Assessing the importation risk of zoonotic and emerging pathogens, from UK and global perspectives

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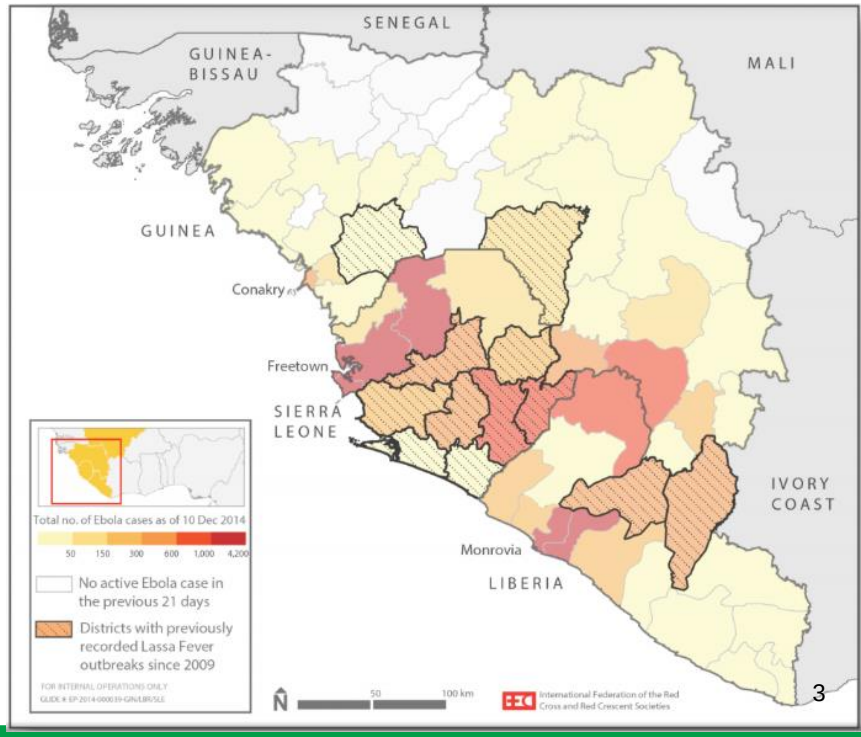
Taipei City Hall being disinfected after dengue fever case

2015/11/02 21:01:16

Spain detects first ever case of mosquito-borne chikungunya virus

Personal background

- University of Edinburgh – BSc Hons Infectious diseases
- London School of Hygiene and Tropical Medicine – MSc Control of Infectious Diseases
- NIHR HPRU EZI – PhD
- British Red Cross volunteering
  - Ebola mapping team



Background to the HPRU EZI

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NIHR funded,

- 5 years from April 2014
- 12 Health Protection Research Units (HPRU)
- Emerging and Zoonotic Infections: 5 research themes

- Improving diagnosis and clinical management of Lyme borreliosis in the UK
- Why do some strains of Ebola virus cause lethal haemorrhagic fever?
- Quantitative analysis of the attraction and feeding of mosquito species to humans in the UK

My PhD plan

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"Assessing the importation risk of zoonotic and emerging pathogens, from UK and global perspectives"

Background
- Increasing travel in shorter time
- Increasing number of (re-)emerging infections

Aims
- Identify suitable data sources
- Develop an importation risk framework applicable to any new pathogen
- Describe trends in UK and global importation risk

Outputs
- Mathematical model of importation risk
- Identifying most probable origins for different pathogen 'types'
- Provide PHE with risk estimation tools

Assessing importation risks

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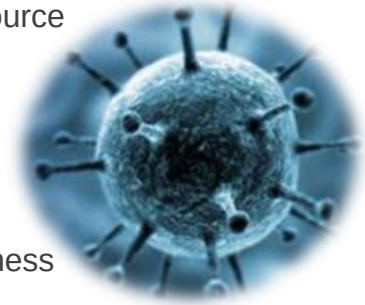
How likely is it to reach us?

Source

Biology

Infectiousness



Ability to intervene

Connections (world)

Transmission

Prevalence

Human behaviour

Risk framework - EBOLA

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- Risk of getting infected in target country
  - Population: prevalence, visitor numbers
  - Behaviour: people, pathogen

- Risk of infected person travelling to the UK
  - Biology: incubation, severity, R0
  - Country profile: health system, airport screening, visitor numbers

- Risk of seeding an epidemic in the UK
  - Biology: incubation, severity, infectious period, generation time
  - Country profile: health system, airport screening, contact patterns

www.ibtimes.co.uk/

2003 - SARS

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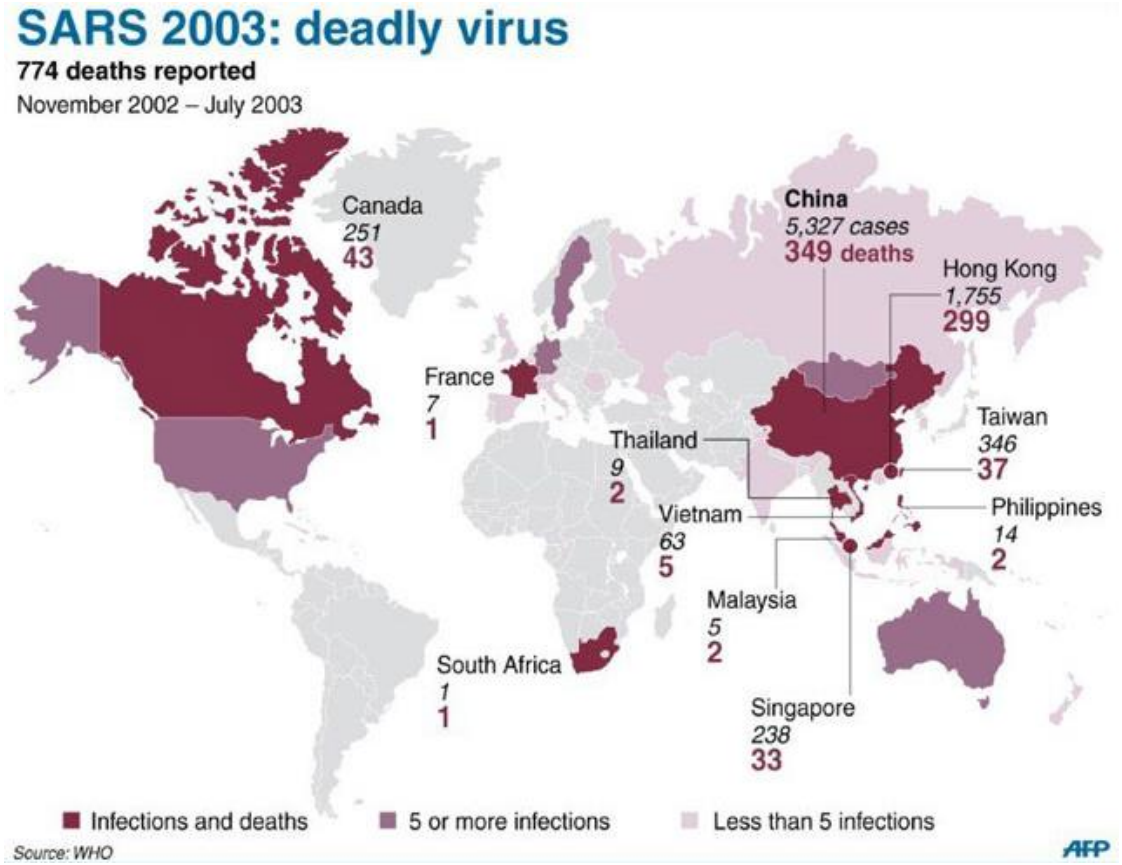
Importance of human travel in spreading pathogens between countries



www.thenewstribe.com/

2009 – pandemic flu

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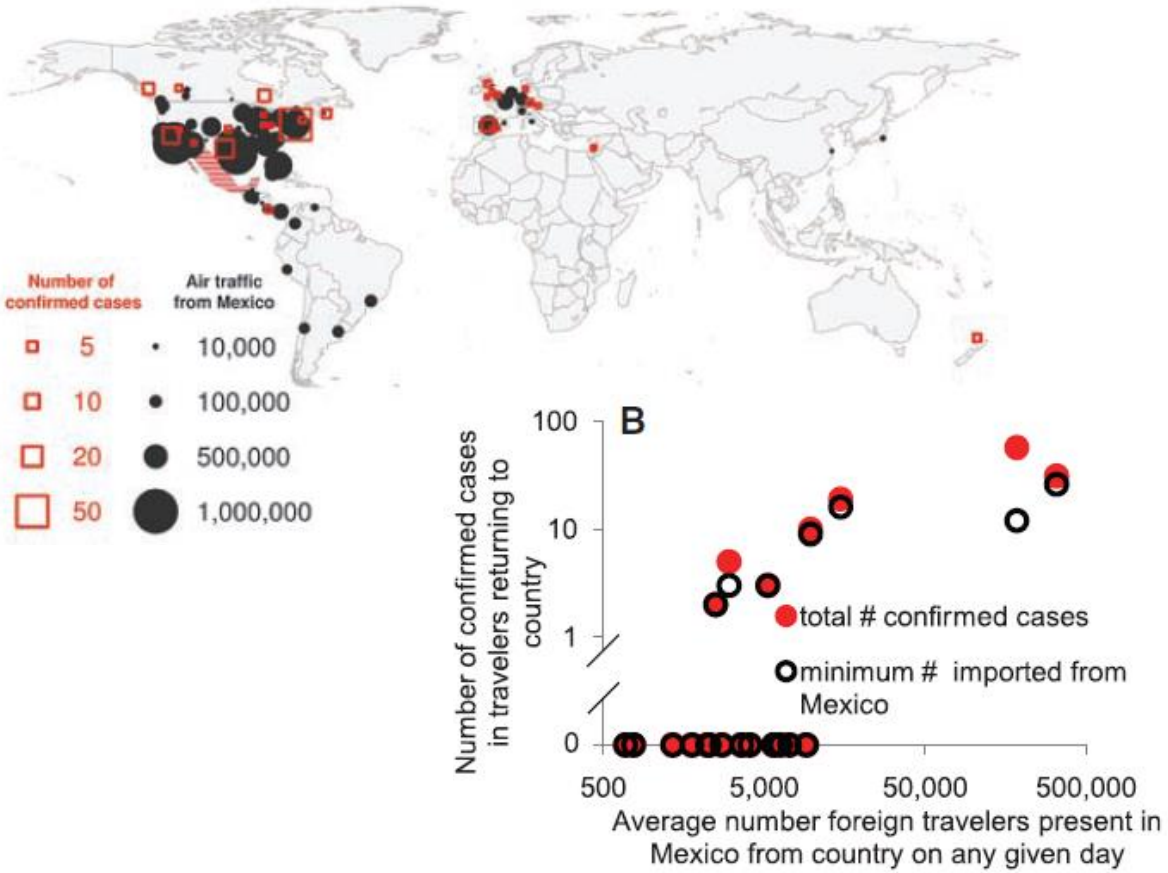
Importance of human travel in spreading pathogens between countries



Fraser *et al*, 2009

2012 – MERS (ongoing)

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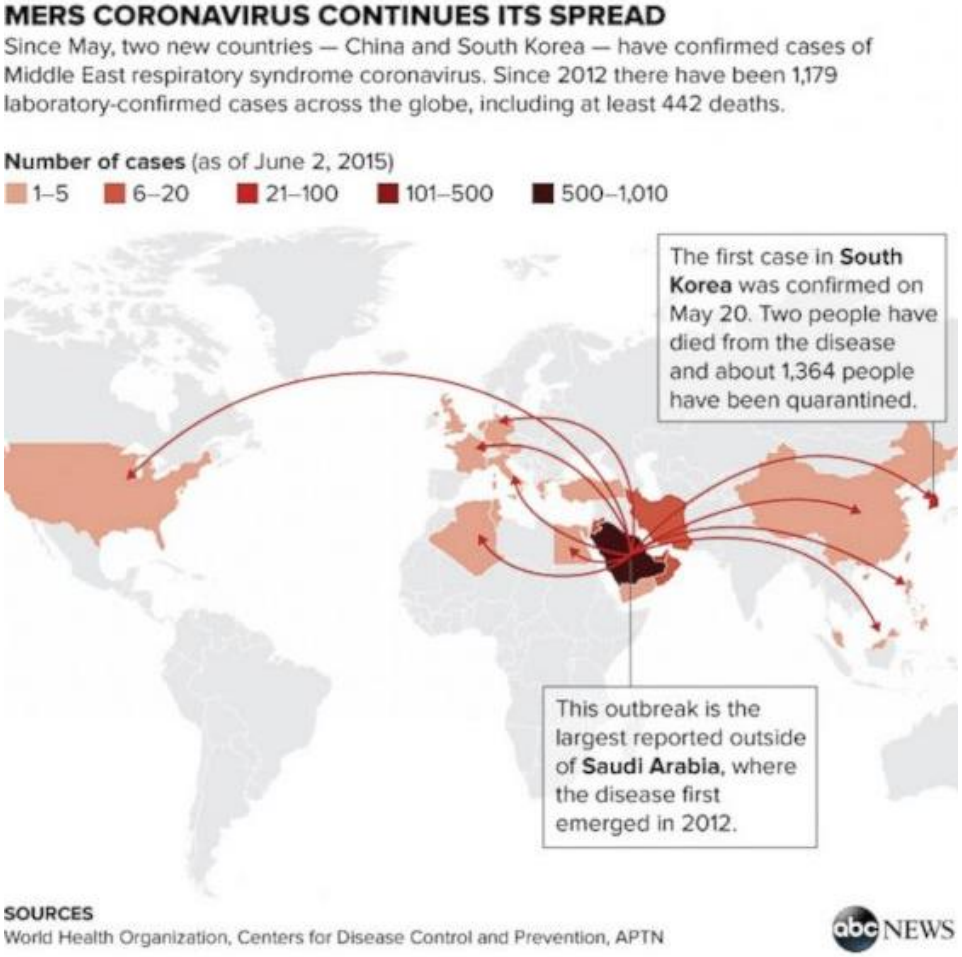
Importance of human travel in spreading pathogens between countries



2013 – Ebola (on-going)

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Biggest Ebola outbreak

Flight restrictions:

Introduced in August 2014

Stop direct flights

Countries or airlines

www.msf.org.uk/

But… there are many ways to reach any place in the world!

Effect of flight restrictions on flights from West Africa

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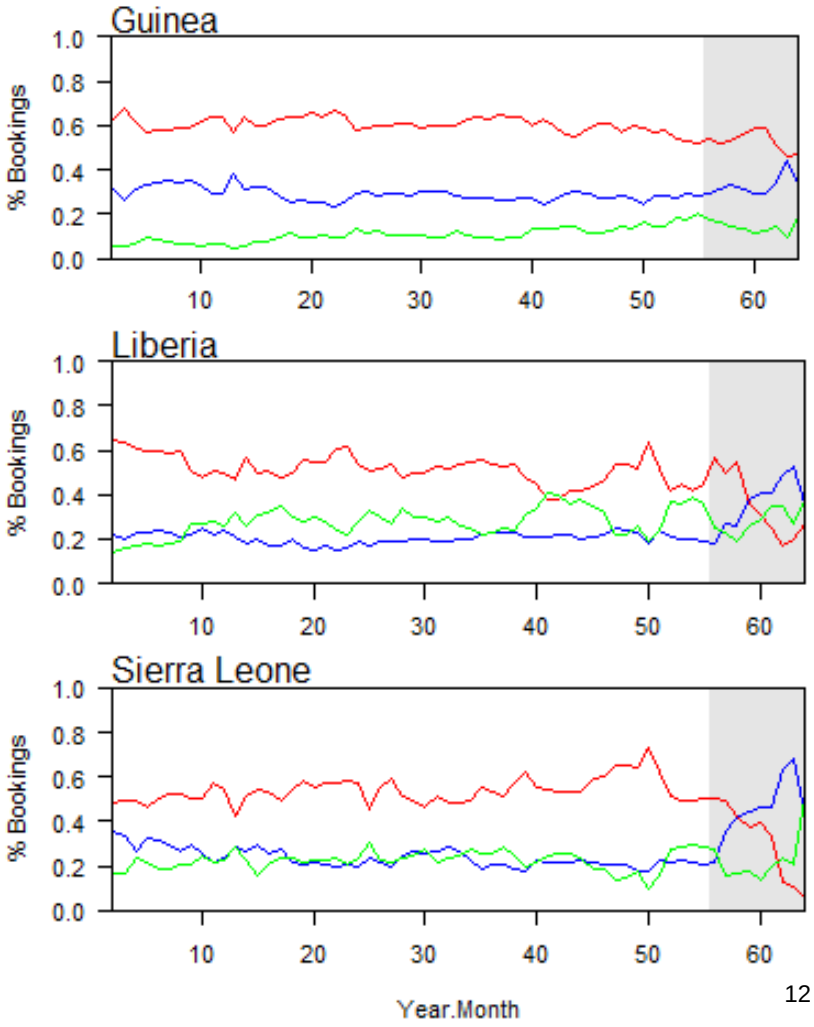
Percentage of bookings with **no**, **one** or **two** (or more) bookings from departing countries, from February 2010

Grey areas represent the period of flight restrictions from August 2014 onwards

Note the impact on flights from Sierra Leone



Probability of importing a case

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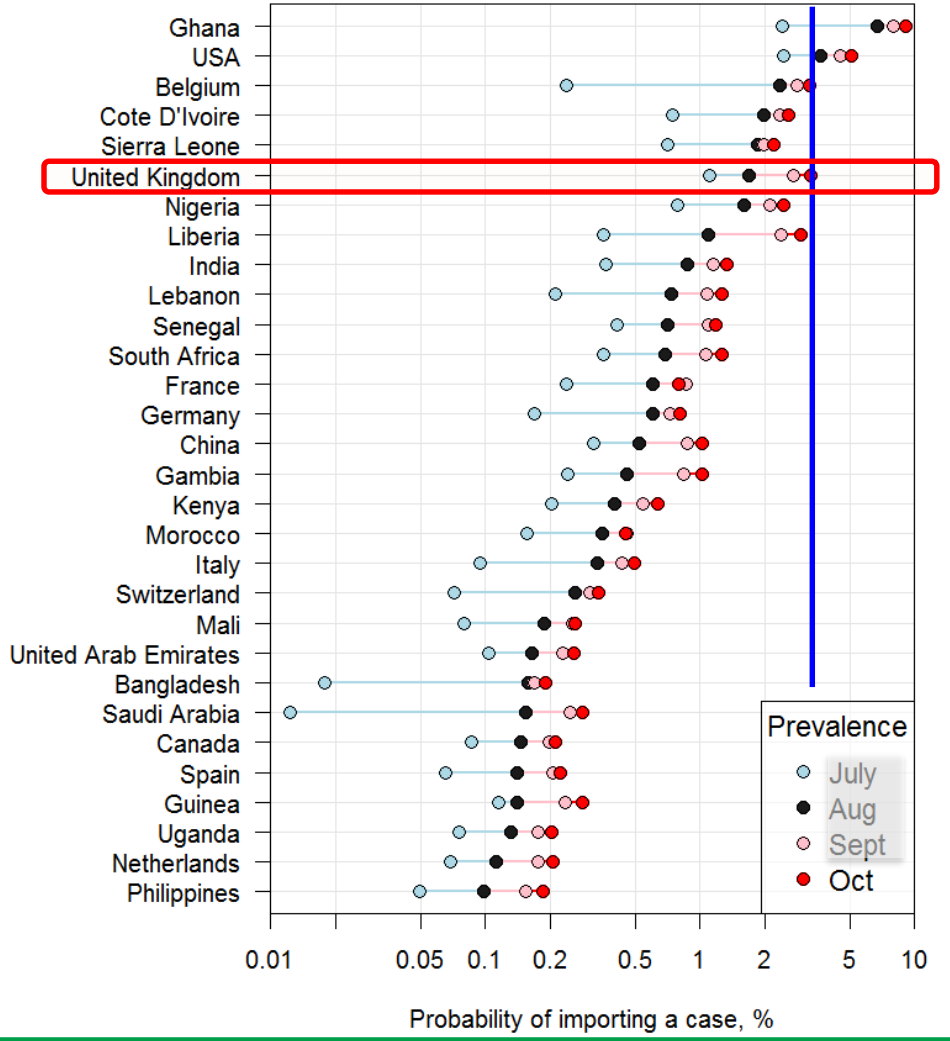
Probability of importing a case of Ebola before and after flight restrictions

USA and UK consistently top of table

Ghana and Cote D'Ivoire consistently high as well



Dr Jon Read

Ebola importations

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International importation events by air travel:

Country	Date	Demog.	Source	Routing
Nigeria	20 Jul 2014	Male	Liberia	MLW-LFW (togo) | LFW-LOS
USA	30 Sep 2014	Male	Liberia	ROB-BRU-IAD-DFW
USA	23 Oct 2014	Male, HCW	Liberia	ROB? - ??? – JFK?
UK	29 Dec 2014	Female, HCW	Sierra Leone	FNA-CMN-LHR-GLA

Note: importation of cases known to be infected – only!

MLW: Monrovia, LFW: Lome, LOS: Lagos,
ROB: Monrovia, BRU: Brussels, IAD: Washington, DFW: Dallas
FNA: Freetown, CMN: Casablanca

Global total passenger bookings

(February 2010 – April 2015)

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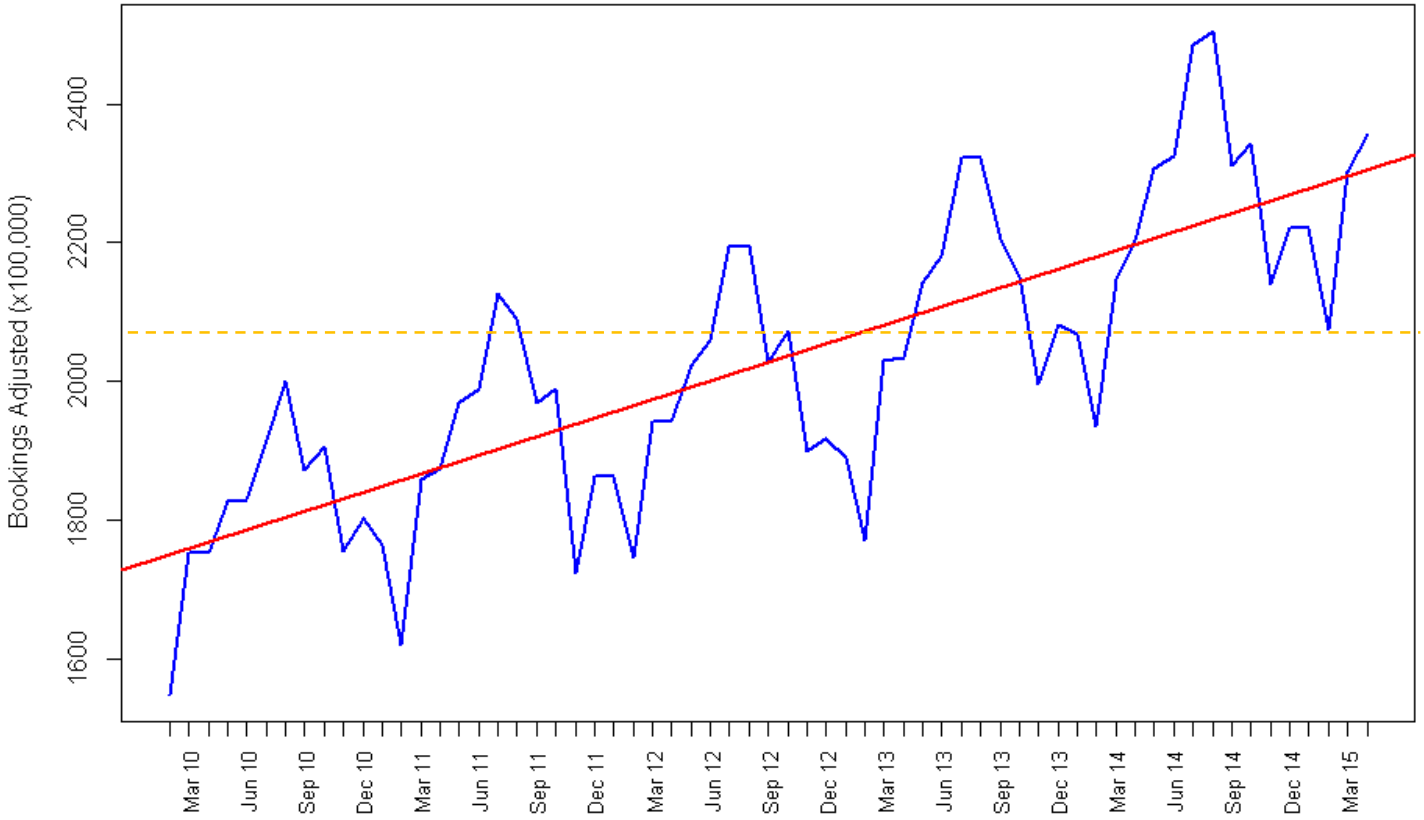
2,699,122,152 passenger bookings in 2014



Global passenger bookings

2013

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All bookings by route, OAG data, 2013
Minimum flow: 10,000 (plotted)
Maximum flow: 4,176,776

Global passenger bookings 2014

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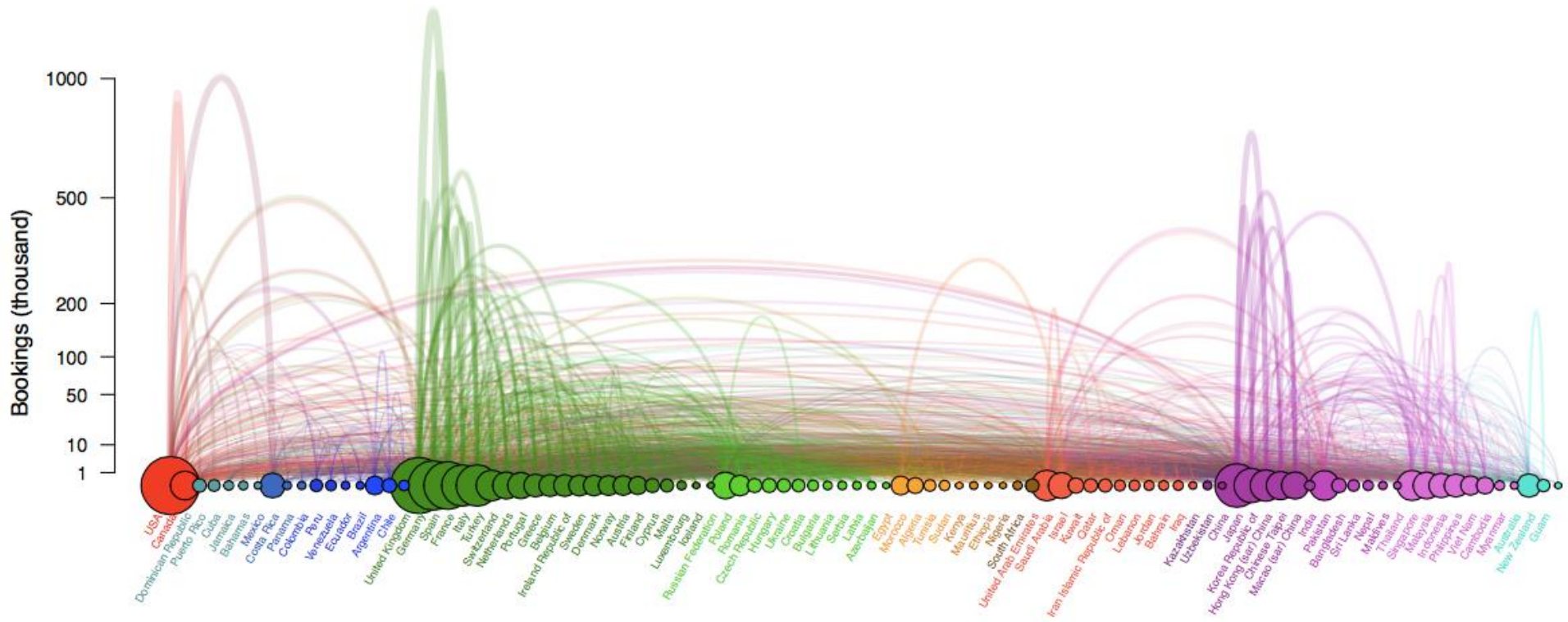
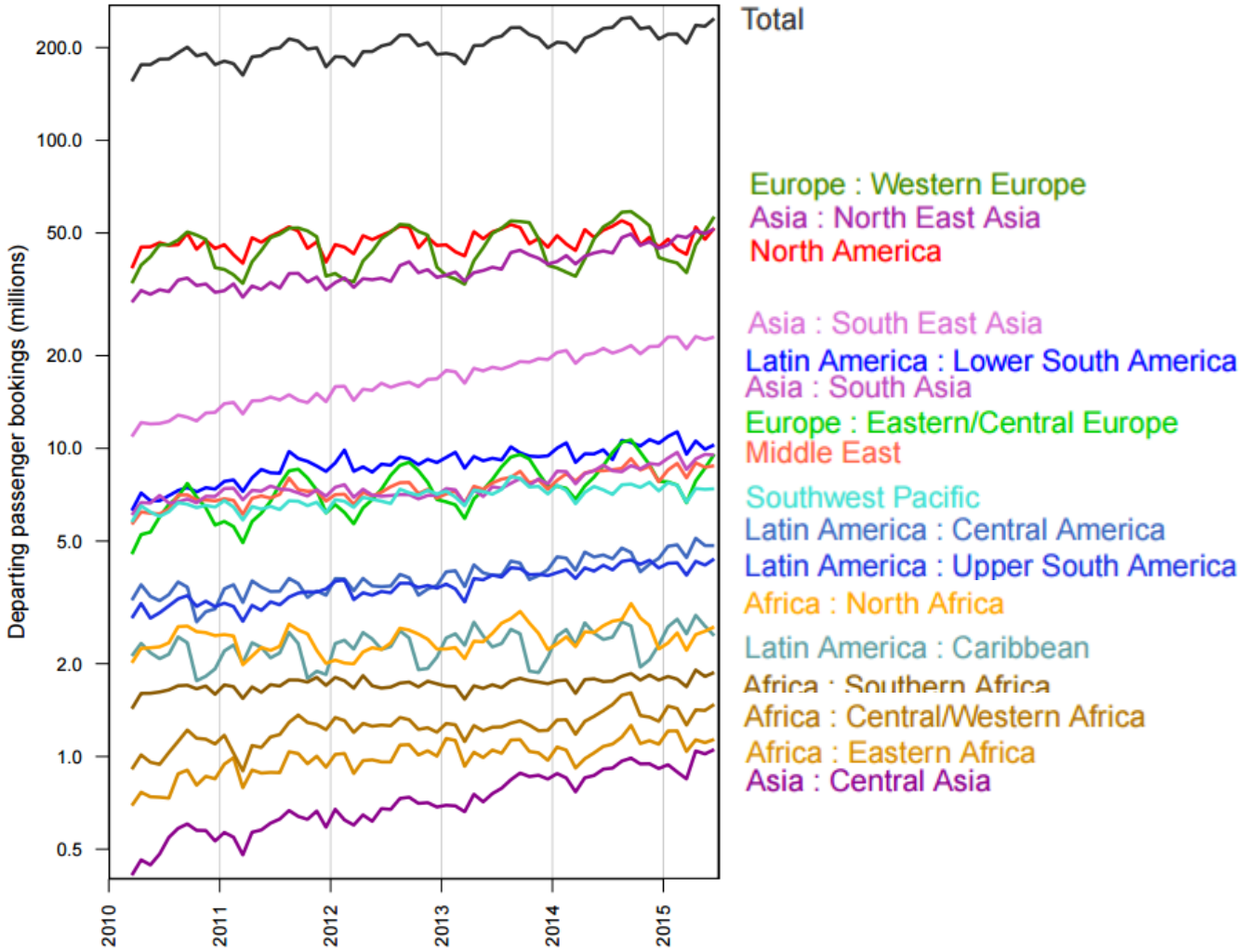


Global passenger bookings, by region



Monthly passenger bookings travelling to the UK, February 2010 – April 2015

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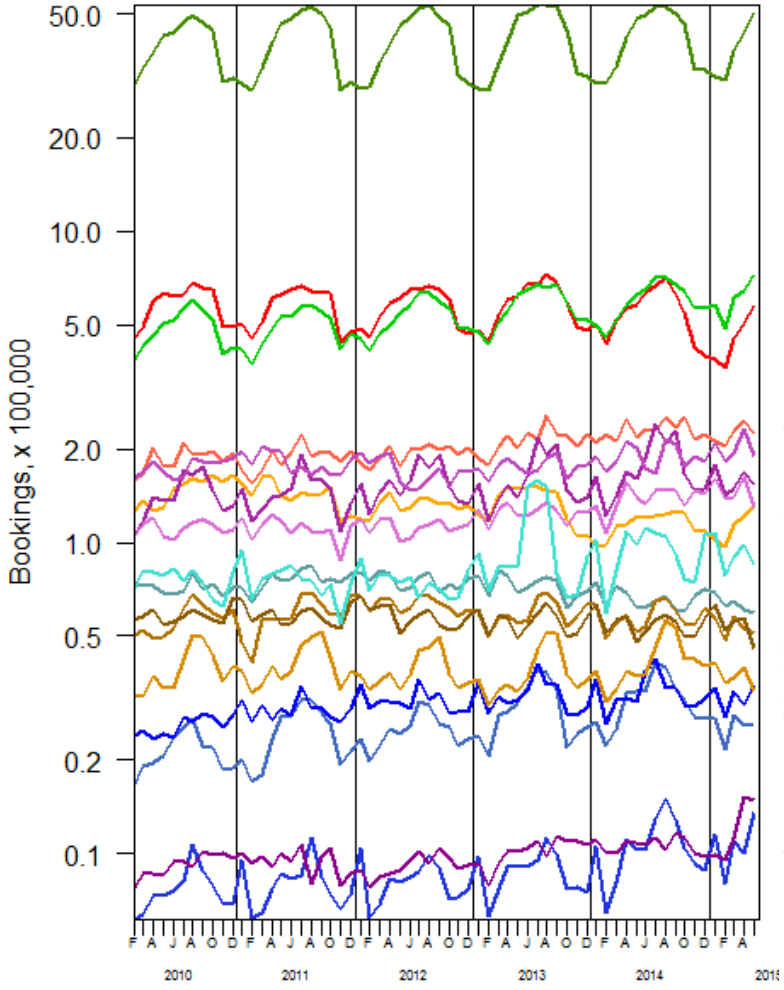


Europe: Western Europe

Europe: Eastern/Central Europe

North America

Middle East

Asia: South Asia

Asia: North East Asia

Asia: South East Asia

Africa: North Africa

Southwest Pacific

Latin America: Caribbean

Africa: Central/Western Africa

Africa: Southern Africa

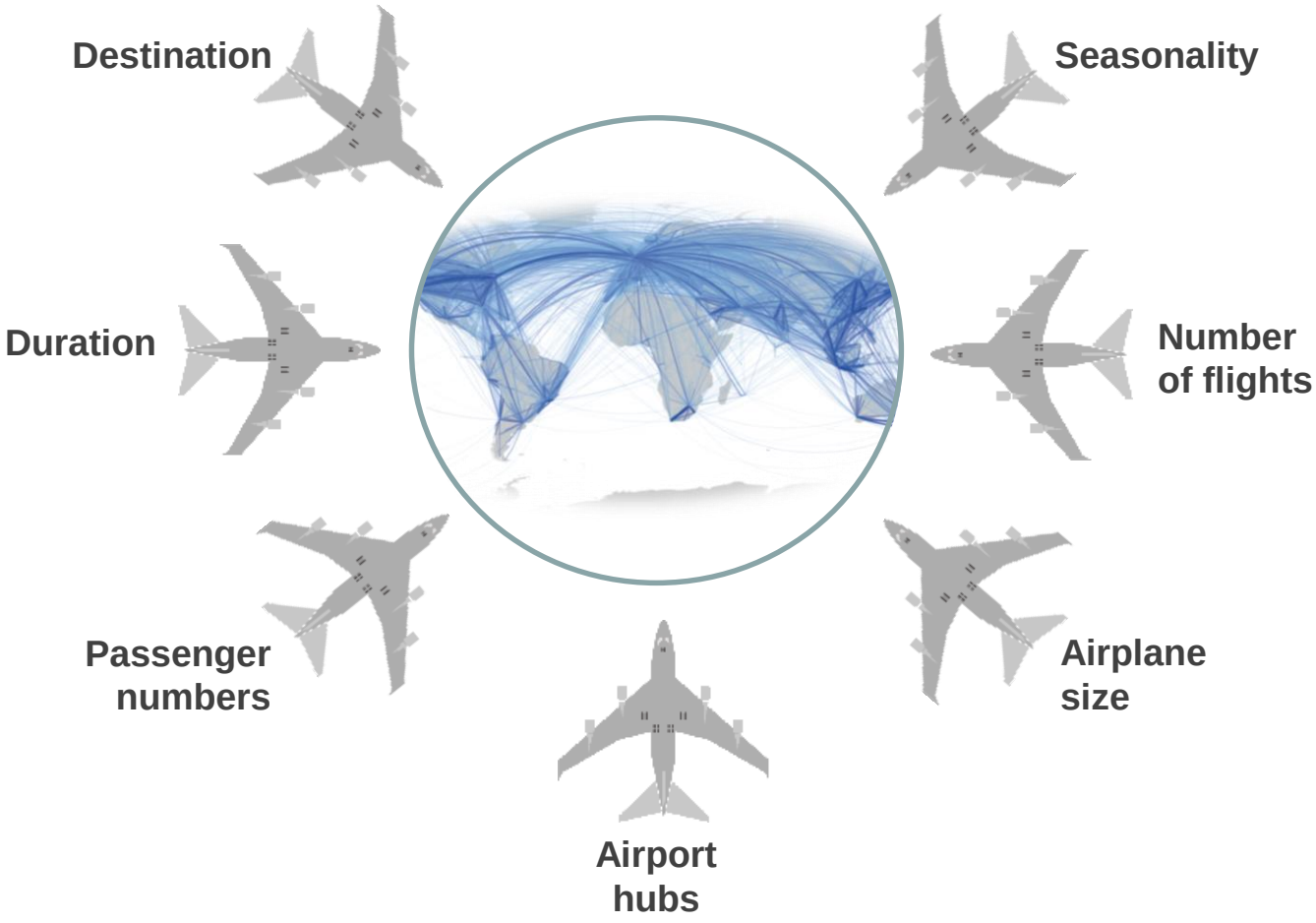
Latin America: Lower South Am

Latin America: Central Am

Asia: Central Asia

Latin America: Upper South Am

Global network characteristics



Importation of (infected) vectors

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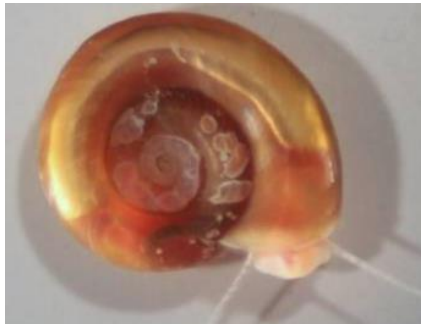
WHO definition of a vector:
"*Living organism that can transmit infectious diseases between humans or from animals to humans*"

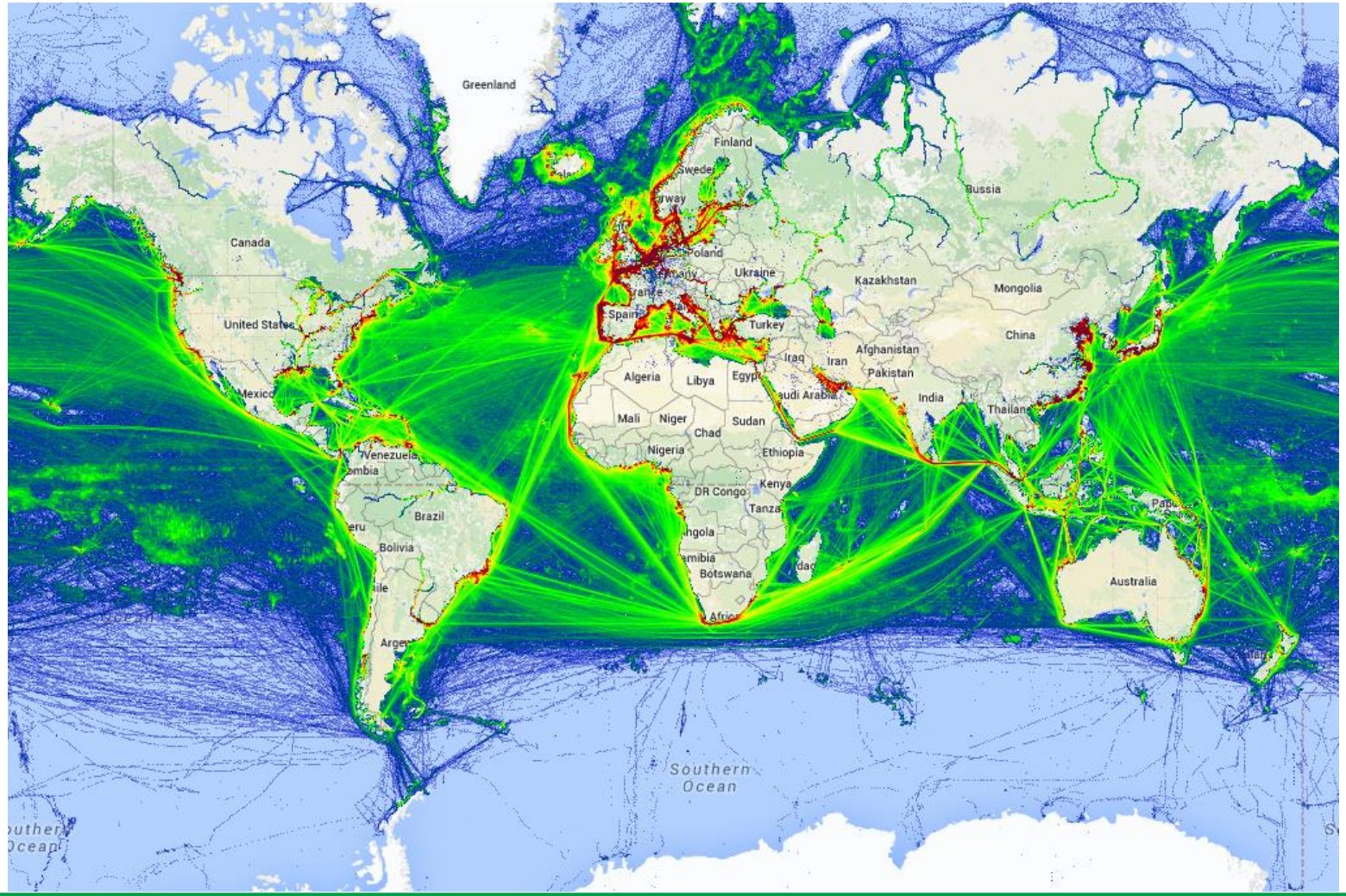


Vectors move with humans and animals:

- trade - tyres and lucky bamboos (mosquito eggs)
- hitchhiking - cabin, cargo (mosquitoes…)
- animal movements (ticks…)

Density map of cargo vessels



Importation of (infected) vectors

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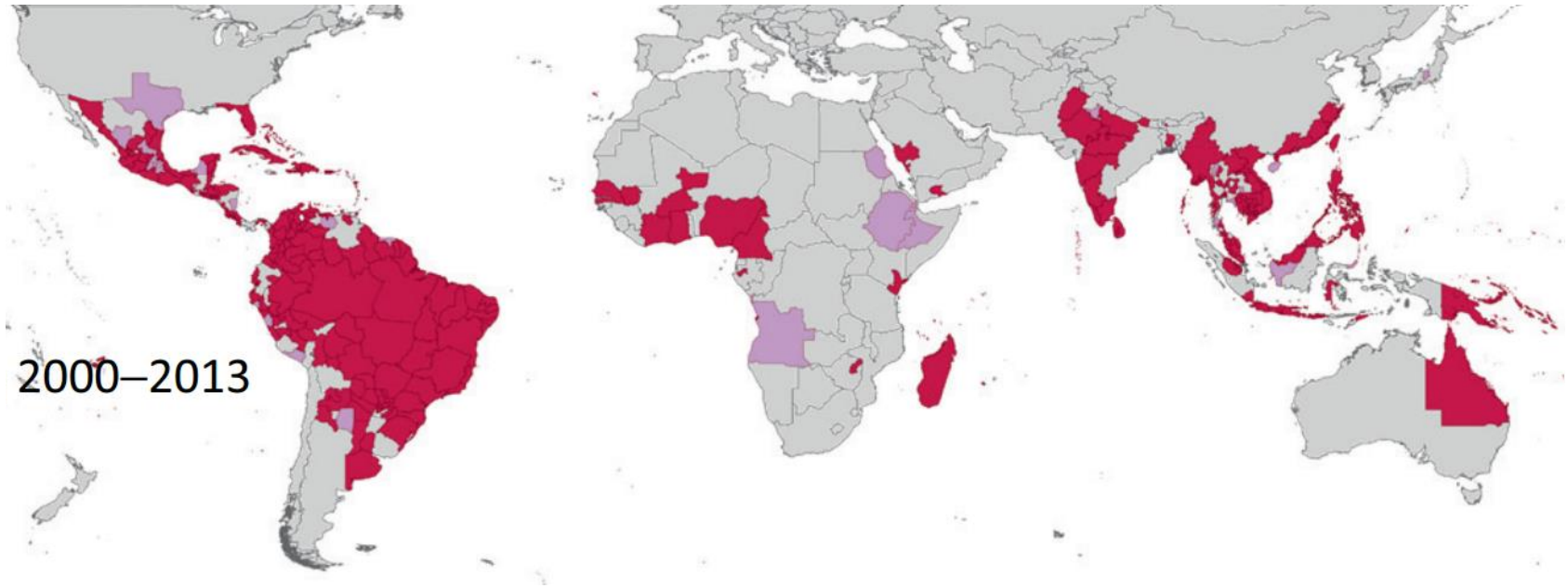
- Vectors adapting to new locations
  - Climate variations are important



Dengue virus serotype 1 world distribution

Messina J. *et al*, (2014)

Data sources

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	Network data	Data details
Flight data:	OAG Absolute Aviation Advantage	Office for National Statistics
Trade data:	MarineTraffic	UNITED NATIONS International Trade Statistics Knowledgebase

Where next???

Problems: - no central database
- units don't always match
- which commodities bring what vector(s), and how?

Implications: hard to assess risk of diseases (re)-emerging

Reaching out to stakeholders

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Currently	• Public Health England
Possibility	• APHA as advisory
Needs	• Real time data on emerging infections • Real time data on flights • Real time response data • Up to date data
Ultimate goals	• Work out response actions in advance • Several organisations working together (eg APHA and PHE) • Exchange of information

Summary and conclusions

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- World increasingly connected
- Travel and trade happening much faster
- Impact on infectious diseases/public health

- More needs to be done to predict and avoid pathogen and/or vector entry
- Live data and information needs to become a reality
- Trade equivalent of flight databases would be ideal

- Work out response actions in advance
- Several organisations working together (eg APHA and PHE)
- Exchange of information

Any questions?

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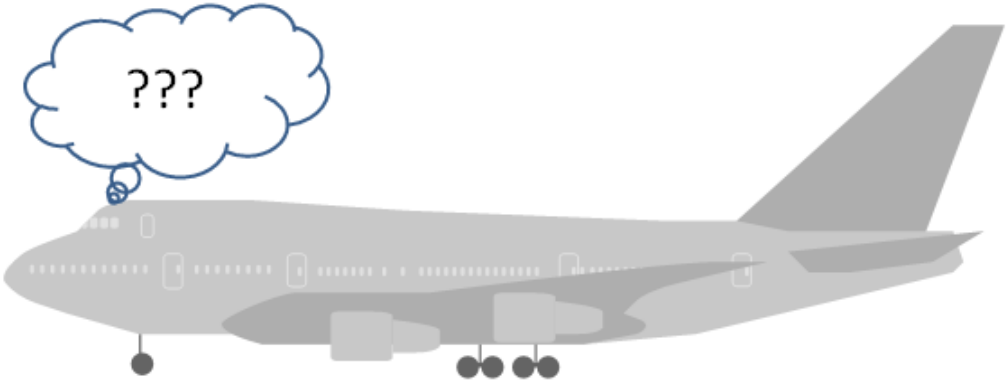
Any questions or comments?



A fact to finish off with…

World's longest flight, in terms of distance Sydney to Dallas

Source: www.flightcentre.com.au/

Thank you

Lynnette Crossley

NIHR (funding)

PHE (Roberto Vivancos) and collaborators (Liverpool School of Tropical Medicine, University of Liverpool)

Supervisors Drs Jon Read and Rob Christley

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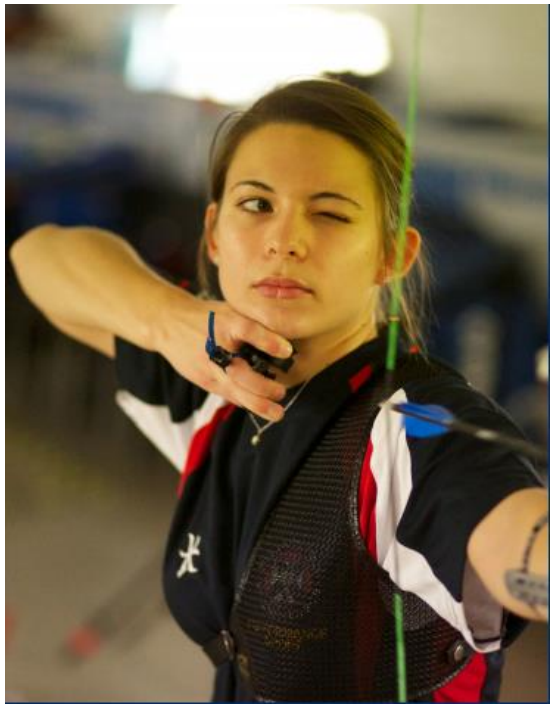

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