NIMBioS

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Disease Ecology, Health and the Environment:
Optimal Control of Neglected Tropical Diseases on network models with human movement and river connectivity

Directors

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Program

Project Summary

Neglected Tropical Diseases (NTDs) such as amebiasis, Chagas disease, hookworm, leishmaniasis, and schistosomiasis affect more than 1.4 billion people worldwide. Their impacts—expressed as mortality, morbidity, reduced educational and employment opportunities, or social stigma—tend to be greatest among the global rural poor. Controlling NTDs is particularly challenging because of a lack of vaccines that can provide life-long immunity, and the existence of important environmental reservoirs where pathogens persist even as populations are successfully treated for their infections. After mass drug administrations (MDA) of the population at risk, treated people are commonly re-exposed to the parasite or pathogen in the environment, resulting in an endless cycle of treatment and reinfection. Two and a half billion dollars are currently disbursed yearly in tropical and subtropical regions in efforts to control NTDs. Such funding and control efforts are directed mainly toward MDA, with little theoretical understanding of the dynamics of elimination, nor of the conditions for optimal, cost-effective intervention.

The goal of this working group is to investigate cost-effective NTD control and elimination measures through the application of optimal control theory, and through the use of cutting-edge computational techniques applied to a range of mathematical transmission models exhibiting increasing levels of complexity. The group will assess the cost-effectiveness of alternative strategies for NTD elimination in addition to MDA, as well as innovative and creative ecological solutions aimed at interrupting environmental transmission through water, sanitation and hygiene interventions (WASH) and biological control of free-living stages of pathogens and/or intermediate hosts.

Specific goals

- Analyze through OCT best drug administration strategies for schistosomiasis and soil transmitted helminthiasis control by expanding the age structured modelling framework developed by Lo et al. (2015);
- Investigate the most cost-effective ways of combining MDA with biological control of schistosomiasis intermediate hosts by using OCT in a non-spatially explicit model;
- Assess optimal *timing* for MDA administration and environmental control in a highly seasonal framework
- Analyze how information at different geographical scales on network topology, distribution of human population/movement and habitat quality for free-living stages (in the case of soil-transmitted helminthiasis) and intermediate hosts (in the case of trematode infections) allow to devise and deploy optimal control strategies for NTD-control and elimination. Data from our Senegal and Burkina Faso projects may be used to calibrate the models.
- Analyze optimal control strategies in coupled models of disease and poverty
- By leveraging on participants' expertise in other diseased systems, assess structural differences in optimal control approaches for endemic (e.g., schistosomiasis and malaria) vs epidemics (e.g., cholera) diseases
- Advance possible policy recommendations emanating from the studies

Evaluation of workshop success

Our main metric of success is to publish foundational papers casting light on optimal control of schistosomiasis and other NTDs in high Impact Factor journals. Computer codes will be made available. Discussion of other metrics for evaluation of working group activities will be held, possibly in conjunction with NIMBioS evaluation staff.

Preliminary agenda

Monday, May 8th

	Introduction
9:00	NIMBioS Director presentation
9:20	Welcome of the directors, Program presentation, expectations and goals and quick participants' introduction
	First session: **Status of research and unanswered questions in schistosomiasis control**
9:30	Sokolow: Current optimization questions/challenges in schistosomiasis control
9:45	De Leo: The effect of network topology on schisto dynamics: Implications for control
10:00	Casagrandi & Mari: disease dynamics on river and human mobility network (Haiti and Senegal). Implications for control
10:15	Discussion
10:40	Coffee break
	Second session: **the economics perspective on schistosomiasis control and poverty**
11:00	Andrews (by Skype): a cost-effectiveness modelling study of integrated mass drug administration strategies for schistosomiasis
11:15	Bonds: Optimization challenges in characterizing the relationship between poverty and disease
11:30	Ngonghala: a library of models to capture the joint dynamics of poverty and diseases. Implications for control
11:45	Discussion
12:00-12:05	Group picture #1
12:05	Lunch
	Third session (a): **Methods and applications**
1:30pm	Remais: stability analysis and the need for optimization theory in NTD control
1:45	Discussion
	Fourth session: **moving forward**
2:00	Identifying research questions and breakout groups
3:00	Coffee break
3:30	Discussion/Break out session
4:30	Wrap up from rapporteurs – laying the foundations for next days' work
5:00	NIMBioS Reception
6:00	Adjournment

Tuesday, May 9th

	More on Methods and applications (b):
9:00	Lenhart: OCT in biology
9:15	Eisenberg: OCT in epidemiology
9:30	Discussion
10:00	*Coffee break*
10:30	Breakout session
11:40	Brief Joint Update (15')
11:55-*Noon*	Group picture #2
Noon	*Lunch*
1:00	Break out session
2:30	*Coffee break*
3:00	Break out session
4:15	Joint Update (45')
5:00	Adjournment

Wednesday, May 10th

9:00	Break out session
10:30	*Coffee break*
11:00	Joint update and discussion on way forward (1h)
Noon	*Lunch-End*

List of participants

Name	Affiliations	Areas of PhD and the areas of expertise
Giulio A. De Leo <deleo@stanford.edu>	Hopkins Marine Station (Dept. of Biology), Woods Institute for the Environment, Stanford University	PhD in Ecology; Population Biology, disease ecology
Calistus Ngonghala <ngonghala@yahoo.com>	University of Florida (Department of Mathematics/Emerging Pathogens Institute)	PhD in Mathematics; Disease Dynamics, Ecology of poverty and poverty traps (integrating disease and economic growth models), Nonlinear dynamics
Justin Remais <justin.remais@berkeley.edu>	School of Public Health, UC Berkeley	PhD in Environmental Health Sciences; Dynamics of waterborne and vector-borne infections in rapidly changing environments
Matt Bonds <mhbonds@gmail.com>	Harvard Medical School.	Double PhD, the first in economics (2003) and the second in ecology (2006). Disease economics and poverty traps. CEO of the no profit organization based in Madagascar
Renato Casagrandi <renato.casagrandi@polimi.it>	Department of Electronics, Information Science and Bioengineering, Politecnico di Milano (Italy)	PhD in Ecology/Automation and Control, depending whether Renato or Lorenzo?), analysis of dynamics systems, bifurcation theory, cholera dynamics
Marisa Eisenberg <marisae@umich.edu>	School of Public Health, U of Michigan	PhD in Mathematics - Mathematical biology, disease dynamics, parameters estimations
Christopher Hoover <choover@berkeley.edu>	School of Public Health, UC Berkeley	PhD in Environmental Health Sciences; Dynamics of waterborne and vector-borne infections in rapidly changing environments
Suzanne Lenhart <lenhart@math.utk.edu>	NIMBioS & Mathematics Department at University of Tennessee	PhD in Mathematics, Optimal Control Theory applied to biology
Lorenzo Mari <lorenzo.mari@polimi.it@polimi.it>	Department of Electronics, Information Science and Bioengineering, Politecnico di Milano (Italy)	PhD in Ecology/Automation and Control, depending whether Renato or Lorenzo?), analysis of dynamics systems, bifurcation theory, cholera dynamics
Jim Sanchirico <jsanchirico@ucdavis.edu>	Dept. of Environmental Science & Policy, UC Davis	PhD in economics; environmental and resource economics, OCT
Susanne H. Sokolow <shsokolow@gmail.com>	Hopkins Marine Station (dept. of biology) and Center for innovation in global health, Stanford University	Doctor of Veterinary Medicine (DVM), PhD in Ecology; Experimental Ecology and Disease Ecology, schistosomiasis; Planetary Health

Jason Andrews (via Skype) <jandr@stanford.edu>	Division of Infectious Diseases and Geographic Medicine, School of Medicine, Stanford University	DM, infectious diseases, epidemiology, cost-effectiveness analysis, schistosomiasis
Stefano Ermon <ermon@cs.stanford.edu>	Computer Science, Stanford University	PhD in Computer Science; Numerical methods
Andrea Rinaldo <andrea.rinaldo@epfl.ch> Personal Assistant: anna.rothenbuehler@epfl.ch	ECHO | Laboratoire d'Ecohydrologie, Ecole Polytechnique Fédérale de Lausanne (Switzerland)	Hydrology, hydroepidemiology, malaria and cholera dynamics

Logistic, travel location, meals, etc.

Lodging: You will be staying at the Four Points Sheraton Hotel (1109 White Avenue, Knoxville, TN 37916; 865- 971-4663). A rooming list has already been provided to the hotel, so when you arrive, tell the front desk you are here with the NIMBioS group and they will check you in. For more information on the Four Points, visit: https://goo.gl/j6iBtV .You will need to take a taxi from the airport to the hotel

(cost ~$35 oneway for ~20 min ride; you can be reimbursed for this). You will have access to the hospitality suite at the hotel during your stay (ask at the front desk). It is a convenient and comfortable place if you are looking to meet in the evening when you are not at NIMBioS.

Air travel: If you have any problems with flights during your trip, call the number for World Travel that is on your itinerary. In the US the toll-free number is 1-800-251-9047 ext 1. We hope you won't be delayed overnight, but if you are, please call the Four Points at 1-865-971-4663 and cancel your room for the night.

Location: The working group will meet at the NIMBioS offices located on the 1st floor of 1122 Volunteer Blvd.Claxton Complex.

To get here from the Four Points Sheraton, simply go right out the front door of the hotel, turn right onto White Ave and continue straight for 3 blocks. Turn left onto James Agee St. and continue straight through the stop light at Cumberland Ave. White Ave. has now turned into Philip Fulmer Way. (Walters Life Sciences Building will be on your left and the University Center across Philip Fulmer on your right). Continue down Philip Fulmer Way until you pass the Student Union on your right. Turn right just after the Student Union and continue up the sidewalk. Less than a block up the hill is a water feature (Blueberry Falls). Turn Left below the falls and enter into the backside of the Claxton Complex at the 1st floor entrance of NIMBioS (there is a big sign for NIMBioS outside the door). If you reach Volunteer Blvd, you've gone too far. You will enter the building into the participant break room where breakfast will be served.

Meals: Breakfast and lunch will be available at NIMBioS each day with breakfast from 0800-0900. There will be a reception on Monday evening prior to heading out for dinner. On meeting days when breakfast and lunch (but not dinner) are provided by NIMBioS, there is a $29.50 allowance for dinner. Reimbursement for meals during travel to/from NIMBioS is set at $44.25 travel status. We do not need receipts for meals.

Internet: Wireless internet access is available at the hotel and at NIMBioS.

Receipts: We only need receipts for expenses that are $50 or more. Save original taxi receipts, airport parking receipts, etc., that are $50 or more. We do not need meal receipts.

Rental cars: The NIMBioS offices are only a couple of blocks from the hotel, so you will not need a car during your stay.

Travel reimbursement: The Travel Expense Worksheet (Expense claim worksheet.doc or pdf) and instructions (Expense claim instructions.pdf) are available from the NIMBioS website (see the "LINKS" section at http://nimbios.org/visitorinfo/travel). Please skim them prior to traveling, so you'll know what is needed for us to process reimbursement requests.

Weather: The forecast for next week is calling for sunny skies. Highs will be in the middle 70's and lows in the middle 50's. Be prepared and pack a rain jacket or umbrella for the chance of rain.

A welcome packet with agenda and directions to NIMBioS will be available at hotel check- in. If you have anyquestions about the logistics of your visit, feel free to contact me, Jennifer Spar (jspar@nimbios.org, 865-974-9317).