Liver fluke risk in a changing climate

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Key Messages

Future risk maps for liver fluke outbreaks in the UK predict unprecedented levels in some areas (including parts of Scotland) and changes in the timing of outbreaks.

- Liver fluke (*Fasciola hepatica*) is a physically and economically damaging parasite affecting sheep and cattle. Heavily infected hosts may die, those with lighter infections may suffer inhibited growth and reduced production efficiency, while the detection of pathological lesions leads to liver condemnation.

- Figure 1 shows the parasite’s lifecycle. Climate has a large impact on the free-living stages of the parasite and its intermediate host, the dwarf pond snail (*Lymnaea truncatula*). The interactions between rainfall and temperature have the greatest influence on transmission.

- The rise in fluke outbreaks in recent years has been attributed to climate change, with the parasites and their intermediate snail hosts thriving in warm wet conditions.

- By combining a risk model with observed climate data we demonstrate the impact that climate change has had on liver fluke risk over the past four decades. By then applying this risk model to the latest climate change projections, future risk maps are generated for 2020-2070³.

- The future risk maps predict unprecedented levels of liver fluke in parts of the UK including the west of Scotland and Wales due to warmer and wetter conditions. Changes in the timings of outbreaks are also predicted. Despite an overall long term increase in all regions of the UK, variation in risk levels is expected, with infection risk due to reduce in some areas and vary greatly in others dependent on levels of rainfall and optimum temperatures.

- Record levels of rainfall in 2012 provided ideal conditions for fluke transmission. Consequently Scotland’s sheep and cattle have recently been suffering from high parasite levels. With warm and wet conditions predicted to become the norm for some regions of the UK, the high fluke outbreaks experienced in the last grazing season could become a common occurrence.

- This work indicates where active surveillance and long term control strategies, such as improved drainage and sustainable anthelmintic use, should be targeted.

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³ For more information on the liver fluke predictions, see: [http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0016126](http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0016126). This research was undertaken within the Scottish Government Rural Affairs and the Environment Portfolio Strategic Research Programme 2011-2016, Programme 1 Environmental Change (Local Responses to Global Change). For more information, see: [http://www.scotland.gov.uk/Topics/Research/About/EBAR/StrategicResearch/future-research-strategy/Themes/ThemesIntro](http://www.scotland.gov.uk/Topics/Research/About/EBAR/StrategicResearch/future-research-strategy/Themes/ThemesIntro).
Introduction and Rationale
Liver fluke is a physically and economically damaging parasite of sheep and cattle, and outbreaks have been on the rise in the UK. The severe liver fluke outbreaks that accompanied the record levels of rainfall in 2012 exemplify the close relationship between weather and disease levels. As parasite survival and transmission is heavily dependent on abiotic factors it is expected that long term climate change has had, and will continue to have, a profound impact on parasite prevalence and distribution. As parts of the UK are predicted to become warmer and wetter under climate change, potential impacts on future liver fluke risk need to be considered.

Methods
A correlative forecasting model was used (the Ollerenshaw index), which is based on the strong links between climatic conditions and liver fluke levels. This model was applied to past observed climate data (UKCIP) to show how climate change has already driven changes in liver fluke levels across the UK since the 1970s. The model was then applied to future climate projections (UKCP09 data) to develop the first long-term predictions of future liver fluke risk in the UK.

Key findings
Over the past four decades liver fluke risk has spread across the UK from a restricted distribution in 1970, to the current levels where large swathes of the UK are seeing regular outbreaks (Figure 2).

Although liver fluke has had a big impact on farms in recent years with occasional high intensity outbreaks, according to the Ollerenshaw index we are yet to experience extended large scale epidemics. As average conditions become warmer and wetter in parts of the UK, the high outbreak levels experienced in 2012 could become an increasingly common occurrence, with serious epidemics predicted to be the norm by 2020 in parts of Scotland (particularly in the north and west), and by 2050 in parts of Wales (Figure 2). Some parts of the UK will also experience longer development windows, allowing infection to extend from being a seasonal to a year-round threat.

Policy messages
This forecast is the first prediction of the potential impacts of climate change on liver fluke risk in the UK. These maps predict extended periods of high infection risk in parts of Scotland and Wales, which could result in reduced animal welfare and production efficiency. Predicted changes in the timing of disease outbreaks could make the parasite harder to control. There is currently no active surveillance for liver fluke; the risk maps provide an indication of where future disease surveillance should be actively targeted, and where long term control strategies should be implemented.

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