Satellite based oil spill detection and impact assessment – The chronology of the Deepwater Horizon Accident

This is an EO services success story on assessing the extent and the impact of oil spills

Summary

Latest since large scale oil spill events, such as BP's Deepwater Horizon accident, it became clear that technology for effectively monitoring, documenting and analysing oil spill dynamics is urgently needed. Moreover, the techniques shall allow a spatio-temporal explicit identification and quantitative assessment of the interaction with terrestrial and marine habitats of natural and economic value.

GeoVille Group, specialized in the development and application of state of the art satellite remote sensing and Geographic Information System(GIS) based spatial analysis techniques, was contracted to establish the first full spatial chronology of the Deepwater Horizon accident oil spill evolution and the identification as well as quantification of its site impacts. The coupled multi-source satellite monitoring and GIS approaches, with the involvement of world class institutions, allowed documenting the temporal evolution and dimensions. This provided accurate information on the location, extent, and temporal evolution of the oil spill and delivering means for a quantitative assessment of the impact on marine/coastal habitats affected.

Project Background

On April 20, 2010, catastrophe struck the Gulf of Mexico with the explosion and sinking of BP's Deepwater Horizon oil rig, which left the drilling hole open. Crude oil has been expelled, affecting the marine and onshore environment, as well as the marine dependent economy throughout the Gulf. Not until September 19, 2010, a relief well successfully closed the original drilling hole. Meanwhile the controversy over the use of dispersants, the fate of the oil and the impact on the marine environment as well as economy in the Gulf has made clear that technology for effectively monitoring, documenting and analysing the oil spill dynamics as well as an assessment of its interaction with natural habitats is needed.

To be able to fully respond to such events on all levels of solution management, a multi-source satellite based documentation of the geographical and temporal impact of an oil spill on a variety of coastal and marine is required. Specifically, a standardized documentation in digital map and statistical form featuring:

- Daily and weekly maps documenting the maximum extent of the oil spill and identifying site impacts of critical terrestrial and marine habitats of natural and economic value
- Summary statistics and graphs quantifying area and sequences of oil interaction with terrestrial and marine habitats of natural and economic value
- High resolution assessments for “hotspot” impact areas

Issues & Needs

The dynamic nature of oil spills due to the ocean’s changing environment is a huge challenge for management authorities, institutions involved in habitat protection as well as the full range of marine economic operators – from hotels to fishermen to local communities.

The specific needs were:

- the geospatial explicit assessment on the extent and location of the oil spill, identifying also areas that were most frequently affected, for the entire duration of the oil spill.
- an assessment of the oil spill interaction with natural habitats, in particular seagrass and turtle nesting beaches. A focus was placed on where and how often the oil occurred and which habitats were affected.
- Detailed information for sites most impacted by the oil spill.
- the geospatial and temporal interaction between the oil spill and the spawning habitat of the endangered Atlantic Bluefin Tuna (ABFT) that was located in the GOM during the time of the oil spill.
- a detailed documentation of the oil spill interaction with the various habitats and a quantification of the affected areas and habitat types.
- digital data for further analytical studies as well as communication material summarizing the impact of the oil spill in the GOM.

The geographic and temporal focus of this particular assessment was the north-eastern part of the Gulf of Mexico (GOM), including Florida and Cuba, for the time period from the start of the accident on 20th of April until 30th of September.

Solution

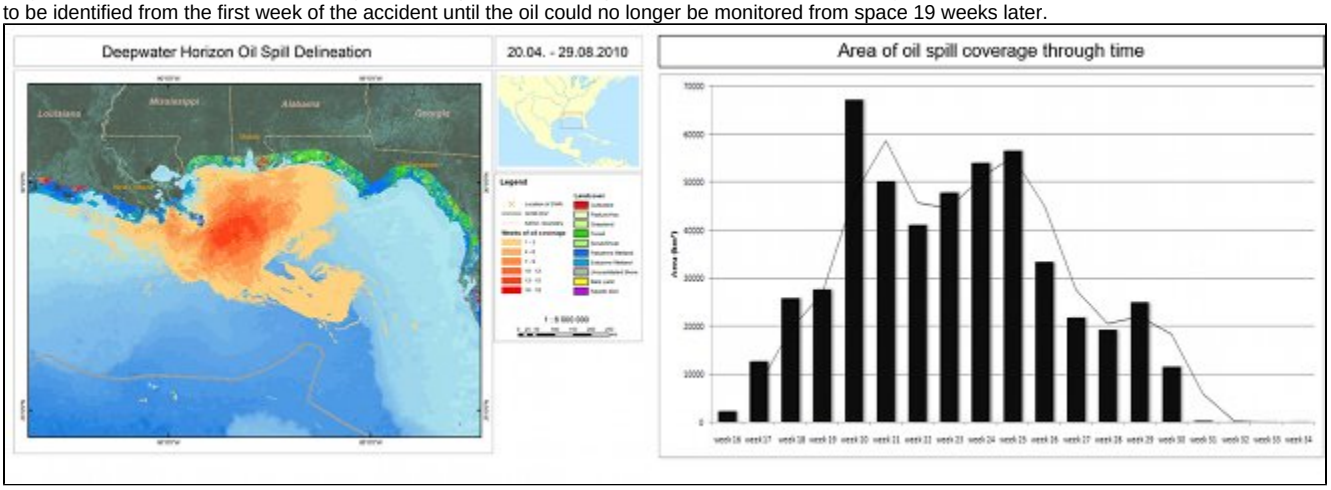
The coupled approach of employing multi-source optical and radar satellite data (i.e. from various satellite systems) allowed for a timely, synoptic, consistent and precise mapping of the oil spill extent in the Gulf of Mexico (GOM). Radar satellite data in particular is very suitable for water surface oil slick mapping due to the strong absorbance of the radar signal by the oil slick. To derive a consistent chronology of the oil spill the custom mapping productions were combined with oil spill delineations made available through public identities to accumulate a complete database of the temporal oil slick coverage's. These were analysed through a GIS to produce daily and weekly summary frequency maps depicting how often an area was covered by oil from the beginning to the end of the drilling hole opening. The accumulation of satellite derived oil spill extents allows identification and quantification of areas that have been affected hardest, on the ocean as well as on the coast.

To determine the oil interaction within coastal habitats, the cumulative weekly maps were intersected coastal land cover data classified into habitats of particular interest. In this way, the length of the shoreline affected by the oil spill was identified for each land cover class, indicating also the frequency of oil contact. The resulting GIS database provided the basis for statistical analyses that were carried out for the affected shorelines in Louisiana, Mississippi, Alabama and western Florida.

Sea turtle nesting sites and Atlantic Bluefin Tuna spawning habitat spawning index grids were intersected with the cumulative weekly oil spill maps to identify affected sites of this marine species of particular interest.

Results & Perspective

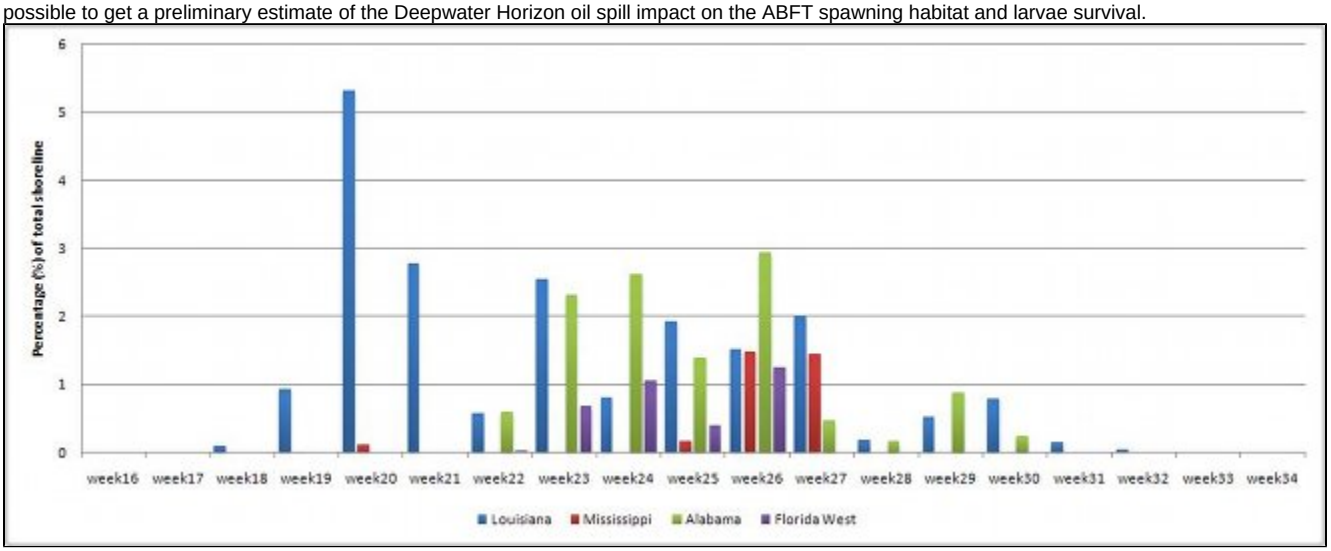
The oil slick summary frequency maps derived from satellite data depict for each area how often it was affected by the oil spill between 20 April and 29 August 2010. The continuous monitoring of the oil spill extent from space allowed the area covered by the oil spill to be estimated and the sites of landfall to be identified from the first week of the accident until the oil could no longer be monitored from space 19 weeks later.



Analysis of the satellite data and the shoreline land cover revealed that mainly unconsolidated shores, bare areas (i.e. beaches) and estuarine wetlands were affected by oil landfall in Louisiana, Mississippi, Alabama and western Florida. For example, in Louisiana, the percentage of affected wetland shorelines exceeded 15%. These habitats are home for many species and include important breeding sites and nursery grounds of marine animals, such as fishes, shrimps, sea turtles and birds.

Common straight-line distance assessments of the affected coastline, revealed that approximately 167 km of Gulf Coast shoreline experienced moderate to heavy oil impacts. Satellite technology allows assessing the exact length of the affected shoreline, defined as the length of the edge of a body of water, thereby including all water boundaries of inlets, estuaries etc. This methodology reveals the fine scale impact and was used to gather the oil spill interaction information. To allow comparability of results with other impact assessments, the summaries of the presented key results were therefore provided in proportions of the affected shoreline versus the total length of the shoreline.

To understand how far sea turtles were affected by the oil landfall, a detailed map of sea turtle nesting sites was intersected with the cumulative weekly maps. The number of weeks the oil spill was present at the nesting site is an important indicator for the state of the sea turtle population. Besides the impact on the coasts, marine species, such as the Atlantic Bluefin Tuna, were also affected by the oil spill. Using various satellite data and models it was possible to get a preliminary estimate of the Deepwater Horizon oil spill impact on the ABFT spawning habitat and larvae survival.



The study demonstrated well how large scale disasters can be efficiently monitored from space to identify most impacted areas. Multi-source satellite data provided valuable input for models and for the direct mapping of oil slick extents, allowing a timely, synoptic, continuous and precise mapping of the oil spill extent in the Gulf of Mexico (GOM). The intersection of satellite derived oil spill extents with various GIS datasets on valuable coastal and maritime habitats allows providing detailed information on the impacts of the oil spill on natural habitats, on the shoreline and in the GOM. The results derived in this study also highlight hot spot areas where increased restoration efforts are needed.
Necessary tools and processing chains to derive products for almost near real time and historical oils spill status and impact assessments were developed and are ready for operational applications or refinement for other oil related monitoring tasks.

Related Info

GeoVille Group is a private sector enterprise located in Austria and Luxembourg. GeoVille Group specialises in products and services related to Earth Observation (EO) and Geographic Information Systems (GIS) applications.

GeoVille is Europe's leading company in using satellite data for land monitoring and spatial planning applications.

Our services provide the bridge from user needs to technical implementation - merging geospatial explicit data with statistics - to the analysis of what on-going processes and trends mean for real world applications.

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