NATO CCMS

VISTULA LAGOON
SVETLOGORSK
KALININGRAD REGION
RUSSIA
Workshop
Report

Dr. Ethem Gonenc
NATO CCMS Study Director

Mr. John P. Wolflin
NATO CCMS Study Co-Director

May 19 – 23, 2004

EXECUTIVE SUMMARY

The NATO CCMS (Committee on the Challenges of Modern Society) Study on Ecosystem Modeling of Coastal Lagoons for Sustainable Management concluded a workshop on the Vistula Lagoon in Svetlogorsk, Kaliningrad, Russia on May 23, 2004. During the Seminar three key components of sustainable management of the Vistula Lagoon were evaluated: ecology biogeochemistry, hydrodynamic and ecological modeling, and management decision making processes. Recommendations for sustainable use and development of the Vistula Logoon were discussed during working groups and are contained in this report.

Dr. Ethem Gonenc from Turkey, Director of the Study, stated that the conference was successful for the exchange of opinions and development of recommendations to promote scientifically based resource management on an interjurisdictional / trans-boundary basis between Russia and Poland. Mr. Zagorski, Deputy Head of the Department for Natural Resources and Environmental Protection of the Ministry of Natural Resources of the Russian Federation in Kaliningrad Region, commented that the NATO CCMS Program and contact between experts within this program may help Russia to assess existing natural resource problems and to fulfill international obligations. Mr. Zagorski called for increased collaboration with Poland and Lithuania on management of the Vistula and Curonian Lagoons and greater involvement with European and American scientists. Representatives from different branches of federal and local environmental authorities shared with participants their views on current problems in the Vistula and Curonian Lagoons. The Port Authority and Luck Oil Company representatives discussed efforts current modeling management actions.

Over sixty scientist represent twelve countries including Russia, Kazakhstan, Kyrgyz Republic, Azerbaijan, Turkey, Italy, Romania, Spain, Lithuania, and the United States were involved in the Seminar.

The NATO CCMS Scientist have been meeting since 1995 with scientists of many countries under the mission of science for peace. It is NATO's intent to enhance stability with programs aimed at establishing and maintaining communications with the scientific elite. The NATO Scientist will be releasing a manuscript entitled: Coastal Lagoons: Ecosystem Processes and Modeling for Sustainable Use and Development in fall 2004. The book is being published by CRC Press, Boca Raton, Florida, USA.

.

21.05. 2004/ Svetlogorsk/ Russia ***A. Vadineanu***
NATO- CCMS workshop

Working Group: ECOSYSTEM AND BIOGEOCHEMESTRY

A - A group of twelve senior and young scientists, most of them working on the hydrobiology and ecology of Vistula lagoon, have attended the discussion which was focused on the "Ecosystem and Biogeochemistry" approach for development mathematical models as tools for sustainable use and adaptative management.

B - **Goal:**

i) to assess and identify in what extent this approach was applied and the historical ecological data have been used for mathematical modeling of Vistula lagoon?

ii) What have been achieved? And in what extent? they are used as tools for policy and decision making process or the adaptative management of the local socio-ecological complex to which Vistula lagoon belong (! Space scale equivalent to the catchement area);

iii) Which type of gaps and shortages in the ecological data and information's concerning Vistula lagoon, have limited the implementation of this approach? Which other constraints have had the impact?

iv) What measures are required? And how to be implemented?

C - Brief comments: (Synthesis of the discussion)

i) * Mathematical modeling has been applied successfully only for understanding and description of hydromorphological and physico - chemical dynamics of the Vistula lagoon. The developed models are available and they can serve for both managerial activities and ecological investigations. However, these type of achievements which are crucial for ecosystem modeling and ecosystem management, are not properly used. The reasons are explained in the report of WG which delt with modeling.

** Due to many reasons the modeling of changes in species composition, of tropho- dynamic structure and of the ecological processes are missing.

Among the limiting factors which explains the current situation, the following have been listed: lack of interest of the both scientists and users; very sectorial way of investigation; lack of some type of data concerning the processes; lack of appropriate financial resources to support an expensive research of this type; limited cooperation among experts, teams and institutions.

*** However, ther'are a huge bulk of data concerning changes in the structure (species composition, population size, biomass Chla, spatial distribution) of primary producers, zooplankton and benthic communities which has been accumulated since many years. These

data have been correlated with those describing the dynamics of physico - chemical properties in order to bring proves about eutrophication of the lagoon. They can also be used for formulation the general tropho-dynamic model and to calculate different indices like: biodiversity index or BII (Biological Integrity Index)

ii) Hydrobiological and ecological data have been used (especially Chla, primary production and phytoplankton's species composition) for water quality assessment in the last years. As was stated before, even existing data which describes major changes occurred in the trophic structure are not properly integrated in some potential mathematical models (meaning is in this case that they are not used for testing and validation some of the existing models) which can after be used as efficient tools in supporting decision making by different users of the lagoon's resources.

However, this type of historical data could very valuable for defining the reference state of the lagoon and the trend of its dynamic. More than that, it might be considered the opportunity for adding to these valuable data, those compiled from literature about the functioning role of dominant species. On this way the main functions (e.g. production and regulation functions) and respective services might be roughly estimated. Further, these type of data would serve for economic valuation of the Vistula lagoon at the reference and current states and would indicate on costs and benefits of the past management.

Unfortunately, these data have not been used in the policy and management plan development for land use and economic development within the catchment area, in order to control the pressure of main driving forces.

iii) One of the main constraint for applying the ecosystem approach and adaptative management in order to proper tackle most critical issues (e.g. Eutrophication of the Vistula lagoon; structural changes by opening new canals and building new ports; intensification of water transport; establishing new oil terminals; sewage discharges from Kaliningrad city and industry; unregulated tourism; increased probability for oil spills) the region are facing and to achieve the goal for: a) rehabilitation of ecological integrity of the lagoon system; b) sustainable use of resources and services provided by the lagoon and; c) development of the local economy and assuring social security , is related to the absence of **well structured and accessible data base**.

- Lack of data concerning major ecological functions and processes;
- Fragmented operational infrastructure (within the Kaliningrad region and among russian and polish authorities);
- Weak cooperation among research institutions, teams and experts on one side and among scientists and decision makers on the other side.
- Ther'are no correlation's among driving forces and pressures which operate at cachment scale and recorder ecological changes from Vistula lagoon.
- Ther's not yet a structured knowledge based consisting in a package of ecological models (in mathematical terms formulated) which might form together with the "date base" the

information system describing the structural and functional dynamics of Vistula lagoon under the pressure of major driving forces from its cathement.

iv) Suggestions:

- Ecosystem modeling of the Vistula lagoon should take into consideration a good ecosystem identification. That should include: a) the physico -chemical compartment or hydro-geomorphic unit (UHGM); b) the tropho-dynamic structure of biological community; c) species composition; d) main processes (e.g. nutrient or other chemical cycling; energy flow; resilience) and ecosystem functions (production, regulation, support and information/cultural); and e) the external driving forces and pressures acting at the catchment scale.
- The current and previous monitoring activities carried on Vistula lagoon should be adapted and improved according with the needs for integrated and adaptative management. That should be done based on close cooperation among polish and Russian scientists, managers and decision makers. However, in addition to monitoring activities should be designed and implemented joint extensive and intensive research programme which have to feed and fill up the identified gaps in the knowledge base.
- The designed common data base and knowledge base should rely on the integration of all historical data and information's deposited by different institutes, institutions or research teams, about the lagoon ecosystem's dynamics and past and current policies and management plans, from both countries which shares the lagoon and its catchment area.
- After filling up the designed data and knowledge base with historical and quality assessed data and information's, the first version of the information system to support integrated and adaptative management of the Vistula lagoon should be available for the users. Moreover, the gaps and shortages in data and knowledge could be identified and that will help to focus data collecting (monitoring) and research.
- Data and knowledge should be effectively made available for decision making and scenarios development through a package of dynamic mathematical models describing structural and functional changes in the lagoon, under different driving forces and pressures. Ther's a need for mathematical models of different complexities in order to meet the wide range of requirements for decision making (e.g. specific models for water quality; dynamics of fish resources; but also complex models able to describe the overall lagoon processes under major driving forces);
- The assessment of the lagoon's economic value (TEV - total economic value) is a fundamental condition for decision making;
- Ecologists and ecological modelers have to plan in advance a common working programme which takes into consideration: types of required data (parameters and state variables); methods for data collecting; data quality assessment etc.
- Networking among research institutions, research teams, end users, policy makers.

Report on the Vistula Lagoon

The Modeling Group, LEMSM

G. Umgiesser,

A. Aliyev, B. Chubarenko, I. Chubarenko,

L. Davulienė, M. Golenko, J. Kazmierski

Short description of the Vistula Lagoon basin

Vistula lagoon (Fig.1) is located in the south-eastern corner of the Baltic sea. The lagoon represents a long bay, extending from south-west to north-east for 91 km. The average width of the lagoon is about 9 km, the maximum 13 km. The surface area is 838 km^2, of which 472.5 km^2 belongs to Russia, and the other part to Poland. The length of the coastline is about 270 km, the average depth is 2.7 m, and its maximum 5.2 m.

The Vistula lagoon is separated from the Baltic sea by the Vistula spit - a sandy bank with a length of 55 km - and communicates with the Baltic sea by a strait 400 m wide. The artificially deepened mouth of the river Pregel is linked to the Baltic by the Kaliningrad Ship Channel with depths of 8.5 m. The dredging works are annually carried out. It is partially protected from the lagoon with a number of artificial islands. The openings between the islands are only 10-30 m wide and 0.5 - 1.5 m deep.

Fig. 1: The Vistula lagoon

Data availability for the Vistula Lagoon

Bathymetry data is available good enough to make a fine resolution grid (50-100 m grid cell) for the entire lagoon and Kaliningrad Navigation Canal (20-40 m grid cell).

The existing coastal monitoring network (Fig. 2) comprises 7 water level points, 3 points of water quality measurements and 3 points of meteorological measurements. Four grid points of the regional meteorological model HIRLAM cover the lagoon area.

Existing monitoring network for water quality in lagoon comprises 10 points on the Russian side and 10 points on the Polish side. Russian monitoring stations follow the deeper parts of the lagoon and are situated along main lagoon axis. Polish monitoring stations are along the coast of the lagoon.

Historical data sets of hydro-meteorological coastal stations exist for the period starting in the 18th century for the lagoon inlet, and from 19th century for the Pregel river mouth and central part of the lagoon. Data for lagoon water quality collected in a regular way is starting from 1970 .

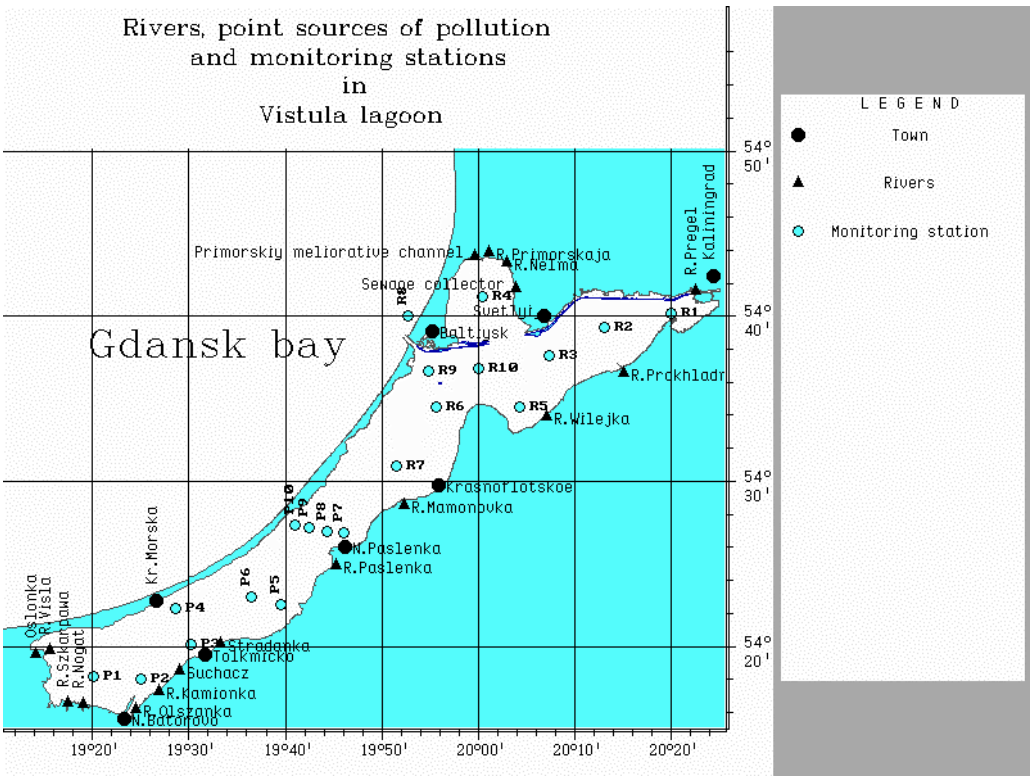


Fig. 2: Monitoring stations in the Vistula lagoon

Capacity of modeling teams

Several computer models for the Vistula Lagoon exist or were used in the past by different institutions in the area:

- Atlantic Branch of P. P. Shirshov Institute of Oceanology, Russian Academy of Sciences and Kaliningrad Department for Natural Resources and Nature Conservation: MIKE21 2D horizontal model (hydrodynamic, transport and eutrophication modules).
- Atlantic Branch of P. P. Shirshov Institute of Oceanology, Russian Academy of Sciences and Kaliningrad Center for Hydrometeorolgy and Environmental Monitoring: MIKE11 1D river-network model (hydrodynamic, transport, water quality and runoff-rainfall modules).
- Kaliningrad State University: current applications of a principal 2D vertical baroclinic model to inlet water exchange problems and principal catchment model for nitrogen dynamics in the Pregel river basin considering the land use.

- GEOMOR and Regional Management Board (Poland): MIKE21 (hydrodynamic, transport, water quality and eutrophication modules).
- Institute of Hydro-engineering of Polish Academy of Sciences – 2D finite difference personal scientific model (personal scientific model of R. Szymkiewicz was applied in 80th) and Delft3D FLOW module (was applied during 2003).
- Institute of Oceanology of Polish Academy of Sciences (personal scientific model of A. Jankowski was applied in 80th).

The following principal international projects, which were devoted to or contain the numerical modeling component, were executed in the area:

- Danish-Polish-Russia project "Prioritizing Hot Spot Remediation in Vistula Lagoon Catchment: Environmental Assessment and Planning for the Polish and Kaliningrad parts of the lagoon" in 1994-1997: implementation of MIKE21 hydrodynamic, transport and eutrophication modules, training of personal, assessment of scenarios.
- TACIS ENVRUS 9803 Project "Water monitoring and management in the Kaliningrad Oblast" in 2000-2002: MIKE11 1D river-network model (hydrodynamic, transport, water quality and runoff-rainfall modules), introductory training of personal, demonstration simulations of salt wedge dynamics and assessment of scenarios.
- MANTRA-East "Integrated Strategies for the Management of Trans-boundary Waters on the Eastern European fringe" extended by additional Vistula Lagoon case study, 2003: application of MIKE21 (hydrodynamic, transport and water quality modules) and Delft3D FLOW module for assessment of scenarios of water quality improvement.
- Environmental Impact Assessment of new port developments in Ust-Luga and Kaliningrad (Russia), EBRD, 2003: MIKE21 (hydrodynamics, sediment transport modules) was applied for impact assessment of maintenance and port development (dredging).

Innovative modeling and resolution of physical processes

Progress in understanding of the ecosystem functioning, links between physical, chemical and biological processes is coupled with advances in modern computer tools and techniques. This raises the question of corresponding improvement of operational models and models used for management purposes. These models are supposed to resolve more and more complicated processes, to embrace wider ranges of relationships and to deal with more complex problems.

Several processes in the Curonian and Vistula lagoons were pointed out. For the Vistula lagoon, the water exchange with the Baltic sea should be resolved more accurately and described in terms of inflow/outflow events, with their own (different) mixing features. Additionally, sea water transport upstream the Kaliningrad marine channel has to be taken

into account. A sediment re-suspension is of importance for biochemical processes in both the Vistula and Curonian lagoons. Structure, composition and pollution density of bottom sediment must be included in both physical and chemical and biological modeling.

However, model complexity causes difficulties in its use and significant increase of data required for calibration, verification and operation of it. A management practice indicates some ways how to balance these contradictions. Conceptually, there are several ways of possible development of environmental modeling today. Most probably, the future is in the development of systems of linked models, responsible for simulation of more and more fine processes in detail. One methodology, applied already in many such systems, is to develop several separated modules (or models), working one after another, providing the flow of information from background physical processes through simulation of chemical features to biological characteristics. They are rather flexible and can be adapted to both

- very accurate simulation of particular process (or particular small areas) and
- very wide range of (averaged) processes.

An alternative methodology is the development of coupled models, which exchange information after a certain number of time steps. They are also structured as separated modules, calculating different processes, and can be adapted to specific needs by additional programs.

Modern environmental models deal with large water bodies, catchment areas etc., i.e., with large-scale objects. So, not only direct contact measurements, but also remote sensing data can be widely used, especially for large-scale forecast simulations. Various institutions have data banks and services for remote sensing data handling, which display via Internet an information on surface temperature, water level variations, etc.

Similarities and differences between the Vistula and the Curonian Lagoon

Both lagoons are shared by two countries that makes monitoring difficult. Data exchange is also not regulated.

The connection between the Curonian lagoon and the Baltic Sea occurs thought the Klaipeda Strait, which is several kilometers long and has a width of 400 to 800 m. The only Lithuanian port is situated in the Klaipeda Strait and large economically important actives are going on there. Therefore modeling of the Klaipeda Strait is of great importance for the port administration (and Lithuanian authorities). It was done using. MIKE21 hydrodynamic and transport modules were applied, for example, before performing dredging activities in the Klaipeda Strait.

In case of Vistula Lagoon the port is situated in the lagoon and the port administration is also recognizing the importance of modeling results in a decision making process. The artificial ca. 40 km long channel partly separated from the lagoon by artificial islands and connecting the

Baltiysk Strait with the port situated in the mouth of the Pregel River is one of the challenges to model.

MIKE 21 was applied for the Vistula Lagoon, also for Klaipeda Strait. MIKE21 was not applied to the Curonian Lagoon itself. Personal scientific model (on the basis of a finite element approach) was applied to the Curonian Lagoon only for scientific estimation of current structures during western storm (Irina & Boris Chubarenko, 1995).

No operational models in both cases exist. However the Marine institute in Gdansk, Poland, has started setting up the operational model of Vistula lagoon using HIROMB data at the open boundaries and HIRLAM data for forcing. This is not the case for the Curonian Lagoon.

Modeling of the Curonian Lagoon was interesting only for some scientific groups so far. Two models exists:

- the BSHcmod for Lithuanian coastal waters, using data of the regional model for the North and Baltic Seas (known as BSHcmod and closely related to the HIROMB model) and
- SHYFEM finite element model developed in collaboration between Klaipeda University and ISMAR-CNR, Italy.

The similarities of the lagoons are:

- Shallow waters – in average ca. 2.5 – 3.5 m deep, maximum does not exceed 5.5 m.
- One connection to the Baltic Sea – channel 400 m width.

The main basic hydrographic differences which leads to many consequent differences at hydro-chemical and hydro-biological levels are:

- The Curonian lagoon hydrology is completely controlled by river the discharge of the Nemunas rivers, while the Vistula Lagoon is under influences of both water exchange with the Baltic Sea and fresh water flux.
- The Curonian Lagoon is practically fresh and may be considered as a running lake, while the Vistula Lagoon has an intermediate salinity (2-4 psu in average).

Problems

In this section some problems are listed that are specific to the Vistula lagoon and the application of models. These problems concern:

General problems

- The Vistula lagoon is a trans-boundary lagoon. The lagoon itself as well as some enterprises and water treatment plants in the lagoon catchment are included in the HELCOM list of prioritized “hot spots” for the Baltic Sea.

- The Vistula Lagoon is used for different purposes: transportation (oil, dry cargos, containers, ferry connection), fishery and recreation. The Kaliningrad Navigation Canal is a hydro-technical construction which plays a main role in water dynamics of the lagoon. It is a reason of "conflicts" which together with trans-boundary issues makes the Vistula Lagoon management a real challenge. To balance national and regional interests and to avoid the conflicts a joint comprehensive international management plan is needed.
- Eutrophication of lagoon water is rather high, blooms of different species of phytoplankton start in spring and continue until the beginning of autumn. Eutrophication as a problem is mostly connected with poor water treatment in the catchment area and diffusive agricultural sources. The diffusive load is a main problem both for management and inclusion in modeling.

Information and data problems

- Joint monitoring does not exist now. All problems arising from data collection and exchange, measurement campaigns and joint activities must be solved before on the political level. An international committee should be set up that could solve arising problems in coordination of these activities. The fish stocks are stable and are determined by nowadays levels of eutrophication and salinity regime.
- In spite of many data were collected for the Vistula Lagoon, it is spread among different organization and only few years (1994-1995 and 1998-2000) of complete data set needed for hydrodynamic and water quality simulations were compiled during joint Polish-Russian projects.

Modeling problems

- Input data is known with different accuracy. The data on water level and wind variations are known very well, discharge data (river input) is known not for all rivers and on the basis of hydrographic calculations on the basis of level variations. The most problematic data are about nutrient load from point and diffusive sources in the catchment. These data must be provided in order to successfully model the Vistula lagoon.
- The open boundary specification is another problem when numerical model is applied to the lagoon. These boundaries can be specified in the open sea, which enables the model also to solve coastal problems, and in the connecting channel, where data is measured and therefore more reliable and more frequent. However, in this case exchange processes cannot be modeled adequately.
- From the scientific point of view models can describe the basic phenomena of the lagoon. The logic of model development force scientists include in the model more and more details. Finally it makes model too complicated and data consuming.

However, decision makers are very often overwhelmed with information of this kind. An easy way has to be found to aggregate and simplify that information in a way that the agencies can work with this data. Applied models s a tool for management should be constructed in view of the necessities of the environmental administration.

- Models as a management tool were only poorly applied for the Vistula Lagoon. The capacity of scientific and consultancy groups in Poland and Russia is high enough to be deeper involved in the process of evaluation, impact assessment and forecast of the environmental situation.

Conclusions and recommendations

General recommendations

- Modeling is recommended as a powerful tool for impact assessment of scenarios of socio-economic development in the catchment area and of harbor, industrial and construction activities along the lagoon coast. Even if the advances in modeling applications in the Vistula Lagoon are obvious, the modern level of water management have not yet taken them into account.
- Modeling makes sense in forecast assessment of short- and long-term changes in the lagoon water quality under natural condition, especially in the assessment of consequences of climatic changes, which became very obvious in the region. The models are the tool which allows quantitative impact assessment in the Vistula Lagoon.
- Due to the trans-boundary status of the Vistula Lagoon a unification of modeling tools is recommended. It permits environmental authorities in Kaliningrad region and Poland to communicate at the same level of understanding, it will provide a vital force for development of a common data base and will guide the process of monitoring and data collection.

Monitoring

Monitoring of physical and biochemical properties is important for the scope of numerical modeling. The most important quantities to monitor are

- water level variations around the lagoon coast (not less then 6 times per day), and especially continuous (hourly) measurements at the lagoon inlet
- river discharges on daily basis for main rivers
- temperature and salinity (continuous at open boundary, weekly or monthly in the inside), as well as the vertical structure of these parameters (if possible)
- water quality variables (monthly inside the lagoon, but more frequent for river loading)

- meteorological parameters such as wind, radiation, air temperature, humidity, precipitation and evaporation, etc. (4-6 times per day, wind – hourly)
- regular collection of remote sensing data (aircraft or satellite images)

The quality of data should be checked continuously. Especially important are the regular calibration of the sensors (water level, T/S, wind) in order to provide reliable boundary conditions for the model. The sampling points should be representative for the variables measured.

Long term scenarios

In general 2-D models will be sufficient for analysis of consequences of pollution in the Vistula lagoon. Exceptions may concern the vicinity of the connecting strait. An approximate resolution of 1 km would be acceptable for these applications. This would be a compromise between the spatial resolution to be achieved and the temporal dimension that can be explored (seasonal variations during several years).

The problem of sediment transport, erosion and deposition is to be described by suitable models. This is especially important for lagoon inlet, Navigation Canal and coastal protection.

Problems might arise with exceptional events that cannot be modeled by this type of applications. In such cases it is possible to apply short-term operational models and only in a second moment the results of the model could be aggregated for including them into the long-term scenario.

The models could be used in the administration of long-term pollution, fishery management and quantification of the Total Daily Maximum Loading (TDML) for the lagoon. To estimate this load the water quality objectives and "reference conditions" (in terms of values for parameters) have to formulated.

An application of watershed models for the drainage basin with the integration of land use data and waste loads is recommended for the estimation of the loads from the land towards the lagoon.

Operational models

For the operational models available frameworks should be used. In the case of the Vistula lagoon this framework consists in coupling the local model with the available HIRLAM atmospheric model (Swedish Met and Hydrologic Institute, SMHI) and the HIROMB Baltic Sea model. These models provide the local model with the necessary boundary and initial conditions, both as hindcast and forecast (48 hours).

The local model should be integrated seamlessly into this framework in order to produce flood and storm warnings, forecast possible oil pollution at the coast and inside the lagoon, and help with rescue operations and lost dangerous items. In the case of simulations concerning short term analysis 3-D models would be more appropriate.

Coordination of activities

Data collection, to be useful for modeling work, should be uniform in time and space. This means that monitoring activities from different countries should be carried out in a way that the density and location of the network of data points are comparable and are taken during the same periods. Methodologies of sampling should also be uniformed across institutes and countries.

Dissemination of information

It is recommended to publish the papers presented during the seminar as proceedings and to include a preface from the NATO CCMS Pilot study, the welcome speeches with mentioning of real problems of the area, and the recommendations of the NATO CCMS group.

Report of the Decision Making Working Group for the Vistula Lagoon Workshop, Svetlogorsk, Kaliningrad Region, Russia, May 2004

Decision Making

The purpose of this report is to suggest a basic framework for making informed decisions and taking positive actions for sustained use and development of the Vistula Lagoon. Russia and Poland both have conventional decision making processes, although the countries differ on the level of authority provided and exercised at federal and regional levels of government. There is an interjurisdictional / trans-boundary agreement(s) for management of resource uses and issues. They address management of transportation, water quality, fisheries, environmental protection, and others.

However, the key missing element for informed decision making and taking positive actions for sustained use and development is a Catchment / Watershed Area Organization. Such an organization is recommended and should include: (1) regularly scheduled meeting for technical work; (2) consistent membership / involvement of individuals on technical work groups; (3) a formal working group at the Policy Level that meets regularly; (4) involvement of top leaders for each Country in establishing goals for sustained use and monitoring program implementation; and (5) stakeholder involvement.

Terms and Principles

Terms and Principles to be applied in implementing sustainable use and development practices:

1. Sustainable management is managing to meet present needs as well as providing for future generations to meet their own needs. Conceptually it requires the awareness and consideration of the ecological system. It, also, requires measurement of, and accountability of the values that an ecological unit, such as the Vistula Lagoon and its catchment / watershed area. It, further, requires measurements of and accountability for the values that the ecological unit provides to society.

2. Sustainable management is a conscious social decision that provides for the long term health of both the ecological and economic systems of the ecological unit. The finite capacity of the ecological unit's natural capital can not meet the growing demands of society without a plan for sustainable management.

3. The use of the best available information, knowledge, and tools needs to be infused throughout the decision making process. A monitoring program is a key factor in management for sustainable management.

4. The use of models as tools in the decision making process will enhance awareness of the interrelationships within the ecological unit, especially its input and output variables. This will further enhance accuracy of predictions for, and awareness of the consequences of decision on management actions.

5. Decision making should involve all interested parties including government (federal/national, regional, and local), non-government organizations (NGO's), scientific institutions, business users groups and industry, agriculture, and tourism, and general public.

6. Management of decision making requires a formal cooperative institutional structure (CIA) that is empowered through appropriate policy and legal authority.

7. The CIA should have a written Charter or Agreement that commits the parties to work cooperatively to address the goal of sustainable use and development of the natural capital.

8. A conflict resolution process should be identified that provides ample and open consideration of differing view and interests.

9. Environmental education is essential in order to insure long-term sustainability of a participatory process. Education should be at two levels: (1) public awareness of the problems of the environment, especially the linkages between catchment area/watershed activities and consequences on the downstream water body and; (2) formal education of young people in order for them to understand the central role of the natural environment in their future welfare.

Recommendations

The following recommendations are respectfully provided as guidelines. They are based on successful work directed at sustained use and development of natural capital / resources in interjurisdictional / trans-boundary situations. It should be recognized that in different countries with different cultures the recommendations may need to modified to address unique interests of those involved.

1. Establish a Cooperative Institutional Structure (CIS), empowered through appropriate policy, legal, and financial instruments. An example is provided in Appendix 1.
2. Establish a Charter, a formal Letter of Agreement that commits cooperation between National and Regional governments. The signatories should be at the highest levels of the respective governments, and this group will serve as an Executive Committee.

` (Existing Agreements need to be inventional and referenced as basic tools for guiding management decisions.)

3. Establish a Policy Committee and identify specific staff to service and manage the CIA. The Policy Committee will identify policy / legal needs and seek consistency in management of trans-boundary issue. The staff needs to include experts in lagoon management and conflict resolution. The Policy Committee also should serve a functional role in directing representatives from the technical working groups (noted below) priority work issues.
4. Establish Technical Working Groups. The following working groups are recommended: Water Quality, Nutrients, Toxics, Hydrologic, Hydrobiological, Coastal Monitoring, Fisheries, Exotic/Invasive Species, Dredging, Migratory Birds. Working Groups should be established to address local needs and national interests. These groups will establish plans to address agreed upon (at Executive and Policy Committee levels) goals and objectives. These groups also will recommend goals and objectives to Executive and Policy Committee for adoption.
5. Establish Advisory Committees for the general public (citizens), scientific and technical interests, local governments, and non government organizations (NGO's). Other Advisory committees also may be appropriate to meet local interests and needs.
6. Invite stakeholder involvement from all businesses that have an interest in Vistula Lagoon and its catchment / watershed area. This should include representatives from industry, agriculture, fisherman, tourist industry (developers and managers), and others.
7. Hold Round Table meetings at each level of the CIS on a regular basis. For example:

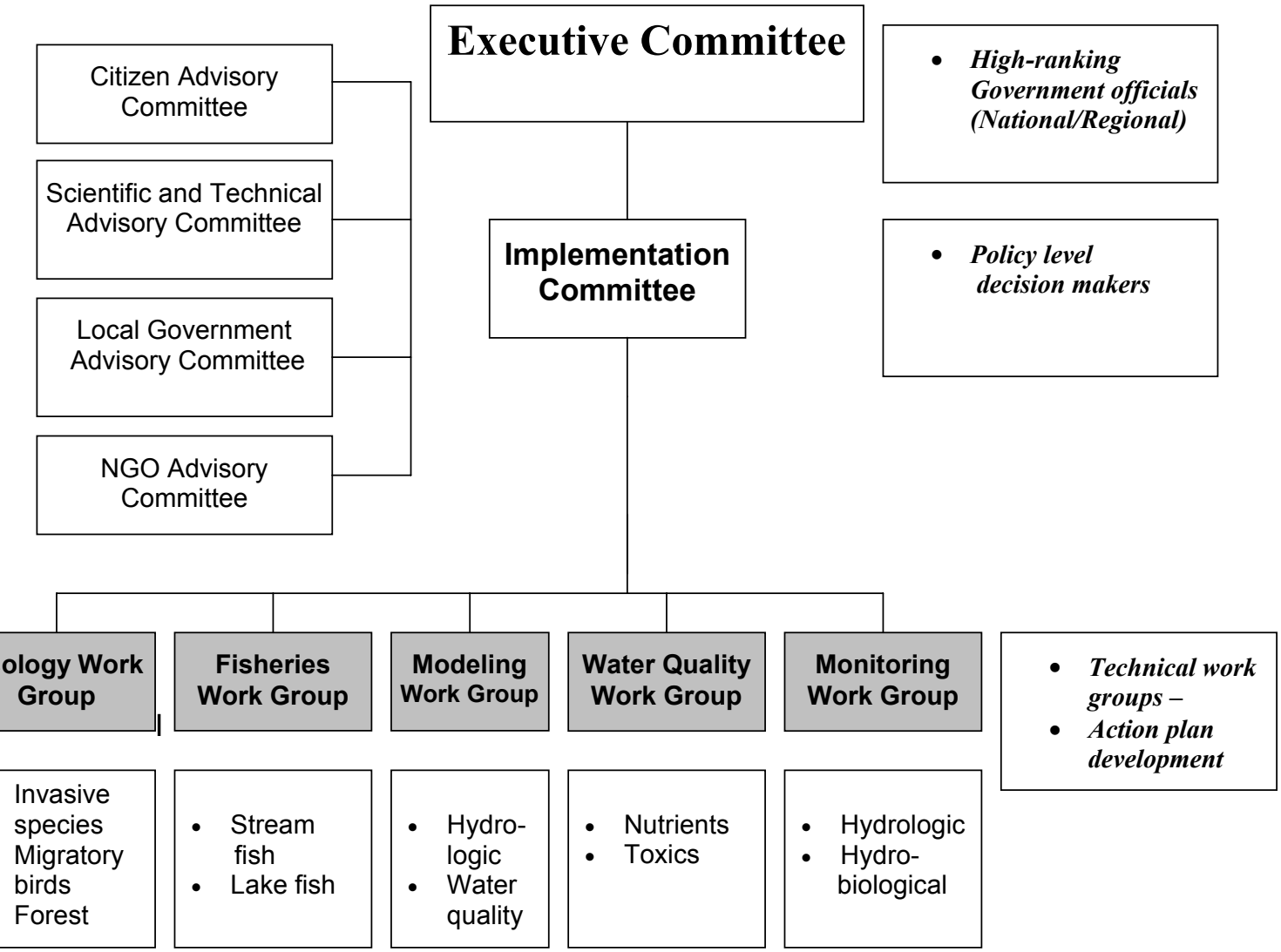
- Executive Committee – Annual
- Policy Committee – Semi-annual
- Working Groups – Quarterly

8. Facilitate decision making process by modern and joint tools for trans-boundary management, like united data base and modeling tools for impact assessment. Establish procedures of data base replenishment and access to data base resources as well as exchange of information for environmental impact assessment and operational needs.
9. Establish a formal dispute resolution process. Differences of opinion need to be elevated to higher authority within CIS to ensure that sectorial competing interests for national capital are fully considered.
10. Establish an environmental education program directed at (1) public awareness of the problems of the environment, especially the linkages between catchment / watershed area activities and consequences on the downstream water body(s) and; (2) formal education of young people (education curriculum for primary and secondary levels) in order for them to understand the central role of the natural environment in their life and life of future generations.
11. Establish a planning process. The planning process can be simple. It can be described as the following seven step process on components listed below:
    1. Set the goals for sustainable use and development of the Vistula Lagoon and its catchment area / watershed.

2. Define problem(s) – describe the problems/conditions that affect the Vistula Lagoon ecological and social-economic structures.
3. Define the system – Vistula Lagoon's ecological and socio-economic structural components.
4. Develop and use an effective decision support system, a CIS.
5. Develop and integrate this plan into the infrastructure by function (committees and workgroups of the CIS).
6. Formulate Action Plans to address identified needs for information, policy, and legal framework..
7. Evaluate progress on a regular basis (at least annually by the Executive Committee and Policy Committee).

Conclusion

Russia and Poland should take great pride in the level of collaboration that is occurring. The recommendations provided are suggested as guidelines to improve their working relationship. Specifically, to improve the effectiveness and efficiency of decision making on interjurisdictional / trans-boundary issues for the purpose of sustained use and development of the Vistula Lagoon.

Attached is a list of participants in the Decision Making Working Group at the Vistula Lagoon Workshop, Svetlogorsk, Kaliningrad Region, Russia, May 2004.

Appendix I
Sample Cooperation International Structure