Impact of climate change on the spread of pests and diseases in Scotland

Project lead: Adam Kleczkowski (Strathclyde)

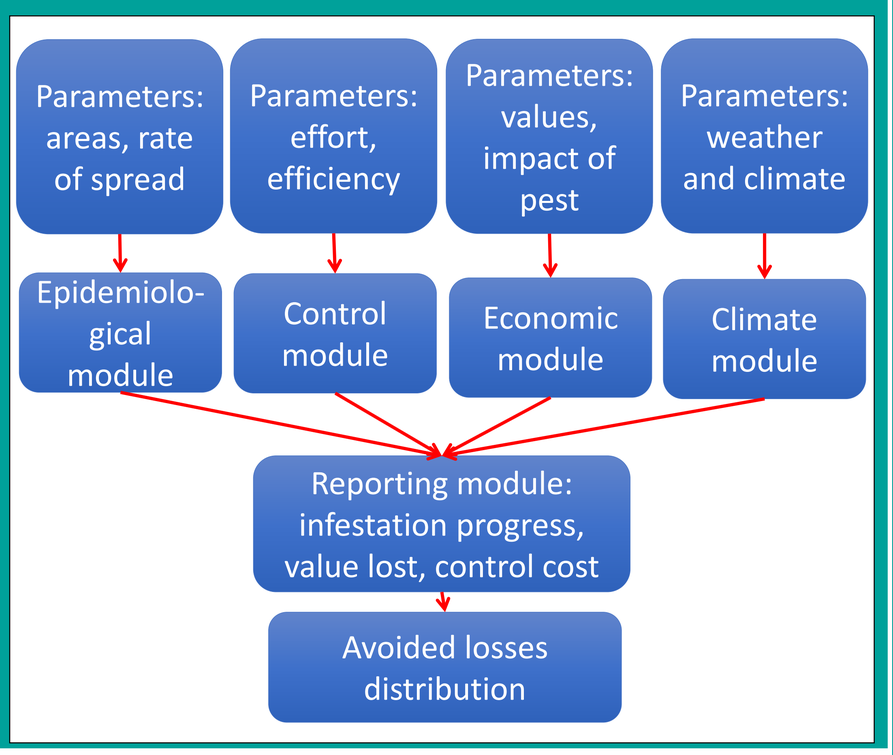
Project partners: Crawford Revie and Oleg Sheremet (Strathclyde); Matt Castle (Cambridge)

Plant Health Centre
Scotland's Centre of Expertise

Scottish Government
Riaghaltas na h-Alba
gov.scot

Introduction

Climate change provides a huge challenge to planning the response of the Scottish Government to plant health threats. New threats and existing pests will become more severe or spread at a higher rate. We need to be able to rapidly, transparently and consistently assess the extent of the outbreak and its economic impact under different scenarios. We develop a modelling tool to assess damages caused by forest and agriculture pests over time.



Acknowledgements

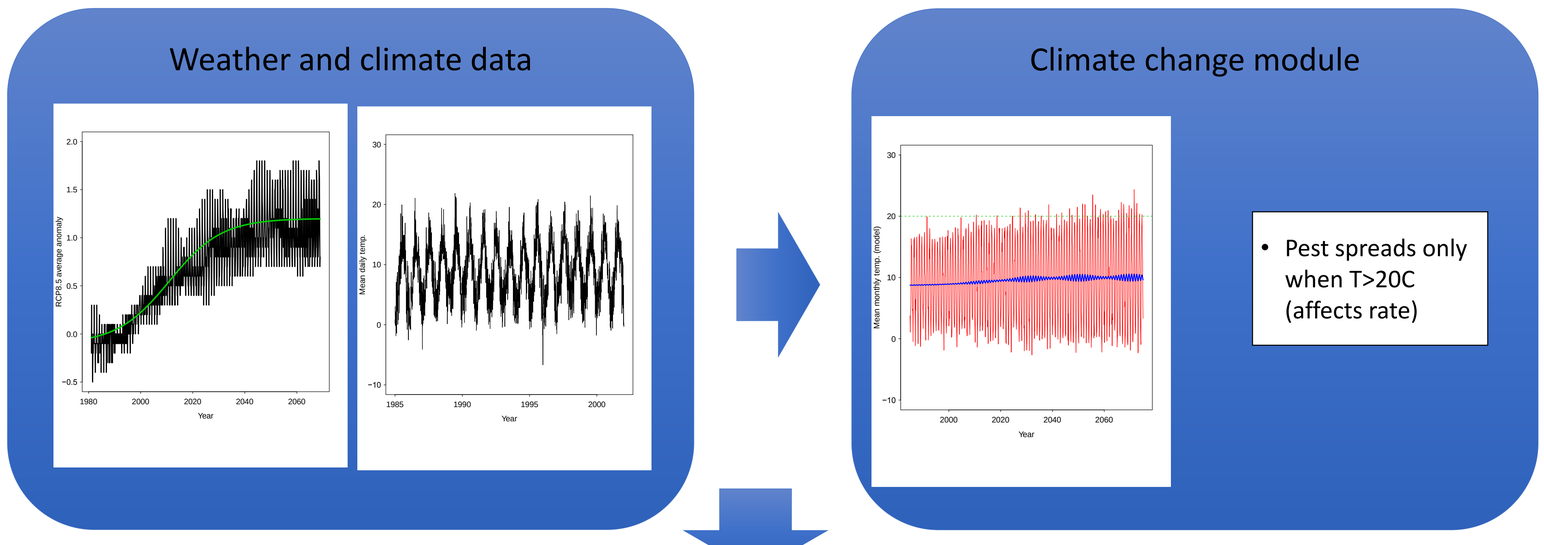
This work was funded by the Scottish Government's Rural and Environment Science and Analytical Services (RESAS) Division through the Centre of Expertise for Plant Health.

Objectives

- To illustrate the effects of climate change on spread of pests and pathogens
- To assess how the key parameters and values at risk are expected to vary with the climate change
- To use a model to study epidemiological and economic outcomes for selected pests and pathogens

Project outcomes

- The decision support system (DEFRA ITT FEE/0365, 2018) is being extended to include climate change and weather
- RCP8.5 climate model and data from weather records (1985-2001) for Scotland have been used to produce a synthetic weather record for 90 years, coupled with a threshold behaviour for a pest spread rate
- Illustrative results have been poroduced to study the risk of spread as warm events (T>20C) become more frequent
- Parameterisation of the model for selected pests (bark beetle, *Ips typographicus*; *Xylella fastidiosa;* Zebra chip) is in progress



$$\left.\begin{aligned} S^*_{t+1} &= S_t - b(e)\frac{S_t I_t}{N} \\ I^*_{t+1} &= I_t + b(e)\frac{S_t I_t}{N} \end{aligned}\right\}$$ infection step

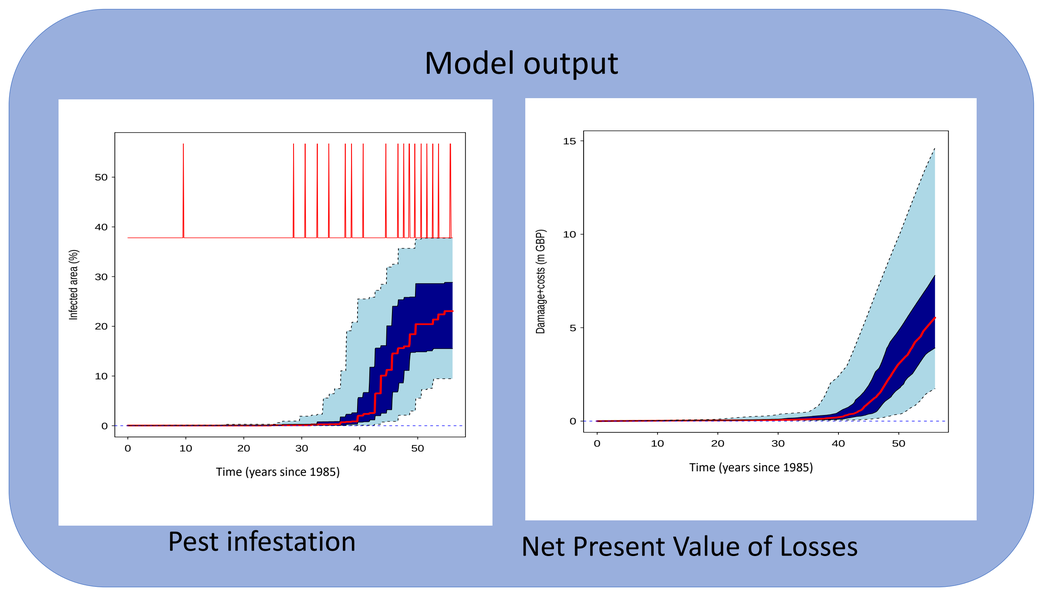
$$\left.\begin{aligned} S^*_{t+1} &= S^*_{t+1} - a\times\min\left(S^*_{t+1}, eN\right) \\ I^*_{t+1} &= I^*_{t+1} - c\times\min\left(I^*_{t+1}, eN\right) \end{aligned}\right\}$$ control step

$$\left.\begin{aligned} V_{t+1} &= a\times\min\left(I^*_{t+1}, eN\right) \\ R_{t+1} &= c\times\min\left(I^*_{t+1}, eN\right) \end{aligned}\right\}$$ control effect

$$b(e) = \frac{b_0}{1+beN}$$

$$\begin{cases} \beta(e), \beta_0 & \text{exponential rate of spread} \\ \beta = \dfrac{\ln(2)}{T_2}; & T_2 \quad \text{doubling time} \end{cases} \qquad rate = \begin{cases} 0 & T < 20^\circ C \\ \beta & T \geq 20^\circ C \end{cases}$$

e control effort
a prevention effectiveness
c culling/clear felling effectiveness
b rate reduction effectiveness
N population area



Key messages

- The project demonstrates the feasibility of risk and economic impact analysis.
- As the climate changes and warm weather events become more frequent, more pests can invade and cause economic damage.
- The damage can be estimated using a simple model.
- Further work is needed to identify key parameters affecting the invasion and spread of pests and pathogens (i.e. rate, susceptibility, values, impact) and nonlinearities (i.e. number of pest generations per year, synchronicity).