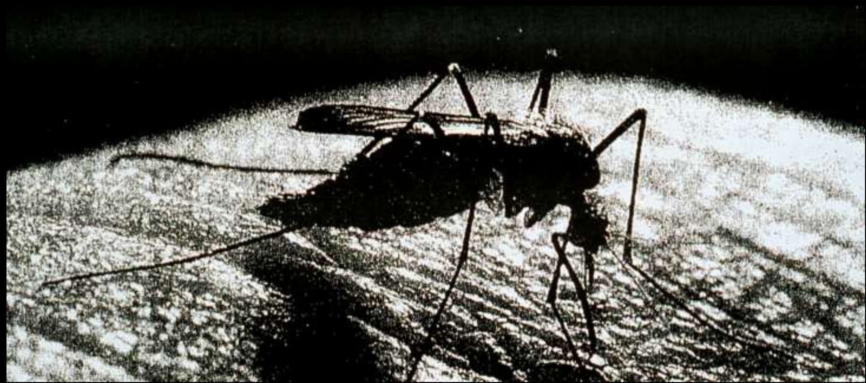
The impact of climate change on pests



APSE online webinar - Developing a service fit for the future

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NIHR Health Protection Research Unit in emerging and zoonotic infections, Liverpool, UK
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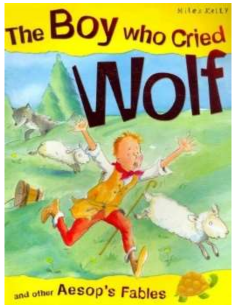
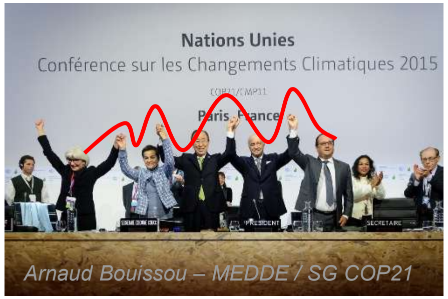
Climate change – a brief summary

1995 onwards

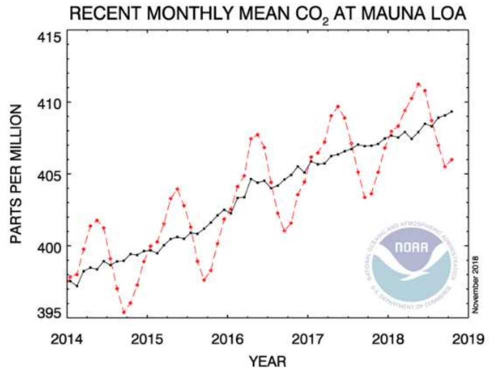


2016



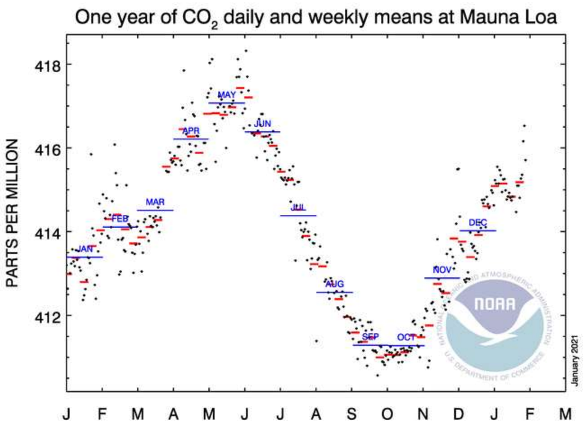
*"The Paris Agreement entered into force on 4 November **2016**" - UNCC*

CO2 last 5 years



Old news, ouch…
But better now…

- Covid19 pandemic makes you realize how far we are from CO2 targets
- Scenario estimates a 4-7% decrease in global emissions for 2020 (Le Quéré et al., 2020)
- COP26 in Nov 2021 in Glasgow!



https://www.esrl.noaa.gov/gmd/ccgg/trends/weekly.html

https://www.nbcnews.com/science/environment/elon-musk-offer-100-million-prize-best-carbon-capture-tech-rcna234

Multi-faceted impacts of climate on human and animal health

Heatwaves


An Iraqi man shows a thermometer reading more than fifty degrees Celsius on **July 30, 2015** in Baghdad.

Hurricanes and floods

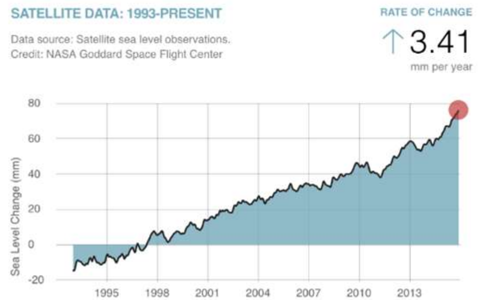

Irma summer 2017


Floods in Florida October 2015

Air pollution


Harbin, China

Sea level rise



Climate sensitive diseases

Arthropods are ectotherms

Vector, water and soil borne pathogens are impacted

Water, agriculture and biodiversity


Scientific American artwork


Starving polar bear National Geographic

Climate refugees and migration

Somali refugees flee flooding in Dabaab, Kenya (UNHCR)

Infrastructures

Genoa Morandi bridge collapsed in Aug 2018 due to heavy rainfall (ABC news)

Direct impacts

Mediated impacts

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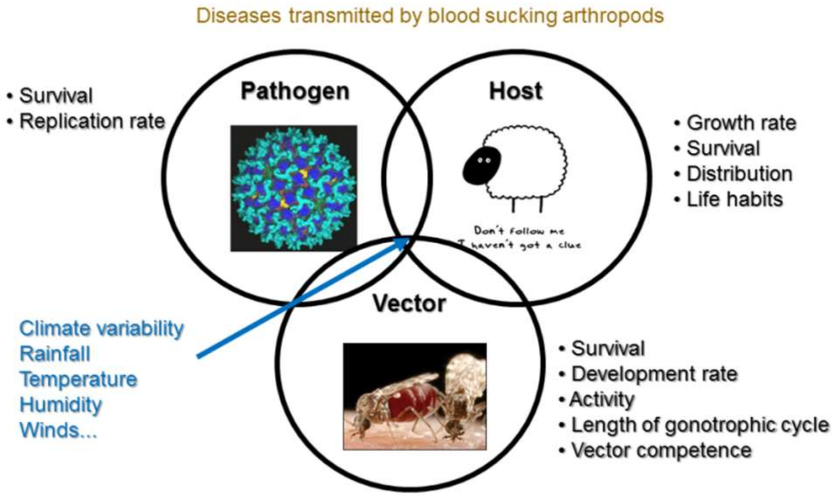
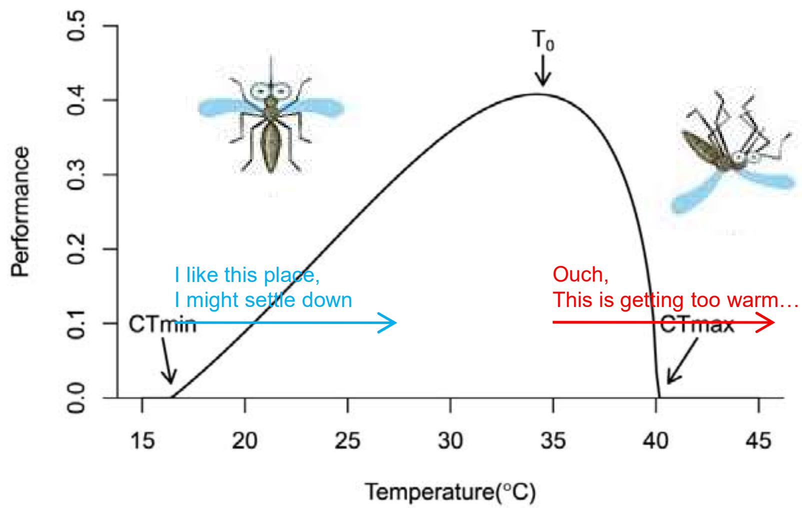
Climate change impacts on pests and VBDs

VBDs are climate sensitive



Vectorial capacity = f(T°)



Lafferty KD and Mordecai EA 2016 - F1000Research 2016, 5:2040

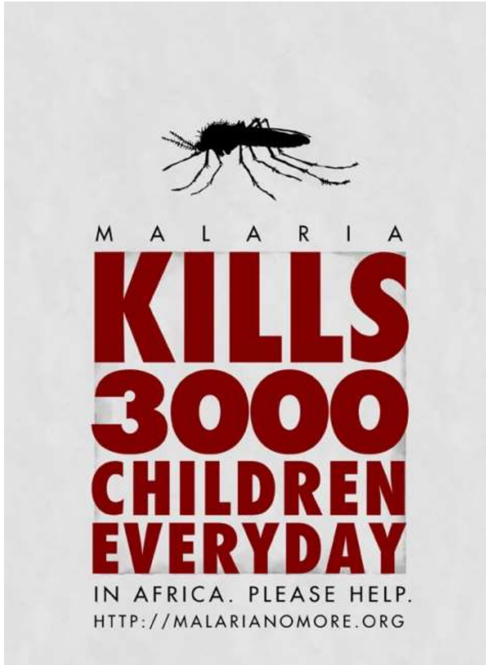
Vectorial capacity encapsulates:

- Development and mortality rates
- Pathogen incubation period in the vector
- Biting rates

Modelling the impact of climate variability on VBD burden, development of early warning systems (seasonal to climate change time scales).

Impacts of vector-borne diseases (VBD)

2nd Plague pandemic 14th century

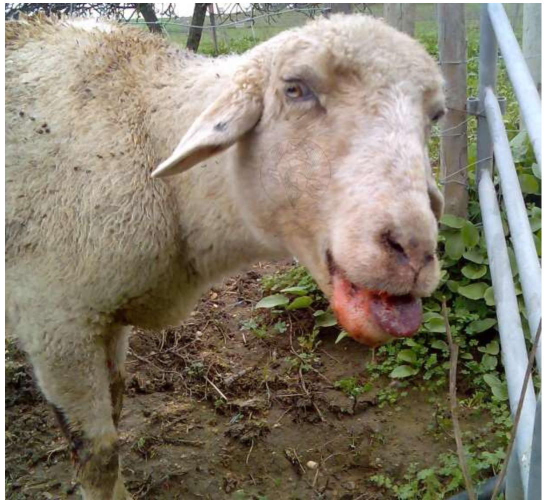


Malaria in Africa

Zika outbreak in Latin America 2015-2016

Yellow fever outbreak – Angola, DRC 2015-2016

Bluetongue outbreak in Northern Europe Aug-Sep-Oct 2006



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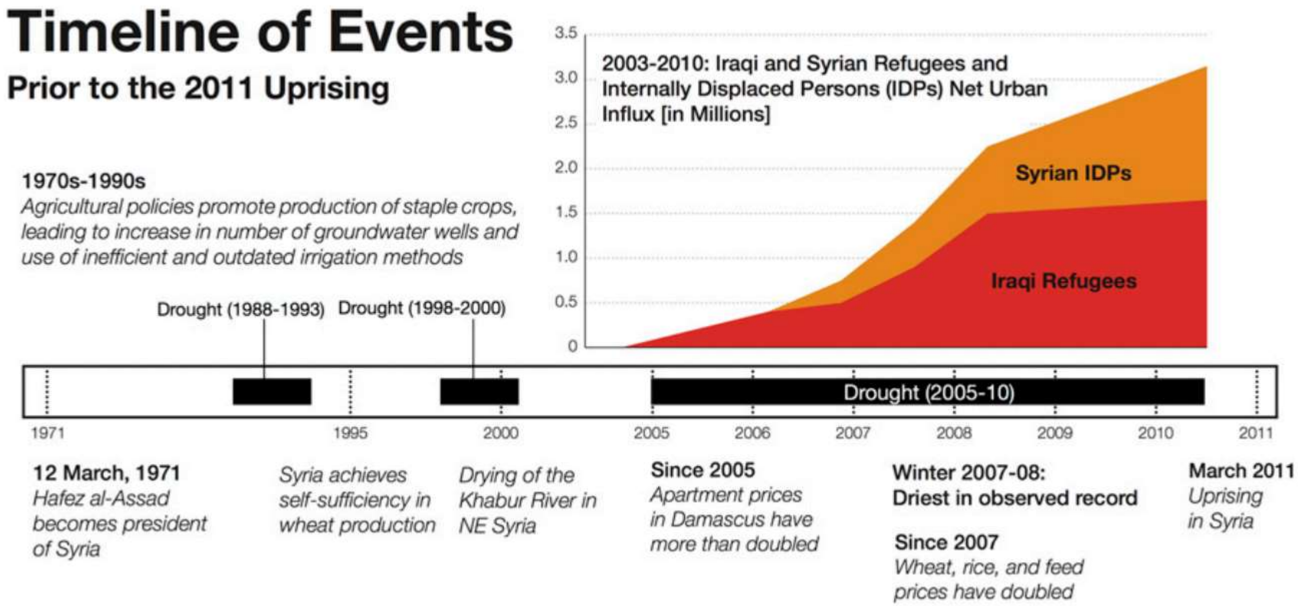
Relevance to food production and catering services

Impact of climate change on catering services can be divided into two sub-components: from the farm to the plate basically

- **Agricultural production** (supply): farmers and producers
- **Supply chains and delivery :** network can be extremely complex depending on the food product. Issues: cold chain, chain supply network, contamination during the process (norovirus, salmonella, Listeriosis, faecal contamination by rodents, black flies etc). Large variability from country to country depending on food standards. Expert Prof John Rushton, Liverpool Uni. RUC-APS EU project (contact Jorge Hernandez)



Timeline of events leading up to the civil uprising in Syria in March 2011, along with a graph showing the net migration of displaced Syrians and Iraqi refugees into urban areas (in millions) since 2005. Source: Kelley et al. (2015) https://doi.org/10.1073/pnas.1421533112

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The example of the sheep liver fluke for UK farmers: impact on livestock and dairy sector

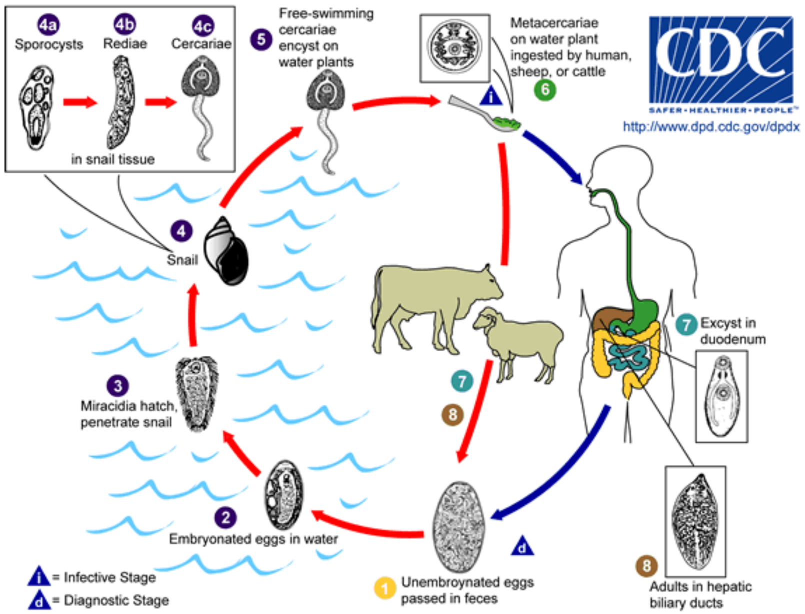
The sheep liver fluke: a burden for UK farmers

Liver fluke is the second most frequently diagnosed disease of sheep and cattle in GB (after GI nematodes)(AHDB/RUMA report 2019)

Climate change, animal movements and changes to agri-environmental schemes are affecting prevalence (Fox et al, 2011; Caminade et al 2015; Skuce et al 2013; Coyne et al, 2020)

Control is based on use of flukicides in the absence of any diagnostic or evidence-based information.

Resistance to veterinary medicines (flukicides) used to control fluke is prevalent (Kamaludeen et al 2019)



Fasciola hepatica, also known as the **common liver fluke** or **sheep liver fluke** is a parasitic flatworm of the class Trematoda, infects liver of various mammals, including humans.

The disease caused by the fluke is called fascioliasis (also known as fasciolosis).

Its life cycle requires a freshwater snail as intermediate host.

It occurs in wet grassland settings (western UK and Ireland).

F. hepatica is world-wide distributed and causes great economic losses in sheep and cattle.

Slide adapted from Prof Diana Williams, University of Liverpool

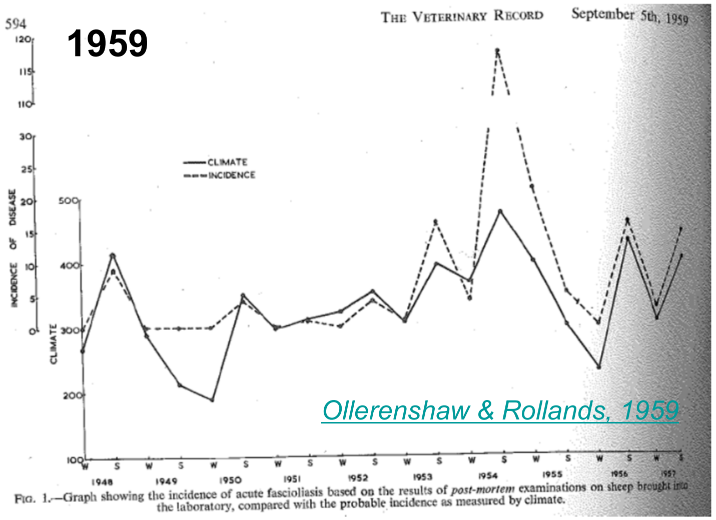
Ollerenshaw Mt model late 1950s!

$$Mt = n\left(\frac{R}{25.4} - \frac{P}{25.4} + 5\right)$$

How wet vs how warm & dry are the soils?

R: Rainfall (mm/month)
P: Potential evapotranspiration (mm/month) based on Hargreaves equation
n: Number of rainy days per month (days > 1mm)

Mt is originally summed over a 6 months period (from May to October) and varies between 0-100 for a month
The standard risk thresholds are as follows:
Mt ≤ 300 - no risk (green)
300 ≤ Mt ≤ 400 - occasional loses (yellow warning)
400 ≤ Mt ≤ 474 - disease prevalence (orange warning)
474 < Mt - Serious epidemic (red warning)



- Mt model used by NADIS to provide operational risk forecast for UK farmers at 40km
- Used for long term-climate change risk assessment (Caminade et al., 2015)

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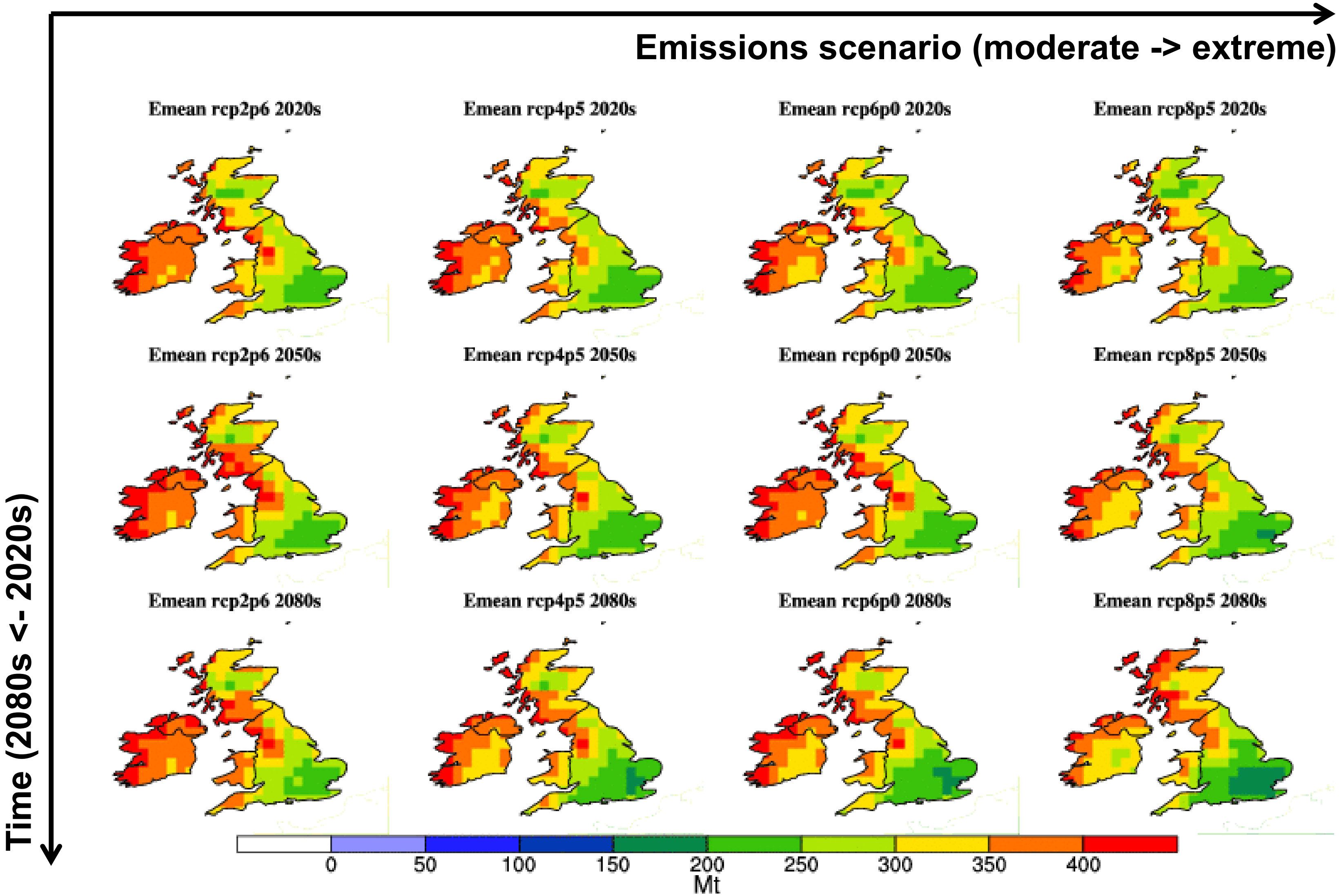
Future scenario, summer infections (May->Oct)



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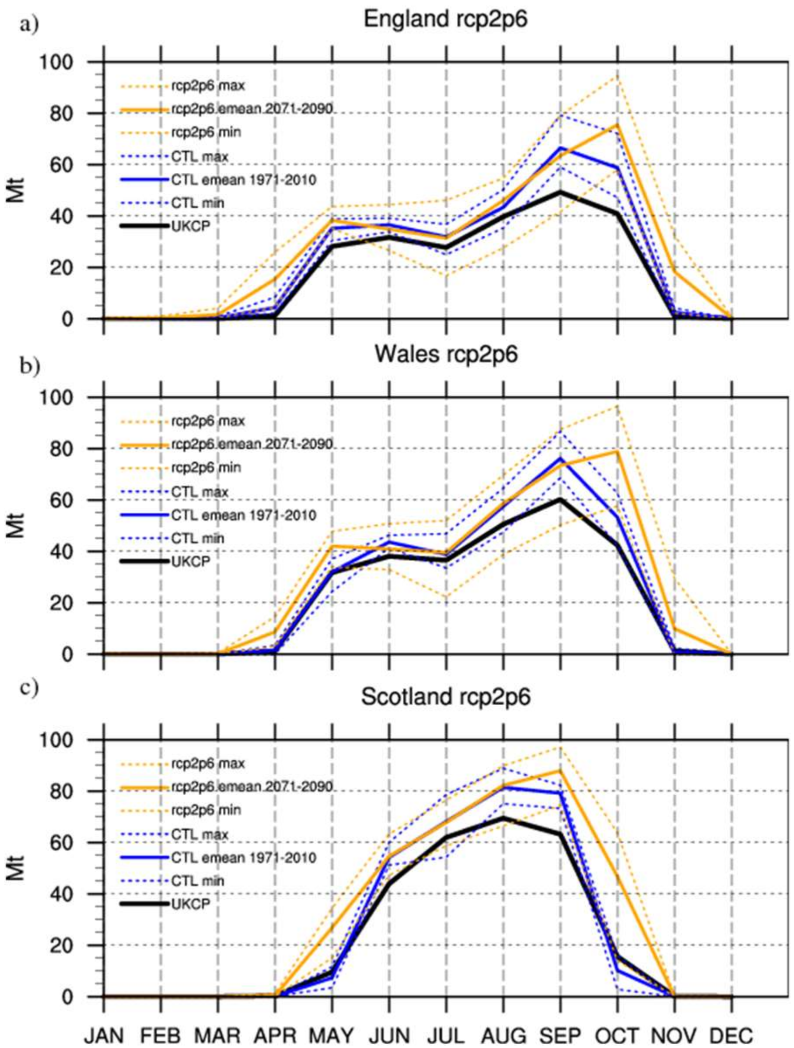
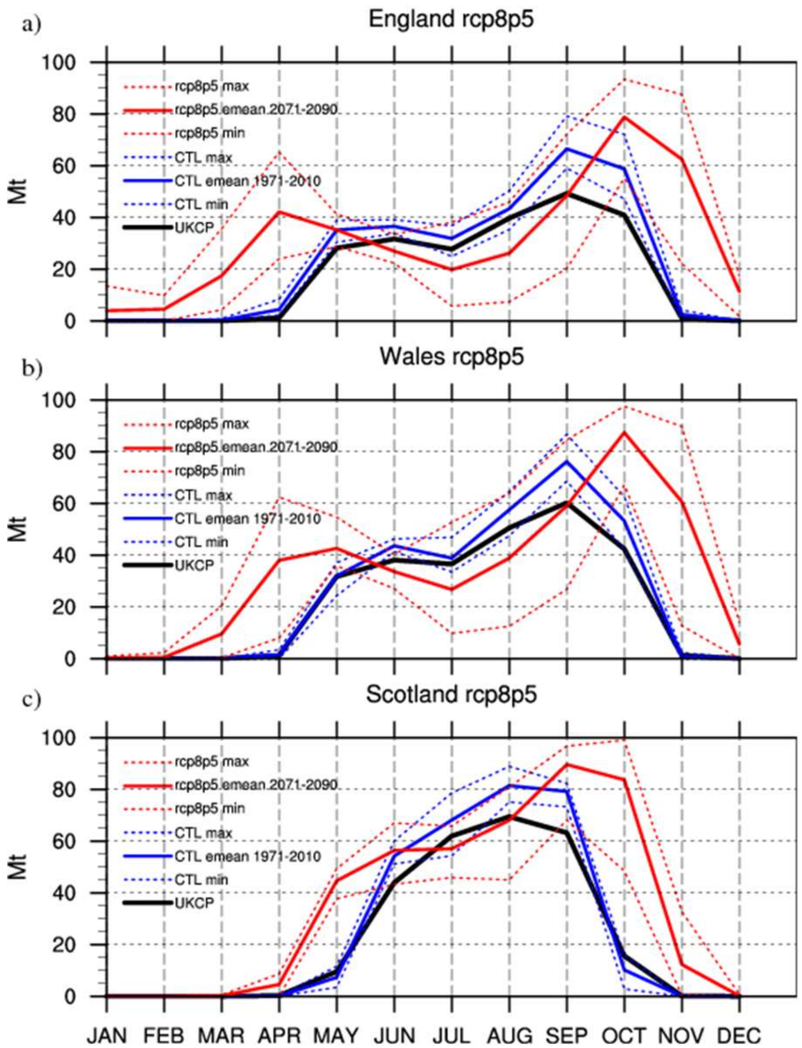
Future scenario, seasonal cycle

Mild emission scenario



Extreme emission scenario



Other examples briefly

Xylella fastidiosa (Xf)

Article | Open Access | Published: 20 June 2019

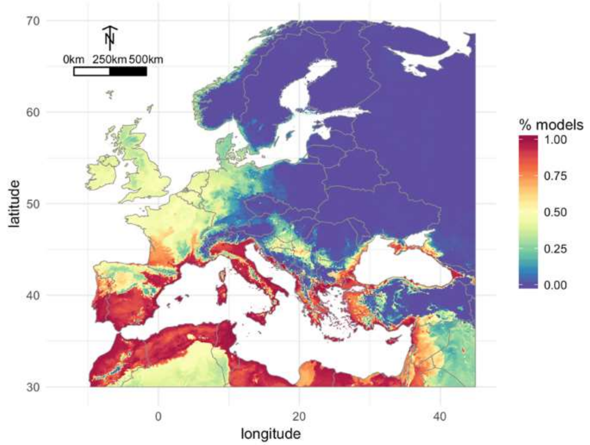
Xylella fastidiosa: climate suitability of European continent

Martin Godefroid, Astrid Cruaud, Jean-Claude Streito, Jean-Yves Rasplus & Jean-Pierre Rossi

Scientific Reports **9**, Article number: 8844 (2019) | Cite this article

3454 Accesses | **7** Citations | **6** Altmetric | Metrics

A *Xylella fastidiosa fastidiosa*



Food and Agriculture Organization of the United Nations

International Plant Protection Convention
Protecting the world's plant resources from pests

Facing the threat of *Xylella fastidiosa* together

The bacterium *Xylella fastidiosa* is a serious threat to agriculture, the environment and the economy. Its geographical distribution and its host range have greatly expanded in recent years.

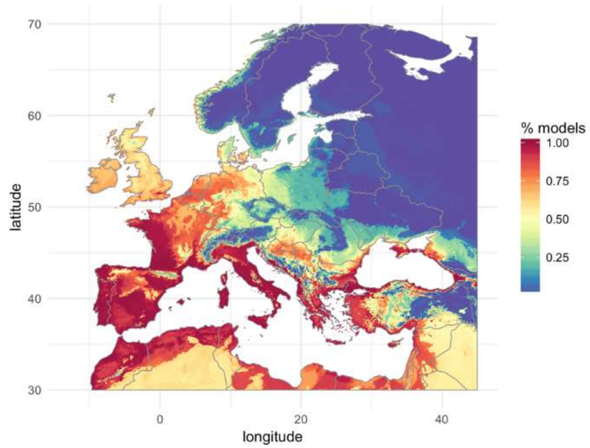
Coordinated efforts should be made globally to avoid further spread.

Figure 1 - Olive quick decline syndrome (Source: Franco Valentini, CIHEAM)

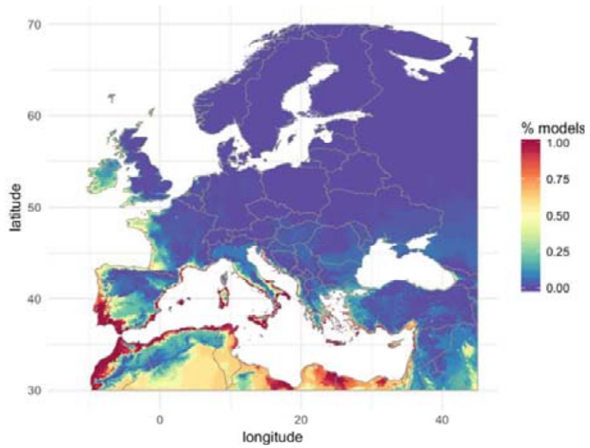
About the vectors

Any xylem sap feeding insect is a potential vector of *Xylella fastidiosa*. The sharpshooters *Homalodisca vitripennis* and *Acrogonia terminalis* are primary vectors in California and Brazil, respectively. The meadow spittlebug *Philaenus spumarius* is the only known vector in Italy and is widely distributed in Europe and in the Mediterranean region. However, with ongoing research, new vectors may be identified as the bacterium expands its geographical range.

B *Xylella fastidiosa multiplex*



C *Xylella fastidiosa pauca*



Asian Hornet

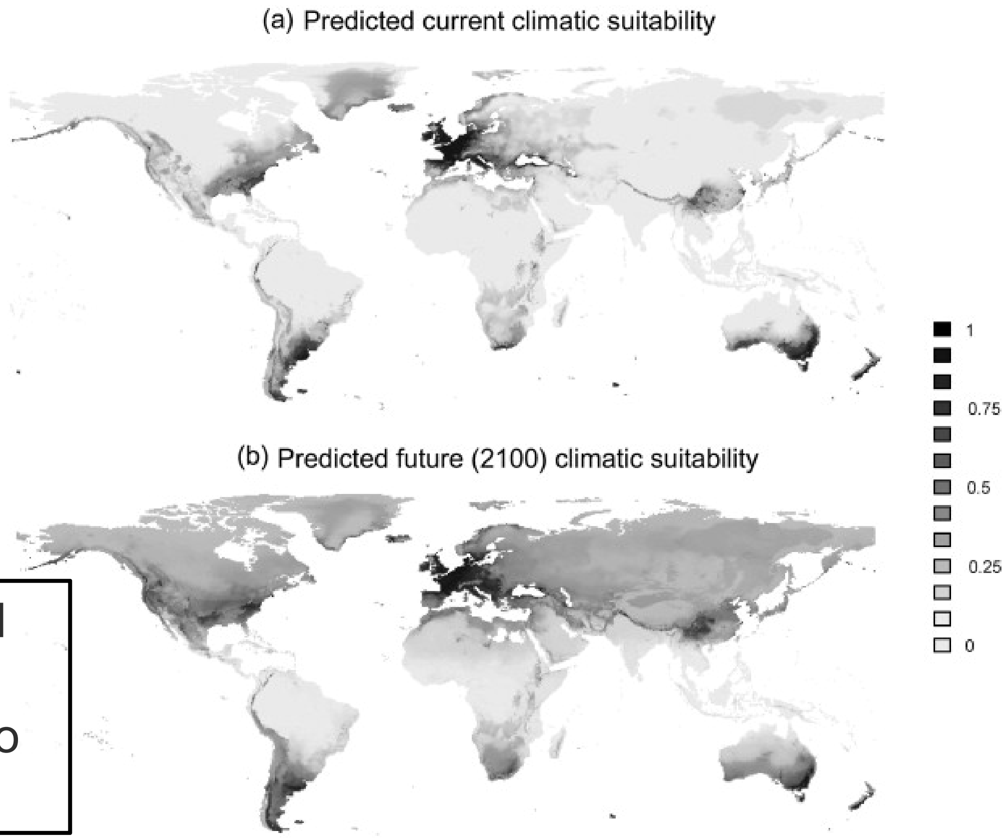
Chris Looney fills a tree cavity with carbon dioxide after vacuuming a nest of **Asian giant hornets** from inside it, on 24 October in Blaine, Washington.
Photograph: Elaine Thompson/AFP/Getty Images
Source: Guardian
https://www.theguardian.com/environment/2020/oct/31/us-murder-hornets-nest-asian-giant

This **bee-hawking hornet** already invaded range in Europe, in Spain and in Central and Eastern Europe – from Switzerland to Hungary up to Southern Sweden.

ELSEVIER
Biological Conservation
Volume 157, January 2013, Pages 4-10

Climate change increases the risk of invasion by the Yellow-legged hornet

Morgane Barbet-Massin [a, b], Quentin Rome [c], Franck Muller [c], Adrien Perrard [c], Claire Villemant [c], Frédéric Jiguet [a]



Conclusions

- Climate change, coupled with globalization, impacts pest distribution and food production
- Increasing evidences that climate change already played a role in the background over the past 20 years: worrying vector trends have been observed in different temperate, arctic and highland regions.
- Many factors to consider in order to anticipate the real future of pests (socio-economic, demography, policy, land use changes, drug and insecticide resistance, technological break through, human behavior, interaction with animals…) -> One Health framework
- Crystal ball modelling: need to use different disease modelling approaches and ensemble of climate models, emission & population scenarios to assess uncertainties, and these can be quite large!
- Climate change is already affecting our health directly (climatic extremes: heat waves, floods, air pollution…) and will have significant indirect effects from macro to micro scale e.g. on freshwater and oceanic resources, agriculture, livelihoods, population migration… It only started e.g. aperitif time…
- Complex issue for catering services, climate undoubtedly impact food production (pests, crops, livestock, horticulture etc). Climate extremes can also disrupt supply networks (Genoa bridge example). Other important critical factors to consider: pesticides, fertilizers, low carbon strategies for food transportation, drug resistance, biodiversity…