R workshop

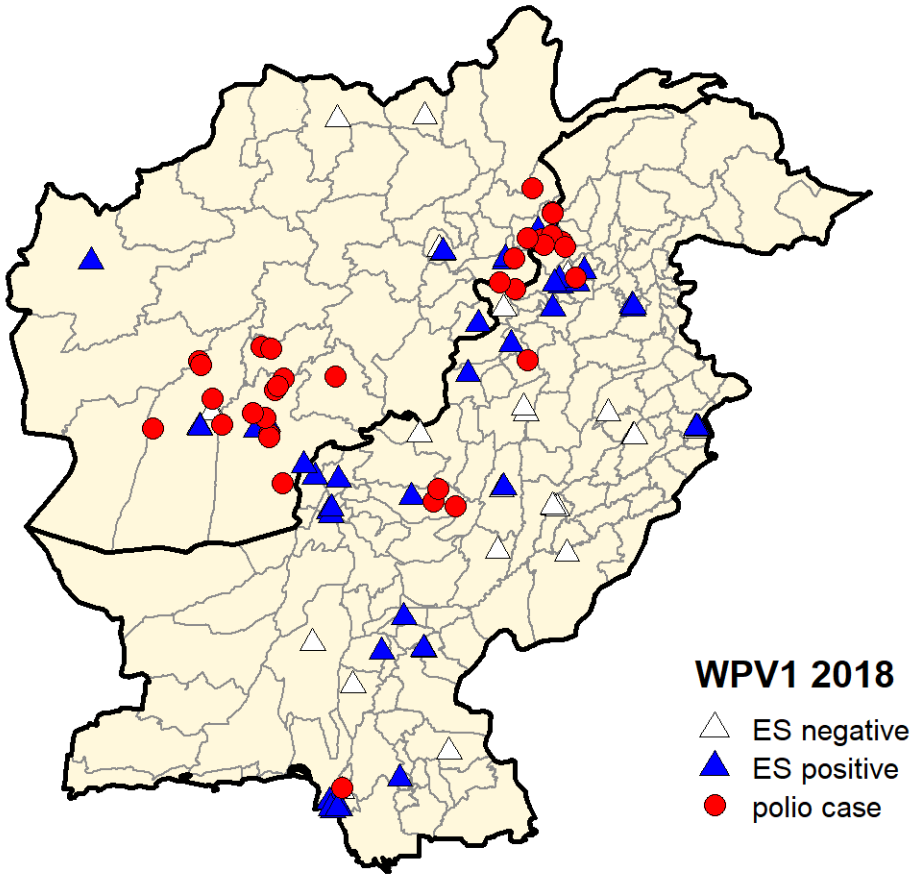
- The next few days will introduce you to using R and Rstudio to interact with and plot data.
- The data we will work with later in the week is related to prediction of the risk of poliovirus in Pakistan.
- The next few slides will introduce how this data is used in risk assessments.

Risk factors and short-term projections for serotype-1 poliomyelitis incidence in Pakistan: A spatiotemporal analysis

Molodecky et al. 2017 Plos. Med.

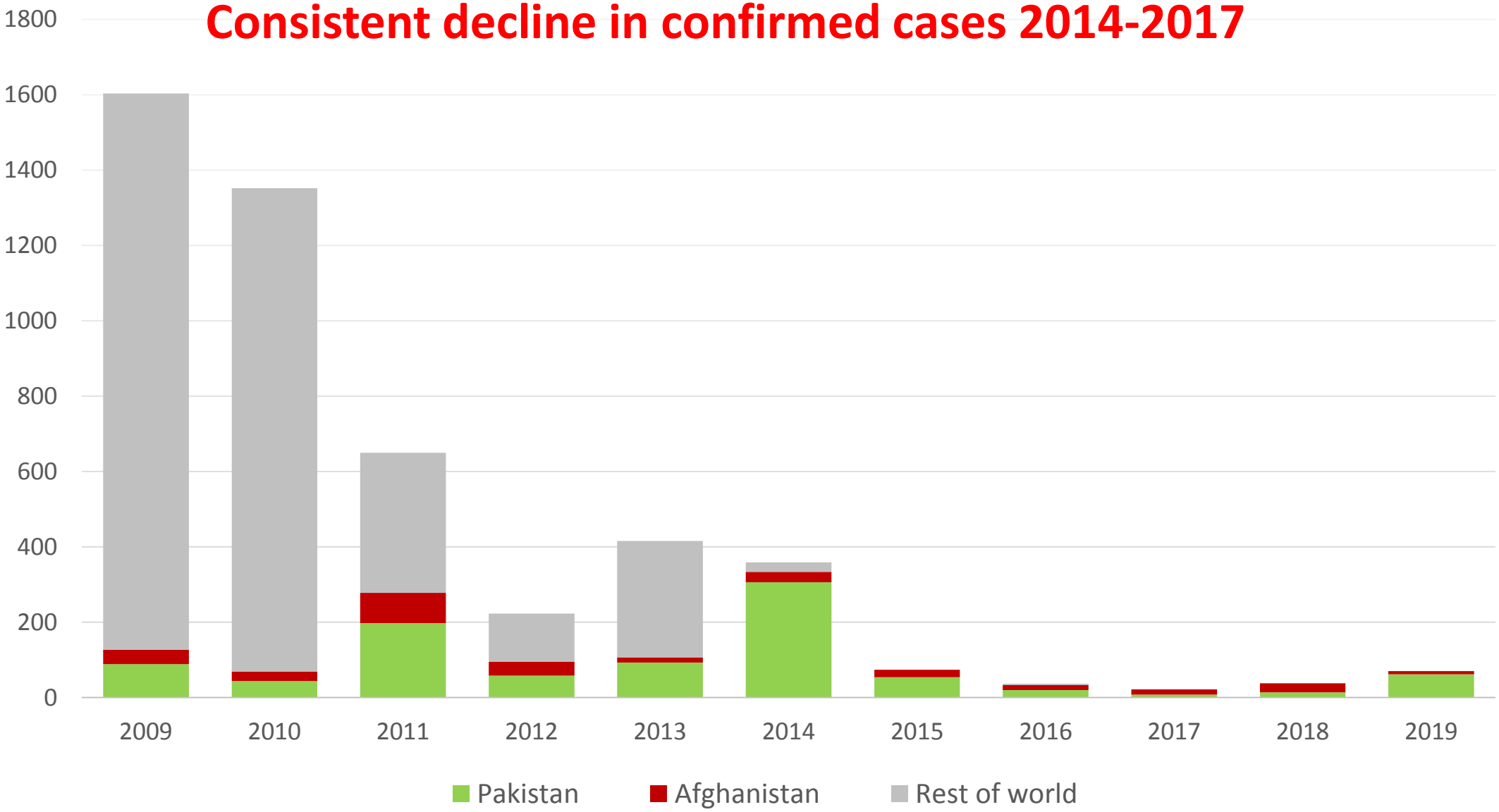
Background

- Pakistan and Afghanistan represent the last remaining cluster of wild poliovirus transmission globally. No cases have been seen in Nigeria since 2016
- RI and SIAs are the key interventions in Pakistan to interrupt transmission
- Accessibility issues are known – estimating risk in inaccessible areas is hard but they also represent risk of transmission to surrounding areas
- OPV immunogenicity poorer in Pakistan – multiple doses needed
- Targeting interventions important to maximise utility of doses



Global WPV1 Cases, 2009–2019*

Consistent decline in confirmed cases 2014-2017



Updated from presentation by Natalia Molodecky, WHO

Model aim

- This work aimed to include movement data in polio risk models to see if polio spread could be better estimated.
- Risk models are used to plan SIAs so accuracy is important to the interruption of WPV transmission.

Basic parameters

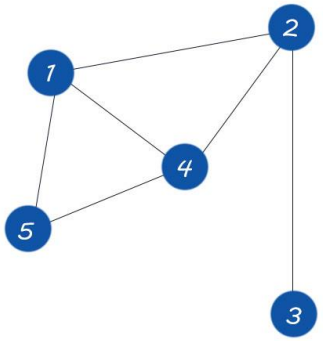
- Vaccination history of AFP cases – reported vaccine doses of non-polio AFP cases divided by number of SIA campaigns in their district between birth and paralysis
- RI coverage - % of children receiving 3 RI doses of OPV

Pop^{n} immunity

- Non-polio AFP rate – marker of surveillance intensity
- Cases in the same spatial unit
- Population and density of each spatial unit – number of individuals important to risk of spread
- Population living in poverty
- Precipitation

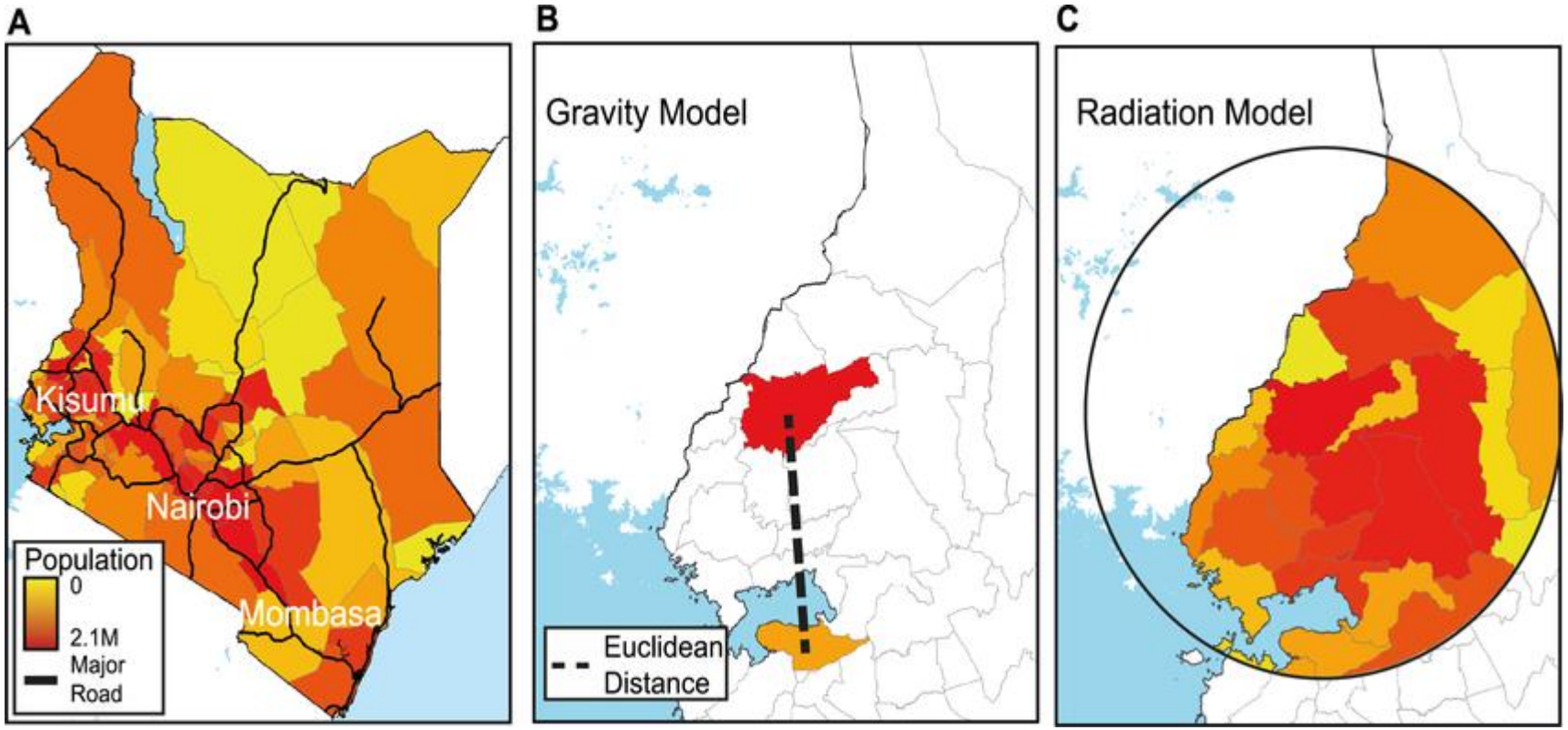
Movement models

First order adjacency



$$A = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{array}{c} \begin{array}{ccccc} 1 & 2 & 3 & 4 & 5 \end{array} \\ \begin{bmatrix} 0 & 1 & 0 & 1 & 1 \\ 1 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 \end{bmatrix} \end{array}$$

Gravity and radiation models



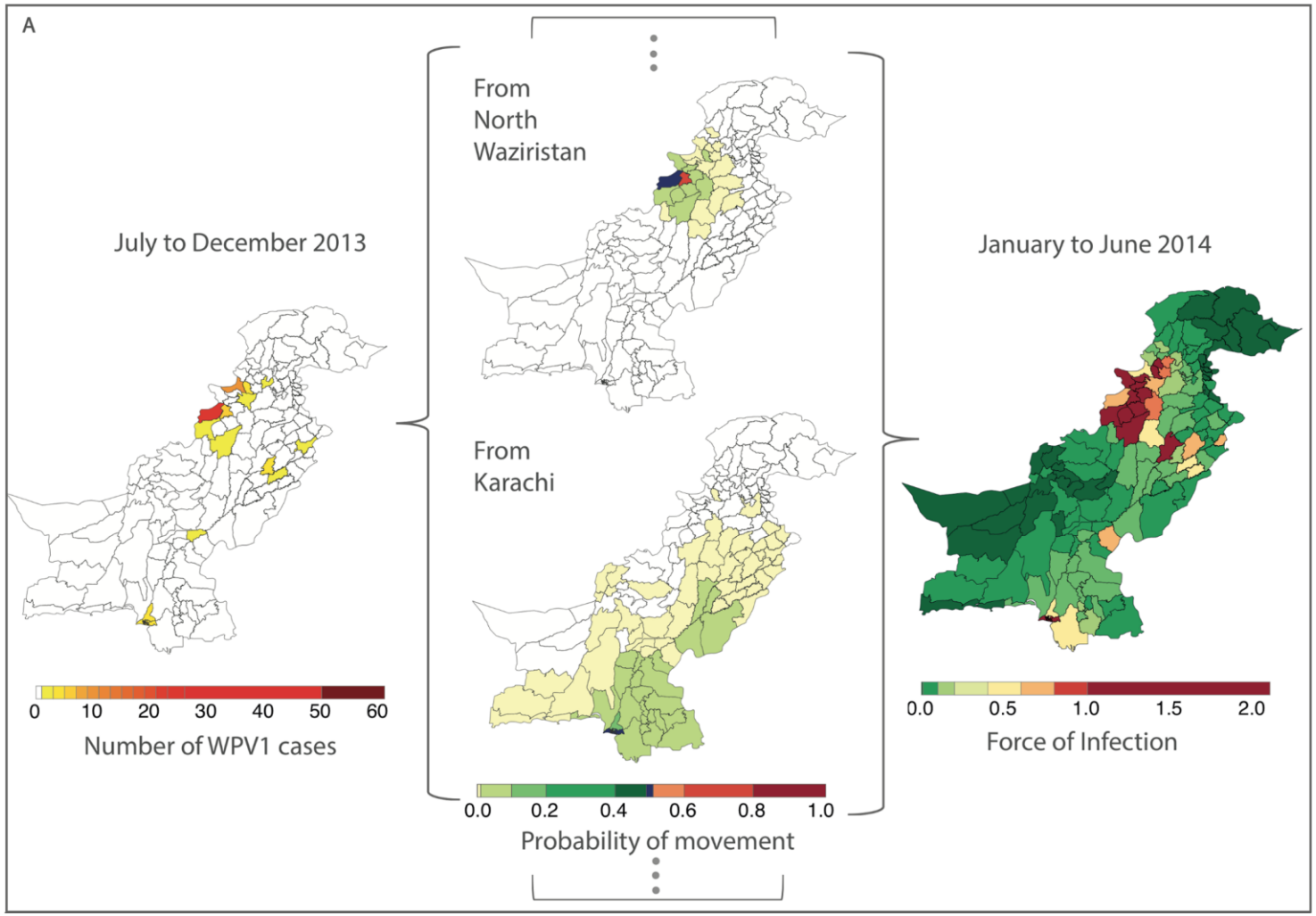
Wesolowski et al. Plos Comp. Biol. 2015

Movement models

Extensions to these movement models incorporated:

- Population density in the radiation model – a small district with high population density is more likely to attract a migrant than a large district with the same population.
- Travel time in the radiation model – rather than direct distance we can use road network maps etc to estimate real world travel time.
- Mobile phone data in the gravity model – mobile phone data gives an indication of where people are travelling in reality to fit the model to.

FOI


A
July to December 2013
From
North
Waziristan
From
Karachi
January to June 2014
0 10 20 30 40 50 60
Number of WPV1 cases
0.0 0.2 0.4 0.6 0.8 1.0
Probability of movement
0.0 0.5 1.0 1.5 2.0
Force of Infection

Results

Table 1. Risk factors associated with the incidence of wild poliovirus type 1 (WPV1) cases based on the best-fitting multivariable mixed-effects lagged regression model for January–June 2010 through July–December 2016. The odds ratio (OR) and the 95% confidence interval (CI) for routine immunization and supplementary immunization activity (SIA) coverage are for an absolute 10% increase in these variables and a 1-unit increase for all other variables. Non-polio acute flaccid paralysis (AFP) rate is per 100,000 persons aged <15 years.

Variable (fixed effects)	**OR (95% CI)**	***P* value**
Routine immunization coverage (previous 6 months)	0.75 (0.67–0.84)	<0.001
SIA coverage (previous 6 months)	0.75 (0.66–0.85)	<0.001
Non-polio AFP rate (previous 6 months)	1.13 (1.02–1.26)	0.025
Log (population size)	2.62 (1.94–3.55)	<0.001
Cases in the same district (previous 6 months)	1.16 (1.04–1.28)	0.006
Cases in all other districts, weighted by probability of movement (previous 6 months; radiation model)	1.14 (1.02–1.27)	0.021
Variable (random intercepts)	**Variance**	**Standard Deviation**
Province	0.393	0.627
Year (6-month interval)	0.838	0.915