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Designing Science in a Crisis: The Deepwater Horizon Oil Spill

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In a crisis, there is little room for prolonged debate or hesitation. Decisions can yield tremendous consequences and time is of the essence.

The Deepwater Horizon (DWH) oil spill, like many disasters before it, challenged the scientific community to do their best work under dire circumstances. Scientists from more than a dozen federal agencies and the private and academic communities were called to bring the best science, expertise, and assets to bear on an unprecedented situation. As teams worked together to respond to what President Obama called "the worst environmental disaster America has ever faced", scientists were denied the luxury of lengthy deliberation.

In this issue of Environmental Science & Technology, there are two examples of "crisis science" designed and conducted by the U.S. Environmental Protection Agency (EPA) to support the DWH oil spill response (*1*, *2*). They represent efforts made in the midst of a disaster to determine whether dioxins formed during controlled surface burns and, if so, what the potential impacts were.

These two papers are just a small piece of a much larger story about designing the best possible science during an environmental emergency.

In a crisis, scientists face a unique set of challenges:

- Realized or potential adverse consequences
- Significant uncertainties and unknowns
- An urgent time frame for decisions and actions

Throughout the DWH spill, there was a direct threat of oil reaching shoreline ecosystems, harming aquatic species, compromising fisheries, and impacting communities. There were also potential indirect concerns associated with response actions like controlled burns and dispersant use. EPA worked with interagency teams to address these immediate threats without losing sight of the secondary, yet equally important, concerns.

The ongoing disaster also presented extraordinary challenges and unknowns. The combination of the spill's depth at sea and distance from shore was unprecedented. The spill's elusive flow rate and unpredictable cessation posed tremendous scientific unknowns. Scientists worked amidst these challenges and under urgent time pressure for three months.

Despite challenges that seemed, at times, insurmountable, EPA worked to uphold its commitment to scientific integrity—because to adequately support decision-making, science has to be strong. To cope with this requirement and produce the best possible work, EPA designed a crisis science framework around three fundamental elements.

The first element involved *tapping into all existing relevant knowledge*. The DWH spill was not the first oil spill, nor even the first spill in the Gulf of Mexico to require a response. Searching for lessons learned from events like the Exxon Valdez and Ixtoc spills was an important first step. Scientists also turned to previously published analyses such as those conducted by the U.S. National Academy of Sciences (*3*) to learn as much as possible from the existing body of response technology literature. EPA gathered information about relevant work within the Agency and engaged academic institutions, especially those along the Gulf coast, to take advantage of ongoing research and avoid duplication of effort.

The second element was *working to understand and meet the specific needs of the crisis response*. There were a myriad of scientifically interesting questions surrounding the DWH oil spill. EPA scientists needed to prioritize only those questions that would directly inform the emergency response. This is why EPA, with its partners, implemented air, water, and sediment monitoring regimes. This is also why interagency scientists conducted daily monitoring of dissolved oxygen levels, organism (rotifer) mortality, and particle size. To understand the impact and effectiveness of dispersant use, EPA conducted comparative toxicity tests (*4*) that informed actions and decisions. The testing for dioxin formation described in this journal was undertaken on the same grounds—response-relevance.

The third element was *working to ensure the highest possible data quality and reliability, and fastest possible data*

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delivery within the time constraints of the crisis. It was an Agency imperative to rapidly communicate the best possible data to responders and the public. EPA scientists implemented quality controls, quality assurance protocols, and data management processes to address this critical need. In cooperation with federal partners, EPA posted thousands of data points on the Internet in an unprecedented effort to make data available as quickly as possible.

The two papers published in this issue are examples of EPA's efforts to address an important scientific question in the context of these unique elements of crisis science.

At the outset, it was not clear whether dioxin formation at sea could, in fact, be measured. The first paper describes EPA's effort to measure dioxins, which ultimately required intense coordination among scientists, responders, and Gulf operations authorities. In the end, scientists worked to adapt an existing resource—a monitoring tool developed for use at detonation sites on land—for use at sea.

The second paper provides context and meaning for the reported measurements. EPA scientists conducted a screening assessment on the exposures and risks posed by measured dioxin emissions, including those associated with inhalation exposures for workers near the site, inhalation exposures for residents on the mainland, and fish ingestion exposures.

Designing and implementing the tests described here required intense teamwork and the discovery and utilization of the best available information. Despite challenges, these tests were vital to the pursuit of asking and answering the hard questions.

There is no doubt that many additional scientific questions remain unanswered. This is precisely why long-term research is necessary. The history of the DWH oil spill and its response will continue to be written and evaluated over the coming years. Whether and to what extent the response community succeeded or failed can only be determined in retrospect.

The scientific community has emerged from this incident with greater perspective, information, and knowledge about how to structure science during a crisis. It is our responsibility to heed the lessons learned, for if we fail as a society to avoid the avoidable, we will again be left to manage unintended consequences.

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