Geospatial Analysis of Environmental Suitability for Burkholderia species Using Data Analytics

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Burkholderia infection

Burkholderia - genus of Proteobacteria whose pathogenic members include:

https://en.wikipedia.org/wiki/Burkholderia

- *Burkholderia pseudomallei*, causative agent of melioidosis – human pathogen
- *Burkholderia cepacia*, an important pathogen of pulmonary infections in people with cystic fibrosis (CF)
- Burkholderia cepacia complex - human pathogen
- *Burkholderia mallei*, responsible for glanders - equine pathogen; zoonotic transfer to humans

https://www.bangkokpost.com/thailand/general/823108/alert-sounded-over-deadly-melioidosis

Infection is mainly acquired cutaneously through abrasions in the skin or inhalation of contaminated particles.
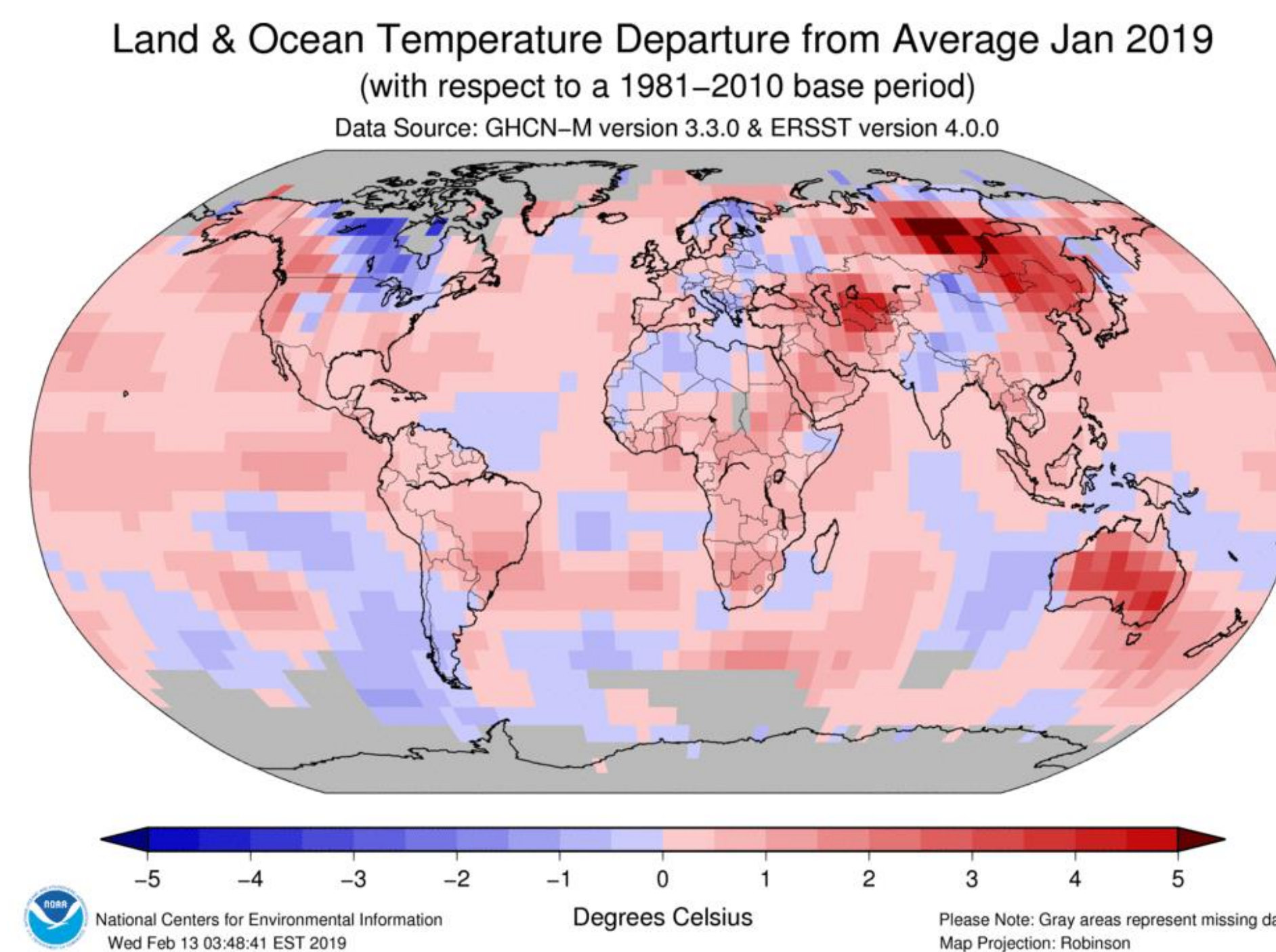
Melioidosis is classically characterized by:
- Pneumonia
- Multiple abscesses
- Septicemia
- Mortality rate of up to 40% or more

Predisposing factors include:
- Diabetes
- Chronic kidney disease
- Immunosuppression

Climate change

Land & Ocean Temperature Departure from Average Jan 2019 (with respect to a 1981–2010 base period)
Data Source: GHCN–M version 3.3.0 & ERSST version 4.0.0

https://www.ncdc.noaa.gov/sotc/service/global/map-blended-mntp/201901.gif

In addition to increased migration, rising global temperatures and flooding may contribute to creating climates that support better growth of Burkholderia.

Aims & Methodology

- Explore existing data about soil, water, weather, land use and melioidosis risk factors
- Generate geospatial data and maps to identify ecological niches for *B. pseudomallei* and related soil organisms
- Future Work: Investigate DataX to improve performance and add additional layers to our analysis. DataX enables researchers to access, share, understand, and analyze critical data using the high performance computational resources at the Texas Advanced Computing Center (TACC).

Acknowledgements

Geospatial analysis

Suitable Soil Only
Suitable Climate Only
Suitable Soil & Climate Conditions
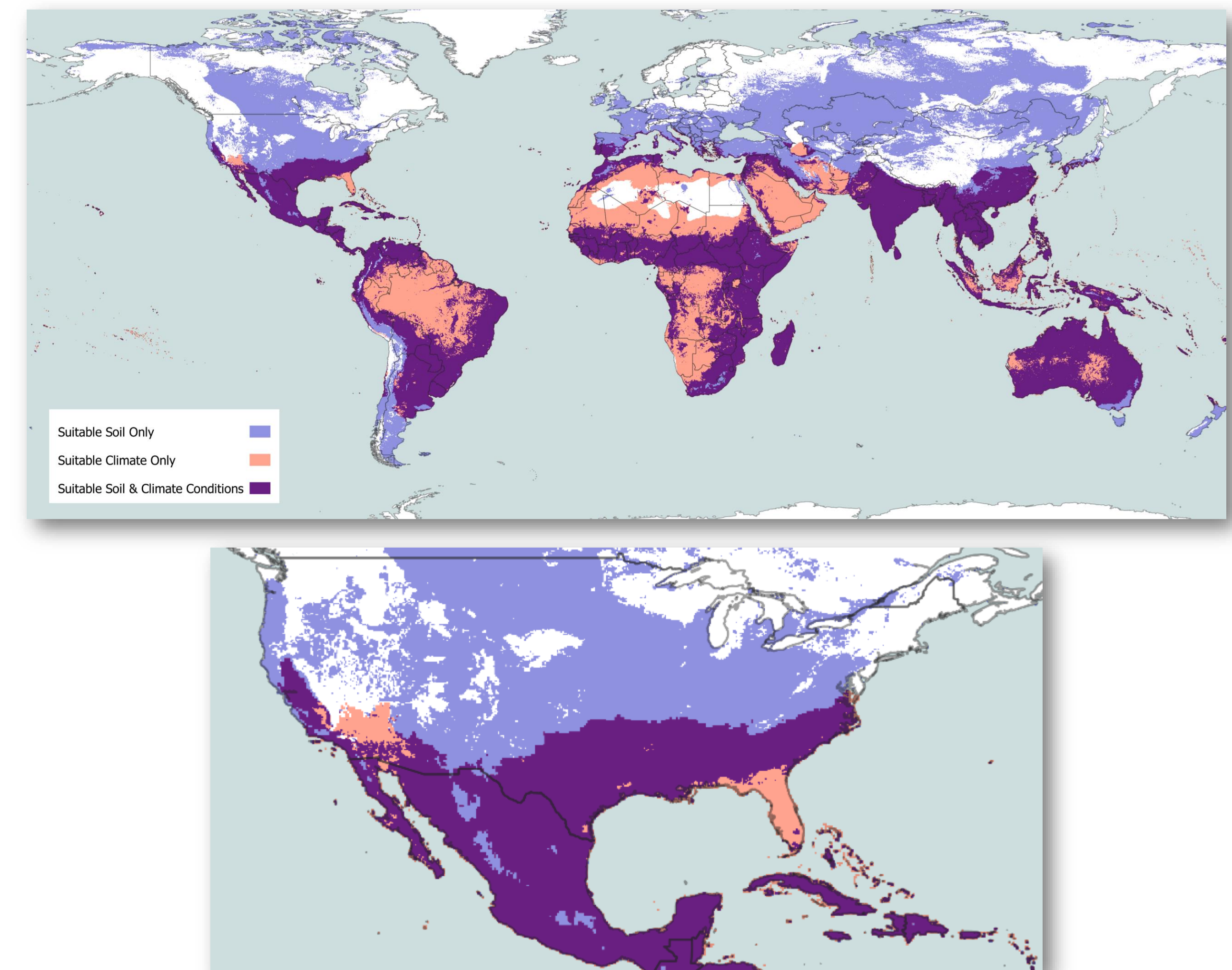
This predicted potential range of *Burkholderia pseudomallei* was based on a dataset[2] of documented worldwide soil and water occurrences between 1933 and 2013 and global datasets of soil[6] and climatic[7] conditions. Suitability for climate factors was based on annual mean temperature, minimum temperature of the coldest month, mean annual precipitation, and mean precipitation of the wettest month while soil suitability was based on cation exchange capacity, percent clay composition, pH, and organic carbon content at depths of 30cm, 60cm, and 100cm for all soil variables.

References

Limmathurotsakul et al. Nature Microbiology, (2016). doi: 10.1038/nmicrobiol.2015.8.
Limmathurotsakul, D. (2015). Data_Melioidosis_1910_2014. doi: 10.6084/m9.figshare.1447097.v1
TACC: http://tacc.utexas.edu/
DataX: https://ptdatax.tacc.utexas.edu/
Bridging Barriers: https://bridgingbarriers.utexas.edu/planet-texas-2050/
Global soil data: https://files.isric.org/soilgrids/data/recent/
Global climate data: http://worldclim.org/bioclim
QGIS: https://qgis.org
Python: https://python.org

Geospatial Analysis to Guide Identification of Environments Suitable of Supporting *B. pseudomallei* in Africa
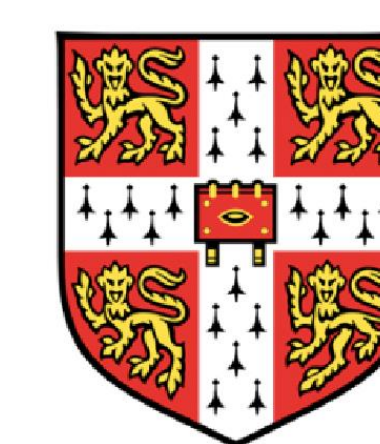
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Burkholderia may be underreported in West Africa

Although considered a tropical disease, the hub of melioidosis infection was previously thought to be within Southeast Asia and Northern Australia (Selected regions in the area circled red below)

http://ontheworldmap.com/

A recent environmental suitability model has however predicted the occurrence of the soil-dwelling *B. pseudomallei in* regions in West Africa where melioidosis may be endemic but underreported (Selected regions in the area circled blue above).

https://www.nejm.org/doi/full/10.1056/NEJMra1204699

The low reported cases in West Africa may be due to the diverse clinical manifestations of the disease as well as inadequate availability of identification methods

http://www.usccn.org/Pages/default.aspx

Of the 470 strains listed in the published *global B. pseudomallei* culture collection, only 8 are reported to be African strains [Nat Microbiol, 2017 2:16263] .
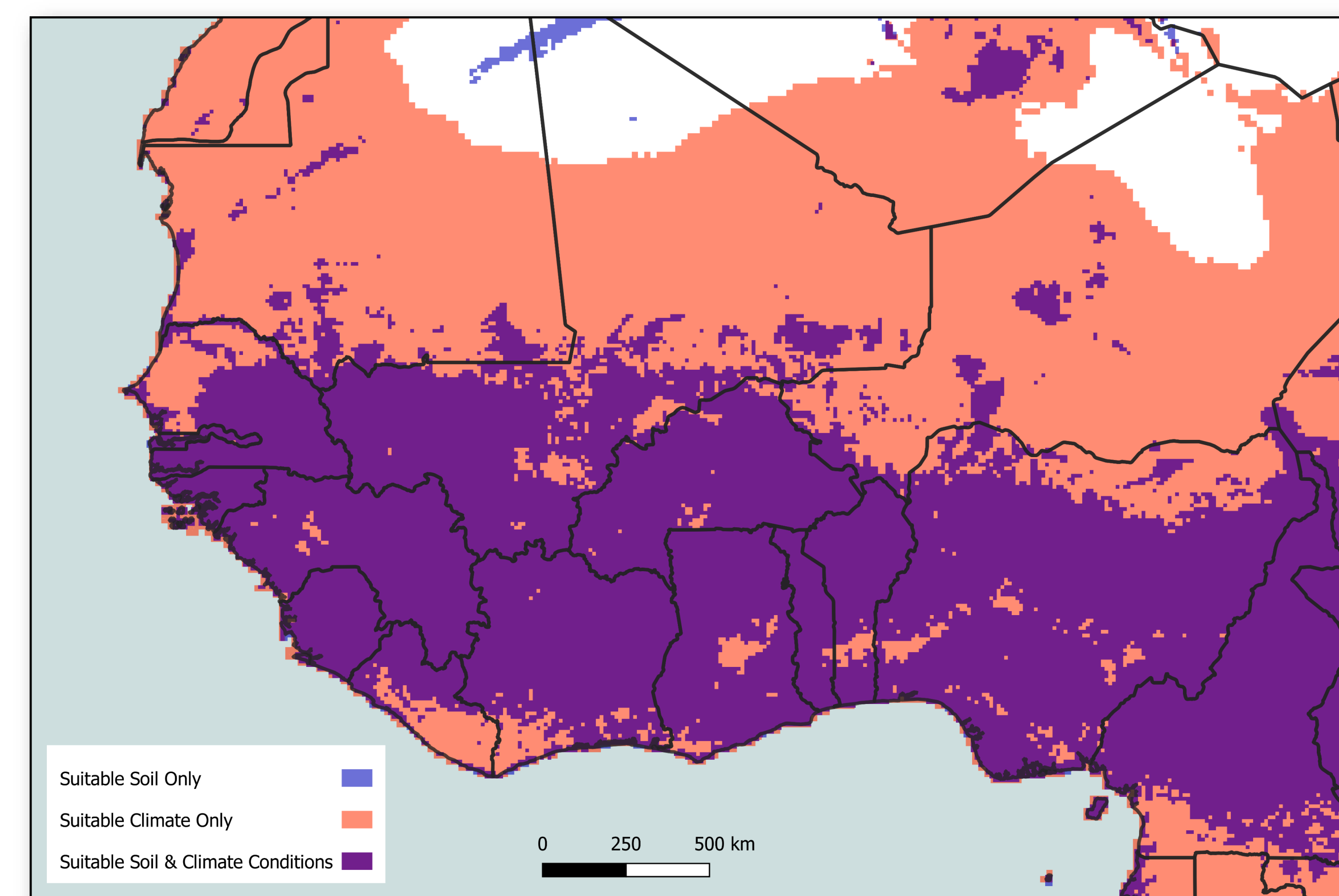
Aims & Methodology

- Explore existing data about soil, water, weather, land use and melioidosis risk factors in West Africa
- Generate geospatial data and maps to improve identification of areas for soil sampling and clinical research of melioidosis in Africa.
- Future Work: Investigate DataX to improve performance and add additional layers to our analysis. DataX enables researchers to access, share, understand, and analyze critical data using the high performance computational resources at the Texas Advanced Computing Center (TACC).

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Geospatial analysis

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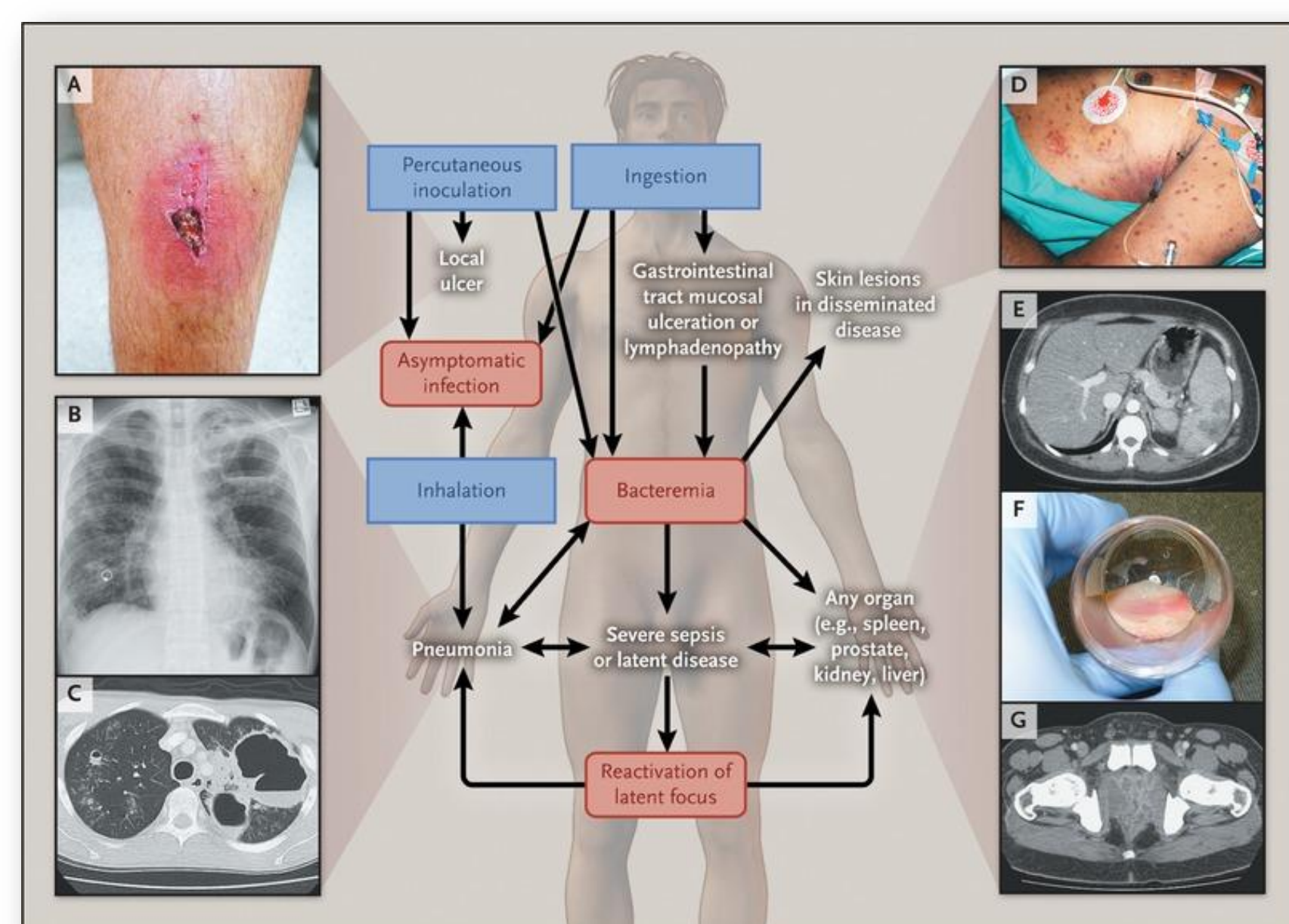Suitable Climate Only
Suitable Soil & Climate Conditions

0   250   500 km

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References

Limmathurotsakul et al. Nature Microbiology, (2016). doi: 10.1038/nmicrobiol.2015.8.
Limmathurotsakul, D. (2015). Data_Melioidosis_1910_2014. doi: 10.6084/m9.figshare.1447097.v1
Chewapreecha et al. (2017) Nature Microbiology. doi: 10.1038/nmicrobiol.2016.263.
http://tacc.utexas.edu/
https://ptdatax.tacc.utexas.edu/
https://bridgingbarriers.utexas.edu/planet-texas-2050/
Global soil data: https://files.isric.org/soilgrids/data/recent/
Global climate data: http://worldclim.org/bioclim
QGIS: https://qgis.org
Python: https://python.org