Protecting Canada's coastlines

Oil spills pose environmental and economic threats to the nearly 6.5 million people who live in Canada's marine and coastal areas. Researchers at the world-class Coastal Environment Research Laboratory (CERL) are studying how oils behave in marine waters and developing evidence-based ways to expand the country's oil-spill toolkit.

The researcher

A professor in the Department of Civil Engineering at Memorial University of Newfoundland, **Baiyu Zhang** is a Tier 2 Canada Research Chair in Coastal Environmental Engineering. She is also a Member of the Royal Society of Canada's College of New Scholars, Artists and Scientists, and a lead scientist for the Multi-Partner Oil Spill Research Initiative, a federal program that is part of Canada's Oceans Protection Plan.

The research

Zhang's research explores the ecological impacts of oil spills and clean-up operations, how oils behave when they spill into marine waters and how spills can be cleaned up safely and effectively. Using equipment funded by the CFI, Zhang **analyzes environmental samples to identify spilled oil contaminants**, sometimes at trace levels, that can have dire ecological impacts. She also **studies the effects on marine ecosystems of oil interacting with microplastic pollution**. To improve remediation operations, her lab is **generating and testing new bioproducts for removing oil from cold waters**.

About the Canada Foundation for Innovation

Since its creation in 1997, the CFI has committed more than $10 billion in support of more than 13,000 research infrastructure projects in all disciplines at 173 institutions in 81 municipalities across Canada.

Natural and accidental oil spills have long-term consequences for the environment, the economy and human and animal health. One of the most widely used technologies to clean up spills is dispersion. Adding a dispersant to the water helps decrease the size of oil droplets and increase their solubility. Naturally occurring bacteria in seawater degrades smaller oil droplets. Zhang's team has developed environmentally friendly and **effective biodispersant products that improve the biodegradability of spilled oil**.

While investigating the dispersal of oil particles in Canada's northern environment, Zhang and her team discovered that when oil encounters the microplastics that are becoming increasingly prevalent in marine waters, they form new "microplastic-oil-dispersant aggregates" which affect oil dispersion. They determined that when microplastics are present a higher volume of oil dispersant is needed to increase its effectiveness.

Since April 2018, Zhang's research has generated over **100 peer-reviewed publications** and **two books**, and been the subject of more than **60 presentations**.

The research infrastructure

Zhang was awarded **$50,000** in 2017 and **$82,000** in 2022 from the CFI in support of research equipment including a solvent evaporator system, which pre-treats samples to aid in characterizing oil compounds, and a fluorescence microscope system that provides high-quality images of interactions between oil and other pollutants, such as microplastics.

The impacts

Zhang's research is helping support **Canada's place as a global leader in oil-spill response** in two important ways. First, her study of coastal oil-pollution control has shown the integrated impacts of oil and microplastics on marine environments. This research is contributing to the development of improved regulatory practices. Second, her research has led to the **creation of biologically based and environmentally friendly products** for mitigating the effects of oil spills.

New bioproducts

A major contribution to oil-spill response that has come out of research at CERL is the production of new types of biosurfactants, which are the key components of bioproducts, such as biodispersants and biodemulsifiers. Zhang and her team studied naturally occurring, biosurfactant-producing and oil-degrading bacteria in marine waters and then used those bacteria to generate biosurfactants.

The team also **repurposes waste materials generated from fisheries and breweries** by transforming them into substrates for microbes that produce biosurfactants. The suite of resulting biosurfactants and associated bioproducts could be used in the future by oil-spill responders such as the Canadian Coast Guard and the Eastern Canada Response Corporation. They are also of interest to the petroleum and shipping industries for mitigating oil spills during their operations. These new products are eco-friendly and could also generate economic benefits for Canada.

Impact on coastal communities

Canada has the longest coastline in the world. One-fifth of Canadian cities are coastal communities and nearly 6.5 million people in Canada live in marine and coastal areas. Oil spills have long-term impacts on the environment, economy and society. They constitute a major hazard to marine life and human health in coastal and Indigenous communities. Spills can also negatively impact fisheries and local tourism industries by despoiling beaches.

Zhang collaborates with coastal communities in Newfoundland and Labrador to address their concerns about potential oil spills. She also shares scientific information with them to explain how research on environmentally friendly oil-spill responses can benefit fishing and other industries by preventing long-term economic loss caused by oil pollution.

Improving regulatory practices

The Government of Canada has identified the protection of the country's oceans and coastlines as a national priority. Zhang's research addresses this priority by developing **evidence-based methods to expand Canada's oil-spill toolkit**.

Canada's current offshore oil-spill-response legislation only allows for mechanical responses, such as booming and skimming, to mitigate damage to the marine environment. However, vessel-based skimming operations collect a large volume of oily seawater that needs to be treated for safe disposal. Further, the **legislated acceptable levels of oil in wastewater has steadily decreased**. Research that advances water treatment technology involving decanting is therefore required to meet both environmental needs and elevated standards.

The biodemulsifiers Zhang's team produces are not only effective at breaking up oily emulsions and treating water over a wide range of seawater conditions, they are also less toxic and more biodegradable than traditional chemical demulsifiers. This technology has caught the attention of the Department of Fisheries and Oceans Canada (DFO) and may help the department **improve its science-based regulatory operations and decision making on marine oil spill response and wastewater treatment**.

Zhang's research may also inform regulatory changes to the use of other non-mechanical oil response techniques. For example, DFO and Environment and Climate Change Canada are supporting oil-spill-response studies that may impact legislation regarding the use of environmentally friendly products in Canadian waters.