Health

AN ECOSYSTEM APPROACH

Fighting Malaria Without DDT

Better management of the environment a key to disease control

Under the terms of the North American Free Trade Agreement, Mexico was committed to eliminating DDT use by 2002. The country's malaria-control efforts, however, depended on this chemical. Researchers set about to develop alternate strategies by addressing factors that affect malaria's spread: humans, mosquitoes, and the local environment in which the parasites persist. As a result of this integrated approach, Mexico was able to abandon DDT ahead of schedule.

IDRC: Peter Bennett

Treatment is delayed when malaria is diagnosed through laboratory analysis of blood samples, which can take up to 28 days.

The black-and-white film footage from the 1950s shows the assault. A small army of men outfitted in protective clothing and masks advances on a village, spray canisters slung over their shoulders. The enemy — mosquitoes that carry malaria. The weapon of choice — DDT.

Fast-forward a few decades to Oaxaca State, Mexico. Several women, ankle-deep in water, throw green mats of algae onto the riverbank. With each toss of the pitchfork, thousands of mosquito larvae lose their habitat.

The women are part of a successful Mexican initiative that is fighting malaria on many fronts. Through community involvement in control strategies, improved surveillance and treatment, and the use of new household spraying techniques, Mexico has dramatically reduced malaria transmission. In 2001 there were just 4,996 cases of malaria — down from 15,121 in 1998. Significantly, this decrease came about without a drop of DDT.

Researchers supported by Canada's International Development Research Centre (IDRC) have been central to this success. Dr Mario Henry Rodriguez, Mr Juan Eugenio Hernández, and their research team have been working on malaria control in Oaxaca State, a part of Mexico where the disease is particularly persistent. With support from several donors and institutions, they are using an ecosystem approach to understand the complexity of the disease and the environment in which it flourishes (see box: Ecosystem Approaches to Human Health). The project they lead has helped Mexico eliminate the use of DDT in just three years. In doing so, it has become a model for other malaria-control programs in the region.

Malaria in Mexico

Malaria has long been a public health problem in Mexico, where conditions in 60% of the country are favourable to malaria transmission. In the 1940s and 1950s, malaria claimed an average of 24,000 lives each year and afflicted some 2.4 million people. The government introduced a malaria-eradication program that

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Bednets help keep malaria at bay

relied on extensive household spraying with DDT and anti-malarial therapy. Cases declined, but it proved impossible to completely rid the country of the disease. The problem was most stubborn in coastal areas, where control measures only succeeded in interrupting malaria transmission. This was demonstrated in dramatic fashion in 1997, when Hurricane Paulina crashed into Mexico, leaving fertile breeding grounds for mosquitoes in its wake. Of the 16,000 cases of malaria that followed, 12,000 were in the coastal state of Oaxaca.

The outbreak triggered a search by Mexico's National Institute of Public Health (NIPH) for new approaches to malaria control that concentrated on "pockets" of persistence. There was a second challenge — within the framework of the North American Free Trade Agreement, Mexico was committed to reducing DDT use by 80% in 2000 and eliminating it completely by 2002 (*see box: Banning DDT*). Any new strategies to fight malaria would have to do without a chemical mainstay of past control programs.

Institutional collaboration

This ambitious goal called for the involvement of several institutions, including the NIPH, the National Centre for Environmental Health, the Malaria Control Program (MCP), and the Centre for Integral Training of Community Promoters. Dr Rodriguez, Director of NIPH's Centre for Research on Infectious Diseases, and Mr Hernández, the Institute's Director of Informatics, undertook an extensive and varied research program. IDRC, Mexico's Ministry of Health, the North American Commission for Environmental Cooperation, and the Mexican National Council for Research and Technology supported various components of the research.

The researchers adopted an ecosystem approach to better understand the complex set of factors that influenced the incidence and spread of malaria in Oaxaca. "We've looked at malaria from many angles, including the molecular biology of the vector and the parasite, community perceptions of malaria, statistical analyses, and a geographic information-based surveillance system," says Mr Hernández.

The team included specialists from several disciplines: epidemiology, informatics, entomology, and the social sciences. Before the project, the researchers had been working on separate areas of inquiry. The "ecohealth" approach, however, brought a measure of both collaboration and coherence to the research. "Ecohealth is a dynamic process that integrates the views of various disciplines as well as those of the stakeholders," says Dr Rodriguez. "It's a way of systematizing the research."

Importance of GIS

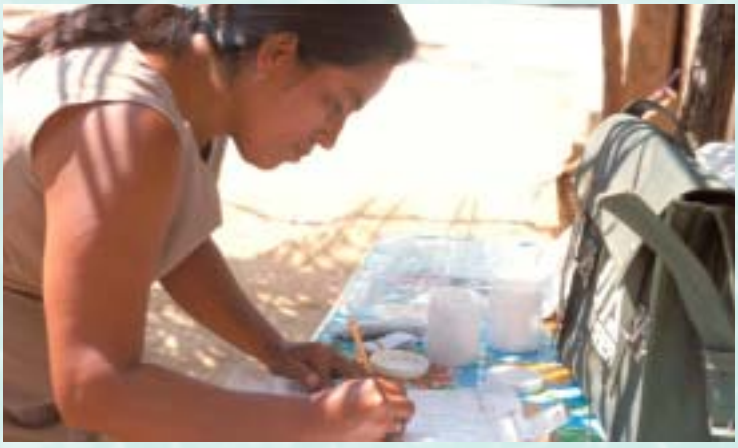
To help assemble the pieces of the malaria puzzle, the project used a geographic information system (GIS) — a computerized mapping tool that processes and synthesizes data from many sources. The GIS application covered more than 2,000 villages and included data on elevation, climate, average rainfall, insecticide spraying, distance to rivers and roads, and short-range human movements.

By analyzing the GIS maps, researchers identified areas of high malaria risk. They found, for example, that the closer a village sits to a main road, the more likely its inhabitants will contract the disease. Research on the ecology of mosquitoes pointed to the reasons why. "Mosquitoes don't move around much," says Dr Rodriguez. "If you have a place to lay your eggs and get your food, why do you have to visit somebody else?"

In other words, although mosquitoes transmit malaria, infected people are responsible for spreading it. When there is easy access to a major road, malaria travels along it. "We are viewing humans as the real vector, with mosquitoes as the dispersing agent in the very local environment. But human beings are transporting the disease further away," stresses Mr Hernández.

How malaria spreads

With the help of community members, researchers looked more closely at how people were contracting and spreading malaria. They gathered basic demographic information and examined such factors as the condition of bednets, type of housing, and



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Volunteer health promoters help identify the risk factors that make households and individuals susceptible to malaria.

the presence of animals and vegetation near homes. The research also looked at gender differences associated with malaria transmission. Women typically fetch water early in the morning — a time when malaria-bearing mosquitoes are biting. Similarly, men are at risk if they spend the night on coffee plantations where they have no protection against the insects.

Data showed that about half of all the malaria cases were relapses. "If you think that after you treat a community, it is free of the parasite, it is not true," says Dr Rodriguez. "It is dormant in the liver of the patients. When the mosquitoes come back, the parasites wake up and malaria returns." GIS maps reinforced this information by showing how malaria was a "repeat offender" in certain households. In San Rafael Toltepec, for example, 78% of the malaria cases were in 28% of the houses.

Focal control

For this reason, public health authorities introduced focal or targeted control of malaria. People who have had malaria the year or two before are given preventative medication during the malaria "high season." Their houses are also sprayed with a pyrethroid-based insecticide that, unlike DDT, does not persist in the environment. "In this way, we think we can block the cycle of transmission and relapse," says Dr. Rodriguez. "It's important that we don't give prophylaxis to everyone, mainly because of the cost but also because the malaria parasite will become increasingly drug resistant."

Dr Rodriguez and other malaria control officials are also promoting a new approach to insecticide spraying. Using a newly developed mechanical pump, two people can spray about 40 houses per day, compared with 8 houses using a manual pump. "This means people are being protected faster, and at the same cost as the previous technology," Dr Rodriguez says.

Banning DDT: a tale of two prizes

In 1948, Paul Hermann Müller won the Nobel Prize for his discovery that DDT was a highly effective insecticide. When it was widely used to fight insect-borne diseases, the World Health Organization estimated that it saved 25 million lives. Today, the chemical has gone from saviour to scourge because of its harmful effects on the environment and to human health.

Canada and the USA banned DDT in the 1970s, but it was still used to control malaria in Mexico. In 1997, Canada, Mexico, and the USA established a North American Regional Action Plan on DDT as a way to cooperate and share experiences in phasing out the substance. The resulting malaria-control program was so successful that Mexico stopped using DDT two years ahead of schedule.

The Mexican model is an integrated strategy based on community participation, prevention, and improved diagnosis and treatment. For their contributions to developing this approach, Mr Hernández and Dr Rodriguez were awarded the Jorge Rosenkranz Award in October 2002. The prize aims to stimulate scientific research and reward academic excellence.

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Despite control efforts, malaria has been a persistent problem in the foothills and plains of the coastal state of Oaxaca, Mexico.

Community action

Community involvement is critical; villagers are literally getting their feet wet in the fight against malaria. Work parties, made up primarily of women, wade into water near their villages every two weeks to remove algae. By getting rid of the plants, the villagers deprive the mosquito larvae of their habitat and populations of the insect subsequently decline.

The community also collaborates in testing new methods of surveillance. The conventional approach to diagnosing malaria is through laboratory tests. Blood smears from people with malaria symptoms are then sent to a hospital for analysis — a process that can take up to 28 days. If the test proves positive, the patient is treated. But the delay between testing and treatment means that malaria continues to be transmitted.

The project is evaluating a new test that provides more than a rapid diagnosis of malaria. "We consider it an intervention too," says Dr Rodriguez. "The most important thing is to catch and stop the outbreak. For that, we need a surveillance mechanism that is effective and timely." The test involves placing a drop of blood on a dipstick, which is put in a reagent mixture for 15 to 30 minutes. If the test is positive, complete treatment can begin immediately and the transmission cycle is broken.

Volunteer health workers are assessing the rapid diagnostic test in more than 60 communities. If it proves to be accurate, "we are empowering the community to treat themselves," says Mr Hernández. Communities are also learning how to reduce their exposure to the disease from an educational video. From sleeping under bednets to chopping shrubbery and removing algae, people can take malaria control into their own hands.

Interventions a success

Statistics show that the interventions are working. In 2002, there were only 237 cases of malaria in Oaxaca State. Researchers are now studying community perceptions of malaria and malaria control to understand the reasons behind this success.

"We are taking a step back," says Dr Rodriguez. "Disease transmission and control might be understood differently by the researchers and the communities." For example, people who had contracted malaria five years ago might say that they have not had the disease. "For them, it is only this year that counts," says Dr Rodriguez. Moreover, many people consult a traditional healer or *saurin* when they have malaria. For these patients, a curse — not a parasite — is causing their suffering.

Even the removal of the algae has challenged researchers' assumptions. According to Dr Rodriguez, the women are clearing the algae because the task is identified as a community endeavour, not because of its connection to malaria.

For these reasons, Dr Rodriguez underlines the importance of continued research. "Our experience is leading us to new understanding that we need to do more social research if we want to expand these interventions to other parts of the country and to maintain them in Oaxaca," he says. "My impression is that we have something that might work. The challenge is to find the lessons that can be applied in a general way to really make a difference."

This *Case Study* was written by Jennifer Pepall, a writer in IDRC's Communications Division.

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A mechanical pump for spraying pyrethroid-based insecticides has helped eliminate DDT in Mexico.

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Ecosystem Approaches to Human Health

Human health and well-being are intimately tied to the health of the ecosystems that sustain life. Yet the potential for improving health by better managing the local environment is an avenue rarely explored in mainstream health programming. Through its Ecosystem Approaches to Human Health (Ecohealth) Program Initiative, IDRC aims to identify the web of economic, social, and environmental factors that influence human health. Communities can then use this knowledge to better manage ecosystems and improve the health of both people and the ecosystem.

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