ABSTRACTS

Selected Abstracts of the First Phase Workshops

A Case Study: Küçükçekmece Lagoon, Turkey

I.E.GÖNENÇ, B.B. BAYKAL, O.INCE, O.ASIKOGLU
Istanbul Technical University, Ayazaga, Istanbul, Turkey

Abstract. The modelling approach for sustainable management is outlined, the results of management scenarios obtained by the modelling studies are discussed and the results taken from the applications of the best management scenarios are presented as a case study. The best management strategy was observed to be the use of the lagoon as a recreational water body. It may be concluded that the WQRRS ecological model originally developed by the US Corp of Engineers can be used successfully to make a decision between various management strategies for maintaining the sustainability of a coastal lagoons.
Keywords: coastal lagoons, salt lakes, ecological modelling, sustainable management

An Overview on Lagoons in the Polish Coastal Area of the Baltic Sea

E.ANDRULEWICZ
Institute of Meteorology and Water Management - Maritime Branch, 81-342, Gdynia, Waszyngtona 42, Poland

Abstract. Coastal lagoons in Poland are biologically diverse and very productive areas, and have a high economic importance as waterways, as tourist resorts and through fisheries. On the other hand they remain under strong antrophogenic pressure due to the high load of nutrients from agriculture, discharge of large amounts of municipal sewage and industrial wastes. Three important Polish lagoons, namely the Odra/Szczecin, the Vistula, the Puck Lagoons are briefly described and environmental problems to be considered for sustainable management are discussed.
Key words: coastal lagoons, Baltic Sea

Oceanographic Projects in Italy with a Focus on the Venice Lagoon

L. CARBOGNIN, G. DALLAPORTA and G. UMGIESSER
Istituto Studio Dinamica Grandi Masse, C.N.R. Consiglio Nazionale delle Ricerche, San Polo 1364, 30125 Venezia, Italy.

Abstract. In the first part of this paper an overview is given about governmental scientific projects related to the Mediterranean Sea in Italy. The focus of the projects will be in the near shore and coastal zone. Examples of projects dealing with lagoons are presented. Some case studies are outlined. The second part of the paper deals with a historical view on the management in the Venice Lagoon as an example of the importance of human intervention. This part includes the interventions of the Venetian Republic diverting rivers that were discharging into the lagoon until the last projects to tame the floodings of the city of Venice.
Key words: Venice Lagoon, Adriatic Sea, Orbetello ecosystem

Modelling the Venice Lagoon

G. UMGIESSER
Istituto Studio Dinamica Grandi Masse,ISDGM - C.N.R., San Polo 1364, 30125 Venezia, Italy.

Abstract. In this paper an overview is given that covers the modelling activities going on at the National Research Council in Venice (ISDGM-CNR) concerning the Venice Lagoon. A short history of former modelling efforts is given. A finite element hydrodynamical model is presented that has been created especially for the Venice Lagoon. This model has been applied to various situations. Residual currents have been computed for one year. A specific storm surge event has been simulated with spatially varying real winds. A transport diffusion model has been applied to model the impact of a treatment plant on the central lagoon. And a subbasin has been modelled with a high resolution grid.
Key words: Venice, lagoon, hydrodynamic modelling

Changes and opportunities for integrated management of the Razim-Sinoe Lagoon System

A. VADINEANU, S. CRISTOFOR, Gh. IGNAT, G. ROMANCA, C. CIUBUC and C. FLORESCU
Bucharest University, Department of Ecology and Environmental Management, Spl. Independentei 91-95 76201 Bucharest, Romania

Abstract. The aim of this paper is to identify the general trend of changes and the basic requirements of the most important lagoon system of the Black Sea, on the basis of a critical analysis of existing data. A more coherent set of data sampled after 1988 on the basis of some intensive and extensive study and research programmes, including the main trophic parameters and the most representative structural and functional features of this complex of ecotonal lakes, is comparatively analysed together with more fragmentary data previously existing. The structural and functional changes within this complex of lakes were analysed based on 31 most representative variables belonging to the main abiotic and biological compartments of the two main lakes, Razim and Sinoe: dissolved organic carbon, dissolved oxygen, trophic state index TSI, nutrient content and ratio, salinity, chlorophyll, fitoplankton, zooplankton, submerged macrophytes, zoobenthos, fish and birds. Two stages were distinguished in the main structural changes, including morphometry connections with the Danube River and the Black Sea and hydrochemics and their effects on communities. These transitions were associated with two main drive forces, water desalinisation and fast eutrophication, and with other two kinds of man-induced changes, local hydrotechnical buildings and long-distance variables operating over the entire Danube River watershed as support system for sustainable management of the Razim - Sinoe Lagoon Complex as a part of the Danube Delta Biosphere Reserve, integrated existing data research programmes for knowledge completion and integrated monitoring system for new data, is a final conclusion on further needs.
Key Words: Danube River, Danube Delta, Black Sea, nutrients, salinity gradient, ecological value, biodiversity.

Sustainable management of a coastal lagoonal system (Ria Formosa, Portugal): An ecological model for extensive aquaculture

S. GAMITO
UCTRA, University of *Algarve, Campus de Gambelas, 8000 Faro, Portugal*

Abstract. The Ria Formosa lies along the South of Portugal, extending for about 55 km. It is a true barrier island system, comprising mainland, backbarrier lagoons, inlet deltas, barrier islands, barrier platforms and shoreface. Within the Ria Formosa system, which covers a total area of 163 km^2, 20 km^2 are occupied by salinas and aquaculture ponds. The main water reservoir of the *salinas* and the extensive aquaculture ponds behave like small lagoons where there are one or more openings to a tidal channel. These small lagoons have the advantage of being easy to study and to model.
An ecological model was recently developed to estimate the potential production of the gilthead seabream in the Ria Formosa, in an extensive aquaculture regime. This model was based on information concerning chemical and physical factors (forcing functions) and secondary production estimates from four sites in the Ria Formosa with different environmental conditions, where extensive aquaculture is practised. Published

information on optimal growth parameters of the gilthead was used to build the model, which was based on some assumptions concerning the detrimental effect of an excessive increase of salinity and other environmental factors both on gilthead growth (one state variable) and on prey production (divided into two state variables), which is essentially benthic microfauna.
The previously developed model will be validated and modified to allow the estimation of potential production of the sole in extensive aquaculture. The joint study of two fish populations will also allow the analysis of predator-prey relationships and of possible feeding competition between the two species. This approach will allow a better understanding of the behaviour of such simple systems, and we hope it will permit a later application to the complex Ria Formosa lagoonal system.
Keywords: ecosystem modelling, aquaculture, fish production.

ECOSYSTEM MODELLING OF COASTAL LAGOONS FOR SUSTAINABLE MANAGEMENT:
basic requirements and their fulfillment for Razim - Sinoe Lagoons System

Prof. Dr. Angheluta Vadineanu,

Abstract: The integrated management of the lagoon systems for sustainable use of the goods and services they are providing could be achieved only if some basic conditions are created and continuously improved.

- An extensive inventory (e.g. covering Baltic Sea, Black Sea, Mediterranean Sea and a part of the Northern Atlantic) of the existing data and knowledge concerning the structure and functioning as well as the type and rate of goods and services provided by different lagoon systems.
- An extensive inventory of the specific boundary conditions and their impact on the dynamics of structure and functioning of the lagoon systems.
- Based on the collected and assessed data and knowledge (including both the organisation of the lagoon and their boundary conditions), the identification of the main categories of lagoon systems should be accomplished.
  For each category of lagoons the system should be identified, including both the structure of HGMU* and biocenosis (the most appropriate homomorf model which preserve the basic structural and functional features of the real system).
- For each "identified system"/"homomorf model", the main structural and functional "parameters" as well as the main drive forces should be indicated.
- The phenomenon, mechanisms and processes should be described accordingly by using the most powerful and adequate package of mathematical models.

  Related to the key parameters and drive forces, clear statements should be made concerning the data availability, the gaps, the possibilities of flling up the gaps either by compilation or by further investigations.

  *Hydrogeomorphological Unit

  These should integrate both the achievements of the team members and the adapted models which were previously used for similar systems.

  * The comprehensive product of all the above steps is the first draft of the "Information system on the dynamic, carrying capacity and productivity of the identified categories of lagoon systems" which have to be used as the most powerful tool for sustainable management of such systems.

In accordance with the above coordinates of the conceptual model, a brief presentation on the egisting data, knowledge and the homomorf model for the Razim - Sinoe Lagoon System (North - Western Black Sea Coast) will be the contribution of the author.
The analysis was focused on the very critical element on which an effective sustainable management of the Razim - Sinoe Lagoon should rely on.

- the spatial and temporal scale;
- the availability of large series of reliable data and knowledge concerning main changes in the structure and functioning of the biological diversity as a consequence of changes occurred at the boundary conditions and their impact on the Health of the Lagoon System as well as on its ability to provide goods and services (productivity);
- better understanding of structural and functional dynamics/"kinetics" of phyto and zooplankton under hypertrophic conditions;
- preliminary ideas concerning identification or development the appropriate and eff cient tools for the description of the main ecological processes (energy flow and biogeochemical cycling) - mathematical and heuristic models.

The author has tried to underline the importance of reliable data and knowledge for a powerful Information System, concerning not only key boundary conditions and internal physico-chemical mechanisms and processes but also that related to the dynamics of biological systems (populations and communities) and their mechanisms and processes which, in fact, are crucial for goods production and services providing. In this respect, it is stated that for Razim - Sinoe lagoons System there are rich and long term data and knowledge pools, which could be however further improved, and that are a good starting point for checking and fitting the developed package of mathematical models (water quality and "ecological models") which were already developed for Chesapeake Bav Svstem.

PUBLIC HEARINGS
Karen Terwilliger

Abstract. All levels of Government have recognized the need for and the importance of public input into policy making. Therefore, over time, public input, including the format of public hearings, has been built into the legislative, regulatory, and planning process at thc federal, state and local levels. The processes by which public input is achieved are both formal and informal means. In general, proposed legislation and regulations are subject to a formal public review process before they become law or regulation at the federal, state, and local levels. Federal and state agencies are required by law to publish their proposed rules and regulations and/ or to hold public hearings to ensure public input into the legislative and regulatory processes. Each state develops its own unique public input requirements and processes which are guided to some extent by federal requirements. State *code* then *sets* forth requirements and guidance for local implementation and public input. Public input into land use policy at the local level enters during the development of the comprehensive plan and zoning ordinances. Localities are encouraged to solicit additional public input beyond the state requirements. A variety of innovative meeting formats and are now bring utilized by federal, state, and local agencies and organizations to enhance public input.

LAND USE PLANNING

Abstract. Land Use planning for the Chesapeake Bay as a geographical entry, is accomplished at several levels according to political boundaries. At the federal level, a number of different agencies have developed programs to provide guidance, support or funding for land use issues in and around the Chesapeake Bay. Each of these agencies have a specific focus and mission in Bay restoration, but all are coordinatcd through thc ChesapeakeBay Program and EPA. At the state level, the states of VA,MD, and PA are represented on the tri-state legislative body, the Chesapeake Bay Commission. Each state enacts its own separate legislation and regulations relating to land use planning, and the Chesapeake Bay Commission is the coordinating body for this legislative action. At the local level, regional, county and municipal planning commissions develop recommendations for land use for the loca1 govarning bodies. Land use planning is

generally implemented at the loca1 level as local governing bodies act to carry out the guidance, policy and legislative mandates generated at the state and federal level. The State and Federal Agencies, however are tasked with the oversight and monitoring of this implementation. Federal and state programs offer technical support and limited funding to localities as they implement land use planning tbrough the development of Comprehensive plans and zoning ordinances. Because of the importance of the Chesapeake Bay ecosystem, a unique regional partnership between three states, the Regional Chesapeake Bay Commission, the US EPA (representing Federal agencies), and the District of Columbia and a number of advisory groups was established in the form of the Chesapeake Bay Program. These efforts have sought a balance between population and economic growth and the delicate ecology of the Bay and to emphasize this correlation through research and educational efforts critical to land use implementation.

HYDRODYNAMIC AND SEDIMENT SUSPENSION MODELLING IN ESTUARINE SYSTEMS

PART I: DESCRIPTION OF THE NUMERICAL MODELS

Leonor Cancino and Ramiro Neves

ABSTRACT. A fully-3D finite difference baroclinic model system for hydrodynamics and fine suspended sediment transport is described. The hydrodynamic model considers the hydrostatic and Boussinesq approximations, uses a vertical double sigma co-ordinate with a staggered grid and a semi-implicit twotime level scheme. In addition to the momentum and continuity equations, the model solve two transport equations for salt and temperature and an equation of state to include the baroclinic effects. The simulation of cohesive sediment transport processes is performed solving the 3D- conservative advection-diffusion equation, in the same double sigma co-ordinate grid used by the hydrodynamic model. For the representation of the processes of flocculation and erosion and deposition of bottom sediments refined empirical formulations based on data field was adopted. The models have been calibrated and tested by simulating tidal flows and suspended sediment transport in different estuaries (two applications are described in Part II). Results show a good agreement between the numerical predictions and corresponding field measurements.

Eutrophication: Harvesting

Sofia Gamito

Abstract. Coastal lagoons are, overall, more productive than other ecosystems in terms of fisheries yields. Some few extremely productive lagoons may benefit from the intersection of several factors, such as:
- a coastal habitat supplying a large recruitment
- Fertilization via agricultural runoff or human sewage and through water exchanges with the sea
- a management regime which makes the best of the incoming recruitments (Pauly and YanezArancibia,1994).

Some factors, however, may lead to unproductive lagoons, such as extreme environn• ental fluctuations due to lack of water renewal (Gamito,1989), or very shallow sills preventing sufficient recruitment (Pauly and Yanez-Arancibia,1994). There are few lagoons where we can still speak about natural production. Most of the lagoons are subjected to human action, through fishery management practices or aquaculture implementation. Some are so polluted that fisheries are seriously affected, not only in quantity, but also in quality.

Boundary characteristics: Transport of micro and macro organisms by rivers and by the sea

Sofia Gamito
UCTRA, University of Algarve 8000 Faro, Portugal

Abstract. Transport of organisms by rivers or by the sea can be passive or active. Transport of phytoplankton and zooplankton, which have only limited possibility for movement, will depend greatly on the hydrodynamics of the systems considered. Other organisms, such as some crustaceans, fish and mammals are capable of active transport, and their entrance into lagoons is related to their behaviour and life histories. The importance of transport of organisms will greatly depend on lagoon's geomorphology and on the region's climatic characteristics. If there is any significant freshwater entering the lagoon, the ecological characteristics will be similar to other fresh or brackish water habitats. The transport will then be done by freshwater inflow. If there is no impartant river, the lagoon may present hypersaline characteristics, depending on the weather of the region. During heavy rains some freshwater organisms can be transported into the lagoon, but these might not survive in hypersaline lagoons.
In semi-enclosed lagoons, which are only temporarily open to the sea, (during storms, for instance), the entrance of marine organisms greatly depends on these events. These organisms will rely on the maintenance of marine conditions inside the lagoon for their subsistence. The presence of transported organisms inside the lagoon can be temporary, and it may lead to a situation where only few species survive throughout the year.
In open lagoons such as Ria Formosa, with an insignificant freshwater input, and where there is 50 to 75 % watex exchange with the sea (in the neap tides and spring tides, respectively), the permanent transport of organisms by the sea is a very important factor.

Eutrophication: Benthic-water column interactions

Sofia Gamito
UCTRA, University of Algarve 8000 Faro, Portugal

Abstract. The biochemical cycles have to be considered in the mathematical description of the benthic-water column interactions, i.e., production of O_2 and organic compounds and absorption of CO_2 and nutrients by primary producers and consumption of O_2, excretion of ammonia, phosphate and other compounds and resuspension of sulphites by heterotrophic organisms.
The abundant presence of primary producers, not only phytoplanton but also microphytobenthos and macrophytes in the shallow-waters of lagoons may increase the concentration of dissolved oxygen in the water, although in confined areas their uncontrolled abundance may lead to dystrophic crisis with complete depletion of oxygen.
The activity of heterotrophic organisms may change the environmental conditions near by. Burrowing species enlarge the oxygenated layer so that the oxidation of compounds in the interstitial water is favoured. The exchange of interstitial water with the overlying water is also accelerated. The perma.nent reworking of the sediment (bioturbation) influences the permeability of the sediment and causes a vertical transport between the anaerobic layer, the aerobic layer, and the water interface. Filterfeeders or suspension-feeders may filter (and clean) large quantities of water. These considerations should be included not only in the mathematical model but also in the management of coastal lagoons.

Eutrophication: Fish growth models

Sofia Gamito
UCTRA, University of Algarve 8000 Faro, Portugal

Abstract

Several models have been developed to describe fish growth and mortality. The decision about which model should be used in ecological modelling is important, as most of the ecological models deal with transfer of energy or matter along the trophic chain. According to the model applied, the quantity transferred can vary. The extreme variability of the environmental conditions in some coastal lagoons also have to be considered in the mathematical description of fish growth.

Eutrophication: harvesting

Sofia Gamito
UCTRA, University of Algarve 8000 Faro, Portugal

Abstract. Coastal lagoons are, overall, more productive than other ecosystems in terms of fisheries yields. Some few extremely productive lagoons may benefit from the intersection of several factors, such as:
- a coastal habitat supplying a large recruitment
- fertilization via agricultural runoff or human sewage and through water exchanges with the sea
- a management regime which makes the best of the incoming recruitment (Pauly and Yanez-Arancibia,1994).
Some factors, however, may lead to unproductive lagoons, such as extreme environmental fluctuations due to lack of water renewal (Gamito, 1989), or very shallow sills preventing sufficient recruitment (Pauly and Yanez-Arancibia,1994). There are few lagoons where we can still speak about natural production. Most of the lagoons are subjected to human action, through fishery management practices or aquaculture implementation. Some are so polluted that fisheries are seriously affected, not only in quantity, but also in quality.

Hindcast of a Storm Surge Induced by Local Real Wind Fields in the Venice Lagoon

S. Zecchetto, G. Umgiesser

Abstract. We investigate the efl'ects produced by the wind blowing over the Venice Lagoon on its water levels and circulation. This has been carried out using a finite element hydrodynamical model, for the first time coupled with wind stress fields, obtained from an objective analysis of the wind stress data recorded in four different sites in the lagoon. The hindcast concerns a case of strong northeasterly wind (Bora) occurred from the 22nd to the 24th of December 1994. The results of the hindcast are discussed both in terms of spatial pattern of the storm surge levels and of the water exchanges with the open sea through the inlets.

The hindcast indicates the existence of an area of set-down (-45 cm, minimum) in the northern lagoon and of one of set-up (+55 cm, maximum) in the South separated by the central lagoon, where the effects of the storm surge are small. Since the set-down and set-up are out of phase, the maximum unbalance of the water level between the North and the South of the lagoon is 70 cm. The results point out the existence of a transversal set-up, that is a positive difference between the western and the eastern lagoon producing a not negligible unbalance between the water levels around the inlets and that of the open sea (-5 cm at the northern inlet, +8 cm at the meridional inlet). This triggers the sea-lagoon water exchanges.

The role played by the inlets in the general circulation has been evaluated investigating the discharges through the inlets and through ideal transects which divide the lagoon in three parts. The analysis has shown that the spatial and the temporal behaviors of the wind induced water level in the South and in the North of the lagoon have a high degree of independency.

During the entire period of study the sea water inflow through the northern inlet is steady and relevant while the outflows through the central and southern inlets remain moderate. After flowing through the northern inlet, the water branches off into a southward and northward flow,

with the former predominating during most of the time. However, slightly after the maximum setdown is reached, the northward flow prevails. The water dynamics in the southern lagoon is driven by the outflows at the meridional inlet.

Hindcasts using spatially constant wind stress fields showed the importance of the wind spatial gradients in the determination of the pattern of the storm surge levels.

The Spreading of the Po Plume and the Italian Coastal Current

Georg Umgiesser, Andrea Bergamasco
ISDGM-CNR, S. Polo 1364, 30125 Venice, Italy

Abstract. The mechanisms that govern the spreading of the Po plume in the Northern Adriatic Sea are still not well understood. Various forcings interact in determining the salinity pattern observed ogthe Po estuary.

The structure of the Po plume is controlled by bathymetry to a high extent. Transient forcings as the varying discharge rate and strong wind events further modulate the plume.

With a finite element primitive equation model the effects of the various forcings have been simulated. In particular the transient forcings have been studied. A strong Po discharge impulse and various wind episodes have been investigated.

It has been found that the only effective forcing that may lead to the Po water spreading into the interior of the Adriatic Sea are the non-homogeneous winds blowing over the North Adriatic. These winds have a rotational component that creates recirculation cells that effectively push water out from the coastal zone into the interior.

Monitoring for Waste Load Characterization

Eugeniusz Andrulewicz

The objectives of monitoring for waste load characterization usually are:

* to compile the total load of important pollutants entering selected water body from different sources on the basis of hannonized monitoring methods,
- to follow-up the long-term changes in pollution load from various sources,
- to determine the priority order of different sources and pollutants,
- to assess the effectiveness of measures taken to reduce the pollution load, ù to provide information for periodic assessments.

The main pollution sources to be considered are:

- riverine inputs,
- discharges from point sources: municipal efþluents, industrial efþluents, aquaculture inputs,
- diffuse inputs: agriculture, forestry, non-managed lands
- airborne pollution load

Parameters to be considered are specific for riverine inputs, municipal effluents, industrial effluents, aquaculture, diffuse inputs. They might include: BOD_7, COD, TOC, SS, AOX; nutrients: TOT-P, $P0_4$-P, TOT-N, NH_4-N, $N0_3$-N, NO_2-N; trace metals: Hg, Cd, Zn, Cu, Pb, Pb, Ni, Cr; POPs: sDDT, CBs, PAHs, organotin compounds and/or others.

Guidelines for the monitoring programs including :eporting format and unified data entry system should be followed.

Assessment of the results will depend on requirements. There is usually a need for overall assessment (containing background - scientific material), executive assessment for management and decision making, popular assessment for press and public.

Monitoring of pollution load is one of the most diff• cult tasks to carry out'and to assess results. As an example, Baltic Sea Pollution Load Compilations: PLC-l, PLC-2, PLC- 3 will be described.

GIS & Data Management System

Eugeniusz Andrulewicz

Abstract. The main purpose of GIS is to facilitate the management and analysis of environment in a selected region by providing coherent spatial information on relevance to environmental issues of the region, and the techniques and tools for analysis and display.

The main geographical area to be covered has to be defined by the project, although the precise delineation might be difficult. Existing data on the area has to be identified as desirable.

The content of GIS is defined by the project. Following features for lagoons are usually included: bathymetry, sea area division, coastline, administrative units, settlements, rivers, lakes, drainage basins, land cover, digital terrain model, sewage plants, industrial facilitieþ, designated areas, soil type, civilian nuclear plants and others.

The distribution policy for data sets has to be determined in details, but the aim is that the access to them should be practically unlimited to all institutions and bodies involved in environmental issues of the region. Agreement between data providers and the project, as well as between the project and the users, should be made to ensure full acknowledgment of the full primary source of the data, and to ensure non-commercial use.

Description of data management system will be based on the activities within the framework of the Helsinki Commission (HELCOM). The primarv function ofthe main HELCOM data activities is to facilitate assessment process. Current data collection activities are:

- data collected within the Baltic Monitoring Program (for open and coastal waters)
- data collected within the Monitoring Program of Radioactive Substances
- data collected within the Monitoring Program of Airborne Pollution
- data collected within the Pollution Load Compilation for the Baltic Sea

Data collection within these monitoring programs are based on HELCOM Environmental Data Center and ICES Data Bank

Additional tasks of data banks are updating of the reporting formats and quality control of the data. Future needs for data collection and processing are in biological effects monitoring and nature conservation field.

Monitoring System Design
Eugeniusz Andrulewicz

Abstract. Monitoring is the process of repetitive observing for defined purposes, of one or more elements of the environment, according to prearranged schedules in space and in time and using comparable methodologies for environmental sensing and data collection (UNEP definition adopted by the ICES and HELCOM). The aim of the open water monitoring is to follow long term trends and changes in the ecosystem in order to

asses the state of the ecosystem and finally to propose appropriate measures for protection. Monitoring program should provide sufficient data to prepare comprehensive and conclusive assessment of the state of the environment. The general objective of the coastal monitoring program is to identify and quantify the effect of, existing anthropogenic discharges in the context of natural variations in the ecosystem and to identify and qualify the improvements in the environment as a result of regulatory actions. Most of monitoring programs for lagoons should consider biological effects of euthrophication and biological effects of contamination of the ecosystem.

Data originators should follow the guidelines and implement data quality system (inhouse quality procedure and external interqalibrations). Data formats and reporting procedures are usually precised by monitoring data center.

Selection of monitoring stations, selection of monitoring parameters and frequency of measurements should take into account natural variability such as seasonal variability, year to year variability and unusual events.

Monitorin5 should be supported by suitable scientific programs. Assessment of the state of the environment should be based not only on monitoring results but should include all the available scientific data.

Temporary revisions of monitoring activities are necessary as a result of experience gained, improvements in monitoring methods and the introduction of new techniques.

Monitoring strategy has been elaborated and improved for the last ?0 years by the International Council for the Exploration of the Sea (ICES). This strategy was adopted by the North Sea countries - OSPARCOM and the Baltic Sea countries - HELCOM.

Transboundary Lagoon Problems

Eugeniusz Andrulewicz

Transboundary co-operation must be built on trust and special political will to cooperate. Co-operation in research and monitoring activities will facilitate practical implementation.

Developing the transboundary lagoon co-operation is a platform for different authorities, sectors, interests and communities to focus on the interaction between various activities and demands for natural resources in coastal zones. The common objective is to achieve an ecological sustainable development within a specific geographical area.

Many problems arise due to the different traditions and approach in monitoring and management of the area. These usually are differences in units and scales, different spatial planning approach, different priorities and different administration systems etc.

Transboundary lagoon problems will be described on examples of three Baltic lagoons shared by different nations which historically have "sensitive" borders: Curonian Lagoon (Lithuania-Russia), Vistula Lagoon (Russia-Poland) and Odra Lagoon, (Poland- Germany).

AN OVERVIEW OF TOXI4 FOR MODELLING ORGANIC CHEMICALS

Bilsen BELER BAYKAL

Abstract. Organic chemicals, taken herein as organic toxicants, may have deleterious effects on various sectors of the ecosystem. They are generally found as micro

pollutants which may have toxic and/or carcinogenic effects at very low concentrations, and are at most times, persistent in the aquatic environment. Except rendering risks to various forms of aquatic life, they may be very unacceptable for water quality for almost all types of beneficial uses. Within this context, proper management of organic chemicals is a must for sustainability of the water body.

TOXI4 is a dynamic model which can be used for the modelling of organic chemicals as well as metals, in all types of aquatic systems. It is capable of combining chemical transformations and sediment balances to be presented herein, with hydrodynamic and transport characteristics of the water body.

Almost all major processes in which organic chemicals take part have been addressed in the model, including sorption, ionization, volatilization ,biodegradation, hydrolysis, photolysis, and chemical oxidation. The model has a provision for one extra reaction in case there is a significant reaction other than those that are normally handled. The model can simulate

- one to three types of chemicals, and
- one to three types of particulate matter,

making a total of six components. Each chemical may exist up to five different species: the neutral molecule, two cationic forms, and two anionic forms.
Each specie can exist in five phases:

- dissolved,
- sorbed to dissolved organic carbon,
- sorbed to three different types of solids.

TOXI4 can calculate concentrations in surface water, underlying water, surface bed and underlying bed.

Among the processes handled in the model, sorption and ionization are taken as equilibrium phenomena while the rest are addressed as rate processes. For equilibrium processes, local equilibrium is assumed to prevail and the distribution of chemicals are defined by distribution or partition coefficients. Rate equations are handled with the assumption of local first order kinetics using a lumped rate constant, based on a summation of several process rates some of which are second order. The effective first order rate coefficent may be dependent on chemical and environment specific parameters that may have spatial or temporal variations.

In order to be able use the model, equlibrium coefficients and rate constants must be known. Site specific calibration is preferred, however, for most of them TOXI4 can make estimates from chemical properties and environmental characteristics.

The most significant limitation of the model is that chemical concentrations should be near trace levels, i.e. below half the solubility or 10^{5} molar. At higher concentrations
the assumption of linearity starts to fail. Large concentrations may become important near sources and can affect key environmental characteristics like pH or bacterial populations, altering transformation rates.

Models of the Chesapeake Bay
By Lewis Linker

Chesapeake Bay, the largest estuary in the United States, has been famous for its abundance of fish, shellfish, and waterfowl since it was explored by John Smith in the early 1600s.By the 197Qs, however, many of the bay's resources were in clear decline. Excess amounts of the nutrients, nitrogen, and phosphorous were identified as the most significant factors impacting the bay's water quality. 'Too many nutrients overfertilized the bay, feeding tht growth of algae blooms which sink to the bottom of the bay and decompose in a process that depletes the water of oxygen. These areas of "dead water" no longcr have oxygen levels necessary to support fish and other aquatic life.

The Chesaprake Bay Program, a voluntary partnership that includes the states of Maryland. Virginia, and Pennsylvania; the District of Columbia; the Chesapeake Bay Commission (a tristate legislative body). and the U.S. Environmental Protection Agency (EPA) was created in 1983 to restore the bay. It was realizcd that the bay's deterioration could not be arrested by one of them acting alone. The entire watershed is a 64,000-square-mile drainage basin expanding from a northern boundary of Cooperstown, New York, to Virginia Beach, Virginia, and west to the Ohio River basin.

Changes in the watershed were accompanied by changes in the airshed, an area that extends from North Carolina to Lake Erie and west to Kentucky. The airshed contributes to the Chesapeake nutrient loads by depositing airborne nitrogen on the watershed and estuary. These airborne nutrients, a chemical combination of atmospheric oxygen and nitrogen were formed at high temperatures and pressures like conditions found in power plants or in automobile engines.

An integrated set of air and water models to track these changes in thc watershed and airshed have been developed and linked together to get an overall simulation of the Chesapeake watershed, airshed, and estuary and have been used to quantify the nutrients contributing to eutrophication. Most importantly, the models have been used to quantify nutrient reductions necessary to restore Chesapeake Bay resources.

The Chesapeakc Bay Program nutrient reduction goal is to reduce the nutrients entering the bay by 40 perccnt by the year 2000. Thc models, which have demonstrated that this goal will significantly decrease the "dead waters' of the Chesapeake, provide guidance to environmental managers and citizens on where the most cost-effective nutrient reductions can be made.

3-D HDRODXNAMIC MODELLING IN COASTAL LAGOONS: A CASE STUDY GÖKSU LAGOON

L, Hapoglu-Balas and Prof.Dr. E. Özhan
Middle East Technical University, Ankara, Turkey

ABSTRACT. The three dimensional mathematical model developed at METU, is capable of computing the water levels and water particle velocity distributions in three principal directions by solving the complete Navier-Stokes equations (Hapoglu-Balas, 1995). Model includes the thermohaline forcing, The temperature and salinity variations in the lagoon are calculated by solving the three dimensional convection-diffusion equations written for these quantitios. These parameters influance the density according to the equation of state (p=f(T,S)), which in return influences the velocity field.

Solution method is a composite finite difference-finite element method. In horizontal plane finite difference approximations and in vertical plane finite element shape functions are used. Equations are solved implicitly allowing relatively large time steps, Courant Number being af the ordcr of 30.

The volume of water in a typical coastal systems like lagoons shows seasonal variations, causing some water areas in the system to dry out or visa versa, Therefore, the boundaries of the coastal area need to be defined as movable boundaries, To take into account variations in vertical eddy viscosity, the simplified one -equation turbulence model is used. The value of vertical eddy viscosity depends both on the water depth and the applied surface wind stress. The model is applied to the Göksu Lagoon located at the Mediterranean coast of Turkey. The Göksu Lagoon system consists of Akgöl and Paradeniz lakes which are connected by a very narrow and shallow channel. Akgöl and Paradeniz may both become eutrophic in the near future, since they receive significant discharges of nutrient-rich drainage waters from the adjacent irrigated agricultural lands.

THE MAIN ASPECTS OF THE MONITORING INVESTIGATIONS IN THE KURSHIU MARIQS LAGOON

Vytautas Dubra

Abstract. The main topic of the presentation is the transport route the Nemunas River - the Kurshiu Marios Lagoon - the Baltic Sea. This region is primarily an agricultural region, serves as a nursery for fisheries, is a recreation area as well as it is a very important water source. The lagoon has come under heavy stress over the last 50 years from the increased pollutant loadings, originating primarily from the river Nemunas drainage area. Lately after the restoration of independence in Lithuania economical difficulties were the reason of the decrease of pollution level. The main purpose ia that future activities would be preparing suggestions for the usage of region resources where economics goes up and reaches the previous higher level. Efforts are taken to calculate water mass circulation balances related to pollution level.

WETLANDS LANDSCAPE ANALYSIS PROJECT, THE CHICKAHOMINY RIVER WATERSHED MODEL
John P. Wolflin

The Wetlands Landscape Analysis Project, Chickahominy River Watershed Model is a cooperative public-private effort that was initiated by the U. S. Fish and Wildlife Service to develop and test a proactive approach to manage cumulative impacts. The project is intended to promote sustainable use and, as possible, development of the watershed. The project includes comprehensive investigations of the Chickahominy River watershed and its ecosystems. The relationships between hydrology, water chemistry, and biotic diversity (including plant communities, amphibians, macro invertebrates, fish, and forest breeding birds) are being documented. A Geographic Information System (GIS) will be used to analyse whether human-induced and natural changes influence these relationships. The Project is currently supported by a Technical Committee and the Chickahominy Citizens' Watershed Alliance. The Technical Committee is coordinated by the U. S. Fish and Wildlife Service and includes members from the Virginia Commonwealth University, the Virginia Institute of Marine Science, the center for Conservation Biology and the Geology Department with the College of William and Mary, the University of Richmond, the Virginia Natural Heritage Program, the U. S. Geological Survey, and the Virginia Department of Game and Inland Fisheries. The Study information will be provided to the Chickahominy Watershed Alliance, local, state, and Federal agencies, and other interested parties so that they can work together to ensure the biological integrity and economic prosperity of the watershed. The project area is located in the State of Virginia and is part of the larger Chesapeake Bay watershed.

Chesapeake Bay Program Structure and Function Maximises Public and Scientific Input Variables
Karen Terwilliger

Abstract. The unique regional partnership, the Chesapeake Bay Program, which directs and conducts the restoration and conservation of the Chesapeake Bay, provides a model for organisational structure and function for such efforts globally. Inherent in its structure is the provision for public as well as scientific and technical input throughout issue and policy formulation. High-level regional commitment and accountability are attained through the Executive Council, the group of high-ranking elected and appointed officials which direct policy development by setting highly publicised goals and objectives. The central Implementation Committee receives input on growth projections

and impacts, and directs the Land, Growth, and Stewardship Committee in order to promote sound land management decisions and public and private actions which reduce these impacts. Local Government and Citizen Advisory Committees input directly to the Executive Council and the Implementation Committee. Additional Subcommittees address Land use actions that can result in improved water quality and attempt to model the effects of varying levels of nutrients, toxics, etc. This complex but effective structure maximises the functional efficiency of this network and can be used as an example for global restoration efforts.

TOXIC ORGANIC CHEMICALS AND THEIR STATUS IN THE KOYCEGIZ LAGOON

Bilsen BELER BAYKAL

Toxic organic chemicals are found as micro pollutants which may have toxic and/or carcinogenic effects at very low concentrations, and are generally persistent in the aquatic environment. They render risks to various forms of aquatic life, and to water quality for almost all types of beneficial uses, threatening the sustainability of the water resource for the prescribed use. Significant sources of pollutants of this type are agricultural and industrial activities. Major processes in which toxic organic chemicals take part include sorption, ionisation, volatilisation, biodegradation, hydrolysis, photolysis, chemical oxidation. Each chemical can exist in a variety of different species, including the neutral molecule, and various ionic forms; in a number of phases, i.e. dissolved, or sorbed to different types of solids. To model toxic organic chemicals in the lagoons selected as the case study, first, toxic chemicals present in the watershed should be specified. Then priority toxic chemicals, their ionic forms and states, and significant processes they are involved in must be specified. Finally, coefficients and constants needed for the model should be determined from on site data, literature values or default values. Toxic organic chemicals in the Koycegiz Lagoon come mainly from agricultural activities within its watershed. The predominant agricultural activity is citrus fruit production. Pesticide use is commonly practiced. Pesticides used in citrus fruits production include various herbicides, insecticides, fungicides, acaricides and nematocides, belonging to various classes of toxicity.

DEVELOPMENT OF 3-D HYDRODYNAMIC FINITE ELEMENT MODEL

G. Umgiesser

Abstract. A new three-dimensional finite element model is presented that is suited for the use in very shallow seas. The model is a semi-implicit model that solves implicitly for the water levels at every time step. This avoids the need to satisfy the well known stability criterion for the fast gravity waves. In space, staggered finite elements are used in the horizontal and a discretization in levels is made for the vertical.
The model does not use a made splitting scheme. E.g., the barotropic mode is not decoupled from the baroclinic modes. Instead, the velocities of all levels are solved for implicitly. The reason for this choice is the possibility to treat the bottom friction term implicitly. This implicit treatment allows the model to work with a very small vertical discretization without being limited by the stability criterion of the bottom friction term. Drying and flooding can be simulated too.
Finally, the model uses a operator splitting scheme for the Coriolis term. In this way the Coriolis terms can be treated implicitly; and the resulting matrix remains symmetric.
The model has been successfully applied to the Venice Lagoon. The computational cost is comparable to the one of a two-dimensional model.

Bacterial growth and abundance in coastal lagoons
Sofia Gamito

Bacterial growth is a fast process, depending on several abiotic and biotic factors, such as temperature, nutrients availability, competition with phytoplankton, or predation by bacterivorous protozoa. Some considerations about theoretical models on bacterial growth rate, abundance and diversity will be made, along with the presentation of some practical applications to the Ria Formosa lagoonal system.

NEW TRENDS AND ACHIEVEMENTS IN THE BASIC AND APPLIED RESEARCH OFF THE LOWER DANUBE RIVER SYSTEM
A. Vadineanu

An attempt to assess the significance of the objectives and the achievements of the recent research projects on the Lower Danube River System as well as the targets of the new projects launched for the next five years for the integrated management of different types of ecosystems, including Razim - Sinoe lagoons system, it will be the core goal of my intervention.
It is also my intention to emphasise the importance of proper system identification for the designing of both research program and mathematical modelling of the ecological systems to be managed in this region.

ENVIRONMENTAL IMPACT OF LAND-BASED POLLUTANTS ON IZMIT BAY (TURKEY)
Short Term Algal Bioassays and Simulation of Toxicity Ditributions in the Marine Environment
Oya S. Okay, Tanan Leuovic, Vildan Tüfekçi, Leyla Egesel, Enis Morkoç

The eight dominant discharges of land based waste entering Izmit Bay as a result of its burgeoning development are characterised here. Chemical analysis of the discharges are described and their toxicity has been quantified as a result of short term ^{14}C algal bioassays. Predictions of toxicity distributions in the upper layer of the bay are obtained by combining the two flow rates of the eight discharges and their qualified toxicities with a 2 dimensional dispersion equation. Uptake by phytoplankton appears to be the dominant mechanism reducing toxicitv in the bay. The second mechanism reducing the toxicitv of the waste is dispersion by wind induced current. The results
show that although the most of the factories contributing to the discharges have biological
treatment plants, the treatment is insufficient to eliminate toxicity.

KÖYCEGIZ-DALYAN LAGOON FISHERIES PROJECT

H. Yilmaz, N. Bilecik, E. Buhan

Coastal lagoons are well investigated areas because of their economical and ecological importance. It is possible to improve the productivity of these areas but very susceptible ecosystem balances should not be ignored. Köycegiz Lagoon System. which has got all kind of properties for natural conservation statues includes different ecological zones. This complex lagoon ecosystem's surface area is 5500 ha. In spite of the System's conservation statutes its structure has been degenerating rapidly because of pressures fishing, tourism and agricultural activities. The areas fish productivity has heen gradually decreasing and it has been losing properties of sheltering, spawning and developing environment hy reason of above-mentioned factors and anoxic layer due to eutrophication and H_2S . Lagoon management has been founded on uncorrect bases in the system. Mullet populations and other fish stocks faced important damages caused by the lagoon fishing with only fish-traps and the pressure of overfishing.

Fishing production of Köycegiz Lagoon System is approximately 52 tons/ha/year. Mullet production which forms major part of the Lagoon fishery is approximately 225 tons and constitute 79% total production. *Mugil cephalus* constitutes a big portion of mullet production which has been decreasing rapidly in last years and constitutes species composition with other mullet species like *Liza aurata , Liza saliens* , *Liza ramada* and, *Chelon labrosus*. Although a serious fishery pressure has been determined in the area, according to mortality rate and age compositions, it has been founded that the growth of miillets in the environment is in good condition.
Growth parameters and coefficients, age compositions and mortality rates, condition factors, exploitation rates, spawning times, first maturity ages of above-named five mullet species has been determined on fishes sampled from Köycegiz Lagoon System during the period between in 1993 and 1994 years. 1n addition, suggestions for development of the lagoon management and maximum sustainable fish production have been offered by determining the present lagoon management and some abiotic characteristics of this ecosystem.

Key Words: *Köycegiz Lagoon System, Mullet sp., Growth, Mortality, Reproduction, Lagoon Ecology, Lagoon Management, Fish Production.*

Hydrodynamic Modelling of Vistula Lagoon and Calibration Currents Measurements

B.V. Chubarenko, I.P.Chubarenko, A.V.Sidorenko
P.P.Shirshov Institute of Oceanology, Atlantic Branch, Prospect Mira, 1, Kaliningrad, 236000, Russia

Abstract. The brief hydrographic description and overview of hydrodynamic modelling efforts for Vistula lagoon (shallow water basin on the South-Eastern Baltic coast) are represented. The results of water level, salinity and current structure simulations on the base of 2D model are discussed. The conclusions about sufficient of 2D approach for modelling of water level variations in any time scale and necessity of 3D modelling for resolving of the deep channel influence on advection and mixing processes are made. Also, the demand of 3D approach using for current simulations in synoptic time scale (and less) is pushed forward. The problem of choosing the control current measurements' points for calibration of hydrodynamic numerical model is discussed. It is mentioned that this problem is very important for field work planning because of financial

reasons. The special procedure is suggested for choosing the sites for these points in the study area. It is proposed the mathematical criterion of currents' jetness as the tool for searching the subareas mostly sufficient for its sites. The example of using this proposed technique for Vistula lagoon is done.
Key words: hydrodynamic, modelling, model calibration, current measurements, lagoon, Baltic Sea

Numerical modeling of currents in lagoons for ecosystem dynamics: 2-D or 3-D models?

Vladimir G. Koutitonsky, Ph.D.

Abstract. Lagoons are shallow marine systems which can be vertically stratified as as a result of river inflows, evaporation and precipitation. Winds also play a major role in the dynamics of the motion in a lagoon. Normally, when winds blow along the lagoon axis, currents are set up near both shores in the same direction and, by continuity, a return flow occurs somewhere in the lagoon, generally in a direction opposite to the winds. The hypothesis put foreward here is that, in the case of a vertically stratified lagoon, the return flow may occur away from the surface, that is near the bottom of the lagoon. This hypothesis was tested for Grande-Entrée lagoon, in the Gulf of St. Lawrence, for which current and sea-level observations are available. The MIKE3 three-dimensional (3-D) hydrodynamical model was first used to simulate the vertically-integrated (2-D) currents under prevailing winds blowing along the lagoon axis. Results show that currents are quickly set up in the lagoon near both shores and that a return flow occurs in between. The model was then used to simulate the 3-D current structure in a vertically stratified water column under the same wind conditions. The hypothesis was verified: a return flow does occur at depth, in the deeper basin of the lagoon, and not in the surface layer. This can have significant effects on water renewal in the bottom layers and more generally on lagoon ecosystem dynamics. It is suggested that a 3-D modeling approach should be considered when developping lagoon ecosystem numerical models.
Key words: Lagoon hydrodynamics, 3-D numerical model, wind-driven currents, Grande-Entrée lagoon, ecosystem dynamics.

Application of WASP to Reservoir and Estuarine Modelling

Wu-Seng Lung, PhD, PE

Three applications of the WASP modelling framework to natural water systems are presented. Model configurations in these applications are different due to site-specific water quality problems. Results of the modelling analysis are used in developing strategies for water quality management. Applied to the Upper Mississippi River and Lake Pepin, the WASP/EUTRO code is used to evaluate the impact of phosphorus removal at a wastewater treatment plant. In addition, the fate and transport of phosphorus from various sources are tracked using a numerical tracer. In a study to

examine the role of the sediment, the model is configured to simulate sediment-water interactions in the Norwalk Harbor. The third example presents a W.~.SP-based water quality model for the Patuxent Estuary, driven by a hydrodynamic model.
Evolution of the WASP Model

A MODEL OF MATTER EXCHANGE AND FLOW OF ENERGY IN THE GULF OF GDANSK ECOSYSTEM - OVERVIEW
JAN JEDRASIK

Abstract. A conception of the ecological model of the Gulf of Gdansk is presented. The model includes both the inflow of matter from land and the flow of energy into the environment of the Gulf. The model consists in submodels which solve the following issues: the inflow of solar energy into the sea surface, light penetration into the deeper parts of the sea, river advection, heat balance at the sea surface, production of organic matter, the spread of suspended matter as well as bacteria and three dimensional hydrodynamics. Configuration and short descriptions of these submodels are given.
Key words: matter exchange, flow of energy, Gulf of Gdansk

ERSEM, structure and applications
Job W. Baretta

A short description of ERSEM, the European Regional Seas Ecosystem Model is given and results of several applications are illustrated, demonstrating the flexibility of the model system. ERSEM is a comprehensive ecosystem model, which dynamically simulates the large-scale cycling of organic carbon, oxygen and the macro nutrients N, P and Si over the seasonal cycle in the temperate marine systems. The model consists of an interlinked set of modules, describing the biological and chemical processes in the stratified or non-stratified water column and in the benthic system, as forced by light and temperature. Physical transport can be included by forcing the model with the output of physical circulation and dispersion models or by directly coupling the biogeochemical modules with a hydrodynamical model. This hydrodynamical model can be either 1D, 2D or 3D. The model runs in the simulation environment OpenSESAME, which allows a seamless integration of hydrodynamical and ecological processe