COOKING OIL AND CLIMATE CHANGE

That order of french fries with a lunchtime hotdog is just one of thousands of daily uses of cooking oil in Canada. What most people don't know, however, is that conventional methods for extracting oil from plant materials require enormous amounts of energy, which in turn produce significant greenhouse gas emissions. These methods also use large quantities of the solvent hexane, which, when released to the environment, degrades to produce greenhouse gases that contribute to climate change.

Canola flower.
Photo: Canola Council of Canada

Scientists from Environment Canada's Environmental Technology Centre in Ottawa are working with CanAmera Foods and BC Research to increase the efficiency of the oil extraction process, and to reduce energy usage and greenhouse gas emissions. The three are undertaking a demonstration project to test the use of Environment Canada's patented Microwave-Assisted Process (MAP™) in extracting cooking oil from canola.

Canola was chosen not only because it is an integral part of Canada's economically important cooking oil industry, but also because current canola oil extraction methods are expensive and require large amounts of hexane. Hexane is not yet accounted for in Canada's greenhouse gas inventory, because its degradation in the environment is complex and not fully understood. It is known, however, that its initial degradation includes the rapid release to the atmosphere of carbon dioxide — a primary greenhouse gas.

The MAP™ technology requires less energy than conventional extraction methods because it uses microwaves to rapidly heat specific components of liquid and solid materials. It has already found extensive use in the laboratory to determine the nature and quantity of contaminants in drinking water samples, and to evaluate petroleum hydrocarbon contamination in plant material and soils. Since applying MAP™ to large-scale use in the food processing industry would require complex retrofitting and a significant investment in equipment, the technology will need to prove itself at least as efficient as current methods in order to be considered for broader applications in the future.

Canola flakes in hexane going through a processing system.

The demonstration phase of the project will involve producing around one tonne of canola oil per hour, but the ultimate goal will be to model the current production of 800 tonnes per day at CanAmera Foods' smallest facility, located in Hamilton, Ontario. In phase two of the project, testing will be done to substitute a liquefied gas, such as propane or butane, for hexane, in the hopes of limiting or eliminating hexane use in the canola oil production industry. Tests will also be performed to determine the feasibility of using MAP™ technology on other feedstock of importance to Canada, such as soya, rapeseed and flax.

Although the energy the food industry could save by using this new technology cannot be accurately determined until data are available on the level of application, a conservative estimate is that MAP™ would reduce energy requirements by at least 50 per cent. A number of private-sector companies in various parts of the world are interested in the outcome of the project, such as South Korea and China for use in rice-bran processing, Malaysia and Colombia for palm oil, Pakistan and India for rapeseed and soya, and various others for cocoa. If the test results are as expected, the technology could be transferred to other countries to help reduce their energy consumption and the greenhouse gas emissions that contribute to climate change. SOE

ST. LAWRENCE HAS ITS UPS AND DOWNS

From the tiniest microorganisms at the bottom of the food chain to the giant ships that ply its channels, the waters of the St. Lawrence River are the lifeblood of an ecosystem that is a unique and integral part of Canada. When these water levels increase or decrease, because of natural or human influences, they cause a ripple effect on virtually every aspect of this ecosystem.

The water levels of the St. Lawrence have been monitored and recorded since the mid-1800s. These records show long-term cycles of peaks and valleys lasting 15 to 35 years, with a two-metre difference in average levels between the highest and lowest years. The river's lowest levels occurred in the 1930s and 1960s, and the trend is once again at the bottom of the curve. These levels could be severely affected by climate change, because higher temperatures would increase evaporation and longer periods of drought would decrease flow.

St. Lawrence Centre biologists taking water-level measurements in a dried-up marsh on the St. Lawrence River near Boucherville, Quebec, in August 1999. Under normal conditions, the water would come up to waist level.

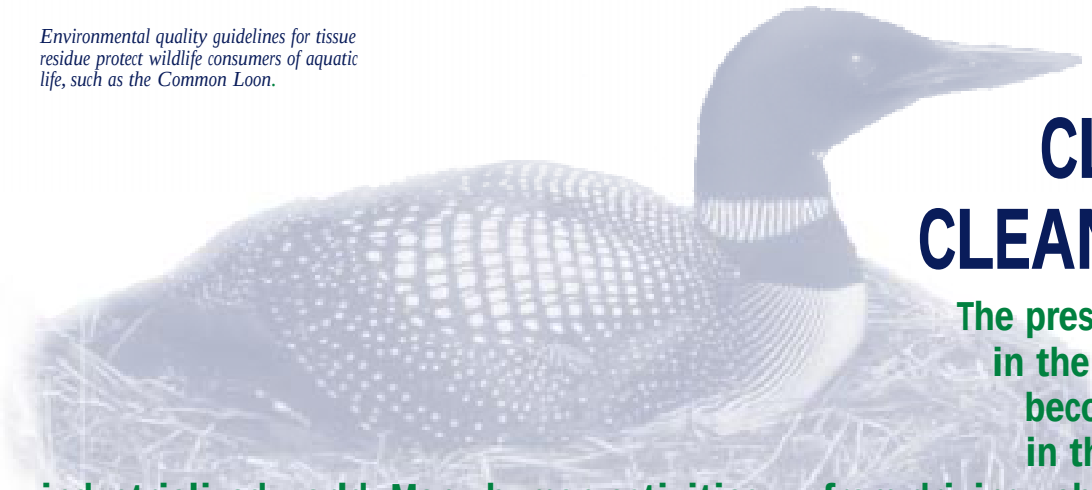
To determine just how severe this effect could be, scientists at Environment Canada's St. Lawrence Centre and in the Meteorological Service of Canada are working with the Quebec government and universities to study the physical, chemical and biological components of the St. Lawrence River ecosystem. Their research involves everything from laboratory work to taking extensive samples of the river, shoreline and surrounding wetlands.

Although the sampling is still in its early stages, several trends are emerging. Extreme low water levels observed in 1999 resulted in a difference in the surface area of available habitats, causing an invasion of terrestrial, opportunistic plants into the dried-out wetlands. To the untrained eye, there may not have seemed much of a difference. For example, certain sections of riverbank seemed quite green, even when water levels were low. However, the question is of quality versus quantity. Are the plants in good variety, are they native plants, or is there an increase in the alien species and plants that don't provide much by way of food and cover for wildlife?

Animals, microorganisms, oxygen levels in the water, and the richness of the ecosystem itself are all affected by lower water levels. In the spring, for instance, less water is an advantage to duck populations because there is less risk of nests being flooded. But if the water stays low, there are no longer deep pools within reed beds where the ducks can feed, forcing them out of sheltered areas to find food. In the open water ducklings become more vulnerable to predators and disturbance by pleasure boaters.

The data collected through field sampling are fed into a numerical model of the St. Lawrence River that was developed by Environment Canada in cooperation with the National Institute for Scientific Research and other partners. The model, which concentrates on the region from Cornwall to Trois-Rivières, can be used to assess the impacts of different water-level scenarios in which the river physics and chemistry change. In essence, it uses physical aspects of the habitat, such as water depth, currents, waves and sediment, to predict the potential impact on the flora and fauna. A greater knowledge of the physics of the river also enables an informed response in the case of an oil spill.

Integrating biological information from field sampling with hydrological modelling will lead to a better understanding of the environmental challenges facing the St. Lawrence River ecosystem, and provide a framework for measures to protect this valued and integral part of Canada's natural landscape. S&E



Environmental quality guidelines for tissue residue protect wildlife consumers of aquatic life, such as the Common Loon.

HOW CLEAN IS CLEAN?

The presence of chemicals in the environment has become a fact of life in the modern, industrialized world. Many human activities — from driving vehicles to manufacturing paper — release potentially harmful pollutants into the world around us. To help protect the quality of our natural resources, Environment Canada scientists recommend specific limits for a variety of substances that, if exceeded, could impair the health and beneficial uses of our ecosystems.

Since 1987, the Department, working in collaboration with provinces and territories, has developed more than 500 national environmental quality guidelines for over 220 toxic substances of concern in Canada. Already in use in this country across all jurisdictions and recognized as a model for guidelines in Australia, southeast Asia, Mexico, Chile and other parts of the world, they were recently updated and released for the first time as a single compendium by the Canadian Council of Ministers of the Environment (CCME). The publication, entitled *1999 Canadian Environmental Quality Guidelines*, is the most comprehensive document of its type ever produced.

The development of environmental quality guidelines is carried out at Environment Canada by toxicologists, chemists and biologists who conduct experiments and comprehensive assessments of each substance. Working in cooperation with researchers from other governments, the private sector and academia, they evaluate the most up-to-date scientific information available from research around the globe, and use the results to determine the "no effect" levels. To make them truly national, the guidelines proposed are reviewed and approved by the federal, provincial and territorial environment ministries that report to the CCME Ministers.

A large and very complex part of this work is establishing scientific protocols for deriving the "no-effect" levels — that is, coming up with objective formulas for determining how much of a substance is too much in the environment. Toxic substances in the environment affect a wide variety of resource uses and, through these uses, numerous different receptors. Receptors affected by soil quality, for example, can include humans, livestock, various food crops and other vegetation, and a host of wildlife species ranging from prairie dogs to earthworms.

The numerous and varied ecosystems found in Canada have different beneficial uses, so the guidelines are developed to protect, maintain or restore these uses. For example, soil quality guidelines protect and sustain agricultural, residential, commercial and industrial land uses; whereas sediment quality guidelines protect aquatic life, and tissue residue guidelines protect wildlife.

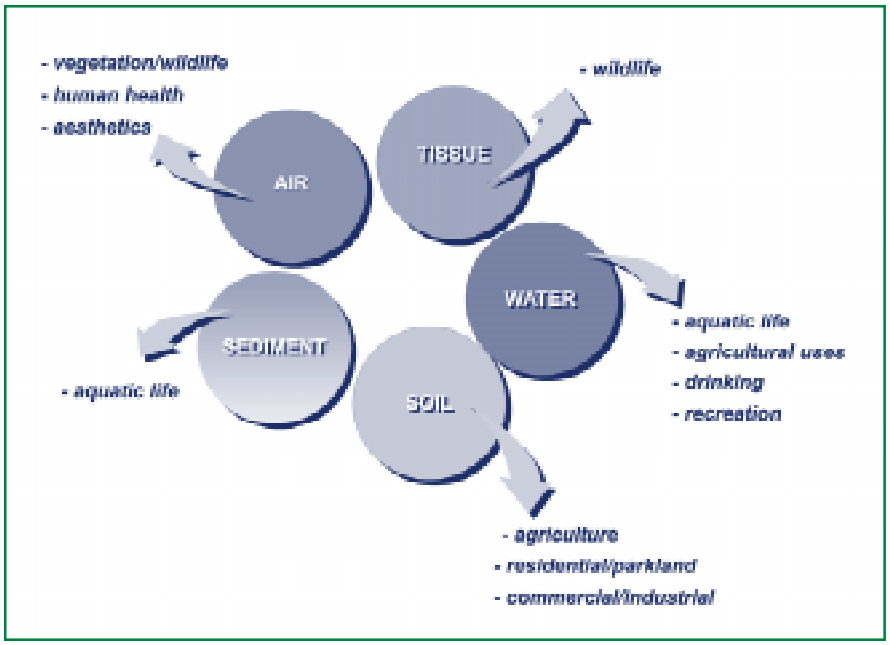
Environmental quality guidelines are also used to promote sustainable agricultural practices.

Continued on page 8

Continued from page 7

Environment Canada's science is critical in the creation of new knowledge and in answering questions regarding the use, behaviour, toxicological effects, major sources, concentrations of chemicals in the environment, their fate and persistence, and the influence of other environmental factors on their toxicity. This information, which is also included in the 1999 Guidelines, provides the scientific context and rationale for the numerical or narrative limits identified, and improves understanding of the impacts of exceeding them. Environment Canada scientists are also involved in determining which substances require environmental quality guidelines through their involvement in the development of the National Priority Substances List and other national activities, such as the development of Canada-wide standards.

As national benchmarks for the quality of our environment, these guidelines are used in a number of ways. They are used extensively as the scientific basis for environmental regulations and standards, as tools to evaluate the effectiveness of point-source pollution controls for industries, and in the assessment and remediation of contaminated sites. Provincial and territorial governments use them frequently in developing and issuing permits for discharges, and they support a variety of federal legislative acts and international conventions. By indicating changes and trends in concentrations of persistent, bioaccumulative and toxic substances in the ambient environment, the guidelines also enable resource managers to track progress toward virtual elimination of this special group of substances, and can serve as interim management objectives. Used as national recommendations rather than across the board standards, they can also be modified to take into account different resource uses and environmental conditions at the local or regional level.



Graphic showing how the environmental quality of our land, water and air affects different resources and users.

Most importantly, the 1999 Guidelines encourage Canadians to incorporate science into their decision making and to look at environmental conservation and protection in a more holistic manner that takes into consideration the far-ranging impacts of human activities on the environment. The document is already available in both printed format and on CD-ROM, and scientists hope it will eventually become more widely available so that all Canadians can develop science-based solutions to minimizing the impact of their day-to-day lives on the quality of our natural environment. S&E

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is a bi-monthly publication produced by Environment Canada to provide information on leading-edge environmental science and technology to Canadians.

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