A Cost-Effective Means of Estimating the Extent of Pollution from Oil Spills in Remote Locations using Hydrodynamic Modeling Techniques

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Introduction: Many oil and gas operations, and associated infrastructure, such as pipelines, are situated in remote locations that present unique environmental challenges. In the event of a spill or pipeline leak, witness reports often are unreliable and it can be many days or weeks before properly-trained professionals arrive at the scene to assess the magnitude of impacts. In addition, the mobilization of equipment—e.g., drill rigs, sub-surface scanning and sampling equipment—to map pollutant plumes can be challenging. By the time suitable equipment is deployed, signs of contamination may no longer be obvious, meaning that post-spill investigations must look at a wide area to establish the potential magnitude and extent of impact.

All of these issues were experienced during works undertaken to assess risks and provide clean-up options following an accidental oil spill at a desert location in the Middle East. The spill occurred in an area characterized by extreme dry weather and irregular, ephemeral surface-water flows. Nevertheless, the vulnerability of local ecological receptors, perceptions of the environment as being pristine, and a lack of previous studies meant that the risk assessment had to be highly sensitive to a wide range of potential influences.

Using a case study to illustrate these challenges, we describe an approach to mapping the area of potential impact of an oil-spill event using novel modeling techniques to provide a more focused and cost-effective investigations, as well as allowing clean-up costs to be estimated far in advance of detailed monitoring results becoming available.

Methods: Information from both field and desk-based studies are presented, including two-dimensional hydrodynamic modeling (TUFLOW, [1]) tailored to the local environment. Additional examples of the use of similar hydrodynamic modeling to determine pollution extents for spills into surface water environments including estuarine waters are provided and contrasted with more traditional methods of data gathering and analysis.

Results: The modelling techniques applied and described in this paper provided the following results:

- Focused and cost-effective delineation of contaminated sediments for use in risk assessment and site cleanup
- Reduced effort in costly and potentially damaging sampling and assessment interventions
- Estimation of cleanup costs far in advance of traditional monitoring methods
- Improved client/regulator visualisation of environmental issues

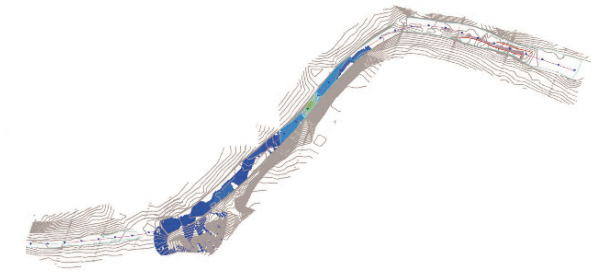

Fig. 1. Model output simulating trajectory and extent of spilled fuel over 24 hours from time of breach for comparison with field estimate.

Discussion: Although further work is needed to refine the use of hydrodynamic software for purposes like the case study discussed herein, the application of TUFLOW suggests promise for similar scenarios. Modelling techniques like these can be expanded for use by petrochemical and other industries to proactively assess risks associated with existing infrastructure—particularly in remote locations. Matching environmental data with modelling of pollutant behaviour within a GIS platform enables the coordination of information in a single location. Such tools can then be used to determine potentially high risk locations, and make it possible to prepare tailored response schedules and approaches, thus improving spill response and cleanup.

References: [1] TUFLOW Flood and Coastal Simulation Software. http://www.tuflow.com/