Annex XII

Development of remote sensing information network

1 Establishment of Digital Library based on Marine Environmental Watch Project

During discussions at the First NOWPAP WG4 Meeting and the Second CEARAC FPM, it was pointed out that common understanding and information sharing should be promoted on application and interpretation, the status and future prospects of research and development, and the real use of remote sensing in marine environmental monitoring. NOWPAP WG4 has devised step-by-step procedures to develop a remote sensing information network, taking into account of realistic limitations, such as development costs, content provision, and so on. The first step is the development of an ongoing portal site that reviews and provides locations of scattered information and data related to RS of the marine environment. The second step is the development of a digital library that also provides the information and data. The Marine Environmental Watch Project (Figure 1.1), which is currently expanding its functions, is worth considering as a base for the digital library.

1.1 Data Contents of Digital Library

Digital Library enables simultaneous provision of the remote sensing data, capturing various marine environment phenomena, and the computerized information associated with it. It is proposed that digital library to be set up based on the existing Marine Environmental Watch Project to effectively achieve the provision of data and information that are precisely what the user expects.

In preparation of data and information to be provided, efforts will be made to minimize work by the users. The following data sets are proposed to be included in digital library.

1) Remote sensing

   - Remote sensing data products on marine environment provided by NASA
     MODIS ocean color data products processed by NASA standard algorithm
     SeaWinds ocean wind data product
     TOPEX/POSEIDON and Joson-1 data products for ocean sea surface height

   - ALOS Products in coastal area provided by JAXA

   - Red tide products developed by Red Tide Watcher Project

2) *In situ* data

   Data on water temperature, salinity, chlorophyll-*a* concentration, etc, used in “Guideline for Eutrophication Monitoring by RS” (to be published at the end of 2006).

3) Manuals for data processing and analysis

   Manuals for processing and analyzing RS data for marine environment monitoring.

1.2 Expected Outcome

By utilizing the Digital Library, users in the NOWPAP Region will be able to acquire and analyze the same data and information. Such environment will promote capacity building and dissemination of information among the NOWPAP Members, and will be a base for providing data for monitoring and assessment of marine and coastal environment in the NOWPAP Region. Also, training materials will be provided at the RS Training Course, which will be held as one of the WG4 activities in 2007 or later.

1.3 Issues to solved

Issues in each of the following steps from acquisition to delivery of data/information need to be solved before the establishment of the Digital Library.

1) Data processing

To distribute remote sensing data products provided by NASA in the NOWPAP Region, automated data acquisition and post processing (clip, thumbnail, etc.) are necessary for ease of use.

2) Delivery of data products

For fabrication and delivery of remote sensing data products, discussion with the data distributors is necessary.

3) Data management and maintenance

Hardware such as high capacity servers will be required to store the large quantity of data and information.

2 Updating of Website on Oil Spill Monitoring

Website on oil spill monitoring (Figure 2.1) was developed by Pacific Oceanological Institute (POI) FEB RAS in 2004. Number of visits, downloaded files, etc. of this site is very high; reflecting both growing demands for information on oil spill monitoring and high level of materials presented on the site. However regular updates need to be made for the appearance of new satellite sensors, images, and advanced techniques of oil pollution detection/monitoring, as well as new projects and publications on oil spill monitoring. Upon the proposal from POI, the secretariat decided to upgrade the Website on Oil Spill Monitoring within the budget of interssional work of CEARAC. Details on this update are described in Appendix A.

2.1 Contents

The following describes the contents will be updated in 2006.

1) Provide new ERS-1/2 SAR and Envisat ASAR images covering the NOWPAP Region.
2) Provide estimates of the polluted water areas and oil volumes.
3) Provide interpretation schemes of SAR images with indication of oceanic phenomena influencing on oil spill spreading.
4) Upgrade section describing algorithms of oil spill detection on SAR images.
5) Provide updated information on similar projects in other countries.
6) Upgrade a list of references on oil spill detection/monitoring and on satellite-derived fields of environmental parameters that are important for forecast of oil spreading and weathering.

The website will continue to serve as a unified entrance into Internet resources on satellite oil spill monitoring. Internet ideology and technology will allow eliminating repetitions and duplication of the information in similar portals (MERRAC, UNEP) using links.

2.2 Expected Outcome

Website on oil spill monitoring will contribute to a more efficient cooperation within the NOWPAP Members by providing additional up-to-date information on new sensors, recently detected oil spills, and advanced techniques for their detection and monitoring. Additionally, the website may be used for the Training Program.

Figure 1.1 Marine Environmental Watch Project.
http://www.nowpap3.go.jp/jsw/eng/index.html

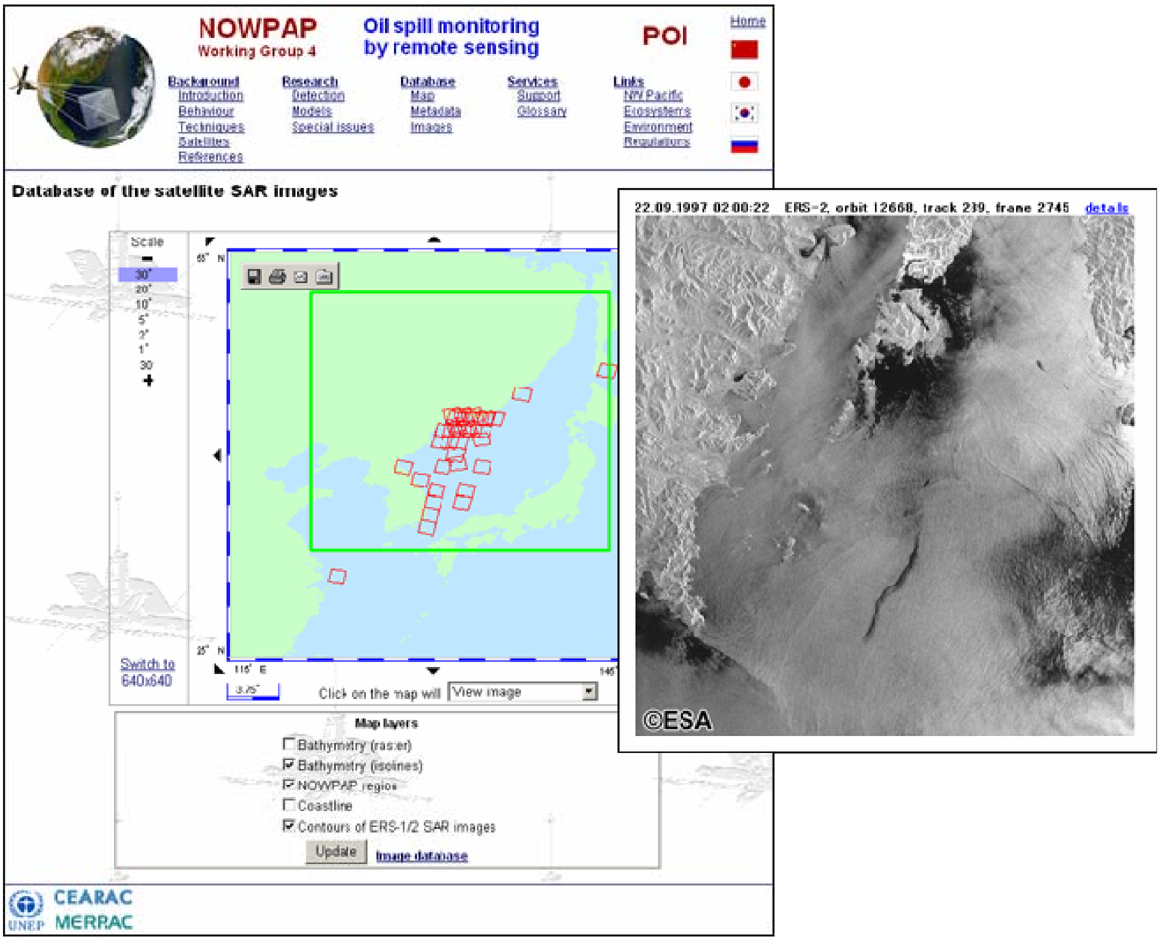

Figure 2.1 Website on Oil Spill Monitoring.
http://cearac.poi.dvo.ru

Appendix A

Updating and modification of the website on oil spill monitoring

Proposal of V.I. Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia

Introduction

Petroleum hydrocarbon contamination is increasing rapidly in all the East Asian seas, which are especially vulnerable to oil contamination because their cold temperatures retard oil evaporation and dissolution, and strong tidal mixing and high residual current can spread spilled oils widely and rapidly. Everyday, new and new quantities of crude oil and oil products are released in the Northwest Pacific Ocean and oil spills continue to occur on the sea surface. They are concentrated along main domestic/international ship routes, in fishing regions and in the coastal zones, in particular, near large river mouths.

Oil and natural gas exploration and production areas, oil terminals, coastal refineries, and major oil tanker casualties and routes are sources of the pollution. Oil refineries are concentrated on the southeast coast of Japan, the south of South Korea, in China along the Bo Hai coast and in Shanghai area, around Taichung and Kaohsiung in Taiwan. There is heavy oil tanker traffic in the East Asian Seas from the Persian Gulf to Japan, Taiwan, and South Korea. Further development of the new oilfields in the Okhotsk and Yellow Seas as well as construction of new oil-pipe-lines from Angarsk (Eastern Siberia) to Nakhodka and/or Perevoznaya Harbor (near Vladivostok) coupled with continuing releases of petroleum hydrocarbons in river waters increase marine water pollution and emphasize the necessity of monitoring of the sea surface.

Recent oil spills near Primorye, Sakhalin, Hokkaido and Honshu coast have demonstrated the high sensitivity of coastal ecosystems to oil contamination and to solid litter that imposed increased requirements upon detection and monitoring of polluted waters both in the open sea and in the coastal zone.

Marine monitoring of oil spills and water quality can be carried out in many different ways, using remote sensing from aircraft and satellites or observations from ship, oil platform, automatic buoys and coast. Space observation has a significant contribution to make to routine spill monitoring. The main strengths of the technique lay in the wide, synoptic coverage that provides consistent results over large areas. Repeatability of results also plays a role in ensuring the usefulness of the image data.

Single sensors are unlikely to provide adequate temporal and spatial coverage at adequate spatial resolution for oil spill monitoring; therefore networks of sensors are required which are coordinated in terms of the data formats, quality control information and distribution, in addition to initial acquisition. In the marine environment, conditions change rapidly and features are frequently obscured by cloud, thus requiring multiple looks. Systematic, routine monitoring of marine pollutants and the dynamic systems (fronts, currents, eddies, etc.) that transport them require inputs of radar, infrared (to sense sea surface temperature) and visible (to retrieve chlorophyll concentration from space ocean color observation) data in ways that take advantage of their respective strengths. At the present, no existing remote sensing platform, in space or airborne, can meet all of the above requirements. Although earth observation has definite strengths, it has weaknesses too and these must be addressed when considering the monitoring of a cloud-covered sea with optical or infrared data or looking for oil spills in predominantly calm or windy locations. Earth observation is a valuable tool, but only when used appropriately. The team comprised of experts in the individual disciplines is required to analyze and exploit the particular sensor data.

Due to the changing environmental conditions, location and properties of the oil spills and their immediate threat to ecosystem, a satellite remote sensing platform is required to have high temporal and spatial resolution and wide spectral resolution, as the position and width of the spectral band is important in distinguishing the oil from the adjacent water.

Remotely sensed data will contribute to oil spill modelling in several ways by improvements in their acquisition, interpretation and transmission. First, nearly and real-time updating of drift and spreading computations will become possible, relying on fast processing of satellite data and direct transmission from over-flight aircraft. Second, the remote estimation of water content in spill may also become possible, in which case synoptic weathering pictures can be built up to supply calibration and test data sets for models. Third, the Internet is likely to result in significant changes in how oil spill models are designed in the future. Nearly real-time acquisition of input data, including satellite and over-flight images as well as winds, currents, can be achieved in this way. Model results can also be disseminated rapidly via the Internet.

Several research and operational projects focused on remote sensing of oil spill were curried out in the European countries and several new projects were started recently. One of the main goals of these projects is the implementation of the sea surface monitoring *from space and aircraft platforms* in particular to detect the areas with oil spill and eutrophication. Today the satellite-based oil monitoring service is in operational use by most of the key end-users in North Europe.

In these projects and services, a satellite Synthetic Aperture Radar (SAR) is considered as a principal space instrument for detecting and monitoring of oil spills. This instrument can collect data independently on weather and light conditions and is an excellent tool to monitor and detect oil on water surfaces. It offers the most effective means of monitoring oil pollution: oil spills appear as dark patches on SAR images because of the damping of the small-scale sea waves by the oil films. The sea appears less rough in these areas and the backscattering is reduced. Hence such areas would appear darker in a radar image. This type of instrument is currently on board the European Space Agency's ERS-2 and Envisat satellites, on the Canadian RADARSAT satellite and on the Japan ALOS satellite launched on 24 January 2006. Several new satellites with a SAR are planned to launch in the nearest years and among them are RADARSAT-2 (Canada), SAR Lupe (Germany, DLR). Russia and Korea also plan to launch satellites equipped by SAR.

At present satellite-based oil spill and ship detection service is transferred from national towards Pan-European multi-user services. In particular, joint service of the North Sea was organized between United Kingdom, Holland, Germany and Belgium and joint service of the Baltic Sea - between Sweden, Finland and Poland.

Today customers require one joint service instead of four separated services for Barents Sea, Baltic Sea, North Sea and English Channel. Kongsberg Satellite Services (KSAT) is merging existing services into one North-European Oil spill service. Very likely, that the same joint service will be organized in the CEARAC area in the nearest future.

Now only SAR images as a source of information on oil spills are available for POI. Both precision (PRI) high-resolution ERS-2 SAR and Envisat ASAR images and quick-look (QL) images are used to detect spills. The European Space Agency (ESA) provides the SAR PRI images to POI free of charge within the quotas assigned for research projects ESA-POI. The QL images are downloaded via the Internet.

A resolution of the visible (250 m) and infrared (1000 m) images taken by MODIS spectroradiometer from Terra and Aqua satellites and by AVHRR radiometer from NOAA satellites (1 km) does not allow registering the polluted waters. The same is true for the Landsat and SPOT QL images as follows from screening the images collected in the archives of the Japan and China ground stations. It is possible to detect the polluted waters on high-resolution Landsat and SPOT images however they are too expensive).*

*) Large spills can be detected on MODIS visible images (250 m) as well as on Landsat and SPOT quick look images at favorable conditions (in sun glint areas).

CEARAC website on oil spill monitoring (http://cearac.poi.dvo.ru) was developed by POI in 2004. Amount of visits, downloaded files, etc. of this site is very high (see site statistics) that reflects both growing demands for information on oil spill monitoring and high level of materials presented on the site. However appearance of new satellite sensors and images and advanced techniques of oil spill detection/monitoring, as well as new projects and publications are factors requiring regular updating of CEARAC website.

1) Objective of the Updating and modification of CEARAC website on oil spill monitoring

(a) Provide 30 new georeferenced ERS-1/2 SAR and Envisat ASAR images covering the CEARAC area and annotate selected images. (Annotation will be given for the most interesting images with oil spills and with the surface manifestations of oceanic dynamic phenomena. Not necessary to give detailed annotation for each image.).
(b) Provide estimates of the polluted water areas and oil volumes.
(c) Provide interpretation schemes of selected SAR images with indication of oceanic phenomena (frontal zones, coastal fronts, eddies, internal waves, etc.) influencing on oil spill spreading (see point (a)).
(d) Upgrade section describing algorithms of oil spill detection on SAR images.
(e) Provide updated information on similar projects in other countries (Links to the European and American projects on oil spill monitoring including application of SAR data).
(f) Upgrade a list of references on oil spill detection/monitoring and on satellite-derived fields of environmental parameters that is important for forecast of oil spreading and weathering.

2) Contributions of the CEARAC website on oil spill monitoring to CEARAC activities (including the relationship between the website and CEARAC activities)

(a) Provide information on availability of airborne and satellite-borne remote sensing instruments for oil spill monitoring in China, Japan, Korea and Russia.
(b) Add information on environmental coastal air patrol and provide information where and how to order the satellite SAR measurements over the particular area in a case of detection of oil spill due to ship transport operation, fishery activity, river outflow as well as due to incidents (the origination of dangerous situation).
(c) Disseminate CEARAC activities and results in the community of potential users of remote sensing techniques for marine pollution and in the public organizations.
(d) Add links to the environmental information important for oil spill monitoring/evolution.

3) Roles of the CEARAC website on oil spill monitoring playing in the CEARAC activities

CEARAC website will contribute to a more efficient cooperation within members in the Northwest Pacific region by providing additional fresh information on new sensors, on recently detected oil spills as well as on advanced techniques for their detection and monitoring.

Additionally, the web site can be used during the RS Training Program scheduled in 2007.

The CEARAC website will continue to serve as a unified entrance into Internet resources on satellite oil spill monitoring. Internet ideology and technology allow eliminating repetitions and duplication of the information that are in the similar portals (MERRAC, UNEP) using links.

4) Contents of the CEARAC website on oil spill monitoring

The following sections in the website is supposed to be developed.

- Global and regional News (tanker incidents, description of incidents, their pictures, hot satellite images, evolution of oil patches, role of remote sensing, etc.) - mainly via Links.
- Remote sensing techniques of oil spill detection. Comparison of their efficiency. Algorithms of interactive and automatic detection of oil spills and false alarms. Examples of oil spill detection in the NOWPAP Region with the usage of different algorithms.
- Updated database of the georeferenced satellite SAR images of the NOWPAP Region. Annotation of selected images with revealed oil spills and oceanic dynamic phenomena.
- Oil pollution of the NOWPAP Region. The main sources of oil pollution. Current situation and tendency (search via Internet).
- Oil spill spreading models with links.
- Environmental information that is important for oil spill monitoring/evolution (winds, currents, ice, weather forecast) - Links to the China, Japan, Korea and Russia.
- Influence of oil pollution on marine ecosystems - Links.
- International regulations on marine oil pollution – Links (UNEP)

PS. Users should be able to get real time access to data and models by means of a user interface that allows interpretation of various formats on a single PC or workstation using a regular browser.

5) Initial cost of updating the CEARAC website on oil spill monitoring

Now the POI FEB RAS continues to advance an Integrated Information-Analytical System (IIAS) for the Northwestern Pacific Ocean. This system is realized as Geo Information System (GIS) based on Internet/Intranet technology (http://gis.poi.dvo.ru). The main goal of the POI GIS is to enhance the efficiency of scientific research in the region by coordinating activities of individual scientists and scientific teams both within a particular Institute and between the Institutes of FEB RAS. In addition, POI GIS serves for data accumulation, visualization and processing.

IIAS recourses are accessible at first for the users of the Vladivostok optical network. They include the local networks of the FEB RAS Institutes and the Universities. Researchers can use the IIAS services and recourses via Internet channels. For external users it is assumed to establish distinction the rights to data access during their registration.

A block of collection, storage, visualization and thematic processing of satellite information is one of the structure elements of the POI GIS. This block is dedicated to solving of various tasks in particular the development and advancement of techniques of detection of the oceanic phenomena using Synthetic Aperture Radar (SAR) images of the ocean.

To update the CEARAC website on oil spill monitoring we suggest using the image software developed at POI for oil spill detection by analysis of space-borne and airborne remote sensing.

Cost estimates (total 3000 USD)

The following expenses determine the cost for the implementation of this plan:

Updating the website –	700 USD
Satellite SAR image processing and annotating, preparing of interpretation schemes:	2000 USD
Search of new information on projects and papers	300 USD
Total	3000 USD