Modelling the dispersal of plant pathogen vectors

Further Details

A 4-year BBSRC funded Industrial CASE PhD studentship is available at the University of Cambridge in collaboration with the UK Met Office.

The aim of this studentship is to provide training for a student in the development of improved epidemiological models to predict the spread of vectored plant pathogens through heterogeneous natural and agricultural landscapes by coupling atmospheric dispersion models with stochastic, spatially-explicit, epidemiological models.

The Epidemiology and Modelling Group at Cambridge has long-term research projects to develop and test stochastic epidemiological models for insect vectored diseases of cassava and beans in Africa and citrus greening (caused by the bacterium Candidatus Liberibacter spp.) in the US, involving white fly (Bemisia spp.), aphid (Aphis spp.) and psyllid (Diaphorina citri) vectors, respectively. The models are designed to predict the spread of disease through heterogeneous populations of host crops at the landscape, regional and larger scales and to predict the effectiveness of mitigation and control strategies. Currently the models treat dispersal processes using dispersal kernels, for which the parameters are estimated by Bayesian statistical inference from successive snapshots of disease. This studentship will contribute to introducing more realistic physical processes to account for responses to topography and meteorological variables in medium to long distance dispersal. The student will also have the opportunity to analyse data for local dispersal within fields and groves, where vector dispersal may interact with crop geometries and local environmental driving variables, leading to non-isotropic dispersal and accumulation along edges.

The approach will involve integration of the Met Office Numerical Atmospheric-Dispersion Modelling Environment (NAME) with stochastic, spatially-explicit epidemiological models. Particular attention will be given to consideration of stochastic aspects of dispersal, local establishment and bulking up of vectors on host sites, and subsequent dispersal, so treating heterogeneous landscapes as stepping-stones of localised sources of susceptible hosts interspersed with inhospitable non-host regions, through which disease vectors spread and multiply. While NAME very efficiently addresses the physical aspects of release, dispersal and deposition, the student will be guided towards considering how to introduce vector dynamics in release and deposition and survival during dispersal. The approach will build on previous work by Dr Laura Burgin (LB) on the spread of midge vectors of bluetongue disease of livestock. The student will begin by considering the differential effects of vector type and weather variables on vector and pathogen bulk-up and on epidemiological and dispersal parameters. S/he will proceed to use NAME to investigate the effects of source strength (reflected in local cropping density and duration of infection, which will be derived from the epidemiological models) on the dynamics of spread. Again attention will focus on computing distributions to improve risk assessments.

The student will be based primarily in Cambridge in the Epidemiology and Modelling Group but will spend several extended periods of time working at the Met Office headquarters in Exeter within the Atmospheric Dispersion and Air Quality Group (ADAQ). This will provide a unique opportunity for her/him to experience a stimulating applied research environment where they will learn how research is translated into operational services for government and other industries.

Whilst at the Met Office the student will be expected to complete courses at the Met Office College (the Met Office’s in-house training provider). The Met Office College provides training on a wide range of subjects such as meteorology, climate change, computer programming, health and safety and personal development. The student will be expected to
complete the courses which are relevant to both the PhD and those which are more business related. They will also be given opportunities to improve their communication skills through presentations at group meetings and a seminar towards the end of the PhD.

Epidemiology and Modelling Group, University of Cambridge

The Epidemiology and Modelling Group comprises a group of mathematicians, physicists, statisticians and biologists led by Professor Chris Gilligan. The group is housed in the Department of Plant Sciences at Cambridge and has close links with other modelling groups in Cambridge and internationally.

The research within the group is focused on developing and testing theoretical frameworks to understand the mechanisms that control invasion, persistence, scaling and variability of epidemics within changing agricultural and natural landscapes. Our models are used to predict the spread of disease and to identify and optimise economically and ecologically sustainable strategies for disease management, encompassing genetical, chemical, biological and cultural methods. The research involves a synthesis of epidemiological theory, population and evolutionary genetics, landscape ecology and economic modelling. The models are tested using data from extensive field and regional data-sets. Current areas of interest include:

- Optimising disease control strategies in heterogeneous environments
- Matching the scale of control with the inherent scale of the epidemic
- Estimation of epidemiological parameters for emerging epidemics
- Coupling of economic and epidemiological models for disease control
- Use of atmospheric dispersion models for long-range fungal pathogens

Current and recent applications of the models include agricultural and horticultural diseases (Citrus canker and citrus greening in the US, cassava mosaic and cassava brown streak disease in Africa, wheat stem rust in Africa and Asia, rhizomania of sugar beet in the UK) and diseases of natural communities (Sudden oak death in the US, ramorum disease and ash dieback in the UK).

The Met Office

The Met Office is a renowned, world leading research institute in computationally intensive meteorological research, with expertise in the delivery of both fundamental and applied research. It has a long history of providing advice on livestock disease outbreaks, such as foot and mouth and, in more recent years, has operated a successful research partnership with the Pirbright Institute into vector-borne diseases such as bluetongue. The atmospheric dispersion and air quality group (ADAQ) within the Met Office carries out research into atmospheric dispersion and air quality aimed at improving numerical models for predicting the transport, dispersion, air chemistry and deposition of atmospheric particles and gases.

Further details of the studentships and the research project are given at [http://www.plantsci.cam.ac.uk/research/chrisgilligan](http://www.plantsci.cam.ac.uk/research/chrisgilligan). Applicants are invited to submit a CV and names of two referees to Sally Hames (sah57@cam.ac.uk).