Updating and modification of website on oil spill monitoring

1. 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. Every day, 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. Only two examples: Appearance of oiled dead sea birds on the northern coast of Hokkaido. The estimated total number of dead birds exceeded 5,000 since late December 2005 till April 2006. The time, place, and source of the oil spill were not determined. On 7 December 2007, a crane-carrying barge slammed into the Hong Kong-registered tanker "Hebei Spirit", which was at anchor approximately 8 km off Malipo in the Taean district on the west coast of the Korea. Three of five containers on the "Hebei Spirit" were punctured releasing roughly 10,500 metric tons of crude oil into the sea. The "Hebei Spirit" was carrying a total of 260,000 metric tonnes of crude oil. The oil started hitting beaches on 8 December 2007. Waves of crude oil washed ashore, turning seagulls black and threatening various fish farms. The stretch of scenic coastline is 100 km south of Seoul. The region is important habitat for migrating birds and has a significant fishing industry.

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 and in Shanghai, and at 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 to Nakhodka 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 in the NOWPAP region 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 environment monitoring is carried out using remote sensing from the coast, ships, oil platform, aircraft, and satellites as well as during field measurements. Space observation has a significant contribution to make to routine pollution 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.

Systematic, routine monitoring of marine pollutants and the dynamic systems (fronts, currents, eddies, etc.) that transport them require inputs of radar, infrared (temperature) and visible (ocean color) 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 slick 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 slick 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 began to provide nearly real-time acquisition of input data, including multichannel satellite and over-flight images as well as winds, currents, etc. Model results can also be disseminated rapidly via the Internet.

Several research and operational projects focused on remote sensing of oil pollution were curried out in the European countries. Several new projects were started recently and several web sites were created. 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 pollution 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 pollution. This instrument can collect data independently of weather and light conditions, is an excellent tool to monitor and detect oil on water surfaces. It offers the most effective means of monitoring oil pollution: oil slicks appear as dark patches on SAR images because of the damping effect of the oil film to the sea waves. The sea appears less rough in these areas and the backscattering is reduced. Hence such an area would appear darker in a radar image. This type of instrument is currently on board the following satellites: ERS-2 and Envisat (European Space Agency), RADARSAT-1 and RADARSAT-2 (Canada), ALOS (Japan), two Lupa (Germany) and Cosmo-Skymed (Italy). Several new satellites with a SAR are planned to launch in the nearest years in, Russia, Korea, and other countries.

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. It is reasonable to organize the joint service in the NOWPAP area after detailed discussion among countries-participants.

Now only SAR images as a source of information on oil pollution are available for POI. Both precision (PRI) high-resolution ERS-2 SAR and Envisat ASAR and quick-look (QL) images are used to detect oil pollution. The ESA transmits the SAR PRI images to POI free of charge within the quotas assigned for research projects ESA-POI. Additionally, high-quality medium resolution ASAR images can be downloaded from ESA rolling archive during two weeks after their acquisition. The QL images are downloaded via Internet. The JAXA transmits the selected ALOS PALSAR precision images to POI free of charge within the quota (50 images per year) assigned for research project 364 ”Oil spill detection and mapping in the Northwest Pacific Ocean by L-band ALOS PALSAR”.

A resolution of the visible (250 m) and infrared (1000 m) images taken by MODIS spectroradiometer from Terra and Aqua satellites and by radiometer AVHRR 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*).

CEARAC Web site on oil spill monitoring (http://cearac.poi.dvo.ru) was developed by POI in 2004 and updated in 2006. 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 pollution detection/monitoring, as well as new projects and publications are factors requiring regular updating of CEARAC website.

2. Objective of the updating and modification of CEARAC website on oil spill monitoring

(a) Provide more than 30 new geo-referenced and annotated ERS-1/2 SAR, Envisat ASAR and ALOS PALSAR images covering the NOWPAP area periodically.
(b) Increase resolution of SAR images embedded in website earlier and new ones.
(c) Provide estimates of the polluted water areas and oil volumes.
(d) Provide interpretation schemes of SAR images with indication of oceanic phenomena (frontal zones, coastal fronts, eddies, internal waves, etc.) influencing on oil spill spreading.
(e) Update section describing algorithms of oil spill detection on SAR images.
(f) Provide updated information on similar projects and resources in other countries (links to the national and international projects on oil spill monitoring including operation usage of SAR data).
(g) Update a list of references on oil spill detection/monitoring and on satellite-derived fields of environmental parameters important for forecast of oil spreading and weathering.

3. Contents of the CEARAC website on oil spill monitoring

It is supposed to update the following sections (pages) in the website:

- News (global and regional, tanker incidence, description, pictures, hot satellite images, evolution, role of remote sensing, etc.) - mainly via links.
- Remote sensing techniques of oil pollution detection. Comparison of their efficiency. Algorithms of interactive and automatic detection of oil spills. False alarm. Examples of oil pollution detection in the NOWPAP area with the usage of different algorithms.
- Database of the georeferenced satellite SAR images of the NOWPAP area.
- Database of the annotated georeferenced satellite SAR images with revealed oil pollution.
- Oil pollution of the NOWPAP area. The main sources of oil pollution. Current situation and tendency (search via Internet).
- Oil pollution spreading models with links.
- Environmental information important for oil pollution monitoring/evolution (winds, currents, ice, weather forecast) - Links to the Japan, Korea, China and Russia sources of data.
- Influence of oil pollution on marine ecosystems - Links.
- International regulations on marine oil pollution – Links (UNEP)

*) 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).

The contents should be optimized for users to be able to get real time by means of a user interface through regular Internet browser.

4. 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

5. 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.

6. Budget

Now the POI FEB RAS continues to advance an Integrated Information-Analytical System (IIAS) for the Northwest Pacific Ocean. This system is realized as GIS-based on Internet/Intranet technology (http://gis.poi.dvo.ru). The main goal of the POI GIS is to raise the efficiency of scientific research in the region by coordination of activity 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 the oceanic phenomena detection using SAR images.

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duplication of the information which is in similar portals (MERRAC, UNEP) using links and mirror sites.

Cost of this proposal is estimated by the following breakdown.

Cost estimates (total 2,000 USD)

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

Updating the website –	600 USD
Satellite SAR image processing and annotating, preparing of interpretation schemes:	900 USD
Search of new information on projects and papers	500 USD
Total	2000 USD