

PostDoc Project

PostDoc Position with fellowship from FAPESP

Associated to the FAPESP sponsored project promoted by the Belmont Forum:

Integrated risk mapping and targeted snail control to support schistosomiasis elimination in Brazil and Cote d'Ivoire under future climate change

Problem statement.

Schistosomiasis is a neglected disease that affects millions of people in tropical regions, mainly Brazil and Africa. Schistosomiasis is a debilitating disease, linked to poverty, caused by a parasite with a complex life cycle: its transmission requires the infection of species of freshwater snails that are obligatory intermediate hosts, which are parasitized by egg larvae released by infected people. In turn, infected snails eliminate larval stages of the parasites that eventually infect people exposed to waters colonized by snails. Ourinhos micro-region, located in the middle section of the Paranapanema River, also gathers a series of factors associated with its physical landscape and its social landscape that has maintained the active transmission of schistosomiasis in the region for decades.

It is a region with important water collections and several dams, elements such as vegetation, geomorphology, geology and pedology, land use, in different combinations, that make up certain spaces favorable to the persistent presence of schistosomiasis in the region. These spaces favored the occurrence of *Biomphalaria glabrata*, a snail that is highly susceptible to the parasite. This species is associated with the high prevalence of the disease in Minas Gerais and Bahia. Outside the Minas Gerais-Bahia axis, Ourinhos in São Paulo, the main municipality of the micro-region, it is the only area that has extensive focal points of the species. Therefore, an area with potential for maintaining the disease at the local level and with the potential for expansion to disease-free areas in the regional space. In addition to *B. glabrata*, the Ourinhos' freshwater collections are colonized by two other schistosomiasis-transmitting snails, *B. tenagophila* and *B. straminea*, in addition to species that are refractory to the parasite, and therefore it is an ideal site for the application of landscape classification methods with the characterization of *habitats* favorable to the occurrence/non-occurrence of the *Biomphalaria* species.

The environmental and social complexity in Ourinhos and its micro-region encourages thinking about the use of technological resources that enable innovative methodologies for integrating information from heterogeneous sources and at different scales enabling an expanding the tools for capturing and describing the local occurrence

of schistosomiasis and its association with the landscape's socio-environmental regional changes. The integrated use of information derived from optical sensing images in different spatial and spectral resolutions with environmental, sociodemographic, economic and health system data will allow to identify *patterns* in this complex landscape associated with the probability of human infection with *Schistosoma mansoni* [1,2,3]. It is these identified *patterns* that define what we call components of a *pathogenic landscape* [4,5] and that assist us in the building of a broader and more integrated description of the *pathogenic complex* [6,7] associated with schistosomiasis in this area [8].

Expected Results.

The main objective of the postdoctoral project is to develop the integration methodology and the methods necessary for its operationalization. It will involve methods of classifying satellite images and evaluating these products based on images generated by drones, in particular, refinements for land use and land cover mappings, disaggregated socio-demographic characterization of the population, characterization of the productive systems involved in the agrarian economy of the micro-region, and integration of information from the physical landscape and the health systems (linked to the schistosomiasis transmission cycle) to build new cartographies that should be representations of specific characteristics associated with certain territories that are shared by vectors, pathogens and humans, defining the *pathogenic landscape units* on a local scale and assist in understanding the *pathogenic complex* associated with the nature of schistosomiasis in the region. We hope that the methodology developed and systematized for this region can generate instruments and more knowledge to assist the management of public health resources applied in the mitigation of neglected diseases that affect human populations at a local scale.

Scientific and Technological Methods

Remote Sensing and Spatial Analysis can locate, characterize, measure and represent interactions that produce the space of everyday life and couple them with the spaces related to the production of diseases. In this segment of the Belmont project developed in Brazil in partnership with INPE, we will characterize the landscape of the Ourinhos micro-region at multiple scales, focusing on climatic-environmental, sociodemographic, economic and health system data. The methodology assumes the use of multispectral images, obtained by satellites and drones. The use of GIS - Geographic Information Systems associated with techniques of spatial data analysis (statistics and computational *ad-hoc* techniques) that can ensure the integration of data from different

sources and in different scales. The analysis of hydrology and water collections will be necessary to allow us to make inferences about the seasonality related to the freshwater system and the possible increase in the frequency of droughts and floods, which affect the presence and distribution of snails and, consequently, the disease. Information on existing dams will be used to explore possible effects on the distribution of pockets of intermediate host snails and *habitats* favorable to the occurrence of the species.

General Schedule

This is a General Plan of the activities that must be developed by the postdoctoral student. The construction of a detailed plan and an outline of the deadlines for each stage is the first task to be done in the project.

First year:

1. Review of the literature on schistosomiasis with a focus on work in the Paranapanema basin and some other sub-basins in the region.
2. Seminars with the group from SUCEN, UNESP (Campus Ourinhos) and Local Health Services stakeholders to understand the field data of the snails and the sensors embedded in the drone.
3. Organization of databases. General data model with identification of sources, type, resolutions (spatial, spectral, temporal), scales, licenses, etc.
4. Construction of a Geographic DB integrating the data of interest from these different sources for the study area.
5. Define a typology for the landscape patterns associated with the occurrence of snail species. It should involve the SUCEN and UNESP-Ourinhos groups.
6. Define a sample strategy and organize a field work in the region to obtain data using the UNESP drone.
7. Define classification methods and a complete methodology to produce and evaluate a first version of a Cartography of Landscape Units with characteristics associated with the support of species of transmitting and non-transmitting snails and of Landscape Units associated with sociodemography and the agrarian economy in the micro-region. The product is the *Cartography of Integrated Landscapes associated with Biomphalaria spp. and Schistosomiasis –v1*
8. First academic article.

Second year:

1. General Seminar to present first results, the initial version of *Cartography of Landscapes associated with Biomphalaria spp and Schistosomiasis* to discuss and compile the adjustments and corrections necessary to produce the second version.
2. Produce the second version of the *Cartography of Landscapes associated with Biomphalaria spp and Schistosomiasis v-2*.
3. Field work for evaluation of the Cartography's version 2 and General Seminar for discussion of the second version for the *Cartography of Landscapes associated with Biomphalaria spp. and Schistosomiasis - v2*.
4. Second academic article
5. Consolidation and systematization of the methodology.
6. Production of the final version of the *Cartography of Landscapes associated with Biomphalaria spp. and Schistosomiasis* with analysis and discussions towards an understanding of the *Pathogenic Complex* of Schistosomiasis in the region and recommendations for the health services on a local and regional scale and for the national schistosomiasis surveillance and control program.

Justification for the Plan in terms of the objectives of the FAPESP PD Scholarship Program

The project that will be developed follows the logic of the interdisciplinary work of the Belmont project by integrating biological and social aspects into the characteristics of the physical landscape. Land use and land cover changes, demography and economics, create urban-rural spaces that take on new dynamics and are a source of maintenance of active schistosomiasis in the municipality of Ourinhos. Together, these factors maintain Ourinhos as a potential regional dispersing center for the disease. There are few studies using integrated methodologies for characterizing the landscape with the use of multiple sources and at multiple scales.

Dissemination and evaluation.

The results of this project have academic value, since there are methodological innovations that will be published in the appropriate scientific journals, but it also presents relevant results for the schistosomiasis surveillance and control program at national, state and local levels. A main *Schistosomiasis ATLAS* for the Ourinhos micro-region will be a

format for disseminating research information and orientation guides must be built together with the local health services working with the surveillance and control of Schistosomiasis. This PD features a project that seeks to bridge the gap between research and operational public health services.

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