



The Program for Disease Ecology, Health and the Environment at Stanford

Ecological solutions that protect people and the planet.

A program of the Stanford Woods Institute for the Environment and the Stanford Center for Innovation in Global Health.





FACING HEALTH & ENVIRONMENTAL CHALLENGES, DISCOVERING CREATIVE SOLUTIONS

Through Stanford's Program for Disease Ecology, Health and the Environment (DEHE), interdisciplinary researchers ranging from epidemiologists to engineers are studying the connections between human health and environmental change. A joint initiative of the Stanford Woods Institute for the Environment and Stanford's Center for Innovation on Global Health, The Program is pioneering solutions that improve public health by fostering healthy environments. DEHE links knowledge to action through keystone projects, grants, curriculum development and deep engagement with affected communities.

ec·o·log·i·cal so·lu·tion

NOUN

- 1** a means to solving a human health problem that is founded on a deep understanding of the interactions of living organisms with each other and their natural environments
- 2** an environmentally-based "intervention" that simultaneously interrupts cycles of human disease and preserves or restores the integrity and functioning of ecosystems

When it comes to understanding human impact on our planet's ecosystem, our children's and grandchildren's health depends on getting it right.

Every day, millions of people—especially those living in poverty—are exposed to a wide variety of pathogens and other health hazards in the environment.

But even as scientists increasingly discover new links between human health and the environment, we lack specific, actionable solutions.

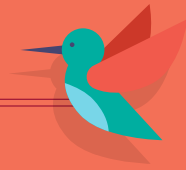
The United Nation's Sustainable Development Goals and a new scientific field, focused on "Planetary Health," are drawing attention to these issues. They're raising questions about how human health relates to a habitable climate, clean water, biodiversity, food, fiber, fuel, and natural systems.

The Program for Disease Ecology, Health and the Environment was established at Stanford in 2015 to support research and creative solutions to modern health and environmental challenges.

Our program focuses on finding sustainable environmental interventions, or "ecological solutions," for a range of diseases. It brings together scientists and stakeholders from Stanford and outside the university in a joint initiative of the Stanford Woods Institute for the Environment and the Center for Innovation in Global Health at the Stanford School of Medicine.

We're advancing research and innovation in disease ecology, health, and the environment through:

- 1** Keystone projects in basic and applied science aimed at ecological solutions for health challenges
- 2** Workshops, working groups, and community-building events
- 3** Interdisciplinary curriculum development and student involvement
- 4** Deep engagement with global health, science, and environmental leaders



We envision a world in which scientists partner with communities to develop sustainable ecological solutions that protect the health of people and our planet.

Sustaining healthy ecosystems is a core issue in public health and a critical factor in health equity. Stanford researchers are connecting the dots between environmental degradation, frequent exposure to health hazards and lack of access to healthcare. By harnessing this knowledge and collaborating with local, regional and national stakeholders, we're pursuing environment-based solutions to disrupt the cycle of poverty and disease.

The background features a stylized landscape with several rounded mountain peaks in shades of green and blue. White, fluffy clouds are scattered across the sky. A thin red horizontal line is positioned below the 'Mission' header.

Mission

To discover ecological solutions to humanity's health challenges and to prepare the next generation of planetary health innovators.

We are committed to building deep local and global collaborations. Collaborations happen across disciplines, between project leaders, and among community participants. We value building a strong community as well as a dedicated network of collaborators—including researchers, students, policymakers, leaders and engaged citizens.

Keystone Project #1

PIGS & PARASITES

Interventions to End Cycles of Poverty Driven by Neurocysticercosis

The Challenge

Pigs, which thrive on cheap and abundant nutritional sources and grow quickly, are one of the most important sources of food and income for the world's poorest populations. But pigs also serve as the reservoir for the pork tapeworm, *Taenia solium*. Humans develop an intestinal infestation after consuming undercooked pork where the tapeworm has encysted, shedding thousands of eggs in their stool which are, in turn, consumed by pigs, beginning the cycle anew.

When humans consume the eggs of the pork tapeworm directly, the tapeworm leaves the gastrointestinal tract and can migrate throughout the body. A serious condition known as neurocysticercosis develops when the parasite enters the brain leading to destruction of tissue. Millions of people living in low-income communities in Latin America, Africa, and Asia are infected and develop a range of symptoms including headaches, seizures, and strokes. In school-aged children, cognitive deficits caused by brain involvement negatively impacts academic performance. By curtailing children's cognitive potential and reducing productivity in affected communities, *T. solium* contributes to a cycle of poverty.

Environmental contamination plays an integral role in sustaining *T. solium* infection. Small holder farmers depend on free-range pig raising, allowing their livestock to forage throughout the surrounding environment, and poor populations lack safeguards to keep their environment free of contamination with human stool and *T. solium* eggs: relying on open sewers, lacking latrines and defecating in the open, and fertilizing their crops using untreated human stool.

The Approach

We have established study sites across Tibetan steppe communities in Western Sichuan, China, where poor smallholder farmers raise free-range pigs, allowing them to range throughout villages, surrounding fields, and mountain environs. Our work has shown that levels of disease in these communities are very high. Behaviors that lead to environmental contamination such as open defecation, lack of proper toilets and sewage systems, and use of untreated human stool as fertilizer on crops are widespread.

Using disease burden studies combined with behavioral and environmental surveys, we are designing, piloting, and evaluating interventions. These interventions combine pig vaccination, treatment of human tapeworm carriers, educational measures to enforce behavioral change, improved methods of sewage handling and treatment, and strategies to decrease environmental contamination with human stool.

The Outcome

We are designing interventions to stop *T. solium* transmission, improve the productivity of smallholder pig farmers, and encourage less contaminated environmental conditions. The burden of *T. solium* and neurocysticercosis is poorly characterized, and effective interventions that both combine these factors and can be implemented in endemic, poor communities are lacking. Our work will directly address this difficult area of developing effective solutions within an environment constrained by poverty. Given the worldwide scope of this infection, our results will be widely applicable to other regions.

Sustainability Strategy

Our close working relationship with our Chinese collaborators allows us to adapt interventions to local communities in discussion with local veterinarians, community leaders, and government authorities. We plan to design interventions around local products, encouraging the growth of local markets. We hope that clear positive improvements in human health, farm productivity, and environmental conditions will create a clear incentive for communities to continue interventions over the long term.

“In a time where we are increasingly changing and disrupting the world around us, we are also developing a growing understanding of the complexity of the earth's ecosystems and how they are intimately tied to human health. It's important that we act in a timely fashion to both protect environments and improve human health.”

JOHN OPENSHAW

Stanford University, Department of Medicine - Infectious Disease

Keystone Project #2

THE UPSTREAM ALLIANCE

Partners in Schistosomiasis Reduction

The Challenge

Water projects like dams and irrigation schemes support agricultural expansion to feed the growing human population (now topping 7 billion worldwide). But these water projects come with costs in the form of degradation of ecosystems and in some cases, of compromised human health.

In West Africa, the construction of the Diama Dam on the Senegal River in the 1980s was followed by a massive outbreak of schistosomiasis, a waterborne parasitic disease that causes debilitating symptoms in humans. The dam blocked the migration of freshwater prawns, predators of the snails that carry the parasite. Without prawns, the snail populations exploded, and so did the disease.

The changing distribution of fresh water and the loss of prawns upstream due to dam-building has caused a rising burden of schistosomiasis in the developing world.



“The Program has a unique combination of creativity and capacity – with deep connections spanning community and global levels – to drive transformational improvements in health and the environment.”

GRETCHEN DAILY

Stanford University, Department of Biology

Our disease control approach is to restore natural snail predators (prawns) within the aquatic ecosystems where schistosomiasis has emerged, especially in managed ecosystems like irrigation schemes throughout the developing world where some of the highest parasite transmission sites exist today.

To achieve this, we formed The Upstream Alliance, a partnership among scientists and citizens on four continents, working together to reduce schistosomiasis. We are conducting research on the feasibility and long-term sustainability of restoring prawns to the waterways and developing a new prawn-farming enterprise for the health and well-being of local communities in West Africa.

The Outcome

We are creating solutions to naturally reduce schistosomiasis, while helping to fight hunger and alleviate poverty. Our win-win approach relies on restoring natural ecological interactions to reduce disease and improve livelihoods. Our strong local partnerships and a dedication to economic and ecological sustainability have been key to success.

Sustainability Strategy

Besides their role as voracious predators of snails that carry schistosome parasites, freshwater prawns are also delicious. Prawns are safe to harvest and eat because they are dead-end hosts to the parasite. So, harvesting of prawns may generate a profit to sustain the intervention and ensure their presence beyond the life of any single grant or project.

But how do we restore prawns over the long-term in ecosystems where they have been excluded by dams, overfishing, or pesticide pollution?

Our long-range sustainability plan is to:

- 1 Restore the migratory pathways of prawns (by building “prawn ladders” in dams)
- 2 Reduce impacts on prawns' natural populations (such as pesticide pollution)
- 3 Encourage entrepreneurship by developing a sustainable prawn industry in rural locations subject to chronic schistosomiasis.

Learn more about Stanford scholars' work with this initiative at: www.theupstreamalliance.org

DIRECTORS & AFFILIATED RESEARCHERS

Susanne Sokolow, DVM, PhD

CO-DIRECTOR

**Stanford University, Department of
Biology, Hopkins Marine Station**

Sanna Sokolow, the co-founder of this program, is interested in disease ecology and the interface between human health and the environment, i.e., “planetary health.” Most recently her work has focused on ecological means to control human schistosomiasis, a neglected tropical disease of poverty.

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Giulio De Leo, PhD

CO-DIRECTOR

**Stanford University, Department of
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Giulio De Leo is a co-founder of this program and is a quantitative ecologist with expertise in the dynamics and control of infectious diseases. He performs theoretical studies to inform practical management of real-world systems. De Leo's goal is to investigate the environmental and anthropogenic drivers of disease dynamics and to develop population models useful for decision-making.

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Meet the Stanford researchers collaborating with us to advance solutions for a healthy planet.

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Join us in developing sustainable ecological solutions to protect the health of people and our planet.

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