PIPELINE AND COASTAL ENVIRONMENTAL SENSITIVITY MAPPING FOR THE BTC PIPELINE SYSTEM IN TURKEY

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ABSTRACT

Sensitivity mapping was completed for 1076 km (645 mi) of pipeline and for coastal areas of the eastern Mediterranean Sea in preparation for completion of the Baku-Tbilisi-Ceyhan (BTC) Pipeline Project. Pipeline sensitivity maps include environmental, human-use and archaeological features as well as drainage patterns indicating potential oil flow and downstream sites for spilled oil containment. The marine maps include environmental and human-use features, and appropriate oil spill containment sites. All information is compiled and stored using a Geographic Information System (GIS) from which hardcopy maps are created at various scales depending on purpose. Both integrated and stand-alone databases are used to quickly access needed environmental and response information. Map and text-based data are stored on a central server to provide internal accessibility and via a web-based, interactive internet mapping system. This is the first time that formalized sensitivity mapping has been carried out in Turkey.

INTRODUCTION

The Baku-Tbilisi-Ceyhan (BTC) Pipeline Project starts at the Caspian Sea in Azerbaijan, extends through Georgia crossing the northeast border into Turkey and continues south-southwest to a new marine terminal at Ceyhan in Iskenderun Gulf (Figure 1). This paper describes a portion of the oil spill response planning that was carried out in Turkey during the project's construction phase in preparation for planned linefill and system operation in 2005.

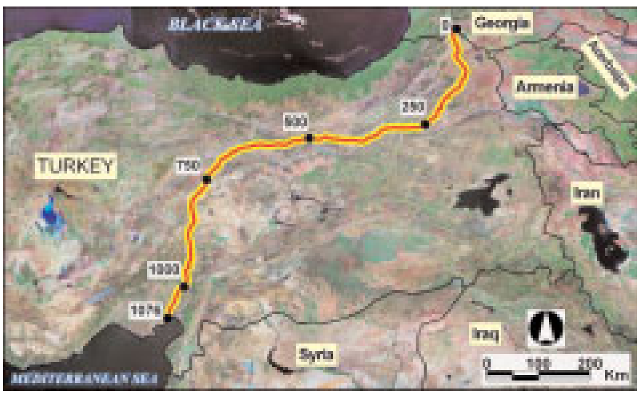

FIGURE 1. LOCATION OF THE BTC PIPELINE IN TURKEY WITH PIPELINE KILOMETERS INDICATED. THE END POINT IS AT CEYHAN TERMINAL AT KILOMETER 1076.

Oil spill sensitivity mapping has become an integral part of spill response planning since inception in 1976, originally starting with marine environments (Gundlach and Hayes, 1976) and later extending to lake, river, and land-based habitats (among many: Gundlach et al., 2001; IPIECA, 1996; NOAA, 1996; Zenger et al. 2001). As part of the BTC Project, sensitivity evaluations were carried out in the Iskenderun Gulf area and along the pipeline in Turkey. This information is incorporated into a Geographic Information System (GIS) and a computerized database / response manual. The opening page of the database, indicating the search features currently available, is provided in Figure 2. After verification of the data sets, information is incorporated into an Internet Mapping System (IMS) available internally and via the internet.

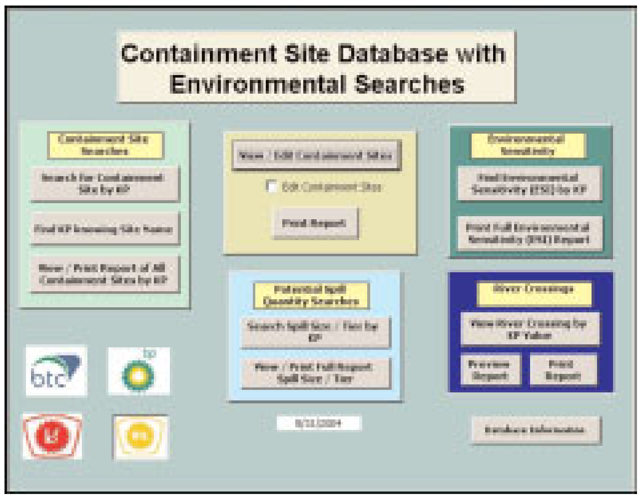

FIGURE 2. OPENING SCREEN OF THE CONTAINMENT MANUAL DATABASE INDICATING ENVIRONMENTAL AND OTHER SEARCHES AVAILABLE.

SENSITIVITY MAPPING OF THE ISKENDERUN GULF AREA

Sensitivity mapping in the Iskenderun Gulf area was completed using the following procedures:

- Selection of the area to be mapped based on the computer-modeled, worst-case extent of oil spillage.
- Obtaining, digitizing and rectification of 1:25,000 topographic base maps from the Turkish Government.

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- Completion of an aerial survey (low-level helicopter) during which a digital video (with time and latitude/longitude titling) and digital still images were taken. Observations were recorded verbally on the digital video tape during the survey.
- Undertaking of a ground survey prior to and after the aerial survey to confirm shoreline classifications.
- Collection of nationally and internationally available information on the principal biological and human-use resources of the area.
- Survey of sensitive sites to develop a containment site database and response manual (also called a Geographic Response Plan in other areas).
- Classification / categorization of shoreline types and biological habitats for inclusion into a GIS (ESRI ArcInfo vers 8.3).
- Internal and external review of all information.
- Translation of material into Turkish and English for government agency approval of the Project's Oil Spill Response Plan.

Results are presented in four formats: (1) Landscape A3-size (29x42 cm; ~11x17 inch) with underlying 1:30,000 topographic maps *(restricted to internal use only)*, (2) Landscape A3-size, also at 1:30,000 scale but without topographic maps (Figure 3), and (3) Mixed landscape and portrait A1-size (60x84 cm; 24x33 inch) 1:30,000 topographic maps with all information indicated (including roads for site access), and (4) an A1-size, 1:230,000-scale summary map of sensitivity information.

FIGURE 3. EXAMPLE COASTAL SENSITIVITY MAP IN THE ISKENDERUN GULF AREA (ORIGINALLY 1:30,000-SCALE). A DETAILED TOPOGRAPHIC MAP FOR LAND FEATURES IS AVAILABLE INTERNALLY).

Principal components of the sensitivity analysis report (A3-format) are as follows:

- Legend, as shown in Figure 4.
- Biological data tables for birds, marine mammals, marine reptiles, with status of national and international protection, concentration (i.e. population size), time (month) in the area, and time most sensitive (e.g. mating, nesting, hatching, spawning, birthing, etc.), and feeding behavior for birds.
- Description of prevalent winds, currents and tides.
- Description of principal biological components, particularly fisheries, marine turtles, marine mammals, birds and internationally Important Bird Areas (IBAs), four of which are in the area. IBA TR079 is partially shown on the north part of Figure 3.

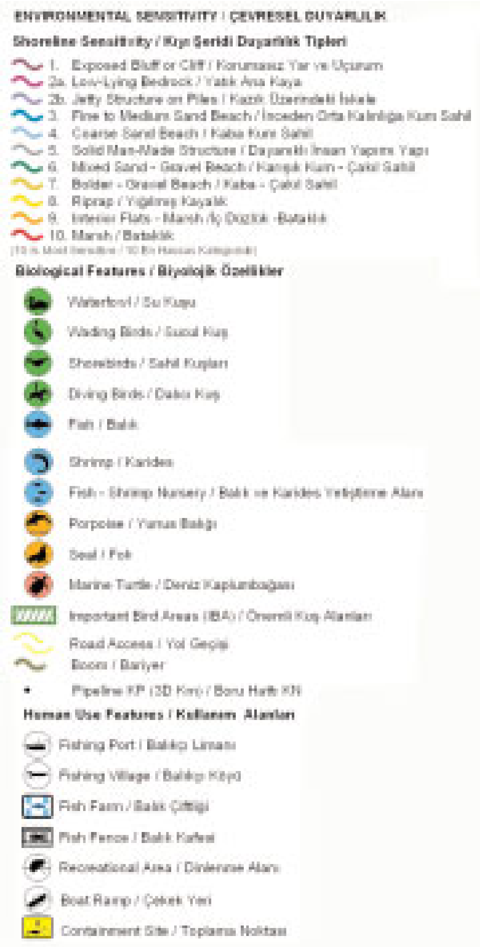

FIGURE 4. LEGEND FOR THE COASTAL SENSITIVITY MAPS.

- Photographs of principal human-use and spill-response features, specifically fish farms, fish fences, fishing ports and villages, and recreational beaches, boat ramps and containment site locations.
- Description of shoreline types, sensitivity, location, predicted oil behavior, response considerations, and photographs of typical examples (Figure 5).

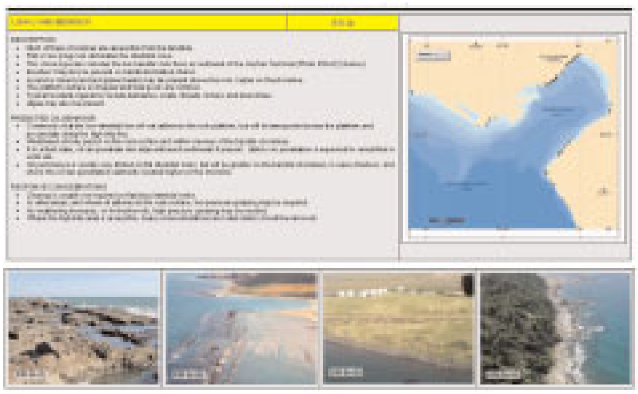

FIGURE 5. EXAMPLE FORMAT FOR EACH SHORELINE TYPE.

- Results of oil spill modeling and zones of projected impact for potential releases in the marine terminal area.
- Description of containment sites and activation guidance.
- Acknowledgement to contributors and references cited.

The summary 1:230,000-scale sensitivity map is provided in Figure 6.

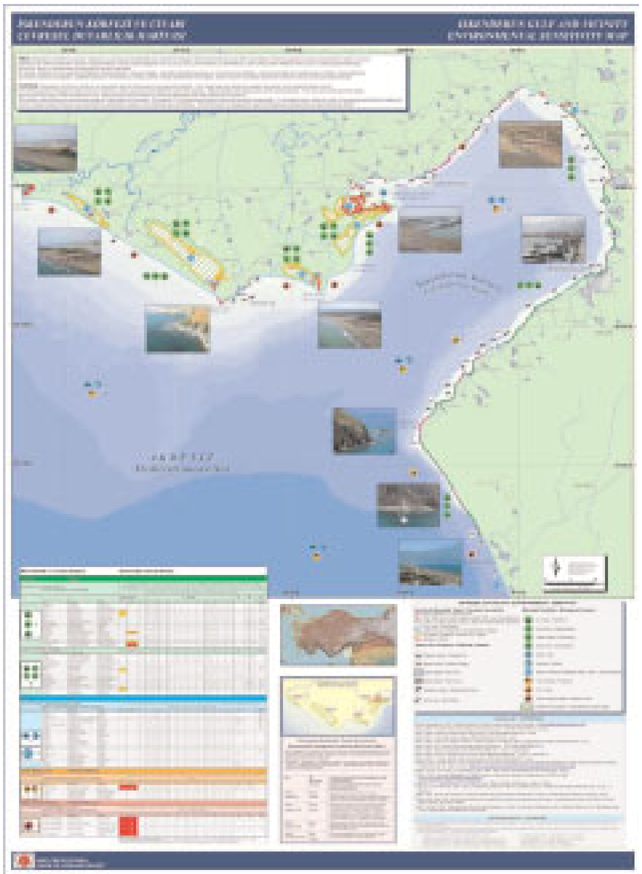

FIGURE 6. SUMMARY SENSITIVITY MAP FOR THE ISKENDERUN GULF AREA (ORIGINALLY AT 1:230,000 SCALE).

INLAND SENSITIVITY MAPPING

The sensitivity maps for the pipeline route include a categorization of features along the pipeline and extend far outside the pipeline corridor to include areas potentially affected via the river transport of spilled oil.

Along the route, the pipeline route is categorized as to sensitive features present (every 0.01 km (33 ft) based on topographic maps). Categories and data sources are listed in Table 1. Like that for shoreline sensitivities, a lower ESI value does not mean a lesser response, only that it may be different. Along the pipeline, all categories present are indicated by different line width, so the responder knows, for example, that an archaeological site is present, but that there is also an environmentally important (Special Response) area, and a zone of ground water extraction (Aquifer Protection Area) (Figure 7).

All rivers and streams are defined in detail along the route in terms of pipeline kilometer point (KP). Rivers greater than 5 m (15.5 ft) wide are designated as highest concern because of the potential spread of oil downstream. In addition to being mapped, all river crossings are included in the Containment Site Database, enabling an immediate lookup based on KP value.

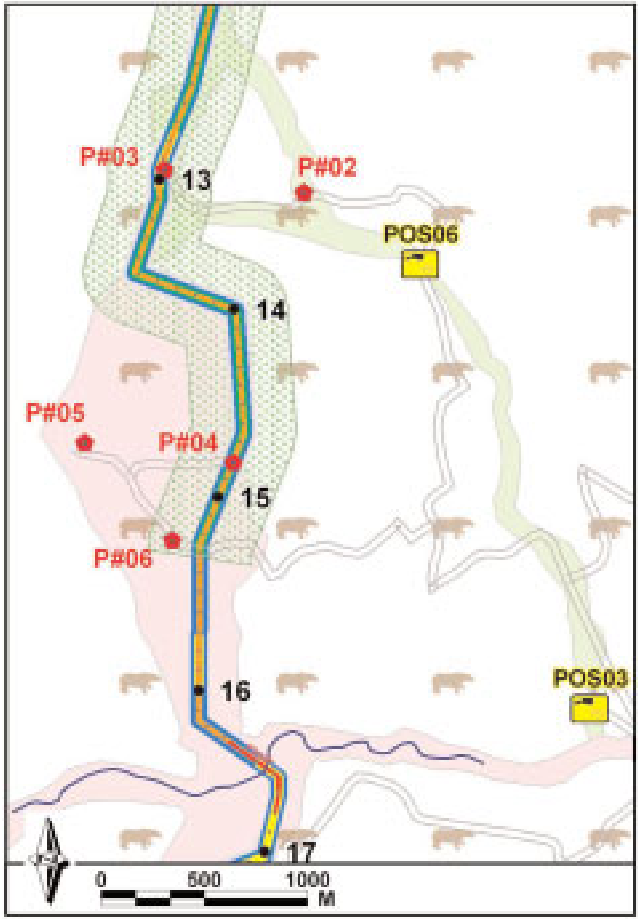

FIGURE 7. EXAMPLE OF SENSITIVITY MAP ALONG THE PIPELINE (SEE FIGURE 8 FOR LEGEND).

FIGURE 8. INLAND SENSITIVITY MAP LEGEND.

Table 1. Inland Sensitivity Categories. EIA = Environmental Impact Analysis, GIS = Geographic Information System.

Category	Description	Data Source(s)
10	Rivers (>5 m width), Lakes and Reservoirs Each has a 200 m buffer.	From a pre-construction engineering study, verified using topographic maps and during construction. Lakes and reservoirs are from Project EIA GIS files, verified during field activities.
9	Special Response Area—Environmental. Areas selected for additional response planning for environmental reasons.	Internal document: Oil Spill Response Plan for Special Response Areas, based on forests, Important Bird Areas, and wetlands.
8	Archaeological Sites, with 200 m buffer.	From Project EIA GIS file, updated with recent finds during construction and data from the government mapping agency.
7	Aquifer Protection Area. Areas of notable aquifers (Pasinler, Erzurum, Göksun, and Adana-Ceyhan).	Internal document: Water Well Analysis Study.
6b	Ecologically Sensitive Area (ESA), designated because of plant species present.	From Project EIA.
6a	Wet Meadow Habitat.	From Project EIA GIS file.
5b	Karst (limestone) Area.	From Project EIA GIS file.
5a	Special Response Area—Fault Zone. Areas surrounding major fault structures for which a special response plan was prepared.	Internal document: Oil Spill Response Plan for Special Response Areas, based on the Project EIA.
4	National Forest, designated by Turkish Government.	From Project EIA, updated with additional research.
3	Wildlife Protection Area.	From Project EIA, updated with additional research.
2	Forest Habitat.	From Project EIA GIS file.
1	Primarily Farm or Grazing Land.	All other areas, confirmed in many locations by field observations.

The Project has determined a number of sites that are particularly sensitive due to environmental conditions, in particular including forests, Important Bird Areas, and wetlands. These are designated as the second highest sensitivity category, called Special Response Areas—Environmental. Each Special Response Area has a detailed response plan focusing on control of oil at or near the pipeline.

Archaeology has received much attention before and during construction. All sites, including ‘chance finds’ located during construction, are included into the GIS and mapped along the route as the third highest category.

Areas of ground water extraction, the next highest category, were studied in detail using ground water modelling, and also have detailed maps and a spill response plan. The four primary ground water zones along the pipeline mostly derive water from depths of ~30 m (100 ft) with overlying layers of silt, sand and gravel, therefore the potential for oil reaching the aquifer is unlikely. Most of the water is used for agriculture. The response plan assumes a worst case, and requires actions to prevent oil migration away from the spill site and the removal of all contaminated sediments.

Areas of important vegetation (designated as Ecologically Sensitive Areas, based on plant species) and wetlands comprise the next category, followed by areas of underlying karst limestone and fault crossings (Special Response Area—Fault Zone). Nationally designated forests, locally denoted Wildlife Protection Areas, and forested areas (not nationally designated) comprise lower categories. The national forests and Wildlife Protection areas, for the most part, are included with Special Response Areas.

The lowest category is famland and / or grazing land, common along much of the route.

UPDATING THE INFORMATION

The GIS enables update of the maps and database to accommodate changes in, for example, the final placement of the pipeline to include re-routes, additional archaeological ‘chance finds’, and new sensitive features.

The Containment Site Database will also be updated as sites are re-visited during different weather conditions and seasons. New sites will be added to both the database and GIS mapping system as they are surveyed. New reports can be generated from the database at any time.

SYSTEM ACCESS DURING OPERATION

All GIS and database information will be transferred to a central server. GIS data is categorized in layers, and each layer is stored in a table. This system allows designers to add new fields to tables to store non-vector (text-based) so that each feature (record) in a table will have spatial information and attached text-based information.

Information on the server will be accessible to responders and other users either directly or via a dial-up connection. Users will see a specialized interface (Internet Mapping System) that allows development of query-based maps without the need for specialized GIS software installed on their machines. Examples of such searches may include: are there Special Response Areas near KP 459, which Containment Sites are activated for an incident at KP 986.5, and are there rivers near KP 534.37.

The field responder will have a tablet personal computer with integrated GPS and GIS software enabling access to relevant response data and maps, as well as to text-based documents such as the Site Safety Plan.

USING THE INFORMATION

As described above, information is purposely provided in various formats. It is expected that the 1:30,000 topographic maps with the various data layers will be most appropriate to provide an overview of the area (spill site), access roads, flow direction, river systems, and sensitive environments. These maps are also reproduced in sufficient numbers to be used as field maps, with the potential to add notations such as spill distribution, containment sites, etc. The Containment Site database and its integrated environmental searches provides a means to rapidly assess response information during a crisis situation. Using the database with a quick analysis of the environmental sensitivity topographic map will provide a coherent picture of the resources at risk, potential flow direction of the spill, applicable response strategy and containment sites.

BIOGRAPHY

Dr. Gundlach has 30 years' international experience in oil spill response, environmental impact analyses, environmental audits, and the use of integrated databases and mapping systems for the analysis, display, and storage of technical information. He has published extensively on oil spill impacts and emergency response management. He has been involved in environmental sensitivity mapping for oil spill planning since 1975.

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