

**DEPARTMENT OCEANOGRAPHY,  
MARINE AND COASTAL ENGINEERING**

**PHYSICAL OCEANOGRAPHY FROM "MORSKAIA VERTUSHKA" TO THE  
DOPPLER EFFECT**

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Knowing the physical and chemical conditions of the marine environment, the processes that govern them and their trends as well, is a key area of oceanography in all countries that have a coastline. The importance of this area stems from the fact that all other subfields of oceanography and consequently any economic activity at sea or in the marine environment requires knowledge of physical and chemical factors of marine waters. In the Romanian Black Sea continental shelf, due to a combination of features of the area - high intake of fresh water rivers, sea currents instability, the existence of large seasonal variations in air temperature - physical and chemical factors of sea water varies in time and space especially in the surface layer of water. This situation increases the need for research and regular observations, so you can get the results needed for all areas of activities (exploitation of mineral and biological resources, coastal zone protection and planning, tourism activities, marine transport, etc.).

Researches by our country in this area started later than in other countries bordering the Black Sea and were sporadic and limited. After creating IRCM, physical and chemical oceanographic research took a great extent both in terms of area knowledge and practical applications of the results. Research purposes Romanian in the continental shelf area, in that first stage was to ensure a minimum volume of information that can be useful to all economic activities related to marine or coastal area. The main issues addressed in this period were:

- Knowledge of hydrology and hydrochemistry conditions affecting the installation and use of offshore platforms, the environmental parameters necessary to design and construct the first offshore drilling platform and influence on marine ecosystems;

- Characteristics of the abiotic factors opening the Danube - Black Sea canal, to estimate local changes and establish the measures necessary to maintain water quality within acceptable limits;

- Wave energy potential of the Romanian Black Sea coast;

- Hydrological and hydrochemical study of water in the Mediterranean coastal Libyan law, to establish exploitable fishery resources.

Researches undertaken during 1976-1980 were aimed at determining the hydrological and hydrochemical parameters of water from the Romanian continental shelf. Through a systematic study of water before flowing river at Sulina into sea considerable nutrient input into coastal area was revealed. The results were embodied in 195 maps and charts published in *Oceanographic Atlas* printed in 1992.

Were also prepared studies on:

- Dynamics of water masses in the area of interest for offshore drilling in the area of potential spreading of petroleum products and their influence on the Romanian Black Sea coast;

- Chemical composition of sea water to determine possible recovery of useful elements, macroions and ionic structure of salinity;

- Wave and tidal regime of coastal marine and trends of shoreline;

- Implications of freshwater discharges heated as a result of their use in cooling facilities at Cernavoda NPP, by the Danube - Black Sea, the sea water and seabed.

Since 1981 physical and chemical oceanographic surveys were conducted in two major directions: research complex hydrological and hydrochemical regime of the coastal area and search for knowledge and deepening sea interaction processes - atmosphere. In the first lines were studied features of the main environmental factors, abiotic, based on systematic observations on a continuing basis in all sectors of the Romanian Black Sea coast. Highlighted the limits of variation, seasonal dynamics and spatial distribution regularities, correlations between these main trends of abiotic environmental factors, data were the basis for explaining changes in structure and function of marine ecosystems (eutrophication, algal blooms, hypoxia.).

The second direction was to include research related to the large interaction study physical phenomena - the atmosphere and the sea, primarily mechanical characteristics and thermal energy exchange at the sea surface and their effects on the structure and dynamics of water masses. Several experiments were conducted to determine the specifics turbulent energy transfer processes and substance in coastal waters and have devised models for forecasting the diffusion of fresh water and wastewater, and numerical simulation movement in the shallow area. At the time this research was novelty, marking the transition from observing and describing phenomena to understanding the mechanisms that generate them allowing their quantitative predictions.

Coastal morphodynamic research consisted of regular topographic profiles across the coastal beaches, bathymetric measurements in shallow coastal waters and measurements of wave action, currents and sediment transport on coastal beaches and shallow submerged areas, comments on the characteristics of sediments in the shallow beach, nature, quality and quantity of the suspension, particle size analysis of unconsolidated sediments and the chemical composition of fractions. All these have provided important data on trends of shoreline, beach dynamics and coastal zone protection measures. In parallel, were discussed research on the use of remote sensing techniques to study the marine environment, using multispectral data processing methods provided by multichannel radiometry installed on satellite platforms, operating aerial photography black and white and color as well, to determine the distribution suspension and chlorophyll pigments. These concerns were absolutely necessary to take decisions about the exploitation of mineral and biological resources of the marine environment, development and operation of industrial projects in coastal and marine area planning optimization solutions for beaches and coastal protection.

An ongoing concern has been the choice of appropriate methodology for processing, analysis and interpretation of results, to improve analysis methods and their adaptation to environmental conditions with low salinity. With insufficient endowment, an almost non-existent information flow and a weak international cooperation, we managed that through the efforts of members of laboratory staff, to ensure a level comparable to that of many countries with traditions in the field of marine research. It was also made more acute problem of finding the technical means capable of delivering synoptic coverage of the entire continental shelf, with adequate repeatability in time and spatial resolution suitable. Another direction of great interest in this stage was a concern to widen the range of parameters that can be determined

either *in situ* or in laboratory, determining the propagation velocity of sound in water bodies characteristic Romanian continental shelf, measuring their optical characteristics, wave frequency spectra determination, measuring currents in shallow areas, determination and dragged the carriage of silt in suspension, determination of dissolved and particulate fractions of organic matter, determine the flow of heat, momentum, substance-air interfaces -water and sediment, establishing the parameters characteristic of nutrient biogeochemical cycles.

Research undertaken since 1990 were considered current state of knowledge in physical oceanography, chemical and coastal morphodynamics and in particular the Western Black Sea and the issues raised by the state of this ecosystem geophysical changes. The main feature was the increasing share of the interdisciplinary approach to fundamental issues in this area in the interaction of mineral-organic and *alive – non live* had a very complex character, the delineation of sub-marine system and the connections between them, with the purpose of the biological component, seen in terms of a natural resource.

Relationship between abiotic factors and organisms are present at all levels, from the processes of assimilation and feeding algae, through behavioral responses of different species of vertebrates and ending with bacterial decomposition reactions.

Themes were included in two major objectives. The first, "*Study characteristics, formation processes and dynamics of specific water bodies Romanian continental shelf and the Western Black Sea. Analysis of transport processes, chemical constituents of the main flow and assessment of development trends*", with following main directions:

- Statistical analysis of the evolution of the main features of hydrological and hydrochemical parameters in Romanian seaside area;
- Experimental determination of water mass characteristics specific to the western Black Sea (quasiomogen top layer, cold layer, permanent pycnocline, anoxic zone, bottom boundary layer);
- Study the effect of meteorological factors (air temperature, wind) on the characteristics of cold intermediate layer and quasi-uniform top layer;
- Analysis of the characteristics of general circulation on the continental shelf and its interaction with the mainstream of the Black Sea, medium scale dynamic phenomena (seishes, meanders of the mainstream, vortexes, inertial currents, internal waves) and their role in changing the spatial distribution of water masses;
- Research entrainment and transport of nutrients into the interlayer cold analysis of chemical transformations in the oxidation-reduction of the interlayer cold and stabilizing role in these processes interface oxic - anoxic;
- Parameterization and mathematical modeling of basic physical processes;
- Database design and implementation of storage and use of results obtained in standard oceanographic stations and coastal stations.

The second major objective "*Study the dynamics of coastal erosion and shoreline change trends, modeling of hydrodynamic processes, strategies and methodologies for integrated coastal zone management development*" was held in the following directions:

- Analysis of current dynamics of the relief area of land, relations with hydraulic characteristics of the area and assess trends coast.
- Study transport patterns and sediment transfer between the shallow and open sea waters, the process of interaction between flow, sediment sources, transport and morphology of the substrate particles.
- Modelling geomorphological evolution of the system components that determine opportunities to establish their control.

- Study the effects of current marine and hydraulic works for coastal protection measures, development of conceptual issues regarding insurance schemes stability coastal area.

In general, the organization and conduct of research was done with traditional means, standard worldwide, aiming at the recruitment requirements and recommendations of international bodies and programmes such as: Intergovernmental Oceanographic Commission (IOC), International Commission for Scientific Exploration Mediterranean Sea (CIESM).

Over time, team researchers have published numerous articles in both scientific journal *Marine Research - Recherches Marines* and in prestigious foreign journals (Deep Sea Research, Marine Chemistry, Marine Pollution Bulletin, Oceanologica Acta, Rapports et Process-Verbaux des réunions CIESM).

In connection with international cooperation activities, the laboratory has been involved in implementing programs CoMSBlack and NATO TU-Black Sea (part of the program "Science for Stability"). The program aims to develop and implement models of the Black Sea ecosystems, to be used as a tool in the management of the marine environment and to develop concepts of high quality research and analysis in all riparian countries.

For carrying out the program IRCM GEF Black Sea, went to the laboratory task common development methodologies integrated coastal zone management (ICZM). In the same components Working out the documentation on the definition of coastal boundaries, the national institutional framework for ICZM. It is also necessary to point out another task particularly difficult by its complexity, namely the documentation for a pilot project funded by the World Bank "*Integrated Coastal Zone Management Midia - Vama Veche*".

It should be stressed that the Romanian experts involved in these programs is a recognition of their competence in these areas. Further effort must be added to the studies required laboratory members of the Institute of certain beneficiaries in the form of briefings, summaries, statistical values, forecasts on the evolution of abiotic parameters. They are a superior way of recovery of past and present data, the recognition of the institute and its outcomes. In such studies using existing data fund, systematized and processed appropriately, completed with a set of data and observations made during the preparation of studies. Since 1972 the Laboratory is publishing *Oceanographic Yearbook*, which includes all physical and chemical data obtained from research conducted.

IRCM was abolished in 1999 and reinstated by Government Decision, becoming the National Institute for Marine Research and Development "Grigore Antipa". In this context, the Laboratory of Oceanography has been transformed into the Department, and included three collectives: physical and chemical oceanography collective, marine engineering team and coastal engineering. The Department continued the research activity of the former Laboratory but new research directions imposed by internal and external developments have been approached as well.

In 1998, following a contract with the National Office for Cadastre Geodesy, it began rehabilitation of the national network of measuring sea level. Significant progress was recorded in 1999 by installing the first digital sea level recorder, received the donation from CIESM in the frame of the MedGLOSS programme. The sea level recorder transmits data in near-real time and one may consider this as the beginning of operational oceanography in our country. The advantages of this new system is derived from that data and information are continuous and thus one can view any deviation from the normal. On the other side an archive was created giving the opportunity to understand the oscillation of this parameter, which largely influences the coast line position.

Another important stage in Department activity started at the Second meeting of themembers Black SeaGOOS Pilot Project. The meeting took place in May 2001, in Poti

(Georgia) and attended all Black Sea states, the Intergovernmental Oceanographic Commission representatives (IOC / UNESCO) and the Black Sea Environmental Programme. Among other objectives, the meeting has adopted a Memorandum of Understanding (MoU) for GOOS Black Sea and was elected Executive Committee of the Black Sea GOOS. MoU was signed by five countries (Georgia, Bulgaria, Russia, Ukraine and Turkey) on July 6 in Paris and Romania signed on October 22. in Paris at the IOC headquarter.

The benefit of signing the MoU consisted of the subsequent launch of the first major project “*A Regional Capacity Building and Networking Programme to Upgrade Monitoring and Forecasting Activity in the Black Sea Basin*” (**ARENA**), funded by the PC5. The project brought together eighteen oceanographic institutes, hydro - meteorological institutes and international organizations such as:

- Black Sea Commission, Istanbul, Turkey
- Intergovernmental Oceanographic Commission, UNESCO, Paris
- Black Sea Environment Program
- Implementation Unit, Istanbul, Turkey
- International Marine Centre, Italy
- EUROGOOS

## **NATIONAL PROGRAMES/PROJECTS**

NUCLEU Programme 2003 – 2005

Objective 1: Deepening the knowledge of interactions in the marine ecosystem abiotic components (PN 03-1401)

1. Research on short and medium term development of large interface area - land, in conjunction with wave regime, sea level change and sediment transport.

2. Evaluation of trends of physical and chemical indicators of marine environment in relation to anthropogenic influences and climate change.

NUCLEU Programme 2006-2008

Objective 1. Deepening knowledge of interactions in the marine ecosystem abiotic components (PN 03-2801)

1. Research on susceptibility to beach erosion in the context of sea level rise in storm conditions.

2. Methodological integration of Romanian operational oceanography in Global Ocean Monitoring System (GOOS).

3. Current status assessment of water eutrophication level transition, coastal and marine priority component of the Community's environmental strategy.

4. Inventory and reconsideration in accordance with the requirements of EU integration of Romania terrestrial sources of pollution in the Black Sea coastline.

5. Strategic impact of port activities in Constanta, Mangalia and Midia marine environment and their effects on surrounding areas.

6. Assessment of intake of heavy metals and persistent organic pollutants of the Danube in the immediate area of influence, in the context of extreme situations triggered by climate change and biotic responses to these compounds.

NUCLEU Programme 2008 – 2011

Objective 1. Dynamic interactions of the abiotic components of the marine ecosystem in terms of climate change and anthropogenic influences (PN 9:32 01)

1. Study mechanisms governing short-term geo-morphological processes and environment under the action of natural phenomena and anthropogenic influences in coastal zone.

2. Study the formation and dynamics of water masses on the continental shelf and their interrelation with coastal waters.

3. The influence of river input on the chemical composition and trophic status of transitional and coastal waters in the implementation Romanian Joint Water Framework Directives and the Marine Strategy

An important period in the Department activity was 2006 - 2008, when it was developed the CEEX project, won the competition launched by the National Centre for Programms Management (Ministry of Education and Research / NASR / CNMP). In this project coordinated by the Institute were partners University of Bucharest, GeoEcoMar and Maritime Hydrographic Directorate.

The project aimed to establishing a platform for scientific and technological transfer in the field of operational oceanography, through the integration of national institutions with concerns in this area and create tools for transfer to users. Complex structure created allows rehabilitation of the infrastructure, storage and transfer of oceanographic data between marine meteorological and oceanographic the centers. The integrated system involves unification and then designing a common network of stations / points of observation, the adaptation of common standardized methodology, assessing the current status of existing equipment (sensors / networks), replacing them where necessary. This alternative involves creating and managing a database data, data quality control (QC), application of models and create different types of meteorological and oceanographic products: forecasts of short and medium term, updated digital maps and the substrate material, newsletters on development parameters significant environmental aspects. With these components the project met the requirements of end users, aiming to achieve a continuous dialogue with them (feedback).

Integrative platform by creating complex oceanographic products, facilitate integration into European structures similar in developing both infrastructure and human resources available and ensure scientific validity of decisions related to the use environment, reducing the risks of extreme events (storms, tsunamis), providing conditions for sustainable exploitation of environmental goods and marine services and recovery of the experience gained in national regional and international projects.

Around this time the Department was a partner in another project won the competition organized by the CNMP "Partnerships". The project called "Geo - influence of climate changes global and regional sustainable development in Dobrogea" acronym GLOBE and was conducted in five phases: Phase I geological definition of global change. Regularity determinants of global change in the geological past of Dobrogea Phase II data acquisition research and development of geo-climatic factors on regional and local level in Dobrogea

## **INTERNATIONAL PROGRAMES/PROEJECTS**

- Black Sea Ecosystem Processes and Forecasting / Operational Database Management System ODBMS Black Sea

- Sea-Search
- SEADATANET-PAN-EUROPEAN INFRASTRUCTURE FOR MARINE DATA (SEADATANET)
  - Upgrade Black Sea Scientific Network UP-GRADE BS-SCENE
  - Preparatory action for European Marine Observation and Data Network - Lot 3 - Chemistry EMODNET Chemistry
  - A Regional Capacity Building and Networking Programme to Upgrade Monitoring and Forecasting Activity in the Black Sea (ARENA)
  - Southern European Seas: Assessing and Modeling Environmental Changes (SESAME)
  - A Supporting Programme for Capacity Building in the Black Sea Region Towards Operational Status of Oceanographic Service (ASCABOS)
  - European coastal shelf sea operational monitoring and forecasting system (ECOOP)

Regarding the field of **coastal geo-morphology** in the period 1995 - 2000 were taken as the primary objective of the study: influence of cold season on the evolution of Romanian coast, influence of the type of change on the beach surface dynamics, determination shoreline position change rate and the relationship between sand sources for tourist beaches and direction of development of this report, determination of the change in intake / deficit of sediment to the beaches of tourist interest (qualitative and quantitative viewpoint) and statistical characterization of particle size deposits sediments from sea-land interface. Additionally it was intended the establishment of management units in terms of distinguished coastal geo-morphological processes and prioritize their needs for intervention, adopting a management plan for sea-land contact area, and a elaboration of a "Regulation on the beach use as the public domain of national interest" (Project in collaboration ).

Experimental research on sediment transport under the effect of waves and coastal currents (Mamaia poligon) were continued. In collaboration with University of Constanta were surveyed on areas of Dobrogea which were proposed for legal protection, development of a mathematical model and an automated computer program for numerical simulation of wave propagation in the surf zone, aiming at improving design of coastal protection works and control pollutants diffusion.

Beach resources for preservation studies were undertaken to implement the solutions / perimeter protection measures on light tourist beaches of southern coastline, resulting in a system location immediately sizing protective fencing action deposits sand driving under wind action on Mamaia beach.

During 1995-1998 national report "*The Integrated Coastal Zone Management Report on the Romanian Coastal Zone and the National Black Sea Environmental Priorities Study for Romania*" in BSEP GEF-funded Black Sea the World Bank were elaborated.

In 1999 the study "*The interaction between hydrodynamic phenomena and abiotic components of coastal ecosystems (delta - land - sea), monitoring and management methods of coastal geo-morphological processes*" was elaborated.

The most important objectives were:

- Changes in multi-annual and seasonal surface area beaches in terms of width and sediment balance;
- Submarine relief of the changes in the shallow and protected area of Mamaia hydro system;

- Assessing the contribution of bivalve populations in the formation of deposits of sand beaches and built hard substrate;
- Determining the rate of shoreline movement and setting its trends over time.

Additionally impact studies, as required by law to align with EU legislative acquis, were the following:

- "Environmental impact study on SC activity S.A Sorena (1997);
- "Environmental impact assessment regarding the activity of a commercial agent(1998-1999);
- "High Resolution Seismic Prospecting in blocks of Midia XV XIII Pelican Black Sea;"Environmental impact study on the Company's activity Paladin Resources (BITTERN)" (1999).

### **Erosion monitoring PROGRAM - 2001-2009 (Ministry of Environment)**

Monitoring program of the Romanian Black Sea coastal erosion, proposed in 2001, currently ongoing, is the prime goal of developing a scientific and technical data of such (adapted to natural conditions of the Romanian coast), providing support for fundamental research and engineering design solutions, aimed at limiting further degradation of the Romanian coastal zone and initiate measures for the recovery of affected areas to ensure conditions for sustainable development of this area.

The main objectives of the program were:

- 1) determination of shoreline changes on an annual basis;
- 2) evaluation of geomorphological component trends of the coastal area, quantifying the causes and risk assessment;
- 3) identification and substantiation of measures, methods and protection technologies
- 4) rehabilitation of coastal zone;
- 5) implement local solutions to rehabilitate coastal areas;
- 6) ensure the protection and regulatory framework for integrated coastal zone rehabilitation and performance obligations of government programs and international conventions to which Romania is a signatory or participant.

### **Environmental Strategy priorities meet program objectives in Romania, and Governance Programme of the Government Action Plan for 2001-2004.**

The program structure is intended, firstly, an accurate assessment of the general status of coastal zone and review of the mechanisms involved in the processes of erosion and transport, in parallel with morphological characteristics and hydrological assessment - on this basis, making a preliminary estimate of the trends both locally and regionally.

Also, for the future, database established during the course program will include information obtained by new methods such as satellite remote sensing, aerofotogrammetria, automated records of waves, currents, level, sediment flows and analysis of the effects of protective measures taken above, medium and long term. While the program is aimed at improving and expanding legislation, having regard to Romania's EU accession process. Results from the monitoring program will be the central unified information and results will be submitted periodically or as needed to different users:

- Ministries (Ministry of Waters and Environment Protection, Ministry of Tourism to);



- Environmental Protection Agency, Constanta and Tulcea
- National Company "Romanian Waters Dobrogea-Litoral Water Directorate;
- Danube Delta Biosphere Reserve;
- Town of coastal localities.

In **2001** under the Theme M1. *"Integrated program for monitoring physical, chemical and biological marine waters and coastal erosion"* was elaborated. There were two studies included in the program:

- Study *"Integrated control of coastal water quality and coastal zone in the context of regional cooperation in the Black Sea"*
- Study *"Monitoring coastal erosion, and the database needed protection measures for the rehabilitation and Romanian coast"*

Studies elaborated in **2002** within the Programmes of Ministry of Education and Research / National Authority for Scientific Research

- *"Study geomorphological changes of sea beaches of tourist interest"*

During **2002-2003**. Technical assistance - JICA, NIMRD, GeoEcoMar, Carex Environment

Project Title: *"Ecosystem Assessment, Coastal Erosion and Protection / Restoration Romanian Black Sea coast"* (Baseline Survey on Assessment of Ecosystem, Coastal Erosion and Protection / Rehabilitation of the Romanian Black Sea shore)

During **2003-2005** activity focused on the project: *"Research on short and medium term development of sea-land interface area, in conjunction with wave regime, sea level change and sediment transport"*

Project in **2005** (documentation): *"Shoreline Change Analysis for the Study on Protection and Rehabilitation of the Southern Romanian Black Sea shore"* for ECOH Corporation.

Between **2006-2008** activity focused on the project: *"Research on beach erosion susceptibility in the context of sea level rise in during storms"*

In **2007** was elaborated: *"The study of coastal processes influenced the evolution of shoreline erosion, to implement protective measures"*

Phase 1: *Monitoring of coastal erosion Romanian to determine most advanced line of water "*

In **2009** was elaborated *"Environment survey of coastal processes and shoreline evolution under the influence of erosion and other extreme events"*

During **2003-2011** activity focused on the NUCLEU Programme: *"Conservation of the marine ecosystem and promote its sustainable development"*

Objective: *"Deepening knowledge of the interactions between abiotic components of the marine ecosystem"*

During **2009 - 2011** activity focused on the NUCLEU Programet: *"Study of the mechanisms that govern short-term geomorphological processes and the*

*environment under the action of natural phenomena and anthropogenic influences in coastal zone"*