S&E SCIENCE AND THE ENVIRONMENT BULLETIN S&E
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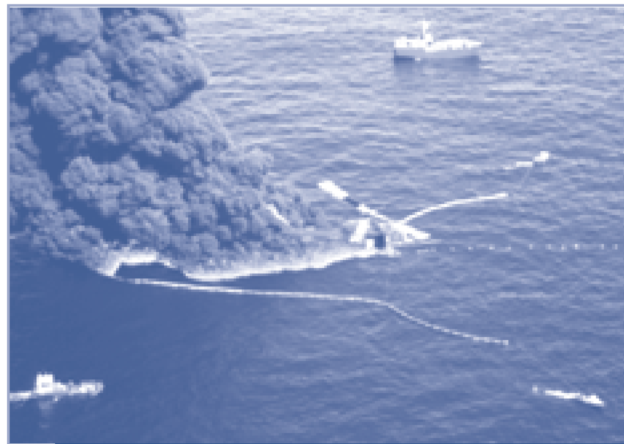
THE BURNING QUESTION

Dozens of large oil spills occur around the world each year—many at sea when tankers capsize, run aground or collide with other ships. Using mechanical skimmers or absorbent materials to clean up such spills is a costly and labour-intensive effort that can take months or years to complete. In cases where access to the site has been difficult or snow and ice interfered with such methods, spills have been successfully burned.



A helicopter takes air samples over a burning oil slick as part of a field experiment to determine the emission levels from controlled burns.

Despite the negative visual connotations of a thick black smoke plume, in-situ burning has been proven through extensive laboratory and field testing to be a fast, effective and often environmentally acceptable oil-spill countermeasure. Burns rapidly reduce the volume of spilled oil, decrease or eliminate the need to collect, store, transport and dispose of large volumes of recovered material, and shorten response time—thereby reducing the chances of a spill spreading and harming aquatic or shoreline wildlife.

Burns are often used as an oil-spill countermeasure in the Arctic, as well as on muskeg, swamps, and remote shorelines that have no vegetation. Yet concerns over atmospheric emissions, and a lack of understanding about combustion products and the combustibility of oil on water, have greatly limited their application. In an effort to address these questions, an international group of scientists and spill response specialists have carried out extensive laboratory tests and more than 45 large-scale burns over the past decade to study various aspects of diesel and crude-oil burning.

Environment Canada's Environmental Technology Centre (ETC) plays a lead role in the group, which comprises more than two dozen government agencies, oil companies and petroleum associations from Canada and the United States, including the Canadian and American coast guards, and the U.S. Minerals Management Service and Environmental Protection Agency. The focus of their efforts has been on measuring emissions to air and water. Data from numerous small burns conducted at the U.S. Coast Guard facility in Mobile, Alabama, and a major large-scale open-water burn carried out off the coast of Newfoundland have been used to develop concentration prediction equations for more than 150 compounds or emission categories. The equations are used to calculate safe distances and emission levels for various burn sizes.

Results of these tests show that levels of most substances released through the in-situ burning of crude oil are below human health limits quite close to the fire—even within 500 metres downwind of the burn. Moreover, if the oil were burned as a fuel source—as usually intended—it would generally emit higher total levels of pollutants to the atmosphere than it would in an in-situ burn. The total emissions of many substances from an in-situ burn are also lower than those released by crude oil or diesel fuel through evaporation. So the longer a spill sits unremediated, the more of these pollutants it releases to the atmosphere.

A major product of all burns is particulate matter. Both crude oil and diesel fuel produce particles when they burn; however, the levels for diesel fuel are about four times those of crude oil, which are considered

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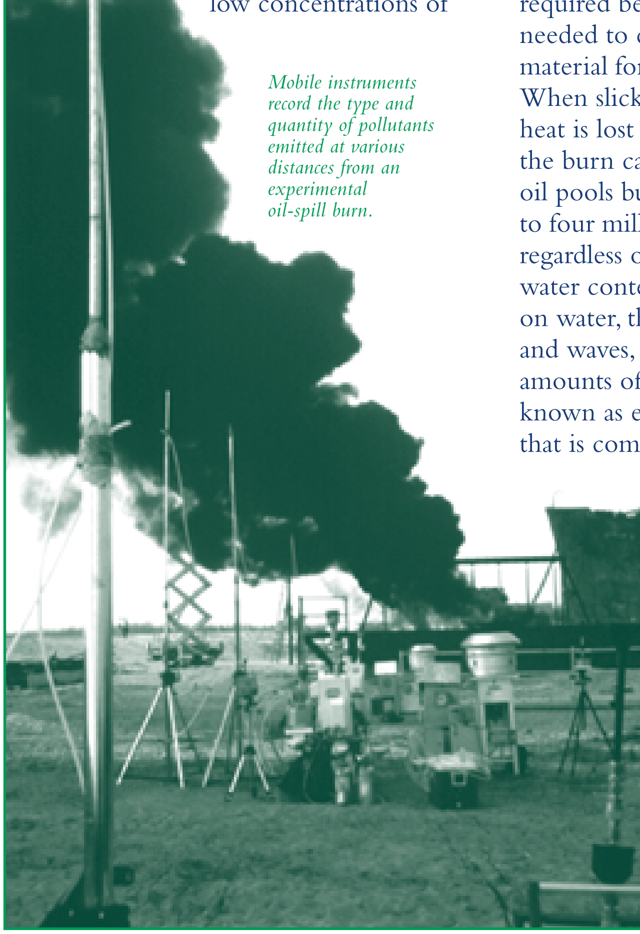
safe for a typical large burn at a distance of half a kilometre downwind from the source. Concentrations of polycyclic aromatic hydrocarbons (PAHs) are found in the particulate matter, soot and residue from such burns, but overall mass concentrations are typically 92-98 per cent lower than in the original oil.

Even close to the fire, combustion gases, including carbon dioxide and carbon monoxide, are typically below exposure-level limits. For example, concentrations of carbon dioxide around a burn can be around 500 parts per million (ppm), compared to normal atmospheric levels of about 300 ppm—but they pose no danger to human health at that concentration. Volatile organic compound (VOC) emissions from burns are extensive, but typically three times lower than the levels emitted from fresh spills through evaporation. Very low concentrations of aldehydes and carbonyls are produced from crude-oil fires, but are well below health concern levels—even close to the source fire.



Mobile instruments record the type and quantity of pollutants emitted at various distances from an experimental oil-spill burn.

Analyses of soot and residue samples show that the bulk of this material is carbon, with several hundred absorbed or adsorbed chemicals also present in very low concentrations. The volume of soot produced through in-situ burning is uncertain because there are no measurement techniques to determine the total emissions for such a large area; however, estimates are from 0.2 to 2 per cent of the original volume for crude oil and about five times that for diesel fuel. The residue itself is mostly unburned oil, which is adhesive and therefore fairly easy to recover using mechanical or manual techniques.

Contrary to what many people think, most if not all oils will burn on water if the slick thickness is at least two to three millimetres. This thickness is required because sufficient heat is needed to continually vaporize the material for sustained combustion. When slicks are thinner, most of their heat is lost to the water below, and the burn cannot be sustained. Most oil pools burn at a rate of about three to four millimetres per minute, regardless of type, weathering and water content. Many oils that are left on water, through the action of wind and waves, can take up significant amounts of water through a process known as emulsification. Although oil that is completely emulsified with water cannot be ignited, some tests show that crude oil can be ignited with up to 70 per cent water content.

Burning in situ without slick containment is usually an option for only a few hours after a spill event, as oil spreads rapidly to an equilibrium thickness of just a fraction of a millimetre on the open sea. Lightweight and fire-resistant containment booms are usually required to concentrate oil slicks so they will ignite easily and continue to burn efficiently until the thickness of the oil and residues falls below two to three millimetres. These booms are typically towed slowly in a "U" shape by two boats, so that the oil will continue to collect and thicken in the apex. The oil can be ignited using a variety of unsophisticated methods, although the latest technology is a helicopter-mounted device that slings packets of burning, gelled fuel at various spots on the surface of the slick.

A trial burn conducted at the site of the 1989 *Exxon Valdez* spill off the coast of Alaska showed that in-situ burning can be used effectively without threatening to ignite the spill source by towing the booms through the slick until they reach capacity, and then moving the captured oil away from the main slick and igniting it. Had in-situ burning been used as the primary countermeasure in this case, scientists estimate that over 60 per cent of the spill would have been destroyed quickly—representing a considerable savings in time and effort, since the actual clean-up cost $2 billion and took two years.

The ETC has written dozens of scientific reports on the results of its in-situ burning studies over the past several years, the last of which were published this summer and synthesized into a summary document. Last year, a special handbook on the in-situ burning of oil and diesel spills was also produced to guide emergency responders. It is hoped that increased scientific and operational knowledge and better awareness of the economic and environmental benefits of in-situ burning will increase the acceptability of this oil-spill countermeasure option—not only in North America, but also in the rest of the world. S&E

NEW REMEDIATION TECHNIQUE TOPS THE LIST

Organic waste from sewage and pulp and paper mills, and chemicals from steel, petroleum and other industries have contaminated sediment in many of the world's harbours, lakes, rivers and canals. In addition to affecting water quality and aquatic life, some of these contaminants combine with others—and with compounds that are naturally present in saltwater—to create foul-smelling, corrosive and highly toxic aerosols.

In some places, such as Asia, the problem has reached such proportions that the health of people living near these waterways and the harvesting of fish and shellfish have been affected. In Canada, the problem is less severe, but it has still reduced water quality in some areas and caused the growth of tumours in some species of fish.

The most common way of dealing with sediment contamination is to scoop or vacuum up the sediment with a barge-mounted dredger and haul it away for long-term storage or for treatment. Unfortunately, trucking and disposal are expensive and pose the risk of an accident or leak. Storing contaminated material on site is handier, but reduces the area of usable land at the site. Dredging itself also has drawbacks—it has a significant impact on habitat, may not remove all of the sediment in question, and may not be feasible if the sediment is unstable or the water too deep. Dredging is also not sustainable over the long term—a problem if remediation must be repeated periodically to address added contamination.

In searching for a better way to deal with extensive sediment contamination in Hamilton Harbour and Sault Ste. Marie, Ontario, scientists with Environment Canada's National Water Research Institute (NWRI) in Burlington have created one of the first commercialized on-site remediation processes. The Limnofix In-Situ Sediment Treatment Technology (LIST) uses an underwater harrow towed behind a boat to till the contaminated sediment and inject it with a chemical oxidant, usually calcium nitrate. Since calcium nitrate is also a nutrient, it must be injected deep into the sediment to prevent it from escaping into the water column and boosting the growth of algae.

Any rich organic waste, such as untreated sewage, can convert sulphates, which are found in industrial waste and occur naturally in sea water, to create a toxic, odorous and corrosive hydrogen sulphide gas. The oxidant injected in the LIST process promotes the aerobic biodegradation of contaminants by providing oxygen to the bacteria in the sediment, and by oxidizing the sulphides that impede this natural process. Although oxidization takes place relatively quickly, bioremediation can take several months—depending on the type and severity of the contamination.

LIST being used in a pilot-scale remediation project in Hamilton Harbour.

LIST has been demonstrated successfully in bench and pilot-scale studies in Canada, the United States, Europe and Asia by Golder Associates—LIST's commercial licensee—with support from NWRI. In 1998, a full-scale treatment was carried out near the old airport in Hong Kong, where sewage-contaminated sediment in the marine environment was causing serious odour problems and corroding nearby buildings and aircraft. Within weeks, the sediment had turned from black to brown, more than 95 per cent of the sulphides were remediated, and the odour had dissipated significantly.

A five-year pilot project initiated the same year in Salem, Massachusetts, is also showing positive results. The site, an inter-tidal mudflat contaminated with coal tar from a coal gasification plant, underwent two LIST treatments in 1998 and 1999 using an injection system towed behind a tractor at low tide. It is now 90-per-cent remediated.

Future uses of LIST are equally promising. Environment Canada is providing technical support for a full-scale remediation to take place on the Shing Mun River in Hong Kong. Through Golder Associates, LIST has been accepted by the United States Naval Facilities Engineering Service Center to clean up some American naval sites. In the meantime, scientists at NWRI continue to explore alternatives—such as capping contaminated sediment with a layer of material fortified with chemical additives—to create a suite of techniques that will be effective in a wide range of situations. S&E

AGRICULTURAL PESTICIDES AND THE ATMOSPHERE

Placing flux chambers on a canola field to measure lindane volatilizing from treated seed.

Humans have waged war against plant and animal pests that threaten their food supplies ever since the first crops were planted thousands of years ago. The arsenal of toxic chemicals used to control weeds and insects nowadays, however, may be causing casualties beyond the borders of our farms.

Studies carried out by scientists at Environment Canada (EC) and Agriculture and Agri-Food Canada (AAFC) show that some pesticides escape into the atmosphere through a process known as volatilization. After application, these chemicals are released as gases or adhere to particles, such as soil dust. Some of these pesticides can travel long distances in the atmosphere before they wash back down to earth in rainfall or settle out through dry deposition. This not only poses a serious threat to non-target areas, such as wetlands and other sensitive ecosystems, but also represents a significant economic loss to farmers.

Pesticides are somewhat unique among industrial chemicals in that they are designed to be highly toxic, yet are distributed and applied widely in the environment. In the Canadian prairies, where agriculture is a primary industry, most cultivated land is treated with pesticides. Herbicides are the most commonly used, with more than 20 000 tonnes applied to farms in Manitoba, Saskatchewan and Alberta every year. Although herbicides are mainly toxic to plant systems, they can be toxic to mammals as well, and little is known about the long-term effects of low levels of such chemicals or their combined effects on other organisms. The use of insecticides, which are generally more toxic to mammals, is less common but has increased significantly in recent years due to a rise in insect-susceptible crops such as canola and lentils.

Saskatchewan uses almost half of all the pesticides applied to crops in the Canadian prairies. To track the movement of these chemicals, EC and AAFC took soil and water samples on treated cropland and nearby sites, and air and bulk-deposition samples at these sites and others located far from agricultural activity. To ensure that measurements reflected the significant quantity of dry deposition that occurs under prairie conditions, scientists developed a system to measure both wet and dry deposition—a self-rinsing steel tray that washes material deposited on its surface into a reservoir for separation and later analysis.

Concentrations of a number of herbicides were detected in the atmosphere as well as in the water and surface film of farm ponds or dugouts. Among the most prevalent were 2,4-D and triallate—pesticides that are applied to crops mainly by tractor-drawn equipment in order to control weed infestations in cereal crops. Both are used extensively in the prairies, where it is estimated that more than 3.8 million kilograms of 2,4-D and 2.7 million kilograms of triallate are applied annually. Results showed that concentrations of pesticides in farm ponds were higher than normal after the growing season—evidence that atmospheric transport is a major source of these contaminants. Studies at agricultural research stations in the province estimated post-application volatilization rates for 2,4-D and triallate at about 18 per cent.

Other evidence of the atmospheric transport of pesticides came from air samples taken near Regina, Saskatchewan, in Yellowknife, Northwest Territories, and in the Arctic—all of which contained pesticides that were not from local sources. Of particular concern were concentrations of the insecticide lindane, a suspected carcinogen that has the potential to accumulate in the fatty tissues of animals. An estimated 20 400 tonnes of lindane are applied annually around the world—500 tonnes of it in Canada alone, where it has been used primarily as a treatment on canola seed.

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While the Regina air samples contained fairly high concentrations of the form of lindane used on canola crops in Canada, Arctic air samples also contained another form used in India and other countries, proof that the pesticide has the capability to travel thousands of kilometres in the atmosphere. To determine just how much lindane was entering the atmosphere from the five million hectares of canola grown in the prairies, where about 95 per cent of canola seed is pre-treated with lindane, Environment Canada scientists undertook the first-ever tests of volatilization from pesticide-treated seed.

Air concentration and wet-dry deposition samplers were stationed in a treated canola field northwest of Saskatoon, Saskatchewan, an abandoned farmyard two kilometres away, and just outside of Waskesiu, in Prince Albert National Park. Data were gathered over two growing seasons, and additional tests were carried out using flux chambers placed directly on the soil to trap escaping gases and particles. Based on their findings, which included atmospheric concentrations of lindane as high as 16.1 nanograms per cubic metre at the treated field, scientists estimate that up to 30 per cent of lindane applied to canola seed enters the atmosphere through volatilization. This represents an atmospheric loading of up to 188.8 tonnes in the prairies alone during the six-week period following planting.

One reason for this high rate of volatilization is that lindane has a high vapour pressure, and the treated seed is planted at a depth of only about three to five centimetres. This makes it readily exposed to the air, particularly in the coarse soil typical of the prairies. It was also noted that soil moisture increases the rate of volatilization, perhaps by displacing the pesticide in the soil or by drawing it out through evaporation. A similar effect has been documented with triallate, which is tilled into the soil as a granule before or after seeding.

The results of the study confirm that quantities of lindane released from treated seed during the growing season contribute significantly to regional atmospheric concentrations. Although the significance of Canada's prairies as a source of lindane to other North American and global ecosystems is currently under study, forward trajectories have shown that both the southern Ontario/Great Lakes region and the Arctic receive lindane from the West through atmospheric deposition. The paths being taken by other pesticides that enter the atmosphere are more difficult to pinpoint because those chemicals are in broader use across the country and, therefore, their sources are less easily defined.

A high-volume air sampler measures concentrations of lindane and other airborne pollutants above a canola field in Saskatchewan.

Lindane manufacturers in Canada voluntarily withdrew the use of lindane as a seed treatment on canola at the end of 1999, although producers were allowed to use existing stock until July 2001. The use of lindane as seed treatment on canola is now discontinued in Canada, although it is still permitted for use on some cereal and vegetable crops. Although they represent a small amount of product use in comparison to lindane use on canola, these remaining uses are undergoing review by Health Canada's Pest Management Regulatory Agency in cooperation with the United States Environmental Protection Agency. Both agencies have expressed interest in the results of the atmospheric transport study.

Scientists are hoping that the results of these studies, all of which have recently been or soon will be published in scientific journals, will encourage more funding for research on the toxicity, behaviour, transport and non-target effects of pesticides currently in use. For example, more than two dozen new herbicides have come into use in Canada within the past two decades that are registered for application in very low concentrations, but are very toxic to plants. As the use of aerially sprayed insecticides increases, so too does the need for studies on the movement and effects of these chemicals.

Exposure to annual releases of some pesticides through breathing, consuming contaminated water, or eating contaminated plants could have significant effects on the health of humans and other animals. Low levels of exposure to a mixture of toxic herbicides may also threaten vegetation in non-target habitats. The more we know about the behaviour and effects of these pesticides, the better equipped we will be to safeguard environmental and human health over the long term. S&E

SAMPLING ON THE GO

For decades, technologies have been used to test exhaust emissions from cars, trucks and other on-road vehicles under actual operating conditions in the field. Until now, however, this capability has not been readily available for most mobile off-road and non-road sources such as planes, trains and industrial equipment, which have been identified as significant contributors to air-quality and climate-change problems.

In an effort to address emissions from this important portion of the transportation sector, Environment Canada's Environmental Technology Centre has created a state-of-the-art, portable, sampling apparatus for testing exhaust emissions from these difficult-to-measure mobile sources. The Dynamic Dilution On/Off-road Exhaust Emissions Sampling System—known as DOES2™—is typically housed in a box about the size of a forty-inch television and operates with the assistance of a small gas generator.

A DOES2™ portable emissions sampler mounted on a container hauler in the port of Houston, Texas.

The DOES2™ is usually mounted on or in the test vehicle and connected to its exhaust pipe by a probe that takes samples of the raw exhaust during operation. The exhaust is mixed with a controlled volume of ambient air, and proportional samples of the dilute mixture are collected for measurement of both regulated and non-regulated emissions. A portable computer connected to the sampling system records engine data and calculates emission characteristics—all with the same accuracy in the field as would normally be expected in a controlled laboratory setting.

Although the DOES2™ can be used for conventional on-road vehicles as well as stationary pollution sources, such as generators and turbines, its real value lies in its application to off- and non-road vehicles that cannot be tested in conventional laboratories. Information gathered from such applications will help to promote better understanding and development of pollution-reducing technologies and alternate fuels, and improved strategies for operating and maintaining existing equipment—both by governments from a regulatory/compliance point of view, and by private-sector companies interested in producing related goods and services.

The DOES2™ has been instrumental in analyzing and demonstrating the performance of retrofitting, upgrading, and fuel-conversion technologies in a number of collaborative projects in Canada, the United States, China and Columbia. In Hong Kong and Columbia, the system has been used to assess the efficiency of alternative fuels in buses. It has also been applied in several projects in the United States to test emissions from underground mining equipment in Cleveland, Ohio, construction equipment in New England, and buses in New York City. In Houston, Texas, one of the Environmental Technology Centre's licensees is using the system to conduct tests and demonstrate benefits of their proprietary, alternate-fuel blend—which is a mixture of 20 per cent water—on shipyard equipment.

Environment Canada is continuing to seek proposals from interested private-sector parties to license and commercialize the various applications of the DOES2™. The widespread use of this technology will be useful in determining the feasibility and viability of strategies and products that will ultimately contribute to improved air quality in Canada and around the world. S&E

LAKE BREEZES LINKED TO SEVERE WEATHER

The seemingly benign breezes that blow inland from lakes and rivers can have a considerable influence on the formation of thunderstorms, hail and even tornadoes, according to scientists with Environment Canada's Meteorological Service of Canada. A field study carried out by the Department and Toronto's York University this summer investigated an apparent link between breezes from the Great Lakes and severe weather in southwestern Ontario's "Tornado Alley".

The experiment on the "Effects of Lake Breezes On Weather", known as ELBOW, was a follow-up to a pilot study carried out in 1997 near London, Ontario, that was the first to look closely at the effect of lake breezes on severe weather.

Lake breezes occur because air over land warms up faster than air over water, creating an imbalance in pressure that causes low-level air from the lake to blow inland at a right angle to the shoreline, forcing the air over the land upward. In places where the shoreline juts outward toward the lake, the breezes themselves converge—creating an even stronger updraft.

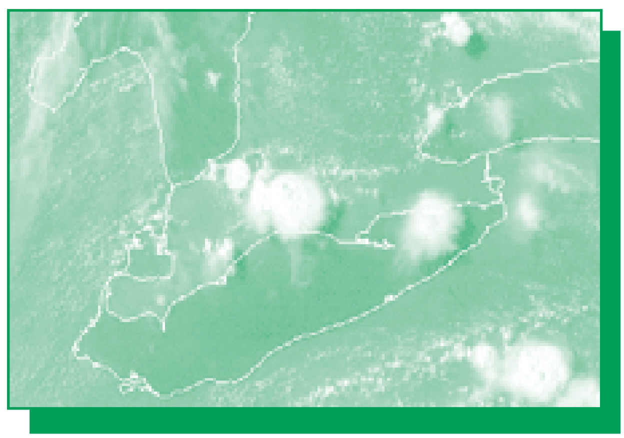
These breezes, however, are not usually the only winds present. Normally, larger-scale high- and low-pressure systems in the atmosphere cause prevailing winds that blow at the same time. The lake breeze circulation and the prevailing winds converge along lines that can extend over 100 kilometres inland. Since there is an updraft along these convergence lines, there is also a strong tendency for clouds to form.

In southern Ontario, prevailing winds in the summertime often blow from the southwest—bringing the warm, moist air needed to form thunderstorms. Under these conditions, convergence lines develop primarily where the shoreline runs parallel to the direction of the prevailing wind—for example, along the northwest shore of Lake Erie and the northwest shore of Lake Ontario between Hamilton and Toronto. These convergence lines are not only capable of triggering storms on their own, but also of interacting with a cold front or colliding with other convergence lines to create particularly severe weather.

An examination of past tornado events shows that most significant twisters have occurred near where convergence lines form when the prevailing wind is from the southwest. This theory is illustrated by the absence of tornadoes on the north shore of Lake Erie east of St. Thomas, where the shoreline does not run southwest-northeast, and a proliferation to the west, where it does.

To get a better picture of the forces at work in this process, a number of observation platforms were deployed this summer between lakes Erie and Huron centred around Exeter, northwest of London. A network of 14 surface weather stations was set up along lines perpendicular to the lakes' shores. Temperature, humidity and wind speed and direction measurements were also taken from permanent weather stations at London, Sarnia and Windsor, as well as from upper-air radiosondes and mobile sources. Additional data were collected from two Doppler radars, two wind profilers and a research aircraft, and forecasts were issued using special ultra-high-resolution versions of the Global Environmental Multi-scale (GEM) numerical weather prediction model with 10- and 2.5-kilometre resolutions.

Despite drier-than-normal conditions, several storms yielded important data. On July 4, satellite imagery showed multiple interactions between a cold front and lake breeze convergence lines on the American side of Lake Huron. Outflow from this storm interacted with a convergence line on the Canadian side to form a supercell storm. Doppler radar captured a strong "hook echo"—a sign of a probable tornado—but no tornado was observed. On July 16, a rotating thunderstorm formed near Melbourne west of London, when convergence lines from Lake Erie and Lake St. Clair merged. Past occurrences in the same area support the theory that tornadoes may be more likely to form in such cases.



Satellite image showing the development of a thunderstorm at the merger point of the Lake Erie and Lake Huron convergence lines. The storm produced local flooding and an unverified report of a funnel cloud.

A closer analysis of the data from ELBOW 2001 will provide scientists with a better three-dimensional view of the atmospheric conditions leading up to lake-breeze-induced severe weather, and enable them to verify and improve models and techniques for forecasting this phenomenon. A related project is proposed to take place in 2003 in the foothills of the Rockies northwest of Calgary, where the mountainous topography causes small-scale air circulations that interact in a similar manner with prevailing winds. S&E

WATER QUALITY IN POINT PELEE MARSH

Point Pelee National Park, on the northwest shore of Lake Erie, contains one of the finest surviving wetlands in the Lower Great Lakes, providing habitat to a rich diversity of species. Over the past decade, however, concern has grown that the quality of water in parts of the marsh has deteriorated to such a point that its natural biodiversity is threatened by a variety of sources.

Elevated levels of nutrients, including phosphates and ammonia, were found in several open-water ponds in Point Pelee marsh, causing a prolific and unsightly growth of algae. The challenge facing researchers from Environment Canada's National Water Research Institute (NWRI) was to discover if the Park's septic systems were the source of the nutrients and find out how they were moving through the hydrogeological environment of the Park.

Very little was known about the mechanisms controlling groundwater flow at Point Pelee National Park. The marsh is separated from Lake Erie by barrier bars along its east and west sides. A barrier bar is a continuous offshore ridge of sand and gravel formed as a result of wave action and lake currents transporting and depositing the sediment. Because the highest concentrations of nutrients were found along the western bar—the main area of human activity—researchers suspected that they were leaching from septic systems to the groundwater, and flowing from there into the marsh.

Using field data and computer modelling techniques, NWRI researchers conducted hydrogeological and geochemical studies that are providing a wealth of information about the flow of groundwater in the Park and the movement and sources of nutrients. Their results show that the barrier bars are sufficiently wide that they do not allow any direct flow of lakewater between Lake Erie and the marsh. The groundwater flow regime between the lake and the marsh, however, is highly complex, with some areas of the barrier bar having a high potential to transport septic-system-derived contaminants to the marsh, and others having almost none.

The research team also discovered that, while the Park's septic systems contribute to excessive nutrient input at certain sites, they were not the major source at Sanctuary Pond—the area of the marsh with the highest nutrient concentration. Instead, the main contributor was the regeneration of nutrients from pond sediment—a

Installing a multi-level groundwater sampling well in Point Pelee marsh.

natural process that takes place in all open-water ponds, but varies from one location to the next due to differing nutrient levels in the sediments. Work to better understand groundwater flow and its influence on nutrient cycling in the Park continues, and will assist in developing management strategies to improve water quality in affected areas.

NWRI researchers have also been grappling with a historical problem that poses a threat to Point Pelee's ecosystems. Between 1949 and 1970, DDT was used on a large scale to control pests in former orchards and mosquitoes in the Park. The pesticide was applied as a particulate spray over wide areas and also as "toss bombs" at specific sites or pools of water. By the late 1990s, it was expected that the DDT would have degraded. However, in 1998 it was detected in shallow soil at several locations.

Parks Canada asked NWRI scientists to confirm the reported high concentrations of DDT, identify the extent of the contaminated area, and determine the reason for the pesticide's persistence. They found that while DDT contamination is widespread in areas formerly occupied by apple orchards, it is restricted to the top few centimetres of the soil where the organic content is high. Through computer simulations, they verified that because of the highly adsorptive nature of DDT and its low solubility, it would be held in the organic-rich portion of the soil and not leach downward to the water table. Hence, the groundwater is not contaminated, and there is little potential for the DDT to be transported to the marsh via groundwater.

Research is now in progress to assess the impact of different soil micro-environments on DDT persistence and degradation pathways. Ultimately, this information will be used to develop technologies to remove and degrade the DDT without causing widespread destruction to the Park's wildlife and vegetation. S&E

S&E Bulletin

This bi-monthly newsletter provides information on Environment Canada's leading-edge science and technology.

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