warrant potentially costly policy responses, and if so, which responses will be feasible and effective. Governments are organising themselves to face these decisions in a variety of local, regional and international bodies, and they are turning to the scientific community for information through specialised initiatives such as the Intergovernmental Panel on Climate Change (IPCC). START seeks to develop needed information by promoting research which focuses on the regional origins and implications of global warming and related environmental changes. This research will provide a basis for understanding regional contributions to the anthropogenic forcing of global cycles, the impact of global changes on the regions, the options for reducing local and regional contributions to these environmental stresses, and potential ways of adapting to those environmental changes which may now be inevitable.

The scientific community, through the mechanisms of the IGBP, the WCRP, and the emerging research framework of the HDGEC, has identified a set of research questions about critical unknowns related to global warming and other global changes. The core projects of these programmes are currently in the early implementation or planning phases, and while much work remains progress is evident. What is lacking is a network of Regional Research Centres, which will facilitate regional participation in the core projects and provide the mechanisms for the necessary interdisciplinary synthesis that is needed to provide the basis for sound development of policy options. Each centre and its related network of research sites will facilitate regional collaboration and research, with special emphasis on aspects of the processes that have distinct manifestations in that region. The centres will assimilate, synthesize and interpret

regional data sets for indigenous analysis and for incorporation into global-scale modelling efforts. They will also extract and interpret the components of global models relevant to their regions, and in this way provide regionally-important information to resource managers and decision makers.

Building the scientific capabilities and infrastructure required to enable scientists from developing countries to participate in all aspects of planning, coordinating and implementing the necessary research on potential causes and impacts of global change is an explicit objective of START. There is genuine concern that without such a programme which explicitly seeks to augment scientific capabilities and infrastructure in developing countries, scientists in these countries will only be involved in collecting data for research projects but will not be involved in global analysis, interpretation and modelling efforts. They will thus not have the opportunity to develop the knowledge and information required by their own governments to formulate effective national policies. Moreover, without the significant involvement of their own scientists, developing countries could disregard research generated primarily in developed countries and hence could decide against taking policy measures, which may be required to mitigate or slow down global warming.

The importance of giving priority to establishing regional research centres and networks in developing countries is also clearly defined by the need to develop national and regional data bases of key variables related to global warming to enable research and analysis to proceed. In many cases, developing countries lack the resources required to design and compile these data and to coordinate national data collection efforts so that they can become part of integrated regional and global systems. Such developments must be done in concert with other ongoing international efforts such as the IGBP Data and Information System (IGBP-DIS), the Global Environmental Monitoring System (GEMS) of UNEP, and the Global Climate Observing System (GCOS) of WMO/IOC/ICSU.

The UN General Assembly has recommended that governments "increase their activities in support of the World Climate Programme and the International Geosphere-Biosphere Programme." It further recommended that "the international community supports efforts by developing countries to participate in these scientific activities" (UN GA resolution 44/207, 1989). The need to involve scientists from developing countries in the IGBP was also stressed in the report of the working group on needs of developing countries of the IPCC.

The technical session of the Second World Climate Conference (SWCC, 1990) called for "a special initiative (that) would create a network of regional interdisciplinary research centres, located primarily in developing countries, and focusing on all the natural sciences, social sciences and engineering disciplines requires to support fully integrated studies of global change and its impacts and policy responses ... and (to) study the interaction of regional and global policies". In addition, a special working group on developing countries at the SWCC stressed the need to ensure the full participation of scientists and policy makers from developing countries in all aspects of global change research, assessment and policy development.

The development of START has been fully supported and encouraged by the UNEP Governing Council in its decision 16/36 (May 1991). *Inter alia*, the council (i) "welcomes the initiative of the International Geosphere-Biosphere Programme to address regional problems of global importance through its Global Change System for Analysis and,

Research and Training (START)"; and (ii) "Requests the Executive Director to provide, within available resources, support to the International Geosphere-Biosphere Programme regional research centres and networks, which should be planned and implemented in conjunction with the relevant World Climate Programme activities."

More than 50 nations have formed their own national committees to facilitate IGBP research, and its widely recognised that a system like START is necessary both to deal with regional causes and implications of global change, as well to effectively engage scientists and decision makers in all nations in the wise and efficient deployment of global change research and the use of its products.

Humans, by taking actions to maintain and improve the quality of their lives--and in some cases simply by attempting to survive-- are forcing large-scale, long-term changes in the global environment. These changes could alter the ability of natural systems to continue to serve as the basis for human progress and economic development. START will contribute to the development of knowledge regarding how human activities in different regions contribute to climate forcing and other environmental changes. It will increase our understanding of how natural systems in the regions will be affected by global warming. This knowledge will be crucial as a basis for formulating effective national and regional development policies as well as identifying strategies for adapting to environmental changes which may be inevitable.

START will help develop indigenous regional scientific competence on climate change and its effects, which will be of great importance for developing national support for long-term, in depth research and analysis of the regional aspects of global change. It will create the basis for a global network for regional research on global warming and other global environmental changes, which will meet the future needs of the research community and policy makers. START will also have other human-resource and capacity building benefits as well. It will enable the scientific communities in the regions to become better trained and to establish networks within and among their regions.

We hope that the current workshop will provide an agenda for a regional research programme that becomes part of a START initiative in Southeast Asia. We are encouraged by the response from countries in the region and look forward to a scientifically stimulating and constructive week.

Keynote Address

Professor Sanga Sabhasri, Minister of Science, Technology and Energy

Introduction

Apparently, the accelerated changes in the global environment are straining social and ecological capacities to protect and enhance the quality of life in all its diverse forms. Global temperatures are increasing, with predicted rises in sea level, largely as a consequence of carbon and other chemical emission in industrialized areas. Population growth and democratization, which resulted in high economic expectations, further stimulate the very process of materials production and consumption that have given rise to current trends. Rapid urbanization is augmenting these trends and increasing human vulnerability to their effects. These changes are occurring on a global scale, and no one nation alone can control them.

In Southeast Asia, it is noticeable that over the past decade there has been tremendous change. The rapid technological, economic and political development of the 1980s have made ASEAN countries more industrialised, more urbanized, and more integrated into the international economy. It is expected that these trends will continue through the 1990s. These changes have made the region affect the environment at the global scale, and the region has to share the problems of global change.

It is therefore an urgent need to expand scientific understanding of the causes and potential consequences of global trends, to develop effective responses to them, and to form the social arrangements, within Southeast Asia as well as other nations of the world, through which responses can be advanced and employed.

Global Change Problems and our Concerns

We are now living under the threat of global change problems. It should be our major concern that unless this dangerous trend is solved, the entire world is bound to suffer.

The global atmosphere is a vital natural resource, which is chemically complex, and it possesses fundamental chemical connections to the oceans, the solid Earth, and most importantly to the biota, which forms an interacting system that collectively determines the global environment and its susceptibility to change. Until recently it appeared unaffected by human activities, except on local scales. However, during the past decades, the atmospheric concentrations of several trace gasses have been clearly

observed to be increasing globally at rates that are leading to important changes in the radiative properties of the atmosphere.

Many prestigious international groups have started discussions on protection of the global atmospheric. Scientists have voiced that, as a result these rapid atmospheric chemical changes, our planet Earth would face serious environmental problems. Of special importance are the greenhouse effect, the depletion of the stratospheric ozone layer, and the acid deposition. They may cause serious adverse effects to mankind in all countries on the planet regardless of where they are situated. At the regional, level, serious implications for the Southeast Asian region are thus also expected.

Although the greenhouse effect and the depletion of the stratospheric ozone layer have only recently become recognised as global environmental problems, they have attracted a tremendous amount of attention over the past years. Both of them affect the geosphere and biosphere through changes in the atmosphere. However, they are of entirely different nature. The only obvious connection between the two is chlorofluorocarbons (CFCs), which have been found partially responsible for causing both problems.

The acid deposition, although occurring on less world-wide scales than the other two phenomena, it is still problematic in large regions. Air pollutants, such as sulphur dioxide (SO_2) and nitrogen oxides (NO_x) from combustion of sulphur-containing fossil fuels, are afflicting many regions with loss of air quality and acid deposition, which causes damages to crops and other plants as well as detrimental impacts on soils, forest, lakes, and unmanaged ecosystems.

Another environmental concern, which can be ascribed to deforestation, is the loss in biodiversity. Biological diversity deals with three levels of biological organisations: firstly, the genetic variability within a population; secondly, the species of taxonomic diversity; and thirdly, the diversity of the environments in which the species live. All levels of diversity are interrelated in a complex way in our environment, and all are essential for the persistence of life on Earth. Tropical forests are the most diverse of the terrestrial ecosystems accounting for 50% and perhaps as much as 90% of all species on Earth. Since tropical forests are being rapidly degraded and destroyed and have the lowest proportion of protected area of any major biome, there is little double that we are presently embarking on a mass extinction that may well be worse than any since the last major ice age.

Climate change also threatens biodiversity, especially the security of existing protected areas. The fact that biodiversity, worldwide, is under threat does not establish sufficient reason for concern. It is, however, necessary to show that biodiversity is worth caring about.

The Importance of Global Change Research

Since most of the Southeast Asian countries are in the tropical zone, the region has much to contribute to the moderation of global climatic trends. The region has capacity to conserve energy and to control future emissions through the design if its growing urban and industrial structures; to augment biological storage of atmospheric carbon through the improvements of its vegetative landscape; and to develop the scientific and institutional basis for determining how such advances will be made. As mentioned

earlier, there is an urgent need to expand research in this region in order to develop scientific understanding of the causes and potential consequences of the problems and to develop effective responses to them.

The kinds of atmospheric changes that are happening now and the speed of those changes demand our prompt attention. However, our current knowledge is very limited, especially in the Southeast Asian region, and must be expanded if the impacts of atmospheric change are to be properly assessed. Increasing research activities are the first step in coping with the global atmospheric changes and its implications. It is essential that we accelerate research in the science of the global environmental changes.

The challenge that faces us today make it our responsibility to understand quantitively the chemical, physical, and biological processes that determine atmospheric composition; to recognise the close linkages with the biosphere and the human activities; as well as to observe and quantify the changes that are now underway. A sufficient understanding should be developed to permit possible predictions so that environmental damage can be restricted, avoided, or reversed in the future, and to use this knowledge to address the past and future evolution of the Earth's atmosphere. Areas of greatest current uncertainty and/or perceived importance should be addressed.

Interdisciplinary approaches to the problems are essential. Thus, collaborations between diverse specialists are required in order to understand adequately the interactions among the Earth's component systems and the complex processes taking place in the atmosphere itself. Due to its global nature, the solution to important problems in global atmospheric changes also requires international cooperation. This is also true with respect to research and development.

Recommended Research

One of the recommendations from the Villach Conference, organised by UNEP, WMO and ICSU in 1985 with the aim of assessing the role of increased CO_2 and other radiatively active constituents of the atmosphere on climate change and associated impacts, was to encourage research and studies undertaken in the regional context in order to assist the formulation of appropriate policies in coping with changes in the climate. In response to this recommendation, the United Nations Environment Programme (UNEP) has initiated, in 1987, a project entitled "Socio-economic Impacts and Policy Responses Resulting from Climate Change in Southeast Asia". Three countries in Southeast Asia, namely, Malaysia, Indonesia, and Thailand, were chosen for undertaking case studies. The draft report was completed in December 1990 and the final report has recently been finalised.

The other interesting recommendations on global change research came from the Conference on the Global Change: Effect of Tropical Forests, Agricultural, Urban, and Industrial Ecosystems which was held in Bangkok in October 1990. The recommended research topics to be carried out in Southeast Asia were grouped into three areas: research on species and ecosystems responses, aquatic and coastal ecosystems, and the agricultural productivity.

Let me first touch upon the case of "Species and Ecosystem Responses" In order to predict, and possibly ameliorate, the effects of climate change on terrestrial ecosystems, research needs to be carried out on the effects of environmental variables that are likely

to be affected by global change, particularly rainfall, temperature, and forest fires. Such research should be carried out on: (i) the effects of climate change on the hydrological cycle, including evapo-transpiration, precipitation, condensation, runoff, erosion, etc., (ii) the responses of important plant and wildlife species to variables such as moisture, temperature, fires, and their seasonality, and how changes in these variables may change their distribution, and (iii) the effects of fragmentation of habitat areas on survivability of wildlife species, and how climate change will effect the availability of suitable habitats.

Next, let me turn briefly to the second case: "Aquatic and Coastal Ecosystems". The consequences in tropical countries of global change will be felt most strongly in the coastal and deltaic regions. Urban and industrial concentrations are greatest in these regions and are increasing most rapidly there. Aquatic and agricultural resources are also richest in these areas. Rising sea level threatens the quality and existence of these national assets and, at a minimum, will intensify the competitive stresses that have already existed among the numerous claims on the limited land, water and biotic resources of coastal areas. Basic research should be carried out on aquatic ecosystems, especially on biological production, eutrophication, and on the ecology and distribution of plants and animals and their overall diversity. In addition, there should be a study on biogeophysical assessment of coastal zone and deltaic dynamics, and how these are likely to be affected by anticipated changes in sea level and climatic patterns. Studies would include attention to matters such as salinity intrusion, subsidence, flooding, change in ecosystem condition, and effects on important biological populations.

I shall now move on to the third case: "Agricultural Productivity". Agroecosystem, including both traditional cash crops as well as agroforestry, are major economic resources for Thailand and other parts of Southeast Asia. Global climatic changes have the potential to influence agricultural productivity in the tropical regions. These include the increased atmospheric concentrations of CO_2, altered precipitation and temperature, increased ultraviolet radiation, and changes in sea levels.

Two principal priorities can be identified for research on global change and tropical agroecosystems. The first is ecophysiological studies of model species that are important in tropical agricultural systems. This effort, in parallel with the efforts being underway for temperate zone crop plants, should select species representing a range of physiological, morphological and ecological modes of growth, and should be part of an international cooperative efforts. Appropriate species for selection may include sugar cane, sorghum, cassava, rice, banana, sweet potato and, pineapple, as well as woody crops species such as coffee and rubber. The second priority is the development of predictive models of crop yield. Such models must have a strong empirical basis incorporating interdisciplinary levels of understanding of the environmental and biological controls regulating single and multiple species systems.

Conclusion

I would like to conclude that many important and unavoidable tasks of global change research lie ahead of us. As the countries belonging to Southeast Asia have always cherished the concept of regional and international cooperation on the basis of mutual interest and benefit, I, therefore, look forward to seeing the emergence of more and more cooperation on this aspect.

I would like, also, to emphasise that we must energetically devote ourselves to conducting and utilising the advances in R&D in such a manner as to meet the challenges of the era now unfolding.

Let me re-assure you that, through such combined efforts of every nation concerned, our aims and objectives for global change research will be fully accomplished.

Summaries of Presentations

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

Thomas Rosswall
Executive Director, IGBP Secretariat, Stockholm, Sweden

The international research community has been involved in the debate on global-change issues for several years. The problem facing scientists is that in order to understand the functioning of the Earth system, and thus to be able to predict the consequences of future changes in the global environment as well as the effects of proposed policies, there is an urgent need for interdisciplinary research. At the international level, the World Climate Research Programme (WCRP) has been in existence for over ten years and is an essential component in our quest for an understanding of the climate system of our planet. The WCRP addresses the physical aspects of the climate system and provides a necessary base for the development of predictive capabilities of climate for different time periods. However, it does not to any significant extent address the biological and chemical controls of the Earth system, and the effects of changing climate on the biosphere are not addressed at all.

These issues are addressed by the IGBP. The objective of the IGBP is 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 activities.

The IGBP is an evolving programme that selects from the broad array of subjects that comprise the science of the Earth system those questions that are deemed to be of greatest importance in contributing to our understanding of the changing nature of the global environment on timescales 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.

The initial operational phase of the programme focuses on seven key questions and a number of specific Core Projects (IGBP, 1990):

1. *How is the chemistry of the global atmosphere regulated and what is the role of biological processes in producing and consuming trace gases?*

    • International Global Atmospheric Chemistry (IGAC) Project; An established IGBP Core Project

2. *How do ocean biogeochemical processes influence and respond to climate change?*

   • Joint Global Ocean Flux Study (JGOFS); An established IGBP Core Project planned and implemented by the ICSU Scientific Committee on Ocean Research (SCOR)

   • Global Ocean Euphotic Zone Study (GOEZS); A potential IGBP Core Project

3. *How are changes in land use affecting the resources of the coastal zone, and how will changes in sea level and climate alter coastal ecosystems?*

   • Land-Ocean Interactions in the Coastal Zone (LOICZ); A proposed IGBP Core Project

4. *How does vegetation interact with physical processes of the hydrological cycle?*

   • Biospheric Aspects of the Hydrological Cycle (BAHC); An established IGBP Core Project

5. *How will global changes affect terrestrial ecosystems?*

   • Global Change and Terrestrial Ecosystems (GCTE); An established IGBP Core Project

6. *What significant climate and environmental changes have occurred in the past and what were their consequences?*

   • Past Global Changes (PAGES); An established IGBP Core Project

7. *How can our knowledge of components of the Earth system be integrated and synthesized in a numerical framework that provides predictive capacity?*

   • Global Analysis, Interpretation and Modelling (GAIM); A proposed IGBP Core Project

In addition, two key activities relate to the needs of all research questions:

- The development of a global Data and Information System that will provide immediate and open access to all researchers, that will provide information needed for Earth system models, and that will define and sustain the long-term observations needed to detect significant global changes. An IGBP-DIS Office is located in France (Paris).

- The establishment of Global Change System for Analysis, Research and Training (START) (IGBP, 1991) consisting of a set of Regional Research Centres with affiliated networks of collaborating institutes. RRCs are expected to be set up in all major regions of the world. The IGBP will in particular promote the establishments of RRCs in developing countries. START is developed in collaboration with WCRP and HDGEC.

The development of joint activities with the programme on "Human Dimensions of Global Environmental Change" (HDGEC), which is being planned by the International

Social Sciences Council. A first joint planning activity considers research necessary to elucidate land-use changes. Land use is a critical factor for many IGBP Core Projects, but the driving forces behind land-use change lie in the socio-economic realm, and the IGBP needs to collaborate with social scientists in order to address this issue in a meaningful way.

Within the decade of the 1990s, the IGBP will launch a world-wide research effort, unprecedented in its comprehensive interdisciplinary scope, to address the functioning of the Earth system and to understand how this system is changing. The body of information generated by the IGBP will form the scientific underpinning for predictions relating to future causes and effects of global changes. Through its observational network and process studies, and the effective communication of the resulting data to scientists in all nations committed to this endeavour, the IGBP will help provide the world's decision makers with input necessary to wisely manage the global environment.

In the course of this endeavour, the IGBP will promote an interdisciplinary approach to studies of the Earth system. It is essential to educate the next generation of scientists in such a manner that they will more fully understand the complexities of this system. This knowledge will be the key to success in the wise use of the Earth's resources for generations to come. Even if predictions of global changes are uncertain, we are certain of one thing: The future is not what it has been.

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Human Dimensions of Global Environmental Change, (HDGEC)

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Introduction

The Human Dimensions of Global Environmental Change Programme (HDGEC) was established by the International Social Science Council to develop research on the interactions of humanity with its global environment. As a prelude to discussing how the HDGEC programme is developing, I thought it would be useful to define the "human dimensions" of changes to the global environment and how these human attributes relate to the research interests of natural scientists working within the framework of the IGBP and WCRP.

The "human dimensions" of global change

Simplifying the issues, I would argue that there are six aspects of the human condition that are important to understanding global change.

Population: Globally, population has doubled since 1950 to approximately 5.2 billion. It will most likely more that double during the next century before it levels off. In many situations, including some which occur in the nations represented here this week, the growth of rural populations has increased pressure on the land to such an extent that traditional agricultural and land use practices are no longer ecologically, economically, or socially viable.

Consumption: Economic activity has quadrupled since 1950. This estimate is derived from energy production statistics. This increase in production, and hence consumption, results in ever larger flows of emissions and effluents which must be cycled through the earth system. It is this increased load on natural cycles that is forcing environmental changes at a global scale.

Technology: Some argue that the development of new technologies has created new possibilities for humankind to disrupt the functioning of natural systems. Others believe that continued development of technologies, such as photovoltaics, will enable us to avoid tradeoffs between environmental protection and economic development. A more neutral view of technology is that it determines how much effluent will result from human consumption and production. The choice of technology employed in production thus determines how much natural biogeochemical flows will be altered.

Aspirations: Increases in consumption and production have occurred largely in developed countries. Those living in developing countries have legitimate aspirations for increased levels of affluence which will mean further increases in economic activity and environmental stress. And those living in developed countries are in no way satisfied simply to maintain their current standards of living. Economic growth is demanded in developed countries and is an issue on which governments rise and fall.

Institutions: "Institutions"-- the diverse political, economic and social structures which shape human behaviour-- modify the rate at which such human driving forces as

population density and level of consumption affect global cycles. They will also exert a strong influence on the formulation of policy responses to global change and thus on the impacts which global changes may have on human societies. These institutions include international organizations such as the United Nations; national, state, provincial, and local governmental bodies; planning agencies; economic markets; land tenure systems; and the like.

Perceptions: Perceptions and values condition how humans react to their surroundings and personal situations. Human perception is subjective and based on a variety of factors such as an individual's psychological makeup; his or her cultural background; and the social, economic, and political conditions in which he or she lives. Human perceptions of global environmental changes -- opportunities and challenges which will take shape over a period of decades and longer -- will most likely be dominated by their attitudes and assessments of the challenges and opportunities they currently face, as well by their attitudes towards their relationship with the environment more generally. Understanding how humans are likely to react to global change is necessary to understanding how to develop effective policy responses.

Human-Nature Interactions

These six aspects of the human condition can be seen in three distinct relationships with global environmental change.

Driving forces: Population growth, consumption and production, and technology interact to produce different levels of environmental stress for a given level of human activity. This relationship can be conceptualized in an admittedly crude and inadequate identity where the three determinants of environmental impact are population growth, density, and structure; the level and patterns of consumption of a particular society or group; and the environmental impact of production, which will be determined by the particular productive technology employed.

Impacts: Global environmental changes, whether to climate, sea level, hydrological cycles, or ecosystems, will affect human societies. Availability of freshwater resources, the productivity of coastal zones, the continued viability of agricultural activities in their current locations, human health, trade patterns, etc., will change as a result of human alterations to the global environment. Thus, the local and regional opportunities and constraints which humankind faces in meeting its basic needs and aspirations will also be affected. Studying the potential impacts of global change is key to developing farsighted resource management strategies, which will minimize the negative effects and enable us to make the most of opportunities.

Responses: The six aspects of the human condition will also affect how societies respond to global environmental changes and their regional and local manifestations. International institutions will affect treaty arrangements and the formulation of mechanisms for resolving disputes which may arise out of global changes. Economic incentives can encourage individual behaviours that may mitigate or slow the rate of change. Culture and values will determine which government policies may be effective and which will have little effect because they violate social norms. Perceptions of the importance of global change and its impacts and assessments of the relative importance of environmental and social problems will determine whether individuals are willing to make changes in their behaviour now to avoid problems which may not be felt for decades.

Ideas for Collaborative Natural-Social Science Research

How do these human dimensions of global environmental change relate to the research interests of natural scientists working within the framework of the IGBP?

To be comprehensive, a programme on the human dimensions of global environmental change needs to address all aspects of this complex set of issues. Some of the required research will require close collaboration between social and natural scientists. This collaboration will be required for two reasons. First, social scientists will need to understand the ways in which human actions are forcing global cycles. Second, natural scientists working within the IGBP framework will need the knowledge and expertise of social scientists to understand how human responses may create new and unexpected feedbacks in natural systems and to develop projections of global change. Some ideas for collaborative research include:

Land use and land cover change: This project is under development by a joint IGBP-HDGEC Working Group. It seeks to improve our understanding of the forces which drive land use decisions, and how these decisions are translated into changes in land cover. The ultimate goal of the project is to develop models which will enable us to project future states of land cover based on both natural and socio-economic variables. Developing this capability is a long way off, but the Working Group has identified a number of activities and projects which will develop this area of study. This is described in a separate presentation by Paul Cheung. This area of research has relevance for a number of IGBP core projects including BAHC, GCTE, LOICZ, GAIM, and that portion of PAGES focusing on global changes of the past 2000 years.

Coastal zone utilization: This potential area of collaboration would link social and natural scientists in the study of the ways that coastal zone resources are used, and how changes in coastal zones may affect the viability of social and economic systems located there. The project might involve social scientists in at least two ways. First, social scientists are needed to conduct detailed studies and mapping of current use and management of resources and incompatibilities that may exist among competing uses of these areas. Second, they also need to develop a more detailed system of resource accounting for the coastal zones that would enable comparisons of the value of various uses of coastal areas, including dumping of wastes. By treating coastal zones, which encompass both urban and rural areas, as integrated social and economic systems, these studies may enable social scientists to gain new insights into the interaction between urban and rural development. These studies would also provide valuable subjects for increasing our understanding of the impact of perceptions and values on resource management decisions.

Socio-economic impacts of meso-scale climate changes: Linking the output of GCMs to weather generators, and then coupling this data to economic and social models, may be one of the best ways of improving our capability to project the potential social impacts of climate change. Using these results to project potential human responses, which will have further impacts on natural cycles, would then complete the feedback loop. While this sort of analysis is beginning to develop in collaborations among the climate modelling community and economists, more integrated studies of social impacts, particularly in developing countries where many important transactions do not take place in monetized economies, have yet to be attempted.

Modelling greenhouse gas emissions: There are already a number of scenarios of greenhouse gas emissions from deforestation, biomass burning, and the use of fossil fuels. Yet the estimates in the scenarios vary tremendously. Since these estimates are becoming the basis of international agreements to reduce CO_2 emissions, careful assessment of why the scenarios differ, including examination of their assumptions about both natural and socio-economic processes, are urgently needed. As many in this room know, most of these scenarios have been created by institutions in developed countries and depend on simple persistence models to derive their results. These scenarios most likely do not take into account recent trends of lower deforestation rates and higher end-use energy efficiency in many countries.

These are only some preliminary ideas about the sort of research topics which will require close collaboration between social and natural scientists. Yet I believe that they give some idea of the need for this collaboration and the results it can yield.

Carrying out this research will not be easy. Social and natural scientists use very different languages and methodologies. They have different ideas about modelling. Socio-economic data are not compatible with grid-based geophysical data and will need to be converted to a grid-based system. Researchers in both camps will need training in the methods and knowledge of their collaborators. These obstacles are not insurmountable, but they will require persistence and programmes like START to overcome.

I should also touch on the importance of regional and local studies in developing these sorts of collaborative projects. It is at these smaller spatial scales that social scientists can formulate concrete projects. In part this may be because there are few truly global systems in the socio-economic sphere. Regional studies are important to the study of global change, because they will reveal the variation in global patterns of driving forces, impacts, and the development of potential responses. This detailed assessment is important not only because it is at the regional and local level that impacts will be felt and responses developed, but also because regional studies will make it easier to compare basic attributes of socio-economic systems and begin to understand why, for example, population pressures lead to deforestation and land-use change in some cases, and not in others.

Ideas for Research in the Social Sciences

Other research projects will be based solely in the social sciences. Some ideas for these sorts of projects include:

Global Omnibus Environmental Survey (GOES): This is a proposed survey of perceptions and attitudes towards environmental issues generally, and global change more specifically. It is planned to be administered on a regular basis throughout the world. It will build on existing questions and surveys but will seek to consolidate and coordinate this research so that the data are more useful comparatively and longitudinally.

Industrial Heritage: This project addresses the issue of how a nation's current industrial metabolism and infrastructure will constrain the adoption of more efficient production technologies which produce less waste and emissions.

Impact of institutions on resource use: This project will addresses the question of how a variety of institutions affects resource management decisions. Institutions to be investigated include land tenure systems, economic incentives, social institutions, and political decision-making arrangements at all levels from the communal to the international.

International economics: This project will seek to encourage the examination of the potential impacts of global environmental change on international trade flows.

Technology transfer and diffusion. Why do some individuals and societies innovate? Why do others fail to adopt even tried-and-true technologies which may be desirable because they have a lower impact on the environment per unit of output?

These are examples of projects which are currently under way or are being planned by social scientists interested in global change. It is my hope that they will be integrated into the framework currently being developed by the HDGEC Programme.

The HDGEC Programme

Succinctly stated, the HDGEC is seeking to develop research in the social sciences on global change. It seeks to relate the growing volume of social science research on the human dimensions of global change in an intellectual structure similar to that provided by the IGBP, so that individual results can be integrated and synthesized into a more complete picture of the ways in which human activities are driving global change, and how global changes will affect human systems. The programme operates through research coordination and development, building on and relating ongoing research in the social sciences and planning new projects to fill in gaps. This work is being guided by an international, multidisciplinary committee. Activities undertaken in cooperation with the IGBP are an important component of the HDGEC work programme. Chief among these joint activities is the START initiative, which will enable the HDGEC to identify social scientists in many nations who are carrying out research relevant to the study of the human dimensions of global change and to contribute to increasing our understanding of how global changes may affect humankind.

The HDGEC is ready to assist social scientists in the region in defining a research agenda, which reflects the principle concerns of the region in relation to global change.

Goals for social scientists participating in the workshop

My recommendation is that those of us from the social sciences participating in this meeting should have moderate expectations. We are small in number and therefore do not represent all of the disciplines needed for a comprehensive assessment of research possibilities. In addition, this is the first attempt to involve social scientists interested in the study of the human dimension of global change in a planning meeting for START. We should develop some preliminary ideas about research topics important within the region and put forward a plan for involving more institutions and individuals in refining those research priorities. This will enable us to develop an input into the emerging plans for a START Regional Research Network in Southeast Asia and to have some influence over the type of research that is carried out within this research network.

The World Climate Research Programme (WCRP)

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The World Climate Research Programme (WCRP) is the international scientific programme which has been established to provide quantitative understanding of climate and predictions of global and regional climate changes on all time scales.

Achieving the objectives of the WCRP, which was established in 1979 as a joint undertaking of the World Meteorological Organization (WMO) and the International Council of Scientific Unions (ICSU), requires quantitative understanding of the physical climate system, constituted by a few major components : the global atmosphere, the world ocean, the cryosphere and the land surface.

The WCRP has instituted three major projects to investigate climate change mechanisms. These project are :

- The Global Energy and Water Cycle Experiment (GEWEX) to observe, understand, model and predict the hydrological cycle and energy influences within the atmosphere and at the Earth surface, as well as the impact of climate change on global and regional rainfall regimes. The GEWEX programme incorporates a major atmospheric modelling and analysis component and achieving its objective will require further development of global observing techniques.

- The World Ocean Circulation Experiment (WOCE) to provide, for the first time, almost simultaneous observations of all oceans. The focus of WOCE is on the prediction of the long-term evolution of the climate. In addition to hydrographic and geochemical surveys at sea, measurements from oceanographic satellite missions planned for the 1990s are a vital aspect of WOCE.

- The Tropical Ocean and Global Atmosphere (TOGA) programme, to understand better the tropical ocean/atmosphere system and its effect on the climate a higher latitudes. The objectives of TOGA are to achieve a description of large-scale transient variations of the tropical ocean basins and the global atmosphere, to determine and understand the extent and underlying mechanisms of predictability of this system on time scales of months to years and to achieve effective predictions. The main specific targets of the TOGA Programme are the El Niño/Southern Oscillation (ENSO) phenomenon and the variations in the monsoon on a month-to-month and year-to-year time span .

Consideration has been given to the scientific concepts of a WCRP climate variability and prediction programme to be conducted up to a decade after the completion of TOGA and WOCE. Such an initiative must combine the global scope of WOCE with the TOGA concern to achieve a dynamical coupling of the ocean-atmosphere (and land) system.

A Global Change System for Analysis, Research and Training (START)

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The IGBP has initiated the planning for a number of Regional Research Networks and Centres within the Global Change System for Analysis, Research and Training (START). This initiative is cosponsored by the World Climate Research Programme (WCRP) and the Human Dimensions of Global Environmental Change Programme (HDGEC).

START will consist of about thirteen Regional Research Networks (RRNs), each of which span a scientifically coherent area. Each RRN will be comprised of a Research Centre (RRC) and affiliated Regional Research Sites (RRSs). The research centres will facilitate regional participation in the core projects of the IGBP, the WCRP, and the HDGEC, with special emphasis on aspects that have distinct regional manifestations. The centres will develop, synthesize, and interpret regional data sets of key variables related to global change research, thus enabling indigenous analysis and the incorporation of these data into global-scale modelling efforts. They will also extract and interpret the components of global models relevant to their regions, and in this way provide regionally-important information to decision makers.

A vital component of START is the commitment to build the scientific capabilities and infrastructure required to enable scientists from developing countries to participate in all aspects of planning, coordinating, and implementing research on the causes and potential impacts of global change.

The Standing Committee for START (START-SC), which oversees the initiative, has defined five sets of objectives for regional research networks.

Research, analysis, and modelling: Stimulate and facilitate interdisciplinary research on regional aspects of global change in both the natural and social sciences; provide regional analysis, interpretation, and modelling of global change phenomena; strengthen regional participation in the projects of the IGBP, the WCRP, and the HDGEC; provide experimental sites with appropriate infrastructure.

Data: Provide a focus for data and information management including data acquisition, quality control, archiving, and effective dissemination and exchange; ensure that development of data-related activities is coordinated with IGBP-DIS and other major international programmes; facilitate the exchange of data with other networks and provide access to the network's data to interested researchers.

Policy outreach: Encourage the incorporation of global change research findings in the policy process and operational management by involving decision makers in some of the activities of the network.

Training: Developing indigenous scientific capabilities through training, collaborative research, and scientific and technical cooperation.

Scientific cooperation and access: Participate fully in START through exchange and collaboration with other RRNs; provide comprehensive knowledge of and directories to the databases, projects, and activities within the RRN.

All regions identified in the START initiative are important in terms of global change; each is distinctive, and only together can they provide a complete representation of environmental changes in a global context. Three regions, however, have been identified as initial priorities for assistance in establishing and funding RRNs. These are Equatorial South America, Tropical Monsoon Asia (with an initial focus on Southeast Asia), and Africa north of the equator.

To begin to build interest in global change research in developing countries, the IGBP over the last years has conducted several regional meetings in Mbabane, Swaziland (1988); São José dos Campos, Brazil (1990); Lomé, Togo (1990); Niamey, Niger (1990); New Delhi, India (1991); Singapore (1991); and in Chiang Mai, Thailand (1992).

In addition, at the initiative of the United States and a number of other countries, an Inter-American Institute for Global Change Research (IAI) will soon be established. It is hoped that the IAI will become affiliated with START as the first operational RRN. Additional meetings and consultations to lay the foundations for RRNs in the priority regions have been held, and others are being planned. Of special interest is a regional workshop for Africa which will be held in Niamey, Niger, in November 1992. A meeting in Toulouse in February to discuss a French initiative for the Mediterranean region (MEDIAS) will provide an excellent basis for the November deliberations and the development of a scientific agenda for a START RRN in Northern Africa (Africa north of the equator).

The Standing Committee for START recently submitted a proposal to the Global Environmental Facility for support of global change research networks in the three priority regions. The Scientific and Technical Advisory Panel of the GEF has given the START proposal its highest priority, and preliminary indications are that the GEF will provide funding. It is hoped that this proposal will be approved and result in the rapid development of START in the Southeast Asian region.

The Role of The Southeast Asian Seas in Regional and Global Climate Change

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Introduction

The waters and islands between Asia and Australia and between the Pacific and the Indian Oceans form a geographical unit because of their special structure and position. In geographical terms, the whole region is part of Asia and is referred to as Southeast Asia. In oceanographic terms, the waters of the region are part of the Pacific Ocean, which is separated from the Indian Ocean by the Indonesian archipelago., in particular the islands of Sumatra, Java, and the Nusa Tenggara (lesser Sunda). The seas in the region are filled with water from the Pacific, to which they provide access.

The Southeast Asian waters comprises the Andaman Sea, the Straits of Malacca, the Strait of Singapore, the South China Sea, the Java Sea, the Flores Sea, the Banda Sea, the Arafura Sea, the Timor Sea, the Celebes Sea, the Sulu Sea, and the Philippines Sea. The whole body of water covers 8.94 million square kilometres in area, which represents about 2.5 percent of the world's ocean surface.

The Southeast Asian seas form one geographic unit, although as a whole the region is not part of the Pacific or Indian oceans. The Andaman Sea, for example, is part of the Indian Ocean but should be regarded as part of the Southeast Asian waters. It is perhaps rather surprising that the Timor and Arafura Seas and Gulf of Carpentaria are often regarded, in oceanographic terms, as part the Pacific Ocean.

Nearly all types of bottom topographic features are found in Southeast Asian waters, as shallow continental shelves, deep sea basin, troughs, trenches, continental slopes, volcanic and coral islands. In its distribution of water and land alone the Southeast Asian region is one of the most complex structures on Earth. The numerous large and small islands divide the waters into different seas connected by many channels, passages, and straits. The complexity of the region is the reason why it has drawn many major international oceanographic expeditions, such as the *Challenger* (1872-75), the *Gazelle* (1875), the *Valdivia* (1899), the *Siboga* (1899-1900), the *Planet* (1906-1907), the *Snellius* (1929-1930), the *Albatros* (1948), The *Spencer F. Baird* (1947-1950), and the *Galathea* (1951). In recent years, a few oceanographic cruises have been organised, locally or as part of some cooperative regional studies, such as the Intergovernmental Oceanographic Commission (IOC) Cooperative Study of Kuroshio which covers also the South China Sea, the International Indian Ocean Expedition (IIOE) and the *Snellius II Expedition* (1984-1985). Thus, it is fortunate to have a fairly good picture of the general oceanographic characteristics of these waters. For a more detailed review one can consult Wyrtki (1961), and Soegiarto and Birowo (1975).

Monsoonal Influence on Oceanographical Features

Located between the Asian and the Australian continents, the Southeast Asian Seas are strongly influenced by the monsoons. The Southeast Asian waters are thus ideal for

studying the effects of the monsoons on both water circulation and the seasonal distribution of its physical, chemical, and biological properties.

The monsoon in Southeast Asia can be briefly described as follows (Soegiarto, 1978). The equatorial pressure trough moves according to the position of the sun, crossing the equator twice each year. In the northern summer, a low pressure area develops over the Asian continent as an extension of the equatorial pressure trough. In winter, a high pressure area is formed over the continent, forming part of the subtropical high pressure system. The monsoons develop between these winter hemisphere "high" and the "low" in the other hemisphere. Because the pressure distribution is stationary, the winds are rather constant, especially over the seas. The windforces are, however, generally small. Storms and typhoons are observed only over the northern parts of the South China Sea and the Philippines, over the Andaman Sea, and the north of Australia. During the inter-monsoon periods when the equatorial trough passes over the Equator, the winds over the region are extremely variable. During the full monsoon the trough is deviated over the land in the direction of the monsoon, owing to thermal influence.

The north monsoon in Southeast Asia lasts from December to February and the south monsoon from June to August. The rest of the year represents the transition from the north the south monsoons (March-May) and from the south to the north monsoons (September-November).

The variation of the atmospheric circulation described above parallels the corresponding variation of the water circulation. Because of the high constancy of the monsoons and the regularity of their appearances, the ocean currents show the same characteristics. Just as the monsoons change direction twice a year and are practically reversed at the time of their strongest development, the oceanic circulation is also reversed over large areas. This complete reversal is typical of the circulation in these waters. The following is the description of the surface current systems in Southeast Asian waters (FAO/IPEC, 1976).

When the south monsoon prevails, northerly monsoon current are dominant in the middle portions of the South China Sea and the Java Sea. The inflow of oceanic water is strong through the Celebes Sea and the Flores Sea from the Pacific. The water of the South China Sea flows out through the Strait of Taiwan and the Luzon Strait. During the north monsoon a southerly flow of water causes a cyclonic pattern of surface water movement. In this season, the inflow of oceanic water is strong through the Taiwan Strait and the Luzon Strait. The outflow from the South China Sea is strong through the Flores Sea and less strong, but with considerable volume, from the Celebes Sea to joint the water mass from the South China Sea flowing eastwards. In both monsoons, smaller amounts of water mass enter the South China Sea through the Philippine Islands from the Pacific and flow out to the Indian Ocean through the Malacca Strait and the Sunda Strait.

As was mentioned earlier, the water mass of the Southeast Asian region originates from the Pacific Ocean. This is also clearly indicated by surface current patterns in this region. The North Equatorial current flows westwards and upon approaching the Philippine Islands, splits into two main branches: the northward branch becomes the Kuroshio, and the southward branch the Mindano current.

The Kuroshio begins east of northern Luzon as a swift and narrow segment of the western boundary current. It flows close to the east coast of Taiwan and then into the

East China Sea and farther north monsoon, a substantial mass of water from the Kuroshio is deflected into the China Sea and then pushed farther south by the prevailing wind into the South China Sea and the Java Sea.

The Mindanao current flows southwards with a speed of one to two knots along the coast of Mindanao Island. Its main part becomes the Equatorial Counter-current. A weaker branch of the Mindano current enters the Celebes through the straits between Mindano and Sagir and Talaut Islands. Within the Celebes Sea, a major portion of its water is deflected to the south and flows along the north coast of Celebes as a coastal current to the east.

Storms and typhoons are observed only in the northern part of South China Sea, the Philippines, the Andaman Sea and North Australia. The presence of typhoons has a marked influence on the state of the seas, increasing the wave and swell conditions and changing their directions.

The Pacific-Indian Ocean Interactions

The Indonesian Seas represent the only tropical inter-ocean link, connecting the reservoir of warm and fresh surface water of the Western Pacific with the eastern Indian Ocean, while transforming it through vertical mixing and air-sea interaction on its way. The heat and water mass flux between both oceans through this link is estimated to be considerable and have large-scale, even perhaps global scale, impact on the world climate.

Water mass analysis shows that a large wedge of water characterized by admixtures of Pacific origin spreads from the Indonesian Seas westward across the entire width of the Indian Ocean in the upper 1000 m. The available water mass data show that most of the throughflow water is of North Pacific origin but some South Pacific contribution, derived from the South Pacific thermocline and spreading along the northern coast of Irian Jaya or even across the shallow Torres Strait, cannot be ruled out. The more uncertain aspect of the water mass source is the path followed by the Pacific to Indian Ocean throughflow. The path within the Banda Sea and the relative contribution of the Maluka and Banda Seas path versus the Makasar Strait is not resolved nor are ventilation characteristics of the deep basins and their contribution to the throughflow at the 1000 meter level.

The mean pressure head across the Indonesian Seas between the Western Pacific and the Eastern Indian Ocean is approximately 10 cm, supporting the conclusion of a mean flow from the Pacific to the Indian Ocean. There is not yet agreement on its magnitude or its seasonal and interannual variability. Various estimates of the mean throughflow transport have been made using different methods. Clearly, there is agreement among all of them that the mean flow is from the Pacific to the Indian Ocean, but there is wide range of estimates of its magnitude. Very little evidence is available as base for speculation on magnitude and time scales of throughflow variability. The monsoonal wind force generates a strong cycle in some of the Indonesian passages and seas, e.g., the north-south sea level slope across the East Java sea changes from 10 cm northward in August to 10 cm southward in February, but it is not known what effect this wind force has on the throughflow transports themselves.

Another phenomenon as part of the Pacific-Indian Oceans interaction is the "El Niño - Southern Oscillation (ENSO). This phenomenon generates adverse climate effects regionally, in the whole Pacific basin, but also globally. Therefore, at present a regional and international study on the ENSO is undertaken throughout the Pacific and the Indian Ocean (TOGA, Tropical Ocean Global Atmosphere Programme of the WCRP.

The Need for Regional and International Cooperation

The importance of the Southeast Asian Seas, in particular the Indonesian Seas, for the local, regional as well as global climate should be clear from the above description. No one country can carry out its own research on this topic independently. The reason is quite obvious; ocean circulations, weather and climate are closely interlinked and interconnected. What happens in one region might have an impact on other regions. Therefore, it is imperative that regional and international cooperation should be developed in order to study the local, regional and global climate. Southeast Asia should participate in such regional and international cooperation.

The following is a list of regional and international cooperative programmes, through which Southeast Asian nation could readily take advantage and participate in accordance with existing capability and national priorities.

1. Regional Cooperation under ASEAN (Association of Southeast Asian Nations), and its Committee on Science and Technology (COST), in particular in the Subcommittee on Climatology, which plans to establish an ASEAN Specialised Regional Meterological Centre (ARSMC), in Singapore. In the Subcommittee on Marine Sciences, there is an ASEAN-Australian project on the Regional Ocean Dynamics, whereby a network of tide gauges and current metres are being installed. In addition, there are various oceanographic regional cooperative programmes coordinated by the ASEAN Senior Officials on the Environment (ASOEN).

2. IOC - Programme Group on the Western Pacific (WESTPAC). In its fourth session held in Bangkok in 1987 (IOC, 1987), a number of regional programme activities have been developed by the IOC-PG WESTPAC. Programmes that are relevant to the ocean circulation and the global climate are:

   - Cooperative research study of the continental shelf circulation in the Western Pacific Region.

   - Cooperative research study of ocean dynamics in the Northwest Pacific.

3. Programme activities under the CCCO (Committee on Climate Changes and the Ocean; CCCO 1988). Since Southeast Asia is situated between the Pacific and the Indian Oceans, Southeast Asia could take advantage of programme activities that have been developed by the CCCO Indian Ocean Panel. The programmes include, among others, real time or near real time measurements of various oceanographic parameters, such as X-BT by ships of opportunity, mooring or drifting buoys, a network to collect sea level measurements etc.,

4. TOGA (Tropical Ocean Global Atmosphere Programme of the WCRP. The thermodynamical structure of the upper regions of the tropical oceans is being

monitored on a regular basis similar to the atmosphere. In addition, process studies have focused on specifics of the dynamical structure of the tropical wave guide as well as its microstructure and salinity distributions.

A parallel modelling effort has led to the first operational ocean model running in real time and being initiated with the data collected from the TOGA monitoring network. Experimental efforts are underway to couple ocean and atmosphere models to provide a synthesis of the total system. Through these observational and modelling efforts there has been considerable progress towards approaching the primary goals of TOGA. Yet, despite this progress, there is still considerable doubt regarding the elementary physical processes which maintain the mean and transient state of the warm pool (surface temp. of 28^0C) isotherm region of the eastern Indian Ocean and the western Pacific Ocean. Due to this serious gap in our knowledge of the atmospheric processes in the warm pool regions, a TOGA Coupled Ocean-Atmosphere Response Experiment (COARE) has been proposed. The location of the proposed COARE domain is between the 10^0 N and 10^0 S latitudes and 14^0 E and 18^0 E longitude, just off Papua-New Guinea and includes part of the Eastern Indonesian archipelago waters. For more detailed reference, see Webster and Lukas (1988).

5. WOCE (World Ocean Circulation Experiment) of the WCRP (WCRP 1988 a,b). For some time oceanographers have realised that growing concern about the Earth's climate could only be addressed seriously if there was a better understanding of the ocean circulation as a whole. In preliminary discussion, it was concluded that it was possible to contemplate observing and modelling the ocean sufficiently well to understand quantitatively how the ocean effects present climate, and how the ocean might change under a changing atmosphere.

   After many years of preparation with support of ICSU's Scientific Committee on Oceanic Research (SCOR) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the goals, objectives, scientific basis and general field programmes of WOCE have been established by the Scientific Steering Group of WOCE. In these programmes various activities in the Pacific and the Indian Oceans are outlined, whereby Southeast Asian nations could readily take advantage of the proximity of the waters to the two oceans and participate in the programmes according to their national and regional priorities.

6. JGOFS (Joint Global Ocean Flux Study), a Core Project of the IGBP. The aim of JGOFS is to improve our understanding of the fluxes of carbon between the atmospere, surface ocean and the ocean interior, and their sensitivity to climate change. That requires a wide suite of biological, chemical and physical measurements, that (ideally) should be carried out over the full cycle of seasonal changes. The Equatorial Pacific and North West Indian Ocean have been selected as regions for intensive, international JGOFS studies in the period 1992-94. Any major JGOFS initiative in Southeast Asean Seas would need to be preceded by preliminary studies on carbon chemistry (total CO_2, partial pressure of CO_2 and alkalinity) and the relationship of these factors to primary production, respiration and particulate fluxes. Because of the physical complexity of the region, and the likelihood of strong coastal influences, sites for detailed study would have to be very carefully chosen; larger scale surveys would also be needed to assess the importance of the region as a whole, either as a sink or source of carbon.

Conclusion

The Southeast Asian waters form the only tropical inter-ocean link between the Pacific and the Indian Oceans. They play a very important role in the regional and even perhaps global climate. Since no one country could carry out research on global climate and ocean circulation independently, Southeast Asian nations should take advantage of the various existing regional and international relevant programmes to participate in accordance to their capabilities as well as national and regional priorities.

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Land Ocean Interactions and Global Change

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Land-oceans and atmosphere are the three parts of the global system. About two thirds of the global surface is covered by water, and the rest is land. Some theories suggest that the first life originated in the sea. Man has had experience with the sea and its vast resources for very long time. It is currently estimated that about 50% of the world's population who used the coastal zone and 50 kilometres from the coast for their habitation and recreation. Global climatic change could have a strong impact on these people.

The purpose of this paper is to introduce the background and the concepts of the IGBP project on land-ocean interactions to delegates from the ASEAN countries who may not be familiar with it. The second purpose is to arouse the interest of the participants for the planning of the scientific activities of JGOFS, GOEZS and LOICZ.

IGBP questions Related to the Land-Ocean Interactions

There are two questions in the IGBP research plan, related to land-ocean interactions:

- How do ocean biogeochemical processes influence and respond to climate change?
- How do changes in land use affect the resources of coastal zone, and how will changes in sea level and climate alter coastal ecosystems.

From these two questions, the IGBP Scientific Committee has developed an established core project (JGOFS), a potential core project (GOEZS) and a proposed core project (LOICZ). The details of these projects discussed in IGBP Report No.12 (1990).

The Southeast Asian region has a long coast line with a large archipelago. The people in this area frequently suffer from natural disasters such as typhoons, storms, coastal land slides and, in recent years, drought and floods. The coastal zones of Southeast Asia are one of the most densely populated areas in the world. This has led to increasing destruction of the coastal natural resources and environment. Countries in this region should pay more attention to the IGBP projects related to land-ocean interaction.

So far there is little participation from the ASEAN countries in JGOFS. This might be either due to the lack of well trained marine scientists in this field or inadequate financial support from governments. The lack of research facilities, such as research vessels, might be one of the problems.

Since there are many ongoing research projects in the coastal zones in this region, it might be necessary to examine the possibility to upgrade LOICZ from a proposed core project to an established core project. It should also be noted that relevant research is already carried on in all ASEAN countries. It is now necessary to address these projects at a global scale.

There are examples of existing national research projects in Thailand which can be of significance to the global programme of IGBP. They are, for example, the changing amount of rainfall due to El Niño phenomena in 1983. Data indicate a significant temperature increase in Thailand from 1960 to 1980. Another example is the increasing erosion of the coast line in the upper part of the Gulf of Thailand from 1969 to 1987. The last example is the prediction of the impact of the future sea level rises on the Bangkok area in 2100.

Global Change and Terrestrial Ecosystems

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Introduction

There are two reasons why the interaction of terrestrial ecosystems and a changing global environment are important for Southeast Asia, and why Southeast Asian countries need to become involved in the international framework for research addressing such issues. These two reasons coincide with the objectives of GCTE. First, it is one of the strong feed-back regions of the globe, i.e., the terrestrial ecosystems in this region have strong connections with the global atmosphere, and any changes in the ecosystems will result in strong feed-back effects to the atmosphere and the regional and global climate. Second, and from the perspective of this workshop more important, atmospheric composition and climate will have significant effects on terrestrial ecosystems, and are therefore of direct importance to Southeast Asia nations since the ecosystems will change in the way they function and in their composition.

The changes will be unique for this region; no-one can transfer studies from another part of the world and apply the results here. So you need either to get people to come here to do these studies or, which is much better, do them yourselves. Scientists from the region will have a better appreciation of the important ecological factors which must be included, and a far better knowledge of the functionally important groups of plants and animals.

It is important to recognise that "global change" is not just climate change. It is the net, interactive effect of changes in land-use, atmospheric composition and climate. Of these, land-use changes are currently by far the most significant, and will be for at least a few decades. Many of the questions we need to answer are complex issues concerning the interactive effects of rising levels of atmospheric CO_2 , changing frequencies of extreme climate events (as well as overall climate regimes), and changing land-use practices (not just deforestation for agriculture, but changes in fertilisation, irrigation, cultivation practices, crop types, etc.).

To tackle this problem, the GCTE project of IGBP has been organised around four main foci, which have strong interactions (Fig. 1).

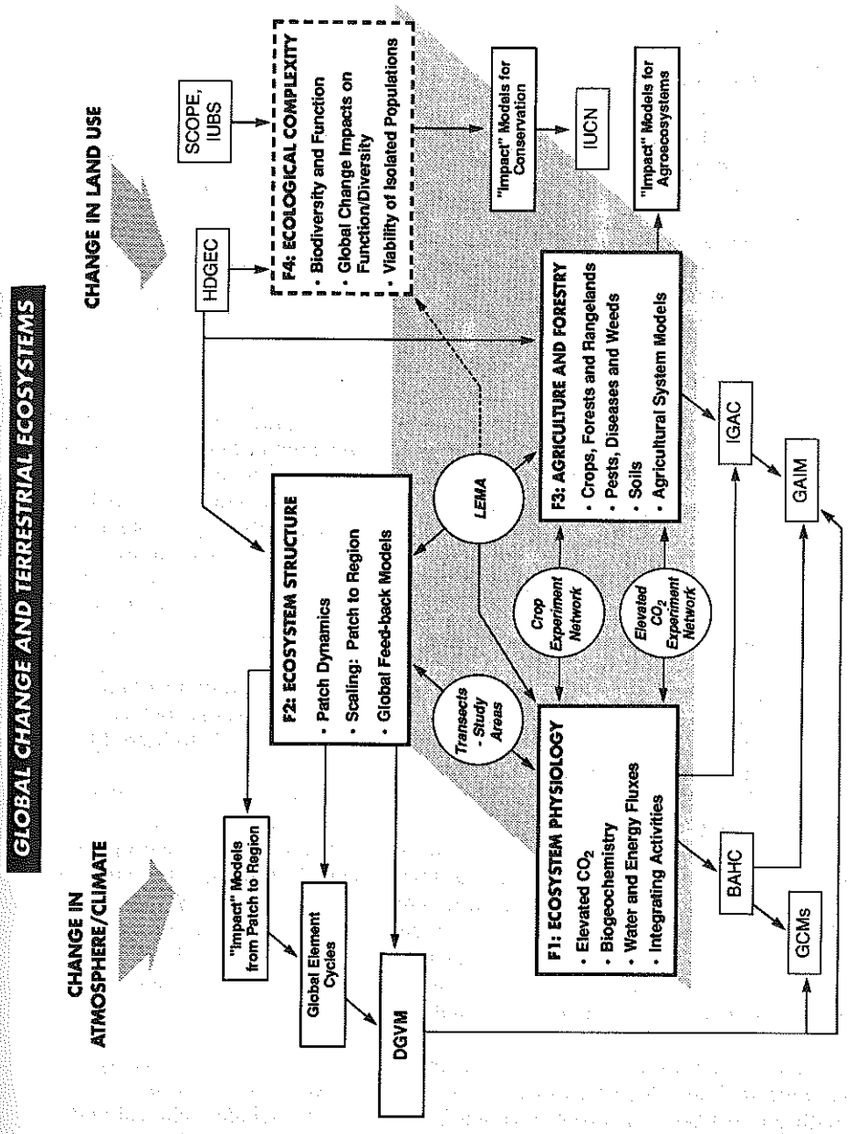

Fig.1 The structure of GCTE. Large boxes represent the four Foci. They are strongly linked through shared modelling efforts, common experimental sites, and several cross-cutting issues. Specific integrating facilities (shown by circles in the figure) further bring the overall GCTE research effort together. Small, bold boxes identify the products of GCTE, and the others are some of the major groups with which GCTE interacts.

The GCTE Project

Focus 1. Ecosystem Physiology

The primary aim of Focus 1 is to understand and model the effects of global change on the physiology of ecosystems, such as the exchange of energy, water and minerals with the atmosphere, nutrient cycling and accumulation, and biomass accumulation or loss.

The ways in which ecosystems function (their physiology) will be strongly affected by the combined and interactive suite of changes in atmospheric CO_2, which will continue to increase beyond the recent 30% rise above pre-industrial levels, in land-use practices, and in the likely changes in the means and extremes of temperature and rainfall..

Activity 1.1. Effects of Elevated CO_2

Although we know fairly well the responses of individual plants, under controlled conditions, to enhanced levels of CO_2 and other changed environmental factors individually, we are unable to predict responses at the ecosystem level because of higher level interactions between environmental factors and between plants and other groups of organisms, some of which are nonlinear. Thus, it is virtually impossible to predict ecosystem responses based on laboratory studies that are generally of short duration and concentrate only on plant parts or, at best, whole plants.

Task 1.1.1. Whole Ecosystem Manipulative Experiments with Elevated CO_2

A set of whole-ecosystem manipulative experiments is proposed that simultaneously vary CO_2 concentration and other critical controllers of ecosystem processes such as nutrients and water. The primary goal of these ecosystems experiments is to identify and quantify the mechanisms underlying the ecosystem responses.

The experiments will integrate the more traditional experimental techniques for elevating CO_2 concentration, such as controlled environment chambers and field open-top chambers, with the newer FACE (Free-Air CO_2 Enrichment) technology. The latter is a fumigation system consisting of a ring of vertical ventpipes (approximately 25m in diameter) with computer-controlled release of gas to ensure adequate uniformity of gas concentration within the ring. It has the advantage of not altering important atmospheric processes and of allowing experimentation on whole ecosystems and their component processes in as close to their natural state as possible.

FACE experiments incorporating nutrient and water interactions will be large, complex and expensive undertakings. A phased development of the programme will be undertaken, with phase 1 being a "proof-of-concept" phase during which technical and logistical problems can be solved and the design of the full experiment can be fine-tuned and modified to ensure success.

Temperate grasslands and forests are the most attractive initial system for study, as they present the fewest technical difficulties. Grasslands, in particular, are low-stature vegetation and are the natural ecosystem most similar structurally to the agricultural systems on which FACE technology has been successfully used in the past. The first component of this project is a New Zealand grasslands project.

Activity 1.2. Changes in Biogeochemistry

Changes in land use and atmospheric composition and anticipated climate change are likely to alter the biogeochemistry of terrestrial ecosystems. The most important of these are: (i) humid tropical forest areas undergoing land use change; (ii) high latitude ecosystems near the boreal forest/tundra transition; and (iii) tropical semi-arid ecosystems along the transition from dry savanna to humid woodlands.

Task 1.2.1. Biogeochemical Studies Along Environmental Gradients in Critical Regions

The most important missing piece in studies of tropical land use change is relatively coarse scale analyses of the pathways of, and process driving, element loss during and following land clearing and during agricultural intensification, including all of the major pathways of loss, hydrological as well as atmospheric. Watershed-level measurements of losses must be combined with atmospheric and soil-plant process measurements. Measurements should include controlling processes such as the effects of cattle grazing on soil structure and the effects of an altered microclimate following land clearing on fire frequency and on litter decomposition in residual forest fragments as well as microbial process measurements. A Southeast Asia study is needed in this task.

In addition, two other regions will be studied: The high latitude boreal forest/tundra transition, and the semi-arid to humid tropical savanna transition. They will be studied in terms of the functional relationships, along their environmental gradients, between ecosystem structure and biogeochemistry, including the effects of land-use practices.

Activity 1.3. Effects of Changes in Vegetation on Water and Energy Fluxes (to be conducted jointly with BAHC)

The aim of Activity 1.3 is to quantify bulk surface conductance, which combines stomatal regulation and physical structure of the vegetation to determine terrestrial evaporation.

Activity 1.4. Integrating Models

To develop linked plant-soil models of carbon, nutrient and water interactions at the patch scale to operate at time scales of days to decades.

Focus 2. Change in Ecosystem Structure

Of the driving forces of global change, the most important for determining the distribution and performance of organisms are the range and seasonality of temperature, precipitation and other environmental factors; the intensity and frequency of severe, episodic events, such as fires and hurricanes; and, for much of the Earth, the group of demographic, economic, and social pressures related to human activities. These factors, combined with physiological responses of plant species, such as longevity and ability to disperse, will determine the future structure of the world's ecosystems.

The goal of Focus 2 is to model this complex suite of impacts and responses so that the pattern of change in ecosystem composition and structure can be predicted.

Activity 2.1. Patch Scale Dynamics

Task 2.1.1. Global Key of Plant and Vegetation Functional Types

The concept that the complexity of the models can be reduced by treating a smaller number of "functional types" (FTs) is central to the work of Focus 2. The FT approach is based on a minimum set of functional attributes, which are considered to be most critical in reliably predicting the present-day distribution of plants from climatic input variables (e.g., frost resistance, phenology, stomatal conductance, longevity, etc.). Without involvement of Southeast Asia scientists, the developed models may not be appropriate for this region of the world. The FT programme will begin with an international symposium to stimulate the development of FTs and to establish the experimental protocols.

Task 2.1.2. Reciprocal Experiments on Ecosystem Structure and Function

The work will be based on a network of, preferably, reciprocal manipulative experiments in which biological composition and abiotic environment are separately altered, and the effects on each other measured. This is fundamental work needed to get the right mechanisms into the models of ecosystem change. The approach will be to use the keys of plant FTs (Task 2.1.1) at regional and global scales.

Activity 2.2. Models from Patch to Region

Task 2.2.2. Ecosystem Dynamics from Patch to Region, based on Change in Land Use

These must incorporate dispersal/migration mechanisms and disturbance regimes such as fire and the occurrence of extreme events (major droughts, cyclones, etc.). Note that such extremes are not predicted by General Circulation Models (GCM's).

Activity 2.3. Regional to Global Models of Vegetation Change for Element Cycles and Climate Feedback

Task 2.3.1. Global Correlative Models of Vegetation Change

Such models are already being developed, e.g. the IIASA Biome model. Their main drawback is that they do not take account of lag effects and various other ecological mechanisms. Their future developments are converging on the more detailed models at the finer scales.

Task 2.3.2. Dynamic Global Vegetation Model (DGCM)

This is the GCTE longer term aim, as depicted in Fig. 2.

1992 Determination of representative sites within biomes; development of the ecosystem dynamics models at the patch scale (see Activity 2.1)

1993 Test of patch-scale models on two intensive study areas; linkage of patch models into landscape and regional units (see Activity 2.2).

1994 Development of the full DGVM and calibration with 'static' global vegetation models.

1995 Coupling of DGVM into GCMs.

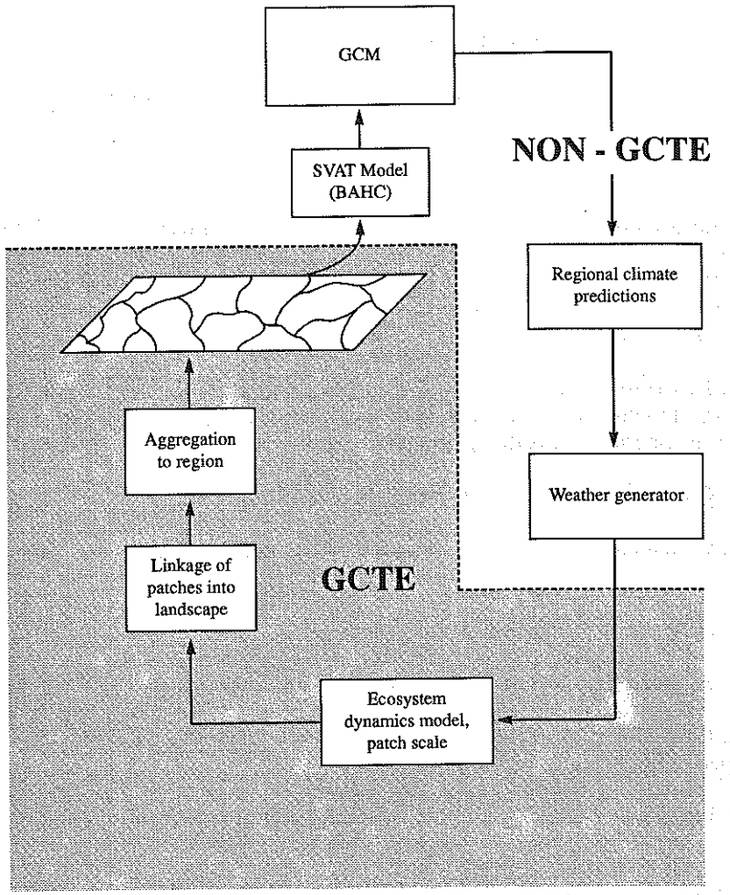

Fig. 2. Proposed strategy for developing a dynamic global vegetation model (DGVM).

Focus 3. Global Change Impact On Agricultural and Forestry

The agreed priority Activities and Tasks are as follows:

Activity 3.1. Effects of Global Change on Key Agronomic Species

Table 1. "Short list" of priority crops for GCTE studies.

Characteristics	Tropical	Temperate
Short grain	Rice	Wheat
Tallgrain	Sorghum	Maize
N-fixing	Groundnut	Soybean
Tuber	Cassava	Potato
Fruit tree	Coffee	Citrus
Fibre	Cotton	Cotton

Table 2. Matrix of suggested genera for experimentation

	Tropical	Temperate	Agroforestry/Biomass
Conifer	Pinus	Pinus	
		Picea	
Broadleaf	Teak	Quercus	Poplar
	Eucalyptus	Beech	Eucalyptus
		Birch	
N-fixing	Prosopis	Alnus	Acacia
	Casuarina	Robinia	
Other	Oil Palm?		

Task 3.1.1. Experiments on key crops (see Tables 1 and 2) with changed atmospheric composition, climate and soils. Crop models will be developed to take into account changed atmospheric composition, climate and soil type.

Task 3.1.2. Global change impact on production forestry.

Task 3.1.3. Global change impact on livestock production in pastures and rangelands.

Activity 3.2. Changes in Pests, Diseases and Weeds

Task 3.2.1. A global monitoring network for pests and diseases.

Task 3.2.2. Predicting distributions, dynamics and abundance of pests and diseases of priority species under global change.

Task 3.2.3. Predicting weed distribution, dynamics and abundance under global change.

Activity 3.3. Effects of Global Change on Soils

Task 3.3.1. Global change impact on soil organic matter

Task 3.3.2. Water erosion in the humid tropics

Task 3.3.3. Wind erosion in semi-arid areas

Task 3.3.4. Greenhouse gas emissions from soils

Activity 3.4. Integrated Experimental and Modelling Programme in Multi-species ("Complex") Agricultural Systems

Task 3.4.1. Global Change effects on "complex" agroecosystems

Focus 4. Global Change and Ecological Complexity

This focus on ecological complexity is still being developed. The suggested three activities are shown in Fig. 1.

Integrating Activities

Long-term Ecosystem Modelling Activity (LEMA)

Significant modelling efforts are already underway at a number of centres around the world. This activity forms an excellent base on which to develop the GCTE modelling programme. Indeed, the increased interest in interfacing models of different processes, in using models to scale results at one level of spatial or temporal resolution to others, and in sharing model development and testing among a wide network of colleagues has been catalyzed to a great degree by the discussions antecedent to the IGBP. The sharing of model development and applications in the geophysical sciences also inspires the parallel development of such models in the ecological sciences.

To maintain and enhance this interaction, GCTE will establish a network of modelling centres called LEMA (Long-term Ecological Modelling Activity). Involvement of Southeast Asia scientists and research groups in LEMA will be strongly encouraged.

GCTE Study Areas for Model Development

The two initial study areas will be located in the GCTE high priority regions (biomes) namely the deciduous forest-boreal-tundra system and the gradient from dry to humid tropical savannas.

Intensive Agricultural Experimental Sites (crops)

A network of agricultural experimental/modelling sites and associated research groups will be established, in order to ensure a cohesive and sufficient programme of the various research tasks, as detailed in Focus 3.

The Oceanic Anthropogenic Carbon Dioxide Sink

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It has been known for decades that the concentration of carbon dioxide in the atmosphere has been increasing due to burning of fossil fuels and clearing of forests. The matter is of great concern because "excess" CO_2 in the atmosphere enhances the greenhouse effect, which may significantly change the climate on Earth. The rate of the climate change depends on the rate of CO_2 increase in the atmosphere. How much CO_2 is left in the atmosphere is in turn controlled by the amount taken up by the oceans. Traditionally the excess CO_2 signal in the oceans is estimated from the highly accurate radio-tracer data such as ^{14}C and ^{3}H, which have large signal to noise ratios. More recently, there are indications that the excess CO_2 signal can be estimated by using carbonate data directly. The latter method is less accurate but the available carbonate data are orders of magnitude more numerous than the tracer data, thus providing a more extensive coverage of the world oceans.

The excess CO_2 signal calculated from the carbonate data in the Atlantic, Pacific and Indian Oceans, including Norwegian, Greenland, Weddell, Bering, South China and the Red Seas indicate that the distribution of anthropogenic CO_2 follows the large scale movements of water masses such as vertical mixing in the northwest North Atlantic, upwelling, and the Mode Water formation. The deepest penetration is found in the Northwest Atlantic and in the Red Sea, where the entire water column has been contaminated by the excess CO_2. Other regions of deep penetration are the four areas where the Subtropical Mode Waters are found: the northwest Pacific off Japan, around 40^0 S in the Atlantic and Indian Oceans, and around 45^0 S in the Pacific. The shallowest penetration areas are around 65^0 S and in the eastern equatorial region in all oceans. The excess CO_2 has penetrated the deepest in the Atlantic Ocean and the shallowest in the Pacific. These results compare well with results implied from ^{3}H and ^{14}C distributions, and with results obtained from a 3-dimensional general circulation model.

Up to approximately 1980, the North Atlantic Ocean contained the most excess carbon at $22.4 \pm 4.6 \times 10^{15}$ g, followed by the South Pacific and the Indian Ocean, both at $16.6 \pm 4.0 \times 10^{15}$ g. The North Pacific and the South Atlantic Ocean contained 14.7 ± 4.0 and $12.0 \pm 2.5 \times 10^{15}$ g, respectively. Overall the major oceans contained $66\text{-}98 \times 10^{15}$ g excess carbon. The high estimate, when combined with the high estimate for the atmospheric sink, could balance the low estimates of the combined fossil fuel and land change sources, but was much lower than the high estimates of the sources.

Past Global Changes (PAGES)

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The Past Global Changes (PAGES) project of IGBP is directed at securing a better understanding of the natural and human-induced variations of the Earth system in the past, through the organization of coordinated national and international endeavours to obtain and interpret a variety of natural and written records.

Information gleaned from a study of historical and natural archives, such as those found in tree-rings, lake and ocean sediment, coral and ice-cores, has been largely responsible for our present awareness of the coupled nature of the global environmental system. To understand global changes of the past or to predict the changes expected in the future, detailed history of environmental changes throughout the full reach of the past, and for every region of the globe is needed. The PAGES project focuses on (i) reconstructing a detailed history of climatic and environmental changes over the past 2000 years, with temporal resolution that is decadal and ideally annual or seasonal, in order to improve our understanding of global change over the span of significant anthropogenic influences; and (ii) reconstructing a history of climatic and environmental changes through a full glacial cycle, in order to improve our understanding of the natural processes that invoke global climatic changes. Coordinated studies within each of the two above two streams will be directed toward four scientific themes:

A. Solar and orbital forcing and response;

B. Fundamental Earth system process including

   (i) Trace-gas composition and climate,
   (ii) Global impacts of volcanic activity
   (iii) Ice-sheet mass balance and global sea-level change, and
   (iv) Biospheric dynamics and environmental change;

C. Rapid and abrupt global changes; and

D. Multi-proxy mapping.

The PAGES project will also address the following cross project needs:

1. Paleoclimate and paleoenvironmental modelling
2. Advances in technology of recovery and interpretation of proxy data
3. Management of paleodata; and
4. The development of improved chronologies for paleoenvironmental research.

A PAGES Project Office is being established in Berne, Switzerland to coordinate these studies. Further details on the specific science topics and implementation strategies are given in IGBP Reports No 12 (1990) and 19 (1992).

The Southeast Asian region contains a wealth of palaeorecord that provide information on environmental changes during both of the above time streams. A full exploitation of

this record would be an extremely valuable contribution to the PAGES project. The scientific community in the region must be mobilized in order to achieve this.

Land Use and Land Cover Change

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Since its inception, the International Geosphere-Biosphere Programme has focused on planning and articulating a global change research programme. In the process of identifying the basic scientific questions to be addressed in its core projects, it has become clear that one key and common issue is the role of land cover and human-induced land cover change in altering global cycles. Thus the IGBP, together with the Human Dimensions of Global Environmental Change Programme (HDGEC) of the International Social Science Council (ISSC), constituted a working group to develop a programme for studying how human land use alters land cover. A report is under preparation.

Human Alterations

Humankind alters the "faces" or states of the Earth's terrestrial surfaces in order to obtain physical resources needed for sustenance, shelter, fuel, and other material consumption. These uses of the Earth rarely take place in a globally systemic way but rather are individual and discrete, reflecting the particular ecological, political, economic, and demographic circumstances of a given location. Yet the sum of these changes can reach a magnitude or spatial scale that is global in its impact. This is particularly true in the case of a set of phenomena and processes known as land-use and land-cover change. *Land cover* refers to physical attributes of a segment of the Earth's surface, including biota, soil, surface and ground water, topography, pavement, and human structures associated with it. *Land use* refers to the productive purpose to which the attributes of land cover are placed.

Changes in land-cover exist as a gradient of transformations. Obvious and direct human-induced conversions such as deforestation convert land cover from one type to another -- in this case from forest to grassland, pasture, settlement, etc. More subtle forms of within-type transformation can result in degraded ecosystems and are caused by such land uses as selective logging or livestock grazing in savannas or semi-arid landscapes. Even though there is no extreme conversion from one cover to another, these land uses transform land covers in ways that may change their biomass content, nutrient status, or net primary productivity.

Land Cover and the Earth System

That land cover and human alterations of land cover should play a major role in global-scale patterns of the climate and biogeochemistry of the Earth system is not self-evident given that land occupies under 30 percent of the Earth's surface. Even though the oceans are the major driving force of the physical climate system, the terrestrial surface has considerable control on the biogeochemistry of the planet, which in turn plays a significant role in driving the climate system because of the radiative characteristics of atmospheric gases such as carbon dioxide and methane. Moreover, the heterogeneity of

the land surface in terms of topography, albedo, and other physical characteristics, generates the intricacies of climate and weather by modifying ocean-driven atmospheric circulation. In addition, the land surface contains relatively high concentrations of the elements found in dilute concentrations in the oceans. The oceans are, in effect, harsh deserts relative to the land surface, something which is particularly evident in the images of the planet acquired from space. While appealing to the eye, the blue colour of the oceans suggests a region of relative sterility compared to the areas of verdant green on portions of the land surface. In fact, much of the fertility and productivity of marine waters in coastal zones derives from the influence of the land.

Consequently, changes in land cover can have important consequences for global biogeochemistry, climate, and ultimately human habitability. Yet we do not understand how different configurations of socio-economic factors including level of economic development, type of land-tenure system, national political instability, population pressures, and international commodity prices influence land use and land use change. Neither do we know very much about the nature, extent, and magnitude of the influence of human activities on land cover or how human-induced changes in land cover will alter biogeochemical cycles or water and energy balances at the global scale. Finally, we do not comprehend how alterations in global cycles or climate will in turn alter the productive uses to which land covers may be put. Without this basic understanding, it is difficult to predict the future consequences of land-use and land-cover change.

Framework for Study

To understand global land-cover change as a segment of global environmental change requires an understanding of the linkages between human systems that generate actions that lead to land-use change and the physical systems that are affected by the resulting changes in land cover. This will require two sets of initiatives. The first will improve the data available to support land use-land cover studies, including the development of data sets that provide information not only on the types and magnitude of land cover conversion, but also on the spatial fragmentation produced by conversion and the latitudinal gradient of conversion. This first initiative will also require efforts to link data on physical changes of land covers to data on socio-economic conditions associated with those conversions.

The second initiative, which is central to the efforts being defined by the joint IGBP-HDGEC working group, is to develop a framework for understanding how changes in land use influence changes in land cover in order to improve projections of land cover change. This initiative will involve three closely related areas of activity. The first is to develop a typology of important land cover conversions based on the attributes of cover type, human driving forces, and conversion process. The second involves a series of integrated case studies -- following a common research protocol -- detailing the relationships between the combinations of human driving forces found in a particular location and the conversion processes and rates associated with those forces and the pre-existing state of land cover. Together, these first two sets of activities will increase our understanding of how the human land-use land-cover change relationship plays out differently in various contexts. For example, they should enable us to understand why in some cases increasing land pressures due to increasing population density lead to deforestation, while in other cases increasing pressure on the land does not cause deforestation and can even lead to afforestation. This improved understanding will in

turn inform the third area of activity, the development of Global Land-use/Cover Models (GLMs) that can be integrated with other global models. Development of GLMs will help to organize existing data on land-use and land-cover change and the human forces that affect it into a global framework. Ultimately, these models will produce crude projections of future states of land cover and generate insights into the mechanisms that cause land cover change and the direction and magnitude of these changes. This knowledge will be important to developing an overall understanding of global change and its human impacts.

Global Change and Resource Use: Carbon Emissions from Deforestation in Thailand.

Somthawin Patanavanich
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Estimates of carbon emissions from deforestation in Thailand vary widely. Some models develop relatively high estimates of emissions. This paper presents results from a model (initially developed at the Lawrence Berkeley Laboratory), which estimates net emissions for a base year according to specific information about forest type and then uses this base for forecasting carbon emissions according to projected states of forest resources. The forecasts are developed for each major mode of deforestation: conversion to agriculture; conversion to grazing land; conversion to managed forest; conversion to other land uses such as dams, roads, and mining; and conversion by forest fire.

Thailand's net carbon release through deforestation for the base year 1989 was estimated at 23 million tons, less than one percent of the estimated world carbon release. Assuming that the population totalled 56 million in the base year, the net carbon release from this source would be 0.4 million tons per capita. The estimates are much lower than those given by other prominent studies.

Forecasts of future net release are based on the knowledge of deforestation in the base year, decomposition period, rate of growth of secondary vegetation, rotation age, and the change in rate of deforestation. The net carbon release is the sum of prompt release and emissions from annual decomposition, less the amount sequestered in the year under consideration. The forecasts show a decreasing trend of net carbon release in the forest sector. If deforestation is one percent per anum, future net emissions were projected to be as high as 47 million tons by 1996 (double the level projected for 1990). If deforestation can be held at 0.3 %, the net carbon emissions from this source will only by 33 million tons in 1996.

Attempts to limit future rates of deforestation must be based on assessments of the causes of deforestation. Major hypotheses were reviewed, including those which point to population pressure and poverty as the principle driving forces. According to research undertaken in conjunction with this study, the primary causes of deforestation in Thailand appear to be rural poverty, forest degradation, agricultural yield decline, and the lack of effective enforcement by the Royal Forestry Department (RFD). Increased access to previously inaccessible areas without a compensatory increase in RFD resources to enforce forestry laws, was also singled out as another cause of deforestation in Thailand.

An Interregional Research Programme on Methane Emission from Rice Fields in Asia

H. U. Neue
International Rice Research Institute (IRRI), Los Baños, Philippines

IRRI is the first International Agricultural Research Institute that has implemented a comprehensive research programme in interactions between agriculture and climate change. The research aims to evaluate:

- how climate change affects rice cultivation (effect of increased atmospheric CO_2 concentrations, temperature and UV-radiation on rice growth and rice pests); and
- how rice cultivation contributes to climate change (trace gas emission from wetland ricefields, especially methane).

Methanogenesis is favoured in wetland ricefields by anoxic conditions, the availability of organic matter from soil, stubbles, photosynthetic aquatic biomass and organic amendments, a soil pH near neutral and soil temperature 20-30^{0}C during the rice growing seasons.

The rice plant acts as a gas vent. Through a special tissue, the aerenchyma, atmospheric oxygen is supplied to the roots and methane is released from the soil to the atmosphere. Rice plants mediate up to 90% of the methane flux, while diffusion and ebullition in undisturbed ricefields contribute only 10-30%. Ebullition is likely underestimated. Disturbance of rice soils cultivation practices (puddling, transplanting, fertilization and weeding, for example) have not been accounted for in reported fluxes. Entrapped methane in the soil may compromise up to 80% of the methane formed and will be oxidized during the growing season. Methane is especially oxidized when fields are drained and remain in dry fallow between rice growing seasons or if an upland crop is planted after rice.

Estimates of global methane emission from ricefields range from 25-100 Tg (million tons) per year. Rice cultivation in Southeast Asia probably contributes 10-16 Tg (Neue and Bachelete, 1992). These estimates are very uncertain because of the few flux measurements reported. No field measurements of methane fluxes have been carried out yet in Southeast Asia. The best guess of the global flux has recently been narrowed to 40-60 Tg per year (Neue and Bachelete, 1992) accounting for soil properties, water regimes and rice growth parameter in different rice ecologies. Since these estimates do not include ebullition due to cultural practices total emission from ricefields may be higher.

Irrigated ricefields, comprising 49% of the global harvested area but 71% of the rice production (IRRI, 1989), are likely to be the major source of methane emission from riceland. The assured water supply and control, intensive soil preparation and fertilization, and the resultant improved growth of rice favour methane formation and emission.

The complex interactions between methane formation, methane oxidation, rice growth

and cultivation, and methane emission require and integrated and interdisciplinary approach to determine and discriminate rice environments more accurately and to develop mitigation technologies accordingly. Reduction in methane emission from ricefields is only feasible if productivity of rice cultivation can be increased at the same time. The projected food (rice) demand over the next three decades can only be met if global rice production increases by about 50%; some major rice growing countries in South and Southeast Asia will have to double production.

Joining together the world leading expertise of the required sciences and regional expertise on rice cultivation and wetland environments is crucial to achieve methodologies and baseline data for reliable regional and global estimates of methane fluxes from ricefields.

Funded by the Environmental Protection Agency of the USA (US-EPA), IRRI has started baseline research on methane fluxes in ricefields in collaboration with the Fraunhofer Institute for Environmental Atmospheric Research, Germany, and the Biogeochemistry Institute of the Louisiana State University providing the expertise on gas flux measurements from soil and plant systems and the expertise on the biogeochemistry of wetlands, respectively. Additional collaborations have been established with the Agricultural University of Wageningen, the Netherlands to discriminate soil types according to methane production potentials, the University of California for isotopic studies of emitted methane, and US-EPA to develop a geographic information system (GIS) on methane emission from ricefields.

To support national rice research systems in developing their own capacity to respond to the issue of methane emission from rice and link their expertise with that of advanced institutions, IRRI is establishing an interregional research programme on methane emission from ricefields funded by the Global Environmental Facility (GEF) of UNDP/UNEP/The World Bank. This programme is essential:

- to characterize and quantify methane emissions from major rice ecosystems;
- to assess effects of current rice technologies on methane formation and emission;
- to evaluate processes that control methane fluxes in different rice ecologies:
- to identify mitigation candidates that are in accord with productivity and sustainability of rice systems; and
- to ensure an early linkage between climate change research and technology development in rice systems.

It is proposed to establish collaborative methane research on irrigated rice in China, India and the Philippines; on rainfed rice in India, Indonesia and the Philippines; and on deepwater rice in Thailand.

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National Reports

Indonesia

Professor Harsano Wiryosumarto
Chairman, National Aeronautics and Space Institute, Jakarta

Indonesia is the largest archipelago in the world. It has about 17,000 islands with a coastline longer than 80,000 km. The total area is about 8.5 million km^2. The Indonesian archipelago is strongly influenced by monsoons. Therefore, it is an ideal site for studying the monsoon and its effects on agriculture, fisheries, and oceanographic features of the Indonesia as well as the adjacent seas.

The Indonesian archipelago also provides the only interocean link between a reservoir of warm surface water of the Western Pacific Ocean with the Eastern Indian Ocean. The heat flux and water mass transfer between the two oceans through this link is global in scale and impacts on the global climate. Another important phenomenon affecting the region is the "El Niño" Southern Oscillitation (ENSO). This phenomenon affects the climate regionally, the whole Pacific basin and even globally.

Along the 80,000 km of coastline, one can find stretches of coastal tropical ecosystems, such as mangroves, coral reefs, sago palm, seagrass, deltas and estuaries. Most of these systems are still in pristine condition. In addition, Indonesia still has one of the largest area of tropical forests in the region, estimated to about 108 million ha.

Situated in the tropics, between two important continents and between two oceans, the coastal zone of Indonesia, due to its position in the western Pacific basin, could become a development centre of the world in the coming century. Based on its natural resources, cities located in the coastal zone areas will be the centres for offshore resources developments such as fisheries, aquaculture, and offshore oil and gas industries. Last but not least it will become centres of international tourism. Considering the above natural physical setting, Indonesia is ideal for establishing a multi-disciplinary Regional Research Centre.

The Indonesian research agencies and research institutes, which are ready to collaborate and initiate activities closely related to the activities of IGBP, are:

- The Agency for the Assessment and Application of Technology (BPPT)
- The Indonesian Institute of Sciences (LIPI)
- National Aeronautics and Space Institute (LAPAN)

- Meteorology and Geophysics Agency (BMG)
- The National Coordinator for Survey and Mapping Agency (BAKOSURTANAL)
- State universities, which is at least one in every province of Indonesia

For equatorial atmosphere study, Indonesia and Japan, through the cooperation between The Agency for the Assessment and Application for Technology (BPPT), and the National Aeronautic and Space Institute (LAPAN), both of Indonesia and the Radio Atmospheric Study Centre (RASC), Kyoto University of Japan are working toward the establishment of an International Centre for Equatorial Atmospheric Research (ICEAR), to explore the dynamics of the atmosphere, especially the upper atmosphere. The giant atmospheric equator radar will be the main equipment of this international centre.

With its challenging natural physical setting, and massive support of the Government including the abundant research facilities available and the ready to support research agencies and institutes, Indonesia is ideal for a multi disciplines Regional Research Centre for the Tropical Asian Monsoon region (see proposal for the establishment of a START RRC).

Malaysia

Mohinder Singh
Ministry of Science, Technology and the Environment, Kuala Lumpur

Malaysia has yet to establish a national Committee for the IGBP, but it is already actively involved in a number of activities related to global change.

At the regional and international level, Malaysia is involved in the Intergovernmental Oceanographic Commission (IOC), the World Meteorological Organisation (WMO), the WMO/UNEP Intergovernmental Panel on Climate Change (IPCC), the United Nations Environment Programme (UNEP), the International Council of Scientific Unions (ICSU), and the UNESCO International Hydrological Programme (IHP) and Man and the Biosphere Programme (MAB). Some of these programme activities can contribute to our knowledge and understanding of global change.

At the national level, several governmental institutions and universities are actively carrying out research and monitoring programmes. Among these are:

Malaysia Meterological Service (ozone monitoring, climate variability, greenhouse gases, acid precipitation).

Department of Environment Malaysia (ozone monitoring, chlorofluorocarbons, aquatic environment).

Science University of Malaysia (ozone research, mangrove swamp ecosystem, solar radiation, marine ecosystem).

National University of Malaysia (surface ozone measurement, suspended particulate, UV measurement).

Agricultural University of Malaysia (coastal erosion, marine ecosystem).

Forestry Research Institute of Malaysia (forestry research, carbon cycle, tropical forest management)

National Population and Family Development Board (population and environment)

Of special interest to IGBP is the recent initiation of four projects in Malaysia involving the Malaysian Meterological Service in the International Global Atmospheric Chemistry Project (IGAC): (i) Cameron Highlands rainwater chemistry project (in collaboration with CSIRO); (ii) Evaluation of sampling and analysis techniques of wet and bulk deposition (in collaboration with University of Stockholm); (iii) Passive sampling of SO_2, NO_2, and NH_3, in tropical areas (in collaboration with Swedish Environmental Research Institute); and (iv) Analysis of aerosol samples to study dry deposition of acidic species in Southeast Asia (in collaboration with University of São Paulo, Brazil).

Malaysia has, since November 1991, commenced a long-term programme for measuring the tropical ozone profile. Measurements of surface ozone and total ozone will commence this year. These initiatives constitute a comprehensive ozone monitoring

programme in Southeast Asia and will have regional as well as global significance in the furtherance ozone knowledge.

The Philippines

Filomena F Campos
NAST Secretariat, Manila

Introduction

One of the more revealing lessons learned during the past two decades of environmental awakening in the Philippines is that the maintenance of the Earth's delicate balance by mere prophylactics of pollution control and other ecological mitigation measures cannot ensure sustainable development. There is now a compelling need to overhaul the traditional concepts of development with its exclusive focus on economic principles and the political economy of natural resources.

Most Filipinos still depend on natural resources systems for their subsistence and must therefore confront the inexorable of ecological principles. Two thirds of the Philippine population live in rural areas and depend on agriculture, fisheries and forestry. Soil erosion, deforestation, pollution and declining fish catch all point to the fact that the limits of the natural carrying capacity are already being exceeded. While it is true that we can extend the limits by technological fixes such as the green revolution and by industrialization, these responses take time and the galloping population growth extinguishes whatever little gains we make.

Indeed, there is strong correlation between population growth, the incidence of poverty resource depletion, and environmental quality. These are the results of the development efforts of the past which failed to consider both population and environment as resource bases that must be nurtured and taken care of as the central assets behind the development process. Since the Philippines was almost all forest in its natural state and since the country's topography and ecology appear to be significantly controlled by the ecological dynamics of the forests, the state of the forests could serve as a qualitative surrogate indicator of environmental quality. There are a host of other quantitative and qualitative indicators that could testify to the ominous decline of environmental quality such as the ravaging of fishing grounds and coral reefs, the pollution of rivers, lakes and bays and the clearly visible air pollution in downtown Manila.

In the years 1990 and 1991, the Philippines was devastated by several natural calamities of varying degrees and magnitude : from the earthquake which brought havoc on thousands of lives and properties to the wrath of Mt. Pinatubo exploding with an intensity comparable to an atomic bomb and spewing tons of volcanic ashes and lava, which affected to a large extent the agricultural activities of the area; changed the course of the rivers and displaced socio-economically a significant segment of the affected population.

Scientists argue that what aggravate some natural calamities are man-made in origin. A case in point is the recent flash flood which was claimed to be caused by massive deforestation of the mountains within the disaster area.

Likewise, it could not be denied that on unquantifiable cost of forest destruction is the loss of species and genetic diversity. It is said that the Philippines has already lost about

40% of its endemic flora.

Another equally important component of our environment, which calls for immediate action, is the marine ecosystem. Among its major problems are : (i) destruction of shallow-water marine ecosystems particularly the coral reefs and mangroves, (ii) the over exploitation of fishing grounds, and (iii) pollution especially with sewage and garbage.

All these affect the capacity of the natural ecosystems to adjust to global change and exacerbate the projected adverse impacts of the change on human population.

Needs and Priorities

1. An efficient system of management, monitoring and strict implementation of laws. Towards this is the information campaign on environmental awareness especially among the politicians, policy-makers and a segment of the affluent sector of our society (as they are the ones who ravage the natural resources more significantly). Likewise, the integration of environmental concepts in formal education is a priority.

2. Mitigate the socio-economic problems that lead to environmental changes such as overpopulation, poverty and the need to develop alternative schemes.

3. Strengthen research on : (i) assessing national opportunities to increase forest carbon storage in line with national resource development policies; (ii) management and monitoring of forests to maintain sustainable yield of forest products, biological diversity, water quality and quantity and other values that forests provide; (iii) study of near-shore oceanographic processes; (iv) long-term measurements to detect relative sea level changes; (v) sedimentation and coastal patterns; (vi) dynamics of coral reef, mangrove and seagrass ecosystems; (vii) impact studies on climate variability/natural disasters on human socio-economic systems as this provide direction to development; and (viii) collate and integrate existing data on global change.

4. We recognize the immediate need for the Philippines to organize a National IGBP Committee to legitimize our participation in the IGBP

5. We strongly advocate the establishment of the START regional network focusing on natural science and social science in support of a fully integrated activities on global change and its impacts and policy responses.

6. We urge that the recommendations of this Regional Workshop that need the cooperation of the Philippines be sent by the IGBP Secretariat to the Secretary of Science and Technology.

Last but not least, we seek accurate public information on global change issues through education and training.

This paper is a synthesis of technical reports and documents of the Department of Natural Resources and Environment, Philippines.

Singapore

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Introduction

Singapore is an island nation with a very small land area of only about 600 km^2. Its infrastructure is basically that of an urban city supporting an industrial/manufacturing base. Hence the environment management programme of the country has been geared towards problems associated with an urban city. Attention has therefore been focused on the control of pollution, particularly those technologies related to the control of water and air pollution. Considerable investment in equipment and manpower has also been made for the measurement and monitoring of water and air quality parameters. These technologies and measurement methods are now fairly well established in the country. We have been successful in this regard and our environment is now "clean and green" and pollution from local industries are well contained.

Model Environment City

A recent plan to turn Singapore into a "model environment" city has been announced and a clear statement to focus attention on the regional and global environmental issues is incorporated in this plan.

Environmental Research

The local environmental research has followed the national objectives. Our universities and research institutes have therefore carried out considerable work on pollution control technologies and the analyses and monitoring of pollution parameters. Research laboratories are well equipped and research staff are appropriately trained in a variety of analytical methodologies.

Some of our recent and current research programmes that focused on issues related to coastal and urban scenario are as follows:

Coastal Studies: (i) effects of tides on flooding probabilities; (ii) physical impacts of sea-level rise on coastal margins; (iii) studies on coastal hydrodynamics; and (iv) coastal quality investigation on marine pollution, sedimentation, coral reef response to sea level variations, coastal eutrophication, etc.

Terrestrial Ecosystem: (i) regeneration of tropical rain forest plants; (ii) photosynthetic characteristics of dominant species; (iii) CO_2 fixation; and (iv) productivity of the tropical rain forests.

Others: (i) environmental impact assessment; (ii) stabilisation and safe disposal of toxic and hazardous wastes; (iii) urban storm water management ; (iv) monitoring of gas emissions from sewage treatment works; and (v) waste minimisation and recycling.

We are hopeful that our experience on the above environmental topics may form a useful and important part of the scientific agenda for this Southeast Asian region. For example, our work on the modelling of coastal hydrodynamics and coastal water quality is well established and a possibility exists to extend such research to the region as part of the global research on land-ocean interactions and effects of sea-level rise. Possibilities also exist for our contribution to regional research programmes in areas of stormwater management and reforestation. We look forward to contribute to the IGBP in this region and strongly support regional cooperation in studies on global change.

Thailand

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Introduction

Forests covered more than 70 % of the country in 1938, and gradually decreased to 28 % in 1990. In contrast, the agricultural lands have rapidly increased, not only in lowland areas but also in rugged terrain, hilly, and mountainous lands. The explosion of the population from 18 million in 1938 to 56 million in 1990 is the main factor leading to increased pressure on land. Shifting cultivation in agriculture has caused losses of soil by erosion process and decrease in soil fertility. Unfertile lands are now found in almost all parts of the country. Thailand is a country in which processes of landuse change and its impact could be studied in an IGBP/HDGEC context.

Slash-and-burn agriculture is the main activity after forest clearing. Burning off at least 500,000 ha per year releases carbon dioxide and contributes to global warming. Other activities also produce greenhouse gases, such as fossil fuel burning, agriculture practices and solid waste treatment.

IGBP National Committee

The IGBP National Committee of Thailand was established in July 1989 by the National Research Council (NRC), Ministry of Science, Technology and Energy. At the beginning, the Committee had eight members from the universities and government agencies. They represented disciplines related to Thai participation in IGBP established Core Projects. Later, another six members were added in order to cover all IGBP Core Projects. The secretariat of this committee is the responsibility of NRC.

Many suggestions related to global environmental issues have been made to the Committee. The IGBP National Committee should initiate projects related to national priorities. Unfortunately, financial support for environmental research has been limited. Hopefully, the IGBP National Committee will be able to develop project proposals for external funding.

IGBP National Activities

After the establishment of the IGBP National Committee, activities in three areas were planned:

1. *National meetings and participation in other meetings*

Two meetings were organised by the IGBP National Committee: The First IGBP National Workshop, 16-17 September 1990, Bangkok; and IGBP Regional Meeting for Southeast Asia, 13-17 January 1992, Chiang Mai,

Members of the Thai National Committee have also participated in: (i) First Meeting of National IGBP Committee Chairpersons in Washington D.C., January 1990; (ii) second meeting of the Scientific Advisory Council (SAC II), September 1990 in Paris, France; (iii) The Global Change and Terrestrial Ecosystems (GCTE) Core Project Open Meeting in Brighton, UK February 1991; (iv) Asian IGBP Workshop, New Delhi, India February 1991; (v) Planning meeting for Asian countries, December 1991, Singapore.

2. *Research and Priorities*

The first national Workshop on IGBP was held on 16-17 September 1990 in Bangkok. The meeting had three objectives:

(i) To inform the Thai scientific community about the IGBP.

(ii) To compile information from the published and ongoing research projects by Thai researchers on the changes occurring on land, in the oceans and the atmosphere.

(iii) To develop ideas and set priorities for future research projects in relation to global change.

The members of the workshop were divided into two groups based on their interests: "Terrestrial Systems and Hydrological Cycle" and "Marine and Atmospheric Systems". Each group formulated recommendations to be used as a guidelines for the future research of IGBP and for the identification of other key environmental issues on Thailand.

1. *Marine and Atmospheric Systems*

IGBP Related Activities

- Past geological changes in Thailand and Southeast Asia.
- Studies on the coastal and near shore water circulation
- Coastal erosion, with the emphasize on the Gulf of Thailand
- Sediment transport in river systems to the Gulf of Thailand and Aaman Sea
- Strengthening the study in the atmospheric chemistry
- Study of the causative factors for the formation of typhoons in the Gulf of Thailand.
- Monitoring ocean and atmosphere temperature

Other Environmental Priorities

- Urban climatology

2. *Terrestrial Systems and the Hydrological Cycle*

Other Environmental Priorities

- Importance of changing climate for economically important plant species and for the biodiversity.
- Relationship between the deforestation and global change.
- Causes for decreasing fresh water supply.
- Use of remote sensing techniques for data gathering.
- Impact of industrial waste dumping on agricultural land;
- Changing condition of soil and erosion, preventive measures, soil improvement. The study should aim at predicting land slides, earthquakes, and coastal erosion.
- Waste water treatments and solid wastes disposal. These studies should aim at increasing the efficiency and economical feasibility.
- Study on the impact of mineral excavation on environmental change.

If the recommendations were implemented, Thailand would significantly contribute to the established core projects of the IGBP.

Academy of Sciences in Taipei, China

Chen-Tung Arthur Chen
Institute of Marine Geology, National Sun Yat-Sen University, Kaoshiung

The people in Taiwan, influenced by the scientific community, are keenly aware of the nature and consequences of the global change problem. As a result the IGBP Committee of Academia Sinica in Taipei, was formed in 1988.

This committee is an umbrella organisation for contributions to the IGBP. The National Science Council, which funds much of the research, has formal relations with the International Group of Funding Agencies for Global Change Research (IGFA).

The overall goal of our global change programme is to ensure that our approach to global change research is cohesive, comprehensive, and responsive to international initiatives, while remaining focused upon regional problems and national needs.

At present, we have formally participated in the Joint Global Ocean Flux Study (JGOFS), and International Global Atmospheric Chemistry Project (IGAC), and have formed national project committees. A national committee has also been established for PAGES. Linkage to the World Ocean Circulation Experiment and Tropical Ocean Global Atmosphere Programme occurs through WOCE and TOGA committees. We have also initiated processes of setting up a Regional Research Site as a component of the IGBP-START Tropical Asian Monsoon Region network.

Bilateral relations have been established through both formal and informal discussions, meetings and workshops between the committee and the corresponding committees in the US, Japan, France, Russia and the Philippines. Closer collaboration with Southeast Asian countries will have higher priority in the next few years. Annual training courses and regional workshops will be held in Taiwan to facilitate the cooperation.

Australia

Brian H. Walker
CSIRO, Division of Wildlife and Ecology, Lyneham, ACT

There are several institutions in Australia which are relevant to the research on the Tropical Asian Monsoon Region (TAM). In particular:

1. CSIRO:
   - Darwin (Tropical Ecosystems Research Centre)
   - Atherton (Tropical Forest Research Centre)
   - Melbourne (Division of Atmospheric Research)

2. Universities:
   - University of the Northern Territory (Darwin)
   - Australian National University, especially: (i) the Research School of Biological Sciences, Ecosystem Dynamics Group, and (ii) The Centre for Resource and Environmental Studies (Canberra)
   - Macquarie University (Climate Impact Centre)

3. Bureau of Meteorology Research Centre (Melbourne)

4. Australian Institute of Marine Science (Townsville)

Each of these institutions is conducting a variety of research projects which contribute to the objectives of a START network in Southeast Asia. Of particular note is the CSIRO programme on global change involving several divisions and aimed at an improved GCM with an emphasis on regional scale predictions for this part of the world.

Planned and newly initiated programmes include:

1. A Tropical Atmosphere Monitoring Station near Darwin (CSIRO and Bureau of Meteorology Research Centre)

2. A Global Change Research and Training Centre (emphasis on climate modelling and atmospheric chemistry) in Melbourne (CSIRO Division of Atmospheric Research and Melbourne University)

3. A Northern Australian Tropical Transect (NATT), extending from Tennant Creek to Darwin, covering a range of vegetation from arid spinifex grassland to humid savanna woodlands and forest, is ca. 1000 km long, covering a rainfall gradient of 1000 mm (ca. 400 to 1400 mm). This transect represents the southern bound of the Asian monsoon. The project will involve the IGAC, GCTE and BAHC Core Projects of IGBP, and the WCRP. It aims to develop a predictive capacity linking changes in atmospheric composition, biogeochemical cycling, ecosystems structure and composition, and climate, along this gradient. Differences in land use and soil type will also be taken into account.

4. A number of other projects in the Australian IGBP programme will also be relevant, e.g., UV-B effects on biota (including rice); a comprehensive PAGES project; a project called OASIS (Observations at Several Interacting Scales) aimed at scaling up hydrological, vegetation and soils data from patches to a region, involving patches with different exchange properties; a JGOFS project involving sub-projects in the Indian Ocean and the monsoonal marine tropics, a comprehensive project on agricultural effects.

5. A subsequent Australian National IGBP Committee meeting (March 1992) has expressed strong support for collaborative research in the TAM region and for the regional START centre and network. There were two important initiatives: (i) the appointment of a Coordinator to gather information on relevant Australian institutions, research, training, programmes, etc., and link it to the TAM START system, and (ii) Australian support for a workshop to develop a regional coordinated palaeomonsoon research project.

Japan

Masatoshi Yoshino
Japanese IGBP National Committee, Aichi University, Toyohashi-City

National Committee

Preparation for research under IGBP in Japan started already in 1984, stimulated by the preparatory discussions in ICSU. An *ad hoc* Committee for IGBP was established as a private advisory body by the President of the Science Council of Japan in 1989 (Chairman: Professor Y. Oshima). This committee began to develop a national plan for the IGBP and became an official body under the Special Committee on "Human Activity and the Global Environment" (Chairman: Professor M. Yoshino) in July 1989.

The General Assembly of the Science Council adopted the recommendation regarding the national IGBP plan to the Japanese Government in May 1990. Eleven ministries/agencies have responded to push IGBP in Japan. In October, 1990, the National Committee for IGBP has started officially with 17 members under a new constitution. The Committee has set up subcommittees on IGAC, JGOFS and GCTE.

Recent Activities

Japan-IGBP Report No. 1 was published in August 1991: "National Plan of IGBP-Japan", 42 pages. Also, for coordination and exchange of information among the Japanese scientists, IGBP-News is distributed in Japanese.

The Committee organized a small international meeting for assessment of the first-year results of Japanese studies related to IGBP on 4-5 February, 1992 in Tokyo. The proceedings are included in Japan-IGBP Report No. 2, 119 pages, published in March, 1992. Another International Symposium on Global Change (Waseda Symposium) was held on 27-29 March, 1992. The results of the first-year results presented at the February meeting have been printed in Report No. 2 and distributed to the participants at the Waseda Symposium.

A National Committee for HDGEC (chairman: Professor T. Fujii) has been established by the Science Council of Japan in October, 1991. The committee has been preparing a national plan for HDGEC-Japan, although the planning is two to three years behind those of IGBP.

National Plan of IGBP-Japan

The National Plan is composed of seven projects:

1. Global change in atmospheric trace gases and their exchanges with the biosphere.

2. Marine environments.

3. Probable effects of climate changes on terrestrial communities.

4. Climate analysis and modelling on consideration of interactions between biosphere and atmosphere as well as ocean-land interactions.

5. Monitoring of environmental change.

6. Paleoenvironmental change.

7. Interaction between global environment and human activities.

Some significant points are: (i) the study regions are focused on the Asian Monsoon and West Pacific regions. Based on previous cooperation between Japan and Southeast Asian countries, we shall develop these further in the framework of the IGBP: (ii) IGBP itself does not deal with socio-economic and human activities, although the global environment change will be analyzed in relation to human activities such as landuse change. The IGBP-Japan, however, includes Project 7 directed to analyze the human activities which will later be expanded to a major contribution to the HDGEC.

Among these seven projects, some have started earlier and are well established nationally, also taking part in international cooperation. In particular, it should be noted that some cooperation on observations and studies with countries in Southeast Asia have already started.

Other IGBP-related Activities

Studies on global change mainly related to IGBP have been studied in the universities and research institutes, which belong to the eleven ministries/agencies, as mentioned above. In addition the following bodies take part: National Institute for Environmental Studies of Environment Agency; Science and Technology Agency; Ministry of Agriculture, Forestry and Fisheries; Ministry of International Trade and Industry; Japan Meteorological Agency of the Ministry of Transportation. In addition, the Ministry of Education, Science and Culture has established a Centre for Climate System Research in the University of Tokyo and a Centre for Ecological Research in Kyoto University.

An "International Symposium on the Little Ice Age Climate" was held at Tokyo Metropolitan University from 25 to 27 September, 1991. The proceedings (342 pages) have been published by T. Mikami (Dept. of Geography, Tokyo Metropolitan Univ., Minami-Ohsawa 1-1, Hachioji-shi, Tokyo, 192-03 Japan). This is one of the results related to PAGES in Japan. The other "Proceedings of the International Conference on Climatic Impacts on the Environments and Society" was held at the University of Tsukuba, Ibaraki, Japan from January 27 - February 1, 1991. The proceedings (416 pages) of this conference was published by World Meteorological Organization (WMO) in Geneva, Switzerland, as TD-No. 435, in early 1992. This conference related to many parts of Japanese IGBP as well as international programme.

Working Group Reports

Greenhouse Gases and Global Change

Chairman: M. Mohinder Singh (Malaysia)
Rapporteur: Jariya Boonjawat (Thailand)

Significance of the Topic to the Region

Greenhouse gases, primarily water vapour and carbon dioxide, play a crucial role in regulating the temperature of the Earth and the Earth's atmosphere. However, there is now concern that tropospheric temperatures will rise further due to steadily increasing concentrations of the various greenhouse gases. The predicted regional changes in temperature, and even more so precipitation, are very unevenly distributed and differ widely from one model to another. The current models of global change cannot provide reliable estimates of climate change on a regional basis.

Therefore, collaborative research at an international level is necessary to study the tropical monsoon region which is seen as a major source of some greenhouse gases such as carbon dioxide, methane, nitrous oxide and chlorofluorocarbons.

According to the basic physical relationship between temperature and the saturation pressure of water vapour, a warmer climate entails a wetter atmosphere and hence a general increase in precipitation. On the other hand, a warmer climate also means enhanced evaporation and dryness, especially in the already dry regions. According to some models an increased greenhouse effect will result in exacerbation of soil aridity and the loss of groundwater in dry temperate regions. Groundwater storage is a difference between rainfall and evaporation, where evaporation is much dependent on soil and vegetation properties. Therefore, a small modification of the soil characteristics can make the difference between wet or dry soil predictions with a doubling of CO_2 concentration. The sensitivity of land hydrological processes is an indication that undesirable climatic impacts might be overcome in some regions by appropriate treatment of soil and adaptation of vegetation.

The tropical monsoon region is characterized by high population density and large population, and recent explosive growth of human activities have led to changes in land use and very intensive industrialization activities, thus contributing to changing pattern of emission of greenhouse gases. The region is also characterized by high volcanic activities and other natural disasters (e.g., El Niño induced droughts, flooding, typhoons), which also have a profound effect on these gases.

At present, the information on atmospheric chemistry of this region is sporadic and

insufficient to provide an accurate assessment of the contribution made by the region to greenhouse gases and global change. However, the region has a relatively large pool of scientists who can be trained to conduct research in this area.

Specific Topics to be Addressed through Regional Collaboration

In keeping with the priorities identified in the International Global Atmospheric Chemistry Project (IGAC), the following research activities are proposed.

Quantification of sources and sinks of some greenhouse gases

How much does the region contribute towards the emission of methane and carbon dioxide? This is the question that needs to be answered through collaborative research within the region. The existing data are unreliable due to different methods of estimation and therefore standardization of methodologies is necessary before setting up any long-term measurement of these greenhouse gases. The second point raised by the Working Group is that contribution of this region as the sink of greenhouse gases should be considered as well.

Flux measurements

In order to measure the total emission of greenhouse gases it would be necessary to obtain flux data from both natural and anthropogenic sources. Every country should focus on both sources and sinks based on areas of current interest and on-going research activities with a view to building up flux data on various ecosystems. The priority ecosystems are :

Wetland and rice ecosystems

Southeast Asia comprises 22% of the global harvested rice area yielding 19% of the world rice production. Irrigated and rainfed rice comprises about 40% each and deepwater and upland rice about 10% each of the total rice area in Southeast Asia. Based on rough extrapolations, rice cultivation in Southeast Asia contributes 25% (10-16 Tg) of the total estimated methane emission from rice. (See also presentation by Neue in this report.) These estimates are very uncertain, since no flux measurements of methane in rice fields of Southeast Asia have been reported. Linked to IGAC, IRRI has initiated an interregional research programme on methane emission from rice fields funded by the GEF (see Neue).

Besides the rice ecosystem, other wetland areas are large natural sources of methane emission, and flux measurement of this system also needs to be compared with the rice ecosystem.

Other major natural sources of methane and carbon dioxide emission.

Forest and grassland burning, volcanic activities, hydrothermal vents, and oceanic ecosystems also produce greenhouse gases. Flux data on both methane and carbon dioxide emission from these natural sources are proposed to be carried out by several countries in the region.

Anthropogenic sources of atmospheric trace gases.

Anthropogenic sources comprise industrial activities, transport activities, sewage disposal, landfill, etc. These activities contribute to emission of several trace gases including carbon dioxide and monoxide, oxides of sulphur and nitrogen, chlorofluorocarbons, and methane

Monitoring of greenhouse gases.

Monitoring should be carried out in collaboration with Global Atmosphere Watch (GAW) of WMO. GAW's aim is to monitor, on a global and regional scale, the chemical composition and related physical characteristics of the background atmosphere. The data gathered will contribute to understanding the changing chemical composition of the atmosphere, long-range atmospheric transport and deposition, and anthropogenic impacts.

Consequences of greenhouse gases on climate.

The radiative forcing of greenhouse gases should be studied in collaboration with WCRP. Data collection, analysis and studies of impacts on a regional scale, conducted within research centres, in close co-operation with national meteorological services, will be of great value to the understanding of climate change in the region. Special note should be taken of an initiative by the ASEAN countries in 1985 to pursue a regional project in meteorology, with strong support from WMO, resulting in the approval by ASEAN in 1989 to establish an ASEAN Regional Specialized Meteorological Centre (ARSMC), which is to be located in Singapore. One of the objectives of the project is to undertake studies on climate variability and climate change. In pursuing the objectives of START in the Southeast Asian region, future collaboration with ARSMC and also the national meteorological and hydrological services of the countries will be of immense benefit to the scientists studying the effects of global change in the region and should be considered as essential.

Effect of perturbations on greenhouse gases.

Emission of several greenhouse gases from natural sources can be affected by human activities, such as changes in land use from forest to agricultural activities, changes in energy acquisition, industrialization, urbanization, shifting cultivation, biomass burning in agricultural practices and high rate of population growth. These activities should appropriately be covered under the HDGEC programme.

Institutions with Relevant Expertise

Indonesia

The Agency for the Assessment and Application of Technology (BPPT).
The Indonesian Institute of Sciences, LIPI.
National Institute of Aeronautics and Space (LAPAN)

Meteorology and Geophysics Agency (BMG)
The National Coordinator for Survey and Mapping Agency (BAKOSURTANAL)
State Universities, which are at least one in every province of Indonesia

Malaysia

Malaysian Meteorological Service
Department of Environment Malaysia
University of Sains Malaysia
University of Malaya
University Kebangsaan Malaysia
University Pertanian Malaysia
Forest Research Institute of Malaysia
National Population and Family Development Board

Philippines

National Research Council of the Philippines
Philippines Council for Aquatic and Marine Research
Philippines Council of Agricultural Research
Philippines Volcanological Institute
Philippines Council for Engineering and Institute Research Philippines
Atmospheric and Geophysical Administration
International Rice Research Institute
University of the Philippines
Department of Environment and Natural Resources

Singapore

National University of Singapore

Thailand

Chiang Mai University
Kasetsart University
King Mongkut Institute of Technology - Bang Mod Campus
Royal Rainmaking Research and Development Institute
Meteorological Department
Environmental Institute
Mahidol University
Silapakorn University
Chulalongkorn University

Suggestions for Strengthening Regional Collaboration

The following activities are proposed to strengthen regional collaboration:

To arrange workshops comprising active research scientists to collect available information, share expertise and plan collaborative research.

A network linking active research groups in the different countries in the tropical monsoon region should be established to coordinate the research on global change

The specific expertise in the different countries within and outside the Asian region be identified, so that resource persons can be tapped to carry out training in fields of atmospheric chemistry.

General Recommendations

As the members of the Workshop Group represented only limited area of expertise, the Working Group was not in a position to draw up detailed research topics. It is therefore proposed that an expert planning group be established of active research scientists to prepare a detail action plan.

While there are a fairly large number of institutions with the requisite manpower to carry out global change research, there is currently very limited work going on in the region in the area of atmospheric chemistry. This is due to insufficient understanding of the problem of global change and inadequate experience in the methodologies. It is therefore necessary that an active programme of training be carried out to build up sufficient expertise in the region. It is also necessary that linkages be established between local institutions and advanced research institutes to provide the training in the methodologies as well as in the calibration, use and maintenance of the specialized equipments. Measurements also need to be standardized for compatibility so that the results can be extrapolated on a regional and global scale.

Sufficient funding is essential to ensure that the programmes can be carried out effectively and on a long-term scale. This funding should be secured through international as well as through national and regional sources. National IGBP committees could assist in identifying such sources.

In order to ensure effective cooperation in the ASEAN region, it is recommended that all ASEAN countries establish national IGBP committees. Also, the IGBP/WCRP/HDGEC global change programmes should be endorsed by ASEAN and given high priority.

Role of Oceans in Global Changes and Land-Ocean Interactions

Chairman: Twesukdi Piyakarnchana (Thailand)
Rapporteur: Helen T. Yap (Philippines)

Significance of the Topic to the Region

The Working Group considered the following topics to be of particular interest to Southeast Asia: Land-ocean interactions, and the interaction between the coastal zone and the open ocean. The reason that these topics are considered to be of primary importance is that Southeast Asia is a maritime region, i.e., the land area is greatly influenced by the ocean, as it possesses some of the longest coastlines in the world. The majority of the populations in the region are concentrated in what is considered to be the coastal zone, which generates a significant amount of economic activity.

Because of the heavy concentration of human settlements in the coastal zone and their great dependence on its resources, this area experiences the destructive influence of a number of factors. The impacts originate from as far inland as the watershed and leave their mark in the coastal as well as the oceanic regions.

The following research agenda proposed by the WG reflects the above concerns.

Specific Topics to be Addressed through Regional Collaboration

In the listing and prioritization of specific research topics to be addressed through regional collaboration, the WG agreed to consult the results of similar exercises conducted in the recent past. In particular, the following were referred to :

(i) The report of the JGOFS Continental Margin Studies group (JGOFS 6, Bermuda, 2 October 1991)

(ii) The proposed project for Asia on Land-Ocean Interactions in the Coastal Zone (LOICZ) discussed during an IGBP meeting in Singapore in December 1991, and

(iii) The WESTPAC/IOC conference held in Malaysia.

After some discussion, the WG agreed to adopt the three foci as proposed for LOICZ (item 2 above) with some modifications. The revised foci are as follows (specific research topics are listed under each heading):

Focus I : Land-Sea Interactions

1. Coastal ecosystems;

2. Biogeochemical processes and energy exchange between the coastal zone and deeper waters;

3. Variability of marginal seas and its relationship with monsoon circulation (heat budget, sea temperature, sea level change, and salinity, esp. as influenced by rainfall;

4. Man induced modification of regional hydrological cycles;

5. Coastal sedimentation, including erosion, deposition;

6. Integrated catchment - coastal zone studies, including material transport, and water resources;

7. Socio-economic impacts and protection of human settlements; and

8. Impacts of urbanization and industrialization on the coastal zone.

Focus II : Coastal Zone - Ocean Carbon Dynamics

Carbon budget on the continental shelf, including land sources, accumulation in sediment and transport to the open ocean is an important topic for study. For its activities, the WG decided to adopt, without amendment, the objectives of the JGOFS Continental Margin Studies Group.

1. To quantify the carbon fluxes from given marginal zones to the open ocean;

2. To understand the seasonal and interannual fluctuation of carbon fluxes due to physical, biological and hydrological variation;

3. To estimate the benthic fluxes exchanged between the slopes and the open ocean by lateral transport;

4. To evaluate the importance of carbon deposition on the continental slope;

5. To determine the air-sea CO_2 exchange rates in strong upwelling areas;

6. To characterize important features of continental margins and to extrapolate from studies of typical sites to the global scale.

It was also suggested that the WG consider the following JGOFS activities for inclusion in their own research agenda :

1. The shelf area around the SE Asian Archipelago (e.g., Indonesia), which is a unique region where the productivity is high and the sediment production is voluminous. The Pacific to Indian Ocean through-flow may be responsible for a significant carbon flux to the deep ocean from this region.

2. The coral reefs, which play a significant role in marine CO_2 dynamics. The fate of coral reefs during climate change has to be considered in the global model.

Focus III : Data Analysis, Integration and Modelling

The processes studied under Focus I and Focus II will be analyzed and the data synthesized. Their relationships with respect to global change will be used for forecasting or predicting of the impacts.

Research Groups/Institutes which Could be Involved in Research of Relevance to Above Topics

Focus I

In general, the representatives of five ASEAN countries expressed interest in doing research connected with all topics listed under Focus 1. However, they did not feel adequately placed to identify specific groups or institute that would carry out particular research activities under the individual topics. Malaysia, in particular, identified the item on variability of marginal seas to be of particular interest to them. The Singapore representatives, for their part, stressed the topics pertaining to human impacts on the coast.

Focus II

The consensus among WG participants was that there was no capability in the region at present to address this focus and a significant amount of external support is required to initiate activities. Indonesia, Malaysia, the Philippines and Thailand expressed interest in developing research under this focus.

Focus III

With respect to Focus 3, only Singapore indicated an existing capability, as reflected in ongoing projects, as well as planned joint research with Malaysia. The other four ASEAN countries again expressed interest in developing the research theme, but reported either limited or no capabilities at present. External support would be needed in the initiation of activities.

Suggestions for Strengthening Regional Collaboration

In order to assure appropriate involvement of the scientific community of Southeast Asia in proposed global change research and proposed action, the following suggestions for strengthening regional collaboration were made :

1. It is imperative that a commitment from the appropriate ASEAN body be obtained. This would pave the way for seeking financial support from this source for the proposed programme.

2. Existing mechanisms for regional cooperation should be strengthened. Among organizations or institutions that already effectively promote such cooperation are the Association of Southeast Asian Marine Scientists (ASEAMS) and the ASEAN Senior Officials on the Environment (ASOEN).

3. The involvement of local scientists should be maximized.

Over-All Recommendations

1. There is need for systematic training programmes to strengthen the manpower resources in the region.

2. A significant amount of funding for the proposed research agenda is necessary.

3. The proposed research agenda requires extensive development of infrastructure.

4. There is a need for networks that wold facilitate the effective sharing of experience. This could be accomplished through activities such as the regular exchange of information, regular meetings and workshops, and the exchange of scientists.

5. It is vital to assure the long-term sustainability of the programme long after external funding has run out.

Biospheric Aspects of the Hydrological Cycle

Chairman and Rapporteur: Dr Hassan Virji
National Science Foundation, Washington DC, USA

Introduction

The BAHC Core Project is of particular relevance to the Southeast Asian region. The combination of varied topography, vegetative cover, climatic regime, etc., provides a unique environment within which the role of biota in the context of the hydrological cycle is of great importance.

Within almost every Southeast Asian country, there exist ongoing work related to BAHC. Examples are the projects under US/ASEAN Watershed Project (Philippines), Mae Sa Watershed Management Project (Thailand), as well as efforts within Malaysia and Indonesia. There also is active cooperation on watershed hydrology efforts among countries of the region. In addition, there exist strong linkages with international organisations such as IHP/IAHS and others on regional watershed hydrology.

Considering that the working group on regional BAHC issues had limited discussion time and scant expertise on the subject, the group opted not to dwell too deeply in the specific BAHC foci and activities. Rather, the group consensus was to recommend the following two specific actions in order to do proper justice to the important aspects of BAHC, foci and activities within the SE Asian region.

Recommendations

1. The IGBP National Committees in the region should undertake a compilation of BAHC/GEWEX related efforts. Results should be transmitted to the BAHC Core Project Office, the BAHC-SSC, and the joint IGBP/WCRP Working Group on Land Surface Experiments.

2. The Land Surface Experiments Working Group, in cooperation with IHP/IAHS, should organise a Southeast Asia regional workshop on BAHC that focuses on development of specific research efforts to undertake field as well as numerical investigations on each of the BAHC foci. It is essential that representatives of LOICZ, GCTE, IGBP-DIS, HDGEC, and START actively participate in this workshop, since sustainability of the regions agricultural and forest enterprises are crucially dependant on refined BAHC "products".

Effects of Global Change on Terrestrial Ecosystems

Chairman: C.J. Goh (Singapore)
Rapporteur: Kansri Boonpragoh (Thailand)

Significance of the Topic to the Region

The Effects of Global Change on terrestrial ecosystem is of particular importance to Southeast Asia for the following reasons:

- the region is a major source of the heat transfer to the atmosphere, and the energy balances is sensitive to vegetation change,
- erosion, sedimentation and changes in land-use area significantly changing regional biogeochemical cycling,
- rich in biodiversity, being one of the highest in the world,
- effects of population pressure on agriculture and land use often result in unsustainable use of tropical forests.
- strong dependency on continued high production of rice and other crops.

The working group recognised the following major ecosystem types and land-uses as being most important within the region:

Specific Topics to be Addressed through Regional Collaboration

GCTE Focus 1: Ecosystem Physiology

(i) Direct effects of elevated CO_2 levels,

(ii) Biogeochemical cycles, in particular in tropical forest undergoing land-use change,

(iii) Water and energy flux in each major ecosystem type.

The first topic is difficult to address in this region and therefore emphasis should be placed on the latter two.

GCTE Focus 2: Change in ecosystem structure

(i) Simulation models of change in selected ecosystems in order to understand landscape-scale dynamics,

(ii) Construction of functional classification of forest types,

(iii) To establish and understand the major environmental determinants of ecosystem composition and change, especially the disturbance events/factors.

GCTE Focus 3: Global change impacts on agricultural and forestry species

(i) Genetic variability and therefore potential for adaptation, in agricultural and forest species - in anticipation of global change,

(ii) Environmental constraints to plantation forestry,

(iii) Changes in the incidence of pests and diseases in response to changes in climate regimes,

(iv) Changes in soil fertility and structure in response to the combined effects of land-use and climate change.

Institutions with Relevant Expertise

Indonesia

BIOTROP
BOGOR Institute of Agriculture
LIPI

Philippines

IRRI
UPLB

Malaysia

Forest Research Institute
University Kebangsan
University Pertanian

Thailand

Kasetsart University
Chiang Mai University
Khon Kaen University
Asian Institute of Technology
Royal Forest Department

Singapore

National University of Singapore

Contact Persons

Prof. Kasem Chunkao, Faculty of Forestry, Kasetsart University, Bangkok, Thailand, Tel: (662) 5790172, Fax: (662) 5798781

Dr. Harsano Wiryosumarto, Chairman, National Aeronautics & Space Institute LAPAN, Jl. Permuda Persil No 4, Jakarta, Indonesia

Prof. Goh Chong Jin, Head, Botany Department, National University of Singapore, Lower Kent Ridge Road, Singapore 0511, Tel: (65) 7722711/7722714, Fax: (65) 7795671

Dr. Percy Sajise, Institute for Environmental Science and Management (ESAM), University of the Philippines at Los Banos, College, Laguna, Philippines

Dr. Brian Walker, Chairman, GCTE SSC, CSIRO, Division of Wildlife & Ecology, PO.BOX 84, Lyneham, ACT 2602, Australia, Tel: (61-62) 421600, Fax: (61-62) 41 33 43

Director, International Division, Ministry of Science, Technology & Environment, 14th Floor, Wisma Sime Darby, Jhr Raja Laut, 50662 Kuala Lumpur, Malaysia

The national committees of IGBP as well as international organizations, e.g., UNESCO, could help to identify relevant institutions and individual scientists for these research programmes.

Recommendations

- For each programme, a meeting to review the current ongoing research and to develop specific plans collaborative projects should be convened as soon as possible.
- A directory of experts should be prepared within the region and also including scientists outside the region with special expertise on Southeast Asian terrestrial ecosystems.
- Workshops and training courses should be conducted for each of the specific projects.
- A data base should be compiled on these specific topics. This data base should be accessible to all researchers.
- The GCTE Core Project Office should play an advisory role to assist in the application for funds and to coordinate or facilitate the organization of workshops and training courses.
- The National IGBP Committees should help to seek funding for local scientists and researchers for their projects.
- It is highly desirable that communications between collaborating parties be maintained and the same team of scientists should meet at planning meetings.

Past Global Changes in Southeast Asia

Chairman: Aprilani Soegiarto (Indonesia)
Rapporteur: Somboon Jarupongsakul (Thailand)

Significance of the Topic to the Region

Southeast Asia is a key region for understanding past global changes related to important phenomena such as monsoons, El Niño-Southern Oscillation (ENSO), ecosystem dynamics, marine processes (e.g., currents, land-ocean interaction). A wealth of proxy information exists in the region that has not been fully exploited. In addition, a strong resource base of active researchers and a tradition of paleoenvironmental research also exists.

Topics to be Addressed Through Regional Collaboration

Monsoon/ENSO

The relevance of this topic needs no justification. A comprehensive research effort aimed at gaining a through understanding of past variations in monsoon/ENSO has to be a high priority for the region. It is essential to study monsoon/ENSO variability across both time scales (streams I and II) of PAGES. The proxy records useful in this regard include: historical records, tree-rings, lake sediments, coral deposits, pollen, ocean cores, paleosoils, and Cenozoic sedimentary rocks.

Ecosystem Dynamics

Significant variations in vegetation cover and faunal characteristics have occurred in the region in the past. Such variations across both PAGES time scales are of great interest. The proxy records useful in this regard include historical records, tree-rings, lake sediments, pollen, and paleosoils.

Volcanic Activity

Southeast Asia is an active region for volcanism. Major episodes of volcanism have produced global impacts. A chronology of such events across both PAGES time scales needs to be developed. The proxy records relevant to this task are : historical records, lake sediments, ocean cores, volcanic ash deposits and paleosoils.

Sea Level Change

The Southeast Asian coast line provides a rich record of past variations in global sea level. This record, already studied in some detail, provides information on past global changes over the stream II timescale of PAGES. Relevant proxy records include, among others: coral reefs, ocean cores, paleosoils, sedimentary rocks, and coastal terraces.

Oceanic Through Flow

The Southeast Asian region is extremely important for oceanic water mass flux. Both present day as well as past variations in currents are not at all well document. Characteristics of variations across both time scales of PAGES are of great interest. Relevant proxy records include coral deposits and ocean cores.

Orbital Forcing and Response

Paleoclimate modelling has illustrated the impact of variations in the Earth's orbit and related solar radiation input changes on the intensity and extent of monsoons over the last glacial to interglacial period. It is important to extend such analyses through both extraction of paleo-records of monsoon/ENSO variability from proxy records as well as modelling for this region. The PAGES time scale of relevance here is stream II. Proxy records relevant in this regard include lake sediments, loess, ocean cores, paleosoils and sedimentary rock.

Multi-proxy Mapping and Paleomodelling

These are two cross-cutting activities of PAGES. Clearly the Southeast Asian paleorecord needs to be incorporated into the global multi-proxy mapping effort to be undertaken through PAGES. In addition, paleomodelling activity needs to be fostered within the SE Asian region.

Institutions with Relevant Expertise

Indonesia

Geological Research and Development Centre, Jalan Diponegoro 57, Bangdung: Mr. Saba Koaesoaemadinata

Department of Soil Science, Bogor Agriculture Institute: Dr.Sabiham Supiandi

University of Gadjah Mada

Malaysia

Geological Survey of Malaysia, Ipoh, Perak: Mr. Hassan Kamaludin

Department of Geology, University of Kebangsaan Malaysia: Prof. H. D. Tjia

Philippines

Geological Survey Division, Bureau of Mines and Geo- Science, North Ave. Dilliman, Quezon City: Mr. Dicarte S. Javelosa

Singapore

Department of Geography, National University of Singapore: Dr. Avijit Gupta

Thailand

Department of Geology, Faculty of Science, Chulalongkorn University: Bangkok 10300: Dr. Narong Thiramongkol

Geological Survey Division, Department of Mineral Resources: Bangkok 10400: Mr. Sin Sinsakul

Geological Servey Division, Department of Mineral Resources: Bangkok 10400: Mr. Sompop Wongsomsak

Soil Survey Division Land Development Department: Bangkok 10900: Dr. Paiboon Pramojanee

Office of Atomic Energy for Peace, Bangkok, Mr. Manit Sonsak

Suggestions for Strengthening Regional Collaboration

IGBP National Committees should prepare an inventory of institution and scientists working on paleo-environmental questions of relevance to PAGES.

A Southeast Asian Workshop on paleoenvironmental change should be held, during 1992, if possible in collaboration with other international organizations such as INQUA, CCOP, etc.

The human resource base of researchers needs to be enhanced through development of specific mechanisms for training young researchers and students (e.g., fellowships).

Exchanges of researchers between participating institution need to be fostered. One possible early action in this regard is development of a short-term focused training course for graduate level young scientists. The first such event could perhaps be held in concert with the workshop proposed above.

The technological capabilities within the region need significant enhancement. It may be possible to develop within the framework of a Southeast Asian Regional Research Network, technical capabilities and facilities such as dedicated ^{14}C laboratories, isotope analysis laboratories, etc. at specific nodes (RRS).

Cooperation at project or at activity level should be enhanced with scientist from Vietnam, Cambodia, Myanmar, etc. Develop strengthened cooperation with PAGES activities also in Australia, China, Japan, New Zealand, the Academy of Sciences in Taipei, etc.

Recommendations

ASEAN endorsement for the START effort within Southeast Asia is a necessary ingredient.

Encourage establishment of IGBP National Committees in each country in the region and neighbouring regions, and foster active participation of scientists from the region in the IGBP Core Projects.

Promotion of access to the Economic Exclusive Zone for bona fide regional collaborative research effort is very essential.

Promotion of access to and easy exchange of scientific data and related information is an important ingredient for a successful START activity within the region.

Note: This report has been drafted by a group that included only one bona fide paleo environmental researcher, hence, it needs substantial review and polishing through input from the paleo-research community within the Southeast Asian region.

Land Use - Land Cover Change

Rapporteur: Richard H. Moss (Sweden)

Important land conversion and transformation processes were identified. Conversion refers to changing one cover type to another: forest to pasture. Transformation refers to changes within a given type of cover: e.g., mixed forest to single species forest. These following conversions and transformations were felt to be of importance to global change processes as well as to the social and economic system of the region.

Conversions

- primary forest to agriculture land, which is important because of its impact on greenhouse gas emissions, biogeochemical cycles, hydrology, ecosystem structure.
- reversion of agricultural lands and other abandoned land to secondary forest, which would increase the uptake of CO_2.
- agricultural land to urban settlement, recreation, and industrial uses, which changes costal zone ecosystem structure, sedimentation processes, erosion, and the transport of nutrients.
- reversion of land in costal zones to or from mangrove forest

Transformations

- conversion of multispecies forest to rubber plantation, with consequence of increased runoff, soil erosion with shift from multi-cropping to mono-cropping

Important Socio-Economic Drivers in the Region

A number of important regional socio-economic drivers of conversion and transformation processes were identified as needing further investigation. These included:

- population growth
- economic factors (commodity prices, investment opportunities, etc., within nations, within regions, and internationally)
- effectiveness of district and local planning councils
- prestige of production and consumption of certain types of agricultural commodities (preference of many rural populations for rice rather than sago, even though the latter is nutritious and can be produced with less

Multi-country case studies focusing on conversions and transformations in the high lands, coastal zones, and in rural areas adjacent to cities were felt to be particularly important.

A Social Science Agenda

Chairman: Filomena F. Campos (Philippines)
Rapporteur: Tan Poo Chang (Malaysia)

Importance and Justification

Environmental degradation in any country or region may affect the global environment. Close collaboration between all nations is necessary to assess and tackle the causes at local, regional and global levels.

There is an urgent need to bring into balance human population numbers and growing needs and available resources, and to limit the pace of environment destruction. The central role of population growth and economic development in environment degradation need to be given greater attention. For example, population growth is both directly and indirectly related to the increase in carbon dioxide emissions, deforestation for fuel, over-grazing and subsistence cultivation, overcropping of agricultural land, land fragmentation, rapid depletion of fresh water resources and pollution of surface water with industrial wastes, and degradation and loss of coastal ecosystems.

Southeast Asia is densely populated. Little detailed information is available on the inter-linkages between population growth, uneven population distribution, urbanization, and environmental decline. Integrating population and environment concerns into development strategies will help achieve ecological and developmental sustainability in the region.

Social scientists are essential to the successful implementation of the results of natural science investigations. Their understanding of socio-economic, cultural and political aspects of the human component of environment provides opportunities for remedial and preventive counter measures in terms of policy responses to global change imperatives. The need to establish understanding of the behavioral response to environmental issues, and the effectiveness of environmental policies are calls for the participation of social scientists.

It is, therefore, vital that national and international interdisciplinary links between social and natural scientists be established and/or strengthened to provide comprehensive solutions to global environmental change issues.

Topics to be Addressed Through Regional Collaboration

Human Dimensions of Natural Resource Management

(i) Land-use change (see report from this Working Group)

(ii) Coastal resource management

- conflict in the use of coastal areas and changes in these ecosystems
- rising sea-level and its effect on the terrestrial ecosystem
- pollutant emissions from industries and human settlements

- economic and resource accounting of coastal zones (e.g., sewage disposal, industrial effluent, fisheries, etc.)

(iii) Inland Resource Management

- interaction of agricultural system and the environment
- human settlement patterns
- social and economic impact assessment of resource utilization

Urbanization and Industrialization Related to Environmental Problems

- rural-urban migration and human settlement problems
- urban concentration and the "heat island effects"
- industrial pollution

As an example, a project involving research within HDGEC could focus on "Human Response to Projected Sea Level Change in Southeast Asia". Existing physical models of sealevel rise are generally not well developed, but they indicate that some Asian coasts may experience negative impacts within a time frame of about 50 years or so. Sea-level change may result in serious problems, but present concern for the future also offers some opportunities. The initiatives required to ameliorate the possible negative impact of sea-level rise must be consistent with desired actions under other environmental programmes (the conservation of coral reefs, for example). Unfortunately little research on the human aspects of sea-level rise in Southeast Asia has been undertaken. Future research might focus on identifying effective management mechanisms to influence land-use regulate activities in the coastal zones of the region including, (i) the development and implementation of national coastal (land-use) policy ; (ii) research of cultural, economic other barriers to formulating a positive response to sea-level rise; (iii) the application of the results of scientific research in the development of policy options. For all this research, it is necessary to develop databases for the coastal zones including both natural and social sciences data.

Institutions with Relevant Expertise

International/regional organizations in social science have national committees, which can be tapped as contact points to provide information on names of national/regional research institutions undertaking social science research and also names of researchers.

At the national level, lists of institutions should be divided into three categories: (i) coordinating institutions; (ii) research institutions; and (iii) interdisciplinary organizations.

Delegates from participating countries have undertaken to provide such information.

Suggestions for Strengthening Regional Collaboration

Regional collaboration can be strengthened through the following mechanisms :

1. Develop closer interactions between natural and social scientists to establish a

clear understanding of the integral role social science should play in many areas of environmental research related to global change. Such interactions could be established through workshops to share experiences, exchange information, develop project proposals and to create a sustainable Regional Research Network within START.

2. Formation of a working group with appropriate representatives in the field of social sciences from all countries to identify important areas of research, which are of interest and of importance in the context of global change. Natural scientists will be invited as resource persons to such working group meetings, and involved in research where appropriate.

3. Tapping into ongoing international organizations with networks in the region, such as UNEP, UNDP, AASSREC, and UNESCO, as well as complementary projects presently being carried out.

4. Use START to endorse a proposal to COST, ASOEN or UNESCO, among other international and/or regional organizations, to support a workshop or workshops focusing on specific areas of interest.

5. Establishing and developing a data base on socio-economic and physical science data.

Recommendations

It is necessary to promote the interaction between social and natural scientists in the implementation of global change research. The results of the research should be applied in the development of remedial and preventive policy.

Social scientists should be appointed as members of the National IGBP Committees of each country.

The Working Group strongly endorses the inclusion of social scientists in the setting up of START.

Training should be provided to increase the participation and contribution of social scientists in global change issues

The Working Group supports the promotion of community participation and public awareness in formulating responses to global change issues.

Global Change Education and Training

Chairperson: Virginia S. Carino (Philippines)
Rapporteur: Florence Delimon, UNESCO

Why is the Topic of Particular Interest to Southeast Asia?

Presentations by country representatives emphasized, in general, a lack of expertise and knowledge about global change, and education and training in this area is a much felt need. Other conferences have expressed the same concern. The other Working Groups have identified a number of priority research areas, but also identified a lack of trained scientists to carry out these investigations.

Presently, no tradition exists in universities for global change education. This is a unique area of study, which entails a mix of all kinds of specialists that have to work together. Hence, the need for training and education must be developed with an interdisciplinary perspective.

In the Southeast Asian region, the technical and scientific language used by international experts is not easily translated to the level of local scientists. In addition, sophisticated equipment requires training at the local level by local experts.

Training Needs Identified in the Region

Training as well as technology must be appropriate to the needs of the region. Alternative technologies for the region should be developed and interfaced with other state-of-the-art technologies.

A need exists for compilation of information on global change research already ongoing in the region. This can serve as a basis for identifying the need for young scientists for on-the-job training of one to two months. It is also necessary to identify the best scientists in the region who can be intensively trained by top-notch international scientists and who could translate the scientific and technological knowledge acquired into simpler information for the local and national scientists and technicians.

Identification of Research Institutes

The Working Group felt strongly that the National IGBP Committees should identify specific research institutions and scientists that can play key roles in global change education and training. With reference to data systems, ESCAP has a directory of experts and institutes that could be used.

Strengthening of Regional Collaboration

Fellowship and exchange agreements should be developed among countries. If facilities and training infrastructure do not exist, on-the-job training and utilization of facilities available in more advanced laboratories should be offered. Training for technicians

should also be considered.

Regular meetings of social and natural scientists for exchange of information on global change issues is recommended. Publications related to global change could be presented in an informative and evaluative way.

Recommendations

- National IGBP Committees should identify on-going education and training activities of relevance to global change research;
- National IGBP Committees should identify necessary areas for training in global change research and scientists that would benefit from such training;
- IGBP and its National Committees should help identify financial resources in the country and in the regional for education and training in global change. Use existing educational networks, such as Unesco and SEAMEO;
- Scientists involved in global change in the region should encourage the inclusion of Earth system science in the curricula of universities at the undergraduate level;
- IGBP and its National Committees should promote public awareness of global change issues;
- Support the strengthening of national GIS capacities in the region;
- Encourage exchange of data in free and open channels.

Proposal for the Establishment of a START Regional Research Centre in Indonesia

A Proposal Submitted by the Indonesian National Committee

Introduction

The IGBP is an international scientific programme, established by ICSU in 1986, to advance the understanding of the interactive physical, chemical and biological processes that regulate the total Earth system. The United Nations (UN) recognized the importance of IGBP through its General Assembly Resolution 44\207 and recommends that international communities should increase their activities in support to the World Climate Programme and the IGBP. The UN further recommended the international communities to support the efforts to increase the participation of developing countries in these scientific activities. The UN support reflects the interaction between the IGBP and UN bodies through the IGBP Interagency Coordinating Committee with the participation of the United Nations Environment Programme (UNEP); The United Nations Educational, Scientific and Cultural Organisations (UNESCO), and the World Meteorological Organisation (WMO).

To ensure success of global collaboration among national activities related to IGBP, the IGBP is establishing a "Global Change System for Analysis, Research and Training" (START), in which networks in various regions, including a Regional Research Centre (RRC), are established. According to the planning process, three regions should get initial priority: Equatorial South America (ESA), Northern Africa (NAF) and the Tropical Asian Monsoon Region (TAM) (IGBP Report 15).

It is in this connection that the Indonesian delegation with full support of the Indonesian Government proposes that Indonesia hosts the Regional Research Centre for the Southeast Asian component of the Tropical Asian Monsoon region. To support this proposal, brief information about Indonesia related to the IGBP goals is given in the national report of Indonesia to this meeting (see p.).

If a Regional Research Centre (RRC) for IGBP is established in Indonesia, it should be jointly supervised and coordinated by the START Standing Committee and a Regional START Committee with representation from the national IGBP committees of the region. The Indonesian Committee for the IGBP is supervised and fully supported by the Minister of State for Population and Environmental Research (KLH). Other Indonesian ministries which are concerned with an establishment of an RRC in Indonesia are the Ministry of Agriculture, Ministry of Forestry and Ministry of Transport.

The Indonesian research agencies and research institutes, which are ready to support the RRC and having activities closely related to the activities of IGBP are listed in the national report.

Existing research facilities that can be utilised by the Regional Centre are:

- Network of meteorological and geophysical monitoring stations of BMG
- Network of tide gauges stations and current meters of the Naval Hydro-Oceanography Office and the ASEAN-Australia Regional Ocean Dynamic Project.
- Three ocean going research vessels and at least five coastal research vessels and fisheries research vessels.
- Satellite ground stations for Landsat, GMS and NOAA satellite of LAPAN
- Airborne sensors and their support systems of LAPAN and BMG
- Stratospheric Balloon Launching Station in Watukosek, East Java
- Series of Ionospheric Observation Station (Medan, Pameungpeuk, Pontianak, Menado, Kupang, Biak)
- Solar observation station in Tanjungsari, West Java
- Marine Pollution Monitoring Centre and its network, which belongs to the Oceanology Centre (LIPI)
- Sea level monitoring network, which belongs to Hydrooceanographic Office
- Remote sensing, mapping, Geographic Information System (GIS), Global Positioning System (GPS), and a tide gauge observations system for mean sea level determination of BAKOSURTANAL
- Remote sensing data processing, which belongs to BPPT.
- Various other research laboratories and facilities of the Department of Forestry and Department of Agriculture.

Under construction and planning:

- A multi-mission satellite ground station of LAPAN is being constructed in Parepare, South Sulawesi, and is expected to be operational by the beginning of 1993. This ground station will have the access to receive data from Landsat (ETM), EERS-1 (SAR data), SPOT and NOAA (meteorological data). This data acquisition station will be supported by a data processing system in Jakarta.
- A wind profiling radar is also being constructed in Biak, on the Equator, near West Irian. It is expected to operate in the last quarter of 1992. This radar will be operated by LAPAN in cooperation with NOAA.

- Giant atmospheric equatorial radar, which can penetrate the upper atmosphere up to 1000 km, which will be completed with meteorological radars, lidars and other facilities necessary for meteorological observation, is being planned on the Equator in Bukit Tinggi, West Sumatra for ICEAR. This facility is planned to be operational in 1995.

Other Supporting Facilities:

- The Palapa Satellite Communication System;
- Training Facilities in the Centre for Research, Science and Technology (PUSPITEK), BAKOSURTANAL and universities, i.e., University of Gadjah Mada (UGM), Bandung Institute of Technology (ITB), Bogor Agriculture Institute (IPB) and others.
- LAPAN Remote Sensing Data Bank in Jakarta, which serve remote sensing data either in hard copy, CCT mode or PC base.

Other International Centre Planned to be Established in Indonesia

The Equatorial region, in which Indonesia lies, which is also referred to as the "Maritime continent", is the most suitable location for studying Equatorial atmospheric dynamics. Intense convection occurs constantly in this area over the world's warmest ocean, a process which releases tremendous thermal energy that drives the atmosphere into global motion. In addition, the Equator also presents a number of topics of considerable scientific interest related to the upper atmosphere, the portion of the atmosphere which constitutes the Earth's outmost environment. For this equatorial atmosphere study, Indonesia and Japan, through the cooperation between the Agency for the Assessment and Application of Technology (BPPT) and the National Aeronautic and Space Agency (LAPAN) both of Indonesia and the Radio Atmospheric Study Centre (RASC) of Kyoto University in Japan are working toward the establishment of an International Centre for Equatorial Atmospheric Research (ICEAR) to explore the dynamics of the atmosphere, especially the upper atmosphere. ICEAR is fully supported by the Scientific Committee on Solar Terrestrial Physics (SCOSTEP) of the International Council of Scientific Unions (ICSU).

Final Remarks

With its challenging natural physical setting and massive support of the Government, including the abundant research facilities available and the ready to support of research agencies and institutes, Indonesia is ideal for a multidisciplinean Regional Research Centre for Southeast Asia within the Tropical Asian Monsoon region.

Proposal for the Establishment of a START Regional Research Centre in Thailand

A Proposal Submitted by the Thai National Committee

Introduction

Thailand has actively participated in the IGBP in most priority areas defined by the initial Core Project. This is reflected in the establishment of a IGBP National Committee consisting of members from various academic institutes and government agencies, whose expertise covers the subject areas of the IGBP Core Projects. The National Research Council of Thailand (NECT) has been the coordinating body for most activities both at the national and international levels. Such activities include participation and organization of meetings and workshops as well as initiation of research and education in areas related to IGBP.

With the growing needs for international and regional collaboration concerning the global change issue there is a need for a network to be established in the Southeast Asian region so that global change scientific expertise can be developed and strengthened. More importantly, the network can serve as an effective mechanism for information exchange between countries within the region as well as with the international programmes and the global focus. Within the existing facilities and capability, Thailand is in the position to support and host a coordinating office for such a network.

Involvement of Thailand in International Activities

Thailand has participated in several international programmes and activities including the following: (i) UNEP/GRID programme; (ii) UN/ESCAP Regional Remote Sensing Programme; (iii) UNESCO Regional Research Project on Mangrove Ecosystem; (iv) FAO Regional Forest Programme; (v) AIT/INDRM Programme; and (vi) UNESCO/SEAMEO Programme, etc.

Existing Facilities and Capability Relevant to IGBP

Thailand Remote Sensing Centre (TRSC)

Thailand is well equipped with satellite receiving and processing facilities. Currently, data from satellites such as LANDSAT, SPOT, MOS and NOAA can be received for Southeast Asian Region. These data have been distributed to users both within and outside the country. Future plans include co-operation with Japan to receive JERS-1 data

and with ESA under EC/ASEAN dialogue to receive ERS-1 radar data. Satellite data have been used for many applications, some of which are already on operational basis. These include forest monitoring, land use mapping and change detection, water resource mapping, and coastal studies.

Thailand SEAWATCH Programme

This programme is being executed by the NRCT under a co-operative agreement between Thailand and Norway. Under this programme a number of oceanographic buoys will be deployed in Thai waters to collect meteorological and oceanographic data on a continuous basis. The parameters to be measured include wind speed and direction, air temperature and pressure, temperature and salinity profile, current speed and direction, oxygen content, nutrient, light attenuation and radioactivity. The collected data are transmitted to land via satellite communication system. The analysis and modelling of the data are undertaken at the centre which is located at NRCT.

Other Related Programmes

In addition, there are several national programmes related such as water supply, rice, land development, industrial estates and public health, etc. As regards data collection survey, there are networks throughout the country, for example in meteorology, forestry and hydrology.

Proposed Structure of the Southeast Asian Regional Research Coordinating Office

Thailand fully supports the concept of establishing a START Regional Research Network (RRN) within Southeast Asia under the auspices of IGBP. In this connection, Thailand offers to host the Coordinating Office to be located at the National Research Council in Bangkok. The RRN would comprise member countries, which express their interest and registered as a member of the Network. A Steering Committee of the Network should be appointed to supervise the activities.

Conclusion

Thailand strongly supports the IGBP concept of establishing a Regional Research Network of START within the Southeast Asian region. A Steering Committee for this network should be appointed to consist of members of the Network. A Coordinating Office should be established and the NRCT office in Bangkok is of a candidate. Coordinating Director can be rotated amongst member countries in similar to the rotating Chairmanship of the ASEAN COST or as deemed appropriate.

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Acronyms and Abbreviations

AASSREC	Association of Asian Social Science Research Councils
AIT/INDRM	Asian Institute of Technology/
ASEAMS	Association of Southeast Asian Marine Scientists
ASEAN	Association of Southeast Asian Nations
ARSMC	ASEAN Regional Specialized Meteorological Centre
ASOEN	ASEAN Senior Officials on the Environment
BAHC	Biospheric Aspects of the Hydrological Cycle (IGBP)
BAKOSURTANAL	National Coordinator for Survey and Mapping Agency, Indonesia
BMG	Meteorology and Geophysics Agency
BPPT	Agency for the Assessment and Application of Technology, Indonesia
CCCO	Committee on Climate Changes and the Ocean (SCOR-IOC)
CCOP	Committee for the Coordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas, Indonesia
CFC	Chlorofluorocarbon
COARE	Coupled Ocean-Atmosphere Response Experiment (TOGA/WCRP)
COST	Committee on Science and Technology (ASEAN)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DGCM	Dynamic Global Vegetation Model
ENSO	El Niño - Southern Oscillation
ESA	Equatorial South America (START)
ESAM	Institute for Environmental Science and Management
ESCAP	United Nations Econimic Soil Commission Asia Pacific
FACE	Free-Air CO_2 Enrichment (GCTE)
FAO/IPEC	Food and Agricultural Organization/
GAIM	Global Analysis, Interpretation and Modelling (IGBP)
GAW	Global Atmosphere Watch (WMO)
GCM	General Circulation Model
GCOS	Global Climate Observing System (WMO/IOC/UNEP/ICSU)
GCTE	Global Change and Terrestrial Ecosystems (IGBP)
GEF	Global Environmental Facility (World Bank/UNDP/UNEP)
GEMS	Global Environmental Monitoring System (UNEP)
GEWEX	Global Energy and Water Cycle Experiment (WCRP)
GIS	Geographic Information System
GOES	Global Omnibus Environmental Survey (HDGEC)
GOEZS	Global Ocean Euphotic Zone Study (IGBP)
GPS	Global Positioning System
GRID	Global Resource Information Database
HDGEC	Human Dimensions of Global Environmental Change Programme (ISSC)
ICEAR	International Centre for Equatorial Atmospheric Research, Indonesia
ICSU	International Council of Scientific Unions
IDRI	Thailand Development Research Institute
IGAC	International Global Atmospheric Chemistry Project (IGBP)

IGBP	International Geosphere-Biosphere Programme: A Study of Global Change
IGBP-DIS	IGBP Data and Information System
IHP	International Hydrological Programme (UNESCO)
IIOE	International Indian Ocean Expedition
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IPB	Bogor Agriculture Institute, Indonesia
IPCC	Intergovernmental Panel on Climate Change (WMO/UNEP)
IRRI	International Rice Research Institute
ISSC	International Social Science Council
ITB	Bandung Institute of Technology, Indonesia
JGOFS	Joint Global Ocean Flux Study (IGBP)
KLH	Minister of State for Population and Research Environment, Indonesia
LAPAN	National Institute of Aeronautics and Space, Indonesia
LIPI	The Indonesian Institute of Sciences
LOICZ	Land-Ocean Interactions in the Coastal Zone (IGBP)
MAB	Man and the Biosphere Programme (UNESCO)
MNRT	Minister of State for Research and Technology
MOS	Marine Observation Sattelite
NAF	Northern Africa (START)
NATT	Northern Australian Tropical Transect
NECT	National Research Council of Thailand
NOAA	National Oceanic and Atmospheric Administration, USA
NRC	National Research Council, USA
NRCT	National Research Council of Thailand
PAGES	Past Global Changes (IGBP)
PUSPITEK	Training Facilities in the Centre for Research, Science and Technology
RASC	Radio Atmospheric Study Centre
RFD	Royal Forestry Department
RRC	Regional Research Centre (START)
RRN	Regional Research Network (START)
RRS	Regional Research Sites
SAR	Synthetic Apparture Radar
SCOR	Scientific Committee on Ocean Research (ICSU)
SEAMEO	Southeast Asian Ministers Education Organisation
SPOT	Système pour l'Observation de la Terre
START	Global Change System for Analysis, Research and Training (IGBP)
SWCC	Second World Climate Conference
TAM	Tropical Asian Monsoon Region (START)
TOGA	Tropical Ocean and Global Atmosphere (WCRP)
TRSC	Thailand Remote Sensing Centre
UGM	University of Gadjah Mada, Indonesia
UN GA	UN General Assembly
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
US-EPA	Environmental Protection Agency of the USA
WCRP	World Climate Research Programme (WMO/ICSU)
WESTPAC	IOC - Programme Group on the Western Pacific
WMO	World Meteorological Organisation
WOCE	World Ocean Circulation Experiment (WCRP)

IGBP Reports

No. 1.	The International Geosphere-Biosphere Programme: A Study of Global Change. Final Report of the *Ad Hoc* Planning Group. (1986) (out of print)
No. 2.	A Document Prepared by the First Meeting of the Special Committee. (1987) (out of print)
No. 3.	A Report from the Second Meeting of the Special Committee. (1988) (out of print)
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