Tackling a neglected disease with math

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Schistosomiasis, or bilharzia, is a parasitic disease that infects people who expose themselves to contaminated lakes and rivers. Over the past decade, campaigns to treat infected individuals have managed to bring down the morbidity of the disease, but eliminating it from entire regions will require an orchestrated approach involving the entire infectious cycle of the disease. In a study published in *PLOS Neglected Tropical Diseases*, a group of researchers led by EPFL show how human mobility

and water resource development contribute to the spread of the disease and layout challenges for the development of more effective treatment strategies in Burkina Faso.

Humans have won the battle against schistosomiasis before. For instance, once prevalent in Japan and Algeria, the disease has been entirely eliminated from both countries. Despite this, over 250 million people are still in need of treatment each year, mostly in sub-Saharan Africa. "In Burkina Faso, a decade of treatment has brought down the prevalence of the disease from close to 40% to 5%," explains Javier Perez-Saez from the EPFL's Laboratory of Ecohydrology and the lead author of the study. "But if we stop treating victims today, we would be back where we started in a matter of decades," he says.

The researchers developed a computer model that accounts for multiple parameters including the waterborne parasite's complex biology. When the parasite's eggs, excreted by humans, find their way into lakes or streams, they hatch and infect freshwater snails that live in reservoirs, streams and irrigation canals. Once in the snails the larvae mature and multiply, the snails then release them back into the water, where they can go on to infect their main host: humans.

Timing is a crucial factor for an intervention's success, but it is challenging due to varying local climates and other factors such as school calendars. For logistical reasons, treatment campaigns targeting children are often carried out on the first day of school in early October, right after the rainy season. But because there is still water everywhere, the children often end up re-infecting themselves, perpetuating the parasite's biological cycle.

Water resources development is another poignant example of how unanticipated factors can help spread the disease, explains Perez-Saez, citing a large dam built to collect water for irrigation in an

uncontaminated region in northern Burkina Faso. Not only did the dam create a new habitat for the parasites intermediate host, the freshwater snails, it also attracted migrants from other parts of the country where the disease was present. The region saw the prevalence of the disease shoot up from close to zero to more the 60% for school-aged children in a matter of a decade.

"If we want to eliminate the disease, we have to look at the big picture, because, at the end of the day, that is the level at which decisions are made," says Perez-Saez. In their study, he and his co-authors present a first version of their computer model. "This first step already let us draw some interesting conclusions regarding the role of human mobility and water resource development. But the main point of our publication was to make an inventory of what remains to be done." Most importantly, he says, their model will have to more closely account for the climate in Burkina Faso, as well as the local sociological context.

This mathematical approach to eliminate the disease from Burkina Faso is only one of the latest facets in a 30-year collaboration between EPFL and the International Institute for Water and Environmental Engineering (2iE), in Ouagadougou, Burkina Faso, on numerous development issues. It complements and informs initiatives involving educating affected populations and improving the availability of clean water and sanitation.

More information: Javier Perez-Saez et al. A Theoretical Analysis of the Geography of Schistosomiasis in Burkina Faso Highlights the Roles of Human Mobility and Water Resources Development in Disease Transmission, *PLOS Neglected Tropical Diseases* (2015). DOI: 10.1371/journal.pntd.0004127

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