Environmental drivers of health in the Kilimanjaro Region, Tanzania

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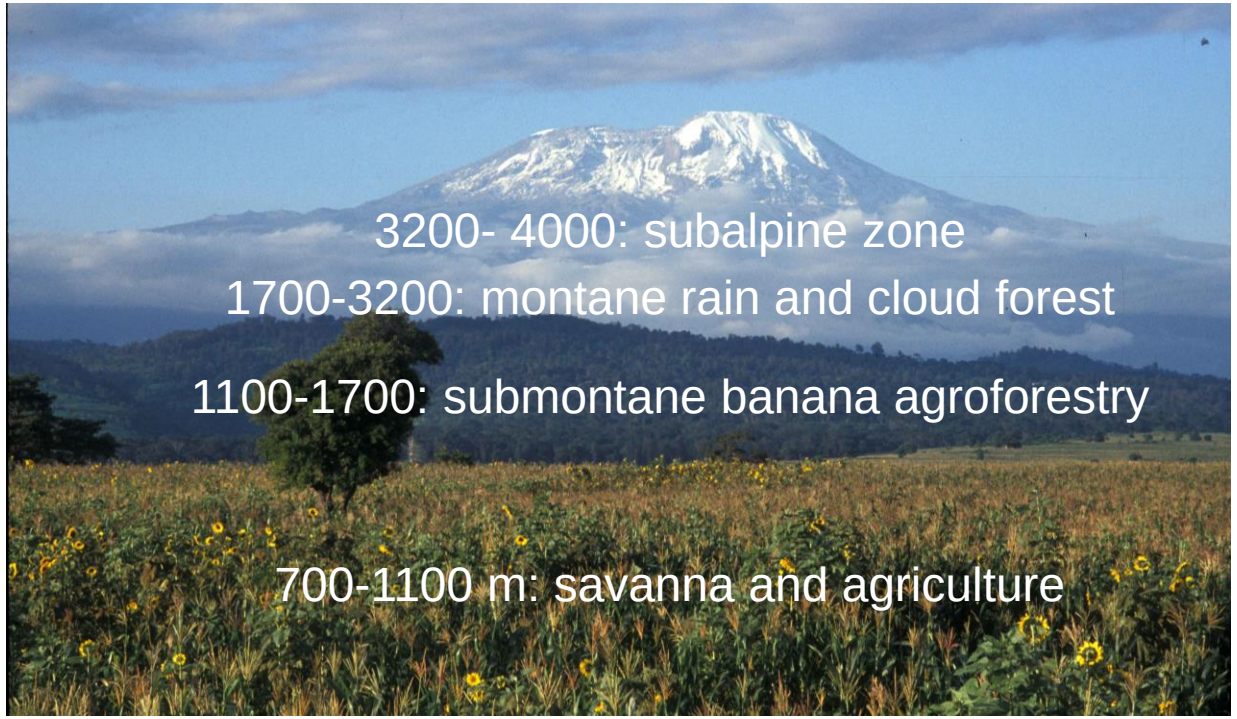
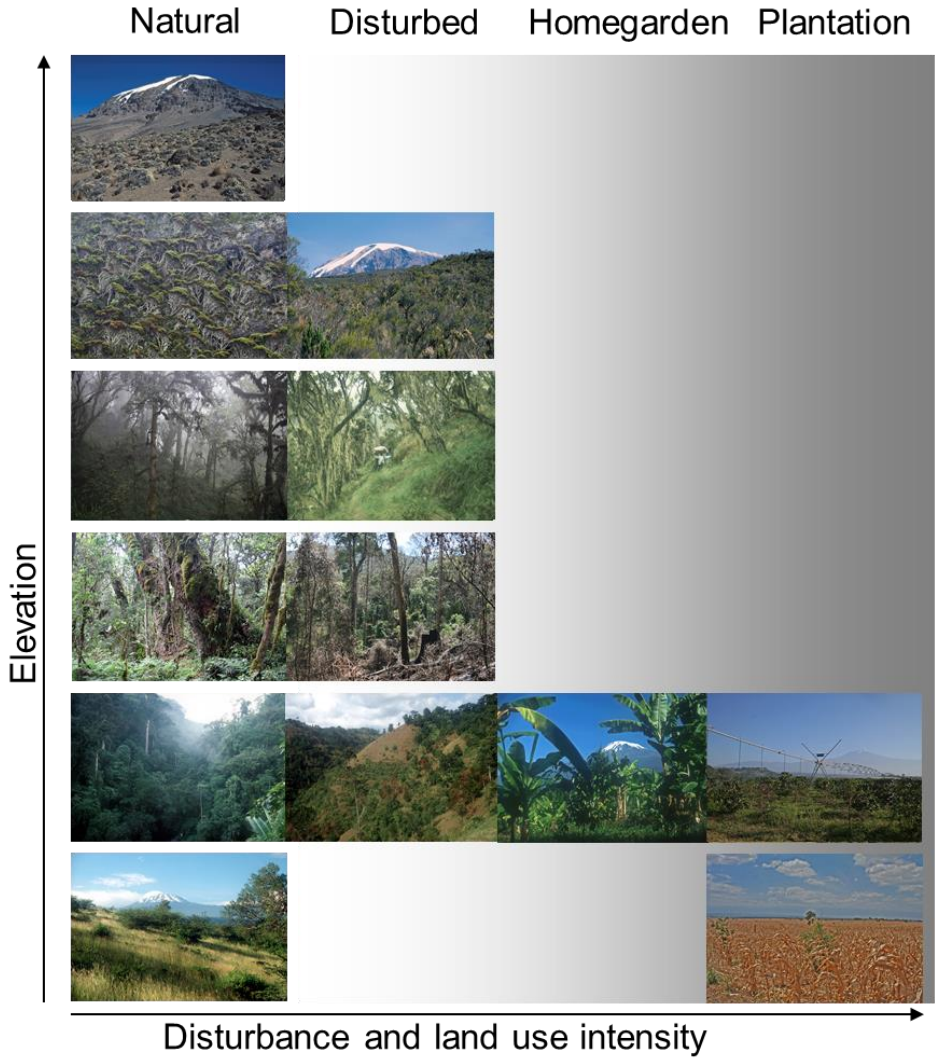
with all members of the RIPA2TAN project

Biodiversity, landuse, and people



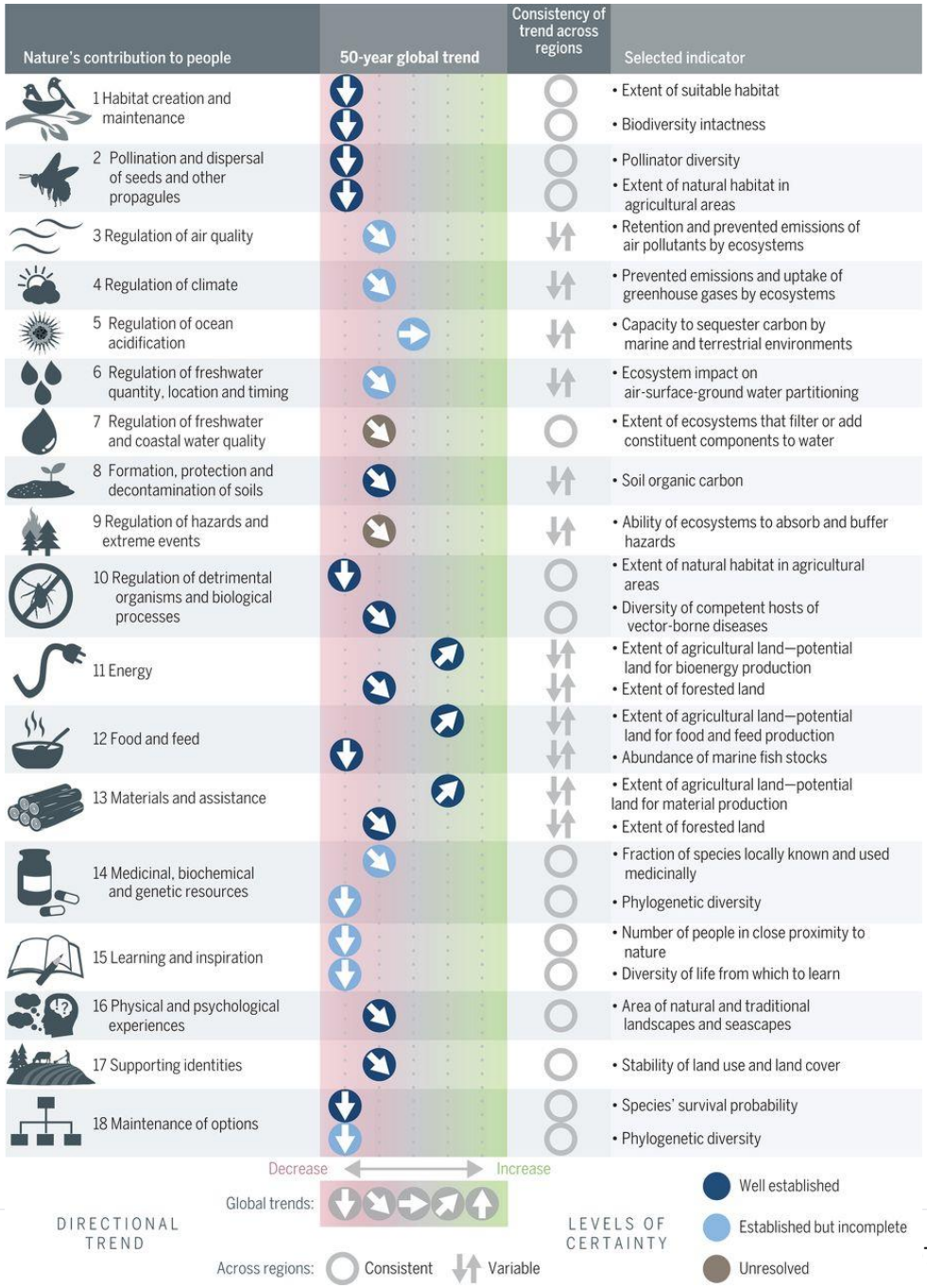
DFG project Kilimanjaro – Socioecological systems
https://kili-ses.senckenberg.de/



Nature’s Contribution to People

Nature's contributions to people (NCP) are all the contributions, both positive and negative, of living nature (i.e. diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to the quality of life for people.

– Diaz et al 2018



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Environment and health

- Hygiene hypothesis
- Biodiversity Hygiene hypothesis
- (von Hertzen et al 2011)

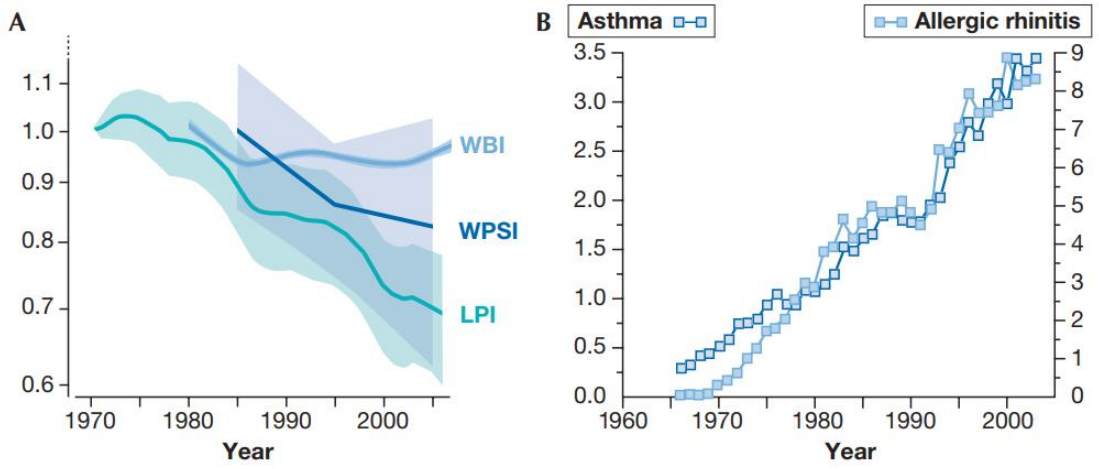
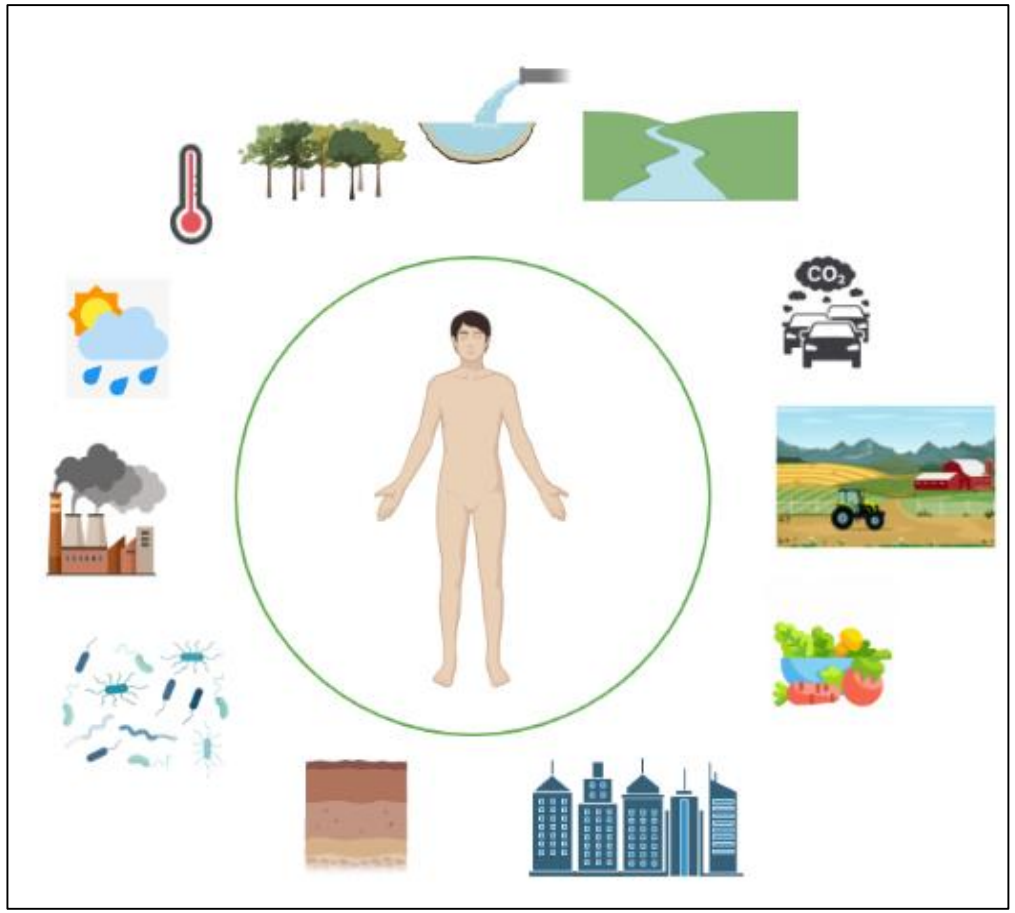
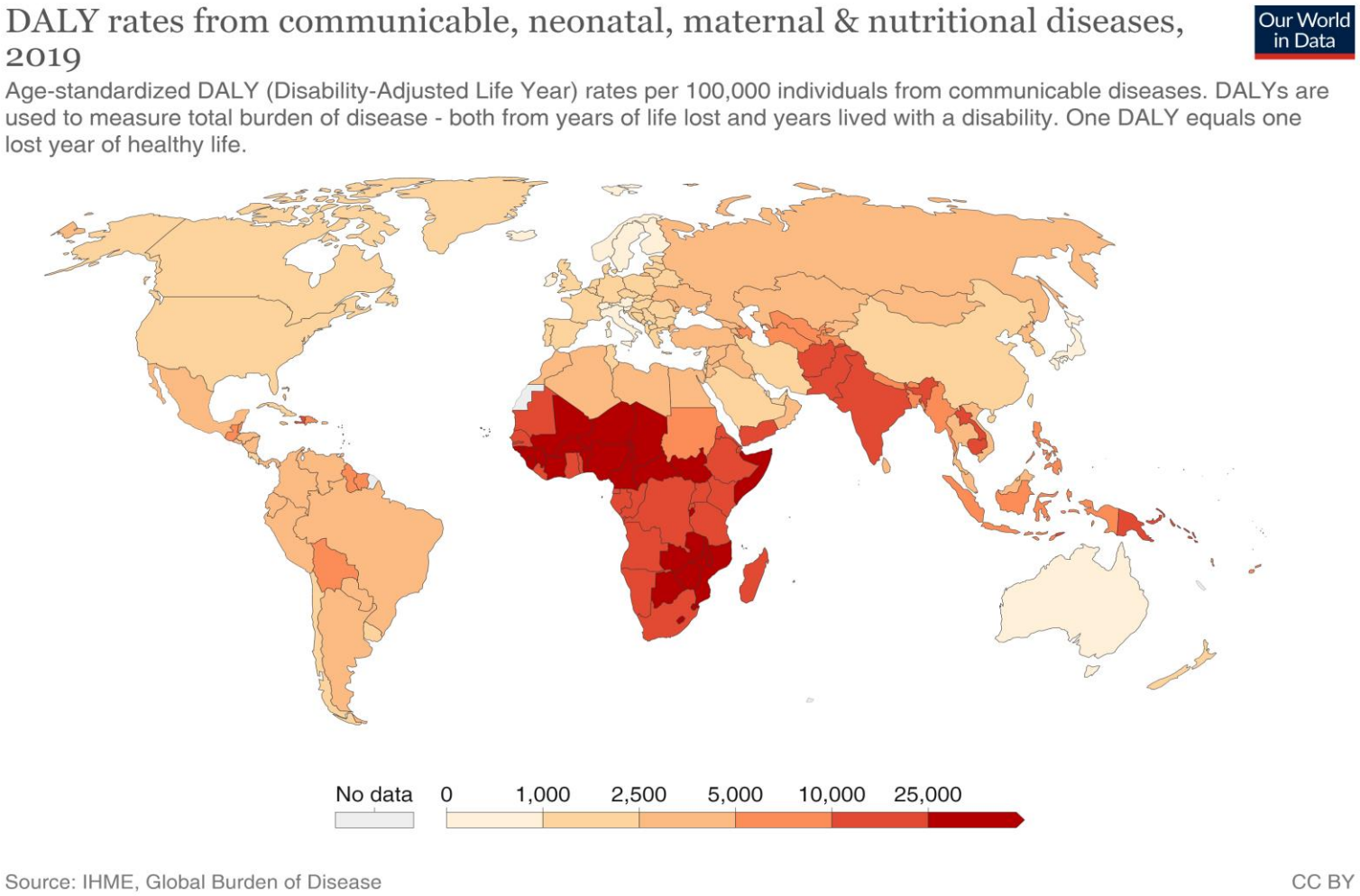


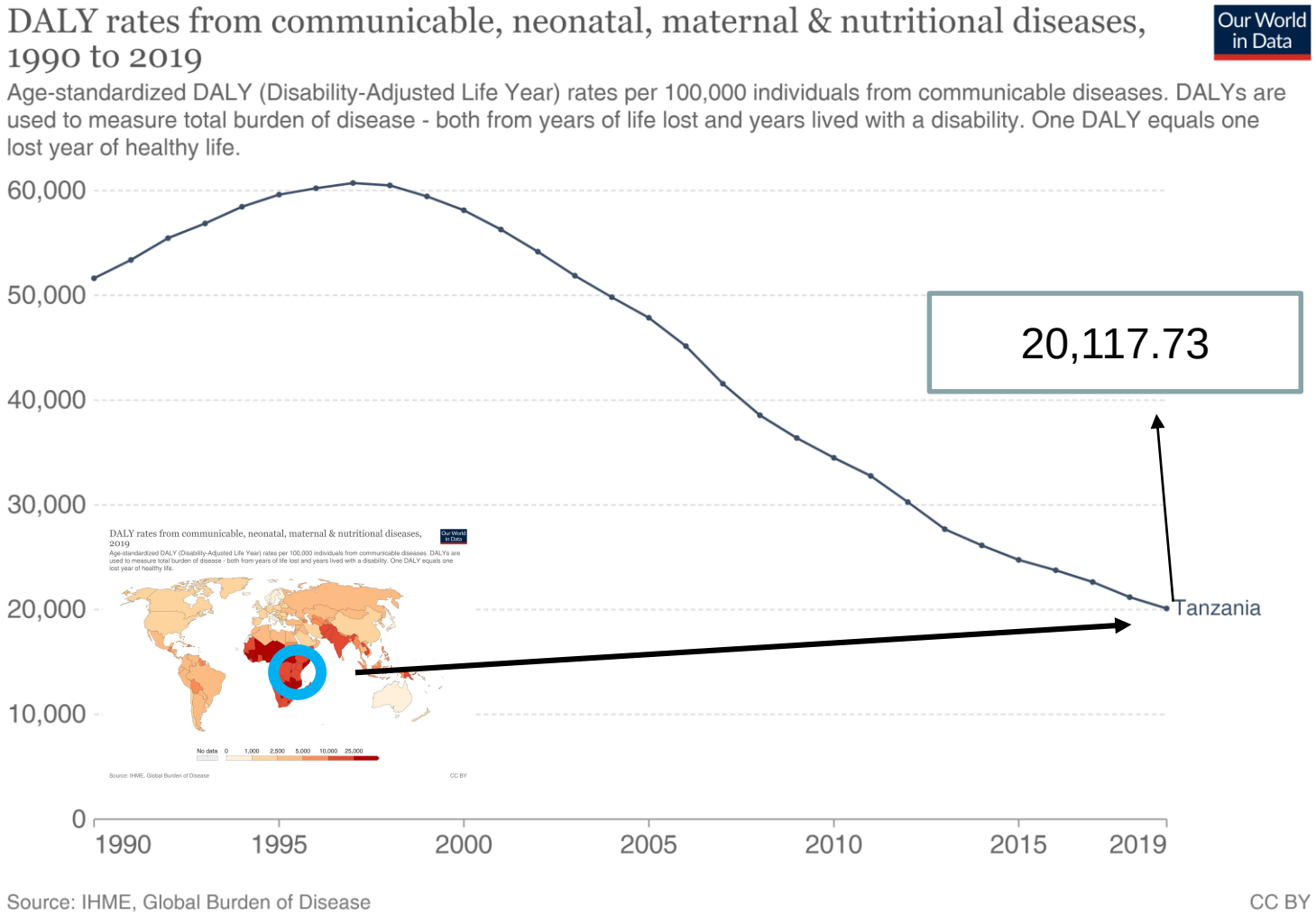
Fig 1 | Two global megatrends in biodiversity and public health. (**A**) Declining biodiversity since 1970 as measured by three indices. LPI, Living Planet Index; WBI, World Bird Index; WPSI, Waterbird Population Status Index (Butchart *et al*, 2010). (**B**) Increasing trends in the prevalence of inflammatory diseases. Asthma and allergic rhinitis among military conscripts from 1966 to 2003 (Latvala *et al*, 2005) are shown as an example.



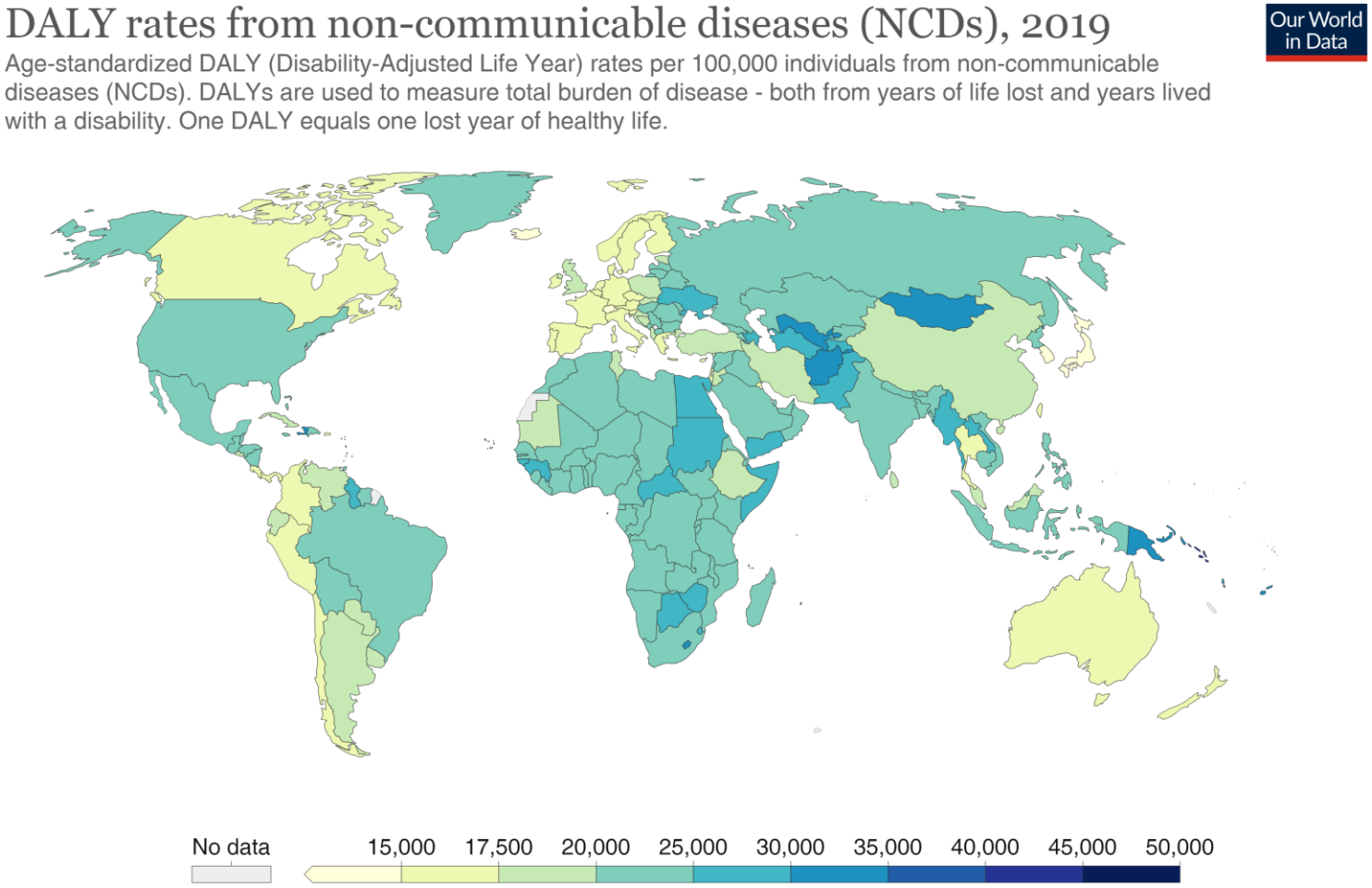
Global Burden of diseases- Communicable, neonatal, maternal & nutritional diseases



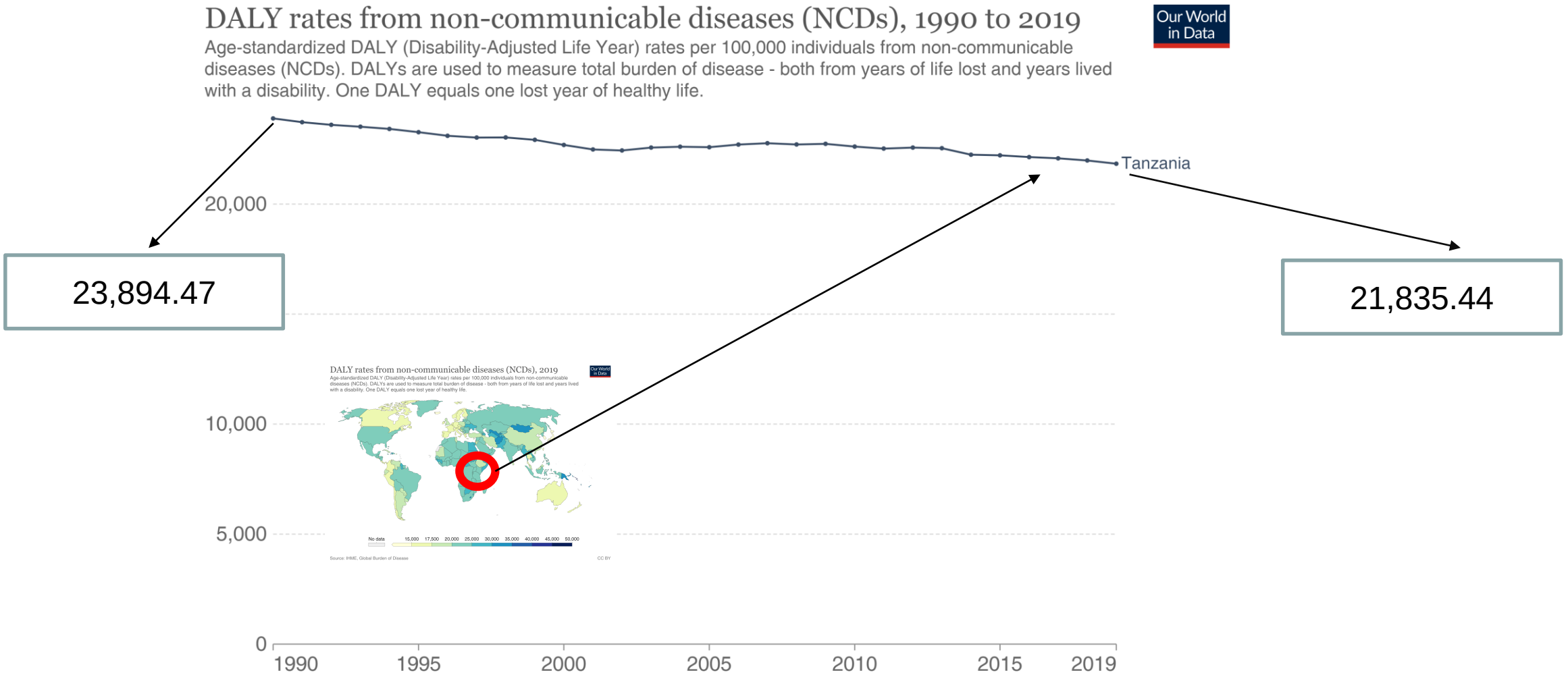
Communicable, neonatal, maternal & nutritional diseases



Global burden of Non-communicable Diseases



Non communicable diseases in Tanzania



Work packages

- WP1

Investigating the association of environmental and socioeconomic drivers with different **health indicators** in the Kilimanjaro region

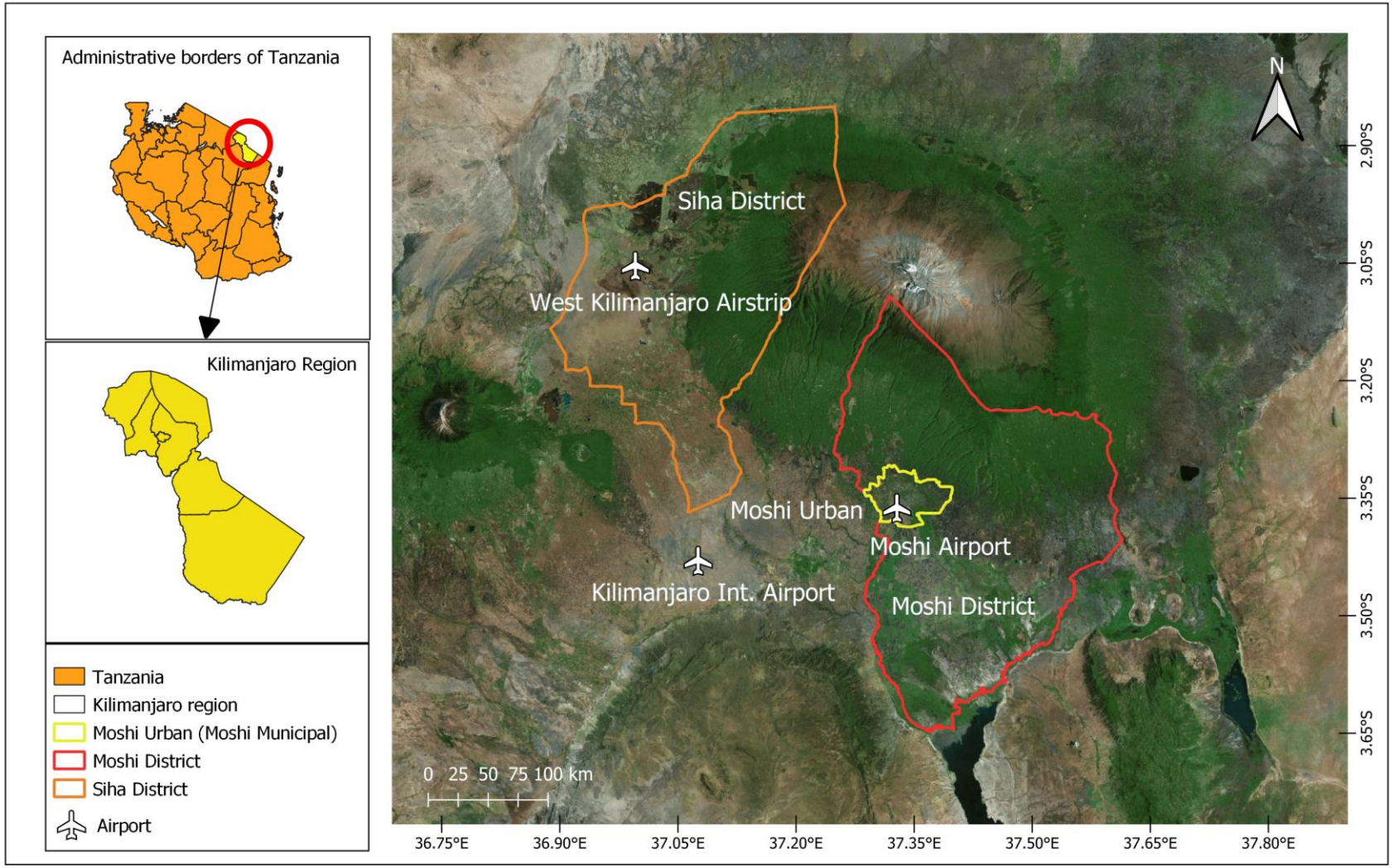
- WP2

Environmental drivers of **Asthma** in the Kilimanjaro region

Kilimanjaro region

Focus areas

- Siha District
- Moshi Urban



WP1

Objectives

- Does the percentage of communicable and non-communicable diseases differ between an urban and a rural area (/semi-urban)
- and are those differences driven by socioeconomic and/or environmental drivers

Status

Years in focus – 2018, 2019, 2020 (and 2021)

District-level data collection – Ongoing

Environmental variables - Ongoing

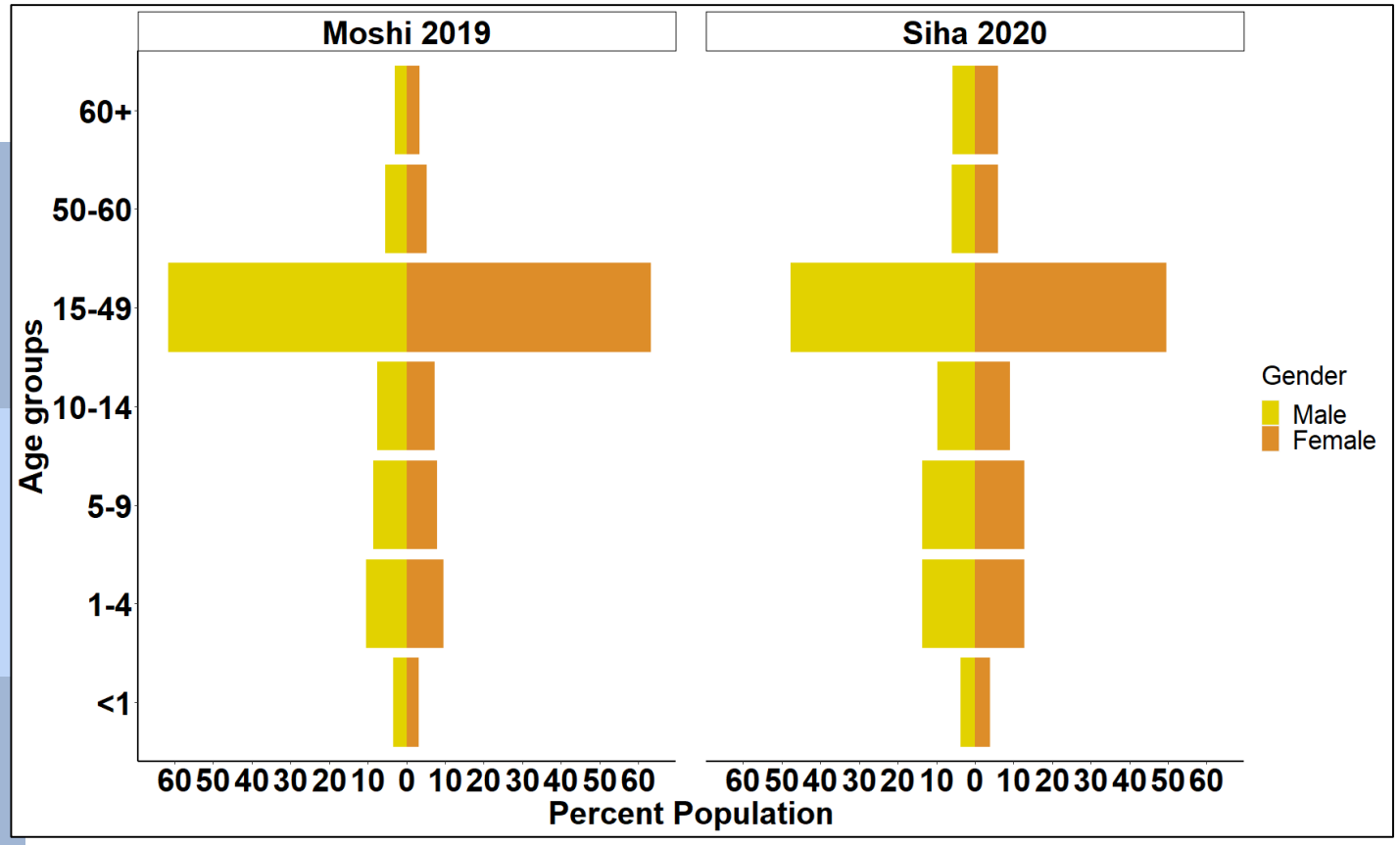
Methods and analysis – Ongoing

The following graphs are all based on currently available data

Moshi urban – 2019

Siha district - 2020

Demographics



District	Year	Total Population
Moshi Urban	2019	230,784
Siha	2020	141,568

Health indicators in the study

Health indicators	Moshi Urban (2019)	Siha (2020)
Birth rate (per 1000)		2.2
Neonatal mortality rate(per 1000)	230	3
Maternal mortality rate(per 1000)	31	154.75
Average life expectancy (years)	65	61
Access and use of medication/ prescribed medication (percent)	100%	

Socio economic variables

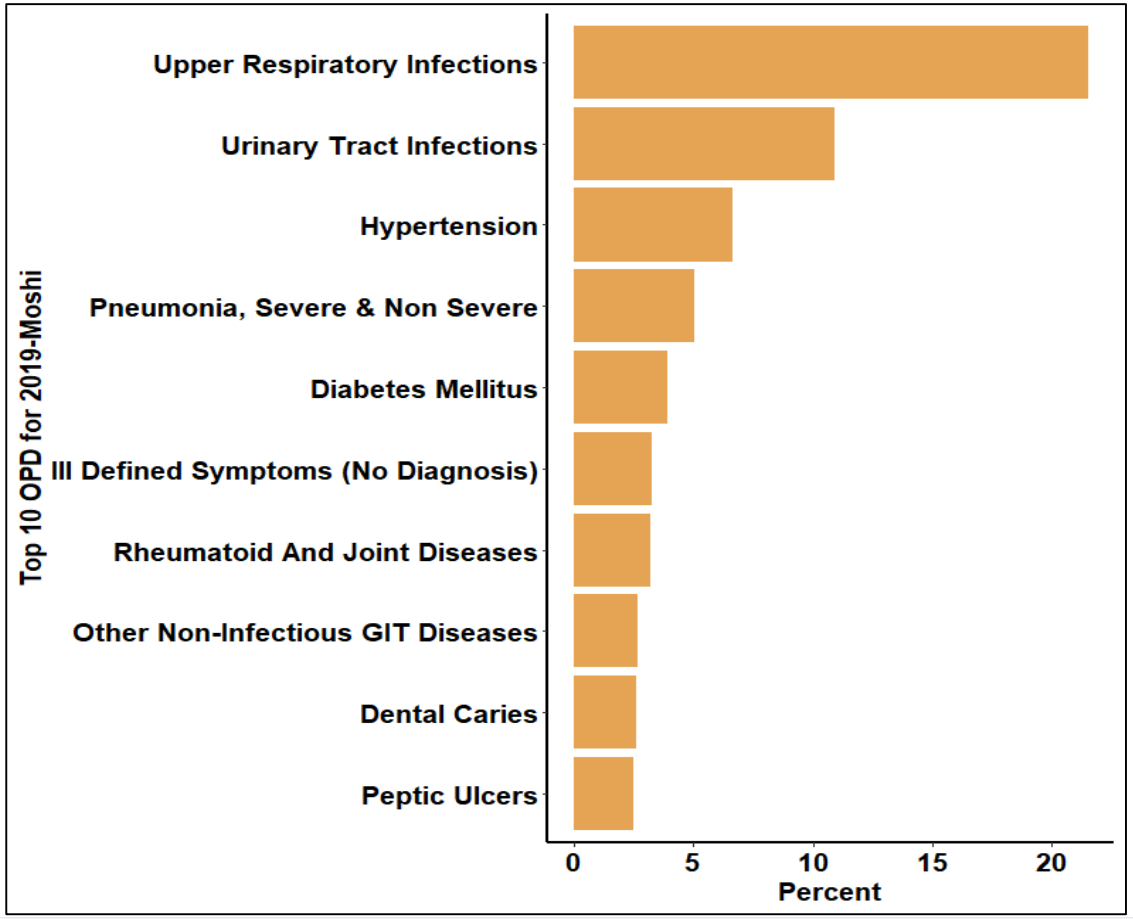
Socioeconomic data	Moshi Urban (2019)	Siha (2020)
Number of households with refrigerators		8848
Number of households with TVs or similar		26544
Household income		2504
Number of cars		
Number of motorbikes		
Unemployment rate		
People per household		4
Cellular phones		703448
No. of registered sim cards		

Healthcare access variables

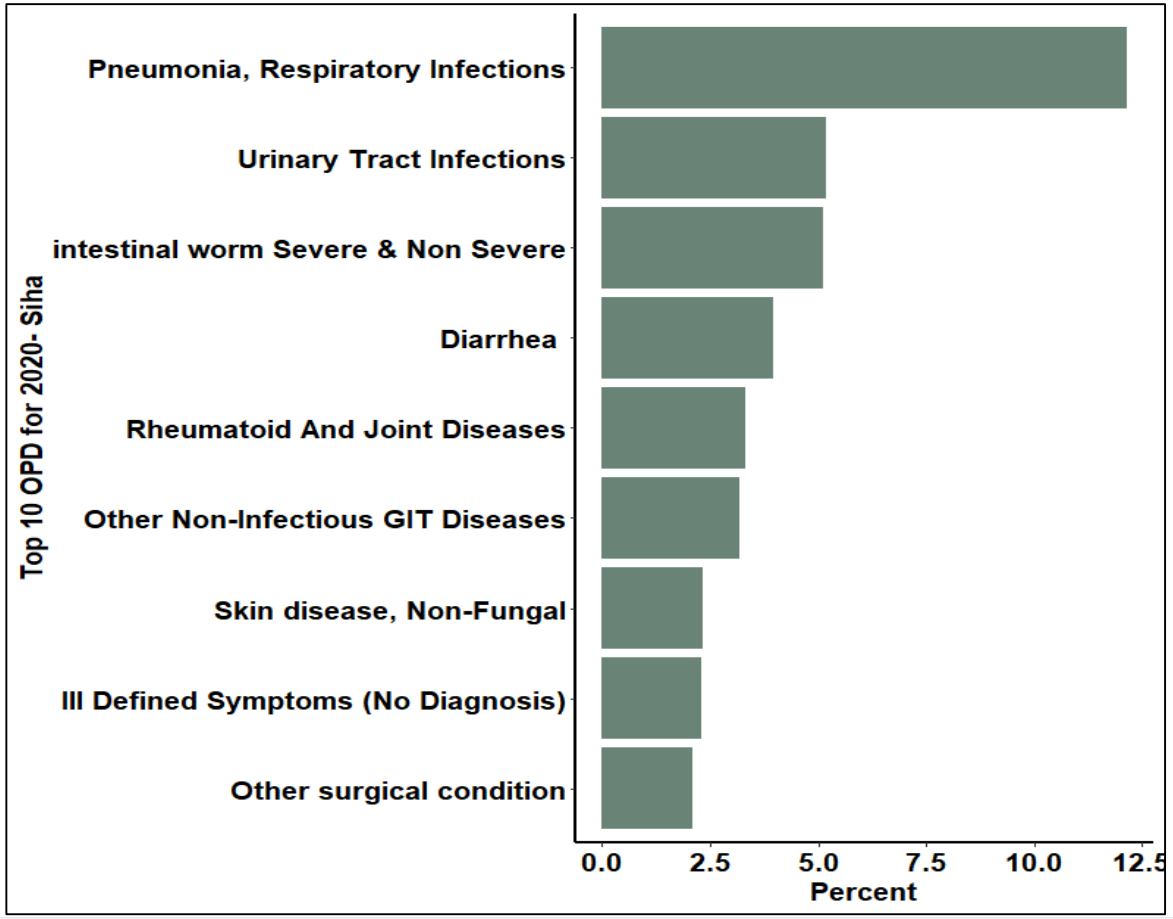
Healthcare access	Moshi Urban (2019)	Siha (2020)
Number of pharmacies	15	1
Number of hospitals	5	3
Number of hospital beds	220257	450
Number of doctors (Bachelor degree, Masters degree)		9
Number of clinical officers		24

Top 10 OPD – Outpatient department

Moshi Urban



Siha



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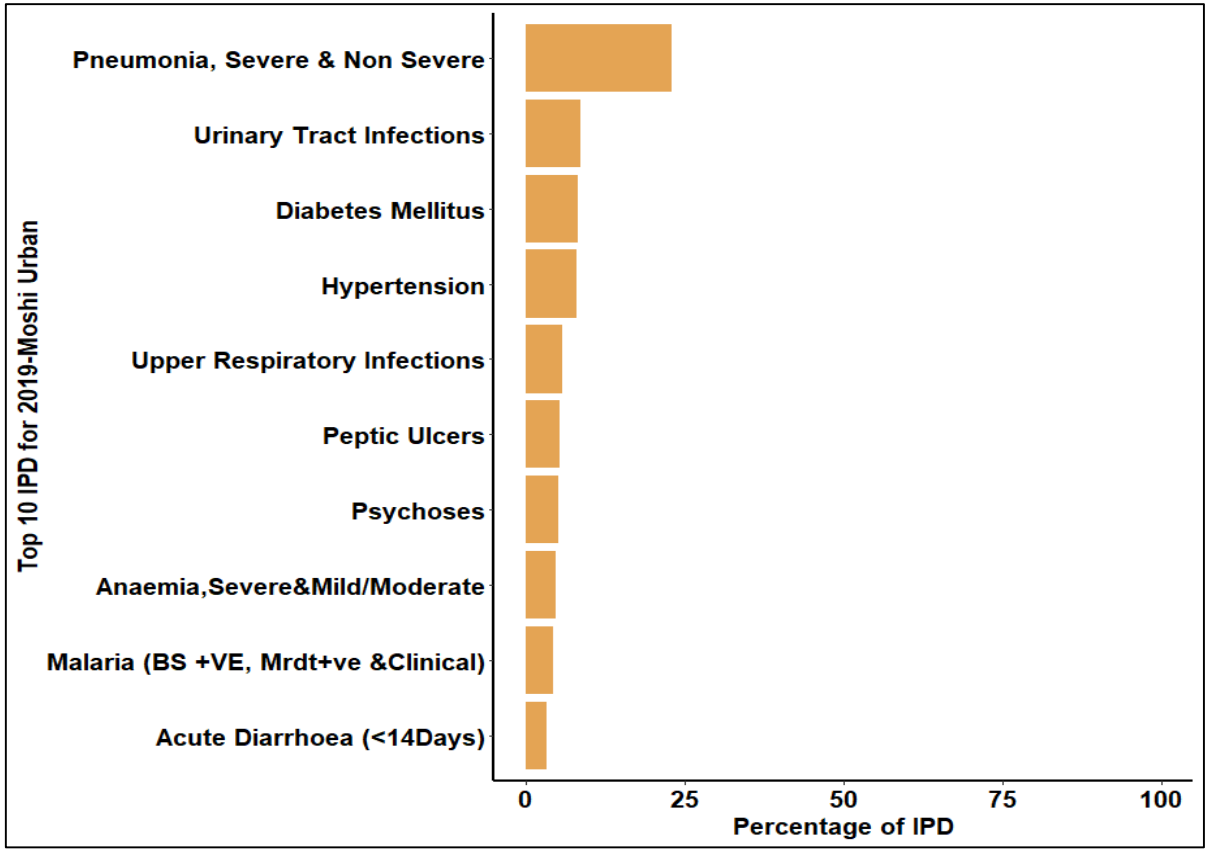
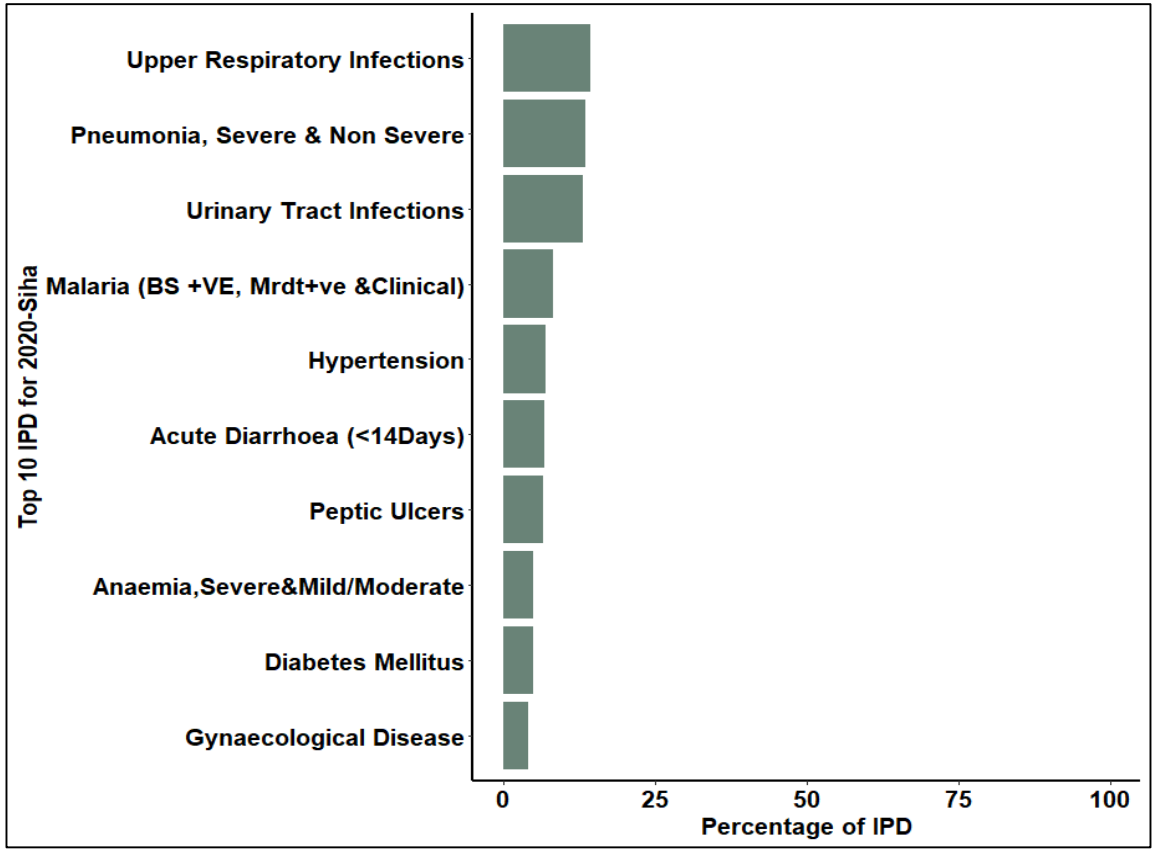
Top 10 IPD- inpatient department

Moshi Urban

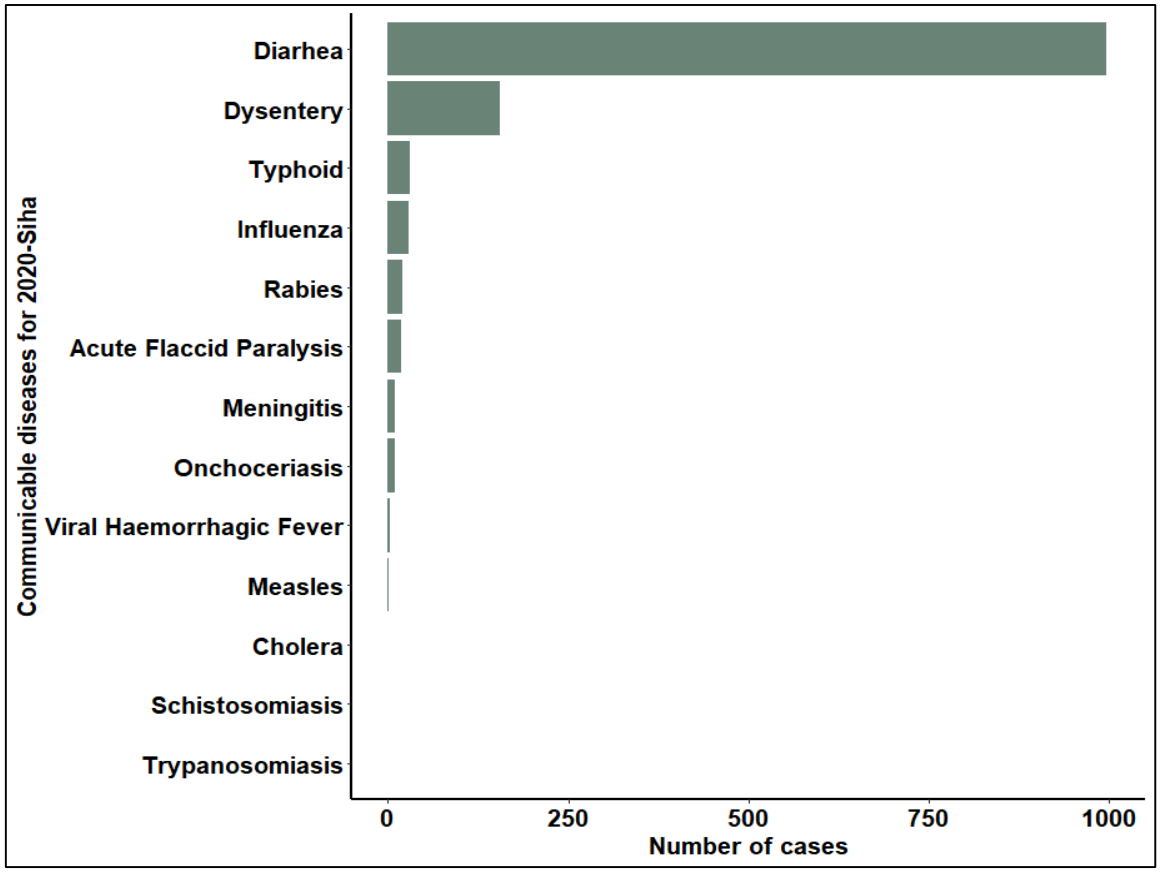


Siha

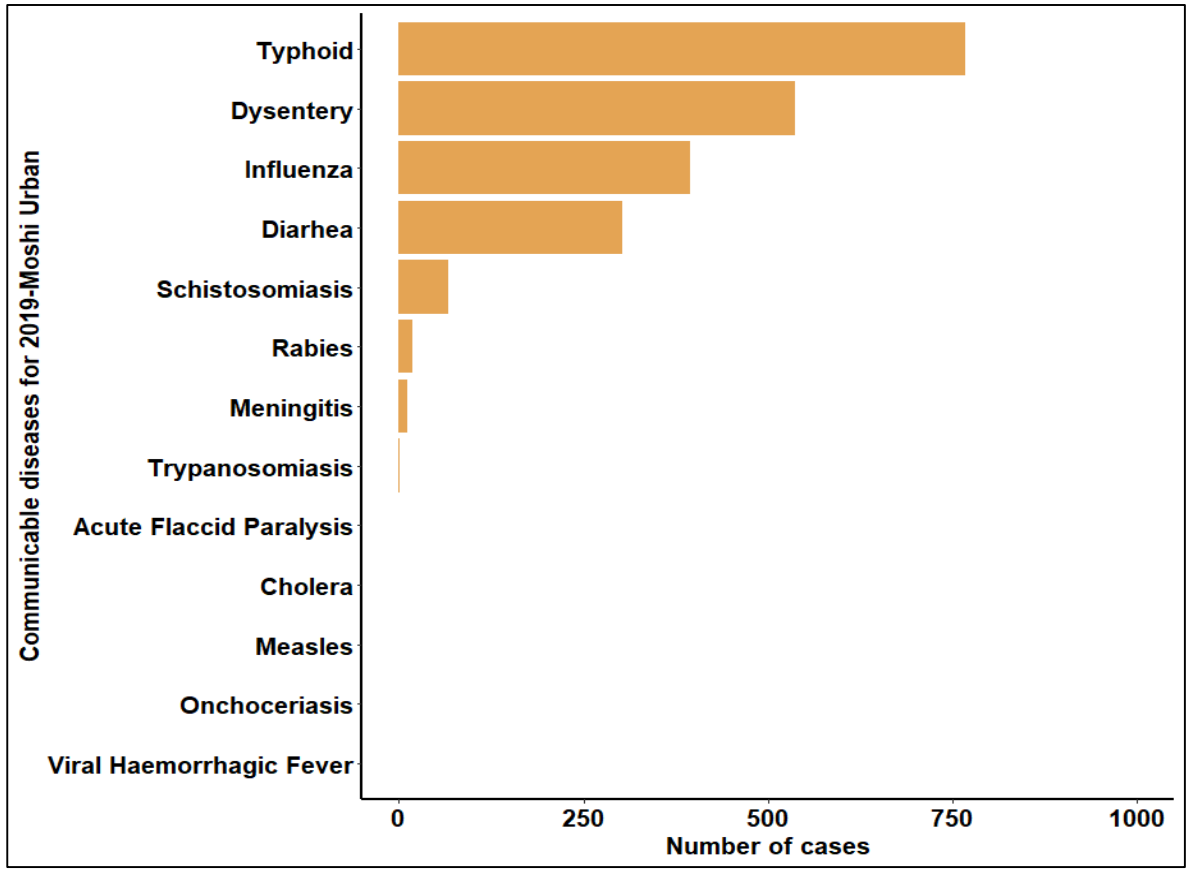


Communicable diseases

Moshi Urban

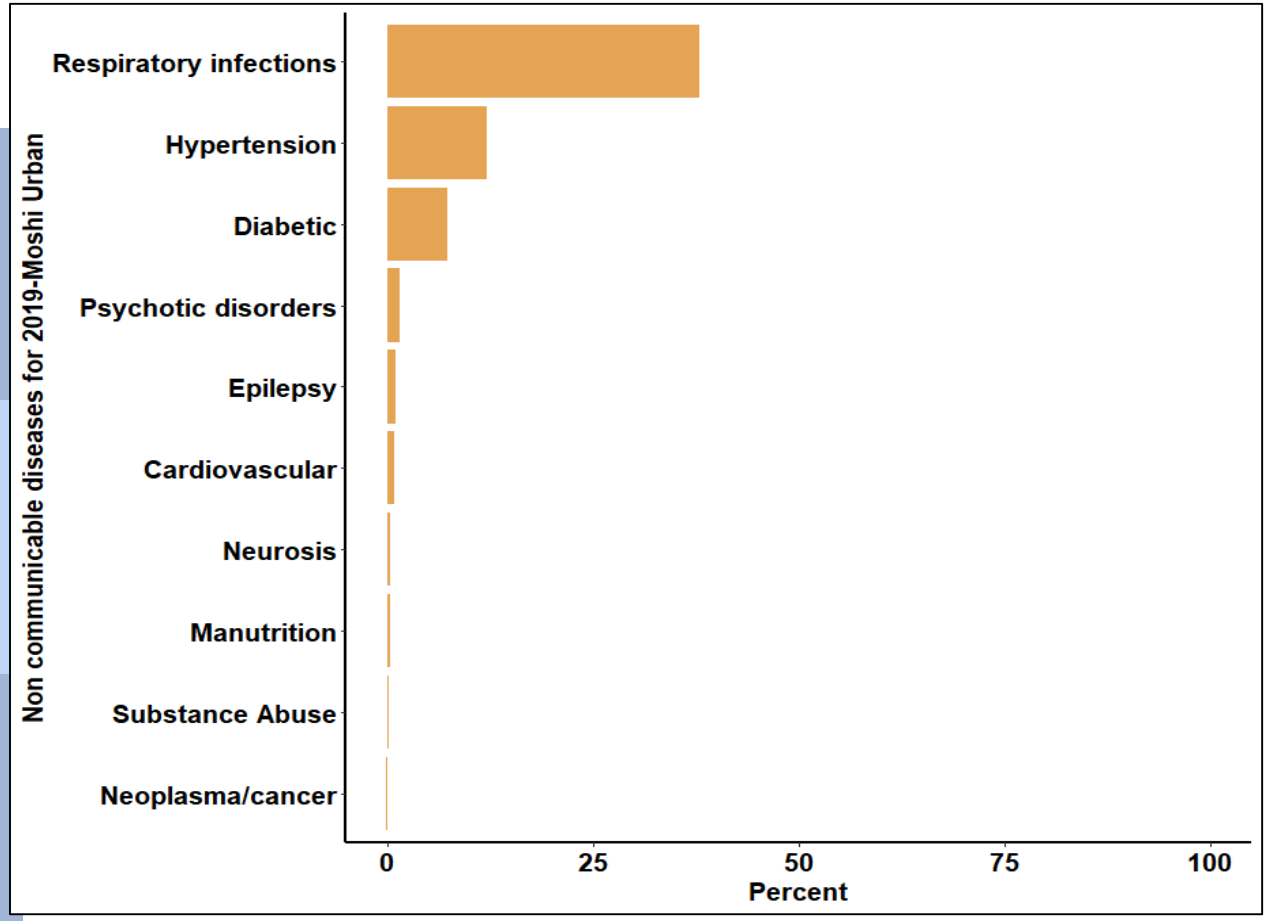


Siha

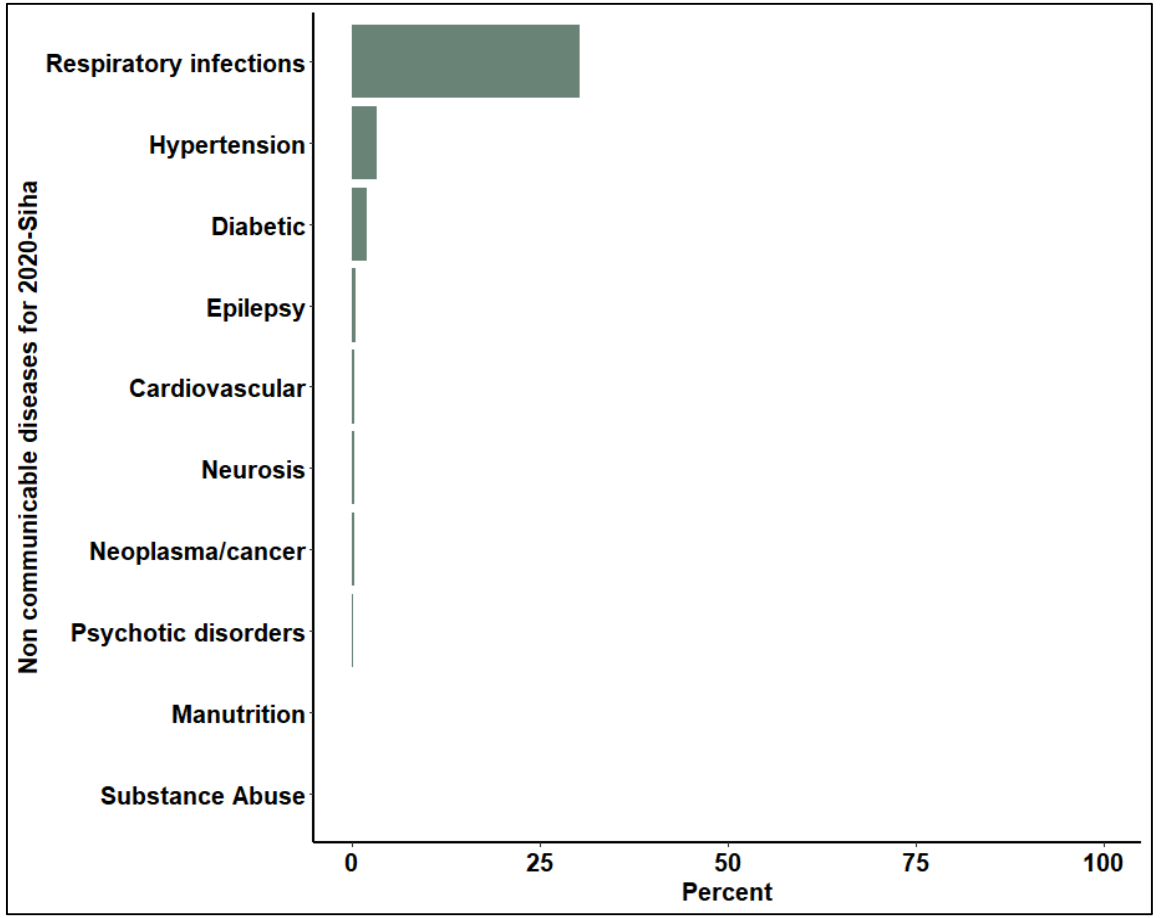


Non communicable diseases

Moshi Urban



Siha

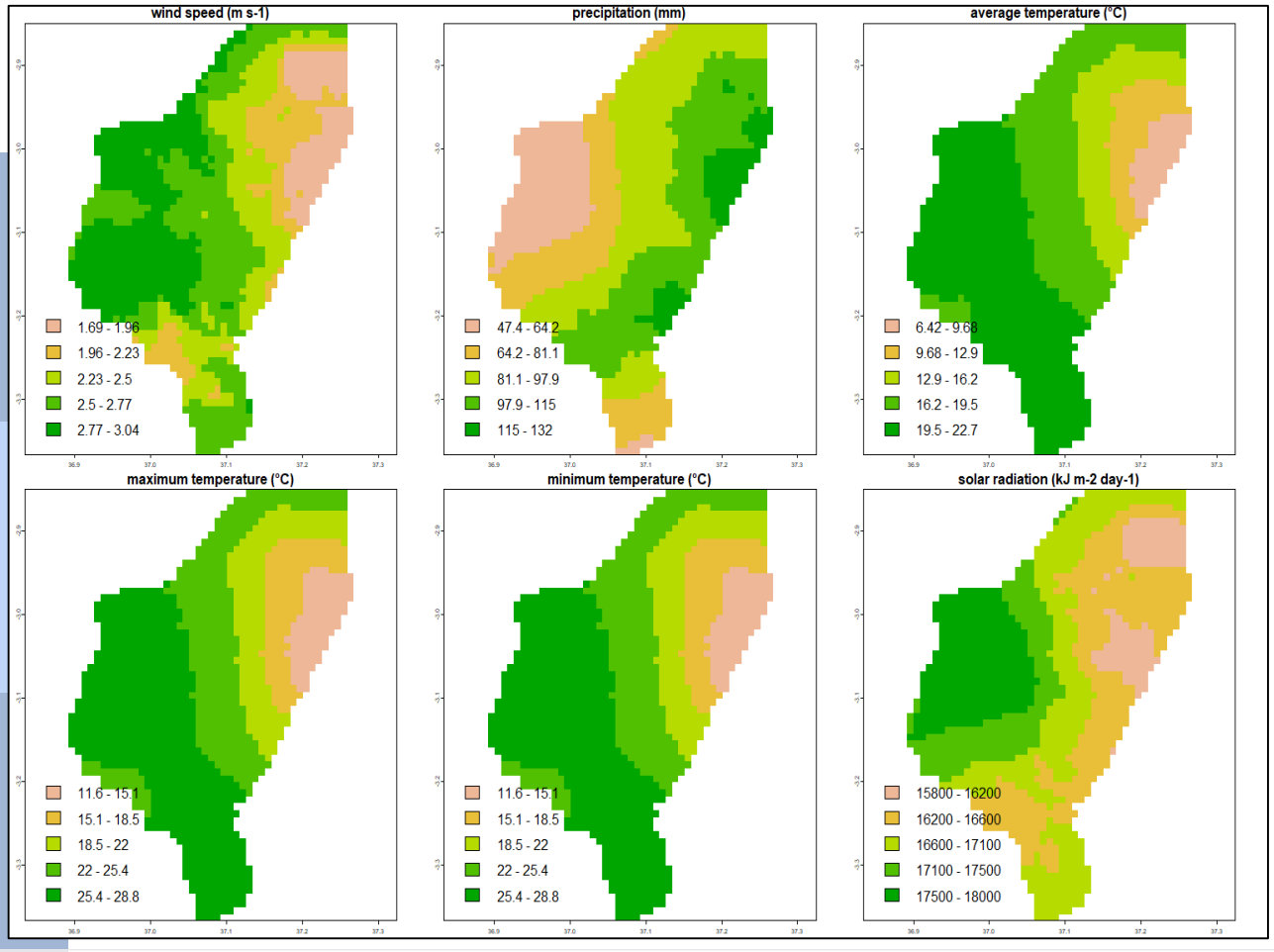


Environmental factors undertaken in the study

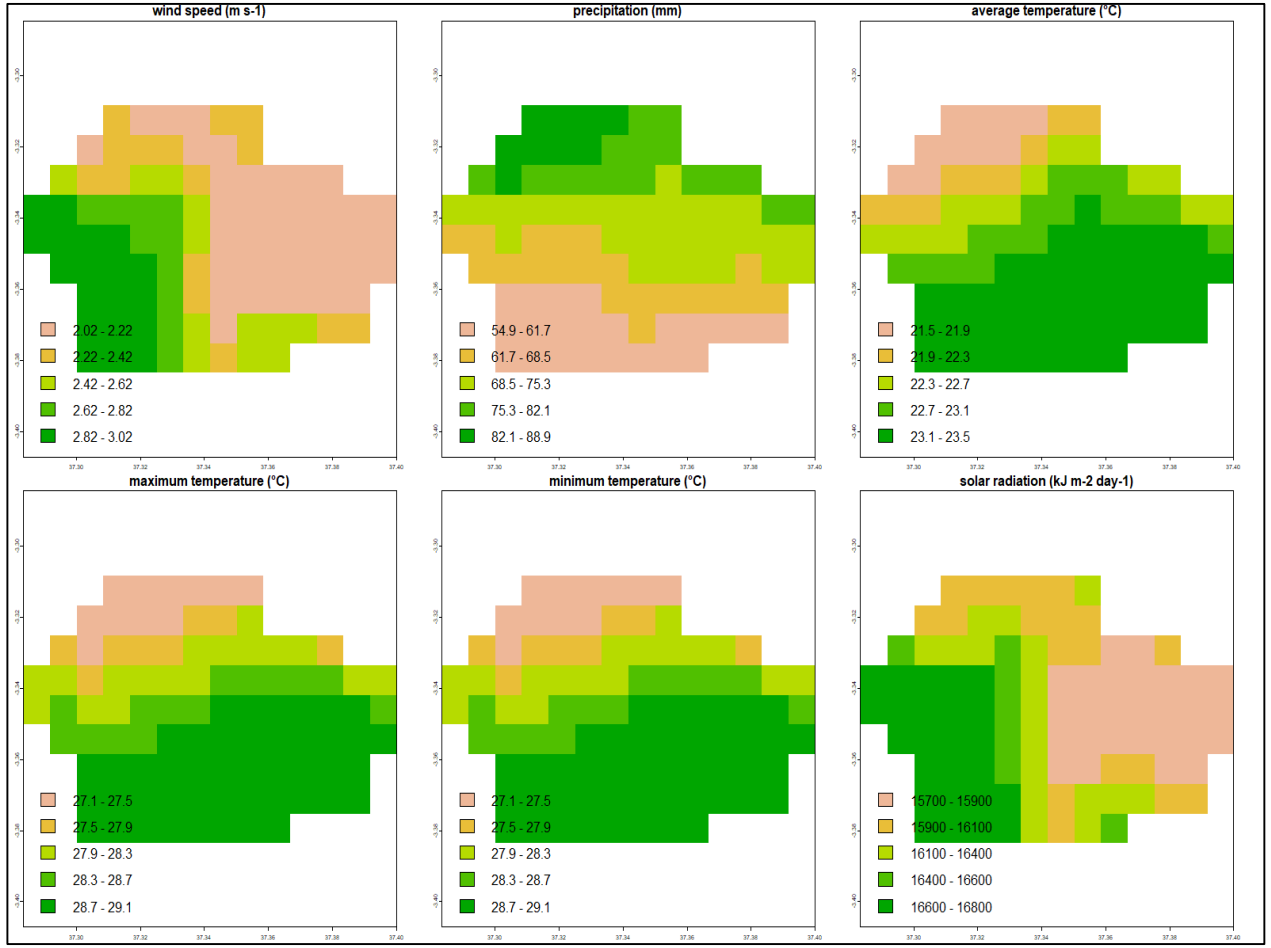
- Altitude
- Greenness
- Avg no. of days with rainfall /per year
- Avg no. of days with sunshine/per year
- Mean temperature/per year
- Seasonal temperature
- Soil microbe for Kilimanjaro
- Distance from water bodies /main source of water
- Air quality index
- Wind direction
- Wind speed
- Main crops grown
- Land use
- Size of agricultural plots
- No. of industries per area
- No. of small scale industries
- No. of large scale industries
- No. of gas stations in the district
- No. of main roads
- Traffic capacity per area

Climatic variables

Siha

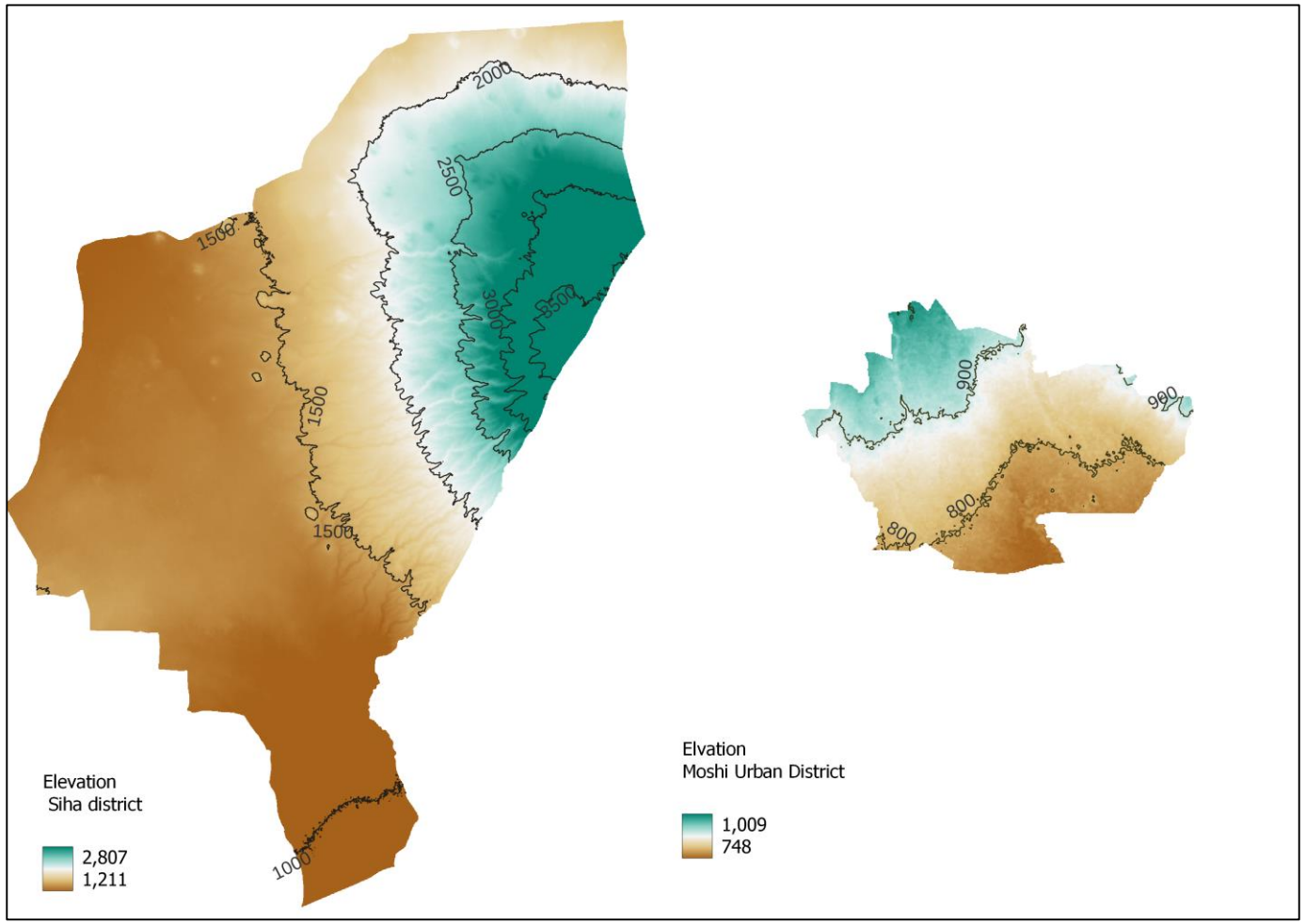


Moshi Urban



WorldClim data (~1km) (https://www.worldclim.org/data/worldclim21.html)

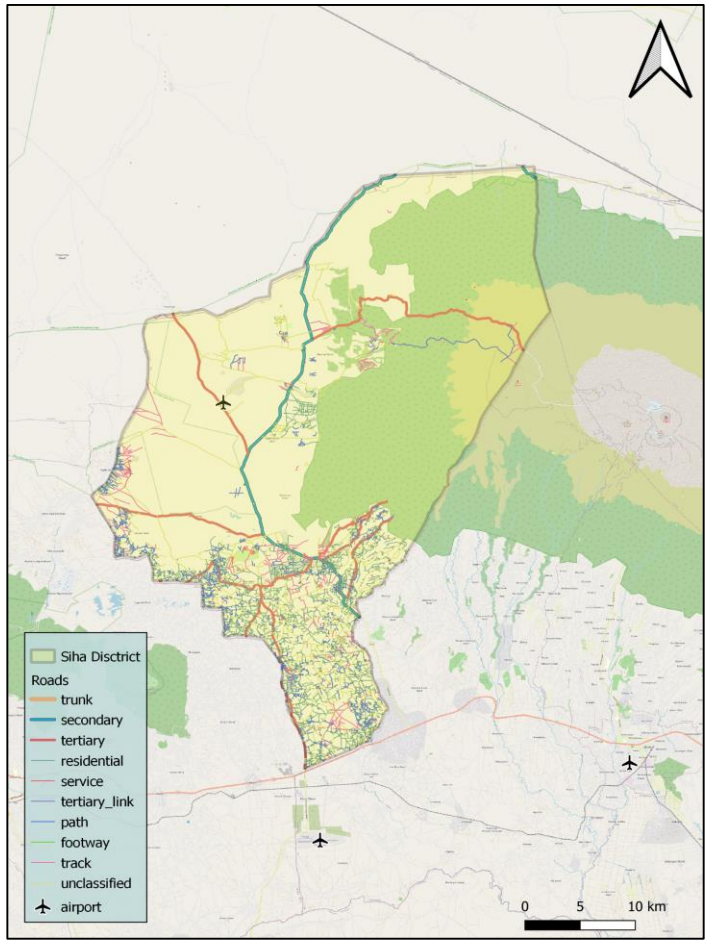
Topographic variables



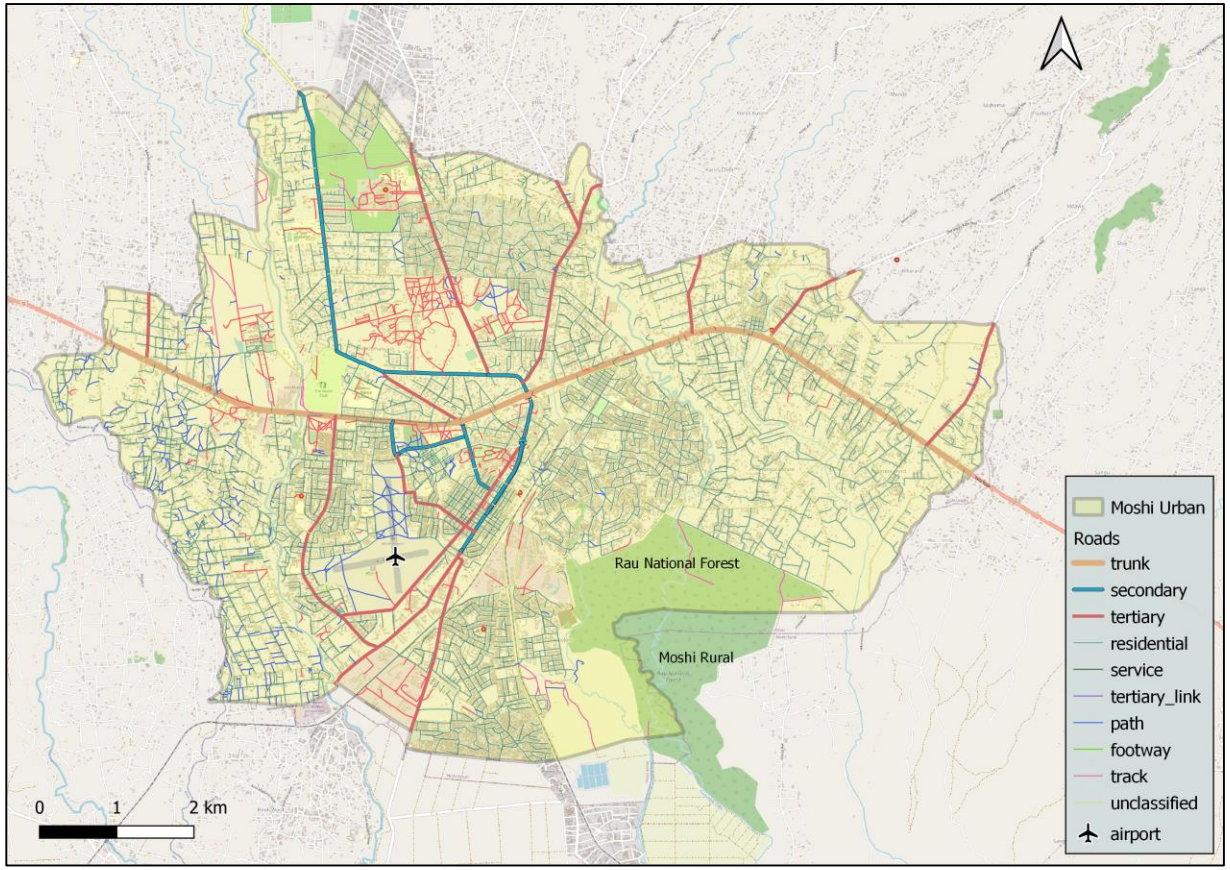
ASTER DEM (30m) (https://asterweb.jpl.nasa.gov/gdem.asp)

Road Network

Siha District

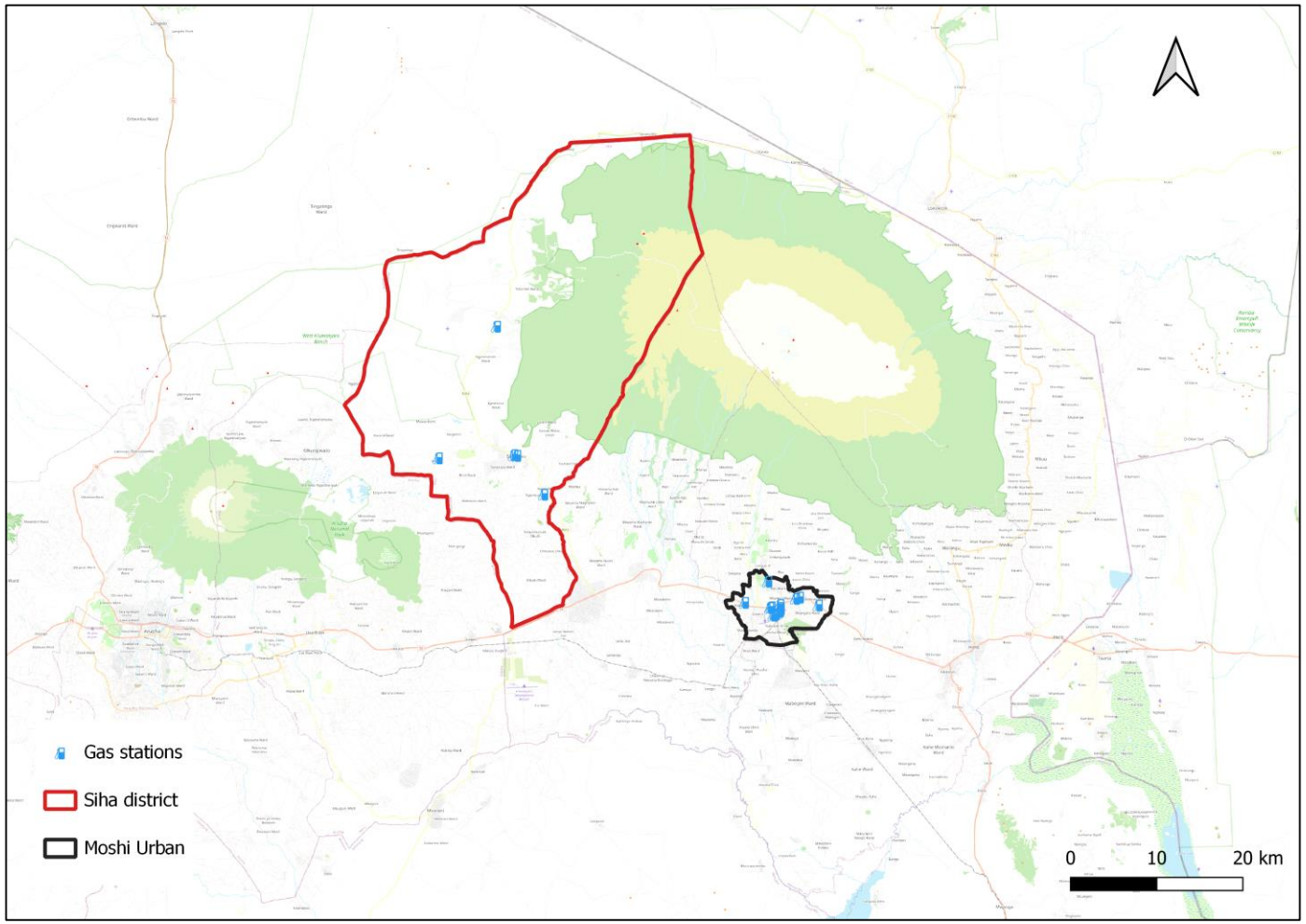


Moshi Urban



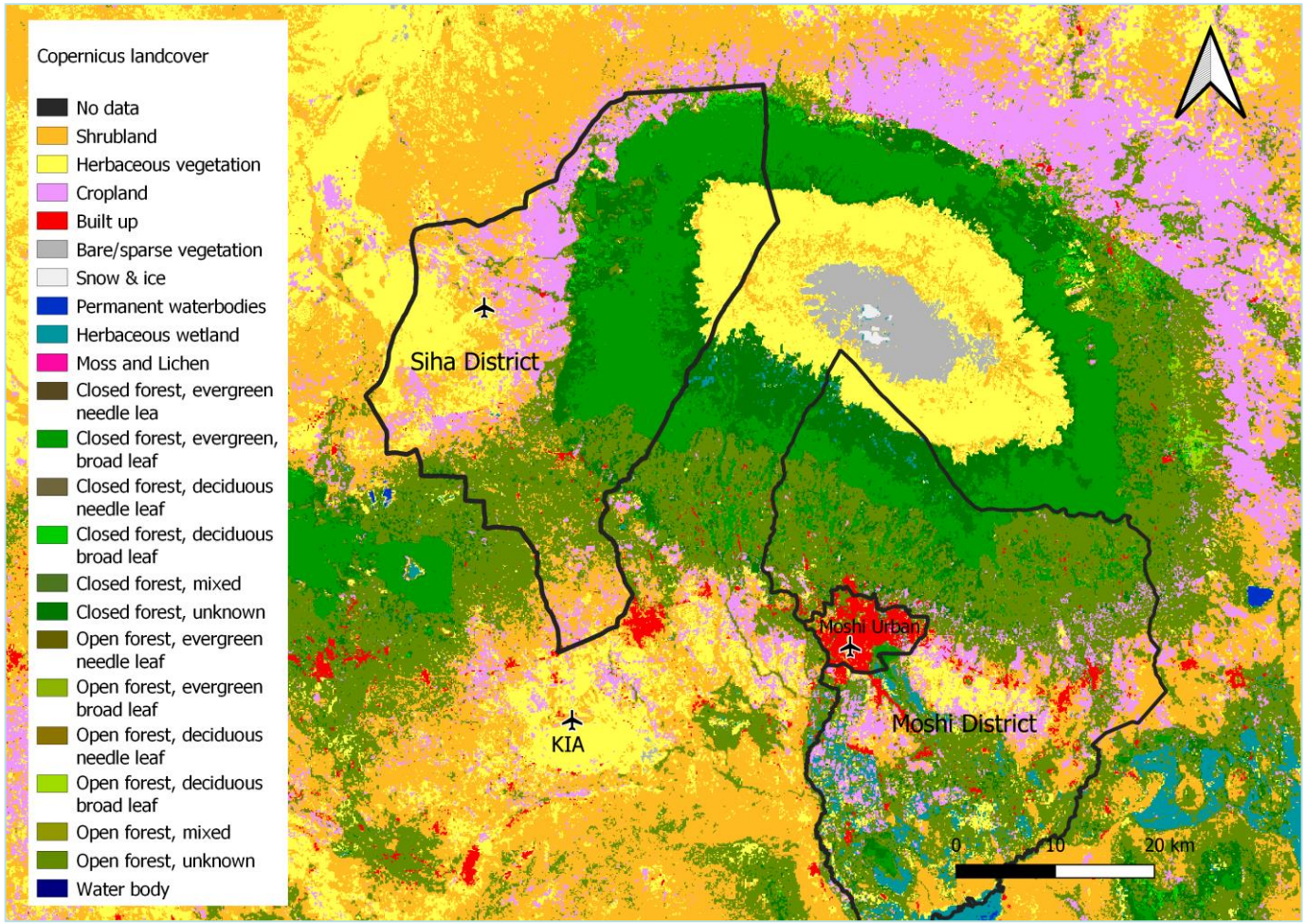
Source – Geofabrik (https://www.geofabrik.de/)

Gas stations



OpenStreetMap https://www.openstreetmap.org

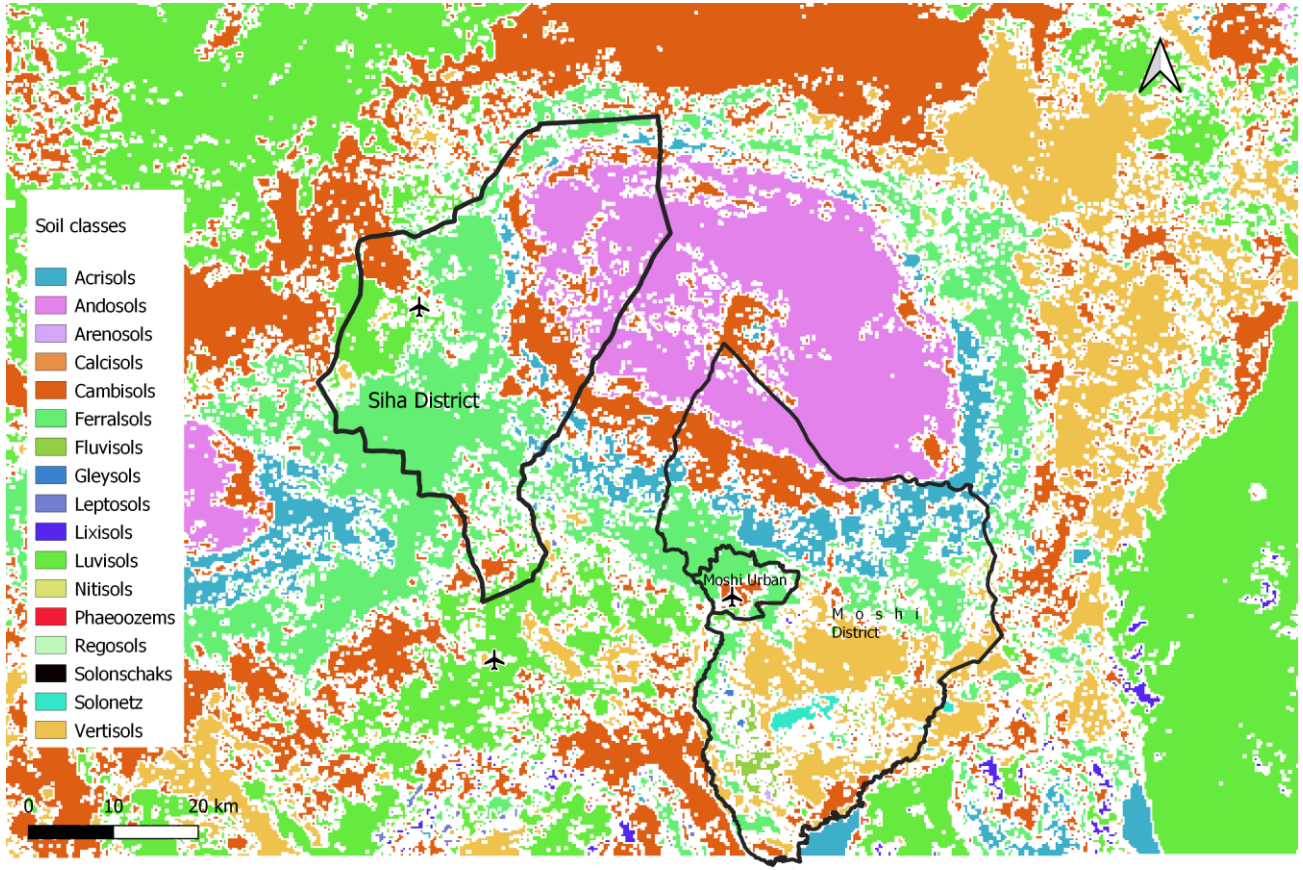
Land use



Copernicus data (100 m, 2019)

https://land.copernicus.eu/

Soil grids data (250 m resolution)

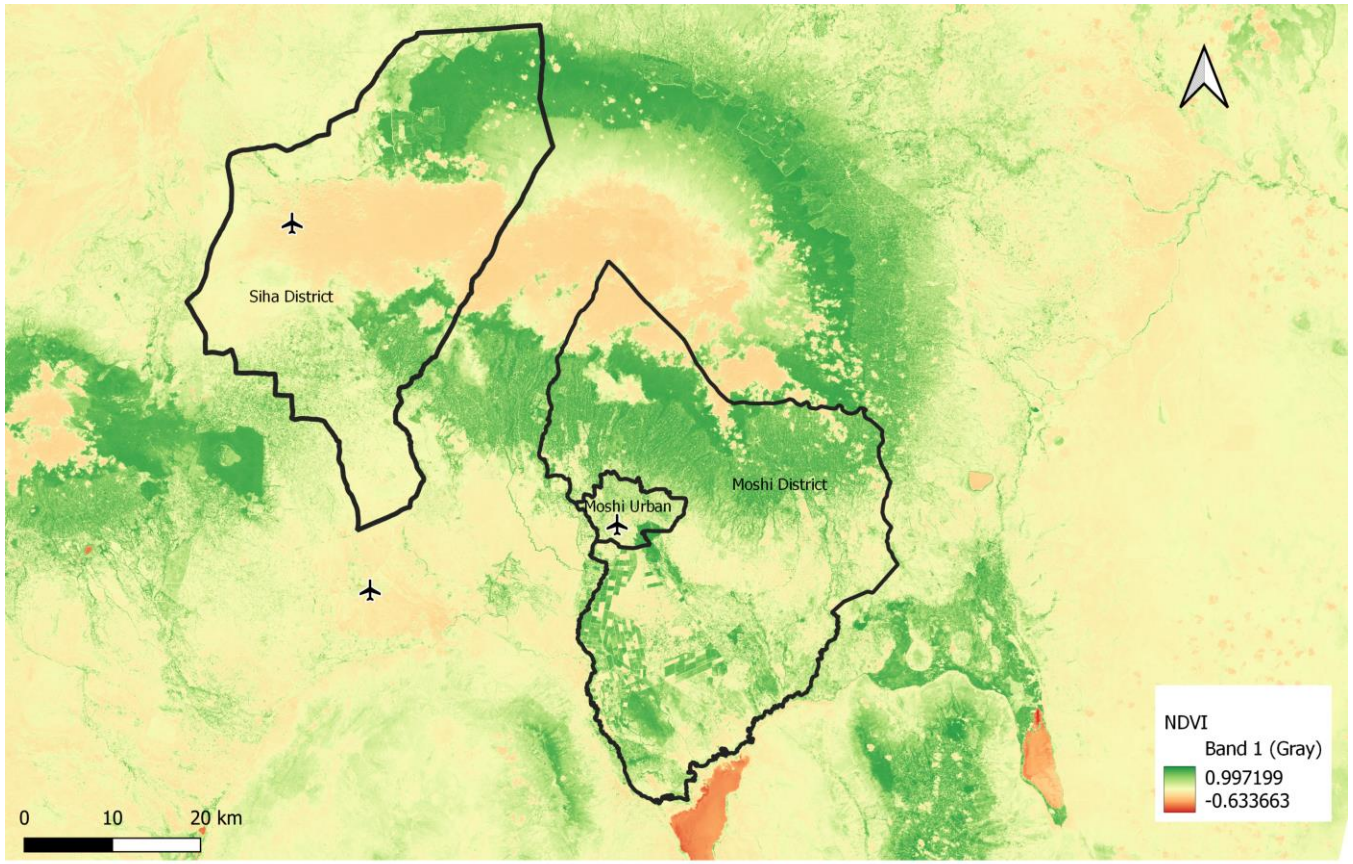


Dominant soil classes

1. Cambisols
2. Andosols
3. Ferrasols
4. Vertisols
5. Acrisols

https://www.isric.org/projects/africa-soil-profiles-database-afsp

NDVI – To measure greenness (10 m resolution)



$$NDVI = \frac{NIR - Red}{NIR + Red}$$

https://sentinel.esa.int/

Air quality and wind direction

- To be collected from Tanzanian Meteorological Agency

Potential statistical analysis

- Chi square test
- Mixed effect models

WP2

Objectives

- assessing the epidemiological characteristics of asthmatic patients,
- comparing rural and urban asthmatic patients,
- elucidating associations of living conditions on asthma symptoms, in order to
- better understand the environmental drivers of Asthma pathogenesis

Status

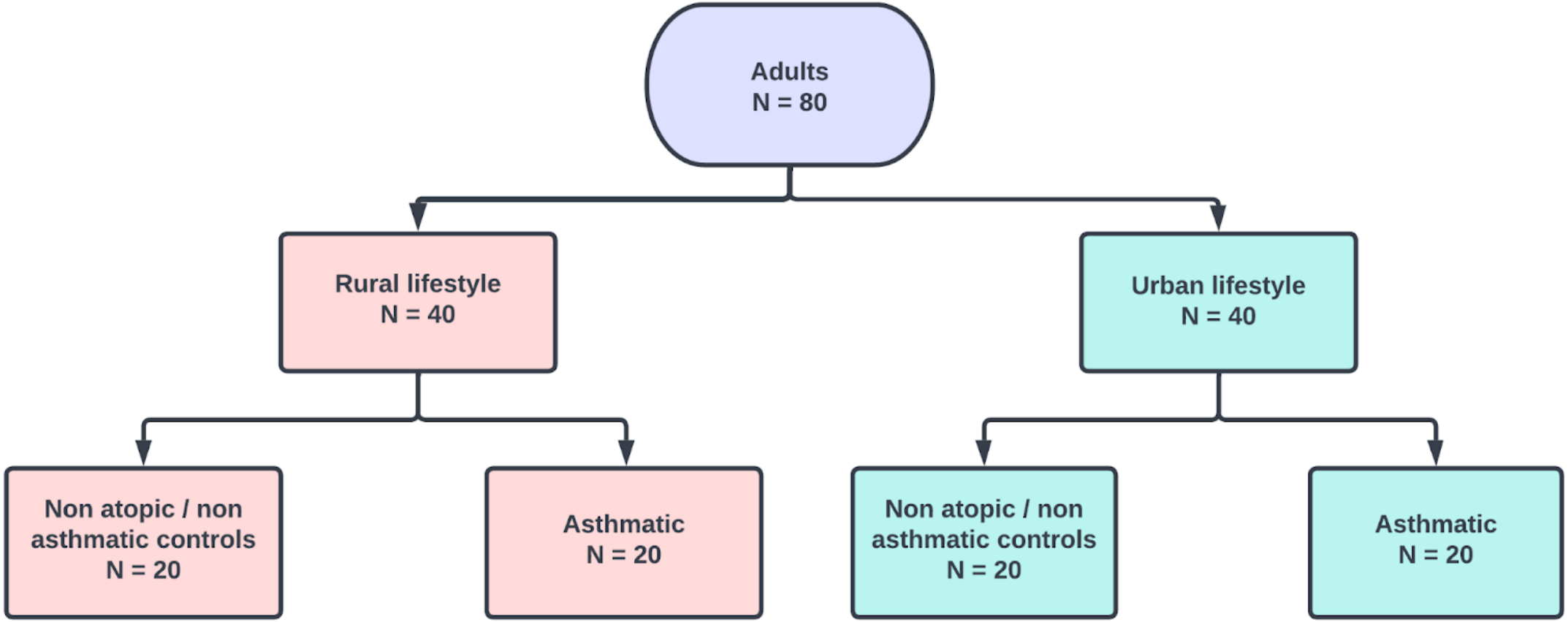
Years in focus – 2018, 2019, 2020 (and 2021)

Patient data collection – to be collected (August-September 2022)

Environmental variables - Ongoing

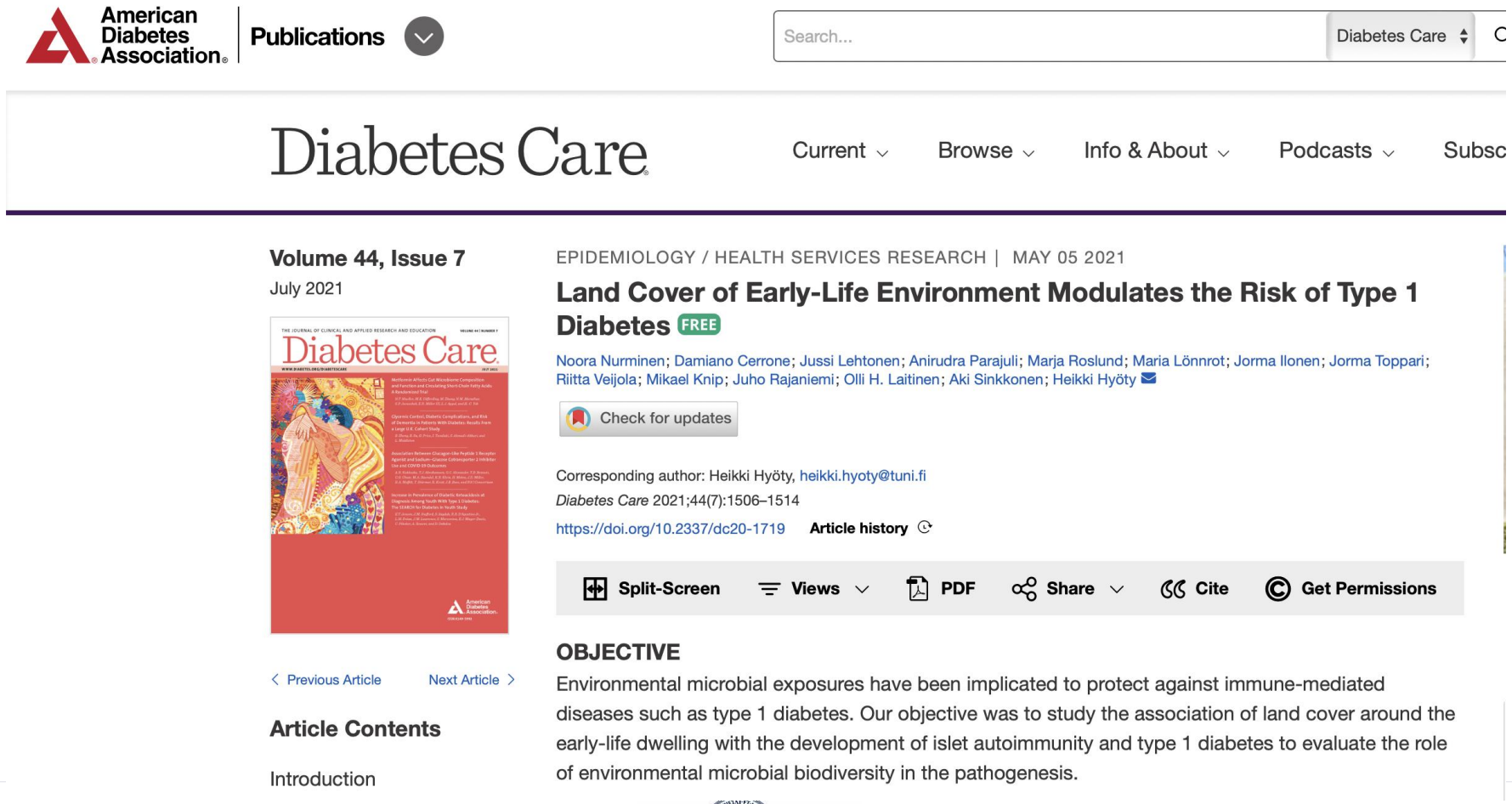
Methods and analysis – Ongoing

Data collection

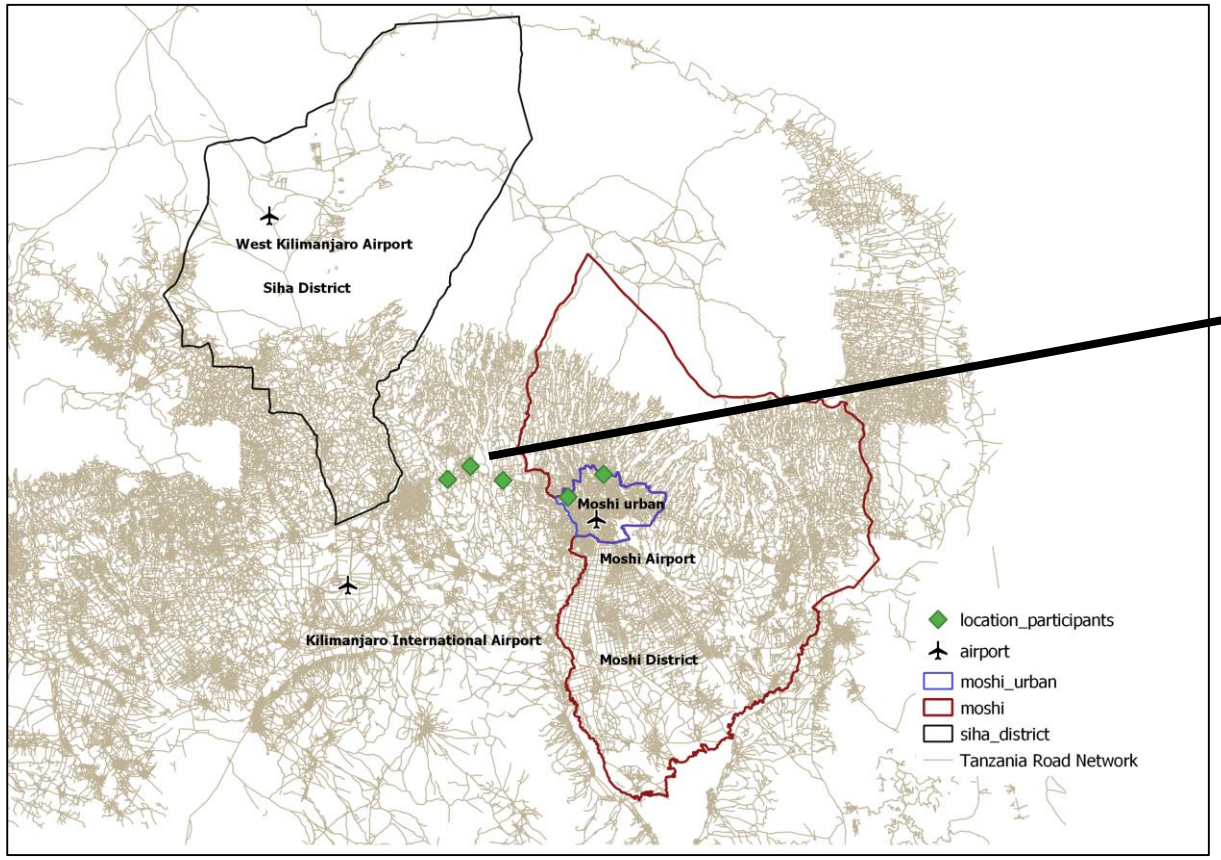


POSSIBILITIES

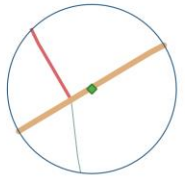
Finding relationships between environmental factors and the incidence of a given (non-communicable) disease.

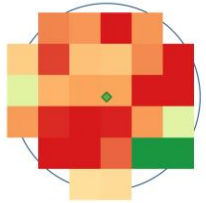


Analysis using spatial buffers

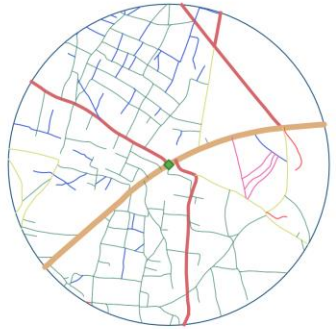


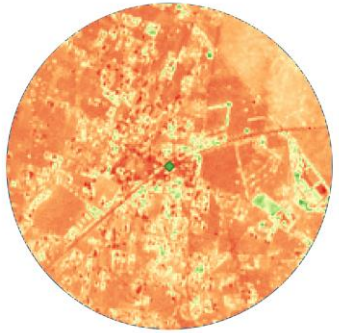
Buffer with 30 m radius





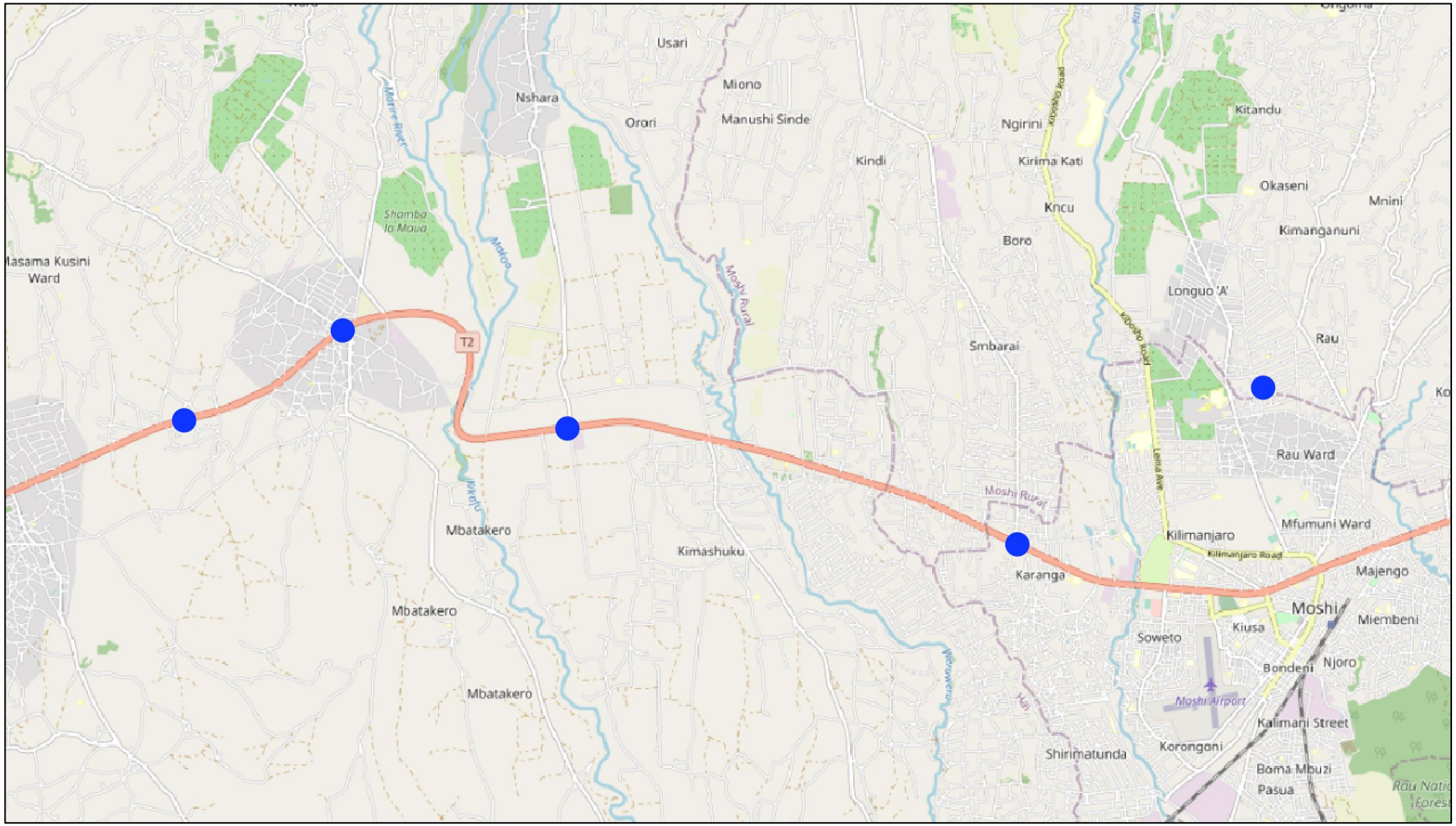
Buffer with 1000 m radius





Selected buffers – 30m, 50m, 100m, 150m, 200m, 250m, 500m, 1000m and 1500m

Demo land-use analysis with sample data



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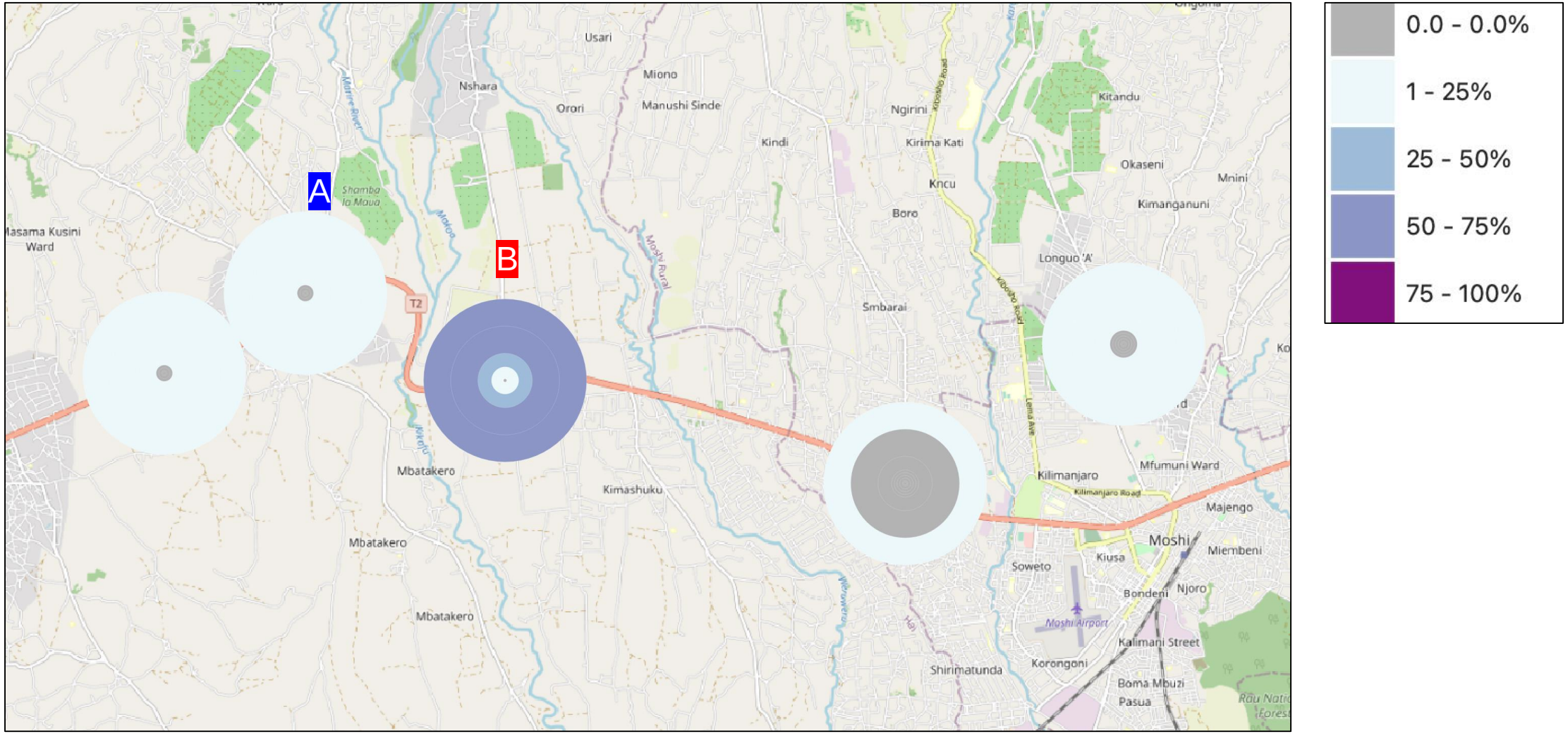
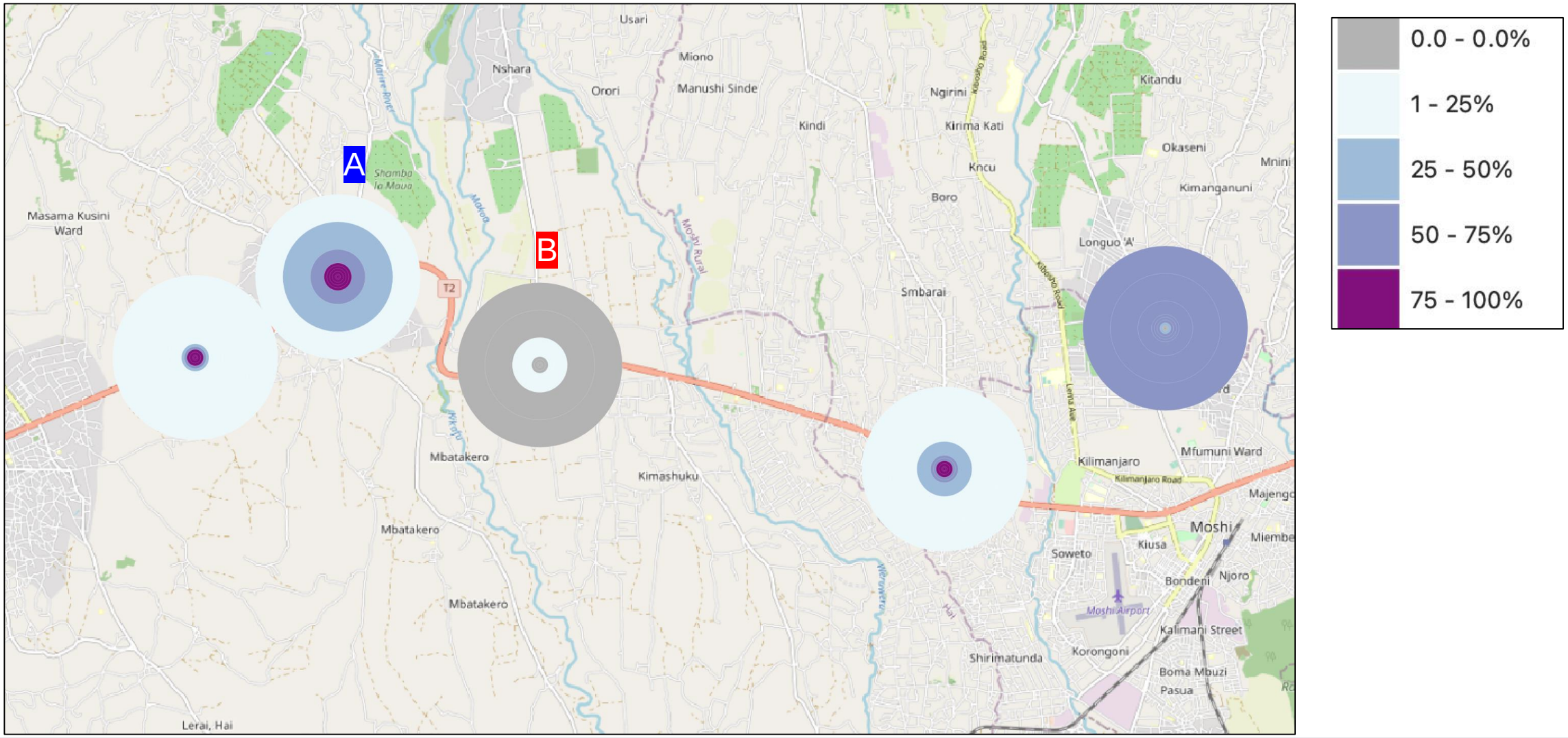
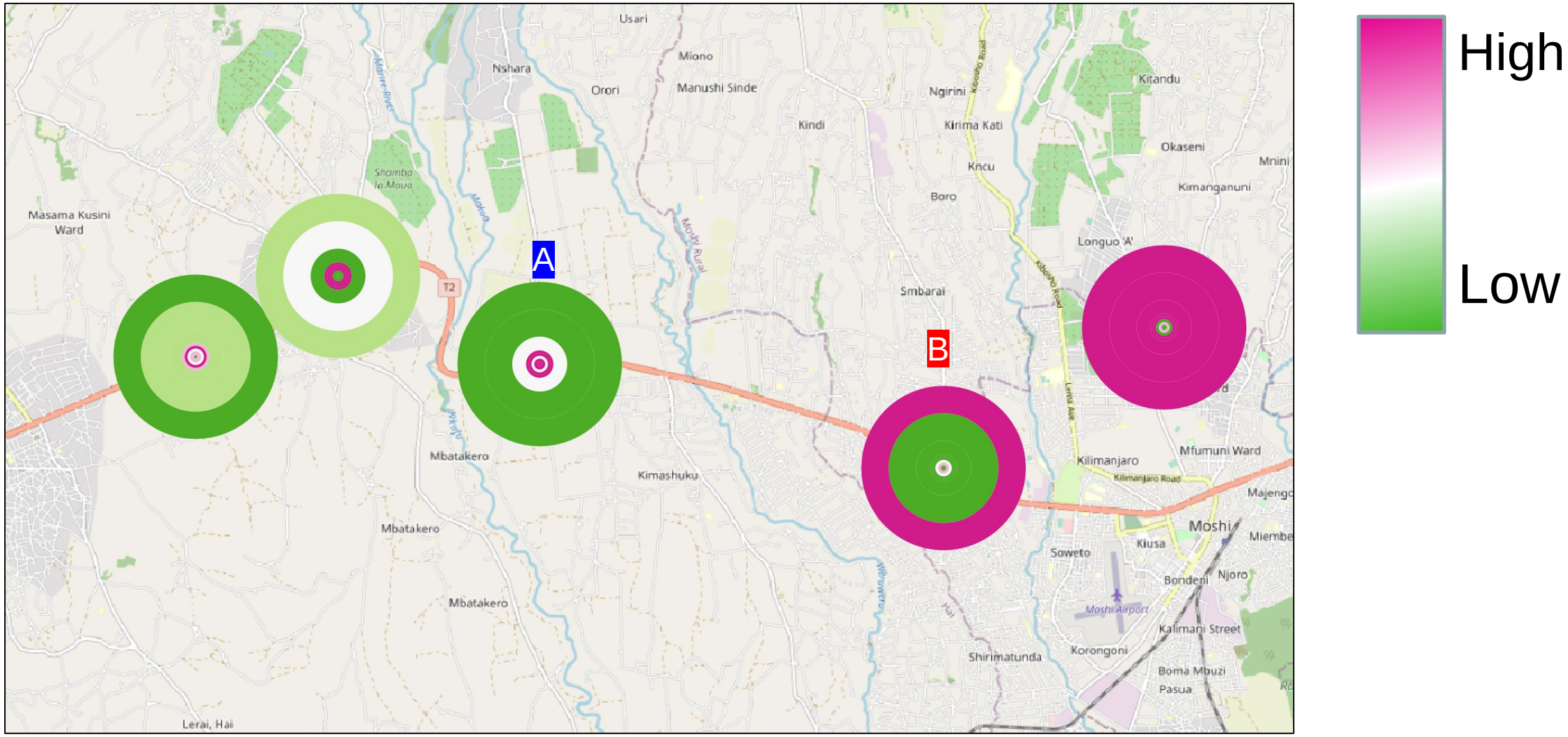
% of Agricultural land within a given radius



% of Urban land within a given radius



Diversity of land uses (Shannon-Weiner index)



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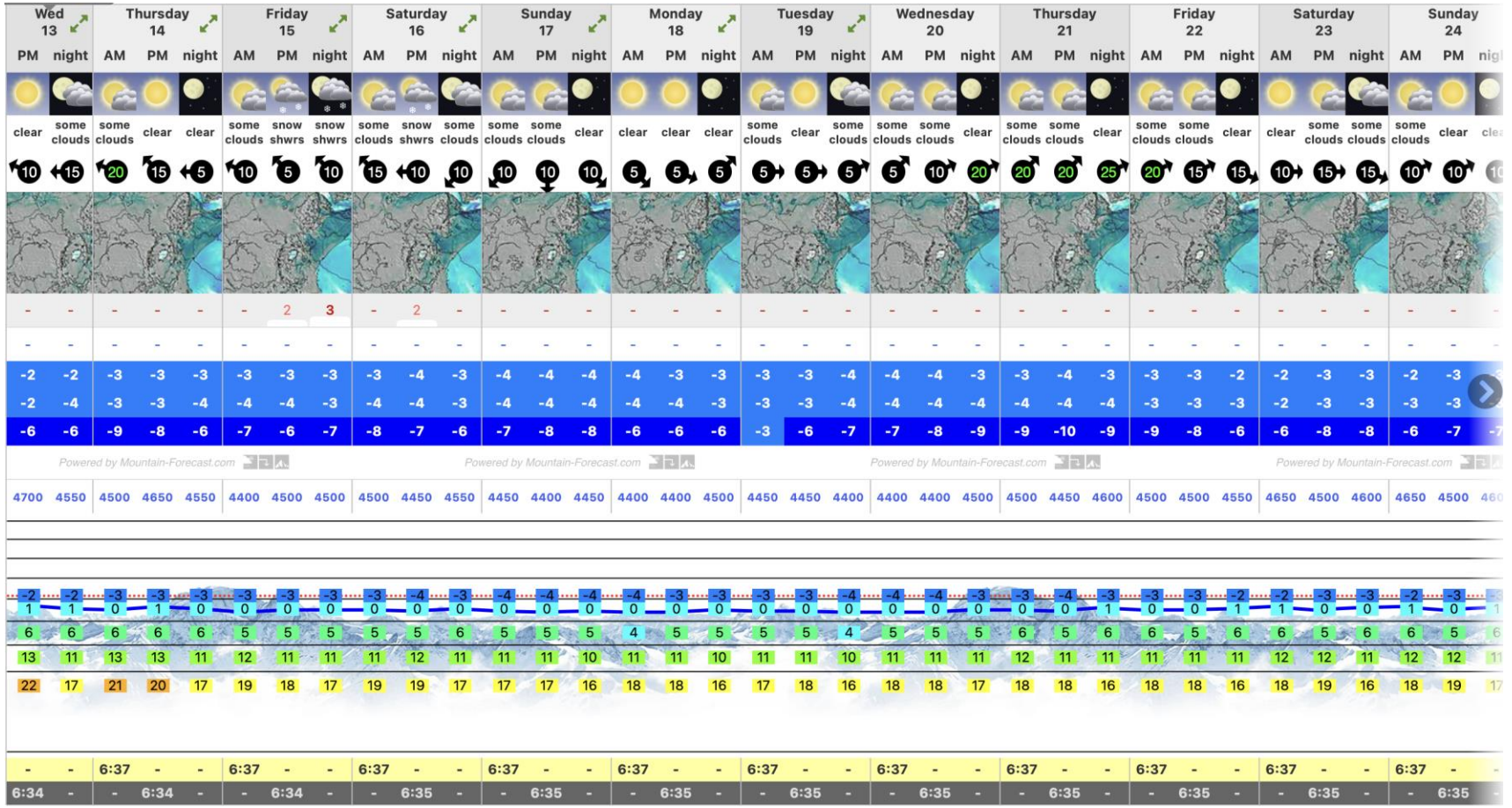
Association analysis through environmental interaction

- Macro-weather conditions
- Localized-weather conditions (pressure, rainfall, humidity)
- Wind direction (transporting materials, dust, pollen etc.)



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Our role: Understanding the mechanisms of developing the disease and finding spatial predictors

Discussion

- Detail the mechanisms
  - Define predicting variables
  - What are the working assumptions? Why and what environmental factors may increase the incidence?
- Data quality
  - Verifying the quality and consistency of the medical data captured during the study
  - Assuring correct data classification
  - Define temporal limits (when in life we expect the development of the disease)
- Spurious correlations
  - Using wrong variables
  - Wrongly translating the mechanism into spatial indicators (Eg. At what distance an environmental factor would affect the subject. At what distance a forest from a person's home, has an effect on the disease mechanism?)
  - Unknown variables
- How would an ideal dataset look like