California's use of GIS Technology for Oil Spill Planning and Response

Judd Muskat
CA Dept of Fish and Game
Office Of Spill Prevention and Response
P.O. Box 944209
Sacramento, CA 94244
jmuskat@dfg.ca.gov

Abstract

This paper gives a brief history of the use of GIS at the California Department of Fish and Game (CDFG), Office of Spill Prevention and Response (OSPR). Specific examples are cited showing the fundamental use of GIS for planning, and from various spill responses highlighting the GIS as well as advanced technology such as satellite and airborne remote sensing.

INTRODUCTION

The California Department of Fish and Game's Office of Spill Prevention and Response is the lead State agency charged with oil spill prevention and response within California's marine environment. The Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990 established OSPR and provides a mechanism for continuous funding. Both spill prevention and a spill response organization, OSPR retains the Department of Fish and Game's public trustee and custodial responsibility for protecting and managing the State's fish, wildlife, and plants. The OSPR Administrator has substantial authority to direct spill response, cleanup and natural resource damage assessment activities[1].

HISTORY OF GIS USE AT OSPR FOR SPILL RESPONSE

At OSPR, GIS technology was initially utilized by the scientific branch for quick and accurate production of biological resource maps of California's coastal and marine environment. The original OSPR GIS was set up on UNIX based workstations in a computer lab in Sacramento. Computer and technology advancements have allowed the routine deployment of GIS in the field on laptop computers and peripherals. GIS is dispatched from Sacramento for emergency response and other field oriented projects.

Currently, OSPR has a very large dependence on GIS within its Units. GIS plays a very important part in assessing damages from an oil spill event. The Legal Unit relies on maps and data for the recovery of damages. The Natural

[1] http://www.dfg.ca.gov/Ospr/index.html

Resources Damage Assessment Unit uses GIS to look at the habitat after a spill occurs for the impact of how much shoreline was involved and to determine the extent of impact. The Marine Safety Branch uses GIS in reviewing plans for readiness and preparedness. Enforcement Wardens use GIS to assist in their investigations. Additionally, the OSPR GIS unit supports the CDFG inland pollution response program.

CONTINGENCY PLANNING

Area Contingency Plans

The statutes (OPA 90 and SB 2040) enacted in consequence of the catastrophic oil spills of 1989 (Exxon Valdez, American Trader), required contingency planning for both State and Federal Governments. The USCG and OSPR agreed to joint preparation of contingency plans through co-chairing the three Port Area Committees for Contingency Planning: USCG Port Areas for San Francisco, Los Angles / Long Beach, and San Diego. A set of six oil spill Area Contingency Plans (ACP) that span the California coastline from Oregon to Mexico have been produced. Each individual ACP lists and depicts environmentally sensitive sites, including a detailed description and sketch of the site, a specific site protection strategy and site specific contact information. These planning data sets were created as GIS layers. The ACP documents are available on the OSPR web site[2].

Special GIS Layers

OSPR has created several statewide GIS layers specifically for coastal oil spill planning and response. These GIS layers are described below. Data sets in the OSPR library that are specific to preparedness and response include the shoreline Environmental Sensitivity Index (ESI), the CA Natural Diversity Data Base (CNDDB), coastal sensitive sites from the California statewide Area Contingency Plans (ACP), site specific response strategies, statewide beach access points, and statewide pre-determined operational division boundaries.

Operational Divisions

The entire California coastline has been segmented into response operational divisions. The operational division segments are based on shoreline type, beach access points, accessibility of response equipment, and/or geopolitical considerations. Having these well thought out response operational divisions included in the ACPs helps make the initial moments of a response more organized. These division designations are used for planning purposes and

[2] http://10.249.32.193/ospr/organizational/scientific/acp/marine3/marine_acp.htm

cleanup operations. The operational divisions can easily be sub-divided into smaller segments as necessary (e.g. for shoreline cleanup assessment teams).

Sensitive Sites

This GIS layer contains all of the California ACP sensitive site locations. A companion layer includes site specific protection strategies. The GIS layer includes the boom or berm configuration, the length and type of boom required, the number and type of anchors, and the number of personnel required to deploy the strategy and maintain it through the tide cycles.

Beach Names

A layer of state-wide standardized beach names is a work in progress. This layer will be helpful for responders unfamiliar with local beach names and will cut the confusion between formal “map” names and colloquial beach names.

Environmental Sensitivity Index (ESI)

The entire coastline of California has been surveyed and classified into an index of sensitivity to an oil spill. The resulting dataset was automated into GIS layers by the National Oceanic & Atmospheric Administration[3] (NOAA). ESI maps help spill responders and planners identify vulnerable coastal locations before a spill happens, so that protection priorities can be established and cleanup strategies identified in advance. The data has been used as part of the natural resource damage assessment for several spill incidents including the Cape Mohican (San Francisco Dry Dock), Platform Irene, MV Kure and MV Stuyvesant incidents.

ESI maps include three kinds of information, delineated on maps by color-coding, symbols, or other markings:

- Shoreline Rankings, shorelines are ranked according to their sensitivity, the natural persistence of oil, and the expected ease of cleanup.
- Biological Resources, oil-sensitive animals, as well as habitats that either (a) are used by oil-sensitive animals, or (b) are themselves sensitive to spilled oil (e.g., coral reefs).
- Human-Use Resources, resources and places important to humans and sensitive to oiling, such as public beaches and parks, marine sanctuaries, water intakes, and archaeological sites.

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[3] http://response.restoration.noaa.gov/index.php

Natural Diversity Data Base

The CDFG has developed and maintains a feature rich GIS data library of statewide natural biodiversity known as the California Natural Diversity Data Base[4] (CNDDB). The CNDDB contains the location and natural history information on special status plants, animals, and natural communities. CNDDB data are available to the public digitally or as hard copy. The primary method of data dissemination is via the computer application RareFind, which allows for complex querying and reporting by the user. Maps of CNDDB data are made early on at an emergency response and provide a quick look at potential resources at risk.

DRILLS AND EXERCISES

Federal Law mandates that area contingency plans be tested at regular intervals through drills and exercises. OSPR regularly provides GIS support to the drills and exercises program.

In 2004 California hosted Spill of National Significance (SONS) exercise. The California SONS 2004 exercise scenario had two major spill incidents occurring off the coast of southern California requiring a vigorous response from State, Federal and Local Agencies. The exercise locations included Port-level incident command posts (ICP) in San Diego, Los Angeles and Ensanada, Mexico. GIS data was electronically transferred between the three ICPs through email attachments to GIS personnel directly, or via ftp to a secure internet site. GIS data layers were transmitted in shapefile format while map files were transmitted in Adobe PDF file format. In addition to the GIS activities at the three ICPs an internet mapping site was available on-line for the duration of the SONS drill on a secure server located in Sacramento, CA. GIS data layer sharing at the individual ICPs was achieved using USB flash memory "sticks".

EMERGENCY SPILL RESPONSE

For a unified multi-agency emergency response the Incident Command System (ICS) is employed for organization and management. The nature of ICS is that the organization will "ramp up" as the incident unfolds. A large response involves several dedicated GIS personnel with full GIS capabilities including computer workstations, "E" size plotter, etc. GIS technical specialists are traditionally deployed in the command center as part of the planning branch (USCG Incident Management Handbook[5]).

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[4] http://www.dfg.ca.gov/whdab/html/cnddb.html

[5] The complete text of this handbook is available at http://www.uscg.mil/hq/g-m/mor/page2index.htm

Typical GIS support includes downloading field data from handheld GPS receivers/computers, or digitized from field maps, drawings, logs or personal communications. This data is then automated into GIS layers in real time. Map and poster products are generated on site in support of all phases of the emergency response including public meetings and press briefings. A portable computer projector is used for large wall size displays such as for the Situation Unit where the status of the response is constantly updated.

Shoreline Cleanup Assessment Teams (SCAT)

Shoreline Cleanup Assessment Teams (SCAT) survey segments of the coastline to determine the amount and type of oiling present, and to recommend to the Incident Command a strategy for cleanup. OSPR has recently purchased new software that allows electronic capture of SCAT data in the field on a hand held windows based integrated GPS receiver. The data is downloaded into the GIS when the SCAT team returns to the command post. GIS maps are used to track the progress of the beach cleanup and help to guide the daily activities.

Resources at Risk

OSPR employs a team of reconnaissance specialists that fly pelagic transects in a CDFG observation aircraft. This team has regularly scheduled training flights. They follow strict protocols for observation and documentation. During emergency spill responses this team has been used to document the locations of marine wildlife that are in the area, in immediate danger or already impacted by the oil. The aircraft flight track and specific resource at risk observations are captured via GPS. The raw data are automated to GIS layers on-board the aircraft in real time then downloaded into the GIS at the command center directly after each mission. These data sets are used during the response and also as part of the post spill formal cooperative natural resource damage assessment.

Wildlife Search and Collection

Wildlife search and recovery teams mark GPS waypoints where oiled wildlife or carcasses are collected. GPS receivers are downloaded back at the command post upon return from the field. Additional information about the animal is generated at the wildlife intake center. All of the collected animals are logged in and tracked in the GIS by a unique intake number. Wildlife stranding maps are used by the wildlife operations branch during the emergency response and after the fact as part of the natural resource damage assessment (NRDA).

Sample Tracking

Both during and after an emergency spill response many samples are collected for various purposes. Mostly, sampling station locations are marked as GPS waypoints. The GPS receivers are downloaded daily and the resulting GPS coordinates are stored in the GIS. As a backup procedure sample locations/GPS coordinates are also recorded on paper forms. If GPS was not available then the locations are digitized from the form or field map or verbal description. Sampling location maps are produced as needed to help guide the daily sampling activities.

REMOTE SENSING FOR PREVENTION AND RESPONSE

Collecting remote sensing data from satellite and aircraft platforms has become more common for OSPR as technology advances and data acquisition expenses decrease.

Satellite Radar

OSPR has used satellite radar (RADARSAT-1, ERS-2) for slick detection at the MV Stuyvesant and SS Jacob Luckenbach responses. In addition, a pilot project by OSPR in 2004/05 showed the feasibility of using satellite radar technology for both ship detection and pollution monitoring (slick detection). Satellite radar in conjunction with aerial over flight or on-water observations can be a powerful tool for detection as well as a deterrent to illegal bilge dumping, if a regular monitoring program were in place.

High Frequency Radar (CODAR)

OSPR funds a research project that is taking advantage of the existing high frequency radar (brand name CODAR) coverage areas around Monterey Bay and San Francisco Bay to develop methodologies and data formats for real-time tracking of drifting material. In turn, these techniques will be made available to the larger statewide monitoring network. The purpose is to have the ability to generate real time maps of surface current fields and be able to use these data as input for trajectory modeling.

Aerial Imaging

For the MV Stuyvesant response in 1999 aerial photographs were acquired in stereo pairs in both natural color and color infra-red. The purpose was to map aquaculture sites in Humboldt and Arcata Bays.

At the Suisun Marsh response in 2004 recent aerial imagery or high resolution base maps of the spill site were not available, so a high resolution digital aerial image was acquired. This image was delivered to the command post then georeferenced in real time using native ArcGIS software. This proved to be the best base map for field responders and briefing displays.

NATURAL RESOURCE DAMAGE ASSESSMENT

Working cooperatively with, but technically separate from the emergency response a cooperative NRDA is conducted by the trustee agencies and the responsible party. At the Suisun Marsh pipeline spill response the trustee agencies and the responsible party undertook several natural resource damage assessment (NRDA) data collection efforts and studies. One study used a multispectral digital camera that was flown over the spill site on two dates several weeks apart. Interpretations from these images helped to quantify acreage affected by the pipeline release. The final GIS products were used as the basis for damage claims, negotiations, and the case settlement.

CONCLUSION

GIS is fully integrated into oil spill prevention and response in California. Initially used for biological resource assessment, GIS proved to be an excellent data management and organizational tool for drills, exercises, contingency planning, natural resource damage assessment, and emergency response. During an oil spill emergency large amounts of data are generated, much with a geospatial component. The inherent ability to import and display convergent data layers provides the incident Unified Command with a powerful decision making tool. GIS products are routinely used to track the progress of the emergency response, to help guide daily activities (incident action plan), as part of the incident investigation, post response for the cooperative natural resource damage assessment, as well as for drills and other planning and prevention purposes.