World Water Council
3rd World Water Forum

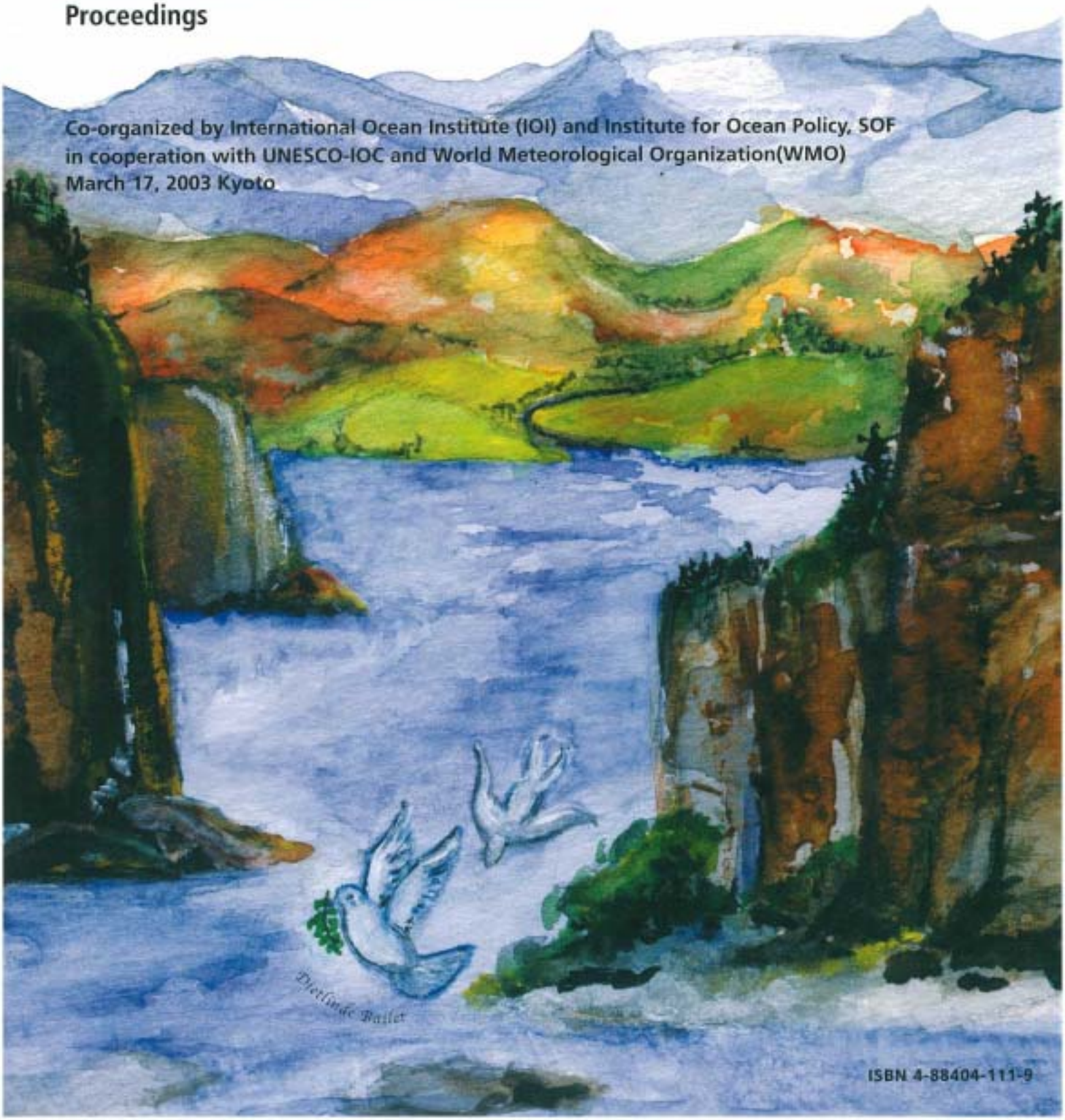
水はめぐる、森川海空

Dialogue between the Ocean and the Freshwater Communities: Forests, Rivers, Oceans and the Skies

Integrated Water Management from Hilltop to the Ocean

Proceedings

Co-organized by International Ocean Institute (IOI) and Institute for Ocean Policy, SOF
in cooperation with UNESCO-IOC and World Meteorological Organization(WMO)
March 17, 2003 Kyoto



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報 告 書

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These Proceedings were edited by
IOI-Japan and Institute for Ocean Policy, SOF in cooperation.

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FOREWORD

"It is the nature of the oceans that pushes science and technology into the foreground. Without marine science and technology we would be blatantly unable to explore, exploit, manage, a conserve marine resources or to navigate safely or to protect our coasts. And it is the nature of the marine environment that forces us to recognize that this science must be interdisciplinary, integrating physical, chemical, biological, and social sciences, and that it must be international, to cover the global dimension of the ocean and its interaction with the land and the atmosphere."

The Oceanic Circle
Elisabeth Mann Borgese

Forests, Rivers, Oceans, and the Skies - Water goes round and round on our planet, in a cycle regulated largely by the oceans. We have organized a session to promote a meaningful exchange of opinions among those involved in water affairs at the 3rd World Water Forum, in the hope of facilitating the integrated management of both our fresh and ocean water resources. Through in-depth discussions, we hope to create an effective model for an integrated management approach to the water cycle.

The session "Dialogue between the Ocean and the Freshwater Communities" was held in Kyoto on March 17, 2003, as part of The 3rd World Water Forum held in Kyoto, Shiga, and Osaka in Japan from March 16 - 23, 2003, attended by more than 24,000 participants from over 150 countries to share wisdom for better water management. The 1st and 2nd Fora were held in Morocco and the Netherlands respectively, and the 4th will be held in Mexico in March, 2006.

International Ocean Institute
Institute for Ocean Policy, SOF

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EXECUTIVE SUMMARY

By Gunnar Kullenberg and Hiroshi Terashima

1. The initiation

The International Ocean Institute Operational Centre in Japan, IOI-Japan, in agreement with IOI Headquarters, first proposed this session in order to draw attention to the role of the ocean in the hydrological cycle and freshwater availability and its management. The IOI-Japan then worked closely with the secretariat of the Third World Water Forum to make the meeting an official WWF3 session. The Institute for Ocean Policy, SOF, acted as Co-Organizer for the session, in line with the policy of the Global Forum on Oceans, Coasts, and Islands, which was formed at the WSSD in Johannesburg. The session also benefited from the cooperation of the World Meteorological Organization and the Intergovernmental Oceanographic Commission of UNESCO.

The co-sponsors IOI and SOF also agreed that the session would include some examples of the local Japanese community, efforts to address the linkages between land-uses and coastal ocean-uses. Several leading Japanese experts were also invited to be present at the session, as speakers or commentators.

The Session was widely advertised. The session profile and programme were circulated to conveners of other sessions, with several personal letters expressing interest in cooperation and inviting representatives from their sessions to attend the dialogue session. Information about the session was also provided to the Global Forum on Oceans, Coasts and Small Islands.

2. The Session

The Session was part of the major theme "Water, Nature and the Environment" organized in Kyoto, 17-18 March, with in all 19 different sessions.

The Session was opened by the co-chairs, Mr. Hiroshi Terashima of SOF and Dr. G. Kullenberg of IOI, who explained the background and aim of the Session and introduced the speakers.

Dr. K. Davidson of WMO highlighted the role of the ENSO phenomenon in relation to climate variability, flooding and drought, freshwater availability and the possibilities of forecasting. He showed the regional and inter-regional influences and impacts of El-Nino, in particular with reference to flooding and drought.

Professor T. Yamagata highlighted the role of the ocean-atmosphere-land interactions, focusing on the Indian Ocean – Western Pacific. He illustrated the importance of feedbacks and interactions between regional phenomena: El-Nino, monsoon, ocean circulation and freshwater input.

Professor M. Collins showed how freshwater management actions and land-uses, such as river dams, diversions, irrigations, agricultural practices, and deforestations influenced the inflow of freshwater and terrestrial material to the ocean, focusing on the Mediterranean Sea. He demonstrated some basin-wide consequences with respect to coastal erosion, water circulation and changes in salinity distributions.

This was further demonstrated by Professor Y. Shirayama, who focused on the importance of the input from land carried by rivers to the coastal zone, of major and minor nutrients and other suspended and dissolved materials. He showed how these materials influence the biological productivity, diversity and ecosystem balance in the shelf seas. He showed through examples the consequences of changes in the input due to freshwater management and other actions on land.

Mr. S. Hatakeyama brought in practical experiences of these interactions by highlighting production variations in coastal areas focusing on Japanese oyster cultivation. He demonstrated from vast practical experiences the importance of maintaining a balance in the natural ecosystem on land. He particularly stressed the role of forests. The devastating impacts of deforestation were again pointed out. The great importance of maintaining and also managing the forests, from the mountains to the coast, was shown, so as to have a healthy coastal zone.

Dr. S. R. Shetye explained how the Indian Ocean South West monsoon phenomenon occurs. He stressed the positive and negative impacts on the land and the coastal areas, focusing on the Bay of Bengal. He highlighted the role of freshwater input to the Bay of Bengal for the generation of air-sea interactions and atmospheric conditions there with resulting cyclone activities. The very large importance of the monsoon for freshwater conditions on the Indian Sub-Continent was shown. He elucidated the problems of forecasting the monsoon, in that

many non-linear, but yet not yet fully understood processes are involved. Successful forecasting so far has been based on statistical modeling. Dr. Shetye stressed the importance of education and public awareness with respect to both uses of freshwater and preparedness for shortages, as well as other natural hazards, e.g. flooding, storm surges, cyclones.

Dr. Kullenberg, finally, first highlighted some aspects of the paper by Dr. V. Ryabinin (of WMO) on the role of the freshwater balance of the Arctic Basin with respect to ocean circulation and climate variations. Then he went on to present the ocean model for comprehensive management and governance, referring to the Common Heritage of Mankind principles of Ambassador Arvid Pardo and further elucidated by Professor Mann Borgese. He reflected that these principles could be applied to freshwater resources together with the model of comprehensive management as laid down in UNCLOS and UNCED 92 agreements, which would also be in harmony with the WSSD partnership approach. In this context he also brought out the importance of education, public awareness enhancement and participation. He referred to the work of the IOI and introduced the concept of the IOI Virtual University as a comprehensive educational mechanism.

The presentations were followed by brief comments from an invited panel. These comments all re-emphasized the importance of enhancing dialogue, the need for a comprehensive approach, governance and policy, public awareness, participation and education. It was agreed that freshwater and ocean water should be regarded as a common heritage of humankind. The need for much more interaction between user sectors, possibly based on the community co-management approach, as well as the use of Integrated Coastal Area Management was emphasized. It was suggested that ICAM could perhaps be expanded to include EEZ regions, although caution was expressed that this may be too large for the on-going programmes. It was also noted that the freshwater community had come a long way in organizing itself through the Water Council and the Water Forum, addressing the central, global issue of freshwater. The ocean community can benefit from learning this through a dialogue with the freshwater community.

The importance of research was brought up, stressing the need for an integrated approach also in this context. However, the practical experiences brought out by Mr. Hatakeyama were considered very important, and research activities should try to establish linkages with practical experiences and applications. Such practical experiences should be used in education, awareness creating, and dialogue efforts, showing the social and economic importance of linkages between ocean, coasts and land uses, with related practices and traditional knowledge. The need for a comprehensive water law, both internationally and

nationally was brought out. This would support comprehensive governance, and could be linked to both community-based local action and a global cooperative approach.

The need for management of forests was stressed, also noting that economic factors can play a negative role in this context, exemplified by some cases in Japan. This again highlights the need for social responsibility and effective governance and government mechanisms at all levels.

Subsequently an open discussion followed. Several points were raised from the floor. The interest and need for dialogue was certainly confirmed. It was noted that the European Union had recently published the Water Framework Directives. These constitute an example of an attempt towards a comprehensive legal approach. The Global International Water Assessment (GIWA) was also referred to as an effort to integrate. The audience stressed and concurred with the importance of education and use of practical experiences, bringing out the importance of an enhanced dialogue.

Dr. Kullenberg then summarized the main conclusions which could be drawn from the presentations and discussions during the session, and thanked all the speakers, commentators, participants, co-sponsors, the Forum Secretariat, local organizers and interpreters.

3. The follow-up

The World Water Forum is a recurring event, and the Secretariat had emphasized that the sessions should endeavor to identify an action plan which might be implemented as a follow-up in order to maintain the various efforts which had been initiated. The Secretariat had also stressed that one should seek to obtain commitments towards implementation, and aim at reporting progress to the next World Water Forum.

Accordingly, during the consultations and preparations for the Session we had considered possible follow-up actions. These had also been indicated in the pre-session report requested by the Forum Secretariat in January-February 2003. During the Session itself the elements of a follow-up were highlighted. The presentations, comments and discussions were all supportive of a follow-up action plan. The Chair summarized the possible follow-up actions in the form of an inter-sessional action plan as given in the conclusions.

Session Chair
Gunnar Kullenberg
Hiroshi Terashima

要旨 （和訳）

グンナ･クーレンバーグ、寺島紘士

1. 準備段階

水循環および淡水の確保と管理に関する海洋の役割の重要性に注目し、国際海洋研究所(IOI - 本部マルタ共和国)の日本におけるオペレーショナル･センターである IOI ジャパンは、IOI 本部の同意を得て当分科会の開催を企画した。第３回水フォーラム事務局は IOI ジャパンとの打合せを通じて、当セッションを第３回世界水フォーラム(WWF3)の公式な分科会とした。シップ・アンド・オーシャン財団(SOF)海洋政策研究所は、ヨハネスブルグでの「持続可能な開発に関する世界首脳会議(WSSD)」を契機に設立されたグローバルフォーラム「海洋、沿岸、島嶼に関する世界会議」の趣旨に基づき当分科会を共同開催することとした。当分科会は、また、ユネスコ政府間海洋学委員会(IOC)ならびに世界気象機関(WMO)の協力も得た。

共催者となった IOI と SOF 海洋政策研究所は、陸地利用と沿岸海域利用の連続性を示す日本国内の事例を分科会に取り入れるとともに、国内外の優秀な専門家をスピーカーあるいはコメンテーターとして招聘することとした。

当分科会は広く告知された。他の分科会の主催者たちに対し、分科会概要とプログラムを配布して協力を要請、他の分科会の代表者たちには手紙を送り、討議への参加を呼びかけた。当分科会開催の情報は、WSSD グローバルフォーラム「海洋、沿岸、島嶼に関する世界会議」のメンバーにも伝えられた。

2. 分科会

当分科会は、WWF3 のテーマのひとつである「水と自然･環境」(3 月 17～18 日京都で開催)に参加した 19 の分科会の１つとして開かれた。

初めに、共同議長である寺島紘士 SOF 海洋政策研究所所長とグンナ・クーレンバーグ IOI 前事務局長によって開会の辞が述べられた。両氏は当分科会の背景と目的について述べた後、スピーカーを紹介した。

ケネス･デビッドソン博士は、 エルニーニョ南方振動(ENSO)現象の役割を気候変動、洪水、旱魃、淡水の確保、予測の可能性などに関連づけて論じた。特に洪水と旱魃を例に、エルニーニョの国際地域内および国際地域間の影響を提示した。

山形俊男教授は、特にインド洋－西太平洋に焦点をあてて海洋、大気、陸地間の相互作用の役割について論じた。エルニーニョ、モンスーン、海洋の循環、淡水の流入など地域に見られる様々な現象間のフィードバックおよび相互作用の重要性を示した。

マイケル・コリンズ教授は、地中海を例にとり、河川における堰、分水路、灌漑、 農業慣行、森林伐採などの淡水管理活動や土地利用が、海洋に対する淡水や陸上物質の流入にいかなる影響を及ぼしてきたかを示した。沿岸の侵食、水の循環、塩分の分布の変化等に関し、流域全体に及ぼす結果を例証した。

この点について、白山義久教授がさらに論証した。白山教授は、河川が沿岸域に運ぶ陸からの流入物および栄養塩、微量元素など、浮遊あるいは溶解している物質の重要性を強調し、これらの物質が大陸棚の生物生産力、生物多様性、生態系のバランスに与える影響を示した。また、淡水管理や他の陸上における活動による流入物の変化が与える影響を例示した。

畠山重篤氏は、日本の牡蠣養殖に焦点をあて、沿岸域における生産の変動に注目することで、相互作用に関する実践経験を紹介した。畠山氏は、豊富な実践経験に基づき、陸上における自然の生態系のバランスを維持することの重要性を例証し、特に森林の役割を強調した。森林伐採の破壊的な影響を指摘し、健全な沿岸域を保つためには、山から沿岸に亘って森林を維持・管理することが非常に重要であることを提示した。

S.R.シェティエ博士は、インド洋南西モンスーンがどのように発生するかを説明、特にベンガル湾に焦点をあて、モンスーンが陸上と沿岸域に及ぼすプラスとマイナスの影響について論じた。ベンガル湾への淡水の流入が、大気と海の相互作用を引き起こし、サイクロン活動をもたらす大気の状況を形成するのに果たす役割を強調した。インド亜大陸の淡水供給にとって、モンスーンが極めて重要であることも示した。シェティエ博士は、まだ十分に解明されていない多くの非線形プロセスを含むモンスーン予測の問題点を明らかにした。これまでに成功してきた予測は、統計モデルに基づいたものであった。シェティエ博士は、淡水の利用や淡水の不足対策および洪水、高潮、サイクロンなどの自然災害に関して、教育および一般の認識向上が重要であることを強調した。

最後に、グンナ・クーレンバーグ博士が、まず、海洋循環および気候変動に関する北極海の淡水バランスの役割についてのウラジミール・リャビニン博士(WMO)の論文から、一部を紹介した。続いてアービド・パルド大使によって提唱され、エリザベス・マン・ボルゲーゼ教授によって明確にされた「人類の共同財産」原則を引用し、海洋の総合的管理とガバナンスのための海洋モデルを提案した。クーレンバーグ博士は、この原則が国連海洋法条約(UNCLOS)および 1992 年国連環境開発会議(UNCED 92)など数々の合意で策定された統合的管理モデルとともに、淡水資源管理にも適用できるとの考えを示した。これは WSSD のパート

ナーシップ･アプローチとも一致する。これらの点を踏まえ、クーレンバーグ博士も、教育および一般の人々の認識向上と参加の重要性を指摘した。また国際海洋研究所(IOI)の活動に触れ、包括的な教育システムとしての IOI バーチャル･ユニバーシティーの考え方を紹介した。

以上の発表に続き、パネリストが簡潔にコメントを述べた。コメントはいずれも対話の向上、統合的アプローチの必要性、政策とガバナンス、一般の人々の認識と参加、教育の重要性を改めて強調するものであった。また、淡水と海水が人類の共同財産と見なされるべきであるという点でも意見が一致した。地域社会に根ざした共同管理的アプローチや統合的沿岸域管理(ICAM)を利用して、ユーザー・セクター同士の相互活動をさらに活発化する必要があることも強調された。さらに、現行のプログラムにとっては遠大すぎるとされながらも、ICAM を排他的経済水域(EEZ)にまで拡大する可能性も示唆された。淡水コミュニティーが長い道程を経て、水会議や水フォーラムを通じて自らを組織化し、世界的な重要課題である淡水問題に取り組むに至ったという点も確認された。海洋コミュニティーは淡水コミュニティーとの対話を通じ、これを学び役立てることができる。

研究の重要性も取り上げられ、ここでも統合的アプローチの必要性を強調した。一方で、畠山氏が発表されたような実践的経験も非常に重要であり、研究活動は実践的経験と応用との橋渡しを試みるべきである。このような実践的経験は、教育、認識の喚起、対話などの取り組みにおいて用いられるべきである。その中では、慣行や伝統的知識を伴う海洋、沿岸、陸上の利用の連携が社会的、経済的に重要であることを示すことが大切である。国際・国内ともに、水に関する包括的な法整備が必要であることも取り上げた。これは総合的なガバナンスを支え、地域社会に根ざした地元での活動と地球規模的な協力体制の双方に連動するものとなる。

森林管理の必要性が強調され、日本の事例から経済的要因がマイナスの役割を果たす場合があることも指摘した。社会的責任とあらゆるレベルにおける効果的なガバナンスとガバナンス・システムの必要性を再度浮き彫りにした。

引き続き、公開討論が行われ、客席からも多くの意見が出された。対話への関心とその必要性が確実に感じられた。EU が最近「水枠組み条例」を出したことを指摘した。これは、包括的な法的アプローチへ向けての一つの試みである。地球国際水アセスメント(GIWA)もまた、統合への努力の例として取り上げた。聴衆は、教育および実践的経験の利用が重要であることに同意し、対話の推進の重要性を指摘した。

その後クーレンバーグ博士が、それまでの発表および分科会中の討議から得られた主な結論を要約し、すべてのスピーカー、コメンテーター、参加者、共催者、フォーラム事務局、現

地のオーガナイザー、通訳に謝意を表した。

3. フォローアップ

世界水フォーラムは、繰り返し行われるイベントであり、事務局は、各分科会に対し、着手された様々な取り組みを継続するために、フォローアップとして実施可能な行動計画を各分科会で策定するよう強調していている。また、事務局は、実施に向けた公約に合意し、次回の世界水フォーラムに進捗状況を報告することを目指すべきであるとしている。

このため、我々は当分科会の開催に向けた準備期間中に、フォローアップ・アクションについても検討した。これらは 2003 年 1～2 月に同事務局の要請で作成した分科会事前報告書にも示されている。分科会においても、フォローアップの要素が強調された。発表、コメント、討議はすべてフォローアップの行動計画を支持するものであった。議長は、可能なフォローアップ活動を「結論」に記したような行動計画の形でまとめた。

分科会議長
グンナ・クーレンバーグ
寺島紘士

INTRODUCTION

By Hiroshi Terashima
Executive Director, Institute for Ocean Policy, SOF

Distinguished participants, dear colleagues, ladies and gentlemen.

I am Hiroshi Terashima, Executive Director of the Institute for Ocean Policy, SOF, and am privileged to serve as the co-chair of today's session. Welcome to a 'Dialogue between the Ocean and Freshwater Communities'. We are happy to have so many representatives from both communities in attendance today. Thank you for coming.

The Global Forum for Oceans, Coasts, and Islands was established by public and private participants at last year's World Summit for Sustainable Development in order to promote the exchange of information, discussion, and cooperation regarding the important ocean issues raised in UNCLOS, Agenda 21, and the WSSD Plan of Implementation. We decided at that time that in order to make our voice heard on ocean issues we should actively participate in global and regional conferences where these problems are being discussed.

Believing the 3rd World Water Forum an ideal opportunity to do this, IOI (International Ocean Institute), Ship & Ocean Foundation, IOC of UNESCO, and World Meteorological Organization sought to highlight the ocean/freshwater interface by holding today's session. Under the general theme of 'The Water Cycle: Forests, Rivers, Oceans, and the Skies', we will hear presentations and hold discussions on such topics as:

- The effects of El Nino, monsoons, and other ocean-based weather phenomena on land-based rainfall patterns and water use plans,
- The effects of land-based water management on the oceans,
- The roles of education and public awareness in integrated management.

In order to make today's session a meaningful one, we would appreciate your cooperation and active participation.

I would now like to introduce today's other co-chairman and the driving force behind today's session, Dr. Gunnar Kullenberg of IOI. Dr. Kullenberg, you have the floor.

INTRODUCTION

By Gunnar Kullenberg
Senior Executive Director, International Ocean Institute (IOI)

It is well accepted that water is a necessary part of all life on Earth. Water is also the working substance of the global heat engine. The Ocean is the most important and largest source of water vapour which is also the most important greenhouse gas. The evaporation over the Ocean is larger than the precipitation there by 10%, while the evapo-transpiration over land is less than precipitation there by 60%. The global freshwater balance is very sensitive: small changes of it can trigger large changes in the ocean and regional seas circulation and the heat transport. The Ocean provides on an average an annual input of about 40.10^3 Km^3 freshwater to the land, equal to the average annual river runoff. Can we forecast when and where the input of freshwater from the ocean via the atmosphere is coming over the land? If we can, we could be prepared for water harvesting, adjustments of agriculture, impacts on transportation, health problems and flooding, protection of the security of people and resources. The answer is that we can do some such forecasting with acceptable uncertainties. This is possible by a combination of ocean observations, data transmission in near-real time, computer modeling with data assimilation.

Examples are provided by the El-Nino Southern Oscillation (ENSO) and the monsoon phenomena. These are parts of the global climate system, recurrent processes which can be forecasted to some extent. The forecasting can be, and is being, used in relation to planning, adjusting and managing many essential activities on land, even though the decision making has to be made under conditions of uncertainty, as in most other socio-economic cases.

The ENSO phenomenon occurs with an average return of 4 years; it can be 1-2 or even 8-10 years apart. There has over the last decades been a growing interest in the phenomenon due to its large impacts in the Pacific rim countries, and through teleconnections also in other parts of the world. Relations between El-Nino and changes in freshwater resources have been demonstrated for instance in South America, where forecasting of the El-Nino is used in many countries; in Australia, parts of Africa, Japan and South-East Asia.

The Indian Ocean Southwest monsoon is an annual (seasonal) regular process occurring during the months May/June to September, over the northern Indian Ocean, and the Bay of Bengal in particular. The monsoon brings rain to the Indian Sub-continent. It is the major source of freshwater supply for India and other parts of the region. A normal monsoon is essential for most actions on land: water availability; agriculture; energy; transport. A failed monsoon implies a major drought year: about 20 such have occurred over the past 100 years. Improved forecasting of the monsoon will have enormous positive social and economic consequences.

The freshwater management on land can have major impacts not only on the coastal zones, and shelf seas, through alteration of the freshwater and related dissolved and suspended terrestrial material inputs, but also for ocean basin-wide conditions. Examples are provided by the Black Sea, the Mediterranean Sea, the Arctic Basin, the Bay of Bengal. The changes in freshwater input and balance can generate changes in the air-sea interaction which can have very substantial consequences for the ocean circulation and the climatic conditions.

All the examples alluded to here are highlighted further during the session. They all demonstrate the need for an integrated or comprehensive approach in the management and decision making.

The Ocean also provides for a model on how to achieve the integration and comprehensive approach, including governance in the broad sense and sustainable development. The model is specified through the third United Nations Convention on the Law of the Sea and results of the United Nations Conference on Environment and Development 1992 and the associated on-going processes. However, the impetus behind the international legal instrument comes from Ambassador Arvid Pardo of Malta who in the end of the 1960's elaborated two basic ideas:

> "all aspects of ocean space are inter-related and should be treated as a whole," and

> "the resources of the deep sea-bed constitute the common heritage of mankind", this is to be governed and managed for the benefit of all by a suitable international mechanism. This should not at all be misunderstood or misinterpreted as a "tragedy of the commons."

Arvid Pardo gave the concept for dimensions:

- Economic: the Common Heritage has to be developed;
- Ethical: the Common Heritage has to be managed on behalf of mankind as a whole, with special considerations for the needs of the poor;
- Environmental: the Common Heritage has to be conserved to be shared with future generations, which are also part of mankind;
- Peace and security: the Common Heritage has to be reserved exclusively for peaceful purposes, so as to benefit mankind as a whole.

The comprehensive approach cannot be achieved without a concerted and sustained effort to enhance dialogues across society; increase the exchange of information, the education and the public awareness and participation. The current trends of increasing differences between developed and developing, between North and South, must be reversed. Local and traditional knowledge, culture and policies can play a large role, but need to be coupled to regional and global scales as in the oceanic circle model. These aspects were also brought out in the session.

The session stimulated discussion across sectors on subjects such as: a model which can be used to achieve comprehensive global management of water; examples on how to use forecasting, modeling, and observations to enhance water management, and preparedness for water shortages as well as flooding and related natural disasters; cooperation between sectors with respect to consequences of freshwater management actions on land, for coasts and ocean-basins, with enhanced dialogue and awareness; education needs, ethical and attitude changes, public awareness requirements, and ways to achieve these.

SUMMARIES of PRESENTATIONS

El Nino/ENSO Prediction

Kenneth Davidson
World Meteological Organization (WMO)
（Notes on the Presentation by Kenneth Davidson）

El Nino and La Nina are extremes of climate variability. Some basic facts about El Nino and La Nina signals are major departure of normal climate patterns, with a recurring pattern, no two events being identical (Fig.1). We are currently in a moderate El Nino. The predictions are getting better and better. This particular one was forecast about four months in advance. We actually gave countries the very good warning that this was coming, for only the second time in history. We were able to assist countries in understanding what the impacts may be by the El Nino. It is generally detected around May to June, in the years that it occurs. This particular time, it was forecast in February and we actually found the signal and declared an El Nino in late May. It is just one of the extremes of climate variability and it associates with heavy rains and in some areas there are severe dry conditions.

El Nino is basically the departure from normal sea surface temperatures in the Pacific Ocean. This (Fig.2) is 1997-98 El Nino you can see the strength of it, and go all the way back to 1982-83 El Nino. So what is its influence over the Pacific, or the other way around, what is the influence of Pacific over the El Nino. This is the normal conditions (Fig. 3). I think this is a very interesting slide because as you know we have generally an Easterly wind flow here which is depicted here. Let me orient you first. The South American Coast is to the right. This is Central America and over here is Australia (Fig.2). This is going through the depth of Ocean (Fig.3). In normal conditions, December through February, we have convective activity over in the far west Pacific Area, which would create this kind of air flow pattern, you can see very little convective activity here off the coast of South America (Fig.3 middle). We have a normal thermocline with shallow warm water off the coast. Then March to May, a little bit more convective activity so that you can see this circulation of the air patterns here. Slightly more warm temperatures just to the North of the area that we are talking about Central America.

Now an El Nino, once it starts, gets much more convective activity, much more warm water here (Fig.3 left). Notice the difference of the depth of the warm water in December through February verses the December through February in the normal conditions. And

then you can see the difference also March through May. You can see the much more convective activity coming all the way over to the West Coast of South America and Central America (Fig. 3 left).

We always talk about El Nino affects but there is a lot of effects of the opposite called La Nina as well (Fig.3 right, and Fig.4).

So this is just another look at the same situation, this is the El Nino from September 1997 (Fig.2), showing the great pool of warm water off South America. This is La Nina of November 1988 (Fig. 4) and you can see the pool of cold water off South America. So the main predictor of El Nino for the climate centers around the world is both the surface and sub-surface water temperature. We now have the observing buoys all the way across the Pacific Area to monitor this temperature and broadcast up to satellites. The data come back down through a communication system to countries all over the world.

So what are the warm episode affects of El Nino? In the Northern Hemisphere in summer, we have dry and warm conditions. Some windup North America, dry and cool conditions down all the way over Australia. Recall in this past summer and early fall, we had very dry conditions and the fires in Australia. I would say usually about 65% and 70% probability of these things happening during El Nino. When as I started off saying no two El Ninos are alike.

During the cold episode La Nina, we have warm conditions over Australia, dry in the middle of Pacific area, and cold and wet through the Southern portion of Central America and Northern South America.

After 1997-98 El Nino, there was a proposal developed in the UN to create an El Nino Research Center. Efforts were taken up by the Government of Equador, WMO and the ISDR which is the International Strategy for Disaster Reduction.

We have a series of regional climate outlook forums, this actually started during the 97-98 El Nino. What we try to do is to get the countries together from various regions from around the world. We discussed the various global climate forecast. We tempt to downscale these based on meteorologists' and climatologists' knowledge and understandings on local and regional situations, so they can actually use it to better benefit governments. In many times we bring in various economic sectors sometimes it will be energy sector, or agricultural sector to work with the climatologists in order to provide

better information to their governments. They are now a regular feature in Africa where we have four specific sub-regions we are working at; we have two activities in South America, one in Northern South America, one in Central South America, and we have one in Central America as well and we have one going on in the Pacific Region.

With the establishment of ISDR the work of the interagency task force on El Nino was taken up and there is a specific working group called Climate Variability in Disasters. Through this working group we were producing annual climate statements that give the summary of the climate for year, and we are also producing El Nino outlooks which we synthesis for 9 active forecast centers, and they are issued through ISO and WMO. We do this quarterly; we just did the last one in January, and we'll be doing another one in March.

In addition in 2003, finally after almost 4 years of work, we established The El Nino Center. Its just getting started now. I hope this center can provide much more activities and not just research on El Nino. We'd like it to be a center that can help us establish data bases, complete climate data bases and assist the countries in connecting with the various economic sectors within their countries.

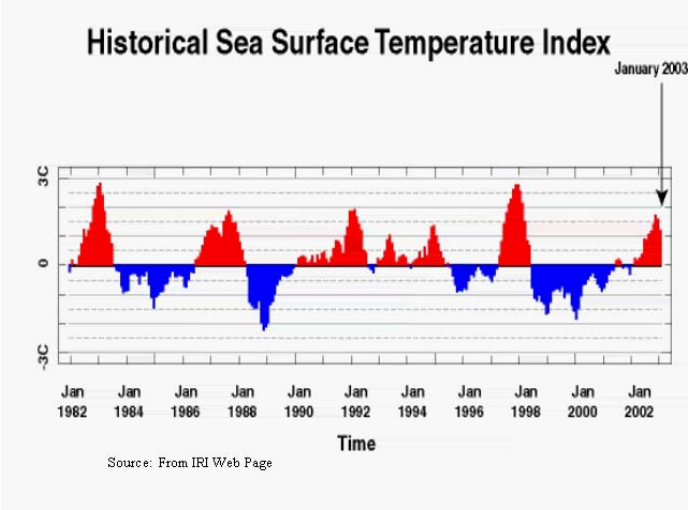
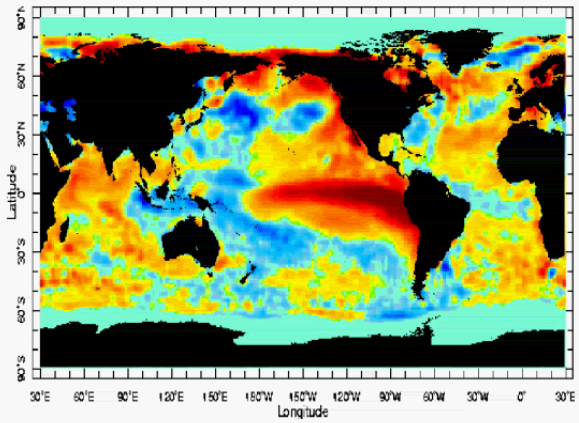


Fig.1



El Niño
SEP 97

Fig.2

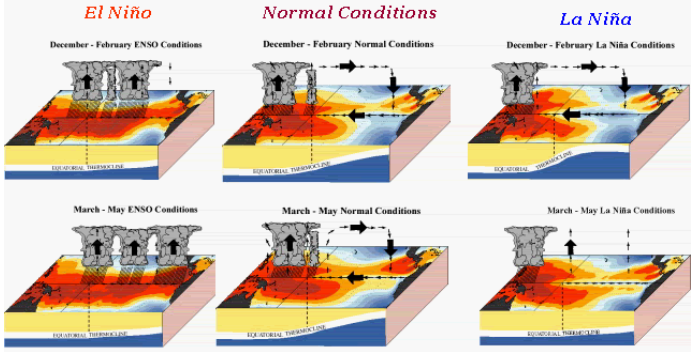
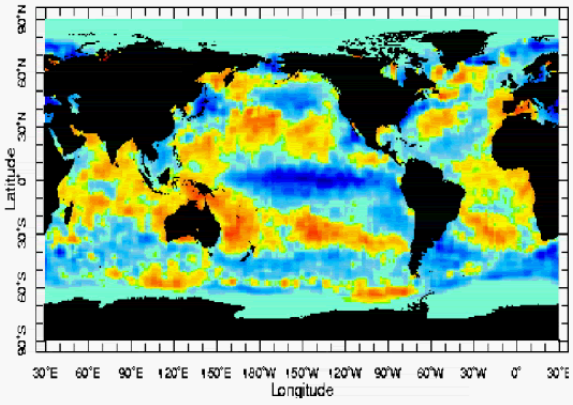


Fig.3



La Niña
Nov 88

Fig.4

The Role of the Indian Ocean in Climate Forecasting with a Particular Emphasis on Summer Conditions in East Asia

Toshio Yamagata
Department of Earth and Planetary Science, The University of Tokyo

ABSTRACT

The Indian Ocean Dipole (IOD) is a natural ocean-atmosphere coupled mode that plays important roles in seasonal and interannual climate variations. In the present article, we describe the IOD event locked to a seasonal cycle and then discuss its close relation with the Asian summer climate variations. In particular, we demonstrate that the extremely hot and dry summer condition in 1994 was due to the positive IOD event.

1 Introduction

It is well known that the summer climate condition over East Asia is dominated by activities of the East Asian summer monsoon system. Since the East Asian summer monsoon system is one subsystem of the Asian Monsoon (Wang and Fan, 1999), it interacts with another subsystem, the Indian summer monsoon, via variations of the Tibetan high and the Asian jet (Rodwell and Hoskins, 1996; Enomoto et al., 2002).

Inspired by the anomalous summer conditions in East Asia during 1994 (e.g. Behera et al., 1999; Vinayachandran et al., 1999), Saji et al. (1999) discovered the existence of an east-west SST dipole in the tropical Indian. They showed that this dipole is coupled to zonal wind anomalies in the central Indian Ocean, suggesting the Bjerknes-type of air-sea interaction as in the tropical Pacific. The term Indian Ocean Dipole (IOD) was introduced to denote this basin-wide ocean-atmosphere coupled mode in the Indian Ocean. The positive IOD event is characterized by the strong positive Sea Surface Temperature Anomalies (SSTA) in the tropical western Indian Ocean (50^{o}E-70^{o}E, 10^{o}S-10^{o}N, denoted as Box A) and the negative SSTA in the southeastern Indian Ocean (90^{o}E- 110^{o}E, 10^{o}S-Eq., denoted as Box B). Thus the Indian Ocean Dipole Mode Index (IODMI) is defined as the zonal difference of SST anomaly of Box A (western pole) from that of Box B (eastern pole).

After introducing the IODMI, Saji et al.(1999) identified six major positive IOD events during the period of 1958 -1999. The composite pictures of those six events (1961, 1967, 1972, 1982, 1994, and 1997) demonstrated that the air-sea coupled IOD event evolves during boreal spring, matures in fall and decays in winter (cf. Figs 2 and 3 in Saji et al., 1999). The dipole pattern related to IOD is identified in heat content/sea level anomalies (Rao et al., 2002a), OLR anomalies (Behera et al., 1999, 2002; Yamagata et al., 2002; Saji and Yamagata, 2002a) and sea level pressure anomalies (Behera and Yamagata, 2002). We show all those indices in Fig.1. Several other authors also discussed this Indian Ocean coupled phenomenon (Webster et al., 1999, Murtugudde et al., 2000, Iizuka et al., 2000; Vinayachandran et al., 2002; Feng et al., 2002; Ashok et al., 2002; Gualdi et al., 2002) using observed data and/or model simulations.

We believe that the IOD has raised a new possibility to make a real advance in the predictability of seasonal and interannual climate variations originating in the tropics. Here we first describe that the IOD is a physical mode and then discuss its teleconnections.

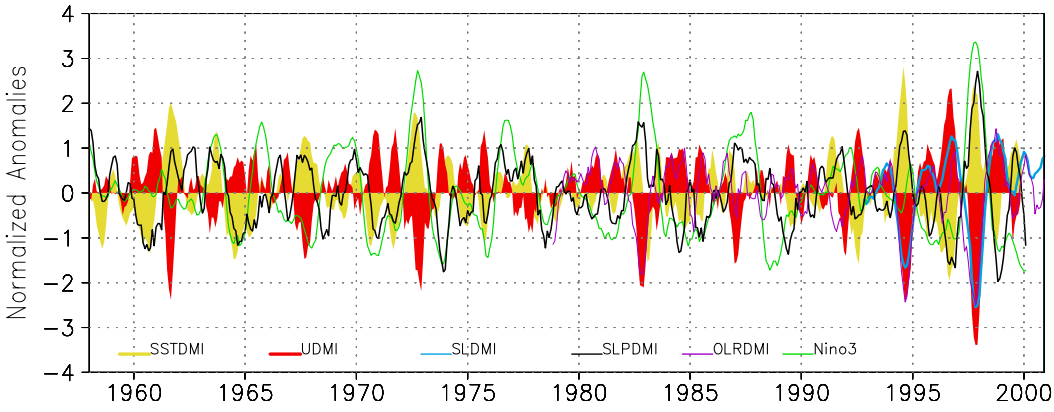


Fig. 1. Normalized indices of IOD, based on the anomalies of SST (SSTDMI) , zonal wind (UDMI), TOPEX/POSEIDON sea level (SLDMI), OLR (OLRDMI) and sea level pressure (SLPDMI). Niño-3 index from the eastern Pacific is shown for reference. SSTDMI is a difference between western (50^{0}E-70^{0}E, 10^{0}S-10^{0}N) and eastern (90^{0}E-120^{0}E, 10^{0}S-Eq) Indian Ocean. Similarly, SLPDMI is a difference between (96^{0}E-100^{0}E, 13^{0}S-9^{0}S) and (52^{0}E-56^{0}E, 9^{0}S-5^{0}S) and OLRDMI is a difference between (70^{0}E-80^{0}E, 5^{0}S-5^{0}N) and (90^{0}E-100^{0}E, 10^{0}S -Eq). The UDMI is obtained by taking area-average in the central equatorial region (70^{0}E-90^{0}E, 5^{0}S-5^{0}N). SLDMI is the sea level anomalies from the eastern box of the SSTDMI.

2 IOD as a natural coupled mode in the tropical Indian Ocean

2.1 IOD's appearance in the statistical analyses

Despite the remarkable presence of IOD events, the dipole pattern appears as the second dominant mode in the SST anomalies in conventional statistical analysis such as the EOF method. It is rare for climate dynamists to discuss the second mode of variability. This is why some felt difficulties in understanding the new concept of the IOD. The dominant EOF mode is a basin-wide SST monopole that has a high correlation (~0.85) with the Nino-3 index, when the latter leads the former by 4 months. Thus, the dominant Indian Ocean SST variability is caused by the external forcing related to ENSO. The wavelet spectra of the SST anomalies in the eastern (10^0S-Eq., 90^0E-110^0E) and western (10^0S-10^0N, 50^0E-70^0E) poles show different behavior because of the masking effect of the dominant EOF mode (Fig. 2). However, we recover a remarkable coherence in the variability of the two boxes after removing the external ENSO effect (Fig 2 lower panels). This shows quite a contrast to other major oscillatory modes such as the Southern Oscillation and the north Atlantic Oscillation that appear as the first dominant modes; the statistical dominance allows a negative correlation between the poles for those two modes in the raw data. Since IOD is the second mode in SST variability, we need to remove the dominant mode to detect its sea-saw statistically as demonstrated in

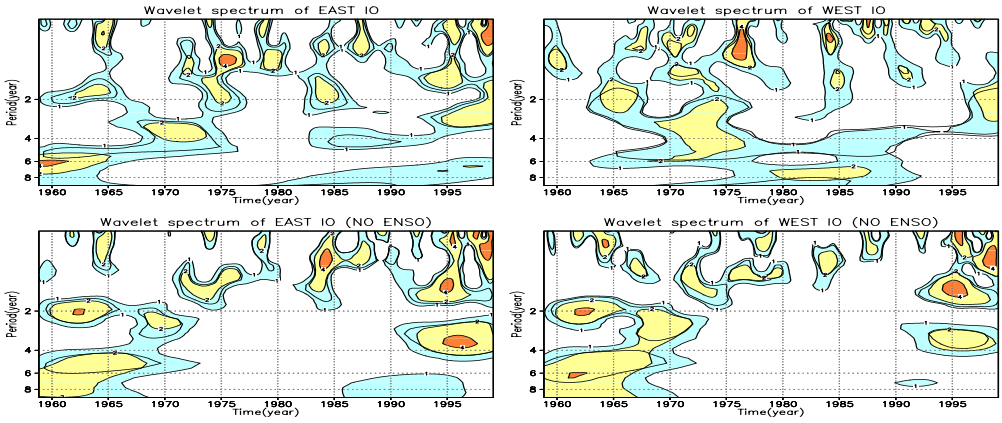


Fig. 2. Wavelet power spectrum (using the Morlet wavelet) of the SST anomalies (derived from GISST, Rayener et al. 1996) in eastern (left panels) and western (right panels) poles of the IOD. Upper two panels show the spectrum for the whole data and lower two panels show the spectrum when ENSO effect is removed from the data through a 4-month lagged regression of the Niño-3 index. Shaded is the wavelet power at each period being normalized by the global wavelet spectrum and the thick black contour is the 95% significance level.

Behera et al. (2002). This subtle aspect of the tropical Indian Ocean variability as discovered by Saji et al. (1999) was missed unfortunately in earlier studies (e.g. Hastenrath et al., 1993).

2.2 IOD's relation with ENSO

The IOD evolution is locked to seasons. Thus it is important to introduce the seasonal stratification in the statistical analysis (cf. Nicholls and Drosdowsky, 2000; Allan et al., 2001). During the peak season (September-November) of the IOD, the first two dominant EOF modes (for the Indian Ocean north of 15^0S) show the east-west dipole patterns (figure not shown). Interestingly, the first EOF mode has a stronger correlation (~0.65) with the IOD as compared to its correlation with the Niño-3 (~ 0.58). The latter correlation corresponds to a similar correlation (~0.54) between IODMI and Niño-3 during this season; one is apt to conclude that IOD events occur as a part of ENSO events because of this high correlation (Allan et al., 2001; Baquero-Bernal et al., 2002). Rather, we claim that it reflects the fact that one third of the positive IOD events co-occur with El Niño events. The non-orthogonality of two time series does not necessarily mean that the two phenomena are always connected in a physical space.

We note that the second EOF mode, which also shows a dipole, has a significant correlation coefficient with IODMI (~0.69) but an insignificant value with the Niño-3 (~0.28). This difference in statistical correlation confirms the visual examination of the principal component that the second dipole mode is related to independent occurrences of IOD in certain years such as 1961, 1967 and 1994 (figure not shown).

	Years of Positive IOD	Years of Negative IOD
1	**1961***	**1958***
2	1963	**1960***
3	**1967***	1964
4	1972	1970
5	**1977***	**1989***
6	1982	**1992***
7	**1994***	**1996***
8	1997	-

Table. 1 Years of IOD events. The asterisk denotes pure events, i.e. no El Niño (La Niña) during a positive (negative) IOD event.

To investigate such a complex relation, Yamagata et al. (2002) have analyzed the Walker circulation that may connect the Indian Ocean with the Pacific through the atmospheric bridge. As 30% of the positive IOD co-occur with El Niño, a simple correlation analysis is misleading. Therefore, they used appropriate statistical tools like the composite technique and the partial correlation method to extract the distinct nature of the IOD. A positive (negative) IOD event is identified as a *pure* event when it is not accompanied simultaneously by El Niño (La Niña) (see Table 1). The presence of the anomalous Walker cell operating only in the Indian Ocean is clearly seen in the *pure* IOD composite (Fig. 3), thereby confirming the independent occurrence of the *pure* IOD. To avoid misunderstanding, we repeat that this analysis does not exclude the possibility that some IODs may be physically linked with some ENSO events.

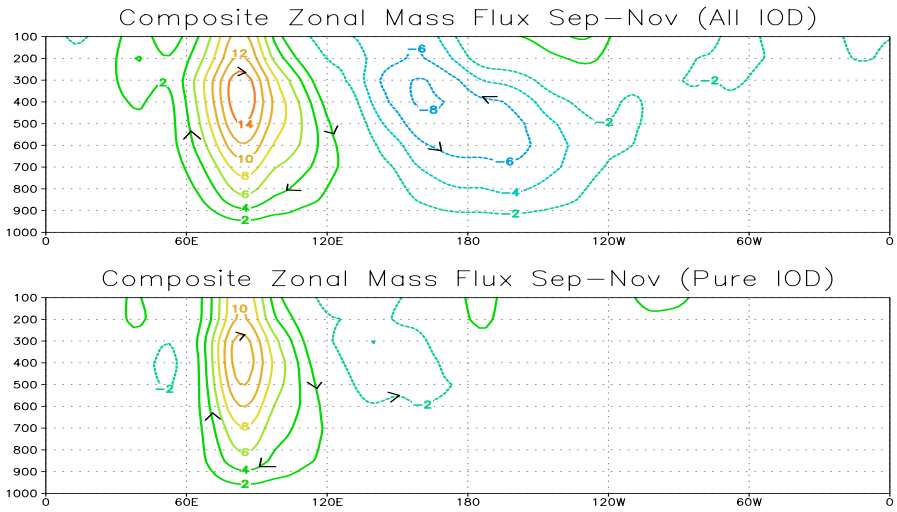


Fig.3: September through November IOD composite ((positive events-negative events)/2) of zonal mass flux in the equatorial band (5^0N-5^0S) for pure IOD events (bottom). Contour interval is $4*10^9$ kg s^{-1}.

3 IOD teleconnections in East Asia

The societal benefit of the IOD can be appreciated by analyzing its impact on the global climate system. Several recent studies (Ashok et al., 2001; Li and Mu, 2001; Behera and Yamagata 2002; Saji and Yamagata 2002b; Guan et al., 2002; Lareef et al., 2002) have shown IOD influences on many parts of the globe such as India, Australia, East Africa, and East Asia. However, we here focus our attention only on East Asia because of limitation of space.

The activities of the East Asian summer monsoon have profound economical and societal impacts on the East Asian countries. The anomalous changes in the summer monsoon circulation can lead to either abnormally hot (and dry) or cold (and humid) summer in this region. As mentioned in Introduction, East Asian countries suffered from the record-breaking hot and dry summer climate in 1994. Park and Schubert (1997) examined the nature of this year using some assimilated data from 1985 through 1994. Their conclusion is that "the anomalous circulation is primarily the result of an orographic forcing associated with zonal wind changes over Tibet". However, we here show that the abnormal 1994 East Asian summer conditions are actually related to an ocean-atmosphere coupled signal in the tropical Indian Ocean, which is now called IOD.

Using the SST data (GISST2.3b) from 1979 through 1999 (Parker et al., 1995), we calculated the SSTA for June-July-August (JJA) and its standard deviation (σ) for three different tropical regions and the IODMI (Table 2, lower line). The IOD event in 1994 shows the variance that reached about 2.6σ, indicating a very strong positive IOD event in the summer of 1994. We also note that the NINO3 region (5 ^{o}S-5 ^{o}N, 150 ^{o}W-90 ^{o}W) showed the weak negative SST anomaly during the same period despite the negative Southern Oscillation Index (cf. Behera and Yamagata, 2002).

Regions	IODMI	Box A	Box B	NINO3
SSTA	0.90	0.24	-0.65	-0.21
σ	0.35	0.32	0.31	0.85

Table 2: JJA mean SSTA (1994) and its standard deviation for different tropical regions

The Indian summer monsoon is expected to be significantly influenced by the IOD. Using all Indian rainfall data derived from the *in situ* observations (Parthasarathy et al., 1995), we actually found that India received good monsoon rainfall during June-July-August of 1994; it amounts to 265mm per month, which is 19% above the mean climatological value. This is consistent with our earlier study using both the observational data and an atmospheric general circulation model (AGCM) which suggests that the well-known negative correlation between Indian summer monsoon rainfall and El Niño can be interfered by the IOD during some decades (Ashok, et al., 2001).

The Indian summer monsoon system interacts with the tropical Indian Ocean. The East Asian summer monsoon interacts with the Indian summer monsoon via the tropospheric jets, Tibetan high, and even the westerly jet stream at about 40^{o}N in the upper troposphere

(e.g. Lau and Li, 1984; Liang and Wang, 1998; Wang and Fan, 1999; Wang et al, 2001; Enomoto et al, 2002; Lu et al, 2002). When the circulation over South Asia changes anomalously, it is reasonable to expect that the summer monsoon circulation over East Asia will also change anomalously. We here show using the reanalysis data how the atmospheric circulation was influenced by the IOD during the summer in 1994.

3.1 Anomalous circulation features

Using the NCEP/NCAR reanalysis data (Kalnay, et al., 1996) from 1979 through 2001 and the CMAP precipitation data from 1979 through 1999 (Xie and Arkin, 1996), we have plotted the circulation anomalies during the summer months (JJA) of 1994 (Figs. 4 and 5). Large positive air temperature anomalies are found over the northeastern and eastern China, Korea, and Japan in 1994 summer (Fig. 4a). Some positive anomalies are also found above the Kuroshio Extension in the Northwestern Pacific. The anomalies of thickness between 200hPa and 850hPa isobaric surfaces are also positive (not shown), indicating the temperature of the air column is anomalously high. Those regions are associated with the strong negative precipitation anomalies (Fig. 4b). The water vapor anomalously diverges from this region, leading to a severe drought condition. These results agree well with those in Park and Schubert (1997). It is known that this northeastern part of Asia was covered during the summer of 1994 by an anomalous anticyclonic circulation in the lower troposphere. This anomalous circulation is found in the upper troposphere over this region (Fig. 5a), showing its equivalent barotropic structure. On the other hand, we find an anomalous cyclonic circulation elongating westward from the tropical western Pacific to the southern part of China (Fig. 4a); this circulation facilitates the surplus rainfall in this region (Fig. 4b). It prevents the moist monsoonal southerly wind from blowing northward from the Bay of Bengal and the South China Sea to the eastern part of China, Korea and Japan.

The above anomalous cyclonic circulation along with the intensified monsoon trough over India appears to be linked directly with the tropical IOD event. As seen in Fig. 4b, the distinctive 1994 IOD structure over the tropical Indian Ocean is manifested in rainfall anomalies and also in the velocity potential field (Fig. 5b). The water vapor converges into the western Indian Ocean (Fig. 4b), while it diverges in the southeastern Indian Ocean. An anomalous meridional circulation associated with the IOD connects the anomalous decent branch over the southeastern Indian Ocean and the anomalous ascent branch at about 20 ^{o}N, as simulated by Ashok et al., (2001). More precisely, the anomalous northwestward low-level winds from the eastern pole of IOD reaches the Peninsula of

India and then turns eastward (Fig. 4a). Since just the opposite winds are seen in the upper troposphere (Fig. 5a,b), the wind field in the tropics has a baroclinic structure. These results are in agreement with other results obtained from both data analysis and AGCM studies (Behera, et al., 1999; Ashok, et al., 2001; Guan et al., 2002).

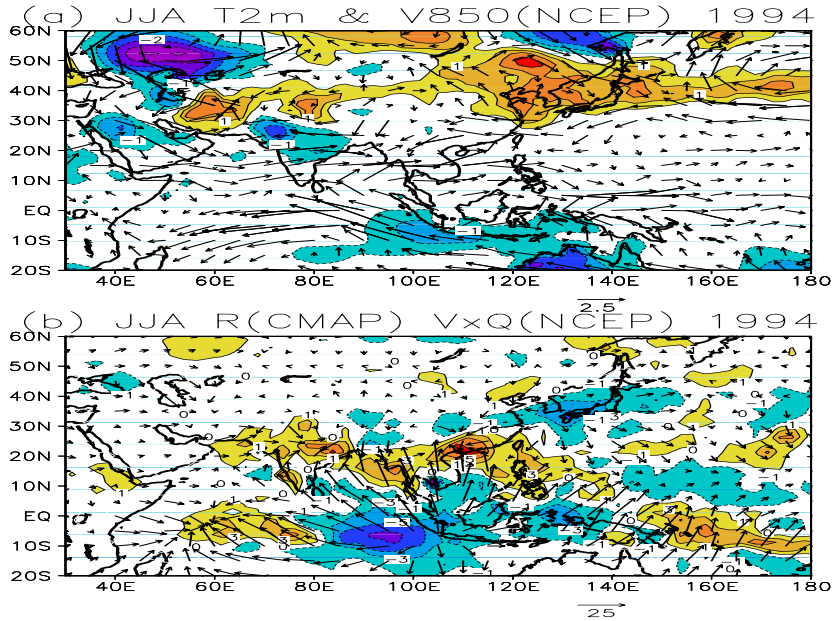


Fig.4. (a)The JJA mean anomalous air temperature at 2m above the earth surface (in ◦C) along with the wind at 850hPa (in $m \cdot s^{-1}$) during 1994. (b) The anomalous precipitation (in $mm \cdot d^{-1}$) and the anomalous water vapor flux (in $Kg \cdot m^{-1} \cdot s^{-1}$) which is vertically integrated from the earth surface up to 300hPa (shown with vectors).

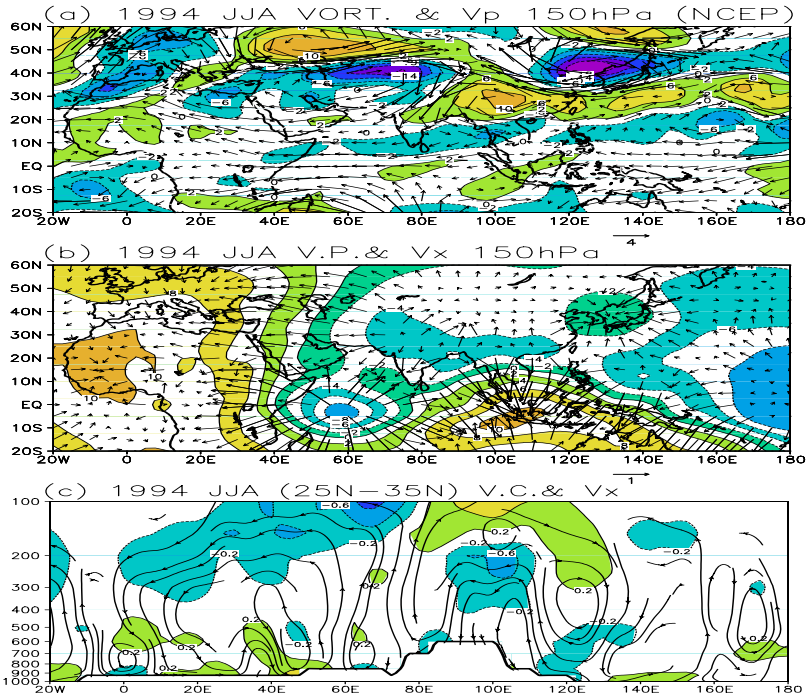


Fig.5: (a) JJA mean anomalous vorticity (to be multiplied by 1×10^{-6} s^{-1}) along with the rotational wind ($m\cdot s^{-1}$) at 150hPa in 1994. (b) JJA mean velocity potential along with the divergent wind ($m\cdot s^{-1}$) at 150hPa in 1994. The contour interval is $4\times10^{-5}m^2\cdot s^{-1}$. (c) JJA mean zonal-vertical circulation averaged over (25°N-25°N). The contours denote the zonal component of the divergent wind with contour interval of $0.2m\cdot s^{-1}$.

3.2 Teleconnection mechanisms

The precipitation over India and the southern part of China is enhanced during the positive IOD event (Saji and Yamagata, 2002b). The northward branch of the meridional circulation excited by the eastern pole of the positive IOD leads to the anomalous updraft and the associated divergent flow in the upper troposphere over the Tibetan Plateau (Fig. 5b). As discussed by Sardeshmukh and Hoskins (1988) using a simple model, we observe the anticyclonic circulation at 150 hPa west of the vorticity source region, i.e., the Tibetan Plateau (Fig. 5a). A cyclonic circulation is simultaneously generated east of the vorticity source region. A Rossby wave train is also excited, propagating northeastward from the monsoon region.

The IOD-induced divergent flow in the upper troposphere near India also progresses westward and converges over Mediterranean/Sahara region (Fig. 5b). The zonal section averaged between 25 °N and 35 °N at 150 hPa captures the vertical circulation (Fig. 5c);

the anomalous convection over India, which is induced by the IOD SSTA as explained, is amazingly linked to the anomalous decent in the Mediterranean/Sahara region, as discussed by Rodwell and Hoskins (1996) in a somewhat different context.

To examine mechanisms behind the above circulation changes in more detail, we show in Fig .6 the heat budget anomalies. Over the northern as well as the eastern part of China, the anomalous diabatic heating is dominant in the thermodynamic equation (Fig. 6c). Over Japan and Korea, the dynamic heating due to the anomalous descent of air is dominant, which cancels the anomalous negative horizontal advection of temperature. Around the Sea of Okhotsk, however, the anomalous positive horizontal advection of temperature balances the dynamic cooling (Fig. 6b). These differences imply, from the viewpoint of the heat budget, that there are different mechanisms of the hot summer over land and sea. Furthermore, these results indicate that the strong positive SSTA around Japan in 1994 (not shown) is not the cause of the hot summer. Rather, it is the result of the hot and dry summer condition.

Over India and the Bay of Bengal, the net anomalous diabatic heating is found (Fig. 6c), which is balanced by the negative anomalies of dynamic cooling due to the anomalous upward motion (Fig. 6b). On the other hand, the net diabatic cooling is found over the Mediterranean Sea/Sahara region (Fig. 6c). The negative anomalies of the horizontal advection of temperature are also found in this region (Fig. 6a). The anomalous dynamic heating due to the decent of air compensates both the diabatic and dynamic cooling.

Based on this heat budget diagnosis along with the vertical circulation shown in Fig. 5c, the relationship between the IOD/Monsoon and the anomalous circulation changes over the Mediterranean Sea/Sahara region can be established. The present view confirms the monsoon-desert mechanism put forward by Rodwell and Hoskins (1996); they suggested that the diabatic heating due to convective activities in the Indian region could induce an anticyclonic Rossby wave pattern that covers west Asia and northern part of Africa. The adiabatic decent thus induced by the remote thermal forcing from the Asian summer monsoon may intensify the decent induced by radiative cooling over the Mediterranean Sea/Sahara region.

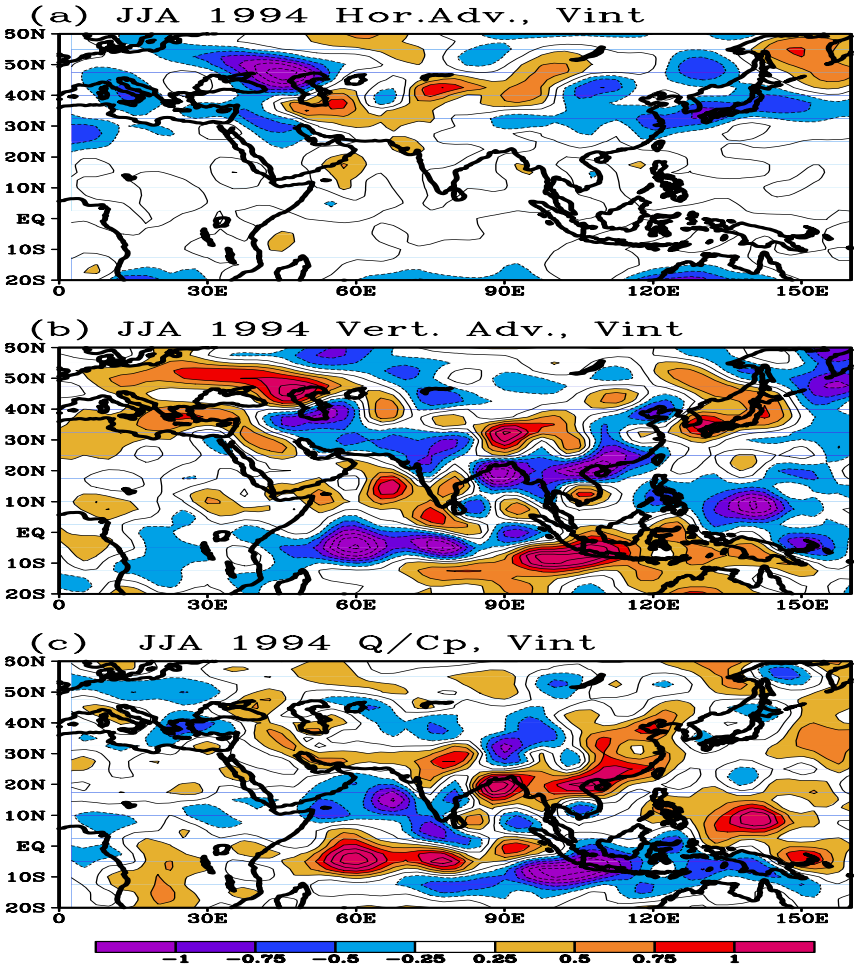


Fig.6. JJA mean vertically integrated quantities for 1994. (a) The anomalous horizontal advection of temperature, (b) the anomalous vertical advection of potential temperature, and (c) the anomalous diabatic heating rate. All these quantities are vertically averaged over pressure from surface to 100hPa. The unit is $^{\circ}C \cdot d^{-1}$.

The IOD-induced dynamic warming due to the decent of the air over the Mediterranean Sea/Sahara region and its vicinity must steadily perturb the mid-latitude westerly. Since the mid-latitude westerly acts as a Rossby wave-guide (Hoskins and Ambrizzi, 1993), the wave energy could propagate along the westerly eastward to East Asia, resulting in the summer circulation variations around East Asia and the Western Pacific.

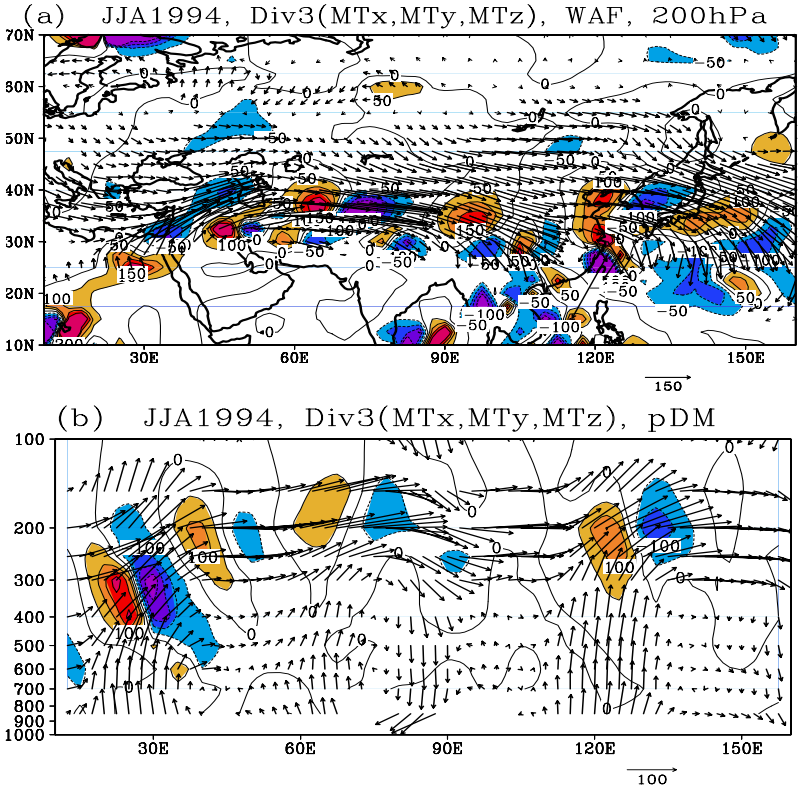


Fig.7. (a)The wave-activity flux $\mathbf{M}_T$ (in $m^2 \cdot s^{-2}$) along with the 3-dimensional divergence $\nabla_3 \cdot \mathbf{M}_T$ (to be multiplied by 1.0×10^{-6} $m \cdot s^{-2}$) at 200hPa. (b) The wave-activity flux (M_{Tx}, M_{Tz}) and the 3-dimensional divergence in zonal-vertical section. The high frequency components in the time-series have been removed by using a 5-day running mean. The wave-activity fluxes and their divergences in (b) have been averaged over (35°N-45°N). The vertical component of wave-activity flux M_{Tz} is enlarged by 10 before plotting.

This scenario can be examined by calculating the wave activity flux (WAF) (Plumb, 1986; Takaya and Nakamura, 2001). Fig. 7a clearly shows that the wave activity flux at 200hPa are much larger along the Asian westerly jet than those over other regions. The longitude-height cross-section (Fig. 7b) shows that the anomalous wave energy propagates upward into the upper troposphere around the regions of the Mediterranean Sea, the Caspian Sea, and the East Asia along the westerly jet stream. To the north of the Asian jet, the wave propagation is very weak; this suggests that the 1994 East Asian summer climate is not directly related to variations in higher latitudes. The upward propagating wave energy in the eastern flank of the Tibetan Plateau suggests that orographic forcing also plays an important role in 1994, as suggested by Park and Schubert (1997).

4 Summary

Using various ocean and atmosphere data, we have demonstrated that the IOD is a natural ocean-atmosphere coupled mode in the Indian Ocean. Although the IOD emerges statistically as the second major mode in the SST anomalies, it shows up as a remarkable event in some years and induces climate variations in many places of the world. The year of 1994 is such a case and the dramatic impact on summer conditions in East Asia actually led authors to shed light on this important climate signal. We have discussed here how the IOD event influences summer conditions in East Asia.

The abnormally hot and dry summer in 1994 was associated with the anomalous anticyclonic circulation over Japan, Korea and the eastern and northeastern part of China. The anomalous cyclonic circulation over the southern part of China and the western Pacific weakened the monsoonal northward wind from the Bay of Bengal, the South China Sea, and the tropical Western Pacific, preventing the subtropical East Asia from receiving the normal water vapor from the tropical regions. The anomalously hot summer climate over East Asia is explained as a result of the anomalous dynamic heating around Japan, and diabatic heating over the northeastern and eastern part of China.

The IOD induced the summer circulation changes over East Asia in 1994 are at least in two ways. One is that a Rossby wave train is excited in the upper troposphere by the IOD-induced divergent flow in the upper troposphere over the Tibetan Plateau. The wave train propagates northeastward from the southern part of China. Another is that the IOD-induced diabatic heating around India excites a long Rossby wave pattern to the west of the heating. Through the monsoon-desert mechanism proposed by Rodwell and Hoskins (1996), the circulation changes over the Mediterranean Sea /Sahara region can be linked to the IOD/Monsoon variations. The westerly Asian jet acts as a waveguide for eastward propagating tropospheric disturbances to connect the circulation change around the Mediterranean Sea with the anomalous circulation changes over East Asia. This process may contribute to strengthening the equivalent barotropic structure in East Asia as suggested by Enomoto et al.(2002).

The study of teleconnections of IOD has just started. It is rather amazing that the monsoon-desert mechanism which plays a key role in understanding the hot and dry summer in East Asia was introduced by examining the summer of 1994 prior to the discovery of IOD (cf. Hoskins, 1996).

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Changes in Terrestrial Material Transport, from the Mountain to the Ocean

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1. The Influence of Fluvial Sediment Supply on Coastal Erosion in West and Central Africa

Processes affecting the supply of sediment to the coastline are examined, together with regional patterns of longshore sand transport. Within such transport systems, instances of high rates of coastal erosion are indentified.

Littoral drift systems extend for thousand of kilometres. Consequently, coastal engeneering works and the extraction of beach/dune sand affects significantly neighbouring areas.

A large-scale programme of dam construction has been undertaken, over the years, on the drainage systems within the catchment areas. It is estimated that the construction of dams in this region of Africa has reduced the catchment areas, as effective sources of sediment, by approximately 70%. Such construction has other effects in the physical characteristics and fisheries in the coastal zone. The problem of reduction in sediment supply is exacerbated by the desertification which is taking place in the upper parts of the drainage basins.

A careful regional analysis of the effects of dam construction, which are of obvious local benefit, is recommended.

2. Fluviatile sediment fluxes to the Mediterranean Sea: a quantitative approach and the influence of dams

The Mediterranean drainage basin incorporates more than 160 rivers with a catchment >200 km^2 , of which only a few are larger than 50 x 10^3 km^2 : this observation emphasises the role of the smaller rivers. The present investigation, incorporating the analysis of the data sets from 69 rivers, has estimated a total sediment flux of some 1 x 10^9 tonnes (t) $year^{-1}$; of this, suspended sediment contributes some two-thirds of the load, with the remaining third supplied by the combined dissolved and bed-load components. The magnitude of the sediment supply is best demonstrated by various observations: (i) some

46% of the total length of the Mediterranean coastline (46,133 km) has been formed by sediment deposition; (ii) many Mediterranean deltas have prograded in recent times by, at least, several metres per year; and (iii) Holocene coastal (inner shelf) deposits are some tens of metres in thickness. The contruction of hundreds of dams around the Mediterranean Sea, especially over the last 50 years, has led to a dramatic reduction in the sediment supply- to approximately 50% of potential (natural) sediment supply. Such a reduction is considered to be the primary factor responsible for the loss of coastal (mainly deltaic) land, with annual rates of erosion ranging form tens (Ebro, Po) to hundreds of metres (Nile).

3. Man-Induced Salinity and Temperature Increases in Western Mediterranean Deep Water

An historical database has been used to study the property changes in both the Western Mediterranean Deep Water (WMDW) and the Levantine Intermediate Water (LIW). Changes in WMDW properties during the past century have been described previously, although on a more limited data base. In the extensive data base used, increases appear in both WMDW temperature and salinity, from 1909 to the present, which substantiate previously reported observations. In addition, the density of the WMDW appears to have increased, which disagrees with previous suggestions that it has remined constant. The WMDW temperature increase displays a distinct acceleration, starting around 1955. A similar, although less conspicuous, accelerated increase occurs in the WMDW. From a study of historical data on LIW properties, the LIW salinity also appears to have increased, since 1909. It is argued that the warming trend in WMDW may well be a response to the salinity increase, which seems to be imported from the eastern Mediterranean freshwater budget; this, in turn, results from the damming of major rivers that drain, either directly or indirectly, into the eastern Mediterranean. Finally, it has been demonstrated that the basin has not yet reached a new ‘steady state’ after this freshwater disturbance and that the response time of the system appears to be of the order of 100 years.

4. Why the Mediterranean Sea is Becoming Saltier

Anthropogenic changes have been made to the water budget from the Mediterranean Sea, as a result of river diversion projects. The decrease in freshwater inflow to the Mediterranean represents an effective increase in the overall net evaporation over the basin. Hydraulic control models for the exchange between the Mediterranean and the Atlantic, through the Strait of Gibraltar, predict that the salinity of the Mediterranean should increase if the net evaporation over the Mediterranean increases. Increases in salinity of the deep waters, in both the western and eastern Mediterranean basins, have

been observed. The causes of such higher deep water salinity are attributed to increases in intermediate water salinity, which are ultimately mixed down into the deep sea during wintertime buoyancy loss events. The pattern of the Mediterranean salinity increase is instructive for understanding how the water masses properties in a basin change, over time, as a result of anthropogenic influences.

The Inseparable Relationship between Marine and Terrestrial Ecosystems through Water

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It is commonly agreed that terrestrial and ocean ecosystems are in a closely connected through rivers. When one observes the coastal zone of the ocean close to the river mouth, it is easy to imagine the strong influence of river on the coastal marine ecosystem, as the water from the river is distinct and recognizable from the oceanic water in its difference of color and turbidity. It is however hard to say that the relationship has been fully understood through scientific research.

From the marine ecological points of view, following 6 items can be raised as major influences of terrestrial ecosystems on coastal environments.

1. Supplying nutrients
2. Supplying trace elements such as iron
3. Supplying anthropogenic substances
4. Supplying organic materials
5. Supplying inorganic sedimentary materials
6. reducing water salinity

With the global geological pattern of oceanic primary production being recently easily observable via satellite images, it is clear that the coastal area is highly productive throughout the globe. This pattern suggests that land is one of the major sources of nutrients for the marine ecosystem, and of course nutrients are conveyed from land to the ocean via river water. One of the important characteristics of marine ecosystem is that due to vertical transport of primary production from the euphotic zone to the deep sea, nutrients are quickly removed from shallow water where phytoplankton can obtain enough light for their growth. Thus, a continuous supply of nutrients from land to the coast is necessary to maintain the productivity of coastal water.
However a continuous supply of nutrients is usually provided only through rivers which have constant volume of water flow. Such pattern is established only in areas where rich forest is growing in mountain areas. If deforestation occurs, water flow in the dry season will be extremely limited, and it will cause a defect of nutrients in the marine area. In such

circumstances, slightly higher amount of rain fall will cause flooding in these areas, and nutrients from the land will be lost to the oceanic area.

Rocky shore denudation is one of the major environmental problems in the northern Japanese coastal waters. In such areas, although enough nutrients exist, growth of algae is abnormal in that calcareous algae predominate over brown algae that should be the dominant taxa in the temperate and boreal hard-bottom coasts. Studies have suggested that iron plays a key role for organizing rocky shore coastal ecosystems as well as open ocean phytoplankton growth. For example, in the Antarctic ocean or boreal north Pacific, where although nutrients exist, phytoplankton does not grow as expected, artificial supply of iron to the surface water stimulated rapid growth of diatoms.

Iron is a metal that is difficult to dissolve in seawater. In addition, phytoplankton can only use iron of a certain condition in seawater. In the coastal area, such iron useful for phytoplankton is supplied from soil of the land. It is known that soil of forests provides more iron to the ocean than does grass land, and the soil of forests consisting of deciduous trees provides more iron than that of acicular trees. Thus conservation of virgin forest is important not only for the terrestrial ecosystem but also for the marine ecosystem as a major source of iron that is indispensable for the primary production that supports the coastal ecosystem.

More than 70% of human population inhabits the coastal zone. Their impact on the marine ecosystem is thus most severe in the coastal area. Excess supply of nutrients causes serious problem such as red tide and harmful algal bloom in the coastal marine ecosystem. There are various sources of excess amount of nutrients, such as fertilizer and human waste. To consider the human impacts, not only the quantity of nutrients but also composition of nutrient species should be taken into account.

Diatom is the most popular phytoplankton in the ocean. For the growth of this plant taxon, not only nitrogen and phosphate but also silica is indispensable. The anthropogenic nutrient supply however does not contain enough silicate, and so excess amount of nitrogen and phosphate will remain in the coastal ocean. On the other hand, flagellates need only nitrogen and phosphate for their growth and silica does not limit their growth. Thus, anthropogenic eutrophication favors explosive growth of flagellates that often produce toxic substances and cause mass mortality of fishes in culture as well as in nature.

Primary production on land is a significant energy source for marine animals. Recent

study of tropical coastal areas suggests that leaves and litters provided from mangrove forest growing in the freshwater area is a major nutrients or source of detritus that supports benthic community of equatorial coastal ecosystem. Recently a lot of mangrove forests have been destroyed in order to use the area for aquaculture or to obtain wood as a source material of pulp and charcoal. Such deforestation of mangroves seems to seriously impact on coastal marine ecosystem.

Rivers also deposit a huge quantity of sedimentary materials into the coastal marine environment. Loss of balance between the supply of sediment from the land and transport of sediment from seashore to the offshore area causes a number of environmental problems along the coasts. Due to loss of seashore, sea turtles have lost many breeding grounds. Erosion of soil in the tropical rain forest causes destruction of coral reefs. To maintain water reservoir quantity, huge amounts of soil are occasionally released from dams in upper rivers into the coastal environment. Such unusual sedimentation causes mass destruction of underwater algal forest growing in shallow water ecosystems.

Brackish water made through mixing of oceanic seawater and freshwater from a river is also very important for organization of the coastal ecosystem. Many species migrate between marine and freshwater ecosystems through the brackish zone. This zone provides those organisms enough time to acclimate their physical condition from a saline condition to a no-saline one. Fluctuation of this environment thus will impact on the organisms, bringing them into a critical condition. To stabilize this fluctuation, the flow of rivers should be constant, and again, from this point of view, forests will help in the conservation of rich coastal aquatic ecosystems.

In turn, marine ecosystems also influence the terrestrial environment. For example, climate change occurs in association with change in ocean ecosystems. Another influence of marine ecosystems on the terrestrial realm is the movement of nutrients and organic materials from marine areas to the land through migration of fishes such as salmon and birds.

In conclusion, water is indispensable for life, and from this aspect, it might be said that the aquatic realm is equivalent to the biosphere. Water is circulating in various shapes within the biosphere. Within this circulation, a variety of materials is transported between ocean and land. In addition to this, however, life itself conveys materials actively. Demonstrating this function of biota is critical for a comprehensive understanding of global ecosystem.

森は海の恋人

畠山重篤
牡蠣の森を慕う会

ただいまご紹介をいただきました、畠山と申します。

私は北日本の三陸リアス式海岸の気仙沼湾という所でカキとか帆立貝の養殖をしているフィッシャーマンです。
なぜ今日こういう場所に来ているのかと言いますと、私は１５年前から海の環境をよくするためには海に注ぐ川を保全すること、そしてその川の上流の森を豊かにすること、それは大事であるということに気がついたからです。今年の６月の第一日曜日に漁民の仲間と一緒に山へ行きまして木を植える植樹祭を行うのですが、15 年前に比べまして私達の気仙沼湾は少しずつ良くなって来ました。私もカキの養殖業者でありますので他のあちらこちらのカキの養殖場を見学する機会があります。日本だけでなく、ほとんど全世界のカキの養殖場も見てまいりました。カキの養殖場はご存知のように川の河口にあります。川の水が流れていないところにはカキはできないのです。それはなぜかといいますとカキの餌は植物プランクトンであるからです。植物プランクトンが増えるには、学者の皆様ですから当然言うまでもありませんが、さまざまな栄養塩が必要です。その中で海の中で非常に不足している栄養塩があるわけです。カキの餌となっているのは主に植物プランクトンの中でも珪藻類というプランクトンなわけです。珪藻類は体の外側に珪酸というもので出来ている殻を持っているわけです。ですから川から珪酸というものが海に流れて来ないと珪藻類というものの繁殖が非常に難しくなります。それから海の中で非常に不足している成分が先ほど先生からお話しがございましたように、鉄分です。この鉄分の供給がどこからなされているかというと、これが私達が一緒に研究して戴きました北海道大学の松永勝彦という方の研究で、森林が非常に大きく係わっているということが解りました。そのメカニズムはどういうことかと言いますと、植物プランクトンは窒素とかリン、そういうものは当然必要です。窒素は硝酸塩という形で存在しております。リンはリン酸塩という形で海のなかに存在しております。植物がこれを吸収する時に還元しなければならないんですが、その還元するときの還元酵素に鉄分が密接にかかわっております。その鉄分が海の中で、非常に不足しているわけです。そのメカニズムは森林の葉っぱが毎年落ちまして腐植土、森林の葉っぱが腐りますね。この中で森林の葉っぱが腐る時に、様々な物質が出来るそうでございまして、その代表的なのがフルボ酸という物質です。これが、土の中でイオン化した、要するに、水に溶けた鉄と結びついてフルボ酸鉄という形になるんですけれども、鉄はご存知のように酸素と結びつくと酸化して粒子になってしまいますので、この粒子が

いくら海に供給されてきても粒子は大きすぎて植物の表面を、細胞膜を通過できないわけです。ところがこのフルボ酸と結びついたフルボ酸鉄というのは非常に小さい形の粒子でありまして、これは植物の表面を細胞膜を通過できる鉄だそうです。といメカニズムがわかってまいりました。

もちろん森だけがいくら良くなっても、今度は森と海の間に住んでいる人間の意識が問題になっております。つまり川が汚れたのでは海は良くない、いつまでたっても良くならないわけです。私達は山に木を植えると同時に、川の流域に住んでいる人々の気持を、川をやっぱり汚さないような生活をしてもらうという風なことを、やはりやらないと最終的に海は良くならないということを考えました。大人にそのことをいくら話してもなかなか方向転換は出来ないので、これは最終的に子供の時からの教育にやはり期待するしかないなということにも気がつきました。それで今、毎年川の上流域の農家の子供達を海に呼んできまして、海の生き物や河口域の生き物は何で育つのかということや、それから人間の生き様と言いますか、そういうものは全部川を通して海に影響があるという風なことを子供達に体験を通して教えることをずーっと続けております。すでにそのことは 12 年間続けておりました。私達の養殖場には今までだいたい 6000 人の子供達を迎え入れました。10 年前に 10 歳に来た子供達はもう大学に行っておりまして、あるいは京都大学にもきっと来ているかも知れませんし、東大にももちろん何人か入れ込みましたし、各地の大学にそういう子供達が行っております。それから子供達を山にもちろん植林の時に連れて行きまして、海と山と両方の体験を子供達にさせております。これは子供達にプランクトンを取って参りまして、顕微鏡でモニターなんですけどあれでキートセロスはどういうプランクトンであるとか、なんでこういうプランクトンが育つのかとか、カキが一日 200 リットルもの水を吸い込んで、そういうものを食べているとか、ま、そういうことを子供達に今、毎年体験学習を通して教えております。この 15 年の間に気仙沼湾に注ぐ大川という川があるんですけれどもそこの流域に住んでいる人々の意識がずいぶん変わってきました。体験学習で来た子供達が時々作文をよこしてくれますけれども、その中の極め付きは、私のところへ体験学習に行って、行った次の日から、私達は朝シャンで使うシャンプーの量を半分にしましたとか、お母さんと台所の排水の穴にストッキングを入れてそれで台所からゴミを流さないようにしましたとか、それから洗濯の時に使う洗剤を注意するようにしましたとか、　それからお父さんには、農家の子供達ですから、農薬とか、除草剤とか、そういうものを少しでいいから減らしてくれるようにお願いしたとか、そういう手紙が来ます。気仙沼湾に注ぐ大川は 25 キロぐらいの小さい川ですけれども、この川の上流は人口 6000 人のムロネン村という所ですけれども、今ムロネン村の子供達は毎朝歯を磨く時の歯磨き粉の量まで注意している生活をしているという風にまで変わってきました。子供のそういう気持は親に伝わる、親から行政にも伝わって行きます。今まで下流のことを考えて川の上流の人間が暮らしていくはという風なことはあまりなかったですけれども、やはりそういうことを解って、上流域の人間として海のことも考えなきゃいけない。それで農

業のありかたも環境保全型農業に少しずつ変えて行きましょうという風なことも始まってきました。農薬を使わないで合鴨を使って米を作るという人も現れてきました。我が大川は今、宮城県で一番いい川になりました。鮭も宮城県で一番上がってきます。何万匹も上がってきます。それから水中昆虫もすごいです。水産試験場がブラックバスの調査のために魚の調査をしましたけれども絶滅種とも思われているような魚まで我が大川には住んでいることも解ってきました。当然それは海に影響してきます。20 年ぐらい前までは私達も赤潮で大変苦労した時代がありましたけれども、今はそういうことは全くおこりません。ですから、問題は人間の問題だなということに私達が気がついているわけです。ですから、それは森林が大事だということはわかりますけれども一番、この川が流れ込む汽水域、海の環境を守るのは最終的にはやはりこれは教育に行くなという、そのことを私達は実感しております。　ですからそのことが日本では今教科書に取り上げられまして、小学校に行きますと必ず社会の教科書でそのことが「森は海の恋人」というタイトルで出てまいります。それから、これは中学校三年生の国語の教科書ですも、とうとう高校の教科書にもこれが登場いたしました。それは国がやはり最終的には人間が何に価値観を持ってどういう生きるのかという風なところまでこの話が行くということは見極めたと言いますか、日本は大したもんだと私はそういう意味で思っているわけです。

私達の気仙沼湾に注ぐ大川の上流に一人の歌を読む歌人がいらっしゃいます。熊谷龍子さんという歌人です。私はこの人と出会いまして、「森は海の恋人」という言葉を作っていただきました。「森は海の恋人」というその言葉の意味は非常に深いものがあります。是非この言葉を全世界に向けて、広げたいという風な願いを持っております。

それで、今私はその歌を下手くそな英語で読み上げますのでまず日本語でその歌をご披露致しますと熊谷さんという方は一種のこういう歌を作りました。

森は海を海は森を恋ながら悠久よりの愛紡ぎ行く

でそういう気持がやっぱり最終的に汽水域を守ることだという風に今確信しております。それで最後に私の下手くそな発音で通じるかどうかわかりませんけれどもそういうことを朗読して、終わりといたします。

As the Forests sighs for the Sea
The Sea yearns for the Forests
Eternal seeds of love are “spread”

ありがとうございました。

The Woods, the Darling of the Sea

Shigeatsu Hatakeyama
Society to Protect the Forests for Oysters

The woods love the sea, the sea the woods,
And they have weaved love
from time immemorial.

by Ryuko Kumagai

The Woods, the Darling of the Sea

> I am a fisherman, specializing in oyster cultivation in Kesunnuma Bay, Miyagi Prefecture, on the convoluted Sanriku Rias coastline.
>
> I have been growing oysters for more than forty years, but about fifteen years ago, a certain event led me to venture into the mountains located on the upper reaches of the Okawa river, which feeds into Kesennuma Bay. In these areas, I have been helping to cultivate forests of broad-leaved deciduous trees. In addition, I have been endeavoring to bring primary and secondary school students from the upstream areas to visit the sea and learn about how marine organisms grow. Why did a fisherman become interested in forests and schools? I would like to discuss the ideas behind the phrase "the woods are the darling of the sea".

A sea suitable for oysters

Do you like oysters? Raw oysters, eaten with a squeeze of lemon juice. Hot oysters in a stew. Deep-fried oysters, coated in crispy batter. Oysters are one of the best-loved types of shellfish, whether raw or cooked. The link between oysters and humans is old; oyster shells have been found in ancient shell mounds on coasts around the world. Traces of shelling dating from Japan's Jomon era have been discovered in Tokyo's Kaminakazato area. These are the so-called Kaminakazato shell mounds. Oyster shells are heaped in a mound that is seven meters high, thirty meters wide and over one kilometer long. According to studies carried out by archeologists, this is the result of more than five hundred years of continuous oyster shelling.

Although it may come as a surprise, even now oysters can be found on the floor of Tokyo Bay in groups stretching across several kilometers, from Kisarazu to Futtsu. The areas of Japan that produce the largest volume of oysters include Hiroshima Bay on the Setouchi coast, and the bays along the Rias coastline of the Sanriku area. These locations, including Tokyo Bay, share one thing in common; they are fed by rivers.

To begin with, the inlets of the Sanriku Rias coast are all fed by rivers. This is, of course, because the convolutions of the coastline were formed as rivers carved out valleys on their way to the sea. The floor of these valleys dropped as the result of seismic movement, deepening them further. In the Jomon period, climatic warming caused the sea level to rise, filling the valleys with seawater. This is how they came to be called “drowned valleys” in Japanese ―― not a very poetic term. Perhaps because of that, the Spanish term ‘Rias’ has come to be used. In Spanish, this term refers to tidal rivers.

The result of these changes is that every inlet, however small, has a river feeding into it. In Miyagi Prefecture, Japan’s fourth-largest river, the Kitakami River, feeds into Ishinomaki Bay, creating one of the world’s largest producers of baby oysters.

The number of rivers around Tokyo Bay is also astounding. It is said that the bay, large as it is, could be filled by the rivers in only two years. In the Jomon era, the Tone River also fed into the bay, so the estuary would have been a mixture of fresh and salt water. The fresh seafood and laver(seaweed) in the bay is a benefit of this. For oyster farmers, the fact that oysters grow well in the bay is no surprise. Incidentally, Kagoshima Bay in southern Kyushu covers roughly the same area as Tokyo Bay; however, Tokyo Bay produces more than thirty times as much seafood. This difference can, without doubt, be attributed to the difference in the number of rivers feeding the bay.

Hiroshima Bay is the largest producer of oysters in the world; at one time, it was responsible for producing 20% of the world’s total volume. Even though it is connected to the sea, it is buried deep in the enclosed Setonaikai area. Why does such a poorly located bay produce so many oysters? It is because the great Ota River, which has its roots in the area around the Shimane border, feeds into the bay. If you go to Hiroshima, you will soon notice that it is covered in bridges - a true water city. Unfortunately, dam construction on tributaries of the Ota River has reduced Hiroshima Bay’s production.

As you can see, the number of rivers feeding into the sea can result in a difference of thirty to a hundred times in its production of seafood. The current problems with seaweed

in the Ariake Sea in northwestern Kyushu also have their origin in the rivers.

We fishermen have known through experience that in years where rain and snow is infrequent, seaweed and oysters do not grow as well. However, marine biologists working in experimental marine centers never told us the scientific mechanism behind this phenomenon. That explanation came when we encountered chemists.

Looking at living things through the eyes of chemists
I think that my meeting with Professor Katsuhiko Matsunaga, of the marine fisheries faculty of Hokkaido University, was a very fortunate occurrence.

At one time, great herds of herrings traversed the Japan Sea side of the Hokkaido coastline, and as is sung in the “Soran” folksongs of the fishermen living in the area, it was once a very successful fishing area. However, it is currently experiencing the phenomenon known as ‘isoyake’, which results in a desert-like sea containing no seaweed. The boulders on the seabed along the coastline are covered in calcareous algae, which makes them appear as if they had been coated in white paint. This organism excretes a substance from its body that destroys seaweed spores, preventing seaweed from clinging to the boulders.

Professor Matsunaga insisted that the cause of this situation was in the forests, many miles from the sea, and the rivers that flowed into the sea. Until then, I had never heard of the idea that the land, and in particular the forests, could be related to what was occurring in the sea. I will touch on Professor Matsunaga’s explanation in a moment.

The richness of the ecosystem around river mouths was well-known as a phenomenon, but the compounds supplied by the river that contributed to this biological richness were unknown. One cause of this was that most researchers working on marine science were biologists, making measurement of the trace elements contained in river and sea water impossible.

Professor Matsunaga did his post-graduate work at Osaka University after graduating from Kyoto’s Ritsumeikan University, and originally specialized in the analysis of trace elements in seawater. After he joined the marine fisheries faculty of Hokkaido University, he began to study biology from the viewpoint of a chemist.

He started by telling me about the relationship between the growth of phytoplankton and

seaweed, and the iron content of seawater. Basically, plants can grow with only sunlight, carbon dioxide and water, but further nourishment is required to grow larger. In the sea, nitrogen(nitrates), phosphorus(phosphates) and silicon (silicate), among others, are needed. In particular, when absorbing large amounts of nitrates, it must be deoxidized. Nitrate reductase is necessary for this deoxidization, but iron is also closely related with this process. Furthermore, iron is vital for the production of chlorophyll, which is a requirement of photosynthesis. In other words, plants cannot grow without iron.

On land, iron is contained in the earth in large quantities; thus, it is rare for there to be a shortage. However, in the sea it exists only in very small amounts. The reason for this is that iron reacts with oxygen to form particles of iron oxide. As phytoplankton and seaweed increase, so do their production of oxygen through photosynthesis. Normally, the iron content of the seawater would combine with this oxygen and the resulting particles would fall to the seafloor. The reason that marine organisms are so common around river mouths is that iron is supplied by the river; however, the form this iron took to avoid oxidization was not known.

Professor Matsunaga succeeded in explaining the mechanism behind this. His research was revolutionary. The mechanism is as follows. Leaves from trees in the forests (in particular broad-leaved deciduous trees) fall and gradually build up on the ground, forming leaf mold. At that point, a compound called fulvic acid is formed. Fulvic acid binds easily and strongly to iron. Iron ionizes (dissolves in water) in the unoxygenated layer below the leaf mold. In this state, it binds with the fulvic acid, and becomes iron fulvate, which does not oxidize even in the presence of oxygen, allowing it to reach the sea. Thus, the sea around a river mouth has a larger amount of seaweed and phytoplankton, which in turn results in a larger amount of seafood higher up the food chain. Even in the ‘isoyake’ area on the Japan Sea side of Hokkaido, areas of the sea fed by rivers contain more seaweed and have a smaller proportion of ‘isoyake’. This can also be attributed to the ability of iron to bind with a variety of compounds - I have heard that scientists call it the “carrier element” - as it attaches to a compound that kills the calcareous algae responsible for ‘isoyake’ and carries it to the sea.

The fishermen climb the mountain

In September 1988, the enormous flags of a fishing fleet were flying over Mt. Murone, which overlooks Kesennuma Bay. The place was Murone Village in Iwate Prefecture, located at the upper reaches of the Okawa River which feeds into the bay.

Although unused to such work, the fishermen were planting broad-leaved deciduous tree seedlings, such as beech, oak and witch hazel. Previously, forest cultivation tended to focus on planting conifers such as Japanese cedar and cypress, but broad-leaved deciduous trees produce richer leaf mold more quickly.

These trees, which do not produce commercially valuable wood, were rapidly felled after the fuel revolution in the 1950s, and the land was replanted with conifers. However, as restrictions on the import of lumber were reduced, and cheap lumber began to be imported from overseas, the price difference between local and imported timber widened rapidly. Right now is the time when thinning of these forests should be taking place, but there are many mountains on which the forests are left uncared for. Every time rain falls, soil is carried away into the rivers from these mountains, which have no undergrowth. The muddy-brown rivers, cloudy with the soil suspended in the water, feed into the sea, greatly damaging the growth of seaweed and phytoplankton. These mountains at the headwaters of the rivers have very serious problems.

In farming, there have been problems with the overuse of pesticides and chemical fertilizers. In the rivers, dam construction and concreting of river banks causes further problems for the ecosystem. The lifestyle of people living on the land, including such things as domestic and industrial waste water and the reclamation of tidal flats, eventually affects the sea. The administrative systems of the government are internally divided and provide no solutions. However, we are all connected with the natural world. The planting of trees by fishermen is intended to remind people of this fact.

The replanting work I began in 1988 has now reached its fifteenth year.
The area we have replanted covers about ten hectares, and contains roughly 30,000 trees of fifty varieties. The forest has grown. My work in educating schoolchildren from the rivers' upper reaches has continued for thirteen years. The children I have invited down to the sea number more than six thousand. I began that work after I realized no matter how large the forests grow, if the attitudes of the people living along the river tributaries do not change, the rivers and the sea will never get better.

As people's attitudes have changed, the number of aquatic insects living in the rivers has increased. Fish that had not been seen for several years along the coast, such as black rockfish and sea horses, have also reappeared. The true meaning of fishermen planting trees in the mountains lies in the reintroduction of nature into people's hearts.

Southwest Monsoon: Provider of Water to South Asia

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1. Introduction

A distinct feature of the Earth's tropical climate is a belt of rain-bearing clouds that girdles the globe. Generally referred to as the Inter-Tropical Convergence Zone (ITCZ), the belt is not stationary. It moves with the Sun, and is normally located in the southern hemisphere in January (Figure 1). By early June it is generally located over the northern hemisphere. At this time over the North Indian Ocean and the surrounding South Asian land masses the ITCZ exhibits its most dynamic behaviour: (1) It disappears over the western Arabian Sea. (2) Intensifies over the eastern Arabian Sea and has a region of very high precipitation located along the central west coast of India. (3) Another region of intense activity is the northern Bay of Bengal where atmospheric processes lead to formation of depressions that bring precipitation to the Indian subcontinent. With (2) and (3) becoming active in June, we say that the Southwest Monsoon has set in. By bringing abundant rain to the region during approximately June-September every year, the monsoon has proved to be a dependable - but there are times of exceptions - provider of freshwater to South Asia.

2. The role of interaction between atmosphere, ocean and land

The three features listed above are a consequence of complex interactions between the atmosphere, the land (particularly mountains), and the North Indian Ocean. Highlighted here are some of these:

(a) As the Sun moves northward during northern hemisphere spring, the land mass of Asia gets heated. In particular the Tibetan plateau, with an average elevation of 5,000 m, serves as an elevated heat source to the atmosphere. This sets up a circulation that brings moist near surface air from the south to the north. There is reverse flow at upper altitude.

(b) The flow from south to north is most intense over east Africa where it attains a jet-like structure (Findlater Jet) that hugs the East African Mountains. The jet triggers ocean processes that cools the western Arabian Sea, making it unsuitable to sustain atmospheric processes that lead to formation of rain-bearing clouds.

(c) The region of high precipitation along the west coast of India is at least partly (particularly over land) the result of topography of the region: the sharp increase

in elevation inland of the coast, known as the Sahyadris or Western Ghats. The ocean processes off the west coast perhaps contribute too. Their role is an area of active study.

(d) The Bay of Bengal stays warm enough throughout the southwest monsoon season (June-September) to support atmospheric processes that produce rain-bearing clouds; this appears to be at least partly related to a low-salinity layer located at the surface. Many rivers bring freshwater to the Bay because of the topography of the continent and hence help in making the bay a breeding ground for important atmospheric processes.

3. Distribution of precipitation over land.

In India an excellent record of precipitation during the last approximately 125 years exists. Figure 2 shows the normal pattern of distribution of precipitation during June-September. Notice that the largest precipitation occurs in the eastern part, the mountainous region to the west of eastern Himalayan mountains. Another region of high precipitation is the west coast of India. Over the rest of the Indian peninsula precipitation decreases from the coastal areas of northern Bay of Bengal towards northwestern India; it decreases further towards Pakistan. This is largely a consequence of storms/depressions that form over the northern Bay of Bengal and then move westward or northwestward bringing rain to the region (Figure 3). For these storms and depressions to form, the bay has to remain warmer than a threshold value of about 28 C. By satisfying this condition, the bay helps in making freshwater available to the Indian subcontinent.

To the north of the region where precipitation values are shown in Figure 2 there is a belt of high precipitation (but with high spatial variability) along the foothills of Himalayas. This precipitation forms the source waters for a number of rivers including the three great rivers of the Indian subcontinent: the Indus, the Ganga and the Brahmaputra.

4. India's water

The rains that the southwest monsoon brings to South Asia become its main source of freshwater. This can be appreciated from Figure 4 that provides an overview of the annual water budget of India over a region of about 3 million square kilometers south of the foothills of the Himalayas. This being the annual budget, it takes into account the processes (precipitation, evaporation, runoff, etc.) during the entire year. It should be noted, however, that the Southwest Monsoon accounts for approximately 80% of the precipitation that the region receives. The 110 cm of average precipitation that the region receives annually translates into 314 x 10^{10} m^3 of water. In addition, the area

receives water in the form of runoff of rivers that originate in the Himalayan mountains. These two contributions together lead to about 225 x 10^{10} m^3 of surface water (in rivers, lakes, etc.) and 106 x 10^{10} m^3 of ground water.

Of the 225 x 10^{10} m^3 of surface water available, about 50 x 10^{10} m^3 are estimated to be put to human use. Of this about 80% is for agriculture, and the rest for domestic and industrial use. A large fraction, about 75%, of the total surface water available goes off to sea as runoff. One reason for such a high runoff to sea is the nature of monsoon precipitation. It generally consists of "active" periods when it rains a lot and "break periods" that are dry. A sizable fraction of the water during active periods ends up as runoff in rivers.

The river systems that contain most of India's water are summarized in Figure 5. The sharp rise in elevation normal to the west coast of India, the Western Ghats, leads to small rivers (about 50 km long, on average) that carry within a period of days a large fraction, by some estimates in excess of 85%, of the rain here to the Arabian Sea. A similar situation also occurs along the mountain slopes on the northeastern part of the Indian subcontinent. In comparison, the rivers that originate on the eastern side of the Western Ghats are long and crisscross the entire peninsula as they move eastward to join the Bay of Bengal. The water of these rivers is much in demand. Water available in these rivers decreases whenever the Southwest Monsoon precipitation is below normal. This often leads to conflicts between communities that share waters from the rivers.

As seen from Figure 4, the groundwater available to India is little over 225 x 10^{10} m^3. About 80% is lost to evapotranspiration. The remaining caters to about a third of irrigation (some have estimated this figure to be close to a half) and other needs. A concern about the groundwater resource is that it might have already been overexploited and hence damaged.

The water budget given in Figure 4 provides a broad picture. Local water budget can differ significantly from location to location. Overall, the budget tells us that of the total water available as surface water and ground water, well over 75 percent is lost through natural processes: runoff and evapotranspiration. To a great extent this loss is inevitable. However, there are water management practices that can reduce the losses. The large losses imply that potential exists to make more water available for human use. There is therefore scope for judicious use of natural systems.

5. Implications of Southwest Monsoon inter-annual variability

As pointed out earlier, the Southwest Monsoon precipitation consists of active periods when there is heavy rainfall, and break periods that are dry. The number of days of active and break periods determines the rain that south Asia receives during the southwest monsoon. Figure 6 shows how all-India rainfall during the southwest monsoon has varied during the last century. Annual departure from the mean is generally less than 10%. The June-September all India mean precipitation is 85 cm and the standard deviation 9 cm (Anon., 1996). This makes the monsoon a relatively stable feature of the climate, but the variation that does occur is enough to lead to considerable hardship to the people of the region.

One reason for the hardship is that in the regions of scanty precipitation (see Figure 2), a 10% drop in all-India rainfall can imply a much larger drop in local precipitation. There exist considerable spatial differences in coefficient of variation of the rain. The variation is smallest along the west coast of India, northeastern India, Bangladesh and the land to the northwest of northern Bay of Bengal. It increases from the northwest coast of the Bay of Bengal towards northwestern India. The variability is largest over the northwestern part of the country. In essence, the coefficient of variability increases with decrease in rainfall. Hence whenever Southwest Monsoon precipitation is below normal, areas that can afford it the least, suffer the most.

Agriculture suffers because a large fraction of it is rain-fed. During the last few decades Indian agricultural production has shown enough increase to feed its population and sometimes even generate some surplus. This has been possible through introduction of new technologies (improved varieties of seeds, for examples) and improving availability of water. However, the agriculture's dependence on the Southwest Monsoon is still strong. This can be seen in Figure 6 (lower panel). It shows that years with less (more) than normal precipitation are also years of reduced (increased) foodgrain production. Agriculture is not the only sufferer. As the Southwest Monsoon is the principal provider of water to South Asia, a below normal rainy season implies reduced supply of freshwater to both the domestic and the industrial sectors. This imposes serious stresses on the socio-economic fabric of the region, both in the urban and rural areas.

6. Forecasting of the Southwest Monsoon

The best way to reduce the socio-economic stresses would be to have an ability to predict the monsoon at least a few months in advance. Can the present models of the global

atmosphere-ocean system do it? In Sections 1 and 2 we saw that the Southwest Monsoon not only has links to global-scale atmospheric processes such as formation of the ITCZ, but it is strongly influenced by local factors such as heating of the atmosphere by Asian land masses. The monsoon is also influenced by other factors such as the El Nino and Eurosian snow cover. No global-scale coupled atmosphere-ocean model available at the present can do justice to the full array of processes that influence the Southwest Monsoon. Hence predictive capability of the model in case of Southwest Monsoon has been limited.

A more promising approach has been statistical prediction based on empirical data. After careful search, parameters with potential for forecasting the monsoon rainfall a few months in advance have been identified. These have then been used to prediction total seasonal rainfall. Since about 1990 India Meteorology Department used such techniques for predicting in May all India rainfall during June-September. Their prediction turned out to be reasonably valid till the 2001 monsoon season. The prediction failed in 2002. The monsoon rainfall during this year was lower than normal by well over 15% on average. Of course, in many parts of the country the reduction in rainfall was much larger. The cause of this failure has not been identified.

7. Implications of monsoonal climate to coastal areas

A good fraction of rainfall over the Indian peninsula comes from the storms and depressions that from over the Bay of Bengal (Figure 3). While this is a beneficial impact of the storms, they also have an adverse impact. The storms, particularly the more severe cyclonic storms, lead to generation of devastating surges in sea-level along the coastline. This has made the Bay of Bengal one of the most badly storm surge affected coastal region of the world. The severe damage that has been caused here can be appreciated from the list given by Ali and Chowdhury (1997) of worst killer storm surges on record anywhere in the world. Of the 34 disasters they listed in which death toll was 5000 or more, 26 occurred along the coast of the Indian peninsula. Of these, 15 were along the coast of Bangladesh. An episode in 1970 killed 500,000 in Bangladesh; another in 1991 killed 138,000 in the same country.

The severity of such damage has prompted need for: (1) a system to forecast storm surges; (2) disaster mitigation plans. The first is based on use of storm surge numerical models that use predicted winds to simulate surges. The models have been reasonably successful in identifying the areas that are most vulnerable to an approaching storm. In disaster mitigation plans an effective approach has been construction of elevated

structures for evacuating the population that is in danger of getting affected by a surge.

8. Concluding comments

In this note we have seen how a global-scale feature of the tropical climate, the ITCZ, is influenced by atmosphere-ocean-land interactions to produce the phenomenon of the Southwest Monsoon over the South Asia and the surrounding seas. The phenomenon is the principal provider of freshwater to this region. The natural interannual variability associated with the Southwest Monsoon determines how much more or less better off the region will be in a year.

The dialogue such as the one taken up in this session of the World Water Forum is a welcome step towards developing a holistic picture of the Southwest Monsoon and its implications. Such an approach needs to be encouraged to become aware of the complex array of natural processes that make life sustainable in the region. The approach is particularly welcome because it helps to improve our understanding of the socio-economic state of the almost one-fourth of the world's people who live in South Asia.

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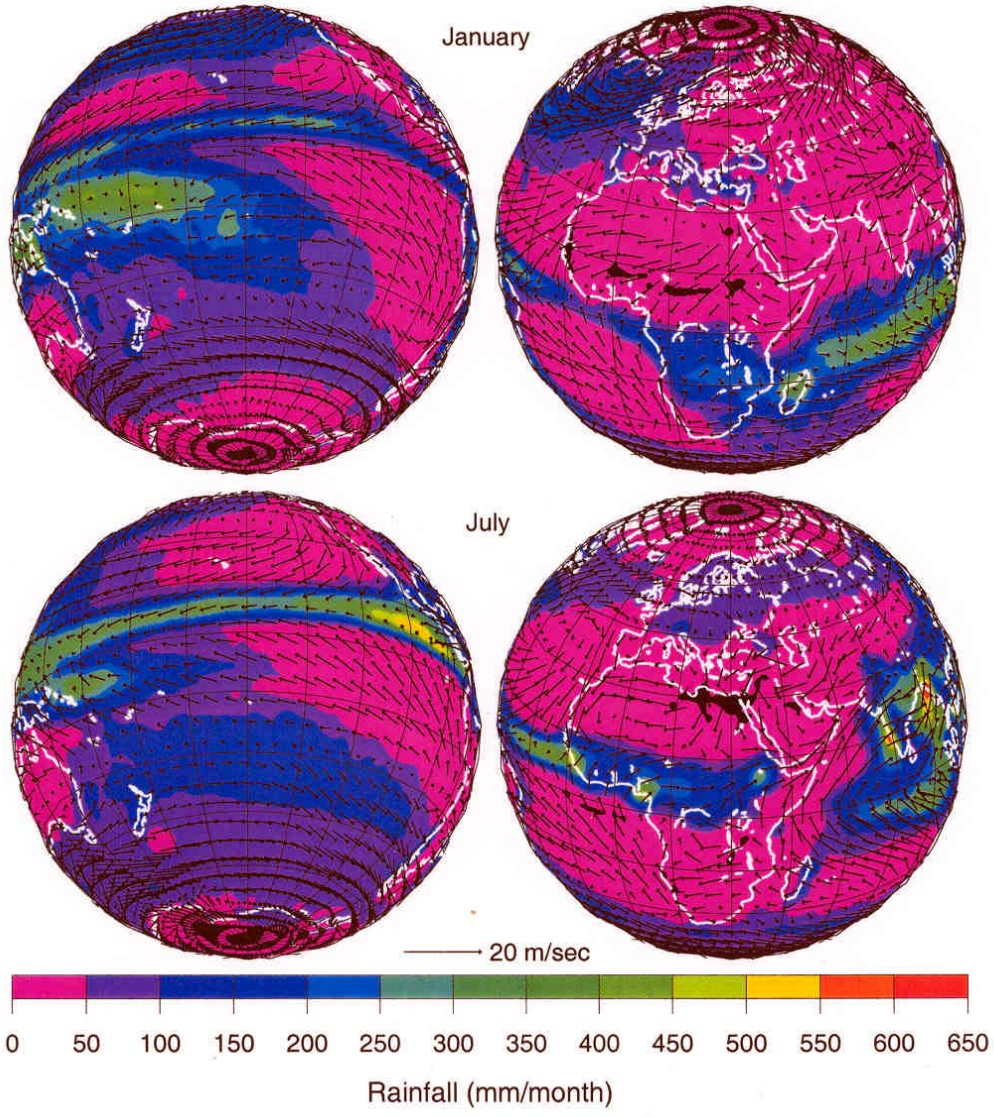

Figure 1: Climatology of monthly precipitation (mm/month) is shown in colour (see scale at the bottom of the figure). Climatology of monthly winds is shown using dark arrows (for scale see the arrow just above the colour scale).

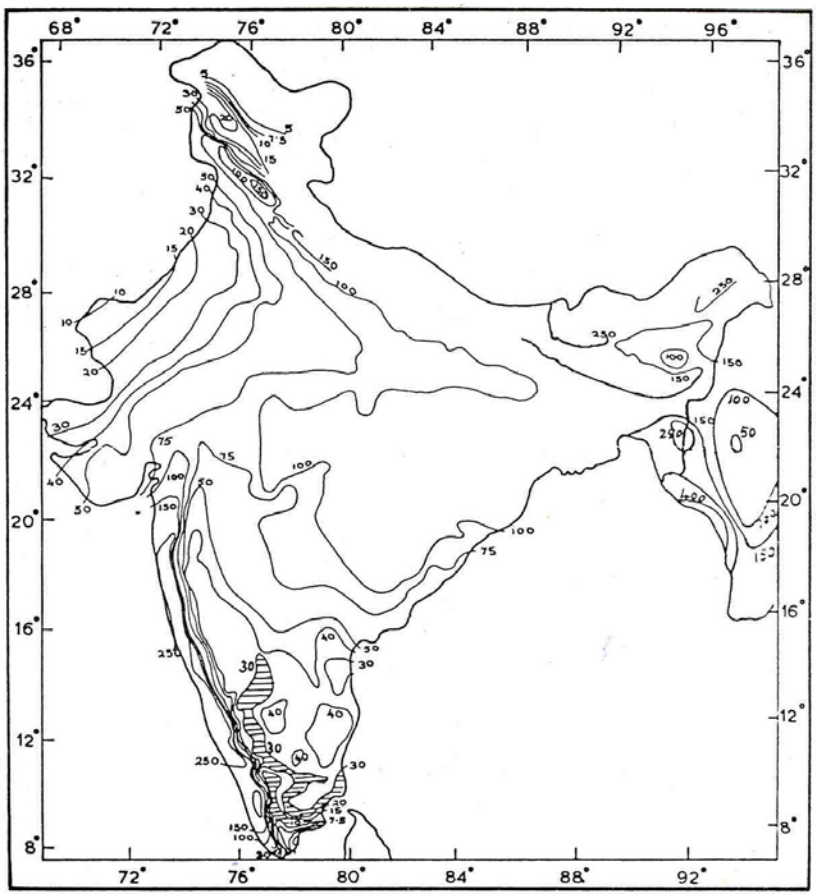

Figure 2: Geographical distribution of the normal monsoon (June to September) rainfall (cm) over India (after Rao, 1976)

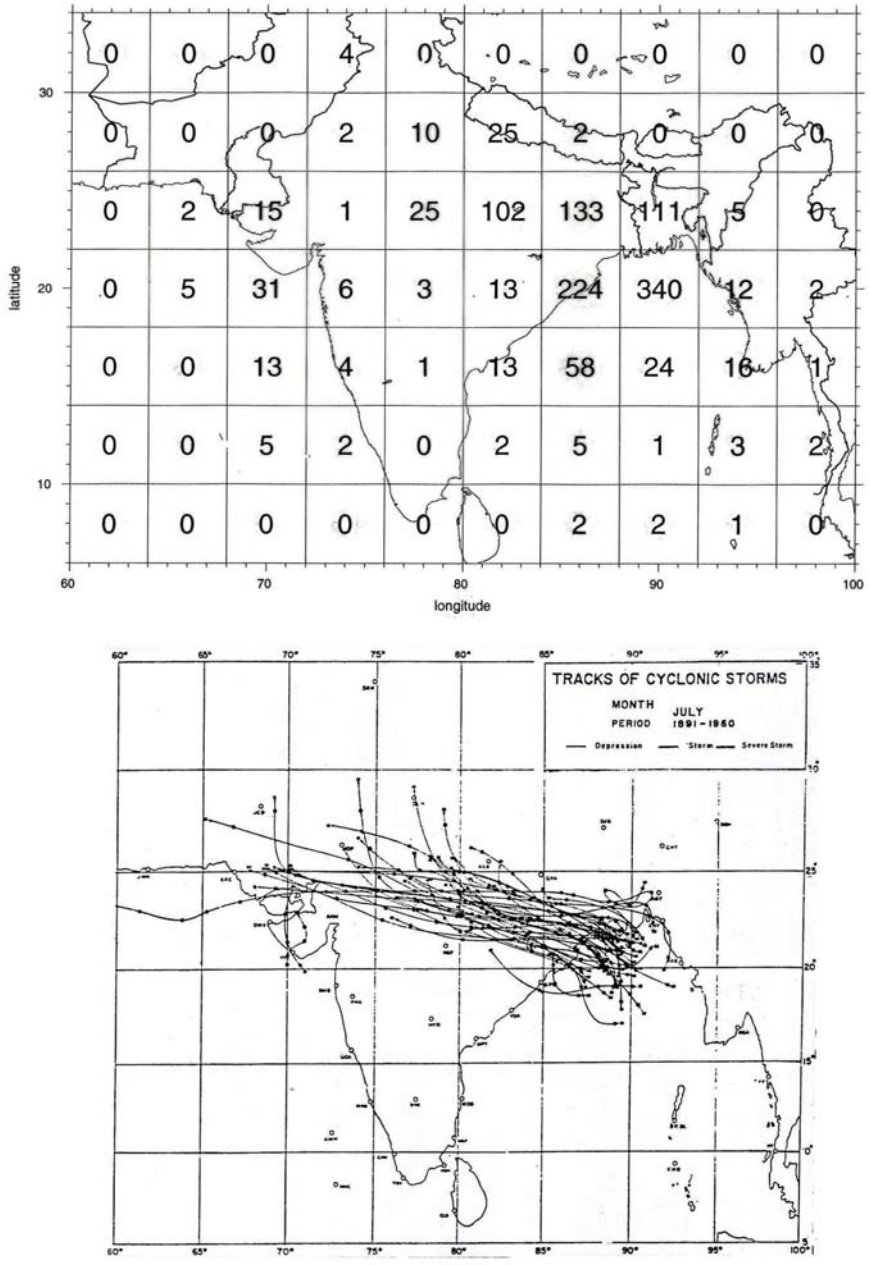

Figure 3: Upper panel: Total number of low-pressure systems that formed during June-September over four-degree-boxes of the North Indian Ocean and the Indian subcontinent during 1888-1983 (adapted from Mooley and Shukla, 1989). Lower panel: Tracks of depressions, storms, and severe storms in July during 1891-1960. (Taken from Gadgil, 2000, and based on data reported by Indian Meterology Department, New Delhi.)

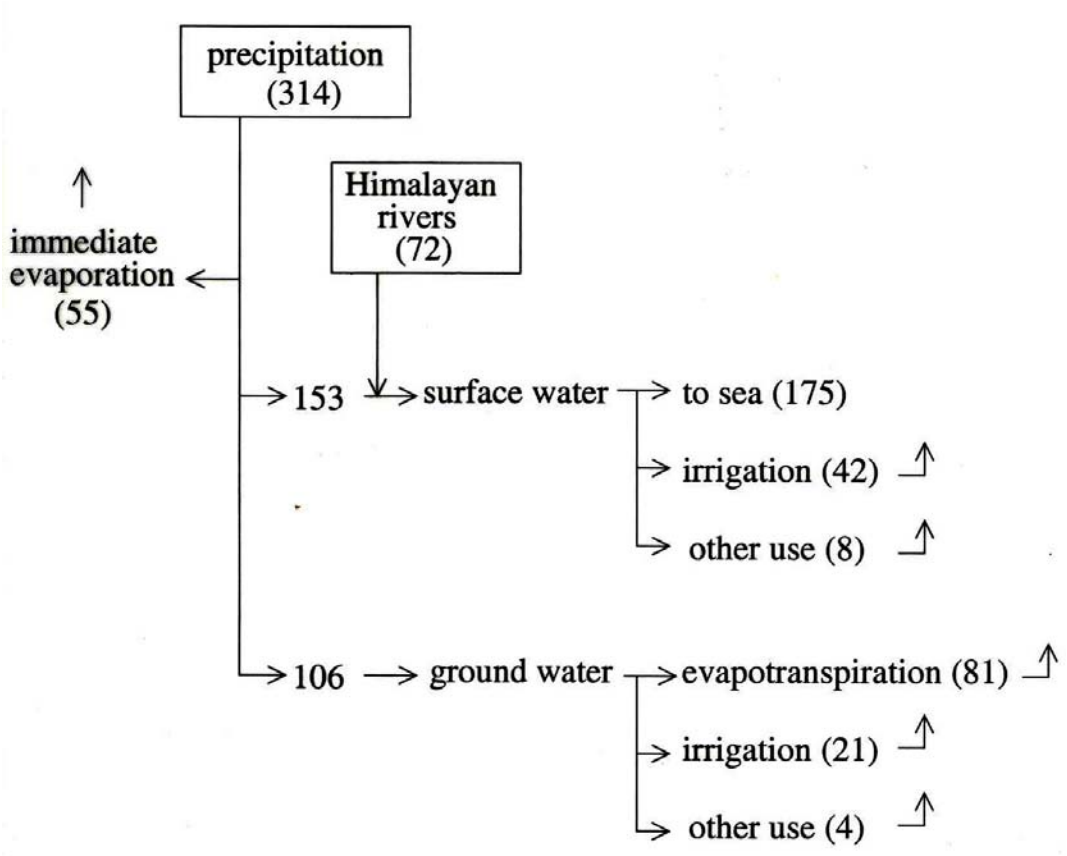

Figure 4: India's annual water budget. The unit is 10^{10} m^3. The area covered for this budget is south of Himalayan foot-hills and is approximately 3 x 10^6 sq. km. Monthly-mean precipitation data are from Indian Institute of Tropical Meteorology, Pune (Parthasarathy data set). Evaporation data are from NCEP/NCAR reanalysis (Kalnay et al., 1996) Other data were taken from: Agarwal and Narayanan (1999), Nag and Kathpalia (1975), and Rao (1979)

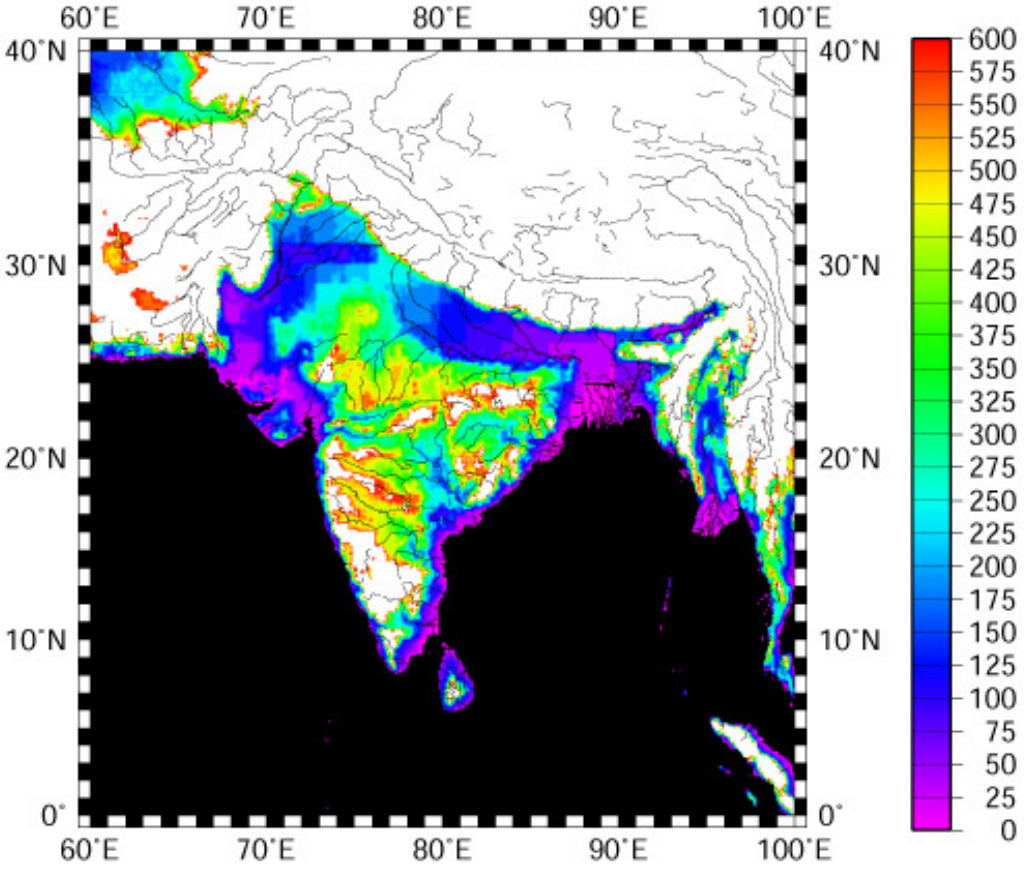

Figure 5: Major rivers and surface elevation of South Asia. The elevation (0-600 m) is shown in colour (scale is given on the right). Elevations above 600 m are not shown. River channels are shown in blue. The elevations are based on ETOPO-5 dataset; river channels are taken from Generic Mapping Tools high resolution database.

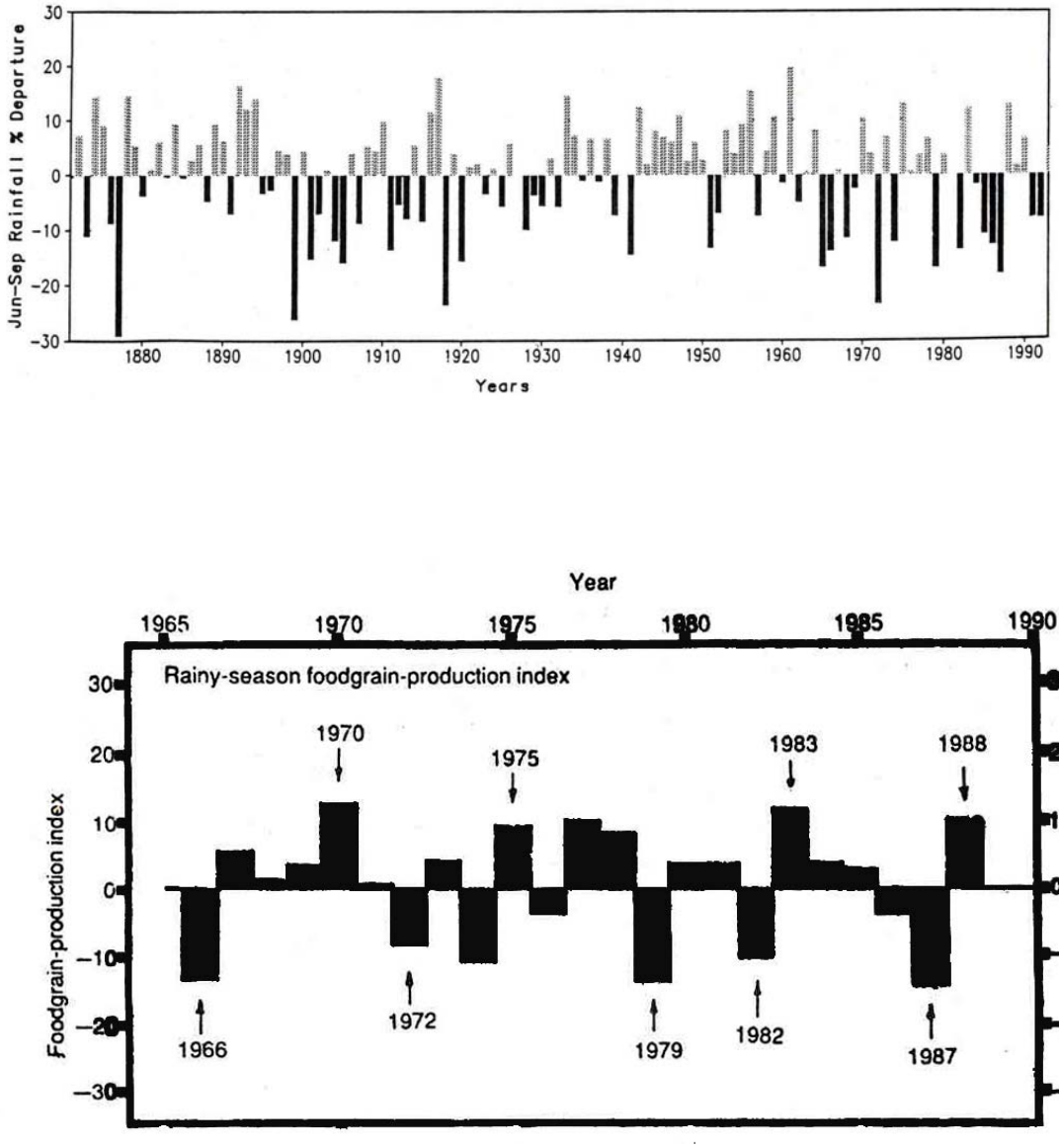

Figure 6: Upper panel: variation of the all India summer monsoon rainfall over the last century as given in Parthasarathy et al., 1994). Lower panel: All India southwest monsoon season foodgrain production index during 1966-88 (Parthasarathy et al., 1992)

The Ocean Model of Comprehensive Management and Education

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1. Introduction

It is well accepted that freshwater is a natural resource which society must treat with respect; in some places it is a delicate resource and a limiting factor for development, just as soil can be. Today about 550 million live in areas with a water shortage; estimated to increase to 1 billion by 2010. The population increase has elevated the freshwater usage and need. The global annual freshwater withdrawal at the end of the last century was about 3800 km^3 and is projected to increase to around 5200 km^3 during the first quarter of this century. While the population has increased by a factor of 3 since 1900, the amount of freshwater has remained essentially the same. The amount of clean and safe freshwater has decreased considerably. On Earth about 40 million km^3 is freshwater, or 2.5% of all water. Of this about 0.3% is available as renewable freshwater for our consumption, or around 120 thousand km^3. Where does the water come from? The ocean provides about 40.10^3 km^3 per year.

The most important source of freshwater is the ocean: we get it through rain, snow or through desalination. The source of the rain is the immense evaporation over the ocean and the evapotranspiration over land. This latter is less than the precipitation over land by about 60%. The evaporation over the ocean is the major source of water vapour in our atmosphere. This is the most important greenhouse gas, without which we would in any case not be living here. The warmer the air is the more water vapour can be stored in it. Very large air masses are carried by regular winds from the ocean towards land. There natural processes of cooling forces the warmer air to release much of its water, as rain or snow. This is the freshwater society must make use of in the wisest way possible. For management of the freshwater amounts it would be extremely valuable if we could know sufficiently in advance when the water is going to come, as rain, snow or river flow. Such advanced knowledge will make it possible to arrange for storage, for protection against flooding and temporary drought, and for the most appropriate agriculture. Such advanced knowledge can now be obtained in several areas through long-range forecasting up to months and over a season. This is possible through the combination of adequate ocean observations and modeling with real-time use of the observations through data assimilation. Again the key to this is the ocean. It is the long memory of the ocean

which makes it possible to achieve the long-range forecasts. This is not possible through use of observations of the atmosphere alone.

The ocean also provides for a model on how to achieve comprehensive governance including an adequate resources management. For the coast it has been realized that integrated management is required. However, this is necessary also for the ocean as a whole. The model has been specified through the United Nations Convention on the Law of the Sea (UNCLOS) of 1982, which entered into force in 1994. This provides for a constitution of the ocean. This has been made comprehensive through the additional conventions and agreements resulting from the United Nations Conference on Environment and Development (UNCED) in 1992 and the related on-going process. Together these provide for a legal and institutional framework. Tools for implementation include: educational, technological and financial means; and means for monitoring, surveillance and enforcement.

The International Ocean Institute's vision is to address the education need and the challenge through the establishment of an internationally recognized interdisciplinary and intersectoral programme of study which will not only serve to facilitate the integration of knowledge, but will also allow access to any professional and student in the world. To realize the vision the IOI Virtual University is being established. This is constituted as a network of education, training and research centers of expertise in ocean, coastal and marine-related affairs and governance, joined together in a partnership to provide for an interdisciplinary and comprehensive coverage of the subject areas.

2. The Ocean Management

It was Arvid Pardo who formulated the seminal idea by stating in his speech to the UN General Assembly in 1967 that "all aspects of ocean space are inter-related and should be treated as a whole."

The how to achieve this was also injected by Arvid Pardo through his other seminal idea that "the resources of the deep sea-bed constitute the common heritage of mankind" to be protected and developed for the benefit of all, and in particular developing countries.

This should not be confused with "the tragedy of the commons." The idea was that the common heritage should be governed, developed, protected, and managed through a suitable international mechanism, possibly under the United Nations.

The basis for the legal framework is the United Nations Convention on the Law of the Sea. The Convention includes a number of innovations, e.g.:

- replacing often conflicting claims by coastal States with universally agreed limits on the territorial sea, on the contiguous zone, on the exclusive economic zone and on the continental shelf;

- an elaborate system for mandatory peaceful settlements of disputes, the most advanced so far ever designed and accepted by the international community;

- the introduction of the principle of the Common Heritage of Mankind as a new principle of international law;

- the establishment of a framework for the development of international environmental law in Part XII of the Convention: Protection and Preservation of the Marine Environment; this has had a profound influence including for the UNCED process;

- the creation of a new regime for the conduct of marine scientific research in Part XIII: Marine Scientific Research, striking an equitable balance between interests of the research States and the coastal States.

The Law of the Sea Convention should be seen as a "process", capable of interacting with changing conditions. It can provide for integration. The Convention provides for regulation of economic activities, and thus can make a contribution to economic security and food security. If the ocean-based and ocean-dependent goods and services were managed sustainably and equitably the positive impact on economic security would be very large. The ocean services influence all sectors of our current service economy. Part XII of the Convention is the most comprehensive and binding instrument to protect the ocean ecosystems and their services, thus providing a great contribution to environmental security. Part XII also provides the legal framework for the ocean-related parts of all subsequent treaties, agreements and programmes resulting from the UNCED process. This framework includes enforcement of rules, regulations and standards, and the Convention includes enforcement also in other parts.

Implementation requires institutions in harmony with the integrated approach.

The basis for the Institutional Framework is found in the Law of the Sea and in results of

the UNCED 92 process, in particular Agenda 21.

The UNCLOS established four institutions:

- The International Sea-bed Authority;
- The Commission on the Limits of the Continental Shelf;
- The International Tribunal for the Law of the Sea, with associated arrangements permitting conciliation commissions, arbitration tribunals;
- The Meeting of States Parties.

The Convention also mandated the establishment of regional Centres for the advancement of science and technology. These have not yet been implemented, whereas the four institutions have been established. Each of these institutions function and are also gradually adjusting to changing situations.

The Commission on the Limits of the Continental Shelf has encountered two major difficulties, both related to the complexity of the definition of the limits of the continental shelf in Article 76 of the Convention. The first is that it is very costly and difficult to prepare the required declaration; the second is that a number of States have already advanced claims exceeding the boundaries, as defined in Article 76. More such claims may well emerge. If boundaries cannot be agreed upon, this threatens to destabilize the convention and the efficiency of Ocean Governance.
The System for Peaceful Settlements of Disputes is a fundamentally important part of the governance, with the International Tribunal for the Law of the Sea, the International Court of Justice, arbitration and special arbitration tribunals and conciliation commissions. The Tribunal has had a number of cases and has delivered judgments swiftly and competently.

The legal framework for Ocean Governance developed through the UNCED 92 process includes essentially 7 other Conventions, agreements, programmes, e.g. Agenda 21; The Straddling Stocks Agreement; The Convention on Biological Diversity; the United Nations Framework Convention on climate change; the FAO Code of Conduct for Responsible Fisheries; the Global Programme of Action for the Protection of the marine Environment from Land-based Activities; the Programme of Action for the Sustainable Development of Small Island Developing States. All these provide for essential elements towards achieving sustainable development; all have strong association or interfaces with the ocean and coasts; all are part of a comprehensive ocean governance

and building blocks for achieving integration of sustainable development and comprehensive security.

The impact of the UNCED 92 Process on the UNCLOS process is large. It extends the scope of the "Constitution for the Ocean" to the coastal land areas where the majority of humankind lives. This is extremely important. For one thing, 80-90% of marine pollution originates from our activities on land. Secondly, the problems of the densely populated coastal zone including conflicts between various users of the space and of the resources, the sustainability of living resources, human health, food and water security,all this also required an integrated approach. This is now referred to as integrated coastal area management. This reflects the seminal idea of Arvid Pardo that "the problems of ocean space are closely inter-related and need to be considered as a whole." It was also realized that the management must be done in conditions of uncertainty and risk. The precautionary principle became a substantial element for sustainable development in conditions of uncertainty.

Integrated coastal management cannot be applied without proper linkages between institutions at all levels: the community, the State, the Region and the Global Developments must work together and in harmony at all levels of ocean management. In order to achieve governance there is also need for some sort of Government.

At the global level the newly created United Nations Informal Consultative process on Oceans and the Law of the Sea is an integrating institution at the highest level. It has addressed such problems as Illegal, Unregulated and Unreported Fishing; the economic and social impact of pollution from land-based activities; marine science, development and transfer of marine technology; and piracy and armed robbery at sea. At the regional level a similar all-embracing mechanism is required.

The legal and institutional frameworks will not function or only be very ineffective if there is a lack of material tools for implementation. These tools include:

- educational means;
- technological means;
- financial means;
- means for monitoring, surveillance and enforcement.

Here we will consider the educational requirements.

3. Education and awareness creation

An education and training system is required to help change attitudes, to enhance understanding, help achieve participation, awareness and responsibility. An advocacy mechanism/institution should be part of this system.

An international agreed framework exists which, when properly implemented and enforced, would lead to adequate ocean and coastal area management and development for the benefit of society, including the developing countries. However, the international agreements are not being fully implemented. One major reason for this is ignorance and lack of understanding for the significance and importance for our society and survival of an adequate management and protection of the whole marine system. To overcome this obstacle, education and provision of reliable information are needed.

Recent decades have seen an enormous development of information technology. At the same time sensors and equipment, which can make observations of the ocean and seas both at the surface and below it and transmit data in near-real time, have been developed. The data when provided to tested models can generate forecasts of various conditions, over different timescales with degrees of uncertainty. These forecasts should be used in the management and decision making schemes. This is for protection of resources, human lives, economic investments, and for management of several basic activities on land, e.g. agriculture, transportation, freshwater systems. This also calls for education and training as regards use of the tools and services the observations and models provide. The enhanced knowledge about the ocean and seas and conditions in the coastal zone, which the research in recent decades has provided, makes all this possible.

Technology transfer and related capacity building are required and are of special concern to UNCLOS and UNCED follow-up and implementation. Today's technology is knowledge and information based; it cannot be bought and transferred, it has to be learned. It calls for an on-going relationship between the producer of the technology and user. Joint ventures have been recommended by the Commission on Sustainable Development, in their review of the implementation of related agreements.

The development of the information technology has also made it possible to radiate the information out onto the population. It is no longer necessary for all people to migrate temporarily for several years to a schoolhouse to become educated and trained. The education and training can be brought to the people.

The International Ocean Institute Virtual University aims at addressing these points: provision of an adequate, inter-sectoral education to as many as possible and in particular to those who are dealing with management of ocean, seas and coasts, or who intend to do so or who should do so.

The goal of the IOI Virtual University (IOIVU) is to enhance the abilities of particularly developing countries to develop and govern their own marine and coastal resources and environment sustainably for the benefit of their people and in harmony with related international conventions and agreements. This is to be achieved through the establishment of an internationally recognized programme of education, leading to a masters degree. The programme is based on a global network of universities, training and research Centres of expertise in ocean, coastal and marine-related affairs and governance, working together in a partnership to provide for an interdisciplinary and comprehensive coverage of the required subject areas. The IOIVU has its Charter, its Board of Governors, its Chancellor and Rector, and its technical infrastructure is in place at IOI-Southern Africa, at the University of the Western Cape in Cape Town.

The primary target groups are mid-level and young professionals working in sectors associated with ocean and coastal affairs. Since much of our present service economy, socio-economic development and vulnerability are coupled to the ocean and coastal resources, processes and conditions, the target groups are fairly large, involving most sectors of society. The students entering the IOIVU are expected to have an initial university degree or equivalent or corresponding study, some professional experiences, confirmed dedication, identified need for the education, sponsorship or permission from the employer, and practical required computer and language knowledge.

The IOIVU will deliver courses through the Knowledge Environment for Web-based Learning (KEWL) course delivery platform which was developed by IOI Southern Africa and the University of Western Cape. The KEWL platform offers many advantages over commercially available software as it is open source in nature thus enabling it to be distributed freely at no cost and to be customized and expanded according to specific needs without the impediments inherent in software copyrights.

The Curriculum will be interdisciplinary, comprehensive, and responding to the purposes and objectives. The structure is specified as:

1. Postgraduate or advanced graduate levels (from 3 years of other university study onwards): core courses, optional courses; thesis (research) work; examination; this part aims at providing a Masters degree.

2. Advanced training in specific subjects, through existing or new courses of IOI or the Host institutions of the Operational Centres; as an option the participation in such advanced training could be given a certificate and a credit, provided there is an examination.

3. Upgrading or supplementary education and training in the form of professional development courses, through individual courses, with examination and certificate as an option. This part could respond to expressed needs for short and specified courses.

The Master's Degree Programme of the IOI Virtual University will have three components:

1. A number of courses will have to be completed, each one with an established number of credits. These courses can be taken through any one of the IOI Operational Centres and/or in their host institutions. They also can be taken through distance-learning arrangements, which should become the primary learning method of the IOIVU.

2. There will be an internship of one quarter, which can be completed in any of the IOI Operational Centres or Host institutions. However, internships in other institutions including UN bodies may also be considered, provided it can be practically arranged and scheduled.

3. There is a thesis requirement. Students can select their supervisor and thesis committee from the roster of the Virtual University Faculty.

The online courses will cover at least the following topics:

- UNCLOS and UNCED: Ocean Governance and the Law of the Sea;
- Integrated Coastal Area Management;
- Sustainable development in Coastal Communities;
- Marine and Coastal Resources economics;

- Integrated management of marine pollution, in particular related to land-based sources;
- Spatial information management and decision making support;
- Coastal and Oceanic ecosystems and processes;
- Introduction to living and non-living marine resources;
- Matters related to maritime transport and issues at sea; to be prepared in cooperation with UNCTAD, WMU and IMLI of IMO;
- Public-private partnerships in ocean management;
- Role of ocean in service economy.

4. Conclusions

This is an age of transformation, information and uncertainty. Transformation and information generate uncertainty. This calls for risk management, application of the precautionary principle, use of insurance, enhanced public awareness, participation and education.

The Global change has impacts everywhere. Perhaps the most significant global change over the past 50 years is the rise of the human population from 2 to 6 billion people. The climate change is another issue of great concern, coupled to the first one. Both these global changes are irreversible – at least over the 100 to 1000 years timescale.

Progress in development essentially occurs when idealism and realism can meet and when their interests coincide, especially in the economic sphere. We are now in the same ship: cooperation and solidarity are required; we face convergence of impacts of global changes, economic and ecological crises. The regional scale of cooperation is emerging since some time as the most promising. It can link to both the local-national interests and the global level. At the same time the community based co-management and co-development model is gaining ground for sustainable development and security at local level.

A model is presented by the requirements at the global level of ocean governance and sustainable development, elucidated through the formulation of Arvid Pardo in 1967, that "all aspects of ocean space are inter-related and should be treated as a whole."

The other statement of Arvid Pardo that, "the resources of the deep sea-bed constitute the Common Heritage of mankind", may be reflected in the water problem by arguing that the fresh-water resources also constitute a Common Heritage of Humankind.

The 4 principles for the Common Heritage of Mankind can as well be reflected in the freshwater problem, in a slightly re-worded way:

- economic: freshwater is a necessary part of sustainable life, development and economy;
- ethical: freshwater has to be managed so that it can be available for the whole of humankind, and special considerations must be given the needs of the poor;
- environment: freshwater resources need to be conserved so they can be shared with future generations;
- peace and security: freshwater availability is part of comprehensive, human security.

The role of the ocean in the hydrological cycle cannot be contested, and is of course recognized. The role and use of ocean information and forecasting for freshwater management and as a freshwater source can, however, be more stressed and elucidated; This is highlighted in other briefs of this session.

On the other hand human activities on land dealing with freshwater resources, including rivers, lakes, groundwater have a profound influence and impact on the marine environment and coastal conditions and resources. This has severe socio-economic consequences for large coastal populations. There are also very important links and inter-relationships between processes related to mountains, forests, coasts and the ocean. The session is highlighting some of these points through examples.

The education, including creation of public awareness, is a key factor. The need to develop an interdisciplinary and integrated culture of knowledge, which is inclusive and accessible for all, is the principal challenge faced by traditional forms of education. This challenge is nowhere more evident than in the realm of ocean affairs. Education, research, management and exploitation of the ocean and its resources are pursued at all geopolitical scales: here knowledge must be truly integrated and interdisciplinary. As stated by Arvid Pardo, “all aspects of ocean space are inter-related and should be treated as a whole”. A similar statement could perhaps be made with respect to the hydrological cycle and freshwater condition.

The IOIVU responds to the strong call for efforts in education and capacity building expressed in Agenda 21 as a whole, and in particular in chapters 36: Education and 37: Capacity Building. The issue of education is a priority, now even more pronounced then in 1990. This is realized by many decision and policy makers. The approach adopted

by IOI in pursuing the development of the IOIVU takes into account the social, scientific, technological and economic developments which have occurred over the last decade. A similar approach could be used in the freshwater case and a course on the role of the ocean with respect to freshwater supply and management could well be included in the IOIVU curriculum.

Annex 1

The International Ocean Institute (IOI)

The International Ocean Institute IOI was created in 1972 to promote education, capacity-building and research as a means to enhance the peaceful and sustainable use and management of ocean and coastal spaces and their resources.

The goals of the IOI are to:

1. enhance the ability of developing countries to develop and manage their ocean and coastal resources sustainably for their own benefit, to establish self-reliant development, and to help with education and eradication of poverty.
2. enhance abilities of self-reliant development at community level, taking into account the diversity in developing as well as developed countries, including control and protection of natural resources for future generations, the eradication of poverty in coastal areas, and mitigation and adaptation to natural hazards.
3. enhance participation of people, in particular women, in development projects which take into account environmental issues.
4. establish sustainable mechanisms able to tackle inter-related social, environmental and economical issues in an integrated fashion.

During the thirty years since its foundation the IOI has been involved in ocean law and governance, and its leaders have played a key role in the development of the United Nations Law of the Sea. For the first twenty years the IOI was centered in Malta and Canada, and its work and programme were largely disseminated through its annual meeting, *Pacem in Maribus*, and through publication of the *Ocean Year Book*. Numerous other papers and reports were written, principally by IOI's Founder, Elisabeth Mann Borgese, who had a profound influence on Ocean policy world-wide. Her seminal book, *The Oceanic Circle* encapsulates her ideas on past, present and future ocean governance issues.

For the past twenty years the International Ocean Institute has been involved in training in Ocean Law and Governance, through an annual, interdisciplinary intensive global programme conducted by leading scholars, designed to assist mid-career civil servants in the implementation of UNCLOS and UNCED. The course has been based at Dalhousie

University in Canada; it is a non-credit course, although a number of the participants have proceeded on to higher degrees.

During the past ten years, the IOI has expanded into a unique network of more than 25 Operational Centres around the world. These Operational Centres and affiliates are located in world-class institutions, each with their own strengths, ranging from law and policy, to science and technology. This enormous expansion is a reflection of global concerns over ocean issues; it has also created a unique interface between the traditional IOI leaders and scientists and technologists who bring new ideas on governance and ocean sustainability issues. The IOI is at a watershed, where the opportunity to bring this interaction to a new and creative level relating to ocean governance issues is exciting and challenging.

The expansion of the IOI has led to new approaches to ocean governance. These approaches have been at many levels, ranging from world leaders, through the conduct of Leader's Seminars, to task-oriented, structured training with the UNDOALOS TRAIN-SEA-COAST programme (IOI-Pacific Islands; IOI-Southern Africa) to the community level through awareness-raising workshops and projects. Many centers offer short courses on topics of relevance to their region and these include:

- Management and Development of Coastal Fisheries;
- Environmental and Resource Economics;
- Deep Seabed Mining;
- Small Islands; and
- Integrated coastal zone management.

These developments have been in parallel with initiatives such as sustainable use of coastal resources (IOI-Southern Africa), marine biodiversity conservation (IOI-Australia), climate change (IOI-Pacific Islands), alternative life-styles (IOI-India), enhancement of the role of women and youth in coastal and ocean decision-making, and many others.

In view of its comprehensive approach it was very appropriate for the IOI to undertake the organization of the WWF3 session on dialogue between ocean and freshwater communities, together with long-standing partners.

In the post-UNCLOS/UNCED paradigm there are many dilemmas in decision-making in the realm of ocean governance that are evident at all levels, from national, to sub-national

and local levels of government. The structure of most government systems continues to reflect the vertical nature of decision-making, and takes insufficient account of the urgent need for integrated decision-making. A significant problem lies in the growing information gap between science and civil society, and the need to allow for informed decision making based on scientific information made available in user-friendly terms. There is no better example of this than the debate surrounding global warming and climate change. A significant difficulty lies in the inherent top-down approach to ocean governance, where the practitioners, the stakeholders and the traditional custodians are uninformed and have inadequate input into decision-making that affects their livelihoods and future survival.

The sustainable development of marine resources is integral to the principles of UNCLOS, UNCED, Barbados and Johannesburg, and it is often the declared foundation of governments. The global population shift to coastal regions places great pressure on ocean and coastal resources that will continue to grow exponentially. The current scenario, however, is one where unsustainable development continues unabated. A good example is the unsustainable use of coastal resources in tropical regions, where human-induced damage to coral reefs is exacerbated by climate change issues such as coral bleaching. While strategies to arrest or at least mitigate these problems are evident, their implementation is impeded by lack of knowledge, capacity, expertise, funds, and lack of political will.

The most critical issues related to ocean governance decision making include:

- The need for integrated decision making at the highest level of government;
- The need for information and technology capacity building at all levels, focusing on improved understanding of global conventions and agreements and of the principles of sustainable development;
- The need to develop appropriate legislation for the marine sector, and to find ways and means of enforcing it;
- The need to enhance marine awareness at all levels of the community.

The IOI recognizes the need to urgently address capacity building in ocean governance, and to develop innovative approaches that will allow global access to its training programmes, and at modest cost. It is now integrating its efforts and experiences in the development of the ***IOI Virtual University (IOIVU)***. The core of the IOIVU will be a Masters Degree that will be available on-line, through use of an innovative Open Learning

system developed by IOI-Southern Africa and the University of the Western Cape, South Africa, the **Knowledge Environment for Web-based Learning (KEWL)**. The Masters degree will include an internship at one of the IOI's Operational Centres, when a thesis will be completed.

Students entering the IOIVU will have an initial undergraduate degree, some professional experience, an identified need for the degree, sponsorship or permission from their employer, the practical experience with computers and the language of instruction. A significant advantage of the IOIVU is that students will be able to complete the majority of the programme from their home base and while employed. Through KEWL, the students will develop a global network of peers that will continue well beyond the completion of their degrees. The internship will expose them to new environments and experiences that they will be able to take back to their home countries.

The IOIVU is not intended to compete with its host institutions, but to complement them. Its fundamental objective is to contribute to the enhancement of knowledge of the oceans and their potential wealth and challenges, with special consideration of the needs of developing countries, through delivery of an interdisciplinary training programme at the Masters level. The great advantage of the IOI is its growing global system of centers which reflect activities in all coastal the ocean sectors, and the breadth of its outreach from coastal communities to the United Nations.

The IOIVU will come on-line at a time when "virtual" university education is growing at a rapid pace. It is important, however, to distinguish between the IOIVU concept, the "virtual" education conducted through distance-learning. Many of the virtual universities springing up around the world are essentially distance learning programmes dressed up in new clothing. They have taken long-standing distance education programmes and re-named them as a "virtual university". This would seem to be a pragmatic and cost-effective way of jump-starting a virtual university approach, but a close examination will show that they do not or will not necessarily function "virtually" in the way conceived for the IOIVU. Furthermore, the delivery platforms used by many of these 'virtual' universities have been commercially developed, are costly and are not open-learning systems like KEWL. Regardless, a debate on this topic is unlikely to be very meaningful since the rapid evolution of distance and electronic learning systems will likely see convergent, divergent and parallel systems develop in the future.

The most important aspects of the IOIVU can be summarized as followed:

1. The IOIVU is presently the only virtual university proposing to concentrate on offering a Masters Degree in Ocean Affairs.
2. Its unique delivery platform, KEWL, is an open-learning system delivered at no cost and that can be customized and expanded according to specific needs without the impediments inherent in software copyrights. It is user-friendly, participatory and student-oriented more than educator-oriented.
3. The courses available can draw on the global knowledge base of IOI Centres and partners institutions.
4. Opportunities for expanding the course programme to include short courses on a variety of specialized topics are extensive. Many of these courses have been developed by IOI Centres and can be adapted for delivery through KEWL.
5. The internship were students will spend time at a participating IOI Centre will provide unique opportunities in experience and learning.
6. The accessibility of the IOIVU will create a rapidly expanding network of graduate coastal and ocean decision makers and practitioners.

Freshwater Input to the Arctic Ocean and its Links to Climate: A Case for Thought

Vladimir E. Ryabinin
World Climate Research Programme, WMO

Introduction

This note discusses a hypothetical scenario linking fresh water transport to the Arctic Ocean with global climatic consequences. It serves as an example supporting the need for scientifically based multi-disciplinary water management. Trough realisation of the complexity of the entire water system and its links to other involved entities such as World Ocean and global climate, understanding the freshwater resources as a Common Heritage of Humankind is emerging. The Arvid Pardo's principle of Common Heritage of Humankind applied to the resources of the ocean bottom has helped to find common ground for the development the United Nations Convention for the Law of the Sea and several other important international agreements. Therefore it contributed very significantly to the development and strengthening of the global ocean governance. The Concept of Common Heritage through its economic, ethical, environmental, and peace/security dimensions may provide a platform for more general understanding of fresh water resources problem and offer ways of addressing it.

The ocean – fresh water – atmosphere system is indeed very complex. This note presents, in very simplistic and qualitative terms, a scenario of climate change, which involves interaction of all its elements. There are considerable uncertainties in all visions / projections to be mentioned here. The note simply tries to describe one of many scenarios of climate change, which are considered by modern science. The goal is not to discuss validity of the proofs or criticise them but to create a basis for appreciation of the scope of the problem.

Freshwater run-off, thermohaline circulation shutdown and consequences for climate

Due to increase of the greenhouse gas concentration in the atmosphere, the air temperature at the surface is expected to rise. The quantitative projections are given in many

publications, the most authoritative being the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC TAR, 2002). Agreement is getting stronger that it is the greenhouse gas concentrations due to humankind activities that are the primary source for such warming. Fig. 1, upper pane, (global temperature rise) and fig. 1 lower pane, (global precipitation increase) provide illustrations from the IPCC TAR.

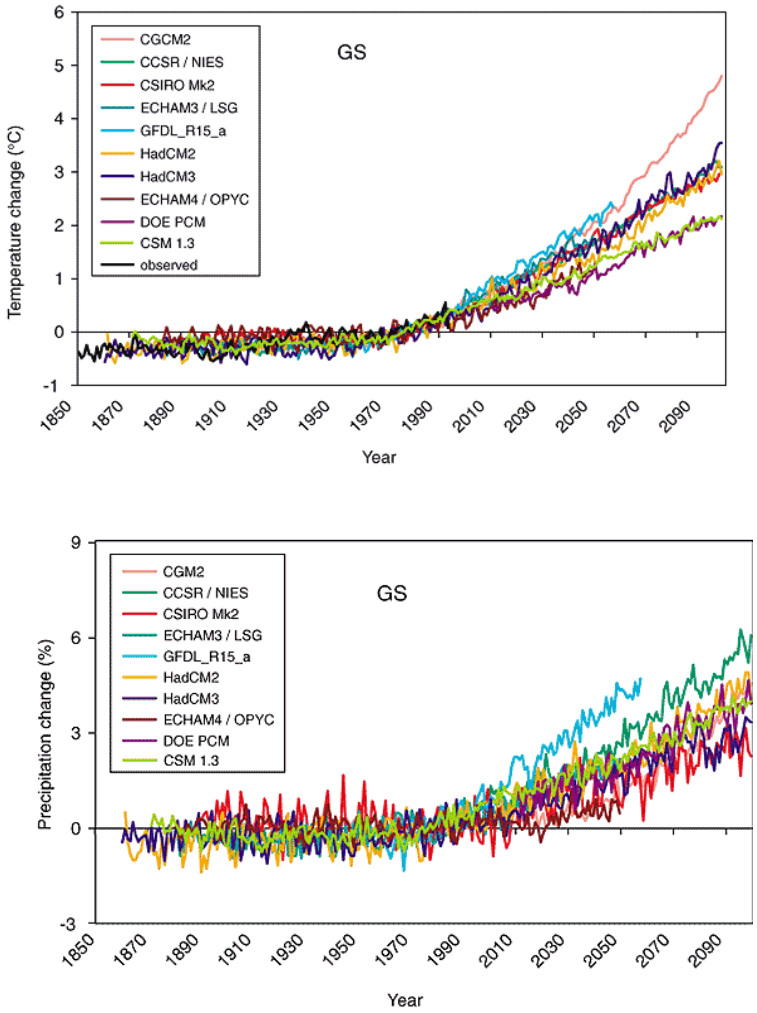


Figure 1. (a – upper pane) Simulated time evolution of the globally averaged temperature change relative to the years 1961 to 1990 (IS92a). Greenhouse gas and sulphate aerosols accounted for. The observed temperature change (Jones, 1994) is indicated by the black line. (Unit: °C). (b – lower pane) Simulated time evolution of the globally averaged precipitation change relative to the years 1961 to 1990. (Unit: %). . (From the IPCC TAR, Vol. 1, fig. 9-5)

The global warming is amplified in the northern polar regions. There are several projections indicating somewhat different amplitudes of warming there. However, the qualitative agreement between almost all of them is apparent (see fig. 2, upper). Also, in addition to increase of precipitation in the tropical region, model ensembles predict its increase over the Arctic Ocean and mid- high- latitudes (fig. 2, lower).

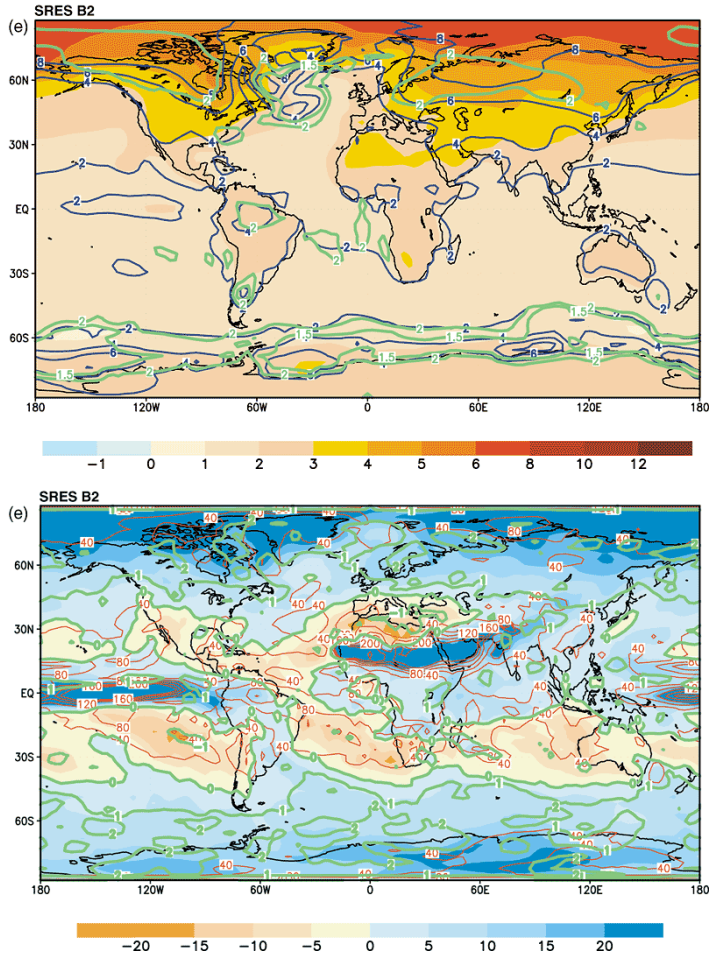
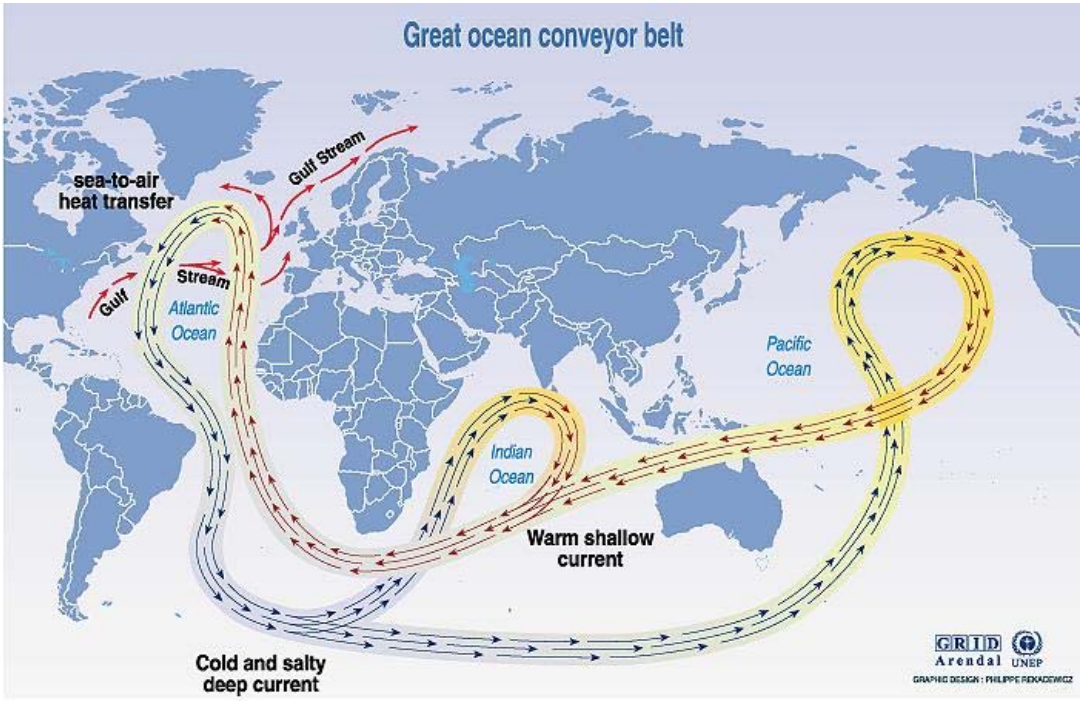


Figure 2. The SRES scenario B2: it shows the period 2071 to 2100 relative to the period 1961 to 1990. Upper: the multi-model ensemble annual mean change of the temperature and precipitation (colour shading), its range (thin blue isolines) (Unit: °C) and the multi-model mean change divided by the multi-model standard deviation (solid green isolines, absolute values), from the IPCC TAR, Vol. 1, fig. 9-10. Lower: the multi-model ensemble annual mean change of the precipitation (colour shading), its range (thin red isolines) (Unit: %) and the multi-model mean change divided by the multi-model standard deviation (solid green isolines, absolute values), from the IPCC TAR, Vol. 1, fig. 9-11.

Ocean and its circulation are playing an important part in formation of the current climate. Through several non-linear processes the oceans interact with atmosphere and land surface and generate variability at time scales from several months to tens and hundreds of years. Much can be understood about the ocean general circulation through considerations of conservation of mass and energy. Ocean specifics are in dependence of water density on temperature and salinity, role of wind stress, bottom relief, and Earth rotation. The concept of so called "conveyor belt" (see fig. 3) presents this in a simplified form of global organisation of deep currents that link together areas of convection where deep water forms and areas where the waters along their path get warmer and return closer to the surface. The somewhat hypothetical circulation associated with these processes is sometimes called meridional overtuning circulation or thermohaline circulation. It is important to realise that the drawn flows do not necessarily represent real currents. Rather they show how the balance of energy and mass is formed in the ocean under cooling and sinking of water in cold latitudes and warming and upwelling at low latitudes.

In the North Atlantic, the Gulf Stream, being a part of the whole current system, brings warmth to the Northern Europe. Correspondingly, air temperatures in Scandinavia are of order of ten of degrees higher than they are in central Siberia or Alaska, which are located at the same latitude. Under the Gulf Stream there is a counter current, which is a branch of the conveyor belt bringing the North Atlantic Deep Water towards the equator. The mass and energy balance of this system and the whole intensity of this overtuning cell of the ocean circulation depend on how intense the convection is in polar latitudes. The intensity of convection depends on the rate of cooling of surface waters. The colder is the air in the area of North Atlantic Deep Water (NADW) formation, the stronger is the convection and hence bigger is the rate of the water formation. Let us call this thermal forcing by atmosphere. The haline forcing acts through salinity. The higher is the salinity of surface waters the denser is the forming water. This accelerates the water formation. A link between salinity anomalies in the subpolar basin and deep water formation was shown by the Great Salinity Anomaly of the 60's - 80's that had negatively affected convection and NADW formation in the Greenland and Norwegian Sea.

The haline forcing is roughly proportional to contribution to buoyancy by changes in salinity that are determined by net precipitation and supply of fresh water to the ocean. It is made of river run-off and melt of glaciers. Brine rejection in the process of sea-ice freezing is another contributing factor, which is mostly associated with the seasonal cycle. The sea ice is fresher than the water, from which it was formed, and therefore horizontal ice drift can alter surface salinity. For example the Great Salinity Anomaly could have been related to anomalously high outflow of ice through the Fram Strait.



Source: Broecker, 1991, in Climate change 1995, Impacts, adaptations and mitigation of climate change: scientific-technical analyses, contribution of working group 2 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

Figure 3. Conveyor belt and Gulf Stream as its part (source is shown above).

How the thermal and haline factors will change as the climate warms?

1. Accelerated warming of polar latitudes reduces the temperature contrast between ocean water and the air thus weakening the thermal forcing factor (see fig. 2 left).
2. Increased precipitation in average tends to freshen the surface waters (see fig. 2 right).
3. Recent results show that 2002 summer Greenland Ice Sheet melting was the strongest for the experimental observations period (K. Steffen, http://cires.colorado.edu/steffen/melt/index.html). Fig. 4 provides an illustration of this process, which also tends to increase the flow of fresh water to the Arctic Ocean.

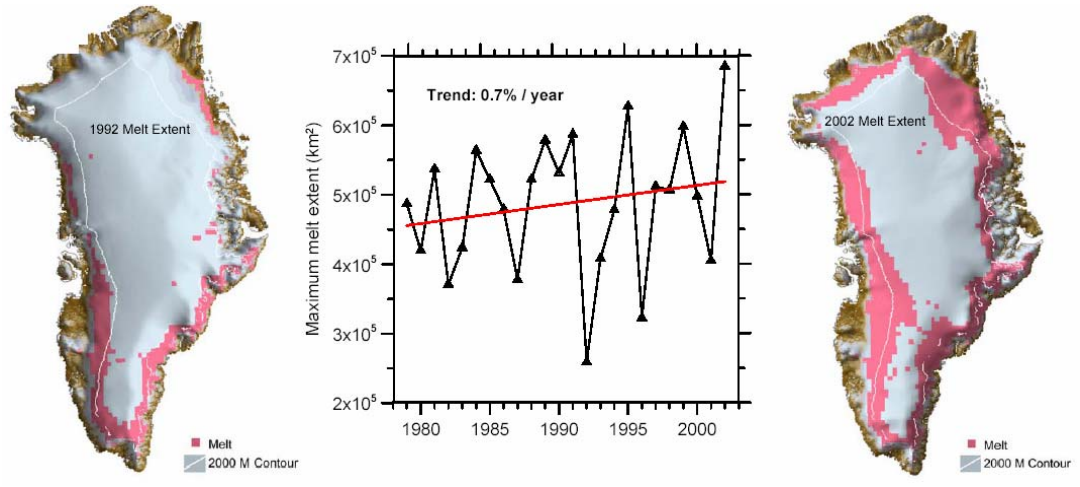


Figure 4. Estimates of Greenland Ice Sheet melt (from K. Steffen, CIRES, University of Colorado, USA)

4. According to (J. Peterson et al, *Science,* 2002, see fig. 5) the average annual discharge of fresh water from the six largest Eurasian rivers to the Arctic Ocean increased by 7% from 1936 to 1999. Average annual discharge from the six rivers is now about 128 cubic kilometres per year greater than it was when routine measurements of discharge began.

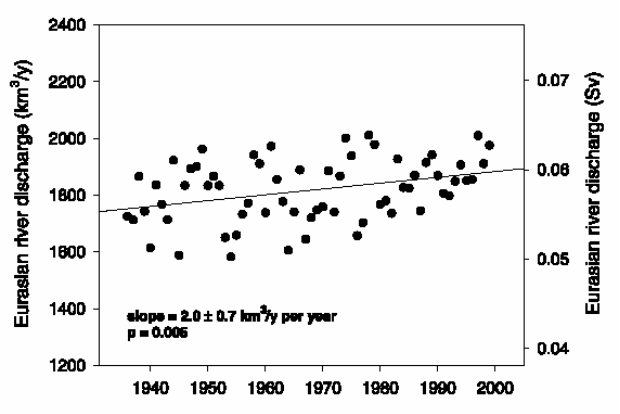


Figure 5. Six rivers discharge to the Arctic Ocean (from J. Peterson et al, Science, 2002)

Processes 2-4 tend to weaken the haline factor. Process 1 reduces the thermal factor. These tendencies correspond to results of several model simulations, which show that due to reduced thermal contrasts and freshening of waters at polar latitudes the thermohaline circulation in the North Atlantic can collapse (e.g., Manabe and Stouffer, 1995). Fig. 6 shows a result of numerical experiments at the Hadley Centre for climate prediction and

research. There are many similar results. The consequences of such "shutdown" for climate of Europe may be significant.

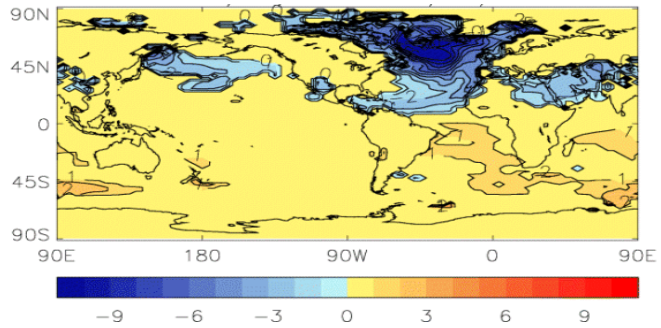


Figure 6. Differences in sea surface climatic temperature for collapsed and not-collapsed thermohaline circulation in the North Atlantic (from Hadley Centre, see http://www.met-office.gov.uk/research/ocean/climate/techniques.html).

In first numerical simulations of the possible collapse of the ocean circulation and significant cooling of otherwise warm regions, the authors artificially forced their models towards the collapse of the thermohaline circulation through adding a pool of fresh water to the part of model domain corresponding to the Arctic Ocean. Through the increased river run-off this process is occurring naturally. This all means that there may be a possible link between the river run-off increase and significant future variations of global climate with amplified effect in the northern latitudes.

One cannot underestimate uncertainties in such links and hypothetical character of all related conclusions. Also, one should not dramatise too much these changes for the climate of Europe. Even with cooling due to possible collapse of the North Atlantic circulation, the climate of Europe is expected to warm due to the global warming. Further studies have revealed several patterns of general circulation change. It has been shown that ocean circulation as part of the coupled ocean – atmosphere system can exhibit totally different responses with non-linear bifurcation occurring out of phase with global warming. In the currently on-going scientific discussions some facts were raised that contradict the above considerations stating that past changes of the North Atlantic circulation happened mostly during glacial stages rather than interglacial ones.

The process presented above should be considered not in isolation but along with other major expected outcomes of climate change. They include the future of sea-ice cover in the Arctic Ocean, potential release of additional carbon the atmosphere as one of the

consequences of permafrost thawing, variations of carbon due to biological and geocryological changes. Also involved and affecting the situation are shifting phases of river run-off, freeze-up and melt dates. This list can be continued.

There are many national and international projects and programmes addressing these issues. On the national scale the biggest role belongs to the national hydrological (hydrometeorological and other related) services as well as to academies of sciences and engineering research organisations. On the international level the work is co-ordinated by the World Climate Research Programme, World Climate Programme, International Geosphere – Biosphere Programme, Global Climate Observing System, Global Ocean Observing System, Global Terrestrial Observing System, World Hydrological Cycle Observing System. Recent developments include the set-up of a Global Terrestrial Network for Hydrology. There are several global data centres providing data support for the hydrological studies including the Global Run-off Data Centre in Germany. Programmes with focus on the Arctic include the Arctic Climate System Study and Climate and Cryosphere projects of the WCRP, Arctic Climate Impact Assessment, Community-wide Hydrological Analysis and Monitoring Program, Study of Environmental Arctic Change, Arctic / Sub-Arctic Ocean Fluxes Project, several projects sponsored and supported by the Arctic Council and many others.

Conclusion

The existence of a causal link between river water run-off to the Arctic Ocean, circulation of the North Atlantic, and variations of global climate serves as an illustration that governance of global fresh water resources has to embrace not only obviously related problems of water supply for agriculture, human consumption and energy but even seemingly distant issues, like climate change. This means that the governance has to be interdisciplinary. Water management for ocean-bound rivers even if their basins are located in one country, should involve international considerations. The economic, ethical, environmental, and peace/security dimensions of the Principle of the Common Heritage of Humankind need to be applied to the fresh water resource management and further elaborated.

ROUND TABLE DISCUSSION

COMMENTS from PANELISTS

Kazuo Matsushita
Graduate School of Global Environmental Studies, Kyoto University

Thank you, Gunnar, for your introduction. Good afternoon ladies and gentlemen. My name is Kazuo Matsushita. I am Professor of the Kyoto University, Graduate School of Global Environmental Studies. It is my pleasure to be here today to make some comments on the very interesting and stimulating presentations.

First of all, let me congratulate the organizers for selecting this very important topic: The Dialogue between the Ocean Communities and Freshwater Communities. As a matter of fact, I am not from the water business, I am not from mizushobai. I am from the environment business. I specialized in environmental governance as well as environmental policy. So I would like to make some comments from that perspective.

More than 10 years ago, as Dr. Kullenberg said, the Earth Summit was held and Agenda 21 as well as important Conventions on the Climate Change and Biodiversity were adopted. Based on these developments, people now think that the atmosphere and oceans are the common heritage of humankind. But frankly, as I recall, fresh water issue and ocean issue were not the priority issues of that time, ten years ago. But in the following 10 years, we have witnessed the emergence of water issues as a truly global one. There are some reasons for that. The first one is the fact that the scarcity of fresh water in terms of quality and quantity has become severer. Secondly, the interlinkages between different environmental problems have been identified, such as the impact of climate change on the water cycle, and water and biological diversity and so forth. Thirdly, as we have learned from the presentations today, the global hydrological cycle: freshwater, oceans, atmosphere and land have been advanced. So what does this imply for the global environmental governance or global environmental policy?

First, I would like to associate myself strongly with Dr. Kullenberg, that the whole water including fresh water and ocean water, or the whole hydrological cycle should be regarded as the common heritage of humankind, or global commons. This is highly important since most of the freshwater we are using today actually comes from the oceans, evaporation from the oceans. Secondly, everything on earth, living or non-living things is connected

through the global water cycle and water circulation. For example, more than 60% of our bodies are composed of water. This implies that most of my body components are actually from the ocean. Based on this understanding, we have to seek for a truly integrated comprehensive water management, including both fresh and ocean water. How do we do that? Dr. Davidson and Professor Yamagata gave us some ideas on the latest results of scientific research on the interaction between the ocean, land, and atmosphere. So we need this kind of research in the global cycle of hydrology. And Mr. Hatakeyama presented a very interesting example of cooperation and cooperative initiative between ocean communities and freshwater communities at the grassroots level. This tells us the importance of local and community based initiatives based on the insight of the interconnection between the ocean and the catchment areas. I think we need a two-pronged approach or two-track approach; one with a long-term comprehensive approach calling for global cooperation combining wisdom of the world and scientific knowledge, the other, a local approach undertaken by various stakeholders particularly by local residents and citizens, or by various actors sharing a common water history and culture.

Finally, I would like to make some comments for the future steps to be taken. First we need to have a comprehensive water law for domestically and internationally. A basic law for integrated and sustainable water management domestically as well as for the global water governance structure. This legislation aims to eliminate existing sectionalism and rivalries between different ministries and agencies, or the vested interests of our water management. Secondly, we need an eco-systems approach. Thirdly, we need a community based and multi-stakeholder approach, encouraging the participation of citizens and NGOs. Fourthly, we need a kind of catchment or river basin approach. Finally, we need environmental education using an eco-system approach based on the results of dialogue between ocean communities and freshwater communities.

Thank you very much for your kind attention.

Biliana Cicin-Sain
Director, Center for the Study of Marine Policy, University of Delaware, USA

It is a great pleasure to be here, thank you for the invitation. I wanted to reflect on this idea of Dialogue between the Ocean and Freshwater Communities starting out by first thinking about the status of the coastal management community. In coastal management, we have gained much experience around the world in the last 30 years particularly since the 1992 Earth Summit. In 1992 there were only about 59 countries that were doing anything in coastal management. Now we have over 100 countries that are working in this area. So we have had quite a rise in awareness about the need to manage the coastal zones in a special way because it is a special area and we have had much institutional change in the last 10 years. But most of the attention in coastal management has been focused primarily on a relatively narrow area of coastal lands and coastal waters nearshore--a few miles inland and a few miles offshore in most cases.

We are now witnessing a rise of awareness about the linkages of coastal issues to inland, up-river issues. Coastal programs, which in many cases are relatively new programs, are being challenged to expand in two directions--one is inland to embrace the river basins and the watersheds, and, at the same time, they are being challenged to expand further offshore to embrace the entire 200-mile Exclusive Economic Zone and to create national oceans policies for these areas. These challenges are posing significant difficulties for many coastal management programs, and many do not have the capacity to expand their efforts in both inland and offshore directions.

Thinking about the link between the oceans, coasts, and freshwater which is the subject of this panel, it seems to me that in this area we are getting to the halfway point in the continuum from understanding to taking action. In conceptual terms, I think most people do understand the linkage and, in fact, the idea that coastal area management should include the whole water cycle has always been part and parcel of the theory of integrated coastal management. But often this idea has not been put into operation. As Dr. Kullenberg pointed out, this link was given a push at the 2002 World Summit on Sustainable Development where a number of the decisions that came out of the World Summit emphasized the linkage and a number of new initiatives have been put into place to really test this linkage in particular contexts. I call your attention, in particular, to the so-called “White Water to Blue Water Initiative” in the Caribbean involving many Caribbean governments as well as the U.S. and others to try to manage from the watersheds all the way out to deep waters. So the rising awareness is taking place

especially among the professionals and it is very heartening to me to see that is also taking place in a number of local communities around the world, as is so well evidenced by Mr. Hatakeyama's story about the linkage between the forest and the sea. But as Dr. Kullenberg pointed out, these concepts are not well incorporated into our educational programs in ocean governance. So I think one challenge is to add this new paradigm to our educational curricula in integrated ocean and coastal management.

The biggest challenge in making the link will be to link the coastal management institutions with the institutions concerned with the management of freshwater supply and allocation in river basin management. The problem here is that these are very different communities who really don't know one another. You have coastal managers who are focusing on nearshore and coastal land issues and who don't have much knowledge of the up-river issues. You also have very localized groups, in many cases watershed councils, in the watershed areas who don't have much appreciation for the down-stream issues. So linking the two communities together, I think, will be quite difficult. In many countries, the U.S. included, people are talking about expanding the boundaries of coastal management to both go all the way from the mountains to the edge of the 200-mile Exclusive Economic Zone. The U.S. Commission on Ocean Policy is talking about these challenges. Frankly, I am worried that this is too big. I think our coastal management programs don't have the capacity to embrace such an expanded domain. The current coastal management institutions could well fall under the weight of all of these challenges. I think we have to think perhaps in more subtle terms. We have to think about nested governance systems where we have the existing institutions for coastal management but we find some way to link them to the watershed councils and other authorities dealing with freshwater, and then to create perhaps some specialized institutions that are linked and nested to address the issues in the further offshore areas.

One of the reasons that I am here is that a number of us who have been involved in trying to organize our oceans, coasts and islands communities such as Dr. Kullenberg and Dr. Terashima, I think we wanted to be here to also learn lessons from the water community on how they have organized so well and have put the water issue so squarely on the world's agenda. I am looking forward to discussions with water policy leaders on this question. But first of all let me say this is such an impressive organization, the Water Council and the Water Forum. It seems to me that you have such a compelling central issue-- water supply, the availability of water as essential to human life. Nobody can dispute that, it's just such a central fact. It is very evident that you have strong participation by a number of governments, you have the main UN agencies involved, you

have a large number of private companies involved. It is very impressive. You have a number of NGOs that are very active and you apparently look like you have funding. In oceans, coasts and islands we are thinking about these issues, and, as you know, we, too, of course, have very gripping issues--for example, dramatic declines in fisheries, marine mammal populations and corals. We have very profound problems in the public health of coastal communities for example, 250 million cases of gastroenteritis related to pollution of coastal waters. But we have many issues. We don't have a central issue like you have in the freshwater area. In another contrast, in our ocean community, it is difficult for us to involve private industry in a sustained way. I think part of the reason is that we have a great deal of diversity in the ocean industries-- we have industries dealing with fishing, tourism, shipping and aquaculture, very specialized interests who don't often see the need to get together among themselves. So we look forward to learning lessons from you on sustained industry involvement in this kind of a dialogue. I have also been very impressed with the very effective involvement of the media that the water community has mobilized in the last three years, for example, the teaching of specialized courses for journalists, awards for journalists who report good stories in this area and so on. This is something we hope to emulate. I have also noticed the demographic contrast between our communities. I have to say that in our community of oceans and coasts we tend to have more women and many young people. So perhaps we can give you some ideas oin how to get these other demographic groups more involved.

In conclusion, I would like to congratulate Dr. Terashima and Dr. Kullenberg for an excellent panel in showing very clearly the connections between Oceans and Freshwater in scientific and in human terms. It seems to me that scientists can sometimes lead the way in achieving dialogue. For example, the first Regional Seas Programme, which was the Mediterranean, is said to have been concluded largely because of the impetus that was given by the marine scientists in the Mediterranean. Through their work and targeted scientific findings showing the pollution problems of the Mediterranean, they prodded the governments to undertake action to conserve and manage the Mediterranean Sea.. Perhaps scientists can lead the way in continuing and deepening the Dialogue between the Ocean and Freshwater Communities. Thank You.

R. Rajagopalan
Professor, IIT Madras/International Ocean Institute - India

Thank you Mr. Chairman.

I am certain that the kind of scientific input that has been brought to this session is certainly very important in understanding the monsoon pattern and why, for example, some parts of India did not get the normal rainfall last year. But to me personally, what Mr. Hatakeyama said was much more interesting. The reason is that we at the International Ocean Insitute in India have also been working closely with the poorer coastal communities for the last six years. When I was asked to come here and make some comments, I just asked myself a question. "Is there a dialogue between fishing and non-fishing communities on the coasts?" And with something of a shock I realized that at least in the geographical area in which we have been working for several years there is hardly any dialogue. And I think that it is important that, just as you must have a dialogue of this kind, there should also be a dialogue at the grassroots level. The reason is that there is a mutual dependence of these communities, one which is primarily dependent on the ocean and the other on the land. For example, the fishermen no longer get the kind of wood (for boats) they used to get before, and the land groups do not get the fish at the prices they were getting before. In fact what has happened in many communities (at least in some places in India) is that there is a conflict between these two communities. For example, there are access problems to the sea, there are problems of the beach and the sea being polluted by one community or the other. In India there are also special caste conflicts: for example a non-fishing community will never be allowed to go out and fish. If they tried to fish there would be even mild skirmishes and so on. But there is one thing that is a common need of both communities and that is fresh water. I have seen that in some villages in India the fisherman comes home in the evening after a long day on the sea and the one thing that he immediately needs is a lot of freshwater to have a bath. And in many cases that water is just not available.

So if fresh water is made as a common agenda for both the communities, there is a possibility of their solving other problems, too. But how do we go about doing that? One way would be to involve both the communities in discussions on the water issues at the local administration level. There are also many NGOs like us who are working with communities, and we must take the initiative. We could also have things like Village Water Festivals where the different communities come together and see the importance of water, and for maintaining and keeping in order the sources of freshwater supply. We

have also been trying some work with children like Mr. Hatakeyama has been doing, trying to convey to the children the importance of both the ocean and freshwater. This morning I was at the gender session at this Forum and it came to me very strongly that it is the women who must be brought together, really. In villages where both the communities are there, we primarily work with the non-fishing community but some times we have also given micro-credit to the fishing community women. And when they come together I think that will be a kind of partnership that will probably help us solve the water problem.

Thank You.

Satoquo Seino
Tokyo University

Thank you.

I would like to introduce my opinion in short. I think you may have sushi in Japan. I think sushi symbolizes the good harmony of dialogue between the ocean and freshwater communities. If Japanese lost freshwater, we cannot have rice, and if we lost the sea environment we cannot have good and healthy and very tasty fish, I think. I think Japan is a small island from the very cold Hokkaido, northern area, to the sub-tropical area. We are very gastronomic people and I think I would like to introduce such harmony of such ecological and cultural history.

This week, I planned to take you to the excursion near Osaka. As you may know Kyoto and Osaka is historically the economic engine of Japan. This very wealthy area gathers very tasty food from around Japan, and now from around the world. As a result this area draws away or gathered from around the area and world natural resources. You can see at the Yoshino River watershed and coastal zone a representative big river of Japan. High economic growth of the 1970s required a great amount of sand from the river mouth, and just after the Expo Yoshino River watershed lost much sand, and the organisms of the Yoshino River watershed and coastal area lost their habitat. Then Japanese people thought about what needed to be protected for tasty sushi. Thank you very much.

中西麻美
京都大学農学研究科

今日はお招きをいただきましてありがとうございます。

今日パネリストで来ている中では畠山さんを除いて森林に携わっているのは私一人だけなので、重責を感じております。

海に携わる人たちが森の存在、森の価値について、強く意識しておられることは森林にかかわる者としては非常にありがたく幸せなことと思います。一方で，森に携わる私達も、海の存在、下流域の存在についてもっと強く意識していく必要があると思いました。私自身は森林における窒素や炭素の循環について研究をしていますので、先ほど発表があった、窒素や、燐、珪素、鉄、フルボ酸などの腐植が森林から川に流れこみ，いくつかの過程を経て海に栄養塩として供給される点について非常に興味を持っています。概念として，森林が河川や海に影響を及ぼしていることは理解されているけれども、科学的に示された例はほとんどありません。森林における窒素や燐、珪素、鉄，腐植などの循環，形成，移動などのメカニズムについても同様で，未知の部分が多く残されています。森林の内部での様々なメカニズムについて、まずは森林に携わる私達がしっかりと調べていかなければいけないし、それと同時に森林が下流域に及ぼす影響についても，海の人たちと一緒に調べていきたいとも思いました。

海の人たちと話していて少し気になることは、海の人たちは，とりあえずは森林に樹木が生えていればいいと思っているのではないかという点です。植林すればいいという単純な問題ではないということを認識していただきたく思います。日本では手入れがされなくなって何十年も経った人工林が大きな問題となっています。安価な外材が大量に輸入されるため、日本産の質のいい材木は高価なため売れなくなってしまいました。いくら熱心に手を入れて管理して良質の材を生産しても売れない、お金にはならないという現実に、やむを得ず放置せざるを得ない状況となりました。森林が抱える問題のひとつとして，そのような人工林について認識していただきたいと思います。

最近では，生物の多様性も大きな問題として取り上げられています。京都市周辺の森林においても，数十年前までには人が森林に入って薪炭材を採り、落ち葉を堆肥にしたりと身近な生活の場として利用していました。利用されることなく放置されることで，生物の多様性が低下していると指摘されています。人工林の問題も，生物多様性の低下の問題も，いずれも人間人間の都合によるものです。

これらの森林が抱える問題について，海の人と協力していくことで、問題解決へのひとつの糸口が見つかるのではないかと期待しています。

私は畠山さんのことを存知あげなかったのですが、森林と海のつながり，自然に対する価値観形成について体験を通じて子供達に教えていく取り組みには，非常に感銘しました。私自身は，公開講座などで一般の人に接する機会が何度かありました。参加者の方々は「楽しかった」、「森は綺麗だった」とよろこんで帰って下さるけれども、森林や自然に対して真に理解していただくためには，それだけでは駄目だということを痛感しています。畠山さんを始めとして海の方々と協力しあいながら，森林と海との繋がりについて意識した自然観の形成に向けて努力していきたいと思いました。どうもありがとうございました。

Asami Nakanishi
Kyoto University Forests, Kyoto University

It is a great honor for me to be invited here today.

I feel very responsible today, because, except for Mr. Hatakeyama, I am the only person working in the area of forest issues among the panelists here.

I, as a person involved in these forest issues, am very thankful and happy about the fact that people involved in the ocean issues so strongly recognize the existence and the importance of forests. And I thought that we people involved in the forest issues also need to become more keenly aware of the existence of oceans and estuaries. I myself am studying nitrogen and carbon cycles in forests. Therefore, I am very interested in the process, as reported earlier, where nitrogen, phosphorous, silicon, iron, and humus like fulvic acid flow into rivers from forests and, through several processes, eventually move to and feed the ocean as nutrients. It is conceptually understood that forests influence rivers and oceans, but there have been very few studies that explain it scientifically. Also very little scientific explanation is available and still a large part remains unknown in terms of the cycle, formation and movement mechanisms of nitrogen, phosphorous, silicon, iron, humus, etc, in forests. I think that we who are involved in forest issues must take the first step to assess such various mechanisms. And I also believe that we need to work with the people involved in the ocean issues on the research on the influence of forests on estuaries.

When talking with people involved in the ocean issues, I sometimes feel a slight concern that they might simply think it all right if forests grow any which way. But I would like you to understand that the problem is not so simple as just planting trees. In Japan, there is a growing problem of much of artificially planted forests that have been abandoned for decades. Since a large volume of inexpensive timber is imported from abroad today, Japanese timber, though of high quality, has not sold well due to its high price. Much of Japanese artificially planted forests, then, had no choice but to be left without being taken care of, because of the reality that they are not profitable no matter how carefully they might be maintained to produce high-quality timber. I would like you to be aware of this issue of artificially planted forests as one of the problems relating to my field.

Recently, biodiversity has emerged as another major issue. Only some decades ago, forests not only around the Kyoto area but also anywhere served as a part of people's daily

life. People would visit forests to gather firewood, or would gather fallen leaves to make compost. It is pointed out that the level of biodiversity has been declining because people stopped utilizing forests and left them. The problem of artificial forests and the problem of declining biodiversity both arose due to the convenience of human beings.

I hope that cooperating with people involved in the ocean issues may open up new dimensions for solving these problems.

Although this was the first occasion for me to find out about Mr. Hatakeyama's activities, I was very impressed by his method of allowing children to learn by experience about the connection between forests and oceans, or helping them establish their own value systems for nature. I personally have had opportunities to spend time with ordinary people on the occasions of open classes, etc. The participants would go home happily, saying "I had a nice time," or "The forest was very nice." But I feel keenly that this is not enough at all. I would like to try harder, in cooperation with Mr. Hatakeyama and other people involved in the ocean issues, to establish a common view on nature that considers the connection between forests and oceans. Thank you very much for your kind attention.

CONCLUSION

This session was intended to stimulate an increasing discussion about the role of the Ocean in the hydrological cycle and for the supply, availability in time and space of freshwater and the related management. One essential element of this is to stimulate and enhance the dialogue between the ocean and freshwater communities across all relevant sectors of society. The session achieved this aim. It was concluded that the dialogue taken up at this session is a welcome step towards developing a holistic water management. The session stressed the need for this by highlighting interactions between ocean-atmosphere-land-mountain ranges and their wide-ranging implications for freshwater availability and management. The session agreed that water should be seen as a Common Heritage in the sense presented by Arvid Pardo, in that all life on Earth is connected by water. Thus water should not be subject to the tragedy of the commons, but be sustainably managed. The importance of education, awareness with involvement and responsibility was demonstrated by the essential roles which can be played by communities at local level. Dialogue at the local level between user sectors, however, needs to be much enhanced. It was agreed that Integrated Coastal Area Management is one model to build further on, which could be developed using a nested governance system. An example of a nested system was given by the reference to Japanese sushi: the combination of fish and rice, both being dependent upon water for their production.

Dialogue can certainly also be stimulated by the concern about climate variability and the required adaptation; the need to address in an integrated way the poverty issue; and inter-dependence and increased vulnerability due to globalization.

With the objective in mind to further stimulate efforts towards an integrated and comprehensive water management, including all major parts of the water system and hydrological cycle, the session concluded that in the period up to the next World Water Forum dialogue would be stimulated through a sustained effort which could include:

- preparation of proceedings of the session and use of these as awareness enhancing materials;

- preparation of one or two in-depth case studies building on the examples of interactions presented at the session with focus on practical applications;

- organization of awareness enhancing and educational events, such as seminars involving several user sectors;

- specification of a comprehensive information programme for managers with respect to the role of the oceans in freshwater management;

- stimulation of actions at local levels through interventions of local NGO's such as those active in Japan, India, as well as through regional and global ones like IOI;

- stimulation of research efforts on specific processes and case studies, involving social, natural and other sciences as pursued by the Institute for Ocean Policy, SOF.

In closing the session, after outlining these conclusions and follow-up actions, the co-chairs also thanked all the participants, contributors, speakers, the WMO and IOC of UNESCO, and all the commentators, the World Water Forum Secretariat, who had been very supportive and stimulating throughout; and the local organizers and interpreters.

結論 （和訳）

当分科会の開催目的は、水循環における海洋の役割、また淡水の供給とその入手可能な時期や場所など水資源管理に果たす海洋の役割について、現在高まりつつある議論を活性化することにあった。そのために不可欠なのは、社会のあらゆる関連部門を通じて海洋コミュニティーと淡水コミュニティー間の対話を促し、レベルを高めることである。今回の分科会ではこの目標が達成できたといえる。当分科会で取り上げられた対話は、全体論的アプローチによる水管理への歓迎すべき一歩であったと結論づけられる。 当分科会では、「森・川・海・空」間における相互作用とそれらの作用が淡水の入手と管理に及ぼす広範な影響に焦点を当てることによって、両者間の対話の必要性が強調された。そして、地球上のすべての生命が水によって繋がっているということから、水はアービド・パルド大使が提唱した意味における「共同財産」と見なされるべきであるという点で合意した。従って水は「共有の悲劇」（tragedy of the commons）の対象であってはならず、持続可能な方法で管理されなければならない。 教育ならびに参加と責任を伴う認識の重要性が、地元レベルの地域社会が果たし得る基本的な役割によって示された。しかしながら、地元レベルにおけるユーザー・セクター同士の対話を更に促進向上させる必要がある。「統合的沿岸域管理」はさらに構築を進めるべきひとつのモデルであり、ネットワーク的ガバナンス・システムを用いて展開が可能であろうという点で意見が一致した。ネットワーク的システムの一例として日本の鮨が挙げられた。鮨は魚と米の組み合わせだが、双方とも生産を水に依存している。

気候変動や変化への懸念とそれに対する適応の必要性や、総合的に取り組むべき貧困の問題、グローバル化による相互依存と脆弱性の高まりなどの課題が海洋コミュニティーと淡水コミュニティーの対話を更に活発にすることも間違いない。

水システムと水循環を包含した統合的かつ包括的な水管理に向けての取り組みをさらに活性化するという目的を念頭に、当分科会では、引き続き対話を活性化するために、次回の世界水フォーラムまでの間、下記のような継続的な努力を行うとの結論に達した。

- 当分科会のプロシーディグスを作成し、認識向上のための題材として用いる。

- 当分科会で発表された相互作用の実例をもとに、実践的応用に重点を置いた詳細なケース･スタディーを 1～2 例作成する。

- 複数のユーザー・セクターを対象としたセミナーなど、認識向上および教育のためのイベントを開催する。

- 水管理担当者を対象に、淡水管理における海洋の役割に関する包括的情報プログラムを策定する。

- 日本やインドで活発に活動している現地 NGO と係わりや、IOI のような地域規模あるいは世界規模の NGO を通じて、地方レベルの行動を活性化する。

- シップ・アンド・オーシャン財団海洋政策研究所で行われているような社会科学、自然科学その他の学問分野を包含した形での、特定のプロセスやケース・スタディーに関する研究の取り組みを活性化する。

これらの結論とフォローアップの行動の概略を示して分科会を閉会するにあたり、共同議長はすべての参加者、スピーカー、コメンテーター、ユネスコ IOC、WMO、そして、大きな支持と刺激を与え続けてくださった世界水フォーラムの事務局、地元のオーガナイザーおよび通訳者の各位に謝意を表した。

APPENDIX

APPENDIX 1

2003 年 3 月 21 日　世界水フォーラム「水と森林円卓会議」(大津市)「水はめぐる森・川・海・空・・・」分科会報告

中西麻美

3 月 17 日午後に，国際海洋研究所(International Ocean Institute)，海洋政策研究所(Institute for Ocean Policy, Ship and Ocean Foundation)，政府間海洋学委員会(UNESCO-Intergovernmental Oceanographic Commission)，世界気象機関(World Meteorological Organization)の 4 団体の協力のもと開催された分科会，「水はめぐる森・川・海・空・・・」について報告する。私自身は，森林におけるリターフォールの供給や分解，土壌の養分について研究を行っている者で，分科会には森林を研究する立場でパネリストとして参加していた。

地球上の水は，海から大気へ，大気から森林へ，森林から河川へ，そして再び海に帰るというふうに絶え間なくめぐり，この水の流れは止まることはない。そこで，海洋，沿岸域，河川，森林と立場の異なる人が一つのテーブルにつき，水や自然環境という人類共有の財産の保全について考えていこうというのが分科会の主旨であった。この分科会では，エルニーニョ，モンスーンなどのグローバルな水循環を取り上げた発表，ダムの建設により河川に流入する堆積物が減少したため，沿岸域の侵食が進んでいるという地中海での事例，森林－河川－沿岸環境の密接な関係に着目した日本での実践的活動などが報告され，意見交換が行われた。

中でも，北日本の宮城県，気仙沼で牡蠣養殖業を営み，牡蠣の森を慕う会の代表でもある畠山氏の実践的活動の報告が印象深く，注目を集めた。畠山さんは，気仙沼湾に注ぐ大川という河川の河口で続けられてきた海苔の養殖が、工場排水や埋立て、海岸のコンクリート化による水質の悪化で壊滅状態となったことと，フランスを訪れた際，そこで養殖されている質の良い牡蠣を見て、上流に豊かな森林が存在し、その森林が牡蠣の養殖に良い影響を与えていることに気付いた。これをきっかけに，15 年前から気仙沼湾の上流域の森林に，仲間の漁師さん達と植林を始めた。海に注ぐ水を生み出す森林の存在，森と海とは深くつながっていることに着目したのだった。

畠山さんは，漁師仲間で植林活動を行っているだけではない。森と海の間には，人間が暮らしている。その人間の意識を変えないことには，森も海もどちらの環境も変わらない。そこで，森と海とのつながりを，実体験を通じて理解してもらうために，上流域の子供達に海と接する体験学習を行うとともに，植林にも参加してもらう活動を 12 年間行っている。この経験による子供たちの意識の変化は，親の世代，大人の意識の変化をもたらし，これがさらに地元行政にも変化をもたらしているとのことである。

この畠山さんの活動と，他のパネリストの発表は，多くのことを森林の側に問いかけて

いるように思う。まず，海の側の人たちは，海と森林とのつながりについて，経験から身をもって感じているとともに，強く意識していることである。これは，海の側は，上流から流れてくるものを受け止めるしかないという受動的な立場に置かれていることに起因するように思う。そして，海から上流域の森林までに暮らす人間の生き方，人間と自然との共存について問うていることである。

私自身，森林と海とのつながりについてイメージしてはいたが，海の側の人のような強いものではなかった。会場の皆さんはどうでしょうか？また，1 年以上前になるが，海が育んだ豊かな森林，という内容のテレビ番組が放映された。畠山さんにしても，テレビ番組にしても，どちらも海側の視点のものである。森林の側からは，集水域，河川とのつながりの意識は強いと思われるが，さらに海までを意識しているかというと，そうでもないように思うがどうでしょうか？また，海側の人たちからは，海を大事に思うように，森林のことも大事にしなければ，と考えていることが伝わってきた。森林のことを理解してくれる仲間の存在が実は海にあった。

森林はいろいろな問題を抱えており，その問題の解決に向けて，ここにいる森林に関わる人間は取り組んで行かねばならない。それにあたって，河川，下流域はもちろん，沿岸域，海洋も含めた意識を持つことで，適切で包括的な森林の保全や管理，水の保全管理に向けて可能性が広がるのではないかと思う。

畠山さんの例では，子供達から始まった森林や海に対する意識の変革は，大人へ，行政へというボトムアップ型の動きを起こした。このような動きを，森林の側でも起こせないものでしょうか。このために，まず森林のことを理解した上で，止まることのない水の流れは，河川，沿岸域，海洋へとつながり，また森林に戻る，という点をより強く意識することが大切だと思う。特に日本は，国土の面積の 6 割以上が森林に覆われ，かつ周囲を海に囲まれており，森林と海とのつながりが生活に密接に関わっている。したがって，森林から海までのつながりをより強く感じて行かねばならないと思う。

森林，河川，沿岸域，海洋，それぞれの生態系がつながりを持ち，相互に作用しながら，自然環境，地球環境を作り出している。地球環境は，人類共有の財産(Common heritage of mankind)であるという自覚を持って，森林，水，地球環境の保全，水と森林の関係，自然と人間のあり方，について考え，取り組んでいけるような体制つくりが，トップダウン方式だけでなく，ボトムアップ方式との協調型で行うことができればと思う。

なお，分科会としては，今後フォローアップを行っていく。プロシーディングの発行，共同プロジェクトの推進，研究会などの開催，次の世界水フォーラムでの分科会開催も計画している。森林，河川，沿岸，海洋の各生態系の相互理解を進め，分野横断的，学際的，包括的な取組みを実践し，経験を通じた教育を行い，トップダウン型とボトムアップ型との協調により，人類共有の財産としての海，森林などの自然の保全，森，川，海，空をめぐる水の統合的な管理に向けて，挑戦していきたいと考えている。そのためには，ここにいる森林の関係者との協力は不可欠である。

World Water Forum: "Roundtable on Water and Forests" March 21, 2003 (Otsu City)

Report on "Dialogue between Ocean and the Freshwater Communities"

by Asami Nakanishi

I would like to make a report on the session "Dialogue between the Ocean and the Freshwater Communities" held in the afternoon of March 17 through the collaboration of 4 organizations; the International Ocean Institute, the Institute for Ocean Policy, Ship and Ocean Foundation, UNESCO-Intergovernmental Oceanographic Commission, and the World Meteorological Organization. I had been researching the litter input and decomposition processes and dynamics of soil nutrients in forests and my role in the session was to be a panelist from a forest research point of view.

On a global scale, the cycle of water supply is a continuous and never-ending one, moving from sea to air, from air to forest, from forest to river and back to the sea again. Therefore, the main goal of the session was to think about water conversation and our natural environment from a shared human perspective. People who work in fields closely associated with the oceans, coastal areas, rivers and forests gathered together at one table to exchange opinions on the global water cycle and to discuss topics such as El Nino and monsoons, a case study on erosion threaten coastal areas in the Mediterranean due to a decrease in sediment washing into rivers resulting from the construction of dams, and a Japanese report that emphasized the close relationship between forests, rivers and coastal environments.

In particular, a report by Mr. Hatakeyama, representative of the "Society to Protect the Forests for Oysters" who is engaged in oyster cultivation in Kesen-numa, Miyagi prefecture in northern Japan was very interesting and drew much public attention. The seaweed industry at the mouth of the Okawa River was on the brink of ruin due to the worsening quality of runoff into the Gulf of Kisennuma caused by waste water discharge from plants, reclamation and concrete construction along coastline. When Mr. Hatakeyama visited France and observed the high-quality oysters cultivated there, he soon realized that the forests upstream had a very important effect on oyster cultivation. Since then, 15 years ago, he began afforestation projects with other fishermen. He observed the close association between forest runoff and its effect on the marine environment.

Mr. Hatakeyama has not only been actively involved in the planting activities of

fishermen; since people reside between the forests and the sea, without better awareness, both our forest and ocean environments cannot improve. Therefore, in order to create a better understanding of the important relationship that exists between the forest and the sea he introduced an experimental watershed study for children and has participated in afforestation projects for the past 12 years. Through various experiences, the change in awareness among children led to better awareness among parents, and brought about a change in the attitude of local administrations.

The activities of Mr. Hatakeyama and presentations by other panelists seemed to emphasize the forest over the ocean. Through their experiences, people living near the sea began to realize the relationship between the sea and forest, and they soon became very aware of it. Perhaps this is because they were used to taking a passive role and usually have no choice in matters emerging upstream. A scheme for which people living near the sea and those living upstream and co-existence of man and the environment were subsequently discussed.

Despite my views on the relationship between the forest and the ocean, the opinions of people living near the sea appeared to be stronger. How about everyone here today? Just over a year ago, a TV program entitled “the sea nurtures bountiful forests” was broadcast. Both the views of Mr. Hatakeyama and the TV program were expressed from a marine perspective. Although there appears to be ample awareness of the connection between watersheds and rivers from the forest point of view, these views alone may be not good enough to understand the relationship between water and forests, wouldn’t you agree? In the same way that people living near the sea are sensitive to the sea, I feel that such individuals are sensitive to the forest. I am quite sure that we who are involved in forest issues have the partner to promote conservation of water and forests together.

To address the various problems facing our forests, people working in forest-related fields should take action. Consequently, not only is better awareness important upstream and downstream, but also along the coasts and oceans as well. If we can achieve this, the possibility of appropriate and comprehensive forest and water conservation and management can be improved.

In Mr. Hatakeyama’s model, there has been a revolution in awareness of the forests and the sea in children all the way to adults and the administrative level. Is a similar movement possible from a forest perspective? Once we understand the forests, we need to become more aware of the never-ending cycle water takes from the rivers to the coastal

areas and oceans and back to the forests again. For example, more than 60 % of Japanese territory is covered by forest and surrounded by the sea. The forests and seas are closely linked to people's lives. Therefore, more than ever we should be aware of the relationship between the forest and sea.

Instead of simply regarding nature as forests, rivers, coastal areas and oceans, we should think about the interactions between each ecosystem and how they connect to create our natural global environment. By regarding our global environment as something Common heritage of mankind, I hope we can create a system through which conservation of our forests, water and global environment, and the relationship between water and forests and the balance between nature and mankind can be achieved not only through cooperation from the top down, but from the bottom up.

In the future, we will follow-up these things such as the issuance of proceedings, promotion of joint projects, a study meeting and session will be held at the next World Water Forum. Let us take steps toward conservation of the oceans and forests as our common heritage and integrate water management of our forests, rivers, oceans and sky by promoting mutual understanding of the forest, river, coastal and marine ecosystems by introducing cross-sectional, academic and comprehensive measures, and by providing education through cooperation from the top down and from the bottom up. The cooperation of forest-related personnel is essential if we are to achieve this.

APPENDIX 2

Biwako Declaration for Actions on Water and Forests

Roundtable on Water and Forests

Otsu, Shiga March21, 2003

The world is facing 'a water crisis'. While there are areas where people do not have access to enough water to fulfill their basic necessity, there are areas where people are suffering from water-related disasters such as floods and debris flows. At the same time, the world is facing 'a forest crisis'. Forests are facing rapid decrease or degradation due to natural and socio-economic causes such as forest fire, over-exploitation, illegal logging, population increase, and poverty. Approximately 9 million hectares of forests are disappearing in the world every year, resulting in disastrous consequences including floods, landslides, soil erosion, desertification and loss of biodiversity.

Forested watersheds are sources of water for households, agriculture, industries and ecosystems, in both upstream and downstream areas. On the other hand, we need to recognize that forests also use water for their growth.

Even though the issues of water and forests are closely interrelated as such, these issues have been discussed separately in the international fora. Based on these facts, we, people with diverse backgrounds and from different disciplines, who came together at this Roundtable on Water and Forests during the Third World Water Forum, will unanimously promote the following actions.

ACTIONS

1. We will fully acknowledge the necessity of actions to promote sustainable forest management toward solving water-related problems as a component of comprehensive and multifaceted water management programmes. Every one of us, individually and cooperatively, will also tackle these problems related to this action at local, national and international levels by formulating necessary policies and strategies for forests, water, watershed, environment, biodiversity and human society in a holistic and inter-disciplinary manner.

2. Recognizing the need to better understand the interactions between upstream and downstream and the relationship between forests and water from catchment to the ocean, we will further develop research and monitoring on related issues, particularly on the effects of forests on river flows, flood mitigation, groundwater recharge and other water-related issues, particularly on the effects of forests on river flows, flood mitigation, groundwater recharge and other water-related phenomena. We will utilize the results of these actions to promote appropriate integrated watershed management practices for conserving and rehabilitating sound hydrological cycle, as well as to promote comprehensive evaluation of forests with regards to their hydrological functions.

3. We realize the cultural, social and economic impacts of policies and measures related to forests and water, and to promote cooperation and partnership among governments, local communities, civil society, and all relevant stakeholders, respecting tradition of local people, through the development of systems which facilitate the relationship between upstream and downstream areas.

4. We recognize the urgent need to widely disseminate relevant scientific knowledge and information to the relevant stakeholders, decision makers and general public in order to promote sustainable forest management, and to solve water-related problems in consequence. We will try to develop effective and easy-to-understand education tools, taking into account the true information needs of the people. In order to facilitate knowledge sharing and capacity building, we will also develop a network for sharing common understandings and for exchanging information and experiences on the issues of water and forests

水と森林に関する行動のための琵琶湖宣言（仮訳）

水と森林円卓会議

2003 年 3 月 21 日　滋賀県大津市

世界は「水危機」に直面している。人間の基本的な必要性を満たすだけの水を確保することもできない地域がある一方、水をコントロールできずに洪水や土砂災害に見舞われている地域も存在している。他方、世界は「森林危機」に直面している。森林は、熱帯地域を中心に森林火災、過剰な伐採や違法な伐採、人口の増加、貧困など自然及び社会経済的な要因により、急激に減少又は荒廃しつつある。全世界で毎年約 900 万ヘクタールの森林が消失し、洪水や地滑り、土砂の流出、砂漠化及び生物多様性の喪失などのきわめて深刻な影響を招いている。

森林に覆われた河川流域は、上流から下流に至るまで、家庭、農業、産業及び生態系のための水の多くの供給源となっている。反面、森林が生育のために水を消費するということを認識しておく必要がある。

このように、水の問題と森林の問題は、相互に密接に関連しているが、国際的に見ると森林の問題と水の問題はそれぞれ別々の場で議論されている状況にある。こうした現状を踏まえ、第 3 回世界水フォーラムの中で、様々な立場の水問題に関する関係者と森林問題に関する関係者が、この「水と森林円卓会議」に参加し、以下のような行動を一致して推進するものである。

行動

１　我々は、水問題の解決に向けた、包括的かつ多面的な水管理プログラムの一環として持続可能な森林経営のための行動の必要性について確認する。我々それぞれが、それぞれの立場で、また連携協力して、森林、水、流域、環境、生物多様性保全、人間社会などに係る必要な政策と戦略立案を通じて、統合的かつ分野横断的に、地域的、国家的かつ国際的なレベルでの問題解決に取り組む。

２　我々は、上流と下流の相互作用及び集水域から海洋までの森林と水との関係について理解を深めることの必要性を認識するとともに、関連する課題、特に森林が河川流量、洪水緩和、地下水のかん養その他の水に関する現象に及ぼす影響についてのさらなる調査研究やモニタリングを推進する。我々は、健全な水循環系の保全と回復のための適切な総合的流域管理及び森林の水文学的な機能に関する総合的な評価を促進させるため、これらの行動の成果を活用する。

３　我々は、森林及び水に関連するさまざまな政策や管理手法がもたらす文化的、社会経済的影響を認識し、地域の人々の伝統を尊重するとともに、上下流の関係を促進させる仕組みの開発を通じて、政府、地域社会、一般市民及び全ての利害関係者間の協力の体制やパートナーシップを促進する。

４　我々は、持続可能な森林経営を促進するため、利害関係者、政策決定者および一般の市民に対して科学的知見と情報を普及していくことが緊急に求められている。このため結果として生じた水問題の解決のため、どのような情報を必要としているのかを考慮し、効果的かつ理解しやすい教育手法を開発するよう努める。我々はまた、知識の共有と人材の育成の促進を目的として、共通の理解を共有し、水と森林に関する情報と経験を交換するためのネットワークを開発する。

APPENDIX 3

Yoshino River Excursion "A Dialogue between the Ocean and Freshwater Communities"

On the 21st and 22nd of March, 2003, the International Ocean Institute – Japan, with the help of Dr. Satoquo Seino, hosted a two-day journey to the Yoshino River in connection with the 3rd World Water Forum. There we not only visited the river and observed its estuary but also met local people who were very active in preserving the natural/social environment of the water along the river from the mountains to the ocean.

According to the "Tokushima Shoreline News", published by the Japan Science Society, the Yoshino River arises in the forest of Kame-ga-Mori in Kochi Prefecture and flows across Tokushima Prefecture from west to east. Its total length is 198 kilometers, making it a major river in Japan.

The ocean is never far away in Japan. Its varied shoreline - beaches, tidal flats and other coastal environments - are seen as everyday natural surroundings. It may be that we take them for granted. The main field sites for our Nature Observation Group include the estuarine tidal flats of the Yoshino River, probably Japan's major site for the Red Data Book-listed fiddler crab Uca arcuata, and also beaches along other parts of Tokushima prefecture's coastline that serve as nesting sites for Loggerhead Sea Turtles.
For more information, see http://www.shiomaneki.net/

Course Schedule & Tour Highlights

Day 1 (March 21, 2003)

9:00	Lv. Kyoto by bus
12:30	Arr. Tokushima City, lunch
13:30	Arr. at river boat dock at the river mouth of the Yoshino River
	Meet local fishermen, including Mr. Yata
	A talk by Mr. Yata "Livelihood and the Estuary in Tokushima"
14:00	Boat ride to the estuary. Take a walk around estuarial tidal flats.
	Meet with local bird-watching and conservation groups.
	Interviewed by Tokushima Newspaper.

15:15 Arr. at Tokushima City Castle Museum

Tokushima Castle was built on one of the islands in the estuary. Lords used network of riverflows for protection. A 200-year-old classic wooden boat - the oldest preserved Japanese traditional ship was used by the Lord of Tokushima used it as a part of his fleet to visit the Shogun. A set of spectacular paintings of the trip is also exhibited in the museum.

16:30 Arr. at Daiju(No.10) Weir

The weir is a traditional flood control and water use facility which was built with stones and pine tree blocks some 250 years ago. However, since the 1990's local people confronted the national government on a multi-billion dollar reconstruction plan which is considered not very nature friendly. Pro and con are still a big political issue in the region. A talk by local resident Mr. Yamashita "History of the Yoshino River and the Weir"

17:30 Visit a "people's shed" where local people gather for discussing the protection of Daiju Weir. Historical records of Daiju Weir are also exhibited and stored in the shed.

19:00 Dinner with local people after checking in at the hotel.

Day 2 (March 22, 2003)

7:30 Breakfast

8:00 Lv. Hotel to visit Zennyuji Shiba Town Island

See riverside bamboo groves, a traditional flood protection mechanism. In the early to mid-1900's residents there were forced to move off the island to protect them from floods. A talk by an official of the National Ministry of Infrastructure, Land and Transportation Office.

10:00 Waki Town de Rijke Siltation Dam

Designed by Dutch engineer Johanas de Rijke more than 100 years ago to control damage from floods and rushing debris during the rainy season. Local residents are proud of Rijke's contribution to their history. A talk by local resident, Mr. Kanahira "The History of the de Rijke Siltation Dam"

11:00 Udatsu Waki Town (old indigo trading post). Udatsu's decorative roof tiles are a symbol of the wealth derived from the river trade in indigo. Lunch.

14:00 Old Tokushima indigo traders, Tanaka Estate

Indigo plantation and trade flourished in middle reach flood plain.

15:00 Visit coastal area reclaimed recently for the airport.

19:00 Arr. Kyoto

SPEAKERS

Gunnar Kullenberg International Ocean Institute (IOI)
Hiroshi Terashima Institute for Ocean Policy, SOF

Kenneth Davidson World Meteological Organization (WMO)
Toshio Yamagata Department of Earth and Planetary Science, The University of Tokyo
Michael Collins School of Ocean and Earth Science, University of Southampton
Yoshihisa Shirayama, Seto Marine Biological Laboratory, Kyoto University
Shigeatsu Hatakeyama Society to Protect the Forests for Oysters
Satish R. Shetye National Institute of Oceanography, India
Vladimir E. Ryabinin World Climate Research Programme, WMO (paper)

Kazuo Matsushita Graduate School of Global Environmental Studies, Kyoto University
Biliana Cicin-Sain Center for the Study of Marine Policy, University of Delaware, USA
R. Rajagopalan Professor, IIT Madras/International Ocean Institute - India
Satoquo Seino Tokyo University
Asami Nakanishi Agricultural Research Department, Kyoto University

SESSION SECRETARIAT

Masako Bannai Otsuka International Ocean Institute-Japan
Tyler Russel International Ocean Institute- Japan
Shuhei Okazaki Institute for Ocean Policy, SOF
Tomohiko Fukushima Institute for Ocean Policy, SOF
John Dolan Institute for Ocean Policy, SOF

水はめぐる、森川海空
Dialogue between the Ocean and the Freshwater Communities:
Forests, Rivers, Oceans and the Skies

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