

PhD contract on the mathematical modeling of vector-borne diseases under climate change and their control

Category

Science – Ecological sciences and epidemiology

Contract

PhD contract, 36 months

Organization

CIRAD, UMR CIRAD-IRD-UM INTERTRYP

PhD co-director: Dr. Sophie Thévenon and Dr. Philippe Solano

PhD main supervision : Dr Antoine Barreaux

Co-supervision : Dr. Tobias Landmann (ICIPE)

Inscription

Montpellier University, GAIA doctoral school, BDI pathway

Job title

PhD contract on the mathematical modeling of vector-borne diseases

Key-words

Epidemiology, vector-borne diseases, modelling, climate change, innovations, impact

Expected beginning date

From 01/10/2025

Job location and work environment

Montpellier, FRANCE (Cirad Baillarguet) and **Nairobi**, KENYA (Icipe)

Summary

As a PhD student in mathematical modeling and epidemiology, you will contribute to an international, interdisciplinary project investigating how climate and environmental changes affect vector-borne diseases (VBD) in Africa. Using your strong quantitative skills, particularly in mathematical biology, and your background in, or demonstrable enthusiasm for epidemiology and disease ecology, you will model the distribution and spread of vectors and pathogens under global change, and/or the effectiveness of innovative surveillance and control strategies.

Job description

Context: VBDs remain a critical public health concern in Africa, disproportionately affecting the most vulnerable populations. Global environmental changes driven by human activity are reshaping ecosystems and intensifying exposure to vector-borne pathogens. Addressing these threats requires an interdisciplinary and cross-sectoral research approach. This PhD position is part of the EU-funded EDCTP project IMPACTING (Integrated multi-vector-borne diseases platform to assess global change impacts on transmission using innovative systems modeling, novel monitoring tools, and transmission-blocking microorganisms) starting in June 2025.

The project focuses on key VBDs including malaria, dengue, human African trypanosomiasis (HAT), onchocerciasis, and Crimean-Congo haemorrhagic fever (CCHF). IMPACTING brings together 10 institutions from East (Kenya), Central (Cameroon), and Southern Africa (Mozambique), as well as

Europe (France and Portugal), with expertise spanning entomology, vector ecology, disease modeling, diagnostics, and community engagement. The project aims to develop a user-friendly dashboard integrating robust modeling outputs to inform policy and enhance disease surveillance and control under global change. Across the participating countries, the focus is on vectors such as *Aedes* mosquitoes (dengue, chikungunya, yellow fever), *Anopheles* mosquitoes (malaria), *Glossina* tsetse flies (gHAT and rHAT), *Simulium* blackflies (onchocerciasis), and *Hyalomma* and *Rhipicephalus* ticks (CCHF).

IMPACTING's key objectives include:

- 1) Modeling VBD risk under climate and environmental change.
- 2) Developing innovative vector monitoring and diagnostic tool for improved surveillance.
- 3) Developing robust pipelines to identify transmission-blocking microorganisms and inform novel control strategies.
- 4) Engaging local communities to co-design effective surveillance and control tools, bypassing current community level barriers
- 5) Building a multi-disease risk prediction dashboard to support evidence-based and climate-resilient policies.

Your role: You will develop and apply mathematical models to understand VBD transmission and evaluate the potential of innovative surveillance and control strategies.

Depending on your background and interests, and in agreement with your PhD supervisors, you may focus on one or both of the following areas:

(i) Modeling disease transmission dynamics and/or vector distribution under climate change:

- a. Vector suitability models: Predict habitat suitability and vector occurrence using species distribution models (SDMs) integrating vector occurrence and environmental data (remote sensing data from satellite imagery allow for real-time tracking of actual environmental changes). Incorporate life cycle information in the learning process to produced hybrid SDM and assess the niche overlap of different vector populations
- b. Disease transmission models: Use compartmental models to simulate disease transmission dynamics, focusing on climate-sensitive parameters like vector density and infection rates. Incorporate nonlinear dynamics (nonlinear resonance, existence and stability of periodic solutions (Floquet Theory), deterministic chaos) to further explore the impact of extreme climatic events and environmental change. Finally, calibrate models using IMPACTING surveillance data and refine the predictive power.

(ii) Simulating the impact of vector surveillance and control innovations

- a. Integrate new surveillance and control innovations into your disease transmission models. Evaluate their effectiveness in reducing vector density, human exposure, or disease transmission. Conduct scenario analyses using system dynamics modeling
- b. Include both short- and long-term climate projections. Produce risk maps to inform evidence-based, climate-resilient decision-making.

Candidates are not expected to cover all areas. You will define your research focus in collaboration with your supervisors, based on your skills and interests. You will initially focus on HAT and malaria, but will have the flexibility to explore other disease-vector systems within the IMPACTING project.

Expected results: Your models will contribute to peer-reviewed publications and feed into broader system dynamics models developed by project partners. These tools will help identify cascading effects of global change and guide public health interventions. Final outputs, including models, predictions, and risk maps, will be integrated into the project's policy-facing dashboard.

You will work in a vibrant interdisciplinary environment with frequent interaction with other modelers, software developers, entomologists, molecular biologists, and social scientists at CIRAD, ICIPE, and partner institutions. You are expected to actively collaborate within this diverse, international research community.

Future organization

You will be joining CIRAD, the French Agricultural Research Centre for International Development, which works with its partners in the Global South to generate and pass on new knowledge to support agricultural development and innovation. CIRAD's mission is to build sustainable farming systems for tropical and Mediterranean regions capable of feeding ten billion human beings by 2050 while preserving the environment.

More specifically you will join UMR INTERTRYP. This CIRAD/IRD/University of Montpellier Joint Research Unit "Intertryp" is a unit composed of about 50 researchers, engineers, technicians and students dedicated to "One Health" research activities on NTDs such as sleeping sickness, leishmaniasis, or Chagas disease, which disproportionately affect the most vulnerable populations.

Following a 3-9 months integration period in the INTERTRYP research unit in Montpellier, France, you will spend most of your PhD abroad as a visiting scientist at the International Centre of Insect Physiology and Ecology (ICIPE), Nairobi, Kenya. You will get direct supervision by Dr Antoine Barreaux (CIRAD-INTERTRYP and visiting scientist at ICIPE, based in Nairobi), epidemiologist, mathematical modeler, and coordinator of the EDCTP IMPACTING project. You will also return to France periodically to attend courses at the GAIA doctoral school.

ICIPE is an international scientific research institute that works committed to improving health and livelihoods in Africa by investigating the impact of insect-borne diseases. It hosts state-of-the-art research units in molecular biology and bioinformatics, behavioral and chemical ecology, data management, modelling and geo-information, social sciences, and technology transfer. You will get further co-supervision by Dr. Tobias Landmann, senior scientist and experienced modeler of the Data management, modeling and geoinformation unit at ICIPE, and WP leader in IMPACTING.

Desired profile

Education:

- Master's degree/MSc in physics, mathematics, applied mathematics, epidemiology, ecology or related fields

Experience:

- Prior experience of research in Sub-Saharan-Africa or tropical contexts is considered a plus
- Prior experience of vector-borne disease research is considered a plus

Skills and abilities:

- Advanced technical skills or willingness to learn in the mathematical modeling of diseases, ecological processes and climate change
- Proficiency in statistical analysis, modelling tools and coding (e.g. R, Python, JavaScript)

- Strong written and oral communication skills in English and French is key; proficiency in other languages is considered an asset.
- Ability to work and foster collaboration in culturally diverse, multidisciplinary environments.

Personal qualities:

- High level of autonomy, sense of organization, and initiative, combined with a spirit of collaboration.
- Motivation, adaptability
- Willingness to work and even leave in Sub-Saharan-Africa

Job constraints

- Fieldwork in remote tropical or subtropical regions.

Position constraints

Screen work in excess of 4 hours

Work performed in tropical/humid/subtropical zones

Frequent travel within Kenya, in France and possible trips to Cameroon and Mozambique

Funding

EDCTP IMPACTING project (Integrated multi-vector-borne diseases platform to assess global change impacts on transmission using innovative systems modeling, novel monitoring tools, and transmission blocking microorganisms)

France base salary, excluding expatriation allowances if applicable. CIRAD provides a comprehensive expatriate package with benefits for PhD students stationed out of France.

Information

How to apply :

Please direct any informal enquires to Dr BARREAUX, antoine.barreaux@cirad.fr .

Applications should be sent by email to Antoine Barreaux (antoine.barreaux@cirad.fr) and to the thesis supervisory team (sophie.thevenon@cirad.fr, tlandmann@icipe.org, philippe.solano@ird.fr, and aurelie.arnou@cirad.fr), specifying the thesis subject and enclosing the following documents: CV, covering letter, full marks from L1 to L3, Master M1 and M2 (or equivalent if engineering course). If the second year of the Master's programme (M2) is in progress, please provide us with the most recent transcript available.

Incomplete applications will not be processed.

Deadline to apply

15/07/25

Expected contract start date :

01/10/2025 (could be delayed depending on management of visa/residence permit applications where applicable)