Department	School of Engineering and the Built Environment
Supervisors	Dr Stathis Tingas, Dr Chris Guiver, Dr Nick Wheelhouse
Project Title	Mathematical modelling of transmission and worldwide distribution of neglected zoonotic diseases (Q fever)

PROJECT DESCRIPTION

A 3-year fully funded position is available to contribute substantially to the development of a new modelling approach for the prediction and control of zoonotic diseases (Q fever). The PhD studentship is funded by the Mechanical Engineering and Mathematics Subject Group in the School of Computing, Engineering and the Built Environment at Edinburgh Napier University.

Q fever is a zoonosis, i.e., a disease that can pass from animals to humans, caused by the bacterium Coxiella burnetii. Transmission to human beings is mainly accomplished through inhalation of contaminated aerosols. Although Q fever is asymptomatic in 60% of human cases, it can lead to acute or chronic infections and cause flu-like syndrome, hepatitis, pneumonia, endocarditis or abortions. In humans, most cases are sporadic but outbreaks have indeed occurred in the past. In addition, Coxiella burnetii is considered a category B bioterrorism agent because it is highly infectious and resistant to physical breakdown.

While little is known about Q fever in the UK, serological evidence suggests the disease is endemic in dairy cattle though little is actually known about the impacts of the disease. Due mainly to the epidemic in the Netherlands (2007-2010), Q fever has received an increase in attention as a potential source of human disease and possible preventative measures in both livestock and humans, yet there is still limited understanding on the transmission dynamics of the disease.

Hence, for public health, economic and animal health concerns, it is important to control Coxiella burnetii infections. However, understanding and predicting the spread of Coxiella burnetii in a herd or identifying such key parameters cannot be assessed by field experiments alone. In this context, mathematical epidemiological models are useful tools for understanding how the infection spreads within the herd and how various inputs (such as epidemiological characteristics of infected animals and different host species) affect the dynamics.

The objective of the project will be a new modelling approach for the transmission of Coxiella Burnetti among different host species and to humans. The new approach will combine features and tools from asymptotic analysis and control theory, supplemented with machine learning algorithms and will be validated against field data. The research work will not be limited to the UK but it will be extended to African countries like Ghana and Kenya (through the supervisory team's existing network), where Q fever poses significant risks to both animals and humans. Therefore, the synergistic approach and the multidisciplinary character of the work will enable tackling effectively the transmission of the highly infectious bacterium, both in the UK and abroad (especially in countries of the Global South that lack the necessary resources). Although the primary focus will be Q fever, extension to other important zoonotic diseases (e.g., Rift Valley fever, food and mouth) will be considered.

The PhD student will be supported through periodic meetings with the supervisory team and trained on technical relevant skills such as writing research articles for publication and presenting at international conferences. Additional support will also be received by the supervisory team's ongoing collaboration with the University of Glasgow (Institute of Biodiversity Animal Health & Comparative Medicine).

Academic qualifications
A first degree (at least a 2.1) ideally in Mathematical Biology or Epidemiology or a closely related discipline with a good fundamental knowledge of infectious disease transmission modeling.

English language requirement
IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:

- Experience of fundamental modelling of dynamical systems of infectious disease transmission.
- Competent in programming.
- Knowledge of compartmental deterministic modelling.
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

Desirable attributes:
Knowledge of asymptotic analysis and/or control theory.
Knowledge of stochastic models of infectious disease transmission.
Knowledge of machine learning algorithms.
Experience in undertaking independent research.
A completed or near completion MSc in a relevant subject area.

Indicative Bibliography

1. Keeling, M. J., & Rohani, P. (2011). *Modeling infectious diseases in humans and animals*. Princeton University Press.
2. Angelakis, E., & Raoult, D. (2010). Q fever. *Veterinary microbiology*, *140*(3-4), 297-309.
3. Guatteo, R., Beaudeau, F., Berri, M., Rodolakis, A., Joly, A., & Seegers, H. (2006). Shedding routes of Coxiella burnetii in dairy cows: implications for detection and control. Veterinary research, 37(6), 827-833.
4. Porter, S. R., Czaplicki, G., Mainil, J., Guattéo, R., & Saegerman, C. (2011). Q fever: current state of knowledge and perspectives of research of a neglected zoonosis. International journal of microbiology, 2011.
5. Rodolakis, A., Berri,M., Hechard, C., Caudron, C., Souriau, A., Bodier, C. C., ... & Arricau-Bouvery, N. (2007). Comparison of Coxiella burnetii shedding in milk of dairy bovine, caprine, and ovine herds. Journal of dairy science, 90(12), 5352-5360.
6. Agerholm, J. S. (2013). Coxiella burnetii associated reproductive disorders in domestic animals-a critical review. Acta Veterinaria Scandinavica, 55(1), 1-11.
7. Patsatzis, D. G., Wheelhouse, N., Tingas, E. A. (2022). Modelling the Transmission of Coxiella burnetii within a UK Dairy Herd: Investigating the Interconnected Relationship between the Parturition Cycle and Environment Contamination. Veterinary Sciences, 9(10), 522.

Enquiries

For informal enquiries about this PhD project, please contact Dr Stathis Tingas (e.tingas@napier.ac.uk)

Web page	https://www.napier.ac.uk/research-and-innovation/research-degrees/application-process