# Ecosystem Approaches to Health

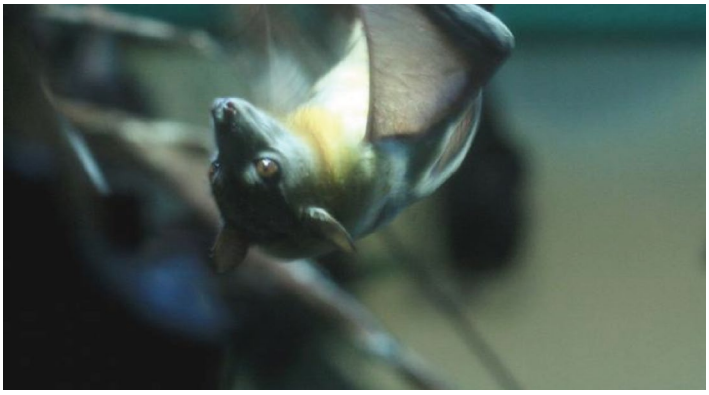
## Introduction

The field of ecosystem approaches to health (EcoHealth) brings together knowledge about ecology, health sciences and society to obtain better outcomes for people, wildlife and ecosystems around the world. It requires collaboration between many fields of scholarship - natural, social and health sciences, and the humanities - as well as educators, policy makers, practitioners and the general public.

This backgrounder provides just a few examples of the ways in which ecological change is having an impact on human health, and highlights some of the researchers looking to make a difference in this emerging field.

## Infectious diseases

Infectious diseases are a leading cause of death worldwide. In 2012, 3.1 million people died as a result of lower respiratory tract infections, while another 1.5 million died of diarrhoeal diseases, 1.5 million of HIV and 900,000 of tuberculosis. The burden is highest in low-income countries, where infectious diseases collectively account for almost one third of all deaths[1]. The economic cost of these diseases is enormous; it's been estimated that tuberculosis costs the global economy $12 billion per year, while malaria may cost up to $73 billion[2]. In addition to these well-established diseases, there is the constant threat of emerging infections, such as new strains of influenza or other viruses. Our increasingly interconnected world - 2.8 million trips were taken on airplanes in 2012[3] - has raised fears that one of these new diseases could become a global pandemic.



*The straw-coloured fruit bat is widespread across sub-saharan Africa. Studies of antibodies in its blood have indicated that it is one of the many species that could act as a natural reservoir for Ebola virusT (Photo credit: Arran ET, via flickr)*

*Mosquitoes are a common vector for carrying many infectious diseases, such as malaria, dengue or West Nile (Photo credit: dr_relling, via flickr)*

Many emerging diseases are zoonotic, meaning that they can jump to humans from animals. Those animals can be wild or domestic, or sometimes a combination of the two. For example, Nipah virus circulates naturally among bats, but with expanding agriculture it can be passed to pigs and from there into humans[4]. Studies using antibodies and other lines of evidence have shown that bats can also harbour strains of Ebola and other viruses in the same family[5]. Middle East Respiratory Syndrome (MERS) is thought to be passed to humans from camels. In the wild, groups of camels might encounter each other infrequently, but the fact that humans keep and trade camels in large numbers could be creating more favourable conditions for such a disease to spread. A similar effect results from rapid urbanization, leading to many humans and animals living in close proximity. A major focus of EcoHealth research is understanding the complex web which links diseases to animal health, human well-being and livelihoods and environmental sustainability. Further, such an approach recognizes marginalized and vulnerable peoples and empowers communities to support their own development goals in ethical, effective and sustainable ways.

Many infectious diseases are transmitted from one animal to another by a 'vector' usually a blood sucking insect. Malaria, dengue or West Nile disease are spread by a mosquito vector. Human activity can significantly alter the environmental conditions that determine whether how these vectors survive and thrive. For example, irrigation of dry areas can leave pools of standing water that are breeding grounds for certain types of mosquitoes. Spraying of insecticides can control some species, but they also open up new ecological niches for other species to thrive. Human migration can bring in non-native species of insects or alter local biodiversity, which often acts as a buffer to keep vector-borne diseases

## Chagas in Guatemala

In Latin America and the Caribbean, more than 10 million people are infected by *Trypanosoma cruzi*, the parasite that causes American trypsomaniasis, or Chagas disease. While the initial symptoms are mild - typically aches, fever, and localized swelling - over 10-20 years the disease progresses into a chronic state that prevents sufferers from being able to work and in some cases leads to organ failure or death. A recent study estimates that the global economic cost of Chagas disease exceeds USD $7 billion annually[7]. In Central America, the parasite is spread by 'kissing bugs' (*Triatoma dimidiata*) which are native, blood-sucking insects which like to live inside human homes. Past efforts to control the bugs by spraying insecticide have been ineffective as native species of the bugs simple recolonize the houses in a matter of weeks.

A project funded in part by Canada's International Development Research Centre has taken an ecohealth approach to the problem. Led by local researchers like Carlota Monroy of the Universidad San Carlos de Guatemala, transdisciplinary teams of engineers, social scientists and health scientists introduced interventions in target villages. For example, they used locally available materials such as volcanic ash and river sand to create plaster and seal over the dirt floors and cracked walls that harbour the insect vector. They also distributed chicken wire to allow farmers to construct outdoor pens for chickens instead of keeping these animals inside. As opposed to humans and most domestic animals, chickens attract kissing bugs, but the parasite cannot survive in their bodies. Thus, changes that prevent house infestations and make chickens the primary food source for bugs help control the spread of disease. Today, the rate of insect infestations decreased fourfold in Guatemala's communities. The project is being expanded to Honduras, El Salvador and other Latin American countries.

*Top: A house in El Salvador before improvement to prevent infestations by 'kissing bugs' that spread Chagas disease. Bottom: The same house after improvement. (Photo credit: CENSALUD/Gladys Quintanilla)*

from spreading too far. Climate change can alter rainfall and temperature patterns, allowing insect vectors to move into new areas. A recent study in the highland regions of Ethiopia and Colombia already shows malaria spreading to higher elevations in warmer years where malaria traditionally had not been seen, thereby exposing the densely populated regions of Africa and South America to the disease[6].

Lyme disease is one of the most commonly reported vector borne diseases in the United States, with an estimated 300,000 new cases diagnosed every year. In Canada, Lyme disease is considered an emerging infectious disease as Lyme infected ticks are now found in most of southern Canada including BC, Manitoba, Ontario, Quebec, New Brunswick, and Nova Scotia. Lyme Disease is caused by the bacterium *Borrelia burgdorferi* which is spread through ticks which require blood meals to complete their lifecycle. The main reservoir for the disease is the white footed mouse. As forests become increasingly fragmented, larger predators or other competitors move out, allowing the mouse population to grow unchecked. Loss of biodiversity can also remove a natural buffer against the spread of Lyme as some animals are less effective reservoirs of the disease. Possums for example are very efficient at grooming, and remove and eat up to 90% of their ticks.

### Nutrition, food security and soil quality

In sub-Saharan Africa, about a quarter of the population does not have enough to eat[8]. In many developing

## Improving food security in Malawi

In the Ekwendeni district of northern Malawi, most people live on smallholder farms subject to the food insecurity issues outlined above. 46% of children in Malawi under the age of five are stunted and 20.5% are underweight for their age.

Starting in the early 2000s Rachel Bezner Kerr (now a cross-appointed to the University of Western Ontario and Cornell University) coordinated a series of projects in collaboration with colleagues in Malawi. Funded by the International Development Research Centre (IDRC) and many other organizations, these projects saw the creation of participatory Farmer Research Teams. These locally led groups involved their friends and neighbours in experiments with new agro-ecological options. For example, legumes like peanuts or soybeans support symbiotic bacteria that can fix nitrogen from the air into a form that can be taken up by plants. Growing these crops and burying the leftover leaves and stems can improve soil fertility.

One issue project encountered early on was that burying the leaf residue was a task that tended to be assigned to women, who had difficulty adding to their already heavy workload. The solution was a Crop Residue Incorporation Day, which taught and encouraged men to bury the residue. Similar events were organized to pass along techniques for cooking the new crops and incorporating them into diets. Other educational campaigns around child feeding practices relied on interventions through grandmothers, who play a significant role in caring for young children.

To date, over 10,000 smallholder farm families have tried out these new approaches. The results are tangible: on average, one-year-old children are 1 kg heavier and three-year-old children are 1.5 kgs heavier in participating villages than in non-participating villages.

*A woman farmer explains her agro-ecological experiment to other visiting farmers in a community Crop Resilience Field Day in March 2014. Such events are part of an ecohealth approach that integrates issues of social and gender equality into interventions designed to improve soil fertility and alleviate problems of malnutrition and food insecurity (Photo credit: Rachel Bezner Kerr)*

countries, one in three children has stunted growth due to malnutrition[8]. Part of the problem is overreliance on staple crops. For example, maize is a fast-growing crop that provides high yields and is rich in calories. For this reason, colonial and post-colonial governments encouraged its cultivation in many parts of Africa. Yet maize is poor in micronutrients that are needed to maintain complete health, and is vulnerable to changes in temperature and rainfall patterns. The prevalence of a single crop leads to large fluctuations in the price farmers can get for their product, and the ability to store grain for long periods while protecting it against fungi and other sources of spoilage is limited due to lack of infrastructure. Finally, maize depletes nitrogen from the soil, and most farmers cannot afford nitrogen-based fertilizers. All of this contributes to food insecurity.

An ecohealth approach is aimed at understanding the interactions between food insecurity, soil fertility, nutrition, economic independence and social inequality. It also is participatory, and actively looks for ways to involve the community in decision making. This includes paying attention to inequalities based on age or gender within communities under investigation.

### Environmental Contaminants

Another way human activities have an impact on health is by spreading environmental contaminants. Lead and mercury are both known to be neurotoxins in short-term, high doses. Long-term, lower-dose exposure to lead and mercury has also been associated with declines in cognitive function[10]. Mercury is also neurotoxic, although certain forms are more easily absorbed by the body than others[11].

The addition of tetraethyl lead to gasoline as a way of preventing engine knocking was widespread from the 1930s to the 1970s, resulting in lead levels in blood that were approximately 7 times higher than they are today[12]. Other man-made sources of lead include lead paint and . For its part, mercury one of the major contaminants released by the burning of coal. After its release into the atmosphere, the mercury vapour finds its way into lakes, rivers and the ocean. There it is transformed by microbial action into methylmercury, a form that is much more easily absorbed into the body. As the microbes are eaten by fish, bigger fish and marine mammals, the concentration of mercury increases up the food chain[13].

An EcoHealth approach considers the source of contaminants like these, but also the cultural factors which may impact people's food choices and other exposure pathways. It can be used to recommend appropriate interventions to reduce people's exposure and sound policy to prevent the release of these contaminants in the first place.

## Lead levels in Northern Canada

The levels of lead in the blood of North Americans have declined greatly since leaded gasoline was banned in the 1970s. However a recent study held as part of the International Polar Year Inuit Health Survey showed elevated levels of lead in the blood of adult Inuit participants from Nunavut[14].

A team of researchers, including Myriam Fillion at the University of Ottawa wanted to find out why. They compared the levels of lead in tap water, house dust, paint, country foods (fish and marine mammals) soil, and ammunition and compared compositions of lead stable isotopes. The analysis showed that showed that ammunition and house dust, likely from degraded house paint, are major sources of lead in this population[13]. The results can help targeted public health programs to reduce exposure to lead, such as construction of improved housing.

*Degraded house paint is one likely source of lead contamination. The blood lead levels of adults in Nunavut are higher than they are in communities further south (Photo credit: zen Sutherland, via flickr)*

### Conclusion

Whether it's predicting the next pandemic, experimenting with agricultural techniques to improve food security or tracking our exposure to environmental contaminants, an understanding of the connections between ecosystems, human health and society is critical. An EcoHealth approach recognizes these connections explicitly, and is a promising way forward in the fight for healthy humans worldwide.

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