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Inter-regional Co-operation on Environmental Issues: The Black Sea Example

I. Introduction

I am asked to make a presentation on a research program that I, through my Institution, lead in the Black Sea. Now, the theme of this conference has been identified as "Inter - Regional Co-Operation & Research And Technological Development". I am not exactly sure about the one-to-one relevancy of what I will be describing to this theme except, perhaps, in words. However, I do hope that the experience I will describe to you may be of use in relation to planned EU collaborative marine research programs with non-EU countries in the seas around Europe in general, and the Mediterranean, in particular.

The **research** program I will describe does involve **a regional activity**. The region is the Black Sea and the **cooperation** is among the top marine **institutions** of the **riparian states** Bulgaria, Romania, Ukraine, Russia, Georgia and Turkey. Institutions from other regions of the globe, notably from the US, also participate so that the program do have an **international** nature not limited to the region. The financial support comes from an **intergovernmental organization**, the **NATO through its Science for Stability Program**, as well as from the internal funds provided by the **Black Sea states** and the other **external institutions** such as the US National Science Foundation.

The purpose of the project is the improvement of the health of the Black Sea through utilization of ecosystem models as a management tool, through capacity building, and by fostering an interactive scientific community for the Black Sea.

The project's purpose reflects a **regional binding socio - economic issue** with much **global scientific interest**, involving the environment degradation of the Black Sea. A short discussion concerning this background setting is thus warranted here.

II. Why the Black Sea ?

The Black Sea constitutes a unique marine environment. It is nearly land locked and the ventilation of the deep waters by lateral influxes is therefore poor. In addition, a strong density stratification effectively inhibits vertical mixing. As a result, permanent anoxia exists within 87% of its volume, making the Black Sea the largest anoxic basin of the entire World Ocean. Its surface area is five times smaller than its catchment basin covering parts of the neighboring European and Asian continents where human activities create loads destined for this basin. About 162 million people live in the catchment area of the Black Sea Basin.

Among the various basins of the World Ocean, the environmental degradation in the Black Sea is the most severe. In a recent study by the Intergovernmental Oceanographic Commission (IOC) examining the health of twelve marine areas (Caribbean, North Sea, West African coast, Baltic Sea, Northern FSU, Mediterranean, Red Sea, the Gulf, Asian Seas, Black Sea, Oligotrophic Gyre and the Great Lakes) with respect to various contaminants, the Black Sea received the poorest marks. The most predominant anthropogenic impact is the severe eutrophication experienced in the surface layers. Regarding marine pollution, the Black Sea thus deserves increased vigilance and effective environmental management.

The environmental crisis in the Black Sea resulting from anthropogenic forcing, and accompanied by natural variability and climatic changes, is manifested by dramatic changes in its ecosystem and resources. The fishery yields have declined dramatically with 80% reduction in total catch in the last few years, and only six out of the 26 species of commercially valuable fish of the 1960's remaining in exploitable quantities. Frequent hypoxia and occasional anoxia have resulted from eutrophication, and have lead to nearly complete decline of benthos over broad regions of the shelf. On the Romanian coast alone, a single event of anoxia in 1991 eliminated an estimated 50% of the remaining benthic fish. Decreased light penetration have lead to 95% loss in the harvest area of the commercially valuable shallow water algae *Phyllophora*. Irretrievable losses of some significant deltaic wetlands and their habitats have taken place. Harmful algal blooms (red tides) are frequently observed. Changes in the species composition and community structure of plankton, and a loss of diversity in phytoplankton have taken place. The basin's food web has been affected significantly by the rapid influx and spread of predators, especially the ctenophore *mnemiopsis leidyi*. Heavy metals, pesticides, and hydrocarbons mostly originating from terrestrial inputs (notably from the Danube in alarmingly high amounts: 60,000t of total phosphorus, 340,000t of total inorganic nitrogen, 1000t of chromium, 900t of copper, 60t of mercury, 4500t of lead, 50000t of oil) have lead to chemical and microbial pollution, affecting public health and tourism industry (annual losses: 400 MUSD).

The Black Sea is of global interest. Firstly, the events in the Black Sea could be nature's warning for other regions of the world. Knowledge gained from the Black Sea could therefore benefit the other regions of the world ocean.

Secondly, the Black Sea is a natural test arena for coupled interdisciplinary models developed for understanding oceanographic phenomena common to other areas of the World Ocean. It is an ideal "laboratory" basin to study the effects of anthropogenic forcing, synoptic and climatic variability on non-equilibrium ecosystems.

On the other hand, significant efforts are needed from the countries of the Black Sea region to address the call from United Nations Conference On Environment and Development and the Convention on Biodiversity, stressing the importance of a scientific basis for decision-making, and establishment of observation and data base management systems for sources, types, amounts and effects of marine pollutants.

It is important to note in passing that, we are talking here about a regional co-operation of states, including one superpower, Russia, with transitionary, often shaky and, at certain cases, nearly collapsed economies. In fact, severe economic problems encountered in the Black Sea riparian states have hindered the marine environmental and oceanographic research and expected to continue to do so for some years (at least for the next five) to come.

The economic constraints have particularly affected the availability of ship time, the qualified scientific / technical staff, upgrading of equipment, availability of expandables / spare parts and communication capabilities. Most research vessels now operate as passenger and cargo ships, the already meager salaries of scientists and technicians are not even paid regularly, a significant portion of the laboratory and shipborne equipment are outdated and even these are not often functional because of lack of spare parts and/or expandables. The migration of qualified scientists to private industry, without their replacements, is a rule rather than an exception.

III. Objectives

With bearing on the marine environment of the Black Sea, the three highly coupled major objectives of the Project involve modeling, capacity building and a data base management system. A subproject is associated with each of these objectives.

The first objective encompasses the development and application of interdisciplinary ecosystem models of the dynamics of the lower trophic levels of the biological community as affected by physical processes, changes in anthropogenic forcing and natural variability.

The second objective involving capacity building is achieved:

- by cross training in methodology and in high quality measurements (intercalibration, intercomparison & modeling workshops - exercises, seminars),

- by providing unified, high tech scientific equipment,
- through intensive - extensive observations,
- by developing satellite image receiving & processing capabilities,
- by supporting collaborative analysis and synthesis of past and recent data leading to joint publications,
- by developing a communication network.

The third objective of the project is associated with a Data Base Management System (DBMS). It is intended to include environmental and oceanographic data pertinent to the goals of this program and is expected to serve as a base line for future research activities and management purposes. The DBMS will be distributed to all the participants.

IV. Who Cooperates ?

Nearly 100 scientists from a total of 13 prominent oceanographic institutions (7 regional, 5 outside the region) collaborate to accomplish the objectives of the Project. The program is thus not an intergovernmental program; it is a "bottom up" activity involving marine scientific institutions and scientific community.

The institutions collaborating in the project include:

COOPERATION PARTNERS (CPs):

- Marine Hydrophysical Institute, UAS, Sevastopol, Ukraine,
- Institute of Biology for the Southern Seas, UAS, Sevastopol, Ukraine,
- Shirshov Institute of Oceanology, RAS, Moscow and Glendjik, Russia,
- Institute of Oceanology, BAS, Varna, Bulgaria,
- Department of Meteorology and Geophysics, University of Sofia, Bulgaria,
- Romanian Marine Research Institute, Constantza, Romania,

NATO

- Woods Hole Oceanographic Institution, MA, USA,
- Division of Applied Sciences, Harvard University, Cambridge, MA, USA,

- Department of Earth, Atmospheric And Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA, USA,
- Department of Oceanography, University of Washington, Seattle, WA, USA,
- Virginia Institute of Marine Sciences, VA, USA,
- Institute of Marine Sciences, Middle East Technical University, Erdemli, Turkey,
- Turkish Scientific And Technical Research Council.

V. Accomplishments to date

5.1. Modeling:

The modeling activities taking place in this project constitute research at the frontiers of ocean science. It is based on a well defined course of action for development and application of defensible, tested and robust ecosystem models. The models adopted are interdisciplinary, eddy resolving, primitive equation models and are based on up to date concepts and methodology. They are developed and applied for the Black Sea through collaborative research among the NATO and the Cooperation Partner countries, involving institutions such as MIT, Harvard, Virginia Institute of Marine Sciences, University Of Washington in USA, Shirshov Institute of Oceanology and the Institute of Numerical Mathematics in Russia, and METU Institute of Marine Sciences in Turkey. Specifically, the models are adopted:

- Princeton Ocean general circulation Model (POM) with Fasham Ducklow biochemistry (MIT / VIMS / IMS METU / SIO collaboration),
- Harvard Ocean Prediction Systems (HOPS; HARVARD / IMS METU collaboration),
- Diagnostic Models (INM / MIT / IMS METU collaboration),
- Fasham - Ducklow Zero - D Mixed Layer Model (MLM; collaboration of all the Project partners).

The modeling efforts are carried out under the supervision of prominent Scientists (Vinogradov, Lebedeva, Shuskina, Sarkisyan, Rizzoli, Robinson, Ducklow, Murray, and Oguz among others). Various Biological and Chemical interactions and cycles, including the microbial loop and those biochemical processes taking place within the suboxic zone, are modeled. The effects of the predator *mnemiopsis leidyi* on the dynamics of the lower trophic levels have been modeled successfully. The results emerging from the models are in harmony with the observations.

Stated succinctly,

- Best available models have been adopted for the Black Sea,
- Encouraging results in harmony with observations have been obtained,
- Collaboration of prominent scientists in Ecosystem Modeling has been accomplished,
- The efforts are well balanced in among the NATO countries and the Cooperation Partners.

Major Problems Encountered and Remedies:

- a. Everyone's model is the best (universal problem), western modelers not being experienced with the Black Sea(regional side), local capabilities are no good (western side); one group work with high tech computational facilities the others do not even have PCs; Bring in the prominent workers on modeling, especially from the west, through workshops let them assess each others' scientific capabilities and generate a strategic plan and make sure everybody stick to it and, when necessary, make changes collectively, supply CPs with better computational equipment.
- b. Continuous time series measurements for data assimilation into the models are scarce; Start limited and new national efforts in cooperation with other programs (GEF) for construction of time series.
- c. Considerable uncertainties on ecosystem rate parameters exist; Carry out special processes study cruises.

5.2. Data Base Management System (DBMS)

In relation to interdisciplinary data, the DBMS developed through the TU-BLACK SEA Project is a **first** in Ocean Science. Above all, it is an excellent indicator of collaborative scientific spirit existing among the scientists involved in the Project.

The DBMS is a distributed data base system having no data center. The attention has been fixed upon the last thirty years of data. A Data Base Inventory (CDBI) is completed and is distributed in hard copy and diskette forms to the Cooperation Partner Institutes and the relevant International Organizations.

As of September, 1996 the DBMS contains 9,656 files (109 MB). The total volume of data provided is 125 MB. The first draft version of the Data Base Management System is finalized with a data volume of 125 MB. This amount of data volume involves 203 data sets (9960 stations) out of the 356 data sets (13,265 stations) listed in CDBI. The quality control DBMS data is in progress by five working groups (bulk of the work is completed as of December, 1996). Operational issues related to the DBMS (including access via certain rules and procedures) are taken care of by an Executive Committee formed by the data contributing Institutions.

The data entries for the for the project final version of the system will cease on 1 January, 1997. The work for preparation of separate DBMS directories for the data submitted later than 1 January, 1997 will commence. DBMS with quality controlled data

submitted before 1 January will be completed by June 1997. An attempt are being made to generate additional DBMS directories on species level plankton data.

In summary:

- DBMS is already a landmark in Ocean Science and encompasses significant amount of data much needed in interdisciplinary research and environmental management,
- It is being a distributed data system make it attractive to the scientific and management community,
- It has nearly reached the stage of development after which it can serve as a continuously updated base line for future activities concerned with the sustainable use and protection of the Black Sea environment.

Major Problems Encountered and Remedies:

- a. Initially, lengthy and endless discussions on formats, variables and time periods; Accept data in existing formats then reformat, ask modelers and others real data needs, require program oriented variables and limit time period to a reasonable range
- b. Intense reluctance to release data; Identify the DBMS as a Distributed Data Base System (:no data banks), support frequent meetings of scientific groups for joint analysis and / or synthesis of past and recent data sets towards scientific publications in western journals (this effort is also instrumental in establishing a large scientific community capable of carrying out collaborative scientific research for years to come)
- c. Most of the biological data sets are not digitized and uniformly adaptable formats these sets is a major issue because of the way they have been stored in the past; Support technical personnel for local data editorial and entries.

5.3. Capacity Building

There are many facets of the Project objective related to capacity building.

Equipment for high quality, unified data collection and analysis have been provided to the Cooperation Partners institutions. Equipment delivered include high-tech CTD probes with PCs, Rosette samplers, plankton nets, AutoAnalyzers, satellite navigation systems, Pentium computers for data entries and work stations for communications and data transfers. A communication net work via Internet has also been developed. Substantial number of intercalibration /intercomparison exercises, modeling workshops / courses for cross training in methodology and in high quality measurements have been held. Manuals / reports for chemical methods, criteria for unified biological sampling are made available for all the participants.

Joint intensive / extensive observations through multi-ship surveys have been carried out and the data collected have been intercompared and pooled through collaborative analysis.

The analysis and / or synthesis of past and recent data through collaborative efforts have already led to a substantial number of joint publications in international journals. A significant number of additional publications are in preparation and will be published by the end of the project. This activity has been instrumental in strengthening of the foundations for cooperative scientific research in the region for the future activities. It has also been instrumental in the rapid development of the DBMS by allowing rapid transfer of voluminous data to the system.

In summary, the achievements to date in the development of a project related infrastructure in terms of equipment, methodology and services are in accord with the objectives of the Project. The efforts related to joint analysis and / or synthesis of past and recent data sets have led not only to scientific publications but also to the establishment of a large scientific community capable of carrying out collaborative scientific research for years to come.

Major Problems Encountered and Remedies:

Availability of ship time for all of the CP Institutions; No definite remedy.

Transfers of large volumes of data via internet is hampered by slow transmission rates. In some of the riparian Black Sea States, the improvement of network qualities awaits country-wide measures in communication systems.

VI. Relation to other Black Sea Programmes

Interactive cooperation with the various programs concerned with the Black Sea can be summarized as follows.

The Black Sea Environmental Program of the Global Environmental Facility (WB, UNEP, UNDP): Through the program unit in Istanbul cooperation on DBMS, coordination of research activities and capacity building;

GLOBEC (SCOR/IGBP, ICES, PICES): TU-BLACK SEA is an associated program of GLOBEC and scientific interactions on small pelagic fish, climate change, modeling, and observation systems,

EROS 2021(European Union): on modeling efforts,

CoMSBlack: on facilitating scientific activities,

Intergovernmental Oceanographic Commission: on regional oceanographic activities especially through IOC's GIPME program,

National Science Foundation (USA): on modeling.

Publications

As of September 1996, 15 papers have been published in the refereed journals and 34 papers have been presented in various conferences.

VII. Summary

In closure, the primary objectives of the Project are being met. It is clear that after its termination, the Project will leave in its wake:

- A unique data base management system that can be accessed to by scientists and managers and can form major foundation for future activities,
- A series of interdisciplinary models for the use of the scientific and management community and ready for further development,
- An infrastructure in terms of equipment, methodology and services that can be utilized by the Black Sea community,
- A community of nearly 100 scientists capable of doing collaborative research in future activities and who are well versed in matters related to the environment of the Black Sea.

Inter-regional co-operation & research and technological development

6th European STRIDE-Conference

WORKSHOP III

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