

*GEF BALTIC SEA REGIONAL PROJECT
PHASE 1: 2003 – 2005*

BSRP REMOTE SENSING QUESTIONNAIRE

SUMMARY OF RESULTS

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BSRP Large Marine Ecosystem Component implemented by:
International Council for the Exploration of the Sea

1 REMOTE SENSING OBJECTIVES IN THE BSRP

The Baltic Sea Regional Project (BSRP) aims to strengthen ecosystem based management in the Baltic Sea region. The project is part of a series of Large Marine Ecosystem projects funded by the Global Environment Facility (GEF) through the World Bank.

The overall goals of the BSRP are to

- develop and apply an ecosystem based management strategy to the Baltic
- strengthen regional institutions through capacity building efforts
- assess and evaluate the socio-economic effects of ecosystem-based management for farming, fishing and coastal communities
- inform and engage stakeholders and decision-makers on ecosystem-based management

The BSRP aims to operationalize monitoring and assessment in the Baltic Sea region. Cost-effective strategies, for example ships of opportunities, should be established, and data should be analyzed taking into account also remotely sensed information. Currently, two coordination centers could support remote sensing activities in the BSRP.

- GIS Coordination Center (CC GIS)
The GIS Coordination Center is responsible for handling spatial information and aims to establish accessible archives of GIS and remotely sensed information for use in the BSRP.
- Productivity Coordination Center (CC PROD)
The Productivity Coordination Center is responsible for activities concerning the lower trophic levels (phytoplankton, zooplankton). Remote sensing could provide a cost efficient strategy for phytoplankton monitoring.

A questionnaire (appendix 1) was developed in summer 2004 and distributed to organizations involved in monitoring and assessment of eutrophication in the Baltic Sea to query the current use of remotely sensed information, main obstacles encountered, future plans, and the type of support that should be provided. 10 organizations responded, 9 returned questionnaires, 6 of them from the BSRP beneficiary countries, and 3 institutes active in using remote sensing for Baltic Sea environmental assessment.

Responding organizations:

- Estonian Marine Institute (EMI, Estonia)
- Institute of Aquatic Ecology, University of Latvia (IAE, Latvia)
- Center of Marine Research (CMR, Lithuania)
- Institute of Ecology, Vilnius University (VUIE, Lithuania)
- Institute of Water Management and Meteorology (IMWM, Poland)
- University of Gdansk (UG, Poland)
- Kaliningrad Center for Hydrometeorology and Monitoring Environment (KCHME, Russia, e-mail communication)
- Finnish Institute of Marine Research (FIMR, Finland)
- Finnish Environment Institute (SYKE, Finland)
- Joint Research Center, Inland and Marine Water Unit, Institute for Environment and Sustainability (JRC, EU)

2 QUESTIONNAIRE RESULTS

2.1 PARAMETERS INVESTIGATED BY REMOTE SENSING

Among the responding institutes, the application of remotely sensed data is most developed in the “western” countries – at FIMR, SYKE, and the JRC. Two institutes from the BSRP beneficiary countries, EMI and IAE, as well as the Kaliningrad Center of Monitoring Environment (e-mail communication) do not use satellite information. CMR uses information published on the internet by other institutions or available on personal request from SMHI, FIMR, or the BOOS/PAPA network.

Remotely sensed information (Table 1) is mainly used for the analysis of chlorophyll *a* and monitoring of algal blooms. Often, also sea surface temperature information is derived from satellite data. Less frequent applications include assessment of turbidity, oil spill monitoring, and in institutes concerned also with navigation/meteorology, sea ice mapping. IEVU, which hosts the BSRP GIS Coordination Center, uses remotely sensed information for terrestrial applications (land cover, habitat mapping, ecological analysis).

	EMI	IAE	CMR	IEVU	IMWM	UG	FIMR	SYKE	JRC
Sea Surface Temperature			√		√	√		√	√
Chlorophyll <i>a</i>			√		√	√	√	√	√
Location and spatial extend of algal blooms			√		√	√	√	√	√
Turbidity						√		√	√
Oil spills								√	
Ice			√		√		√		√
Other				Land cover, habitat mapping, ecological analysis	ice service, marine meteorology service			land cover, snow covered area in spring	water optical properties in general
No use of remotely sensed data	√	√							

Table 1: Parameters investigated by remote sensing

2.2 PURPOSE OF REMOTELY SENSED INFORMATION

All institutes actively using remotely sensed information use the data both for research purposes, as well as for environmental assessments (Table 2, shown are only institutes using remotely sensed information). Assessments are either case-based, national, or on the scale of the entire Baltic Sea. IMWM plans, within the frame of recent EU projects, to use remote sensing as an additional source of information within national marine monitoring of the Baltic Sea.

	CMR	IEVU	IMWM	UG	FIMR	SYKE	JRC
Research	√	√	√	√	√	√	√
Case-based assessments (e.g. environmental impact assessments)		√				√	
National assessment of marine eutrophication/pollution						√	
Assessment of marine eutrophication/pollution for the entire Baltic Sea	√				√		√
Other		Applied ecology projects	Ice service, marine meteorology service, environ- mental use planned		Ice service for com- mercial ferries		Support to EC policy- making process

Table 2: Purpose of using remotely sensed information

2.3 APPLICATION OF REMOTELY SENSED INFORMATION IN ASSESSMENTS OF EUTROPHICATION/POLLUTION

IMWM, University of Gdansk, CMR, FIMR, SYKE and JRC gave examples of the use of remotely sensed information in assessments of eutrophication/pollution (Table 3). Satellite information is used at different stages of assessment, focusing mainly on phytoplankton/algal blooms. SYKE produces daily maps of algae and sea surface temperature, which are used as operational information by environmental authorities. JRC uses remotely sensed information on synoptic scales for the assessment of the EU seas. FIMR stresses the use of Ship-of-Opportunity data for calibrating/validating satellite based chlorophyll *a* maps. Many responders also emphasize, that cloud cover often limits the availability of satellite information in the Baltic Sea.

IMWM	Module for Internet Monitoring Information System to allow end users to compare chlorophyll <i>a</i> distribution as obtained from the images against in-situ measurements (frame of OROMA project), planned to be continued in the future. Verification of algorithms Main obstacle: cloud cover in summer, but a unique dataset for Gulf of Gdansk was collected
CMR	Remotely sensed information was used for assessment of eutrophication and pollution of marine environment in preparing of national reports and in some articles

UG	<p>1) verification of 3D ecological model of the Baltic – computation of sea surface temperature and photosynthetically active radiation flux at the sea surface are checked against or calculated with the use of remotely sensed data (thermal infrared and visible channels of AVHRR, SeaWiFS and Meteosat)</p> <p>2) investigations of harmful algae blooms – AVHRR and SeaWiFS data are used for calculations of spatial range and intensity of the phenomenon (these investigations are rather in very preliminary stage)</p>
FIMR	<p>The spatial distribution of chlorophyll-a was estimated with Modis Terra/Aqua during July-August 2004. Chlorophyll-a was validated against algaline in situ measurements.</p> <p>Benefits: synoptic estimates for the whole Baltic.</p> <p>Shortcomings: not so many clear sky days during the summer 2004.</p>
SYKE	<p>Remotely sensed information is used on daily monitoring of the environment as SST and algae bloom maps are provided to the users via website. Daily processing of AVHRR and MODIS data gives the opportunity to provide near-real time information on temperature and blue-green algae blooms. Environmental authorities use it as additional information along with in-situ measurements. Benefits are the regional coverage and near-real time availability. Shortcomings are the cloud cover which hampers the use of passive satellite instrument data.</p> <p>Links to websites: http://wwwi4.ymparisto.fi/i4/eng/sst/2004/sst_suomi_kalenteri_04_vari_eng.html http://wwwi4.ymparisto.fi/i4/eng/algae/2004/algae_eng_04.htm</p>
JRC	<p>assessments have been made regularly, for many years, in support of the EC policy-making process, for all EU marine basins; mostly optical data are used, coupled to in situ observations for cal/val purposes; main benefits are uniqueness of information derived and possibility to cover ALL EU Seas effectively and at very low cost; shortcomings the typical limitations imposed by optical RS techniques (cloud cover, spatial and depth integration, possible confusion of optically active materials, etc)</p>

Table 3: Application of remotely sensed information in assessments

2.4 TECHNICAL AND ANALYTICAL CAPACITY

2.4.1 SATELLITES AND SENSORS

Most institutes process data from a variety of satellites and sensors (Table 4). CMR uses information published on the internet by other institutions or available on personal request from SMHI, FIMR, or the BOOS/PAPA network.

		CMR	IMWM	UG	IEVU	FIMR	SYKE	JRC
ENVISAT	MERIS		√				√	√
	AATSR							√
	RA-2							
	ASAR							
AQUA	MODIS		√			√	√	√
	AMSR							
TERRA	MODIS						√	√
Orbview-2	SeaWIFS		√	√			√	√
NOAA	AVHRR	√	√	√			√	√
RADARSAT	SAR							
Landsat	TM						√	√
Other								

Table 4: Satellites and sensors

2.4.2 PROCESSING OF REMOTELY SENSED INFORMATION

Most institutes download data from a data provider (Table 5), only IMWM (for meteorological applications) and the University of Gdansk use own data receiving stations. Corrections (atmospheric, geometric, cloud cover) are mainly done in-house. Most institutes also cooperate with partners for processing of remotely sensed data. All institutes involved in marine applications also develop their own algorithms for calculation of indicators.

	CMR	IMWM	UG	IEVU	FIMR	SYKE	JRC
Institute has own data receiving station		√	√				
Data are downloaded from provider	√	√	√	√	√	√	√
All corrections (atmospheric, geometric, cloud cover) are done at institute			√	√		√	√
Institute develops its own algorithms for calculation of indicators			√		√	√	√
Institute cooperates with partners for processing of remotely sensed data		√	√	√	√		√

Table 5: Processing of remotely sensed information

2.4.3 PERSONNEL

Between 2 (CMR, IMWM) and 16 (JRC) persons are involved in processing and analysis of remotely sensed data at each institute. The ratio of scientists/technicians is

approximately 3/2, making remote sensing activities a field with high demand on scientific capacities.

	CMR	IEVU	IMWM	UG	FIMR	SYKE	JRC
Scientists	2	3	1	6	1	8	10
Technicians		1	1	2		1	6

Table 6: Personnel involved in processing and analysis of remotely sensed information

2.4.4 TYPE OF DATA ANALYSIS

Only CMR analyses remotely sensed information solely visually. Mostly, institutes create indicator maps and often extract also “point observations” from the data (Table 7).

	CMR	IEVU	IMWM	UG	FIMR	SYKE	JRC
Images are mainly inspected visually	√	√	√				
Institute generates indicator maps based on remotely sensed data		√	√	√	√	√	√
"Point observations" - values are extracted for certain areas (pixel groups) of interest			√	√		√	√
Other		Spectral analysis, classification					

Table 7: Type of data analysis

2.5 FUTURE IMPROVEMENTS

2.5.1 MAIN OBSTACLES

Cost of data and equipment, as well as personnel cost for data processing, were mentioned mostly by institutes from the BSRP beneficiary countries as obstacles in the use of remotely sensed data (Table 8). Most institutes consider it possible to incorporate satellite information into monitoring and assessment, but problems are seen with respect to data availability (cloud cover), algorithm development, and for some applications also spatial resolution of the data. IMWM states, that the methodology to incorporate satellite data into environmental assessments still has to be developed at the institute. IEVU pointed out, that irregular demand for remote sensing based analysis limits the professional specialization and qualification of people working with remotely sensed data.

	EMI	IAE	CMR	IEVU	IMWM	UG	FIMR	SYKE	JRC
Cost of data		√	√	√	√	√			
Cost of equipment		√	√	√	√	√			
No qualified personnel for data processing	√	√	√						√
Cost of personnel for data processing		√	√	√		√			√
Insufficient data availability due to e.g. cloud cover			√	√	√	√			
Insufficient spatial resolution of remotely sensed data			√					√	
Algorithms for processing data not sufficiently developed			√		√	√		√	
Remotely sensed information is difficult to incorporate into monitoring and assessment			√						
Other				irregular demand for RS-based analysis and studies	Methodology to implement data into assessments			√	

Table 8: Main obstacles for the use of remotely sensed information

2.5.2 FUTURE PLANS

Most institutes will continue to develop the application of remotely sensed data in their work (Table 9). Algorithm development, near real time and operational data processing, as well as the creation of improved data sets were mentioned. IAE, which presently does not use remotely sensed data, considers these data as useful for survey planning and preparation of assessments. CMR is interested in increased networking to share the workload of obtaining and processing satellite data.

IWMW	Plans to continue monitoring information system for chlorophyll <i>a</i>
UG	Looking for improvement of remote sensing algorithms, for possibly new, till now unknown connections between remotely sensed signal and physical, biological and chemical properties of the sea water. Implementing new methods – new satellite sensors not used till now, using microwave data which is very important in such areas like Baltic, where clouds cover sky majority of time.
CMR	It would be useful to increase collaboration among users and institutions skilled in obtaining and processing the data from remote sensors or to create a remote sensing data on-line network between Baltic countries

IAE	Remotely sensed data would be useful for survey planning and preparation of assessments (temperature, chlorophyll a)
IEUV	This strictly depends on real demand and funding for that kind of research
FIMR	to be operational with other Algaline information and disseminated in near real time
SYKE	The RS products that are developed and processed, should be on daily use for all of the researchers. Especially in hydrodynamic water quality modeling work
JRC	improved data sets, algorithms, models

Table 9: Future plans for the application of remotely sensed data

2.5.3 ROLE OF THE BSRP

The responding institutes wish BSRP support with respect to funding, increased networking, and at some institutes also with respect to technical training (Table 10). In the BSRP beneficiary countries, funding is mainly requested for software licenses and the cost of expensive (e.g. microwave) data. Most institutes welcome increased networking between the organizations to exchange images, processing procedures (algorithms, parameters). The internet is regarded as the optimum way of data exchange and both IEVU/CC GIS and FIMR suggest establishing a GIS/remote sensing products server on the internet. Institutes in the BSRP beneficiary countries are mostly also interested in technical training targeted to marine remote sensing applications. SYKE and JRC also suggest joint field campaigns and cooperation in the field of algorithm development and data analysis.

	IAE	CMR	IEVU	IMWM	UG	FIMR	SYKE	JRC
Provide funding for equipment		√	ERDAS imagine, workstations	√	Software and data		For measuring optical properties of BS	
Organize technical training and workshops	√	√	Focus on marine RS application		√			
Increase networking between institutes		√	Images, processing procedures, internet databank	√		GIS/RS products server	√	√
Other	Cost of training and personnel						Joint field campaigns	Joint field campaigns, algorithm development, data analysis

Table 10: Proposed role of the BSRP in increasing the capacity to use remotely sensed data

3 CONCLUSIONS

Less than half of the institutes involved in marine environmental monitoring in the BSRP beneficiary countries have started to develop access to remotely sensed information (CMR, IMWM). Monitoring organizations in Estonia, Latvia, and Russia currently do not use satellite information. Remotely sensed information is mostly applied in the context of chlorophyll *a* and algal bloom mapping. Integration of these data into environmental assessments is at an initial stage in the BSRP beneficiary countries, but more advanced in “western” countries. Cost of equipment and data are claimed as the main obstacles in the beneficiary countries. As satellite data can in many cases be downloaded for free, also lack of information seems to play a role. All institutes involved in using remotely sensed information plan to continue or to expand their activities, while institutes that have not developed data access so far, have not stated future plans. Respondents to the questionnaire welcome BSRP funding for equipment and data. Activities to increase the networking between institutes were considered almost equally important. Technical training is needed by institutes in the initial stage of developing their access to remotely sensed information. One of the major roles of BSRP might be promotion of the remotely sensed (satellite) information use in various aspects of scientific research and practical applications among scientists and decision-makers in the Baltic Sea region.

4 ACKNOWLEDGEMENTS

I would like to thank Saku Anttila (SYKE), Vittorio Barale (JRC), and Gedas Vaitkus (BSRP GIS coordination center) for their help in developing the questionnaire, as well as all respondents.

BSRP remote sensing questionnaire

Purpose of remotely sensed information

Please indicate the parameters, for which remotely sensed data is used in your institute.

- Sea Surface Temperature
- Chlorophyll a
- Location and spatial extend of algal blooms
- Turbidity
- Oil spills
- Ice
- Other (please describe): _____ -
- No use of remotely sensed data

Please indicate the purpose of using remotely sensed data at your institute.

- Research
- Case-based assessments (e.g. environmental impact assessments)
- National assessment of marine eutrophication/pollution
- Assessment of marine eutrophication/pollution for the entire Baltic Sea
- Other (please describe): _____

Application of remotely sensed information in assessments of eutrophication/pollution

Please list assessments of marine eutrophication/pollution, for which remotely sensed information was used, and give a short description. Please indicate the type of information used, its role compared to in-situ observations, and describe benefits/shortcomings of using remotely sensed information

Technical and analytical profile

Please specify the type of sensors, from which information is used for **assessment of eutrophication/pollution**:

<input type="checkbox"/>	ENVISAT	MERIS
<input type="checkbox"/>		AATSR
<input type="checkbox"/>		RA-2
<input type="checkbox"/>		ASAR
<input type="checkbox"/>	AQUA	MODIS
<input type="checkbox"/>		AMSR
<input type="checkbox"/>	TERRA	MODIS
<input type="checkbox"/>	Orbview-2	SeaWIFS
<input type="checkbox"/>	NOAA	AVHRR
<input type="checkbox"/>	RADARSAT	SAR
<input type="checkbox"/>	Landsat	TM
<input type="checkbox"/>	Other (please specify)	

Please characterize the processing of remotely sensed information at your institute

- Institute has own data receiving station
- Data are downloaded from provider
- All corrections (atmospheric, geometric, cloud cover) are done at institute
- Institute develops its own algorithms for calculation of indicators (e.g. algorithms for calculation of Chla, SST)
- Institute cooperates with partners for processing of remotely sensed data (please describe) _____ -

Please give the number of scientists and technicians involved primarily in processing and interpretation of remotely sensed information at your institute.

Scientists _____

Technicians _____

Please describe how remotely sensed information is analyzed at your institute

- Images are mainly inspected visually
- Institute generates indicator maps based on remotely sensed data
- "Point observations" – values are extracted for certain areas (pixel groups) of interest
- Other (please describe) _____

Future improvements

What are the main obstacles for using remotely sensed data for marine monitoring and assessment at your institute?

- Cost of data
- Cost of equipment
- No qualified personnel for data processing
- Cost of personnel for data processing
- Insufficient data availability due to e.g. cloud cover
- Insufficient spatial resolution of remotely sensed data
- Algorithms for processing data not sufficiently developed
- Remotely sensed information is difficult to incorporate into monitoring and assessment
- Other (please describe) _____

How should the use of remotely sensed data for monitoring and assessment of marine eutrophication/pollution at your institute develop in the future?

Role of the BSRP

Please indicate, how the BSRP could contribute to developing the use of remotely sensed data for monitoring and assessment of marine eutrophication/pollution at your institute.

- Provide funding for equipment (please explain in more detail) _____
- Organize technical training and workshops (please explain in more detail) _____

- Increase networking between institutes, e.g. by sharing/publishing of processed information (please explain in more detail) _____
- Other _____

Please return the questionnaire by August 18 to the BSRP Productivity Coordination center – Baerbel Mueller-Karulis, Baerbel@latnet.lv, with CC to GIS Coordination Center - Gedas Vaitkus, Gedas.Vaitkus@ekoi.lt.

Thank you very much for your interest and cooperation.

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