Ebola Outbreak North-Kivu 2018 Risk of Future Cases

Srinivasan Venkatramanan, Bryan Lewis, and Alex Telionis
on behalf of the
Network Systems Science & Advanced Computing Division
Biocomplexity Institute & Initiative
University of Virginia

Approach

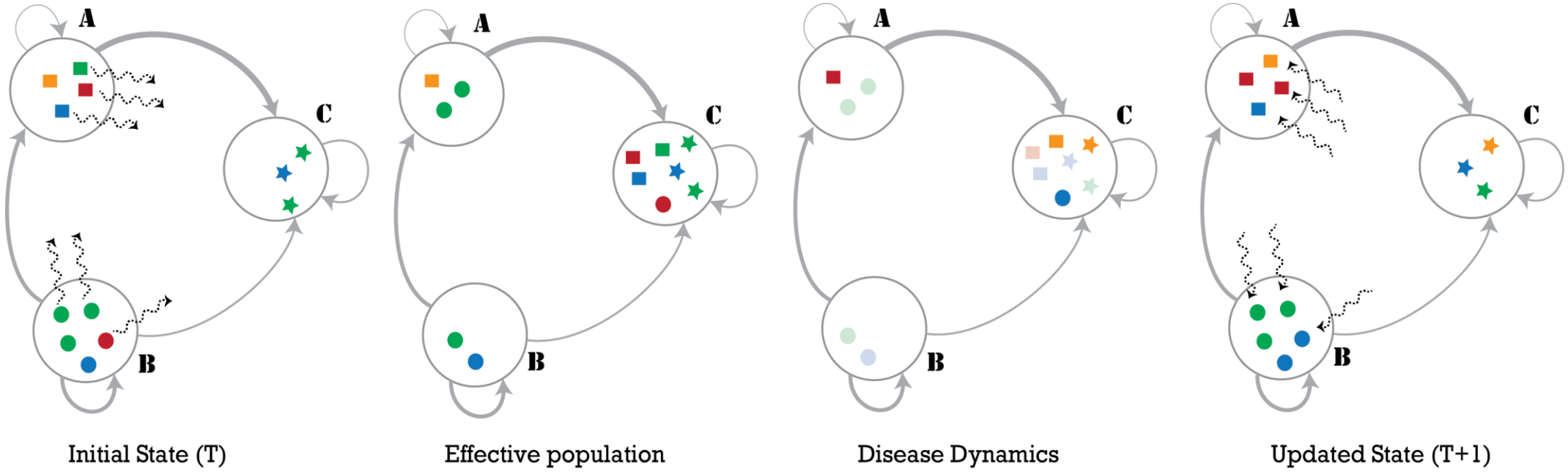
- Data and methods used:
  - Updated Population and Health Zone data
  - Metapopulation transmission model with human mobility for transmission projection
  - Case counts as reported by DRC Ministry of Health
  - International risks estimated for Port of Entry data (cleaned)
- Results:
  - Risk of future cases within the DRC
  - Yet to be done - Risk of arriving cases at international ports of entry

Datasets

- Updated Population for the DRC gathered from Humanitarian Data Exchange: https://data.humdata.org/dataset/rdc-statistiques-des-populations
- Update Health Zone maps via Humanitarian Data Exchange: https://data.humdata.org/dataset/democratic-republic-of-congo-health-boundaries
- River Network and Road Networks via Digital Chart of the World (DCW): diva-gis.org
  - Combined into a single coherent travel network with novel methodology (in preparation) for travel time calculations to feed mobility model
- DRC Ministry of Health as curated by Sophie Meakin: https://github.com/sophiemeakin/ebola_drc/

Model Description

- PatchSim: Metapopulation model with gravity mobility model



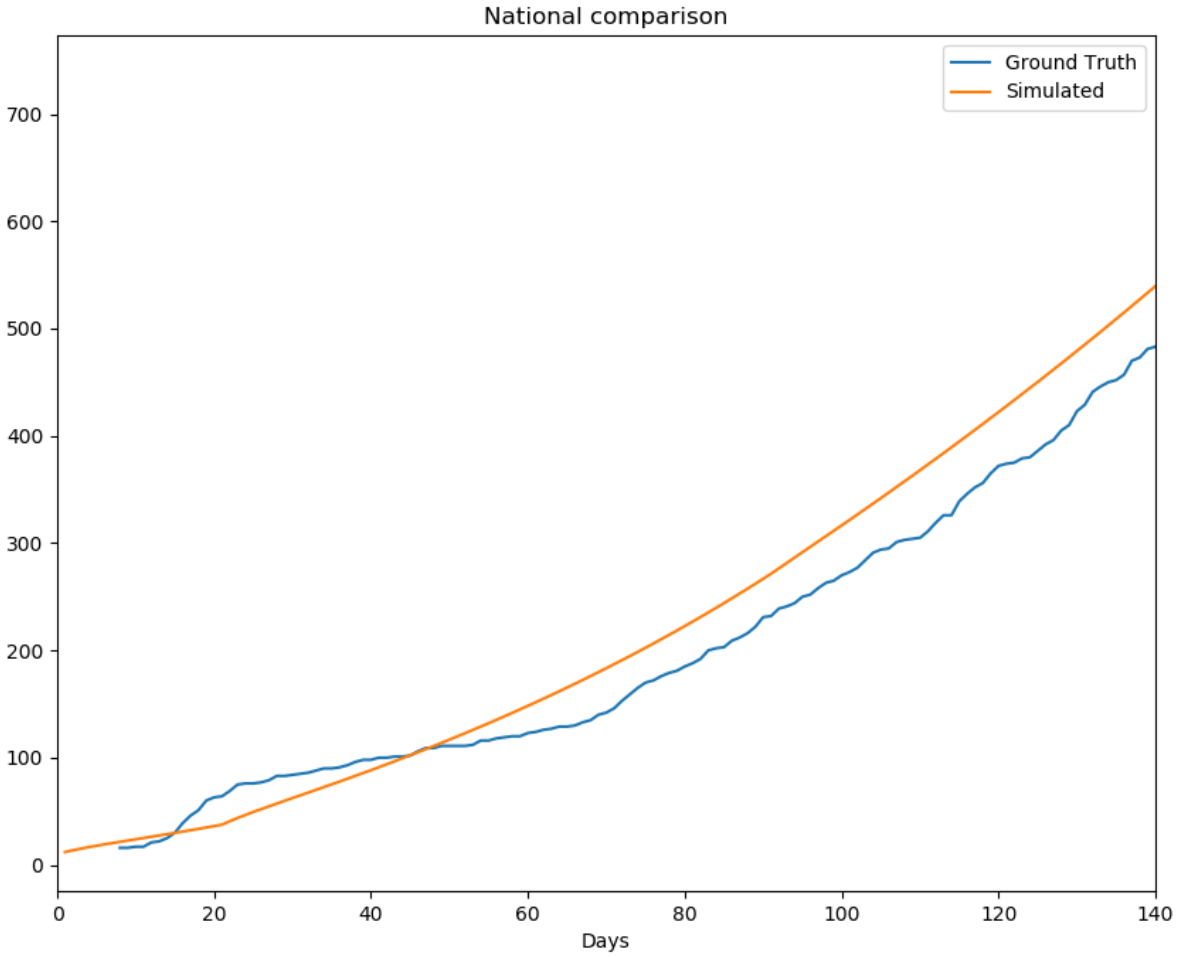
S → E → I → R

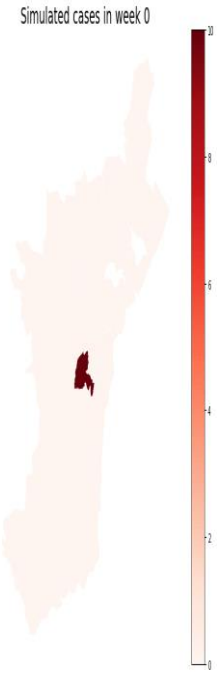
The large circles represent the patches (A,B,C) in the simulation, and the grey edges represent the travel network, colors represent the disease state the individuals are in (susceptible, exposed, infected or recovered), The wavy dashed arrows show movement of individuals. Panel 1. Individuals move moved from home to another patch. Panel 2. This creates another effective population where the disease dynamics operate and individuals become ill (change from green to red) which stand out in the 3rd panel. Panel 4. Finally, the individuals return to their home patch

Calibration Approach

- DRC Health ministry case reports used as ground truth
- Vaccinations and surging case reports used to adjust healthzone specific forces of infection to closely match ground truth

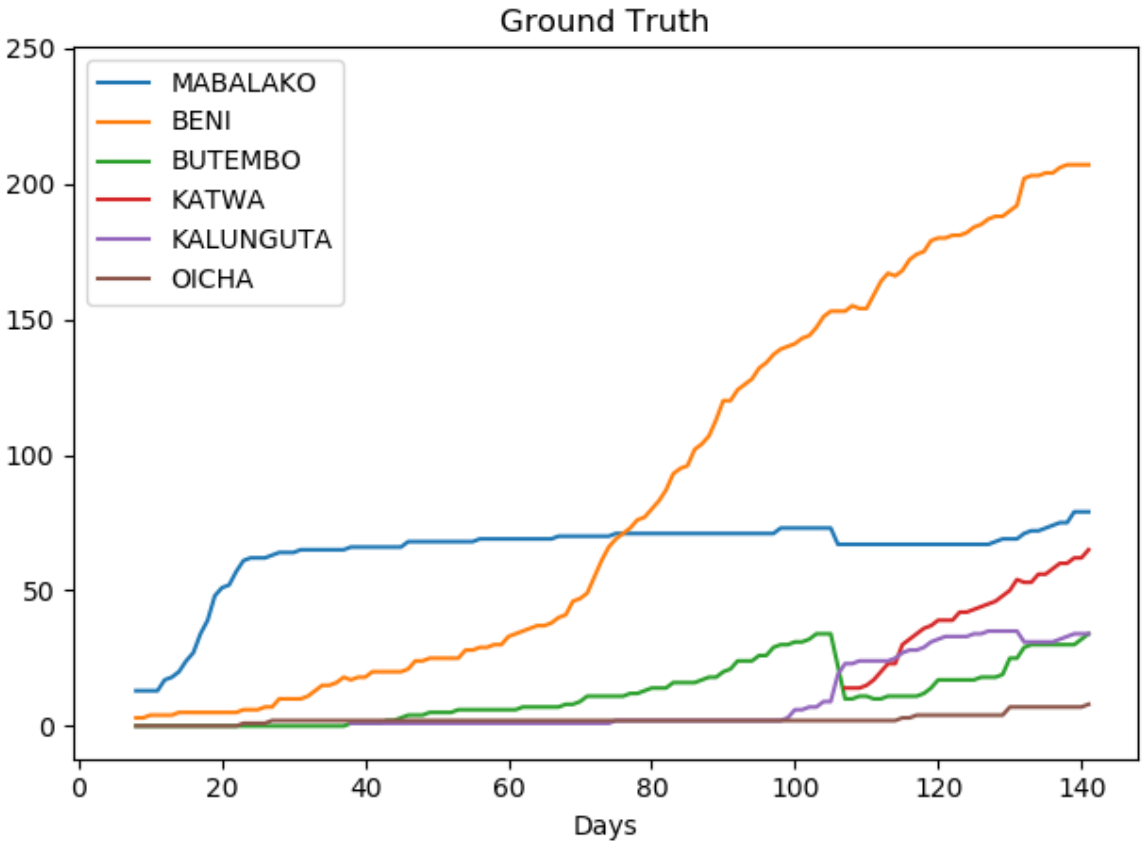
Calibration – National Level

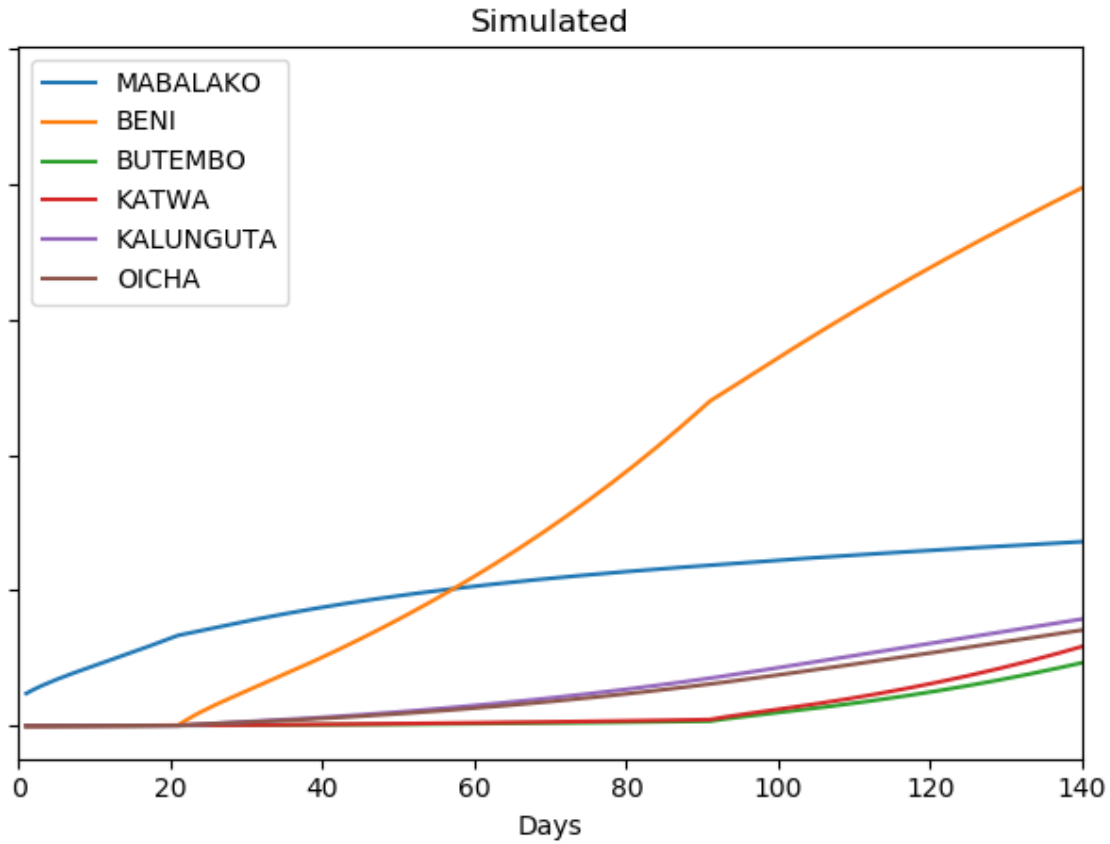




* suspect Oicha ground truth may be undercounted by WHO due to security problems

Calibration





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Risk Calculations

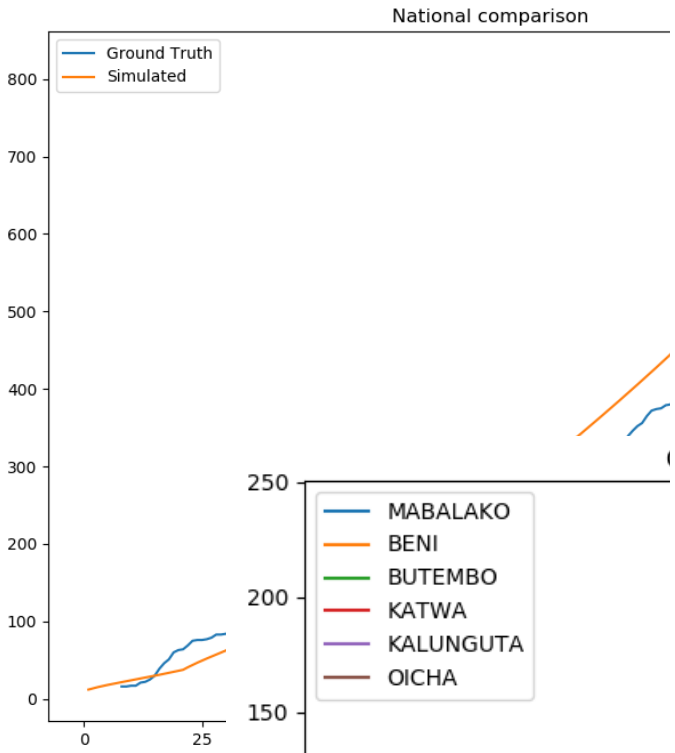
- **Future Cases:** Proportion of future cases generated by running calibrated model beyond the last “observation” 30 days into the future
- Examine 2 scenarios for the future:
  - Scenario 1: Current controls remain in place in the healthzones they’ve been employed
  - Scenario 2: All control efforts are released on the date of last observation
- Yet to be done: International ports of entry: Risk of future cases arriving at ports of entry

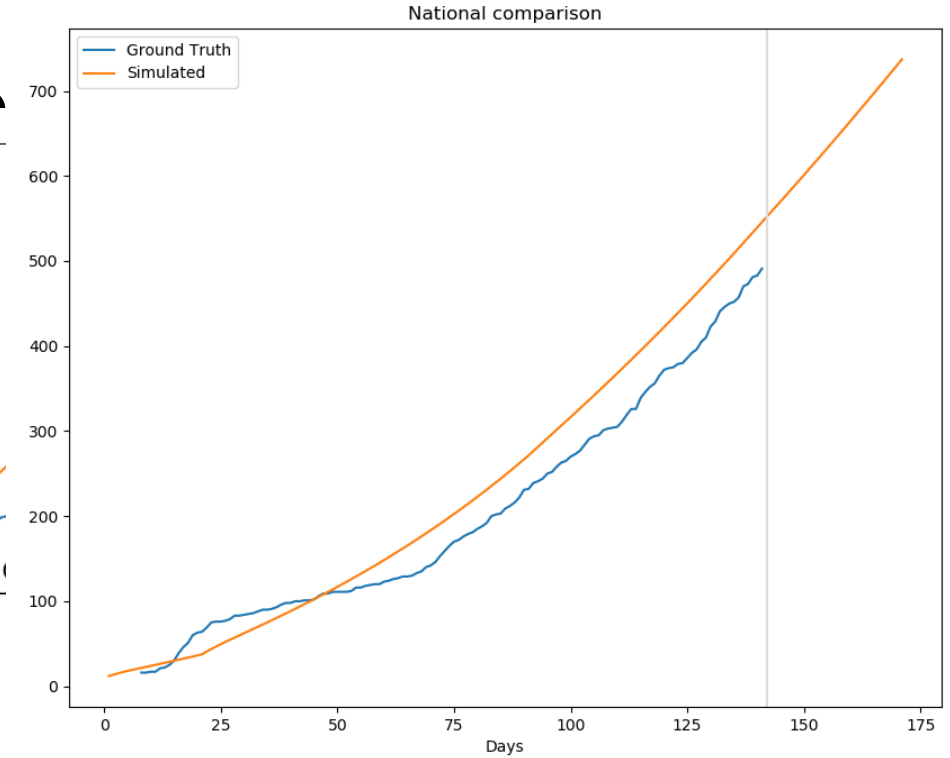
Results – Scenario 1 Healthzone risk (controls remain)

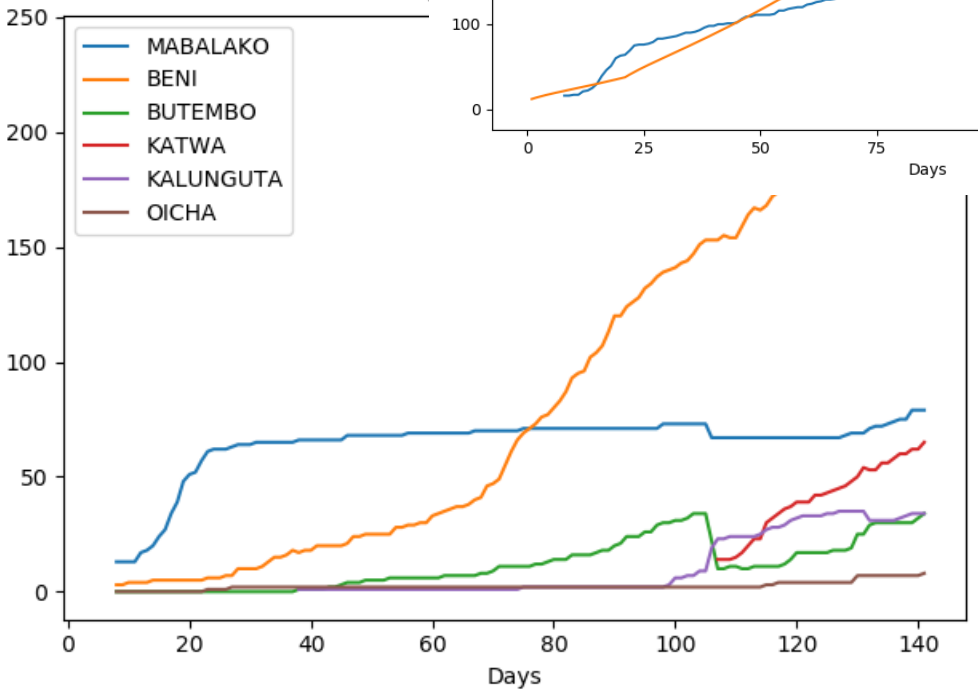
- Likely locations of future cases in the next 30 days
- Estimated future cases beyond current state
  - 35% more cases 30 days out
  - 74% more cases 60 days out
  - 116% more cases 90 days out

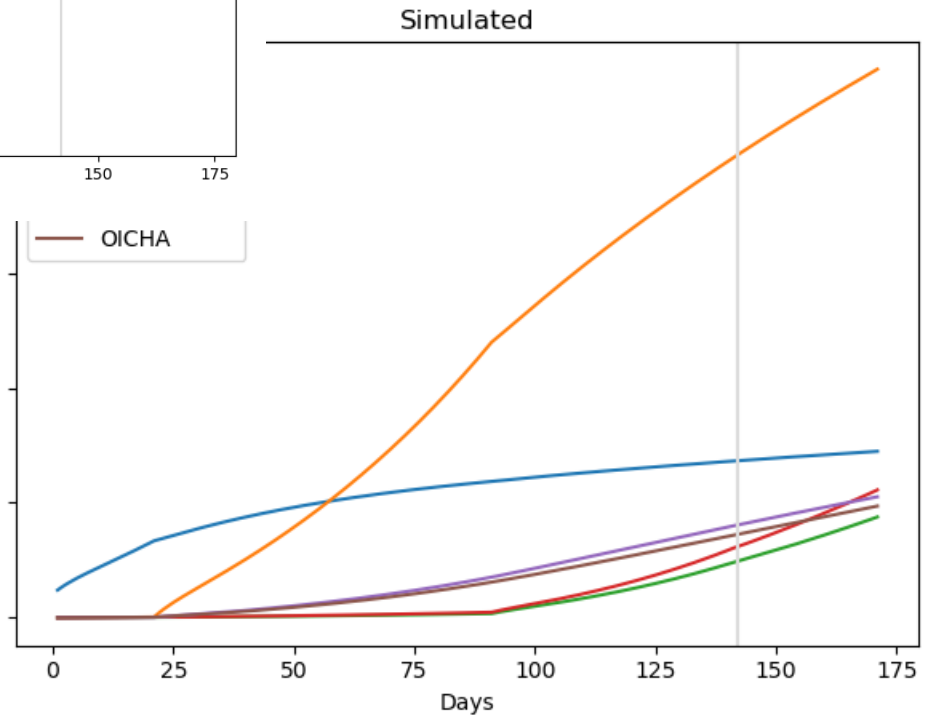
Health Zone	Risk Index
BENI	20.5%
KATWA	13.2%
BUTEMBO	10.3%
KALUNGUTA	6.7%
OICHA	6.7%
MUTWANGA	3.3%
MABALAKO	2.2%
MUSIENENE	2.1%
KYONDO	2.1%
LUBERO	2.0%

Results – Scen[illegible]sk







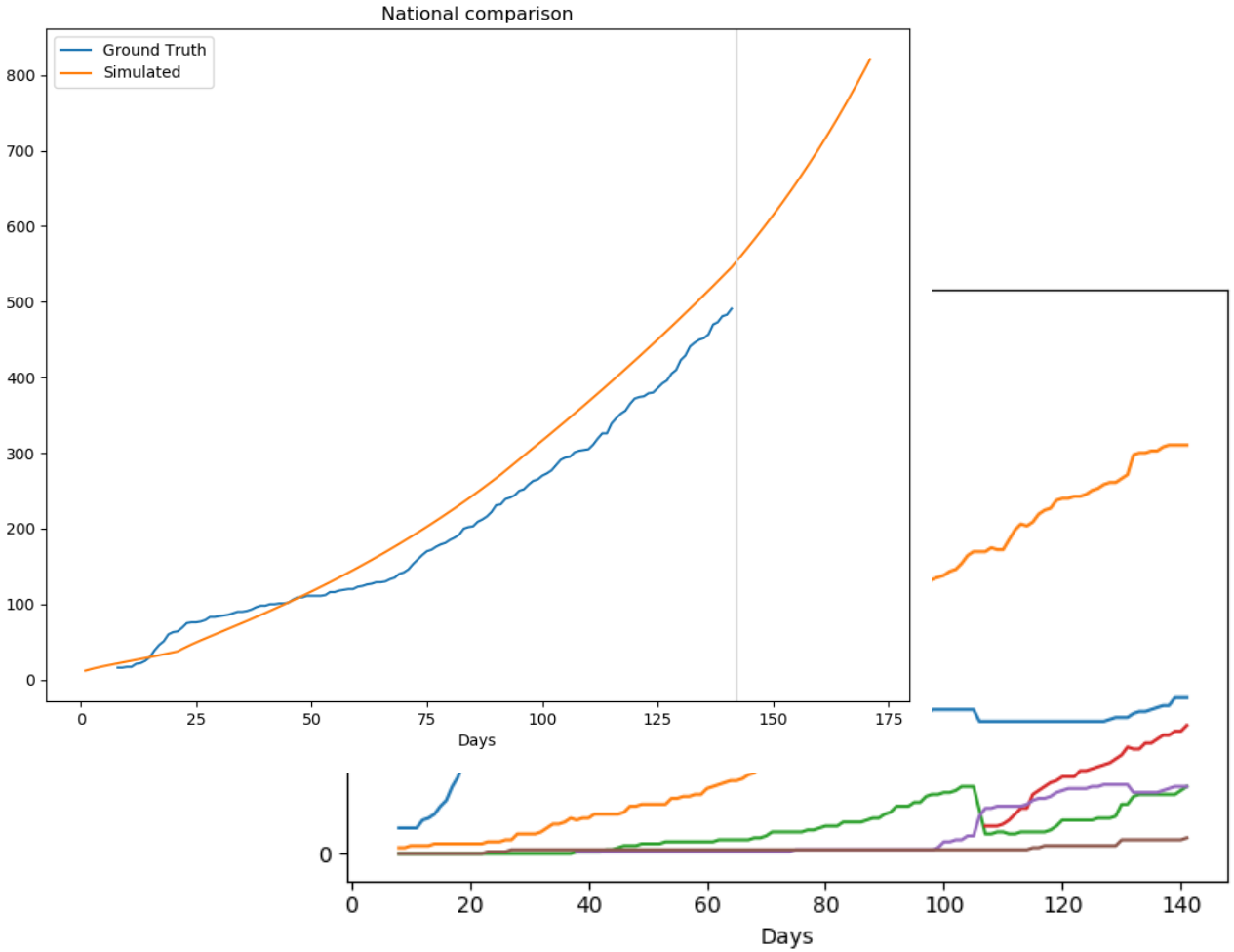


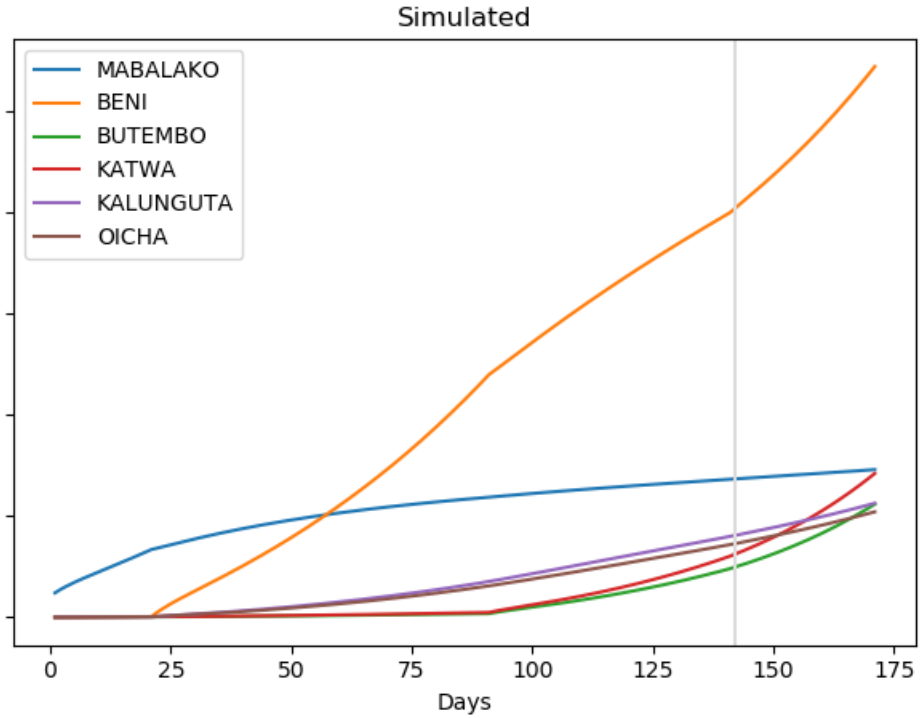
Results – Scenario 2 Healthzone risk (control efforts removed)

- Likely locations of future cases in the next 30 days
- Compared to controls remaining in place how many more cases to expect
  - 11.3% at 30 days out
  - 36.5% at 60 days out
  - 81% at 90 days out
- Should controls remain removed for 90 days there could be roughly 81% more cases than if controls remained in place (roughly 1000 cases)

Health Zone	Risk Index
BENI	26.2%
KATWA	14.6%
BUTEMBO	11.4%
KALUNGUTA	6.0%
OICHA	6.0%
MUTWANGA	2.9%
MUSIENENE	1.9%
KYONDO	1.8%
MABALAKO	1.8%
LUBERO	1.8%

Results – Scenario 2 Healthzone risk (control efforts removed)





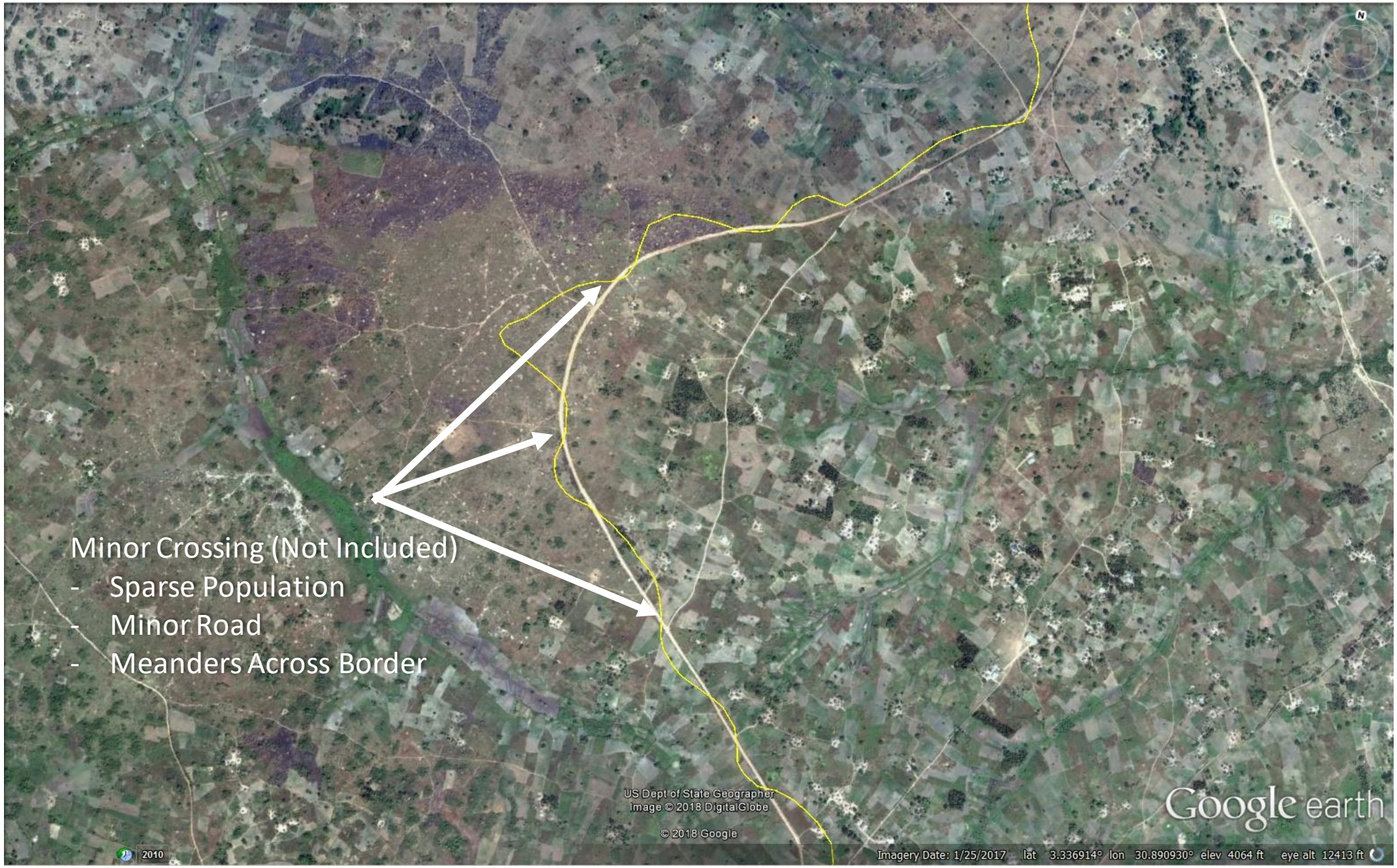
Yet to be completed
Port of Entry calculations

Port of Entry methods

- Ports of Entry identified and matched to existing data (WHO sitreps and POE from Humanitarian data exchange)
- Weights assigned by matched average daily traveler information
- Exposure to future cases calculated through mobility model based on road-river network travel times.


Major Border Crossing
- Visible Population Center
- Major Road
- Visible Border Control (!)
© 2018 Google
US Dept of State Geographer
Image © 2018 DigitalGlobe
Google earth
2003
Imagery Date: 3/31/2018 lat -1.697343° lon 29.245133° elev 4837 ft eye alt 9680 ft


Mid-sized Border Crossing
- Visible Population Center
- Major Road
- No Obvious Border Control
© 2018 Google
Image © 2018 DigitalGlobe
US Dept of State Geographer
Google earth
2003
Imagery Date: 8/4/2018 lat -2.494852° lon 28.886355° elev 4872 ft eye alt 10442 ft


Minor Crossing (Not Included)
- Sparse Population
- Minor Road
- Meanders Across Border
US Dept of State Geographer
Image © 2018 DigitalGlobe
© 2018 Google
Google earth
2010
Imagery Date: 1/25/2017 lat 3.336914° lon 30.890930° elev 4064 ft eye alt 12413 ft


No Visible Crossing
© 2018 Google
US Dept of State Geographer
Image © 2018 CNES / Airbus
2003
Imagery Date: 6/28/2016 lat -1.394477° lon 29.551739° elev 9441 ft eye alt 15195 ft
Google earth