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Edited by D.G. Aubrey, Chairman
Co-operative Marine Science Programme for the Black Sea (CoMSBlack)

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TABLE OF CONTENTS

INTRODUCTION

The Working Group reports of the International Workshop on the Black Sea (Varna, Bulgaria, 30 September-4 October 1991) represent first attempts at defining the critical issues in Black Sea science and management. Though the ideas must be refined in many cases, they form an excellent point of departure for the initiation of CoMSBlack and other related efforts. Some central themes emerge throughout all of these working group reports, representing major needs for the international community, as well as the riparian countries themselves. Some of the dominant themes include:

(i) the need for education, training and technical assistance for the riparian countries, in many related areas of data bases, monitoring, and scientific sampling/analysis;

(ii) the need for advanced, modern instrumentation to conduct oceanographic research, including *in situ* measurement technologies, remote sensing, and data processing;

(iii) the need for a data base management system common to the Black Sea riparian countries, specifically y for applied oceanographic research;

(iv) the need for intercalibration exercises for all phases of oceanographic research and monitoring, to standardize techniques, provide standards for calibrating instruments, and for data reduction;

(v) the need for expanded and enhanced communications capabilities among all participants. Although CoMSBlack has started this by providing some electronic mail capabilities, present facilities are totally inadequate;

(vi) the need for compatible computer platforms (both hardware and software) for all Black Sea riparian countries, to standardize data transfer, data base management, geographic information systems, communication, and rapid computer modeling of Black Sea dynamics and ecosystem processes;

(vii) the need for international frameworks for co-operation, including ratification of the Convention for the Protection of the Black Sea: regional fisheries co-operation, and economic co-operation.

The next few years of CoMSBlack will, hopeful] y, see some new international and regional co-operative protocols implemented, full scientific co-operation between all Black Sea countries and outside countries, improved economic stability to help support Black Sea oceanographic infrastructure, and implemental ion of management frameworks to stabilize first, and ultimate] y to enhance the viability of the Black Sea ecosystem.

The International Workshop on the Black Sea, with a focus on the western shelf, was supported by a number of organizations, including the Bulgarian Academy of Sciences, the US Office of Naval Research, the Regional Environmental Center for Central and Eastern Europe, the Intergovernmental Oceanographic Commission (IOC), the Andrew W. Mellon Foundation, the Woods Hole Oceanographic Institution and its Coastal Research Center, the Mobil Foundation, and many others.

ABSTRACT

Environmental degradation of the Black Sea has continued unabated throughout the past decades, and the past ten years has seen first order ecological changes throughout the entire Black Sea. Decline of fisheries, loss of benthos, massive phytoplankton blooming and eutrophication, and intrusion of non-endemic species of jellyfish and ctenophores have all altered the balance of this nearly land-locked, and hydrogen-sulfide rich sea.. At present, historic intergovernmental efforts are being made to help decelerate this pattern of decline in the Black Sea, partly through the mechanism of the Global Environmental Facility, and partly based on regional conventions.

Regional management efforts recognize the need to develop an integrated management regime for the Black Sea, using science as one of the fundamental bases for such planning. This document reveals the state-of-the-art in Black Sea scientific understanding, as of an international workshop held in Varna, Bulgaria in September and October 199 i. This workshop was attended by participants from all eastern European countries bordering the Black Sea, plus the US and western Europe. The attached documents consist of working group reports recommending future scientific action to help guide the policy, management, and planning for the Black Sea. Whereas the Workshop recognized that science alone will not resolve the environmental degradation of the Black Sea, scientific understanding is a clear, essential requirement to proper regional policy. Just as pollution and environmental degradation are transboundary issues, so is the marine science contributing to the understanding of these issues.

As outgrowth of this Varna Workshop is the Co-operative Marine Science Programme for the Black Sea (CoMSBlack), a co-ordinated scientific framework for investigations and monitoring of the Black Sea. The Varna workshop provided the basis for international collaboration in the Black Sea, a link missing in the past.

CHAPTER I

WORKING GROUP REPORT ON BIOGEOCHEMICAL PROCESSES

CHAIRMAN: A. Stoyanov
RAPPORTEUR: B. Howes

It was the considered conclusion of the Biogeochemistry group based upon published reports, the workshop interdisciplinary papers and in some cases their own measurements, that the nutrient assimilative capacity of the Western shelf region of the Black Sea is being exceeded. While the quantitative measurements needed for science-based management decisions focusing on decreasing the present excessively eutrophic conditions are not available, there are many studies documenting the effects of present nutrient overloading to the system. Speakers in the interdisciplinary talks presented data that the shelf has been becoming increasingly eutrophic during the past three decades. Increases in the quantity of nutrients entering the system are potentially due to both increased loading of nutrients into rivers discharging to the shelf waters and decreases in the biofiltration capacity of the river deltas due to anthropogenic modifications. The qualitative increases in nutrient inputs appear to have resulted in an increased number, magnitude and areal distribution of phytoplankton blooms. Within the same time interval, increases in the number and areal extent of water column hypoxia and anoxia were observed. It is clear that significant changes in benthic animal populations and the loss of large areas of the benthic habitat for both animals and plants have occurred. One of the more major of the ecological changes supporting the contention of an increase in eutrophication is the loss of 95 % of the macrophyte *Phyllophora,* which years ago covered 10,000 km^2 of the northwestern shelf and has diminished to an area of less than 50 km^2 at present. Based upon these and many additional ecological indicators of nutrient overloading/eutrophication, we concluded that the eutrophication of the Western shelf of the Black Sea is the single most important ecological problem in the Black Sea.

Based upon this conclusion, our group focussed on determining an appropriate scientific program and a potential plan of implementation to assess quantitatively present conditions, to determine the quantitative linkages between major elements involved in eutrophication, their inputs, outputs and rates of cycling, and to conduct and coordinate the science in a manner directly applicable to resource management.

The program requires the cooperation and coordination of the Ukraine, Russia, Georgia, Romania, Bulgaria, Turkey with the USA and western European nations. The program must also be interdisciplinary with major inputs from biogeochemists, biologists, geologists, and physicists. The studies require the integrated research of all the Black Sea riparian countries in order to construct the balances required to determine the quantitative relationships between nutrient inputs - organic matter production and decay - hypoxia/anoxia - and changes in animal and plant communities, We envision a 5-10 year program requiring at least five years of shelf wide intensive data collection. We stress the importance of integrating and expanding existing programs where possible.

GOALS

The overall project goals of the Biogeo-chemistry Program are:

1) To determine the current level of N, P, C inputs into the Black Sea and how much would they have to be decreased in order to restore biologically healthy (non-hypoxic) conditions on the Western Shelf and the time scale of response in oxygen conditions relative to changing nutrient inputs;
2) To determine how the eutrophication of the western shelf has affected basic biogeochemical cycles of the Black Sea.

In order to achieve these goals it is necessary to conduct an integrated program with six specific research objectives:

a) To determine the inputs of materials (water, N, P, C, Si, sediments) from rivers, atmosphere and the Sea of Asov and the fraction of the total input from the various sources that is anthropogcnic versus natural;

b) To determine the exchange of materials through the Bosphorus and how these relate to the material balance of the Black Sea, specifically how are Bosphorus flows related to riverine and atmospheric (rain, evaporation) fluxes;

c) To determine the exchanges of N, P, C, Si between shallow shelf and basin waters (biogeochemistry and hydrodynamics) and to determine the potential significance of the reciprocating movement of the oxycline across the shelf as a nutrient pump;

d) To determine the major processes controlling the cycling (pools and fluxes) of N, P, C, Si in shelf waters and sediments and their roles in the eutrophication of the shelf;

e) To determine the potential role of eutrophication on "external" factors, specifically the potential for increased fluxes of methane to the atmosphere due to increased production in shelf sediments, and the extent that increased transport of organic matter and nutrients off the shelf affects the biogeochemical cycles of the basins (e.g., potential changes in the $0_2/H_2S$ interface); and

f) To determine the factors necessary for the potential for "recovery" of plant communities, both the planktonic (diatoms) and the benthic macrophytes *(Phyllophora).*

PROGRAM

We envision a 5-10 year program with a minimum of five years of intensive integrated shelf-wide and hydrologic sampling in order to determine the inputs, outputs and recycling of N, P, C, Si in shelf waters and sediments as they relate to eutrophication phenomena.

PROGRAM ELEMENTS

1) Rivers and Deltas: continuous (daily) measurement of discharge and concentration of N, P, C, Si and TSS. Measurements must be made at both river discharges into deltas and where they discharge to the Black Sea. This dual measurement allows for discrimination of the causes of changes in riverine inputs to the Black Sea due to alterations in the watershed inputs to the river, versus alterations of the filtering capacity of the river deltas. Total nitrogen and phosphorus pools should be fractionated into inorganic ($N0_3$, $N0_2$, NH_4, $P0_4$) and organic (dissolved and particulate) forms so that their impact as a stimulus to algal blooms can be considered and the total mass input required for balance determination is also acquired.

   Only the larger rivers (Table 1) will be intensively monitored, the smaller rivers will be incorporated using transport models and on site verification. Within the major deltaic systems (e.g., Danube) studies of changing land use using GIS and sediment and nutrient accretion should be conducted to determine effects on biofiltering capacity and future stability of these depositional systems. The accretion studies should focus on whether anthropogenic alterations decreasing the sediment inputs to the delta are likely to result in an inability to accumulate sediment to keep up with rising sea level.

2) Bosporus Exchanges: Monthly measurement of N, P, C, Si and continuous measurement of flow. This program is critical both for determining this potentially important nutrient output and for determining the hydrologic balance for the Black Sea. This hydrologic balance is essential for determining the potential basin-wide effects of increasing alteration of water inputs due to modification of river flows. Due to significant natural year to year variations in river flow, a unified long-term data base on Bosphorus flow, atmospheric

exchange and river flow may provide a natural experiment from which to help predict future basin-wide alterations due to river modification.

3) Sea of Asov Exchanges: monthly measurement of N, P, C, Si and continuous measurement of flow (if possible). Data are currently not available from which to determine the magnitude of this significant source, necessary to determine the existing loadings to the Black Sea.

4) Western Shelf Given that the shelf is the region of focus due to its ecological decline, this portion of the research is programatically more complex than the others and involves three basic components:

A) Exchanges of N, P, C, Si between the western shelf and the adjacent basin. This is one of the major program elements; it couples seasonal (or shorter) surveys of materials in shelf waters to hydrodynamic measurements in order to gauge material fluxes. Shelf sampling should include both standard shipbased sampling as well as instrumented moorings (sensors for: oxygen, fluorescence, CTD, transmission, currents and if possible, plankton samplers) and when possible available satellite remote sensing of chlorophyll and circulation parameters. The data on water column oxygen, nutrient and particulate concentrations are not only essential for determining the balance of key materials in the eutrophication of shelf waters when coupled to the hydrodynamic measurements but will also provide an integrated long-term assessment (greater than 5 years) of eutrophication on the shelf. The high frequency measurements of nutrients, oxygen and plankton throughout the shelf will also serve 1) to identify high impact areas; 2) will provide the foundation both for monitoring future changes resulting from remediation (resource management) plans proposed for some of the watersheds contributing nutrients to shelf waters; and 3) will provide the context for evaluating the specific study areas examined in the process-level position of the overall shelf study.

B) Processes controlling the internal cycling and storage of N, P, C, Si in shelf waters and sediments relating to eutrophication and periodic hypoxia and anoxia of shelf waters. This research component requires a minimum of summer (2) and winter (2) shelf wide cruises to identify important processes and to determine their rates of activity. These process-level studies include water column and sediment nutrient cycles and sediment/water column exchanges. Depending on the results from the shelf water column studies (4A above), additional separate, more regionally -limited, smaller-scale cruises may be required to determine the role of the back and forth movement of the chemocline across the sediments of the eastern portion of the shelf on the composition and rate of sediment nutrient flux and its consequence to the rate of recycling, hence eutrophication, of shelf waters. In addition, moored experiments and smaller scale ship studies should be conducted if possible to quantify the exchange of materials and eddies and to quantify the development and course of phytoplankton biomass in space and time.

C) The effects that eutrophication of the Western Shelf region may be having on larger-scale biogeochernical cycles. At present, these would probably be best investigated through small ship-based efforts or as space allows on the region-wide sampling. This portion of the shelf study has significant potential for future expansion of effort, but within the working group only two research questions were developed. First, while marine systems do not generally generate large amounts of CH_4, the brackish nature of shelf waters and the increased organic matter loading to shelf sediments resulting from eutrophic conditions may be causing sulfate depletion and increased methane production in shelf sediments. If this is occurring, the role of the shelf in the global rise in atmospheric methane must be quantified. Second, the increased organic matter production on the shelf and its potential for increased transfer with the increased nutrients being loaded to the shelf waters from the watershed yields the possibility of changing biogeochemical conditions in the central Black Sea system and would provide one potential mechanism for a rise in the $0_2/H_2S$ interface.

Table 1.
Suggested larger rivers for high frequency sampling programs:
an * indicates rivers where some mcasurements are curently being made.

River	Area ($\times 10^6$ km2)	Load ($\times 10^6$ t/yr)	Runoff (mm/yr)
*Y. Bug (USSR)	0.034	**0.53**	
*Dnestr (USSR)	0.062	**2.5**	135
*Dnieper (USSR)	0.38	**2.1**	86
*Don (USSR)	0.42	**0.77**	
*Danube (Rem)	0.81	**67**	250
*Volga (USSR)	1.4	**19**	400
Coruh (Tur)	0.020		312
*Sakarya (Tur)	0.046	**6.2 (8.8)**	140
Kuban (USSR)	0.048	**7.7**	270
Kizil-Irmak (Tur)	0.074	**0.46 (23)**	82

(() - Sediment loading before damming)

We emphasize that although the program has four main sub-programs, the true advances in our understanding of the eutrophication of the Western Shelf of the Black Sea comes from the integration of the data to develop a system-level understanding. The nutrient and organic matter balances will not only yield new scientific insights, but will guide management by identification of sources and pathways of nutrient flow as it relates to eutrophication and will also guide monitoring to determine the efficacy of restoration plans.

IMPLEMENTATION

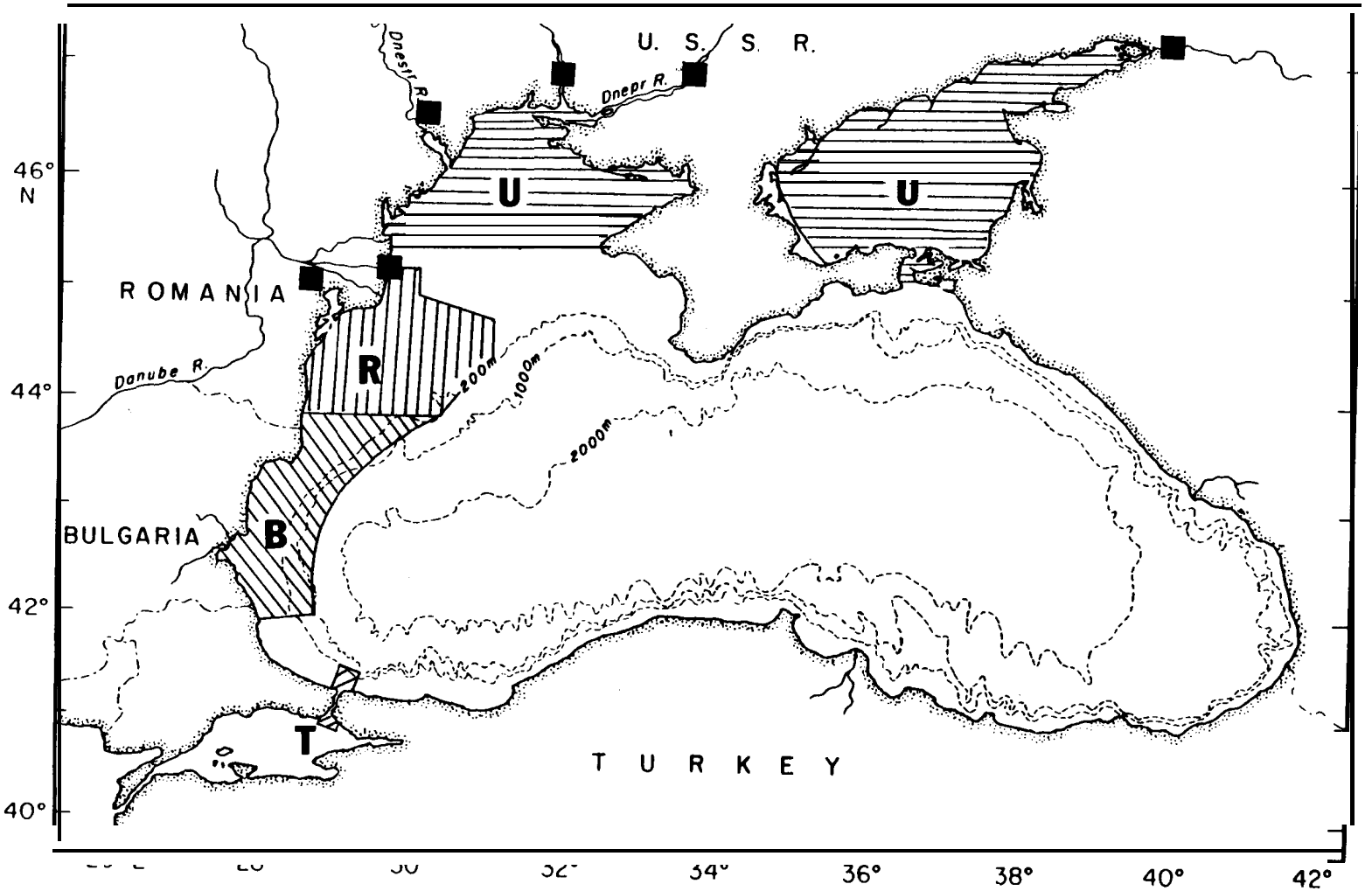
Given the magnitude of the proposed research program, its success will be largely dependent upon the integration of existing programs currently underway documenting ecological conditions on the shelf. It is fortunate that major portions of each of the four research program components are currently being studied (Figure 1) and that the major task is to upgrade the techniques, increase the number of parameters assayed, and unify the approaches rather than to attempt to implement the program de *novo*. Data collection for the program components can be generally divided into two basic groups: monitoring and process level studies.

MONITORING STUDIES

* 1) River inputs: most of the major rivers entering the shelf are currently being monitored in some manner (see Table 1). What is needed is to generate comparable data sets on flow, and transport of N, P, C, Si and TS S. Of particular importance for nutrients will be the inclusion of the two distributaries of the Danube not currently being measured and the Dneister and Dneper Rivers, and for sediment loads the inputs from smaller rivers which are currently not significantly sampled but which need to be modeled. The deployment of automated continuous sampling equipment would greatly help this work.

2) Bosphorus (and Sea of Asov) flows are currently being monitored both for flow and with an increasing data base on nutrient exchanges. The existing study is already a strong foundation but requires some increase in instrumentation and effort, for example measurement of the total pools of N, P, Si for construction of the mass balance of these materials. The Sea of Asov is currently being studied; however at present we do not know the extent of the data required for making the exchange estimates.

* represents highest priority



■ River Monitoring

▤ Marine Sampling

U -- Ukrane + Georgia
B -- Bulgaria
R -- Romania; MHI, IBSS, IMR at Constanza Biosphere Reserve
T -- Turkey (Bosphorus); Inst. Marine Science EADEMLI, Inst. Marine Science + Tech., IZNIA

Figure 1. Ongoing areas for biogeochemical studies.

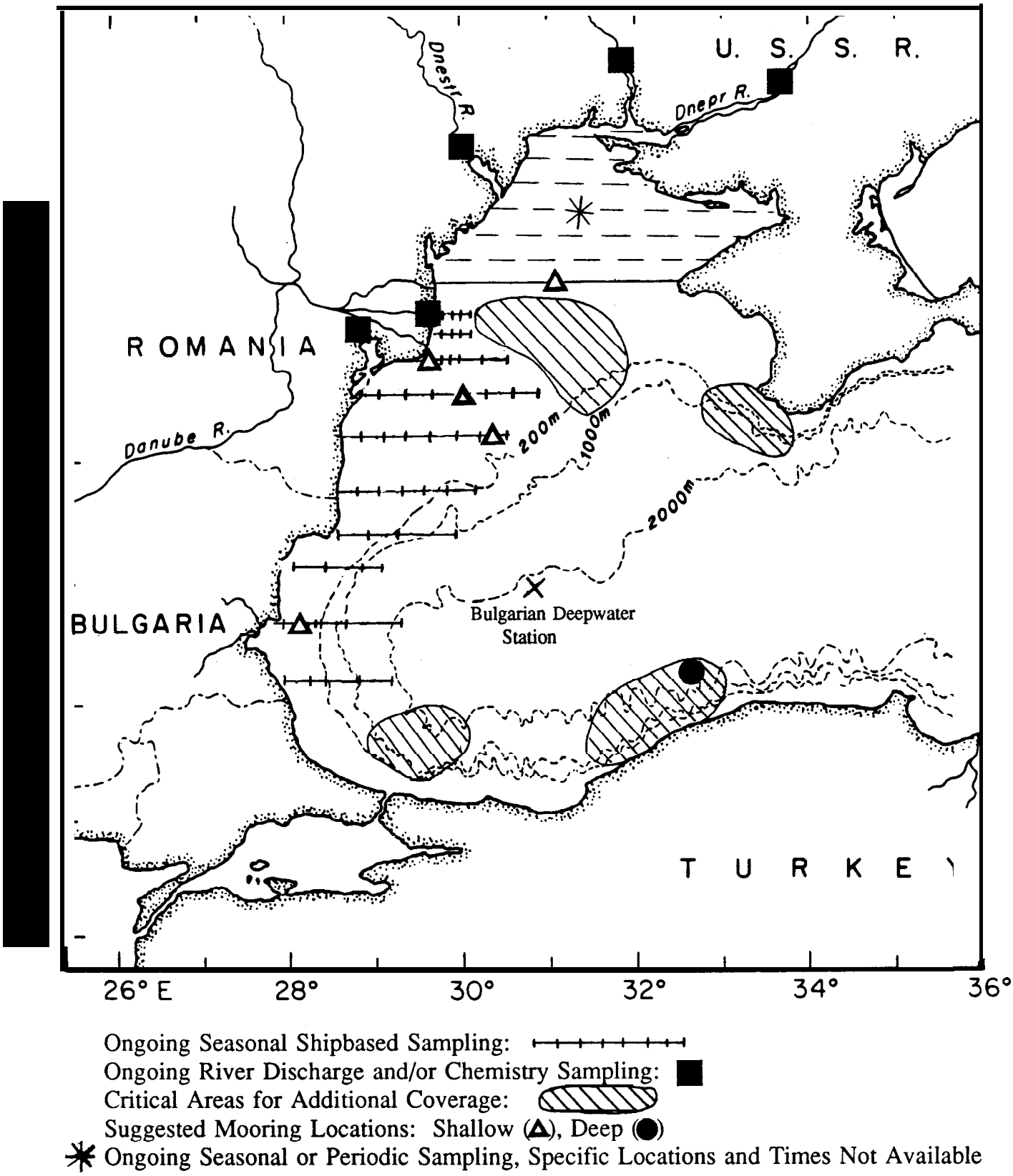


Figure 2. Locations of ongoing biogeochemistry sampling programs.

*3) Seasonal sampling. Fortunately, there are in place seasonal sampling programs by the Ukraine, Russia, Romania and Bulgaria which almost completely cover the shelf region (Figure 2) which, with the inclusion of two areas in the Northwestern shelf, will yield good coverage for the proposed study. The sampling is primarily shipboard and the existing sample locations need little or no modification. Again as in the other components, it is the coordination of effort and a unification of the core assays which is required to yield a region-wide quantification of parameters associated with the eutrophic conditions. To facilitate the coordination and comparability of data, we strongly recommend that at least two joint cruises are conducted to intercalibrate methods, instrumentation and approach, and that these cruises be interdisciplinary. It is critical that the necessary workshops are conducted both before and after these cruises in order to determine the appropriate techniques and to provide, as necessary, detailed demonstration of identified techniques.

4) Given the need for better temporal information on blooms and for determining Shelf-Basin exchanges, moored instrumentation should be employed whenever possible. At present, it appears that five shallow and one deep water moorings (Figure 2) would greatly increase our understanding of circulation and the transport of nutrients and other materials associated with eutrophication shelf wide. Equally important is the ability to determine the frequency and magnitude of short-term phenomena related to hypoxia/anoxia, algal blooms and nutrient pulses within shelf waters, The mooring studies will require significant effort as it represents a new program.

PROCESS-LEVEL STUDIES

The process-level studies all represent new programs. However, they require less sampling in space and time than the monitoring studies.

1) Summer (2) and winter (2) cruises which are shelf-wide and involve process-level studies of the transformations, rates and fluxes of bioactive materials associated with eutrophication. These cruises should be developed through international funding and must be interdisciplinary. They might be modelled on the style of the R/V Knorr expedition. These cruises should include not just researchers who are performing their studies but also should incorporate researchers from riparian countries who plan to conduct similar future work and need to interrelate approaches.

2) Smaller cruises and, if possible, moorings should be deployed to quantify the effect of the back and forth movement of the oxycline across the shelf in accelerating nutrient fluxes between watercolumn and sediments. Two-to-four cruises are envisioned to cover seasonal and annual variation. These measurements are best directed by smaller groups of researchers or if possible be added to a few of the transects of the ongoing monitoring studies. They should be coordinated through the Steering Committee to integrate the results into the growing shelf data base.

3) Smaller Specialized Programs (New Programs): We envision these programs to grow in number as the greater core program evolves. Initially, process-level cruises investigating the Silica cycle, Methane flux and Tracer studies (Isotopes - stable and radioisotopes to trace the flow of nutrients and materials through the shelf region) should be conducted relative to the eutrophication of shelf waters.

We see as the major requirement for this program the need to acquire new, more accurate and automated instrumentation for the many assays to be conducted. In addition, workshops and scientific exchanges for development of coordinated methods and approach are essential. It is not always enough to upgrade analytical capability; the overall approach and experimental design must

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* represents highest priority

generally be comparable in order to allow interpretation of different studies. New instrumentation should include automated wet chemistry equipment (autoanalyzers), CHN elemental analysis, CTD'S with fluorometer and improved equipment for collection of water samples. Equally important is the improvement of electronic communication (E-mail, Fax, Zerox, etc.) since the success of collaboration relies significantly on communication.

We also strongly support the concept of a general annual meeting in the spring of each year to present research results which can also have associated specific symposia and workshops. The general meeting should produce a xerox quality volume of extended abstracts 1-3 pages (submitted camera-ready, months before the meeting) to help facilitate the transmission of research results in these early stages of the overall project.

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CHAPTER 11

WORKING GROUP REPORT ON THE COASTAL AND OPEN SEA DYNAMICS AND TRANSPORT

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The COASTAL AND OPEN SEA DYNAMICS AND TRANSPORT working group of the Varna International Workshop on the Black Sea met during 3-5 October 1991 and developed the following research program. The list of participants attending the working group meetings is given in Annex-1.

EXECUTIVE SUMMARY

This document is a contribution to a first draft research program on the Black Sea oceanography, and emerged from the Working Group meeting on the Coastal and Open Sea Dynamics and Transports held in the Varna Workshop, 30 September-4 October 1991. The research program includes field studies encompassing basin-wide general surveys with adequate mesoscale resolution as well as finer resolution surveys to study coastal and shelf seas circulation dynamics and the interactions with the open sea. Process studies designed for the understanding of formation, dispersal and transformation of water masses are planned. Another element of the program is to implement modern methodology in numerical modeling to study eddy-resolving general circulation, regional processes, long-term and climatic changes, The program in addition includes a series of workshops, symposia and training programs for exchanging information both on the regional and international levels on specific issues of Black Sea oceanography.

MOTIVATION

A significant portion of the population of the riparian states of the Black sea lives in the coastal zone. This population and that of the hinterland affecting the basin is estimated to be of the order of 100 million, and is rising as a result of urbanization at an increasing rate, greater affluence and availability of faster transport facilities. As a result, severe and stringent demands have been placed on the living anti non-living resources of the Black Sea.

Accelerating development of industry and tourist facilities, and activities in the major harbours and the estuaries, have lead to the irretrievable loss of some habitats, eutrophication, microbiological and chemical contamination of the living resources and the water column, increase in the chlorinated hydrocarbons, destruction of wetlands and water quality of the estuaries, and the erosion of the beaches on certain segments of the coast. In particular, over-exploitation and increasing pollution levels have led to dramatic reduction in fish stocks.

Preservation, protection and optimum utilization of the marine environment of the Black Sea will require an effective and integrated management approach that will frequently involve difficult and conflicting economic, social and political issues. An important aspect of the management is the understanding of the physical and biogeochemical characteristics of the marine environment, space-time variability of these characteristics and the underlying fundamental processes.

In particular, many management and resource development programs have been seriously hampered by the absence and/or inadequacy of the physical oceanographic knowledge, The understanding of the physical processes are much needed since they occur on a spectrum of spatial and temporal scales, with important implications with regard to transport and dispersal of various substances, buoyancy and material fluxes from rivers, from benthic and surface layers. Biogechemical and air--sea interactive processes are significantly affected by the physical processes.

The Black Sea, isolated from the Mediterranean by narrow and shallow Turkish straits and from the Sea of Azov by the Kerch Strait, constitutes an entity in itself with its own

circulation and dynamics. It has a unique environment because of the existence of the anoxic bottom layer occupying 90 % of its volume. Winds, buoyancy fluxes and thermal forcing appear as the main driving forces. Topography appears to play an important role in the general circulation and the meso-scale dynamics. Convective and/or isopycnal mixing processes lead to the formation of cold Intermediate Layer (CIL), a crucially important water mass for the ecology of the basin, as well as to the other water masses. Double diffusive phenomena occur in the sinking and the spreading of the Mediterranean inflow and the deep benthic boundary layer.

The Black Sea's mesoscale dynamics and interactions take place over relatively small Rossby radius 0(20 km). Because of this fact and because of the scale of the basin, the Black Sea provides a unique environment to carry out synoptic scale investigations with mesoscale resolution. Furthermore, because of the dramatically adverse changes occurring in the ecology of the basin, a unique opportunity exists to study the complex interrelationships between the physical and the biogeochemical processes involved in its evolution.

Recent studies of limited extent indicate the existence of a variety of phenomena in the Black Sea, involving strongly interacting sub-basin scale gyres that are connected by intense jets, a meandering rim current, dipole eddies, and a modulating and propagating eddy field that interacts with the sub-basin gyres, In this respect the Black Sea may serve as a small scale laboratory for investigation of a series of oceanographic phenomena that are common to different areas of the world ocean. in addition, a wide variety of biological processes exists with myriads of time and space scales. Among various causes, the aforementioned physical processes are responsible for the biological variability. Particular research efforts on the basin and sub-basin scale are therefore warranted.

The meandering rim current, the filaments, etc. in particular imply crucially important dynamical processes with regard to the cross-shelf exchanges as well as with regard to the exchange of the shelf sea with deeper waters. It is therefore timely that the circulation and the dynamics of the region extending from the inner coastal zone (including estuaries), shelf seas and slopes to the interior of the Black Sea are properly studied. An assessment of the fluxes across the shelf break and the coupling mechanisms must be understood. Such studies on the coastal shelf regions will also allow the development of cooperative scientific research between neighboring coastal states.

It is quite clear that there is an urgent need for the establishment of a definitive phenomenology of hydrography, currents and transports of the Black Sea, including the kinematics, dynamics and energetic of the general circulation and mesoscale processes, the relative importance of dominant driving mechanisms (wind forcing, thermohaline fluxes, forcing by the Bosphorus flows), the time-space scales of the flows and the processes leading to the formation and spreading of the Cold Intermediate Layer, the deep water and the benthic boundary layer, the dynamics of the 0_2-H_2S zone as well as the ways in which the nutrient distributions, primary productivity and the living resources are affected by the aforementioned dynamical processes.

PURPOSE AND MAJOR SCIENTIFIC OBJECTIVES

The purpose of the scientific program on COASTAL AND OPEN SEA DYNAMICS AND TRANSPORT for the Black Sea is:

- To obtain a quantitative understanding of the circulation and the dynamics of the Black Sea, including its coastal and shelf regions, and the interactions of these regions with the interior of the basin, fluxes through boundaries, and the transports, transformation and fates of water masses and selected substances.

The major scientific objectives identified by the Working Group are :

- To establish definitive phenomonology for the salinity, temperature, 0_2 and H_2S structures, transport and dispersal characteristics, as well as suspended sediment distribution,

- To assess the relative importance of wind, buoyancy fluxes (from atmosphere, rivers and straits) as well as the role of topography on the general circulation and dynamics,

- To assess space and time scales of general circulation and mesoscale features and their energetic,

- To investigate the processes of water mass formation, spreading and transformation in space-time,

- To evaluate the existing data base on climatic changes (including paleoclimatic data) and to elaborate the theoretical and experimental background for the analysis and forecasting of the possible climatic changes,

- To study the transport, sedimentation and dispersal of terrigeneous materials and some specific tracers,

- To investigate the characteristics, origin and driving mechanisms of the deep benthic boundary layer and its role in the overall therrmohaline structure of the Black Sea,

- To identify the principal processes involved in the circulation and dynamics of the coastal and shelf seas and the shelf-deep sea interactions and fluxes,

- To develop multiple scale models with the components of general circulation and regional processes that will be applicable to the studies concerned with the ecology and biogeochemistry of the Black sea,

- To establish capabilities for continuous monitoring systems, and

- To develop water quality control and management-oriented operational models for transport, spreading and dispersal of contaminants.

PROGRAM ELEMENTS AND IMPLEMENTATION

Field Programs

In order to accomplish the scientific objectives of the COASTAL AND OPEN OCEAN DYNAMICS AND TRASPORT, the working group recommends three different types field programs, with the understanding that these programs will be carried out in a coordinated manner. The three programs are:

- General Surveys,
- Process Studies,
- Coastal Seas Circulation, Dynamics and Fluxes.

The overall program will be carried over a period of five years.

General Surveys

The general circulation surveys will be carried out to establish the overall thermohaline characteristics, and to identify and understand the dynamics of the permanent, recurrent and transient features of the general circulation, such as the rim current, sub-basin scale gyres, mesoscale and sub-rnesoscale eddies. Special attention will be given to the establishment of the interrelationships between the dynamical features and the space-time distribution of CIL, oxygen, hydrogen sulfur and the anoxic interface.

Over the five years the general surveys will be carried out twice a year. The proposed station network is shown in Fig. 1. The most appropriate times chosen for these surveys are September-October and early April, the former corresponding to the preconditioning and the latter to the spreading phase of the CIL.

Process Studies

The working group recommends that after each general circulation survey in the April period, fine resolution process studies be carried out in selected sub regions of the Black Seato investigate the formation of water masses by convection and/or isopycnal mixing or by generation over the shelf regions, including their spreading and transformation. The . investigation of meso and sub- mesoscale structures and their interactions will also be an integral part of these process studies.

The regions recommended for the process studies with adequate resolution are shown in Fig. 2. They include the following;

- the Northwestern and a portion of the Western Shelf region and their extension into the Black Sea interior (down to 1000m contour), for studying the formation of CIL over the shelf and spreading therefrom,

- The centers of cyclonic sub-basin scales gyres for studying CIL formation by convection and or isopycnal mixing processes, spreading and transformation,

- the pre-Bosphorus area to investigate the evolution of the Mediterranean underflow, and the formation of intermediate layers and deep water masses, and

- the persistent anticyclonic flow region in the Southeastern Black Sea to study the dynamics and interactions of meso and sub-meso scale features.

It is recommended that the responsibilities for the regional process studies will be decided by the Steering Committee.

Coastal Seas Circulation Dynamics

In this program special attention be given to the fine resolution field investigations in the Black Sea shelf areas encompassing the northwestern, western, southwestern shelves as well as the southern shelf region extending from the Bosphorus to Sinop peninsula (Fig. 3).

Circulation dynamics of these shelf areas, assessments of fluxes across the shelf break, interactions with the deep, buoyancy and/or material fluxes from rivers ,the straits, benthic and surface layers constitute the main issues. The major processes of interest are meandering of the rim current, filaments, coherent structures; baroclinic-barotropic instability processes, frontal processes including shelf/slope fronts; continental shelf waves, dynamics of river plumes.

The field program will consist of the following measurements:

- hydrographic surveys,
- continuous sea level and meteorological measurements at selected locations,
- moored instruments for continuously measuring currents, turbidity and oxygen,
- ADCP measurements,
- surface wave measurements,
- tracer studies,
- satellite remote sensing of thermal structures and pigment concentrations.

As is the case in other elements of the overall field effort, Process Studies for the formation of CIL on the Northwestern shelf will be coordinated with the field program presently discussed.

The field program for coastal circulation dynamics and fluxes should be elaborated by a special group of experts for it requires complex planning and implementation. This working group should be formed by the Steering Committee. Additional issues related to the development of cooperative scientific research between neighboring states in coastal and shelf regions require special care. It is recommended that the Steering Committee itself considers the special operational issues related to the implementation of this field effort.

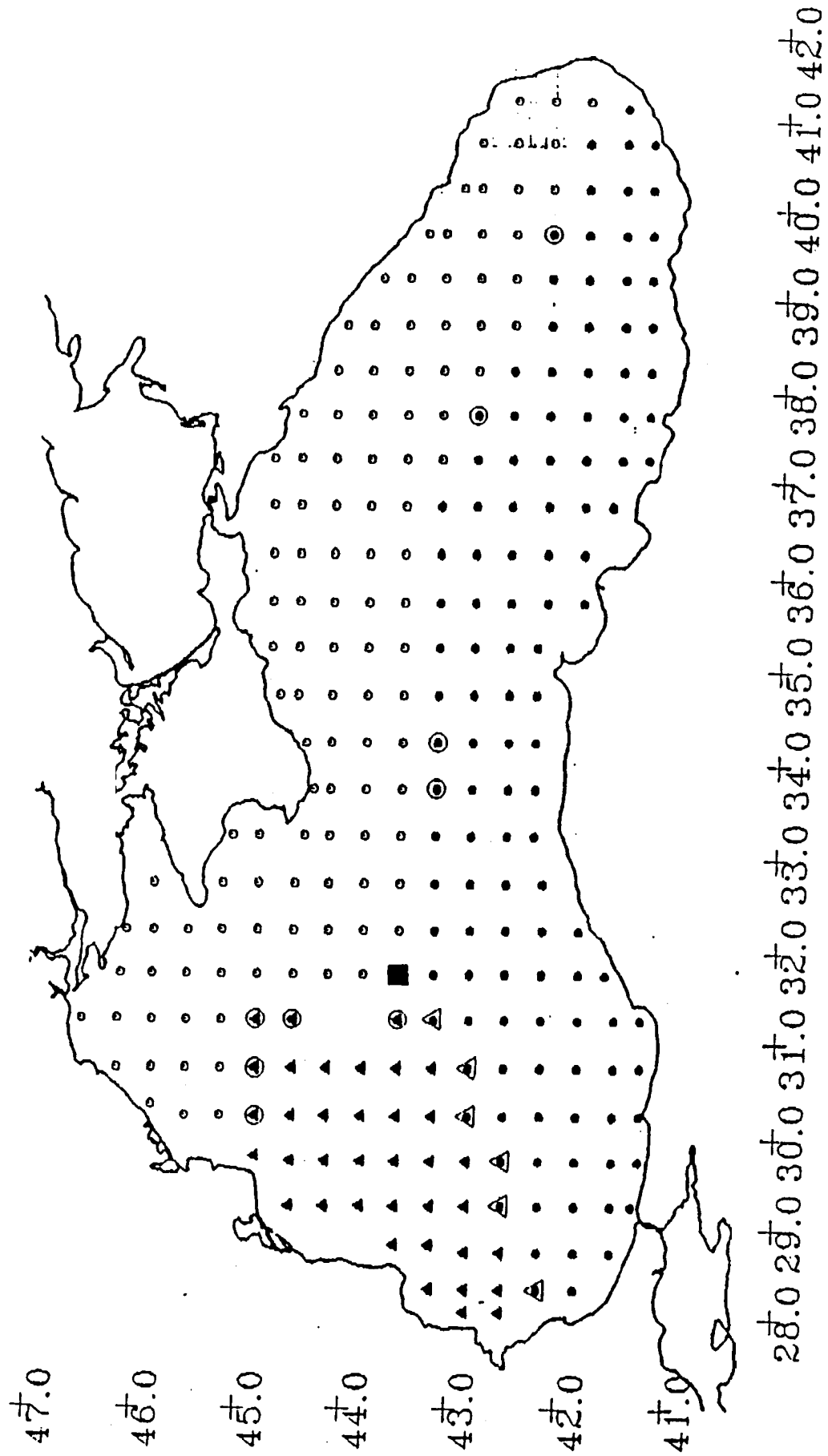

Figure 1. Station network for basinwide hydrographic surveys. The circles and dots denote stations to be carried out by Ukranian and Turkish ships. The triangles are joint Bulgarian and Romanian stations. A series of common stations recommended for intercalibration purposes are shown by larger triangles and circles.

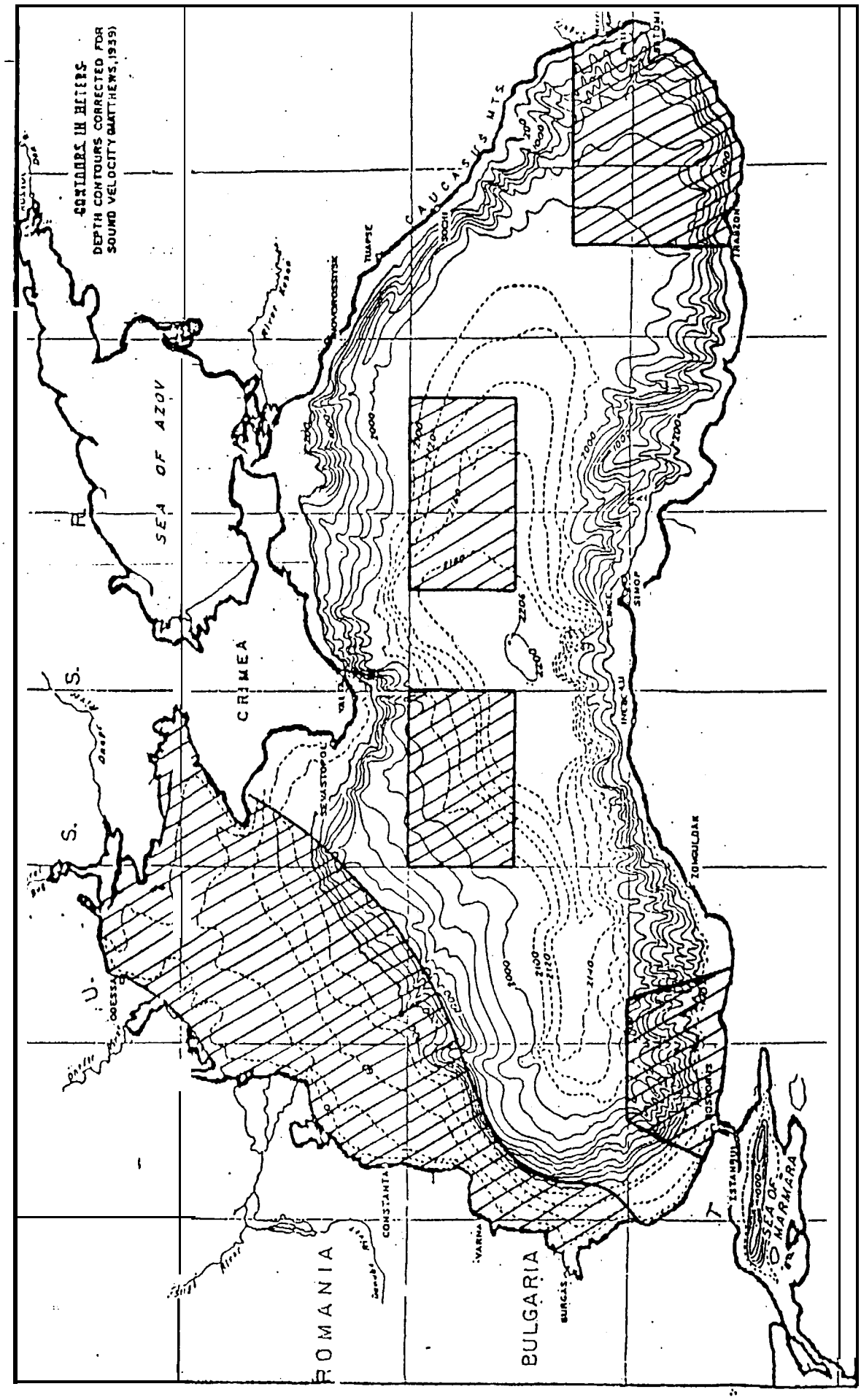

Figure 2. Specific regions of the basin to carry out fine resolution process studies

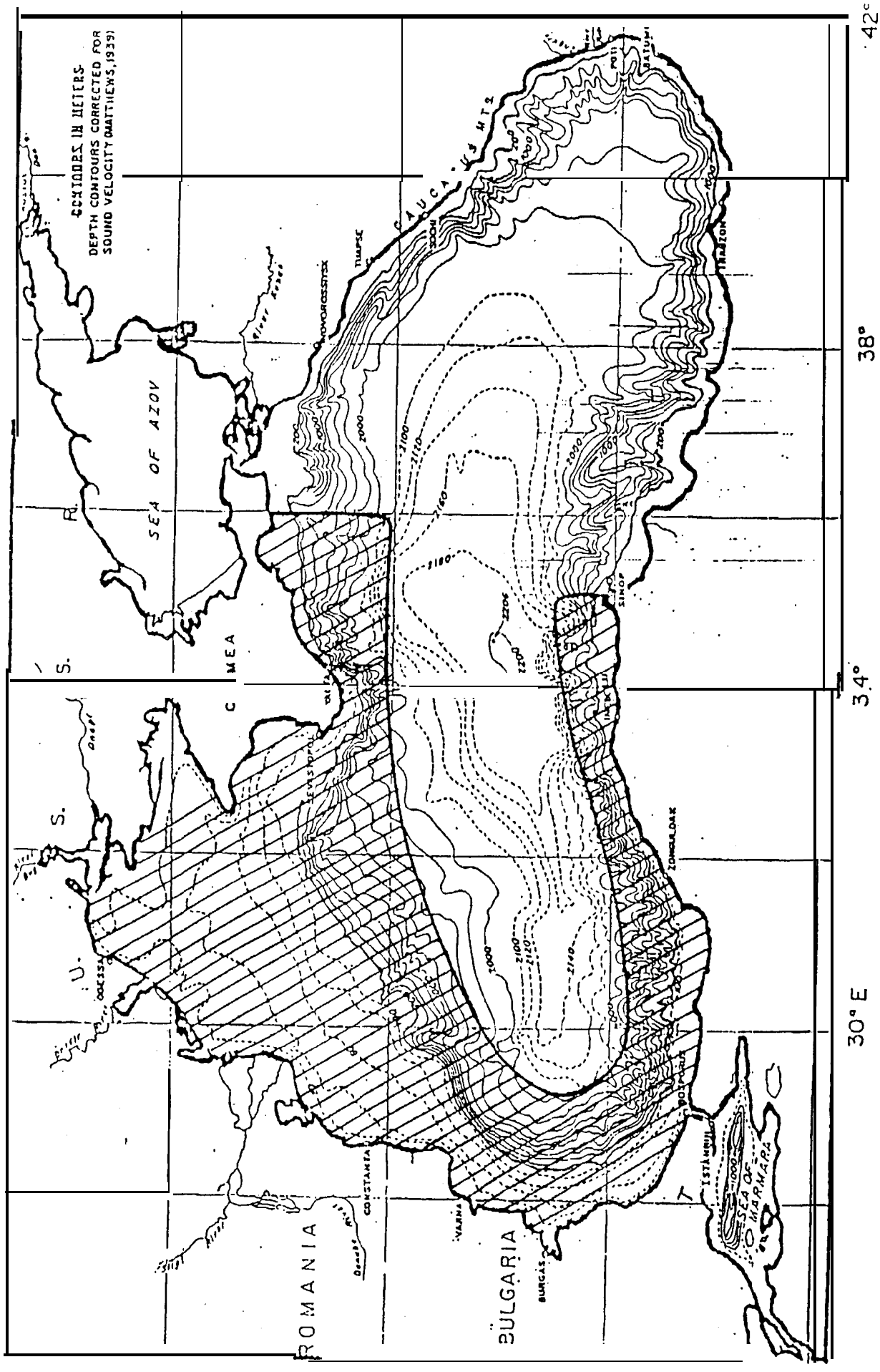

Fig. 3. Black Sea shelf areas requiring closer investigation for studies of contamination and ecosystem change.

Data Base Development

The issues related to the development of a data base were the topic of the working group on DATA BASE MANAGEMENT. The group therefore agreed that it suffices to reemphasize the importance of data acquisition with adequate accuracy and resolution, utilization of proper processing techniques, quality control and exchange in carrying out programs with good scientific quality and to suggest that the Steering Committee take necessary actions for making available the existing data and consider it an issue to be discussed in the first forthcoming workshop. Availability of the existing data is especially important to the topic considered next.

Long Term Variability and Climatic Changes

Black Sea is one of the ideal basins of the world ocean to study long term variability and climatic changes in the sea level, the major elements of the atmospheric forcing, the components of the water balance and the hydrographic characteristics together with the implications on various biogeochemical processes.

The working group came to the conclusion that detailed analyses of the available time series data of physical and meteorological data are of extreme importance to identification of the interannual and long term variability as well as trends taking place within the last century. A specific topic of the recent interest should be the study of the anthropogenically -induced changes.

Modeling

The working group discussed the modeling studies and the state of computational capabilities presently existing in the coastal states. The ongoing Cooperative modeling efforts with the Western European and U.S. institutions were also discussed. It is noted that there already exists a considerable amount of modeling activities devoted to the understanding various aspects of Black Sea Oceanography. The present level of local experience and manpower are sufficient for the development of new generation models and methodology for:

- studying long term and climatic changes,
- carrying out the eddy-resolving general circulation studies encompassing regional processes such as the water mass formation, and
- circulation dynamics of the coastal seas and their interactions with the open sea, requiring adequate resolution and special techniques for complexities due the combined effects of stratification and rapidly varying topography.

The working group agreed that the development of the primitive equation models with sufficiently fine resolution in both horizontal and vertical directions should be started as soon as possible.

During the deliberations of the Working Group, a strong emphasis was placed on preparing a data base for initialization and intercalibration of models. Of primary importance is to put more efforts for preparation of representative forcing fields of monthly mean wind stress, heat flux, evaporation and precipitation as well as river discharges and inflows/outflows from the straits. It is suggested that utilization of data produced by atmospheric models is a most radical solution for the preparation of forcing fields.

The Working group recommends that an interim group be formed by the Steering Committee to discuss the specific issues related with the modeling studies to be carried out within the Cooperative Marine Science Program for the Black Sea. A primary reason for the formation of this group is that the intercomparision of the models implemented by different institutions is one of the first priority in the modeling studies. The interim group will also prepare a detailed inventory of the existing modeling studies on the general circulation and dynamics, ecosystems and biogeochemical processes of the Black Sea.

It is recommended to the Steering Committee that the interim group be formed by Drs. Oguz and Ozsoy from Turkey, Drs. Stanev and Yordanov from Bulgaria and Drs. Ivanov and

Dermyshev from Soviet Union and that the interim group should hold its first meeting in MHI-Sevastopol during the workshop planned for the formation of collected data sets in February 1992.

Workshops and Symposia

Organization of workshops and symposia is considered to be necessary for exchanging information on the national, regional and global base. For this purpose, the working group suggest the following workshops series be held sequentially over a four-year period:

- first year workshop on the comprehensive review of the Physical Oceanography of the Black Sea,
- second year workshop on numerical modeling studies, with emphasis on implementation of new methodology and techniques,
- third year workshop on water mass formation, dispersal and transformation, and
- fourth-year workshop on the long term variability and climatic changes.

In addition to these workshops, organization of a major symposium on the Coastal Seas Circulation Dynamics, and Interactions With the Interior Black Sea is recommended to the Steering Committee for consideration.

For the workshops and the symposium it is recommended that the Steering Committee look for the possibilities of cooperation with the pertinent international programs in existence (see Section 3.5).

Training, Technical Assistance and Equipment

TRAINING: Training constitutes one of the essential elements of the program to be developed here. Training will in particular facilitate the generation of continuous communication between institutions and individual scientists.

It is suggested that this activity should be coordinated with the activies recommended in the preceding section as well as being carried through arrangement of visits between institutions for sufficiently long durations. Furthermore, participation of scientists on board research vessels implementing field work, organization of training courses for field operations, observation techniques, ocean and satellite data processing and modeling techniques and methodology are considered as important components of the training program.

The planning for the training programs is considered to be the responsibility of the Steering Committee. It is recommended, however, that the Steering Committee determines the institutions willing to contribute to the training program and inform the Black Sea scientific community. It is further recommended that the Steering committee contact international training programs such as TEMA of IOC and TEMPUS of EC on this issue.

Equipment: It emerges as a fact that the existing CTD facilities of the institutions participating in the program are generally not appropriate to conduct proper scientific investigations with high accuracy and resolution. Current meters are generally outdated and not accurate in terms of the capabilities of the modern technology. There is need for dedicated computer facilities to study eddy-resolving general circulation, data assimilation, and long term variability studies in the Black Sea. Establishment of necessary computational facilities and of communication links with western institutions are extremely important.

Available physical oceanographic equipment of the Black Sea coastal States leaves much to be desired, An inventory of the existing instrumentation is necessary to assess the capabilities in carrying out the data acquisition and modeling efforts and determine the equipment needs. It is recommended that the task of establishing inventory of major equipment be left to the Steering Committee.

The Working Group emphasizes the obvious necessity for proper-high technology instrumentation in carrying out a scientifically high standard program.

Existing Programs

Within the framework of the national oceanographic programs, Institute of Marine Sciences, Erdemli-Turkey has been carrying out seasonal hydrographic surveys in the southern Black Sea and the Turkish Straits System since 1986. As a subprogram of the Soviet World Ocean Program, Marine Hydrophysics Institute, Sevastopol-USSR has also a hydrophysical research program in the Black Sea carried out on a seasonal basis. This program further includes specially designed surveys oriented towards regional process studies and specific problems. Similar studies also exist but to a somewhat lesser extent in the National programs of B ulgaria and Romania on the western Black Sea.

The Working Group also suggest that the Steering Committee establishes contacts with the following international programs and projects:

Program	Sponsored by	Main activities
Coastal Ocean Circulation	IOC	Physical Oceanogr.
Dynamics and Fluxes	(COCDYF)	Biology, chemistry
Land-ocean interaction in coastal zone (LOCI) Oceanogr.	IGBP	Biology, chemistry Meterology, Physical
Joint Global Ocean Fluxes (JOGS)	SCOR	Air-sea interaction
Integrated management of coastal system (COMAR)	UNESCO IABO, IUBS	Coastal-marine ecosystems
Global energy and water cycle experiment (GEWEX)	WCRP	Hydrology, energy fluxes
International Oceanographic data exchange (IODE)	IOC	Ocean data management and exchange
Biochemical cycles and their interactions	SCOPE	Biology, chemistry meteorology
Marine Sciences and Technology (MAST)	EEC	Oceanography
Chernobyl	UNESCO	Biogeochemistry

It is strongly recommended by the working group that the Steering Committee should take into account the National programs so that unnecessary efforts are not expended and resources are utilized in an optimum sense.

ACKNOWLEDGMENTS

The working group discussions benefitted much from the existing national and international research programs, notably from the Physical Oceanography of the Eastern Mediterranean (POEM), the IOC Program on the Coastal Ocean Circulation Dynamics and Fluxes, and the US Coastal Ocean Processes (COOP) program.

CHAPTER III

WORKING GROUP REPORT ON ENVIRONMENTAL ISSUES

CHAIRMAN: Stanleyh Konovalov
RAPPORTEUR: Alexander Bologa

INTRODUCTION

Basically, environmental concern in the Black Sea consists of the following aspects of marine pollution:

- types, sources and levels of pollutants,
- transport by air and water, and
- distribution (spatial structure in coastal zones and offshore zone) and biological effects.

The geographical distribution of pollutants concern:

- river basins (Danube, Dneper, Don, Dnester, etc.),
- coastal zone, and
- offshore.

The solution to pollution problems can be reached by several stages:

- identification of pollutants in coastal and offshore zones,
- spatial structure of pollutants in river basins,
- identification of sources of pollutants (industry, agriculture, harbour activities, transport, acidic waste water), and
- action plans to reduce pollution impact and improvement of environmental quality.

An important premise in order to resolve environmental problems is the signing of the Convention for the Protection of the Black Sea Against Pollution.

The working group considers the International Programme for the ecological investigation and monitoring of the Black Sea (S. Kiriko, Bulgaria, 1990) as acceptable as a general concept for the ecological approach in the Black Sea.

The basic environmental issues emphasized are based on following scientific conception:

1. The Black Sea is a complex system in which abiotic and biotic components are interconnected;

2. Biotic components of the Black Sea ecosystems influence biogeochemical transformation of the organic matter and cycles of the main chemical elements (C, N, P, S, etc.);
3. Priority problems consist of investigations of the structural and functional characteristic of the biological communities and their fluctuation and changes influenced by the natural climatic and anthropogenic factors at different levels (cells, organisms, communities, ecosystems, etc.);

4. Biological effect assessment must be provided simultaneously with hydrophysical and hydrochemical investigations as the basic environmental properties influencing the structure and functioning of the biological systems;

5. Final results of the investigation must be the development of a dynamic prognostic model of the Black Sea functioning as a whole complex system where climatic, hydrophysical, hydrochemical and biological properties of the environmental are linked.

Climate change studies should include:

a) investigation of probable climate change impacts on hydrometeorolgical processes in the region and on water mass circulation;

b) sea-level fluctuations research in various scenario of climate changes in order to make assessment of ecological and socio-economic matter effects; and

c) research on probable climate change impacts on the hydrogen sulfide zone dynamics.

During the free exchange of ideas and discussion of the following major topics and action groups have been recommended to be developed in the near future:

		Bulgaria	Romania	Ukraine/Russia	Turkey	United States
1.	Balance of water	Madacdzjev	Diaconu	Bronfman	Izdar	
2.	Biogeochemical cycles of C, N, P	Heibaum	Cociasu	Gulin	Izdar	
3.	Biogeochemical cycle of S	Karanfilov	Cociasu	Gulin	Izdar	
4.	Biogeochemical cycles of stable organic substances	?	(Bilal	Gulin	Salihoghu	
5.	Biogeochemical cycles of heavy and trace metals	Andreev	Pecheanu	Kulev	Salihoghu	
6.	Biogeochemical cycles of radionuclides	Dimitrov	Bologa	Egorov	Portakal	
7.	Oil pollution	Boshkova	Piescu	Mironov	Salihoglu	
8.	Microbiological pollution	?	Apas	Mironov	Acam	
9.	Biological effect assessment: structural and functional aspects	Moncheva Dechev	Petran P. Mihnea	Vinogradov Shulnean	Acara Salihoglu	
10,	Eco-technology and mareculture	Konsulova	Telembici	Slikin	Acara	
11,	Fisheries	Kolarov	Nicolaev	Yakovlev	..Acara	
	Climate change	Stanev	Tiganus	Zaitsev	Unluata	Aubrey
12.	Natural resources	Konsulov	Gomoiu	Shadrin	Acara	
14,	Land based sources (waste disposal) and dumping	?	R. Mihnea	ZatsIzdar Bryantsev		

Among these topics the following priorities have been taken into consideration by the working group in order to stabilize and diminish eutrophication:

- biogeochemical cycles of C, N and P including the structure and function of the ecosystems and induced community changes,
- biogeochemical cycle of stable organic substances (pesticides, PCB, dioxides, etc),
- interface communities as indicators of climate and anthropogenic changes.

The priorities could also be synthesized as follows:

- atmospheric and river input to the Black Sea,
- biological factors and effects,
- climate change.

International workshops on priority issues have been proposed to be organized in the Black Sea countries:

- biogeochemical cycles of C, N, P and biogeochemical cycles of stable organic substances;
- biogeochemical cycles of radio-nuclides:;
- microbiological pollution;
- biological effect assessment: structural and functional aspects;
- eco-technology and mareculture;
- fisheries: meeting of the Tripartite Black Sea Fisheries Commissions, with representatives from Turkey;
- climate change;
- natural resources.

Another international workshop on "Atmospheric and river input in the Black Sea: Environmental aspects" is supposed to" be organized at the Bulgarian International Scientific Complex of BAS, with the main support of NIMH, in Varna (Golden Sands), October 1992.

A proposal for the governments was made in order to stop the dumping of toxic chemicals into the Black Sea: first a temporary suspension of dumping sites, and secondly the complete halt of dumping.

These priorities should be fulfilled at a national level through financing, several cruises and supply of equipment and at international level by receiving funds, technical assistance, training of personnel.

All topics will be realized by international teams consisting of national teams represented by national leaders mentioned above.

In order to achieve the previously mentioned goals the necessity of standardization of all methods used by each country was pointed out as a basic need from the beginning of common activities.

A regional center for collecting and analyzing data on stable organic substances should be organized.

Special attention was paid to the problem of transboundary transport of pollutants (by air and water), to the introduction of atmospheric pollution measurements (heavy metals, pesticides), and to the chemical state of some pollutants (speciation, e.g. mercury).

The necessity of developing international co-operation by means of financial research and improving communications between scientist was emphasized.

The working group recommends to look for possibilities of organizing pilot regions for ecological research in the Black Sea.

The working group also proposed during the meeting to draw attention to the governments to encourage co-operation by permitting entrance and work of foreign research vessels in national EEZ for ecological research.

Specialists and experts from international organizations (UNESCO/IOC, UNEP, UNDP, IAO, IAEA, CEC, etc.) should be co-interested in the performance of the Black Sea Action Plan-both for expertise and financial support.

The environmental impact of the Navies (consequences of testing, maneuvers, damaging the bottom of shelf, firing and explosions, dumping, etc.) should be quantitatively estimated. The ecological and economic negative influence of Naval activities has to be determined and compared with other adverse factors in the Black Sea. The Advisory Committee on Protection of the Sea (ACOPS) included such point in the decision of its Brussels meeting on July, 1991.

The participants agreed upon the necessity of linking closely the Black Sea Action Plan with the Black Sea Convention based on the scientific input and the need for help from the international agencies with respect to technical support.

The audience was informed by a representative of the Ukrainian Academy of Sciences about the intention of creating of an international Marine Research Center in Odessa (USSR) in the near future.

CHAPTER IV

WORKING GROUP REPORT ON GEOLOGY AND SEDIMENTOLOGY

CHAIRMAN: Nicolae Panin
RAPPORTEUR: John D. Milliman

WHY IS THE BLACK SEA UNIQUE?

The Black Sea in many ways represents a micro-ocean basin in terms of the land masses surrounding it and the presence of both narrow (south) and wide (west) continental margins. Because the ratio of land area to sea surface area is high (about 2, as compared to the Mediterranean [about 1], the Atlantic [about 1/2], or the Pacific [about 1/20]), the impact of land processes (and human impact) are great.

In addition, of course, the anoxic condition of the Black Sea and the high rate of sediment accumulation lead to a unique environment in which sediments are chemically reduced, methane is produced, and the chemical diagenesis, mass movement and seafloor processes are therefore affected.

The Black Sea may also be considered as an example of black shelf formation environment.

In dealing with the Black Sea it is important also to realize that geology integrates over time, such that we can deal with present and past conditions to understand more accurately current environmental processes and to predict future conditions.

GEOLOGICAL QUESTIONS

In Black Sea research we must concern ourselves with three basic questions relating to geology and sedimentology. Many of these questions have director indirect interaction with the other interests of working groups.

1. What material is brought into the Black Sea? Rivers, wind, coastal erosion and the reworking of present-day sediments (particularly on the shelf) are considered the main sources of sediment, although chemical precipitation and biogeochemical formation locally or temporally may be important.

2. What is produced? That is, where does the sediment go once it reaches the Black Sea'? This relates to modern-day processes.

3. What is the fate of the sediment? This relates to the geologic history of the Black Sea.

Processes - We need to understand the transport and diagenesis of the sediments.

Transport - we are interested in hydrodynamic transport - i.e. transport of sediments in relation to oceanographic processes; this relates mostly to shelf and cross-shelf transport. At the same time, we need to understand downslope transport - that is, mass wasting, particularly on the slope and Danube Fan. This latter process may be particularly important (but as of yet undocumented) in terms of transferring anthropogenically influenced/produced sediments to the deep basin.

Diagenesis - how are the sediments transformed once they are introduced to the Black Sea'? Of particular, interest here is the influence of the anoxic environment on sedimentary diagenesis.

History The **knowledge** of geological history and neotectonic evolution allows a better understanding of present hydrological and sedimentological conditions of the Black Sea. During the Holocene, the paleo-environment of the Black Sea has changed from lacustrine to its present anoxic condition as a result of rising sea level. Of particular interest to this working group, however, is the more recent history during which human activities have influenced the marine environment. By understanding the diagenesis and recent history, for example, we may be able to understand better the natural flux and fates of sediments in the Black Sea, thereby giving us a better idea of the degree of the present environmental stress.

FUTURE STUDIES

What to study?

The geological-sedimentological survey in the Black Sea basin has a truly interdisciplinary character. In this connection we can divide the problems into three groups:

1. problems related to hydrological objectives in order to study the behavior (transport settling, reworking etc.) of the sedimentary material in the water column and at the water - bottom boundary;

2. problems regarding biogeochemical processes in the sediments and at the water-sediment boundary, including for natural conditions and under anthropogenic pollution, and

3. typical geological items, dealing with the geological-sedimentological structure and evolution of the Black Sea basin.

Where?

We have selected three areas in the Black Sea that have highest priority for study.

1. The western shelf, a wide margin, is dominated by the influence of the Danube River, the single largest source of fresh water and sediment to the Black Sea. We need to document the along-shelf transport of sediment to the south and its final cross-shelf and downslope transport off southern Bulgaria.

2. The second area to study is the deep Danube Fan, which presumably received large sediment input during lower stands of sea level.

3. The third area is represented by the Turkish shelf and slope. The Turkish rivers drain onto a narrow active margin. River flow can be episodic, particularly with the smaller rivers, meaning that during these episodic events the water and sediment str more likely to escape the narrow shelf and be transported directly to the slope and beyond.

How?

In both areas the types of field techniques will be roughly similar. Remote geophysical sensing, using both side-scan sonar and high-resolution seismic profiling, can define both the morphology and shallow structure of the shelf and slope. With these data we can define depocenters (e.g. on the shelf and slope), methods of transport (e.g. sand waves on the shelf, mass wasting on the shelf) and therefore areas of deposition and erosion.

Both regional and more site-specific studies should be carried out. With these results, long cores and box cores can be taken to document processes and rates. Specific types of sedimentological studies may be needed. For instance, the distribution of anthropogenically-produced metals within the sedimentary column may define recent pathways and rates of sediment transport and flux.

Monitoring events will include sediment traps, current meters, nephelometers, etc.

FACILITIES AND LOGISTICS

The program will be realized with participation of riparian and other interested countries. The riparian countries will provide research vessels, including:

Bulgaria - R/V *Akademik w* of 1.300t and research submersible PC8;
Romania - R/V *Somes* of 3.000t;
Turkey -2 or 3 research vessels;
Russian and Ukraine: Many

A supply of research vessels with specific geological, geophysical, hydrological, analytical and navigation equipment is needed.

EXISTING AND FUTURE PROGRAMS

1. National programs (Existing. For example, in Romania there are two programs: (a) geological-geophysical mapping at 1:200,000 and 1:50,000 scales of the Romanian continental shelf and (b) gee-ecological monitoring).

2. German - Bulgarian - Romanian joint project: Quaternary sedimentation in the western Black Sea: Sedimentology, geochemistry and paleo-oceanography. (Future, beginning in 1992).

3. Romanian - Soviet - German - American joint project: Structure, sedimentation and geochemistry of the Danube Delta and the neighboring continental margin of the Black Sea. (Partly existing from 1990 between the University of Odessa, Ukraine, and the Institute of Geology and Geophysics of Romania; extending to 4 participants in 1992).

4, Romanian - American project: Gas seeps on the continental shelf and slope of the Black Sea. (Future)

All the listed programs are open to other participants.

CHAPTER V

WORKING GROUP REPORT ON MANAGEMENT, POLICY AND LEGAL ISSUES

CHAIRMAN: Alexander F. Vysotsky
RAPPORTEUR: Jack H. Archer

The main goal of the working group as it was agreed upon by the participants of the group was to frame a document describing a framework for scientific, social and legal research on the Black Sea for the next decade.

In the process of the working group work, discussions and the exchange of views took place. All approaches and points of view were considered and reflected in this document. The working group elaborated and presents to the Steering Committee the following recommendation with the respect to management, policy and legal issues. The working group proposes implementation of the following tasks.

1. Identify management, policy and legal issues and problems, that are of particular relevance to the interest and goals of the "Cooperative Marine Science Program for the Black Sea (CoMSBlack)".

2. Coordinate between the Cooperative marine science programme and other governmental, nongovernmental bodies and competent international organizations with respect to management, policy and legal issues and problems under investigation.

3. Conduct public educational activities related to the interests and goals of the cooperative marine science programme for the Black Sea such as the preparation and distribution through appropriate media of materials to enhance public awareness of the environmental problems of the Black Sea.

4. Conduct training programs appropriate to the interests and goals of CoMSBlack to provide increased capabilities for integrated, comprehensive coastal management of Black Sea land and water resources.

5. Establish effective cooperation with competitive international organizations such as IOC, UNEP, IMO, FAO etc., which have gained considerable experience in the field of marine science and its applications.

6. Examination of theoretical and practical problems concerning the structure of a Black Sea legal and management regime.

7. Preparation of practical recommendations based upon the results of marine scientific research in the Black Sea to establish an appropriate legal framework for managing Black Sea land and water resources.

8. Based upon the results of the marine scientific research in the Black Sea, recommendation of mechanisms for implementation for the Black Sea Convention Against Pollution.

9. Coordination of the investigations of legal issues and problems within each Black Sea country represented in the Sub-Group.

10. Facilitation of legal scientific research related to the Black Sea on national and international levels through conferences, publications, and other media. In addition, a Sub-Group may consider the establishment of special regional or national institutions for legal studies appropriate for the Black Sea.

11. Investigation of a legal and policy framework to implement integrated coastal management in the Black Sea region.

12. In view of the establishment of exclusive economic zones in the Black Sea, consideration of proposals to provide for integrated intcrnational management of the resources of the Black Sea.

13. Consideration of proposals to improve coordination and cooperation between Black Sea and Danube countries with respect to problems of pollution of the Black Sea.

14. Engage in other tasks as determined by the Group and the Steering Committee.

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CHAPTER VI

WORKING GROUP REPORT ON MONITORING AND DATA BASE MANAGEMENT

CHAIRMAN: Dimiter Truhchev
RAPPARTEUR: Iouri Oliounine

1. The Working Group agreed that it was premature to discuss any concrete networks or requirements for data collection systems either for the open sea or the coastal area. Data bases for monitoring data should be part of a Black Sea database management system. However, the Working Group recommended that as a minimum, for future studies, the following types of data require monitoring systems:

- hydrophysical
- hydrochemical
- marine meteorology; atmospheric monitoring
- ecology
- pollution especially with oil products

2. Any future observing system should be a combination of data collection sites on board research and voluntary ships, sea-level stations, drifting and anchored buoys, platforms, remote-sensing by airplanes and satellites, submersibles, and should include capabilities for collection data in real and delayed mode.

3. To solve technical problems it will be important at an early stage to establish a working group of experts consisting of technical experts and representatives of scientific community with the following terms of reference:

- establish requirements for a network of observational platforms;
- prepare recommendations on the accuracy of observations, their frequency, space and time resolutions;
- identify criteria for unification and standardization of observations, develop agreed-upon methodology for data collection and validation;
- recommend ways for automating, and data collection establishment of raw data archives;
- recommend ways to access data banks and provide guidance on uniform data products.

SESSIONAL

The Working Group strongly urged all member states concerned to provide the Steering Committee with the list of candidates for the proposed Group, and to include the Working Group in the final Black Sea project.

4. Noting that processing of the raw data is a special issue which is in fact an intermediate step from data collection to data base development the sessional working group recommended to arrange a special workshop to discuss different options and arrangements for the processing of the data.

5. Workshops should be arranged for consideration of the following problems:

- organization and method of carrying out large-scale experiments;
- organization of pollution monitoring;
- monitoring of hydrophysical fields of the Black Sea.

If a proposed Working Group of Experts is established, it will be a responsibility of the Group's Chairman to develop programs of these workshops jointly with the Chairman of the Steering Committee to identify the most appropriate time schedules and places.

The sessional Working Group was unanimous that three types of needs for monitoring systems should be taken into account while drafting a final scheme: national, regional and international.

To deal with national problems there will be a need to create national committees for the Black Sea project which will include representatives of ministries, scientific institutions, and national governmental organizations. These committees will be responsible for the development of national implementation plans and for taking administrative decisions.

To assist national committees and the Steering Committee of the Black Sea project, the Sessional Working Group strongly urged member states to start immediately to compile information on the national level, or research cruises which have taken place in the region and whose objectives corresponded to these of the Black Sea project:

- on the institutions which are involved in marine data observation, collection and processing schemes;
- on the scientists who participate in national marine programs;
- on the standards used in the member states.

All the information will provide a basis for future regional directories and will help to identify place and role of each institution in the Black Sea project. This information will be available also in a computer readable form and all member states will have access to this information.

The Sessional Working Group noted that the Black Sea project, specially in data management aspects, can be strengthened by reports from other regional environmental programs (like InfoDanube). It is expected that there will be workable channels of data exchange arranged with adjacent rivers and seas.

MONITORING AND DATA BASE MANAGEMENT

The system on data management which will be agreed upon for the Black Sea project needs to be fully implemented and augmented by an improved commitment to a few technical areas which as a minimum will contain: quality control, data base development, formats for data exchange and software development. Special attention should be given to calibration, communication links, documentation and international coordination in data exchange.

Data management should be thought of as the activity for handling data so that it is available where it is needed, when it is needed and has with it all supporting information that is necessary for the user to understand ant{ to use data at its full potential.

Taking the general statements as a starting point for the discussions, the Sessional Working Group came to the following conclusions and recommendations:

Recommended formats already exist for meteorological and oceanographic data (GF.3, BUFR) and the Black Sea project should try to work within this framework. However, it was recognized that existing formats cannot be used for exchange of some data types which have been identified as basic for the project (e.g. biological data, pollution data). There will be a need to develop new formats and modifications of old ones to meet effectively the needs of the Black Sea project. A technical workshop is recommended to address these concerns.

An emphasis should be placed on the need for improved quality control (QC). Strict quality control procedures should be applied at the source of the data as well as at all stages of the data flow before final archiving. It is a challenging task to ensure that data are of the highest quality. Laboratory calibration instruments are encouraged to exchange periodical measurement standards to ensure uniformity. In addition, cruises should be so scheduled that intercomparison of instruments and analytical techniques can be made. There will be a strong request for an envelop of unified prograrnmes which will be recommended for all participants of the project for QC of different types of data. It is strongly advised to arrange a workshop which

will be able to develop requirements for QC regulations and procedures with the invitation of experts from international organizations to help the project formulate the task.

Communications continue to be an issue that slows progress at times. Romania has only a telex which sometimes has difficulty in receiving. Bulgaria has a fax and telex, but the fax is difficult to reach for hours on end. E-mail is not yet used. The usage of E-mail in the former Soviet Union has just been started. The establishment of an appropriate data telecommunications system should be supported in consultation with WMO CBS/CIS which will transmit high data rate and "dburst" data from oceanographic instruments, platforms or ships. For the operational exchange of information such as calibration data, E-mail was recommended. Possible ways of operational exchange of data bases should be thoroughly considered.

Marine data bases are essential to many aspects of ocean research, development and operations. There are hundreds of requirements for ocean data bases of one kind or another. Just a few are:

- numerical model development and calculation;
- experiment design;
- observing system design;
- environmental planning;
- climate change studies and others.

Ocean data bases can be in several forms. The data may be in raw or processed form. They may be in analog or digital form. They maybe organized by specific geographic locations or in gridded form. The data base may be represented in an atlas, or it may be represented by statistical functions derived from the climatology. Data bases may be static or they may be dynamic, in which case new observations are allowed to enter or alter the data base. For the project it may also be advisable to develop data banks in the form of interacted hydrodynamical fields for the solution of chemical, biological, or ecological problems. They will be based on modern methods of objective analysis, dynamic investigations and four-dimensional analysis.

First efforts in the development of data bases for the Black Sea in Bulgaria and the former USSR have been noted with interest. It was recommended to arrange a workshop on the development of structures of data bases and on the means to identify the user needs, composition and approximate volume of data bases.

Despite all reservations, the Working Group concluded that a certain quantity of the data necessary to implement the Black Sea project is already in the data banks and archives of different national institutions. Data covering a number of relevant parameters have been collected by diverse international programs and by diverse national agencies in different formats and with different levels of accuracy.

Considerable data which exist in archives and in manuscript form will be valuable in producing more definitive scientific analysis. These data and all available and relevant data from the past should be documented in computer compatible form and assembled into consistent data sets of the highest quality possible. This will require considerable effort in locating data records, checking their accuracy, and checking the errors of early instrumentation.

It was recognized that an important component of any effective data management system will be a well-established procedure for data flow monitoring. Participants of the project are encouraged to use existing established practices to exchange information of planned national oceanographic programs in advance in accordance with internationally agreed format, and to submit short reports after the completion of each national cruise.

Development of informed manpower is crucial if countries want to contribute fully and effectively to managing coastal areas. Any program in this area should address simultaneously the related issues of education, training and technical assistance.

It will also be necessary to take a more focused approach to training and technology transfer. The training will have to focus on the step-by-step building of capabilities of marine science organizations in member states that can take advantage of it and can pass it on nationally and hopefully to other countries in the region.

Training activities must be structured towards ever-increasing national capacity to apply modern data and information handling techniques to national problems. Insufficiency in trained personnel can be partly redressed, *inter alia,* through:

- information exchange workshops and seminars,
- skill enhancement seminars,
- development of information centers. In this regard an offer by Turkey to host a training course in oceanographic data management for the countries of the Black Sea was noted with appreciation.

Resources are needed and must be planned for the concept, design, development and implementation of the system which will generate the required data sets. As far as possible, it should be encouraged, at the national level, to fund data base support separate from the science. This funding can be supplemented with funds from international or external sources.

RECOMMENDATIONS

Countries are encouraged to promote financial assistance that primarily aims at securing the following:

- data acquisition and exchange;
- data archival, retrieval and analyses;
- education and training including provision of scholarships and fellowships;
- specific technological development.

In order to investigate the most efficient and feasible course of action and determine a practical timetable for the establishment of the data management system the formation of an *ad hoc* working group is suggested with the following Terms of Reference:

- Determine the standard software for database realization.
- Develop the structure of national databases.
- Determine the communication channels and standards.
- Prepare draft Technical Requirements and Working Plan for database development (regional and a typical national data base).
- Identify types of stored information
- Development of handbooks containing information on methods used for measurement and preprocessing of data; of input documents (files and structure) and data presentation (graphs and tables); and of data analysis methods.