PhD offer

Spatial modelling of animal mobility: assimilation of Earth Observation data for the study of contacts between domestic and wildlife fauna and the transmission of pathogens. The example of herbivore populations at the periphery of protected areas in Southern Africa

Deadline for application: 1er June 2018
Start date: Octobre 2018

University: Université de Montpellier, Ecole Doctorale : GAIA
Speciality: Biodiversity, Agriculture, Alimentation, Environment, Earth, Water
Research unit 1: CIRAD, UMR CIRAD-CNRS-IRSTEA-AgroParisTech TETIS (Territories Environment Remote Sensing and Spatial Information), Reunion Island
Research unit 2: CIRAD, UMR CIRAD-INRA ASTRE (AnimalS, health, Territories, Risks and Ecosystems), Mozambique
Research unit 3: IRD, UMR IRD-CNRS-Université de Montpellier MIVEGEC (Infectious Diseases and Vectors: ecology, genetics, evolution and control), Montpellier

Funding : Montpellier University of Excellence (i-site MUSE), 3 years grant

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How to apply
Please send to both contacts annelise.tran@cirad.fr and alexandre.caron@cirad.fr :

- a cover letter detailing your research experiences and interest towards the position
- Curriculum vitae
- academic transcript
- names and contact details of two references

Presentation:

The PhD will aim at modelling using multi-source Earth Observation data the use of landscape by domestic and wildlife animal populations to better characterize the contacts and their determinants and to estimate the risk of pathogen transmission. We propose to take as a model the contacts between domestic and wild herbivores on the periphery of protected areas in southern Africa, a region of the world with many national parks and where animal movements between natural and anthropic habitats are frequently observed in both directions. Two diseases will be studied: foot-and-mouth disease and Rift Valley fever.
The thesis work will be based on telemetry data, surveys and epidemiology data already available, and will focus on the development of innovative spatial modeling methods for the simulation of animal mobility. The main methodological challenges that will be addressed are the assimilation of Earth Observation multi-sensor data in the models, and the modeling of mobility at different spatial scales. The thesis will be structured in three parts:

1. **Use of remote sensing to characterize and monitor the environmental determinants of space occupation, movements of and contacts between wildlife and domestic animals.** The potential of Earth Observation data at different spatial and temporal resolutions to describe the main known determinants (land use and boundaries, vegetation activity, water resource dynamics, savannah fires, villages and associated crop and hunting activities) of habitat and mobility of domestic and wild herds will be evaluated. Processing chains will be developed for the processing of multi-spectral images at medium (MODIS) and high (Sentinel-2, SPOT-6) spatial resolutions.
2. **Modeling the dynamics of land use taking into account these environmental determinants.** This second step involves the development of a model that will integrate the spatial and functional relationships that underlie the use of space by herds of wild buffaloes and livestock, as well as the dynamics of the landscapes in which they evolve. This cartographic simulation tool will (1) synthesize biological and ecological knowledge (population dynamics, behavioral) on mobility and herd dynamics; (2) provide a better understanding of the impacts of landscape structure and its intra-annual variations on animal mobility and on wildlife/livestock contacts. For the development of the models, the Ocelet domain specific language developed by TETIS research unit will be used (http://www.ocelet.fr).
3. **Modeling the transmission of pathogens between wild and domestic animal populations.** The aim of this third part is to apply the animal mobility models developed in Part 2 to the study of transmission dynamics of two pathogens associated with important diseases, a direct transmission animal disease, foot-and-mouth disease, and a vector-borne zoonotic disease, Rift Valley fever. Infectious contact definition will vary between diseases (i.e. based on pathogen-specific modes of transmission) and will impact the risk of pathogen spread at the wildlife/livestock interface with different implications for disease prevention and control.

Partnership: This PhD is part of the TEMPO project (Remote Sensing and Spatial Modelling of Animal Mobility – Application to the study of wildlife/livestock contacts and risk of pathogen transmission) funded by MUSE University and coordinated by CIRAD (2018-2021). The project partners are Cirad (research units TETIS and ASTRE), IRD (UMR MIVEGEC), University of Zimbabwe and Eduardo Mondlane University (Mozambique). The project falls within the Research Platform "Production and Conservation in Partnership (www.rp-pcp.org). During the thesis, the candidate will interact with the different partners of the project, which implies

regular visits between the different research units, with a main location in Reunion (St-Denis), regular missions in Montpellier and field missions to Zimbabwe and Mozambique.

Methods: Modelling (Ocelet), data analysis (R, …), Geographic Information Systems (ArcGIS, QGIS), image processing (ecognition, Erdas, OrfeoToolBox).

Qualifications :
We are looking for a motivated candidate first. This PhD will require skills in programming, modeling and remote sensing and an interest in their applications in ecology or epidemiology.

Some bibliographic references

1. Caron A, Miguel E, Gomo C, Makaya P, Pfukenyi DM, et al. (2013) Relationship between burden of infection in ungulate populations and wildlife/livestock interfaces. Epidemiology and Infection 141: 1522-1535.
2. Caron A, Cornelis D, Foggin C, Hofmeyr M and de Garine-Wichatitsky M (2016). African Buffalo Movement and Zoonotic Disease Risk across Transfrontier Conservation Areas, Southern Africa. Emerg Infect Dis 22: 277-80.
3. Degenne P, Lo Seen D (2016) Ocelet: Simulating processes of landscape changes using interaction graphs, SoftwareX, 5:89-95
4. Degenne P, Lo Seen D, Parigot D, Forax R, Tran A, et al. (2009) Design of a domain specific language for modelling processes in landscapes. Ecological modelling, 220 (24):3527-3535.
5. Miguel E, Grosbois V, Fritz H, Caron A, de Garine-Wichatitsky M, et al. (2017) Drivers of foot-and-mouth disease in cattle at wild/domestic interface: Insights from farmers, buffalo and lions. Diversity and Distributions 23:1018-1030.
6. Miguel E, Grosbois V, Caron A, Boulinier T, Fritz H, et al. (2013) Contacts and foot and mouth disease transmission from wild to domestic bovines in Africa. Ecosphere 4.
7. Soti V, Tran A, Degenne P, Chevalier V, Lo Seen D, et al. (2012) Combining hydrology and mosquito population models to identify the drivers of Rift valley fever emergence in semi-arid regions of west Africa. PLoS Negl Trop Dis 6: e1795.
8. Tran A., Trevennec C., Lutwama J., Sserugga J., Gély M., et al. (2016) Development and assessment of a geographic knowledge-based model for mapping suitable areas for Rift Valley fever transmission in Eastern Africa. PLoS Neglected Tropical Diseases, 10 (9): e0004999 (20 p.).
9. Tran A., Kassie D., Herbreteau V. (2016). Applications of remote sensing to the epidemiology of infectious diseases: Some Examples. In: Baghdadi Nicolas (ed.), Zribi Mehrez (ed.). Land Surface Remote Sensing: Environment and Risks. Londres : Elsevier, ISTE Press, p. 295-315.