A web-based decision support interface for the assessment of physical access to humanitarian site locations

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Overview

- What do we want to achieve?
- How are we achieving this?
- Progress so far - demo
- Future developments
- Discussion

What do we want to achieve?

- Determine the average travel time to services from anywhere within a selected area of interest – health sites for MSF
- MSF contexts are unique
  - Lots of walking for long distances, challenging terrain
- Consider practical factors that influence travel behaviours
  - Topography – steep terrain is more difficult to traverse than flat terrain
  - Land cover – Walking through forests / bush / wetlands / bare ground / etc
  - Roads and paths – people will prefer to walk on these instead of through bush / forests
- Integrate population data to return population-weighted insights
  - For example:
  - The average travel time per person to the nearest hospital in a selected district
  - Size of the population that travels more than 4 hours to reach a health site (lack of coverage)
  - Size of the population that travels less than 4 hours to reach a health site (coverage)

What do we want to achieve?

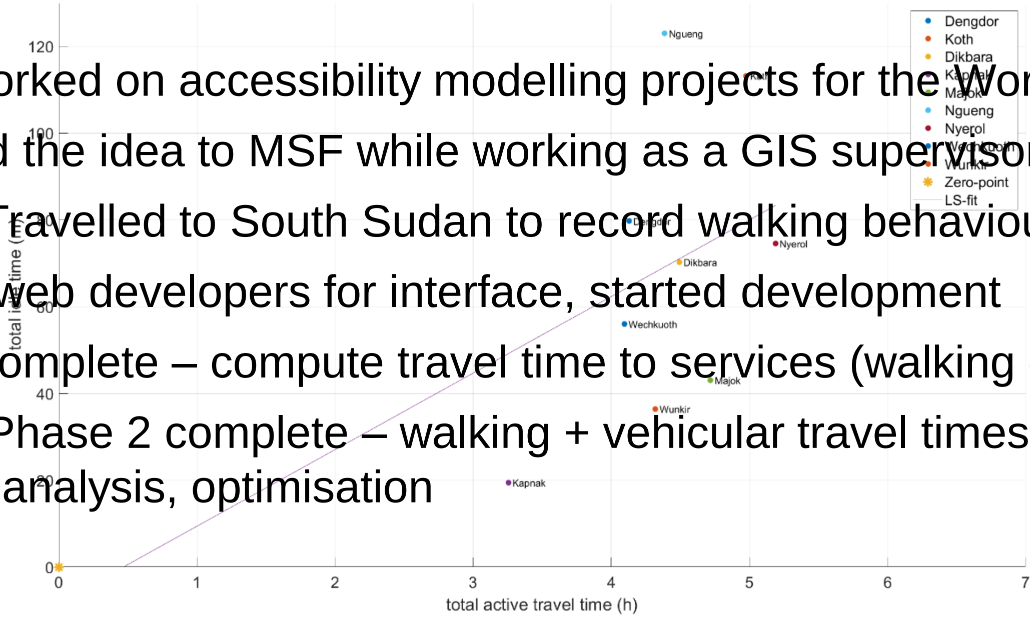
How are we achieving this?

- A web-based user-interface allows the user to select their area of interest
- They choose the profile of the population to investigate
  - Adults, children, healthy, injured, sick
  - Influences walking speeds, idle times, and fatigue
- The user specifies the start and end dates of the seasons they want to investigate – or a generic landcover dataset can be used
- They click RUN
- Topography, land cover, roads, population, and other data downloaded
- Access times calculated and visualised
- Download results

How are we achieving this?

Project timeline

- **2018 – 2021**: Worked on accessibility modelling projects for the World Bank
- **2022**: Introduced the idea to MSF while working as a GIS supervisor
- **January 2023**: Travelled to South Sudan to record walking behaviour
- **2024**: Identified web developers for interface, started development
- **2025**: Phase 1 complete – compute travel time to services (walking only)
- **By early 2026**: Phase 2 complete – walking + vehicular travel times, population metrics, change analysis, optimisation



How are we achieving this?

MEDECINS SANS FRONTIERES

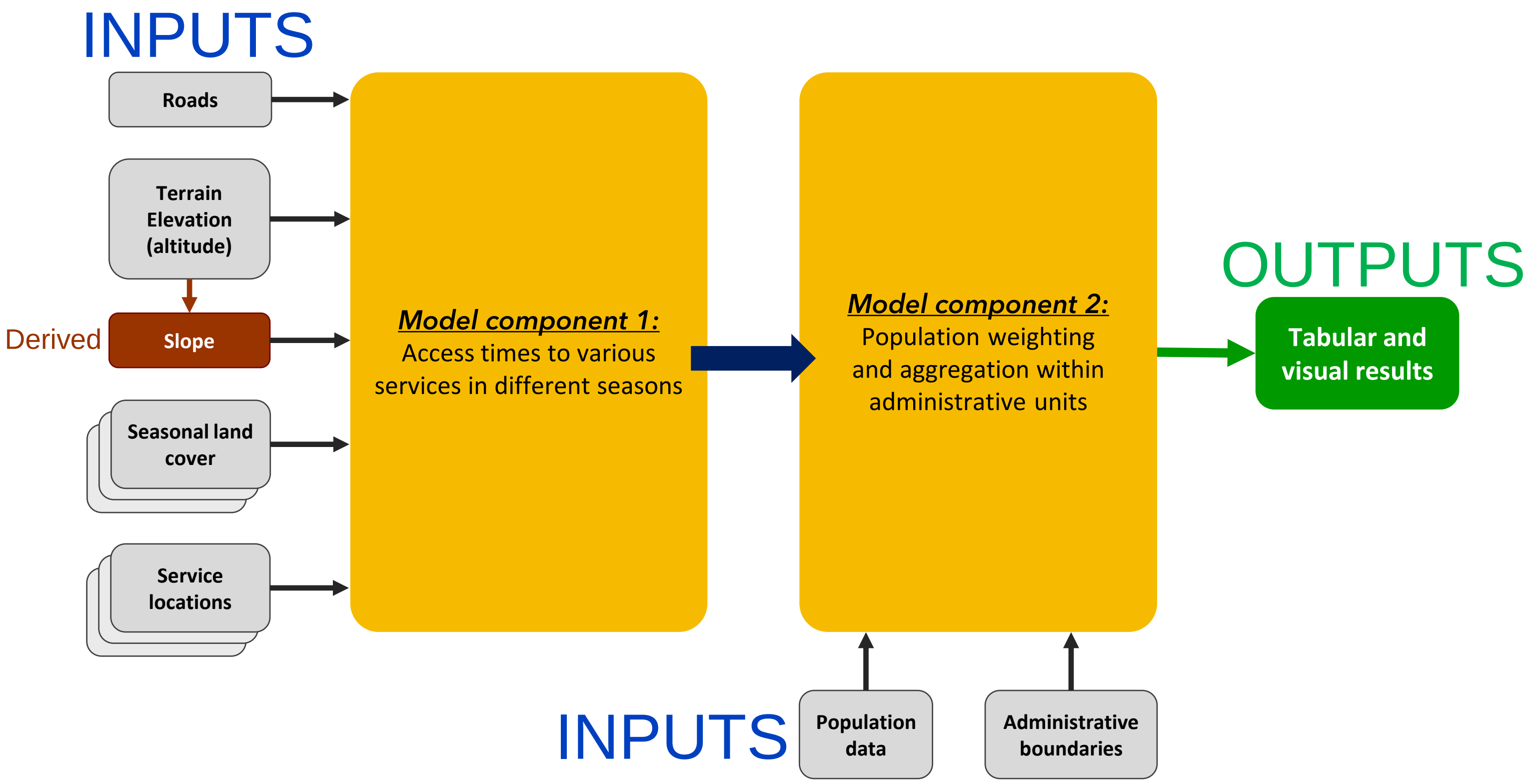
- **The original World Bank model has been rigorously developed, tested, applied, and published**
  - World Bank applications: Nepal, Pakistan, India, Indonesia, Papua New Guinea, Solomon Islands, East-Timor, Mali, Niger
  - World Bank publications: WB Policy Research Working Paper and WB Poverty and Equity Note
  - World Bank blogs: Khyber Pakhtunkhwa baselines and Sindh flood assessment
  - Academic journals (peer-reviewed): Journal of Transport Geography and Transportation
  - Github repository for calculating and aggregating population-weighted access times, with example input and output data: https://github.com/worldbank/Accessibility_Index

Model overview

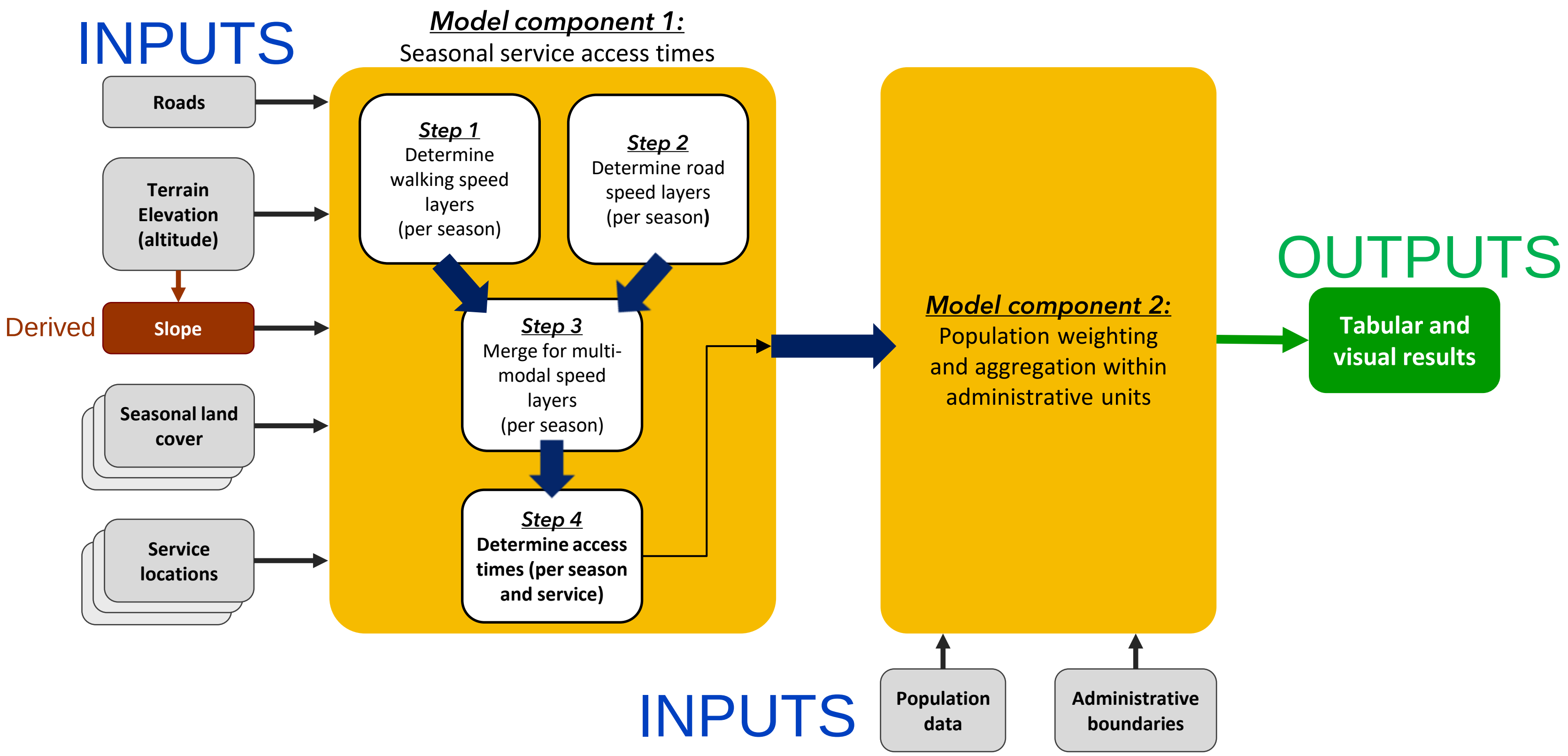
INPUTS

Roads	Locations of roads and paths – and vehicular road travel speeds for multi-modal travel
Terrain Elevation (altitude)	High altitude influences walking speeds
Derived **Slope**	Slope affects vehicular and walking speeds
Seasonal land cover	Land cover affects walking speeds where roads/paths are absent
Service locations	With respect to what are we evaluating accessibility?

Model overview



Model framework



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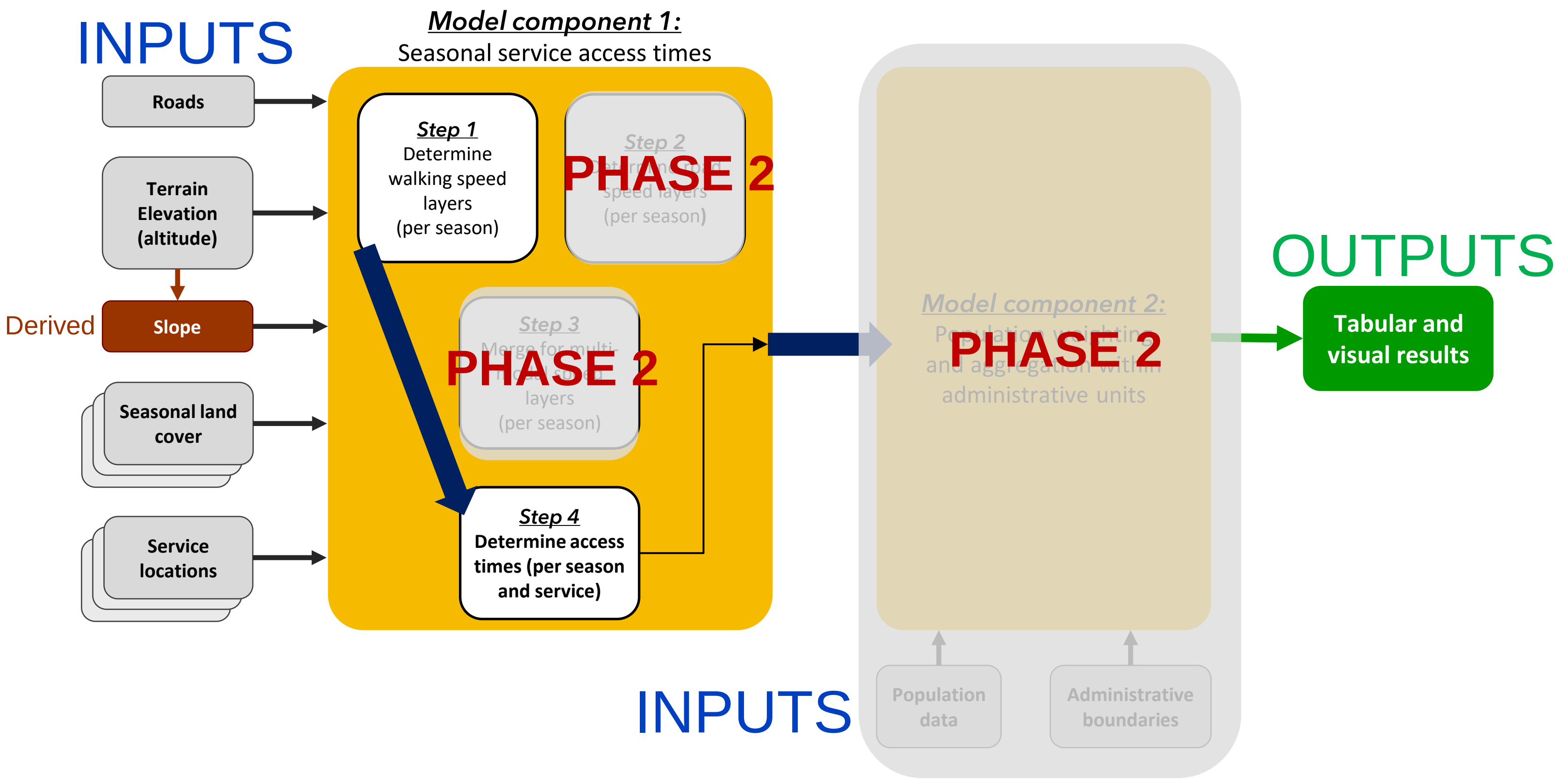

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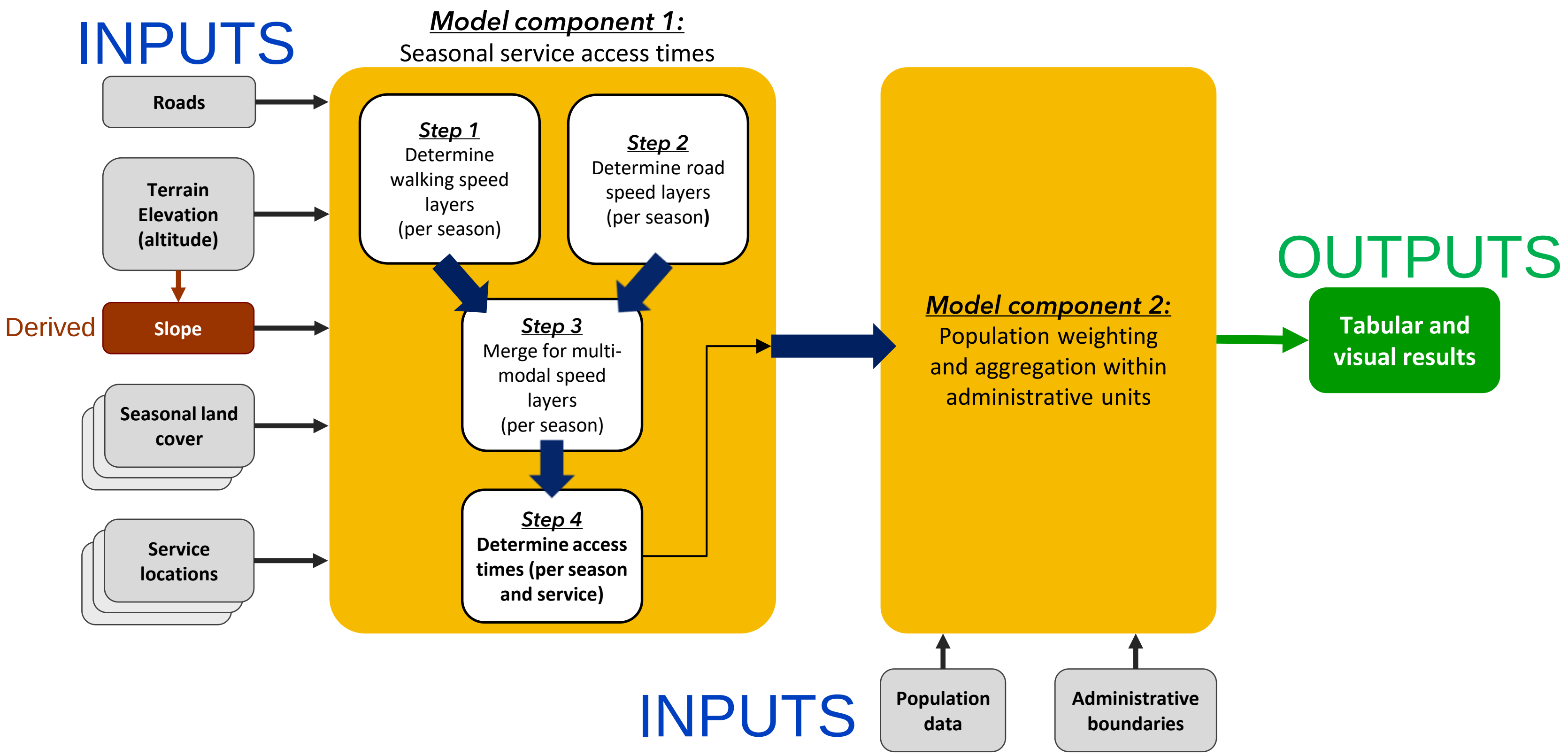

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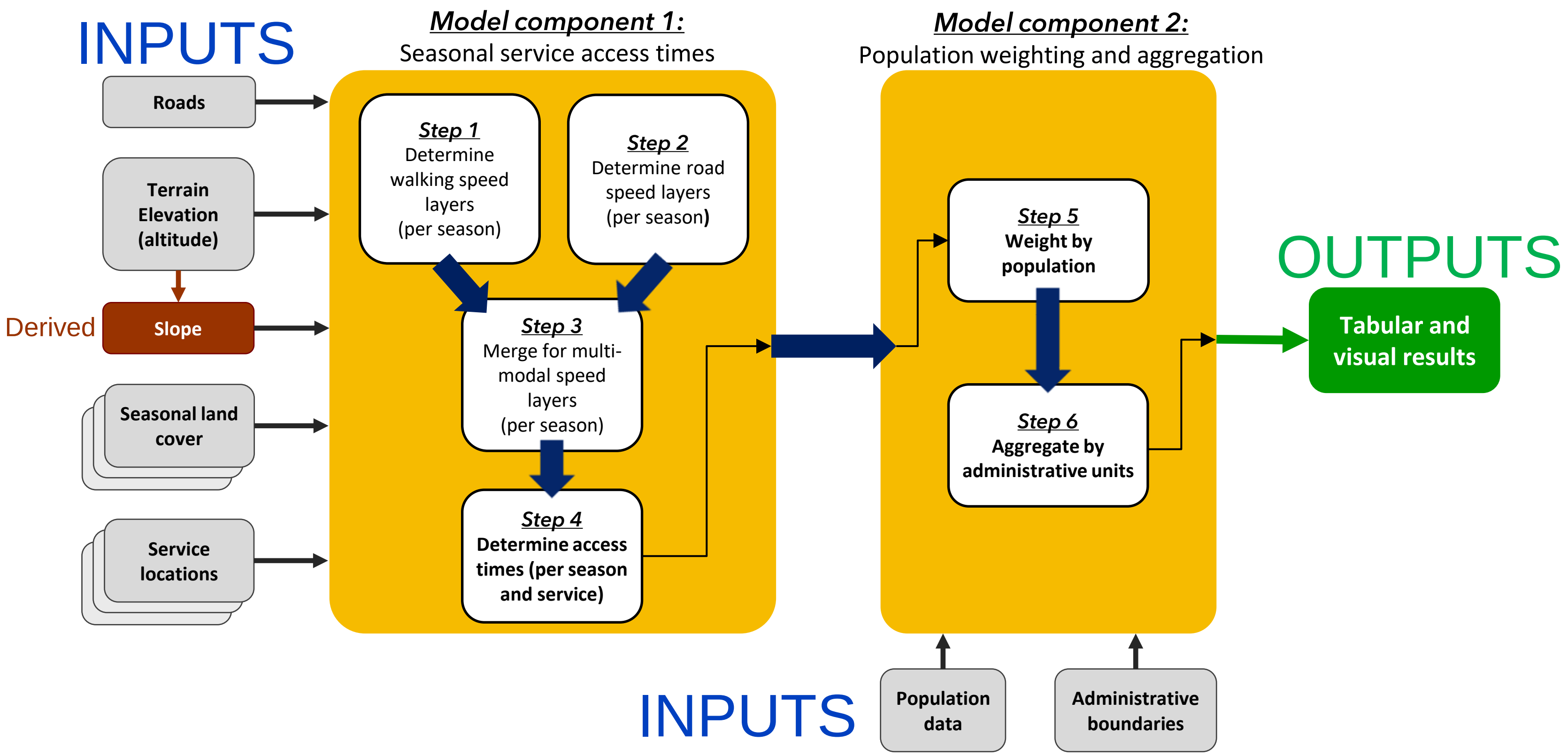
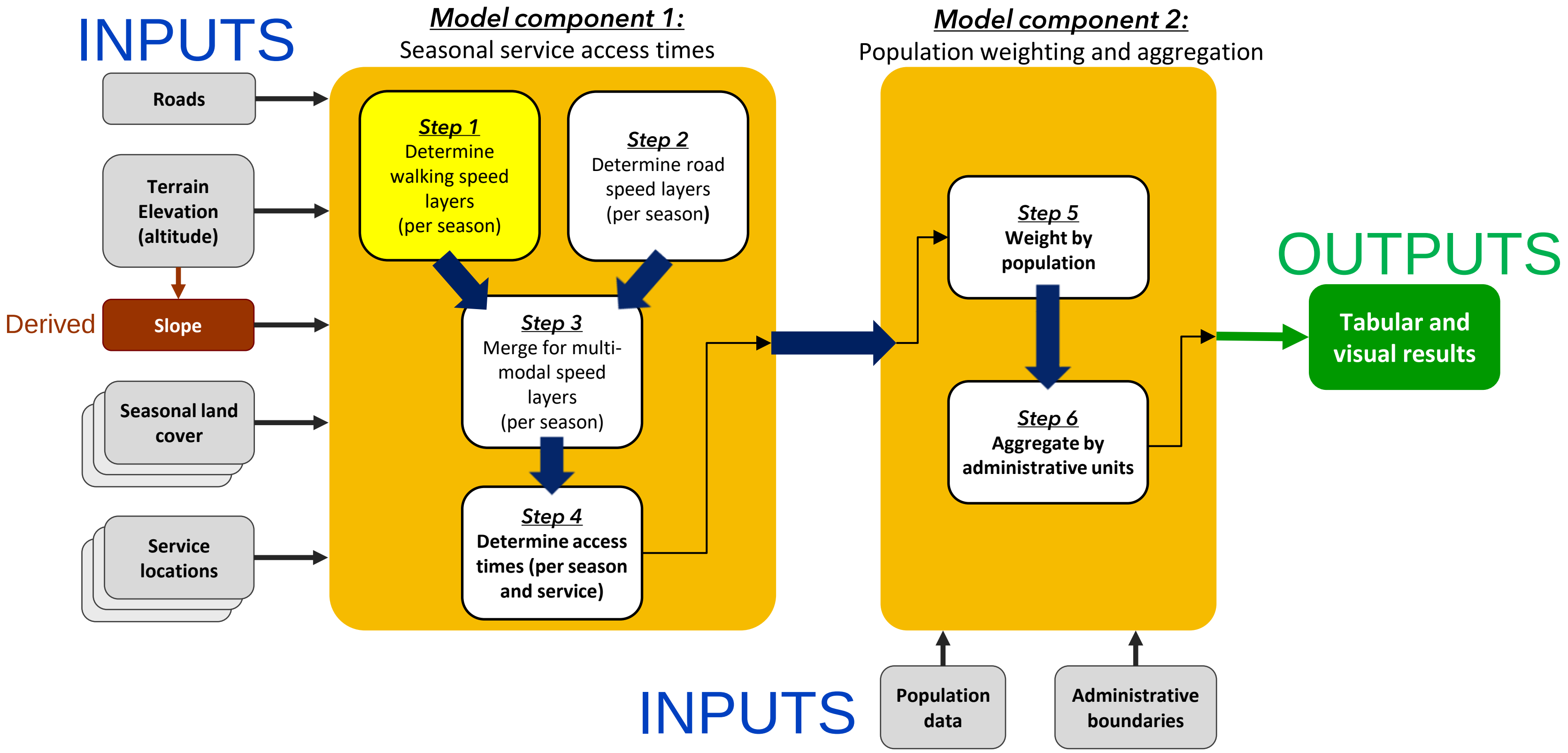
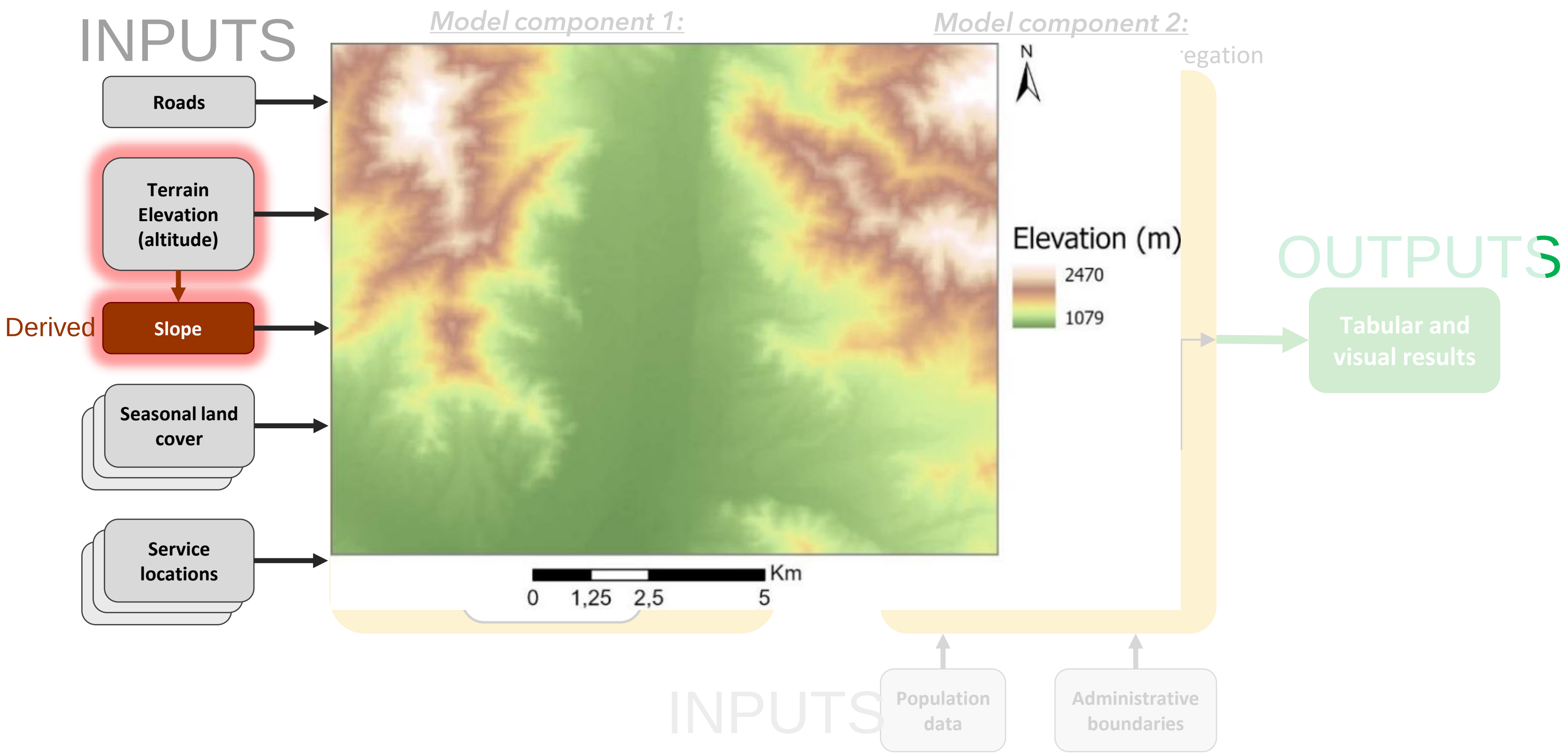


Model framework : determine walking speeds



Model framework : determine walking speeds



Model framework : determine walking speeds

INPUTS

Roads

Terrain Elevation (altitude)

Derived

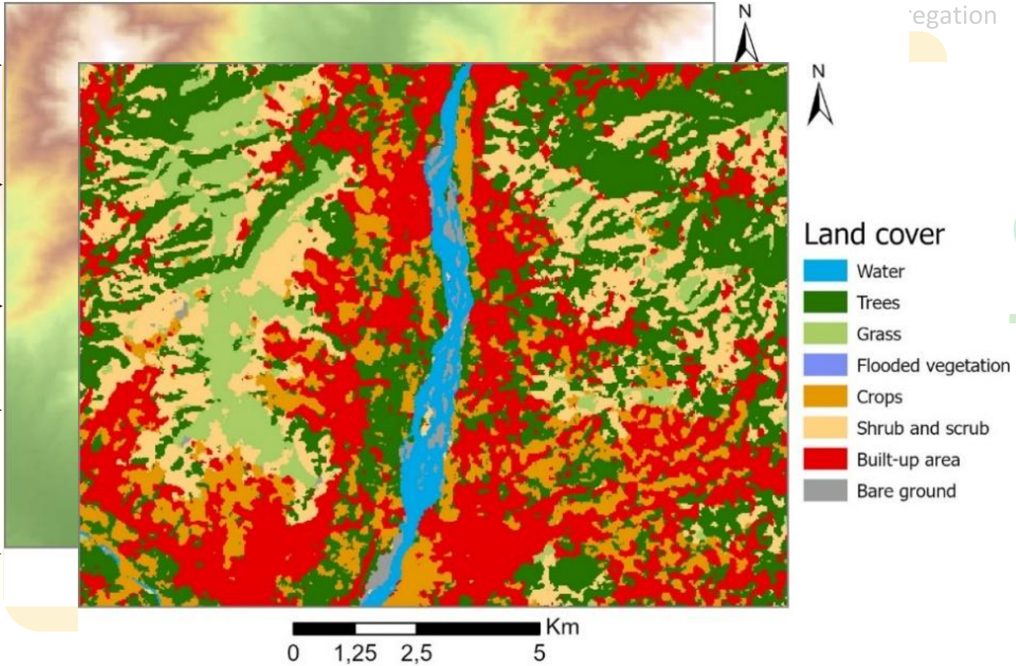
Slope

Seasonal land cover

Service locations

Model component 1:

Model component 2:



OUTPUTS

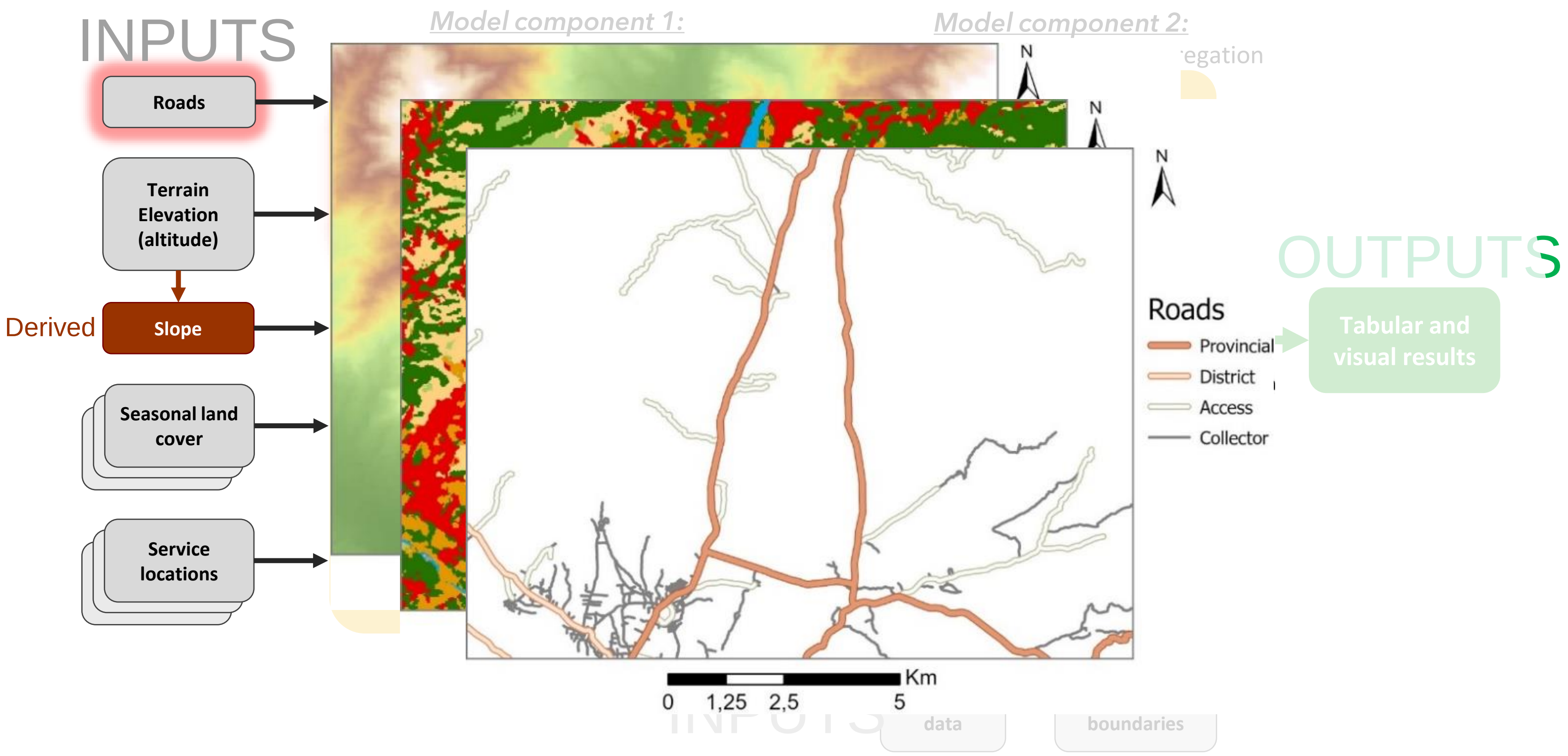
Tabular and visual results

INPUTS

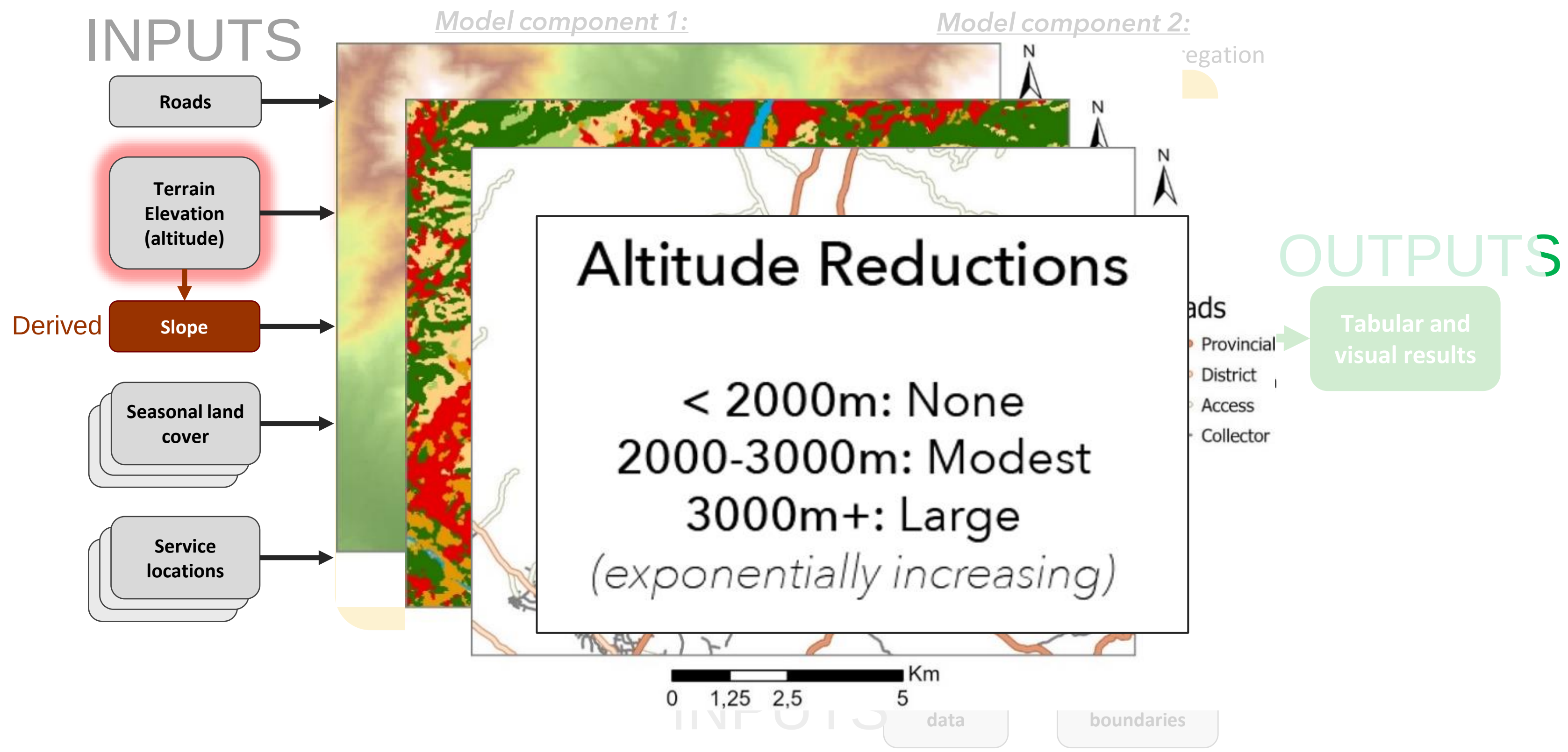
Population data

Administrative boundaries

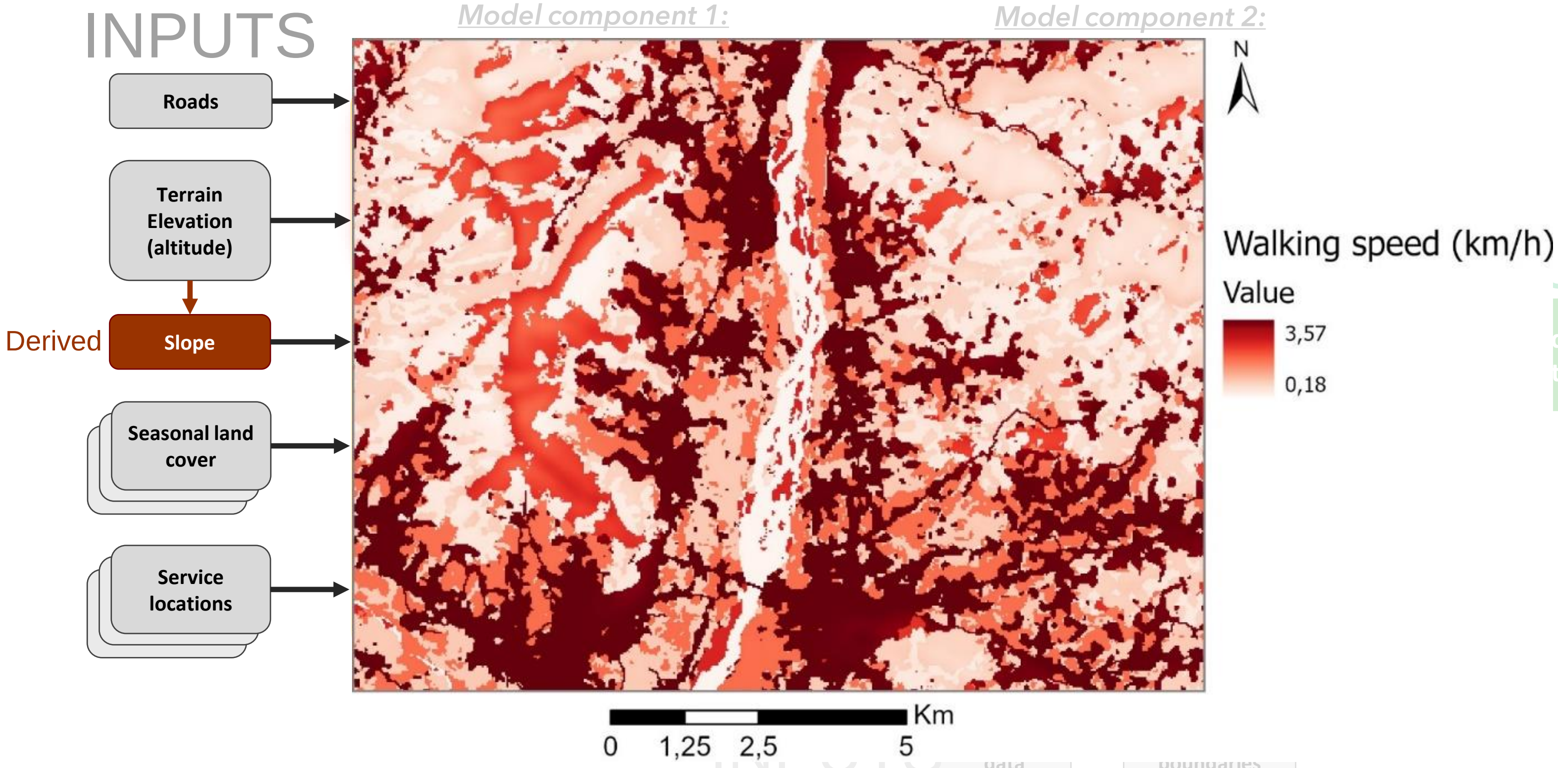
Model framework : determine walking speeds



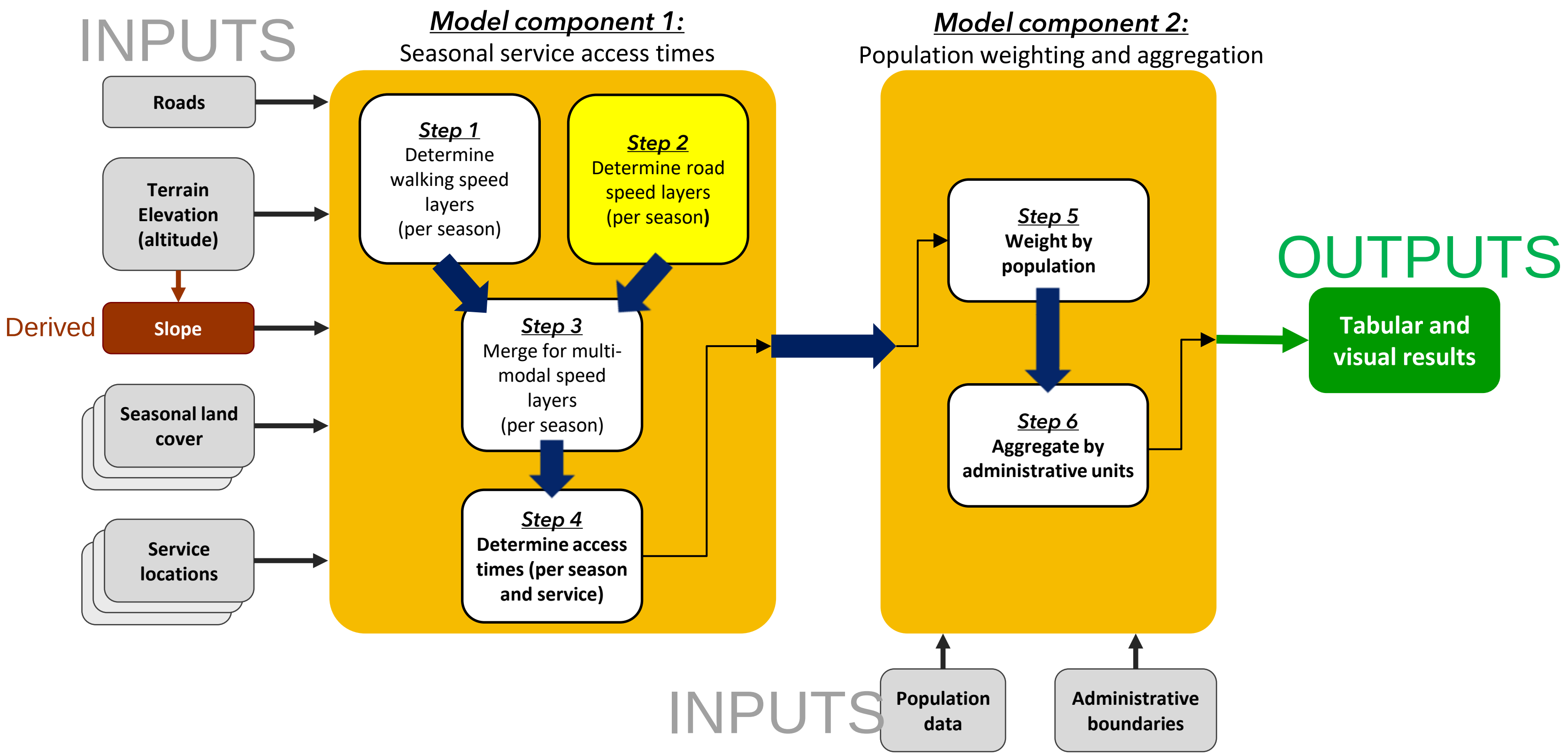
Model framework : determine walking speeds



Model framework : determine walking speeds



Model framework : determine on-road speeds



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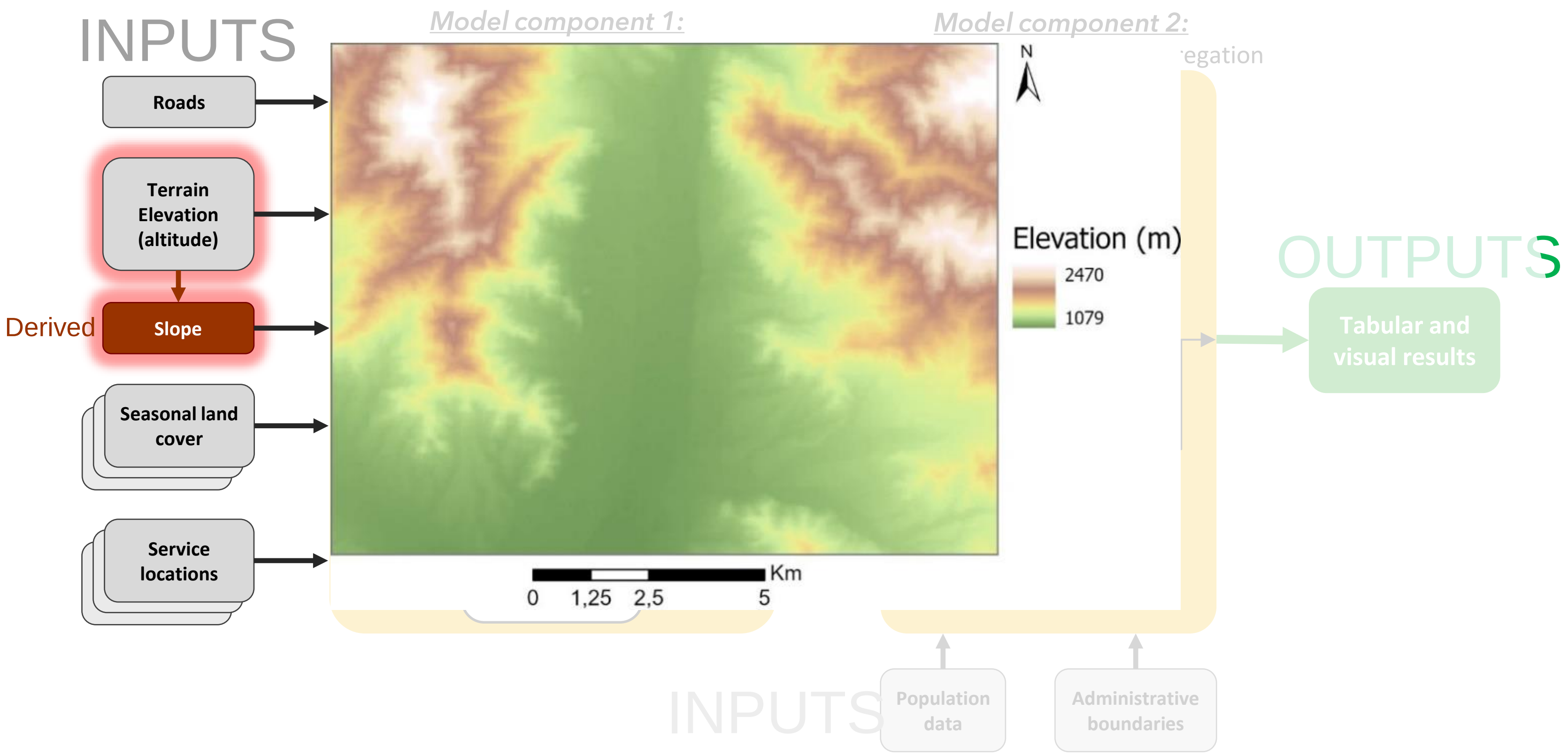

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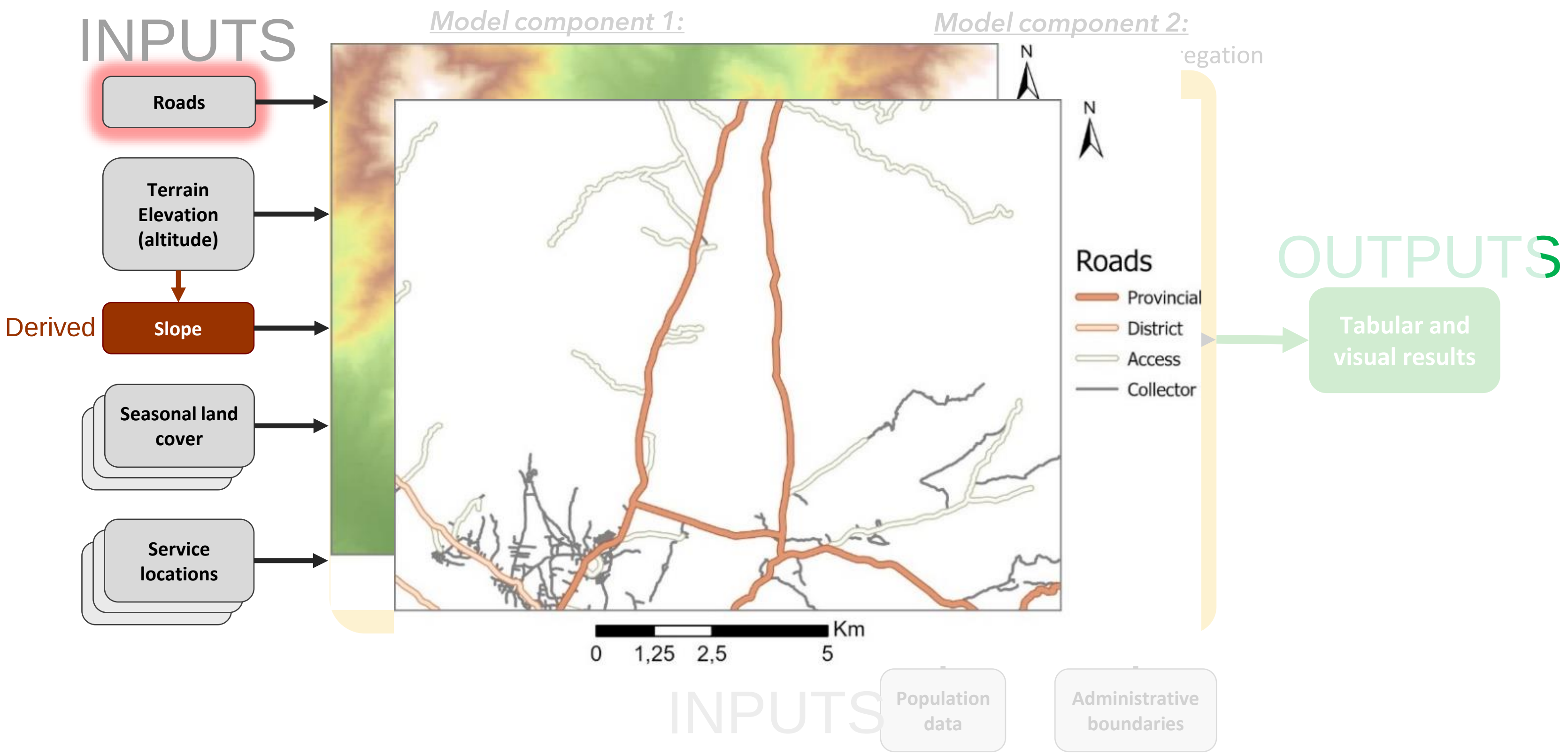


Model framework : determine on-road speeds

INPUTS

Roads

Terrain Elevation (altitude)

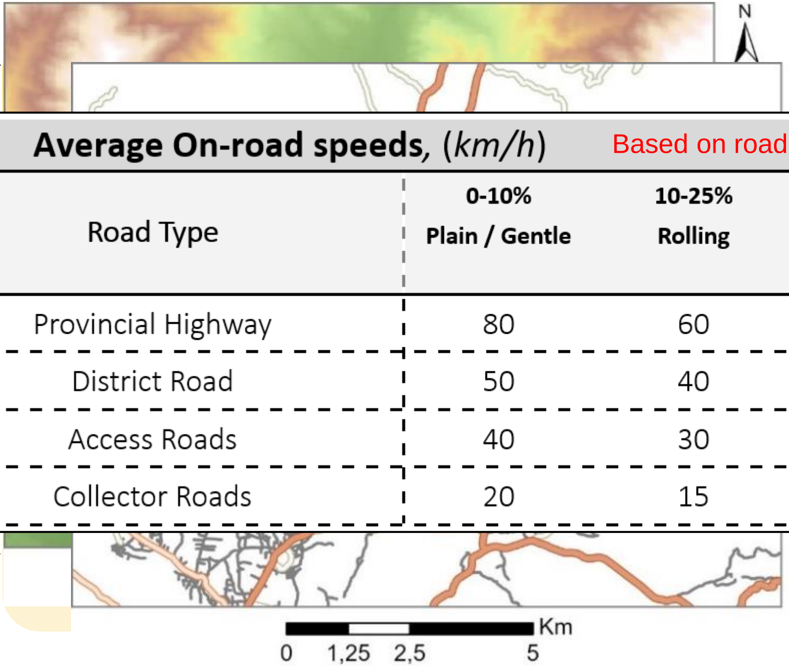
Derived Slope

Seasonal lan cover

Service locations

Model component 1:

Model component 2:



Average On-road speeds, *(km/h)* Based on road and terrain type				
Road Type	**0-10% Plain / Gentle**	**10-25% Rolling**	**25-60% Mountainous / Hilly**	**> 60% Steep**
Provincial Highway	80	60	40	25
District Road	50	40	30	20
Access Roads	40	30	20	15
Collector Roads	20	15	10	7.5

INPUTS

Population data

Administrative boundaries

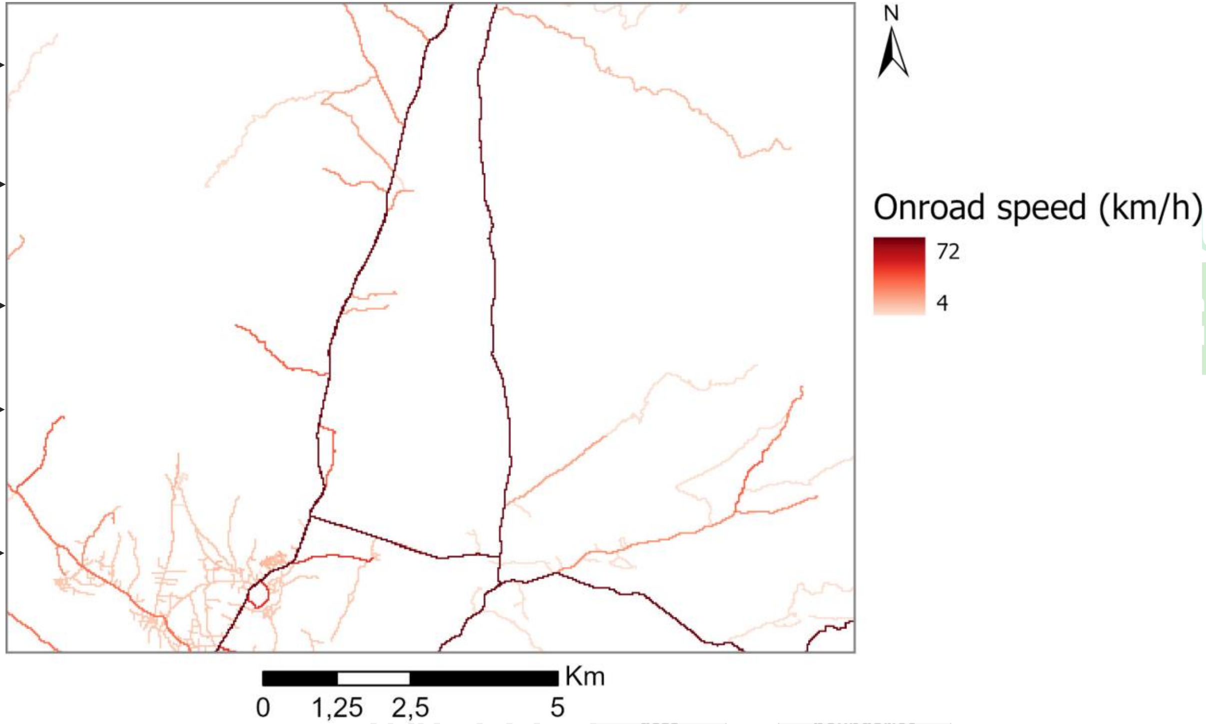
Model framework : determine on-road speeds

INPUTS

Model component 1:

Model component 2:

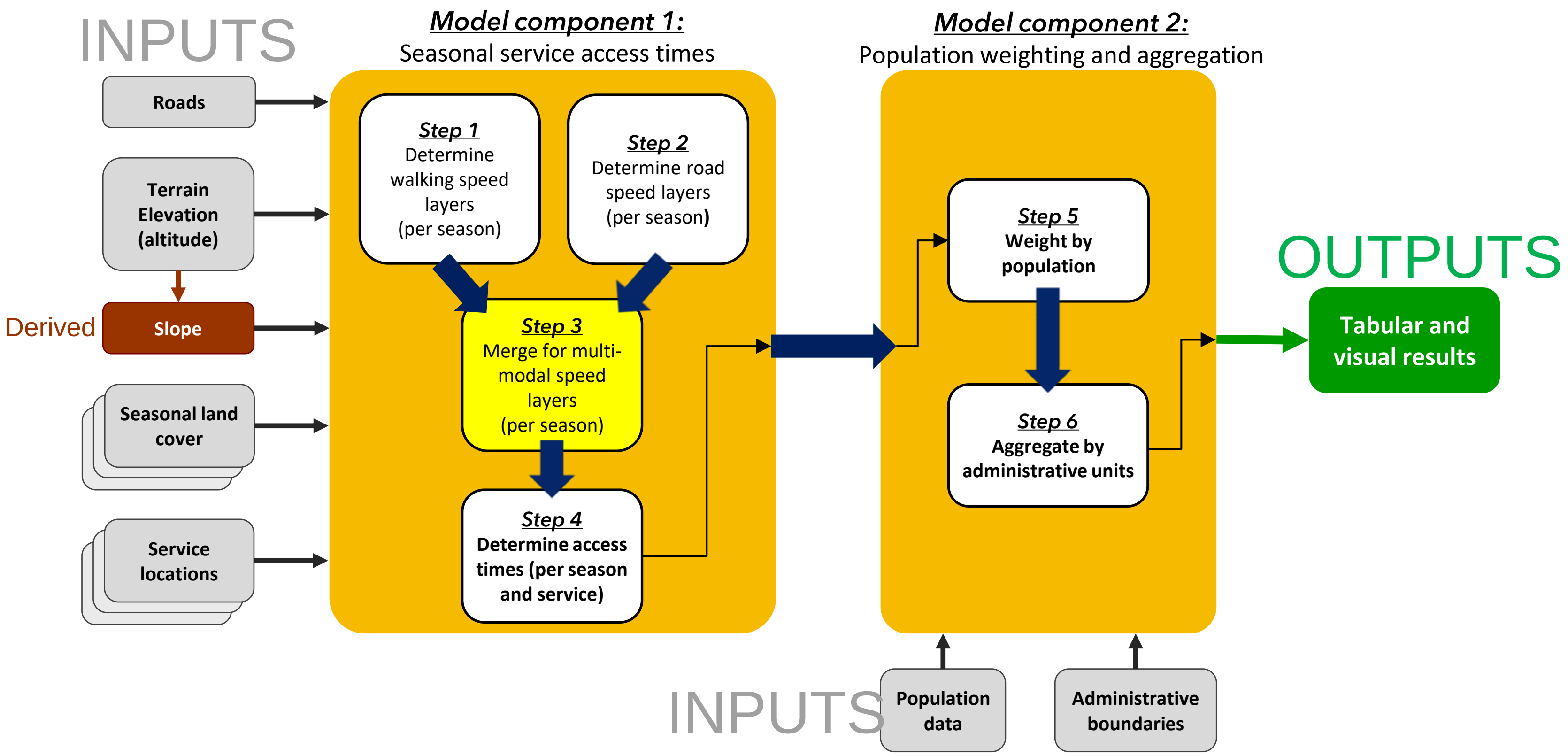
- Roads
- Terrain Elevation (altitude)
- Derived: Slope
- Seasonal land cover
- Service locations



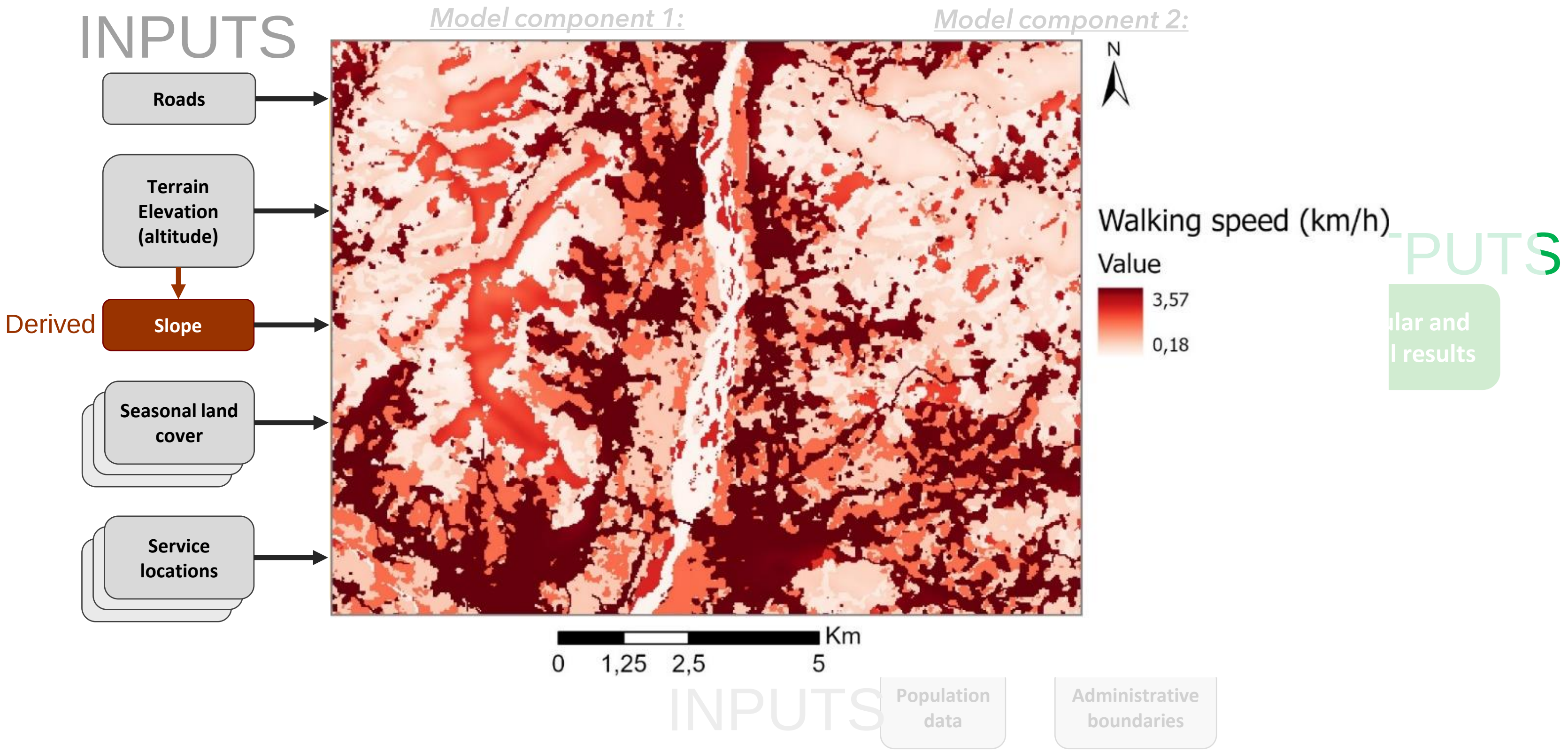
data

boundaries

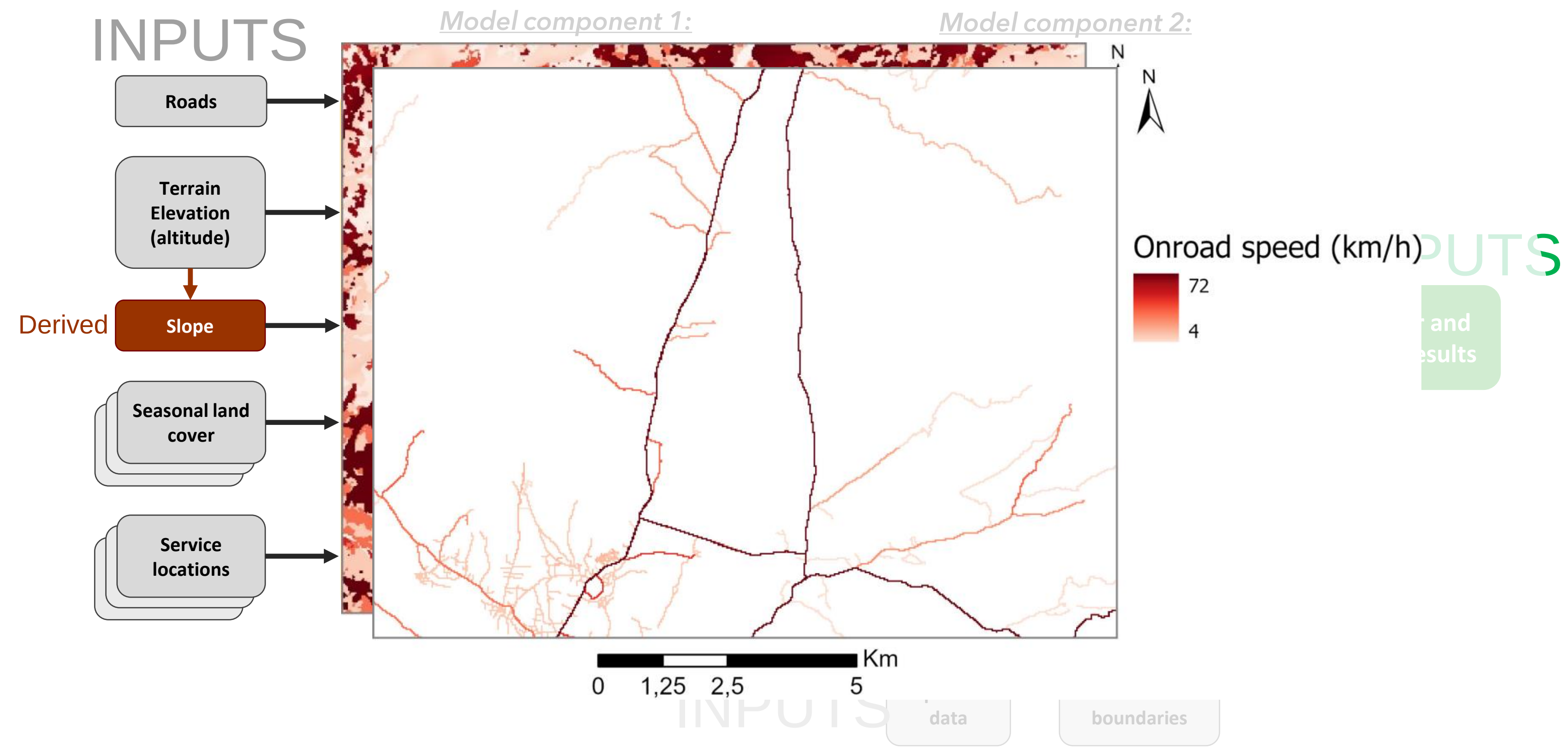
Model framework : multi-modal speeds



Model framework : multi-modal speeds



Model framework : multi-modal speeds



Model framework : multi-modal speeds

INPUTS

Model component 1:

Model component 2:

Roads

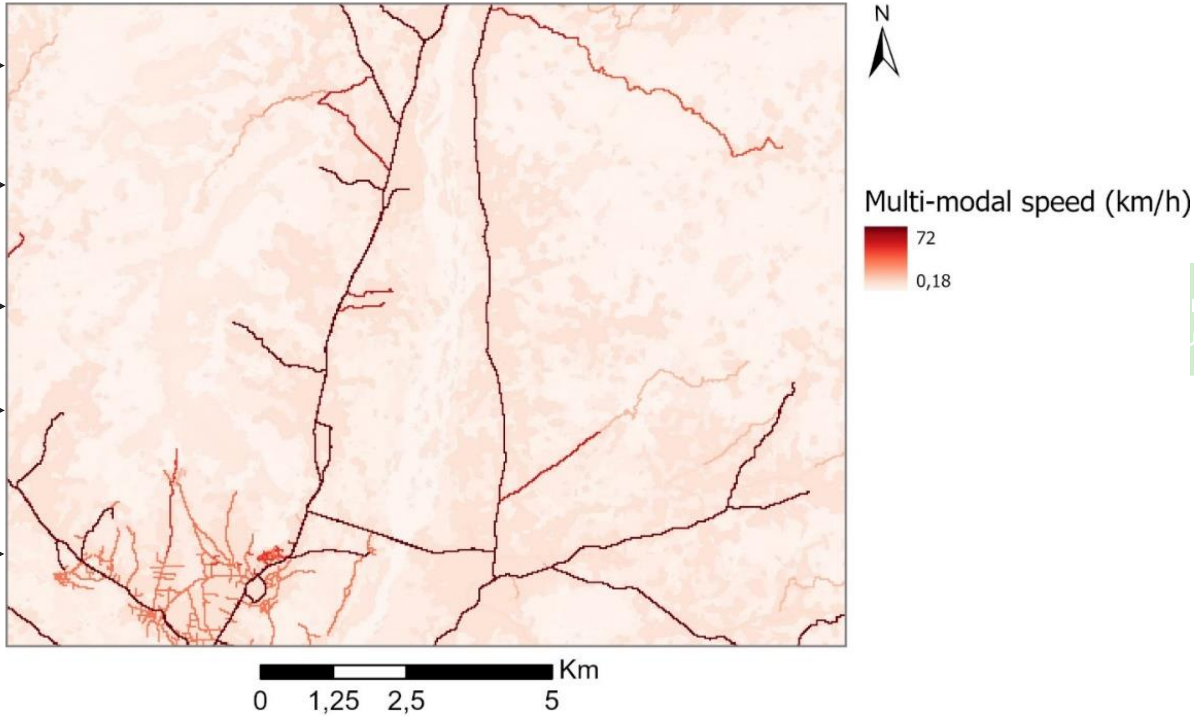
Terrain Elevation (altitude)

Derived

Slope

Seasonal land cover

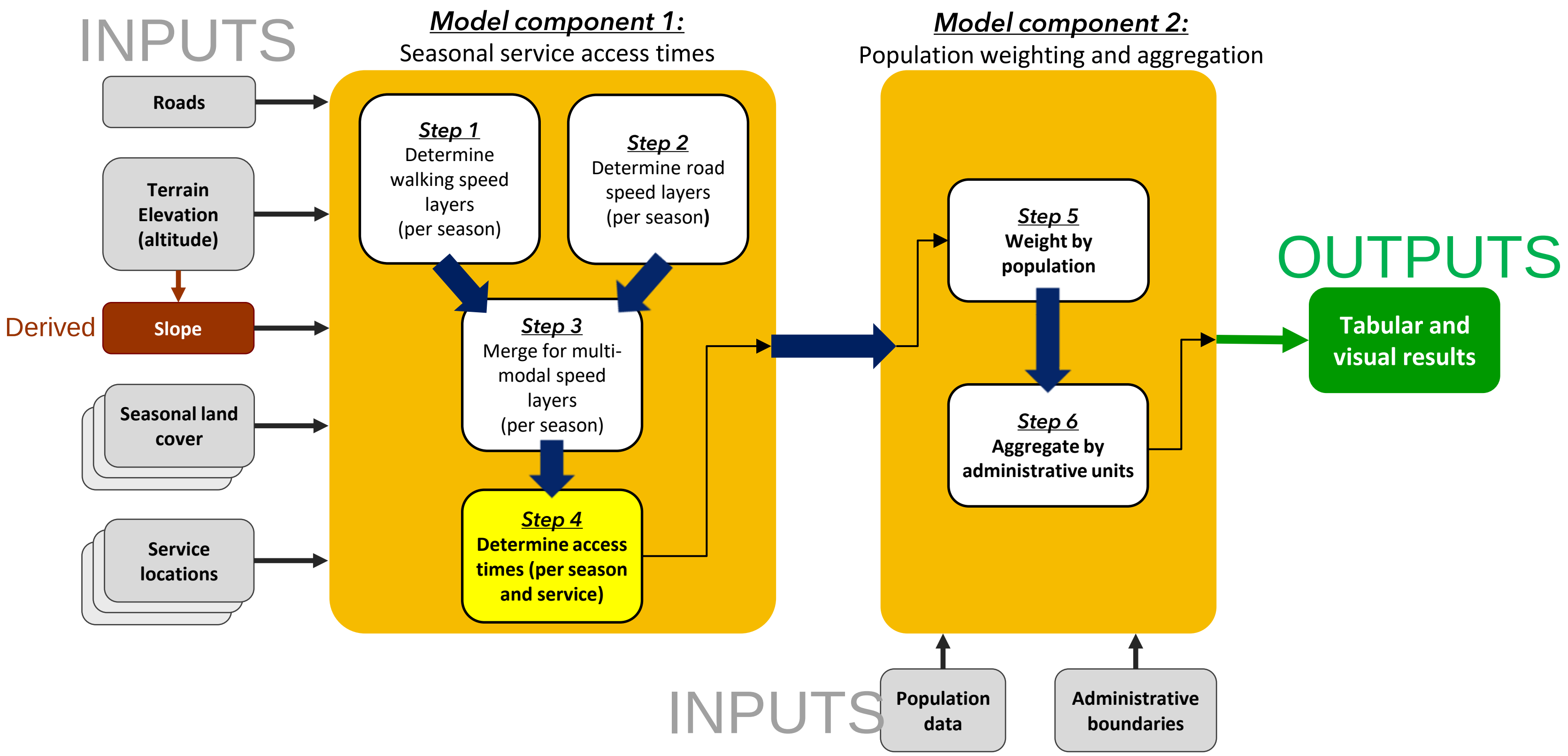
Service locations



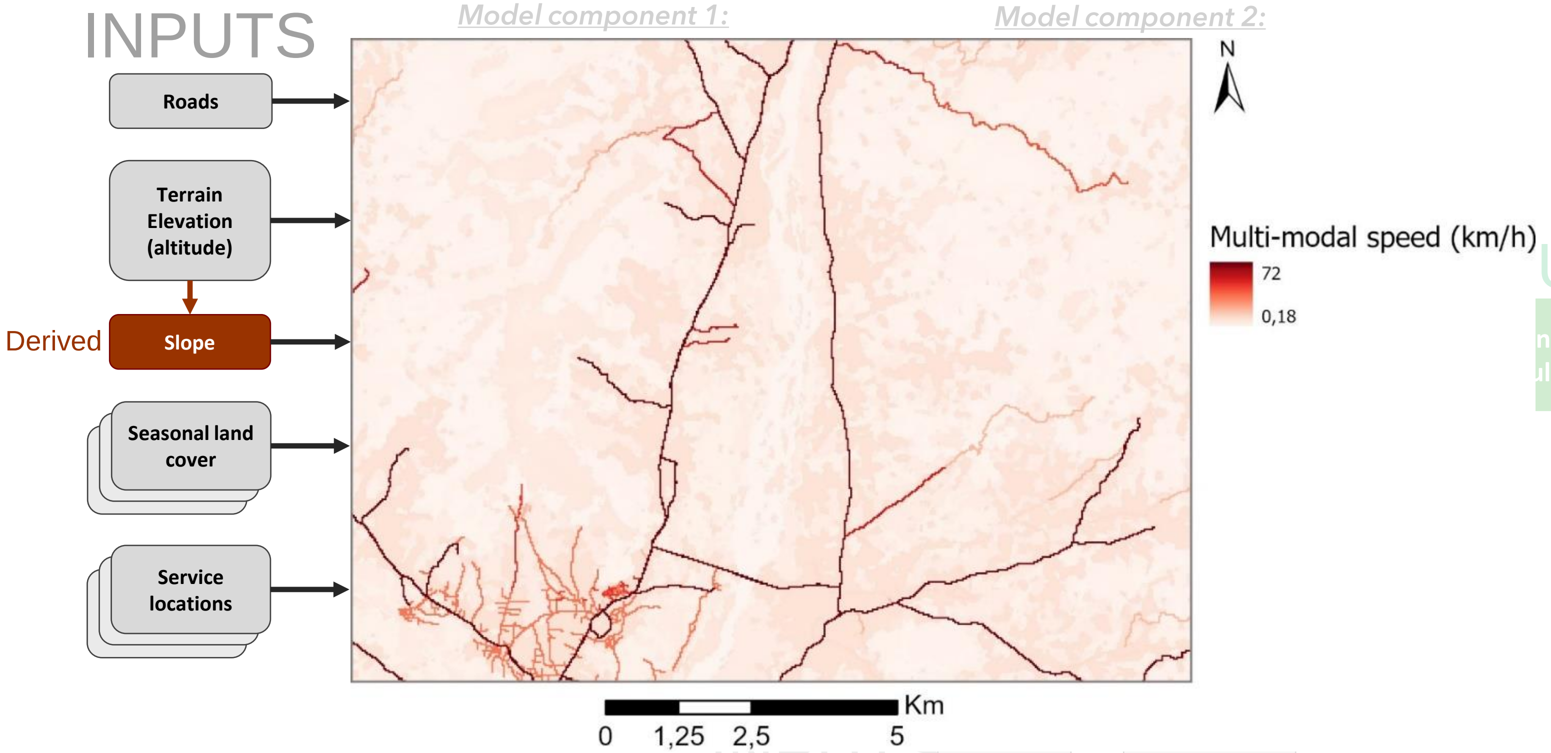
data

boundaries

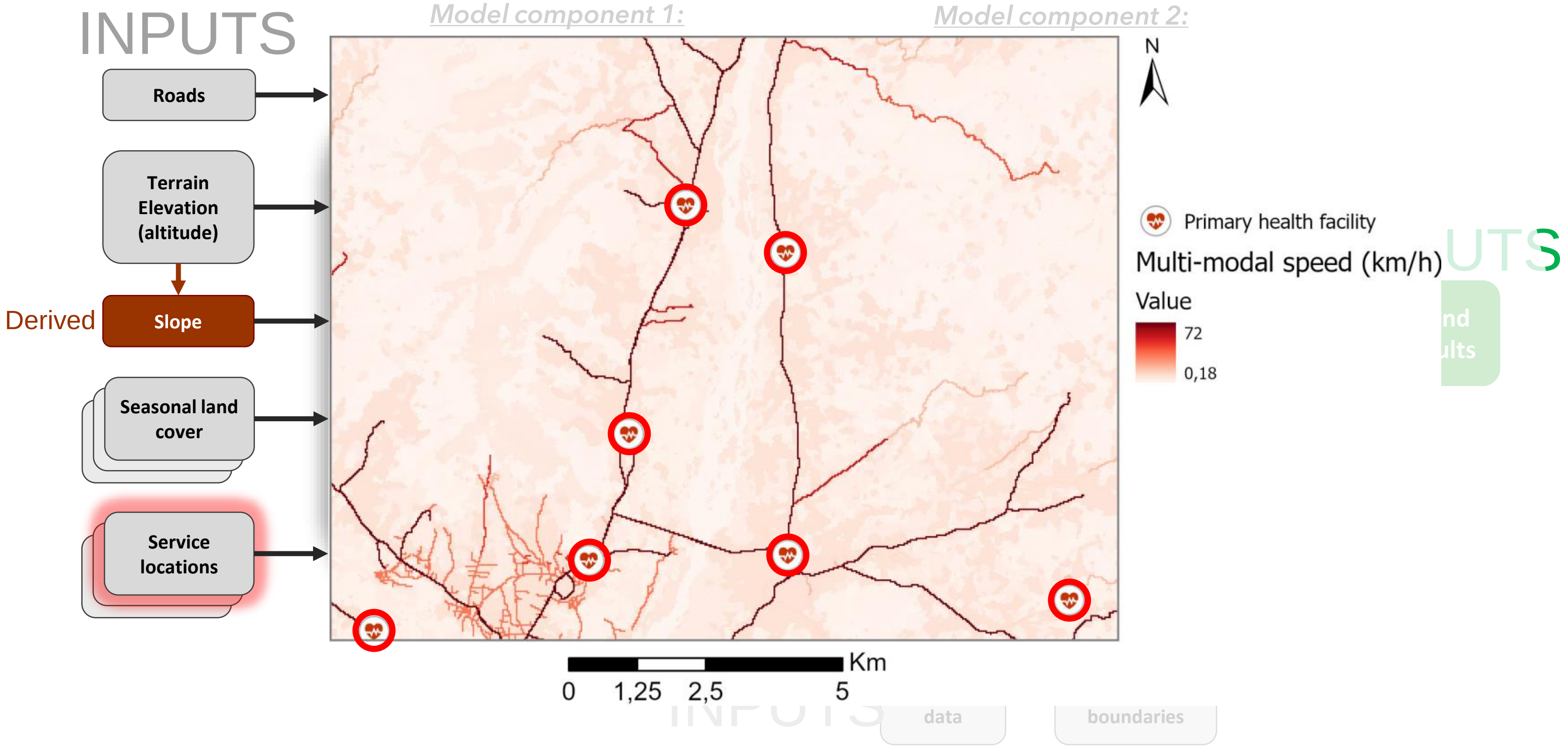
Model framework : access times to services



Model framework : access times to services



Model framework : access times to services



Model framework : access times to services

INPUTS

Model component 1:

Model component 2:

Roads

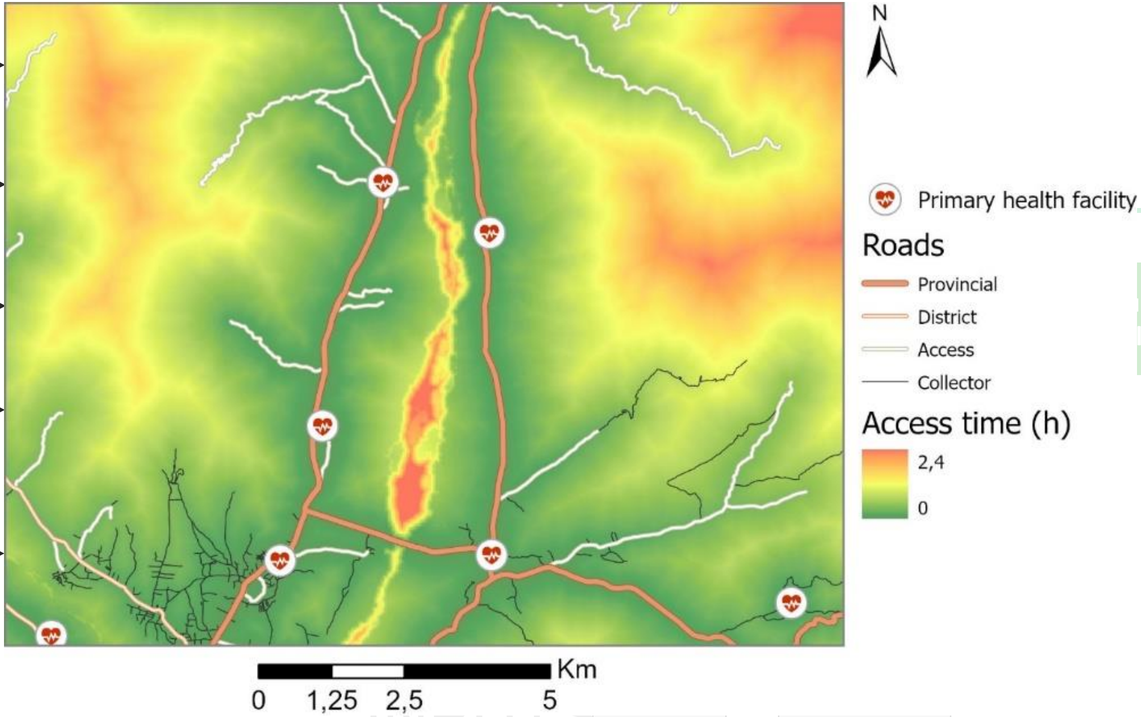
Terrain Elevation (altitude)

Derived

Slope

Seasonal land cover

Service locations



data

boundaries

Progress so far - demo

Future plans

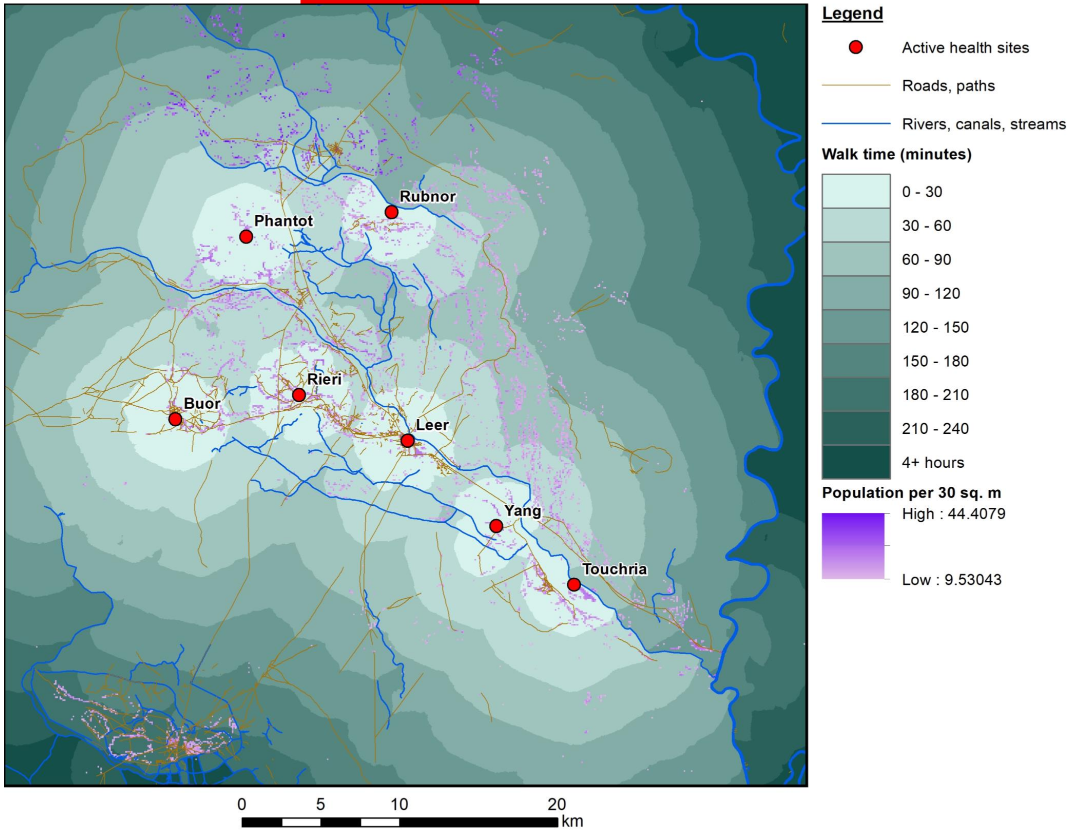
PHASE 2

- Multi-modal travel
- Other modes
  - Cycling, donkey-carts, ferries
- More user input
  - Modify roads – remove / add sections to be more accurate
- Shock/change modelling – how have events such as a bridge construction / addition or destruction of sites / flooding affected accessibility, and where?
- Optimisation – rapid, automated identification of the best locations for new health sites such as vaccinations sites, mobile clinics, etc.

Example Scenarios – Current accessibility

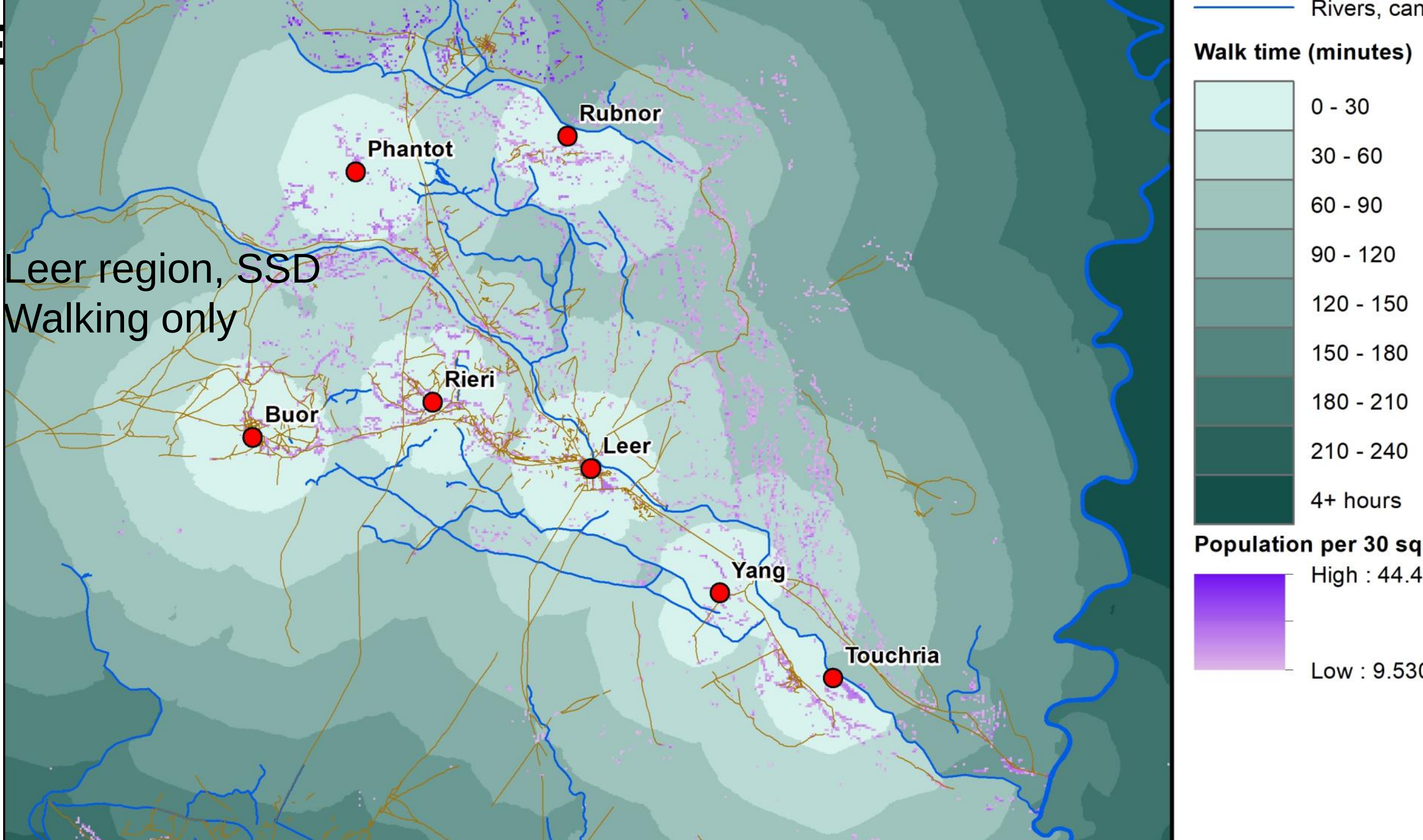
Leer region, SSD
Walking only

Current



E

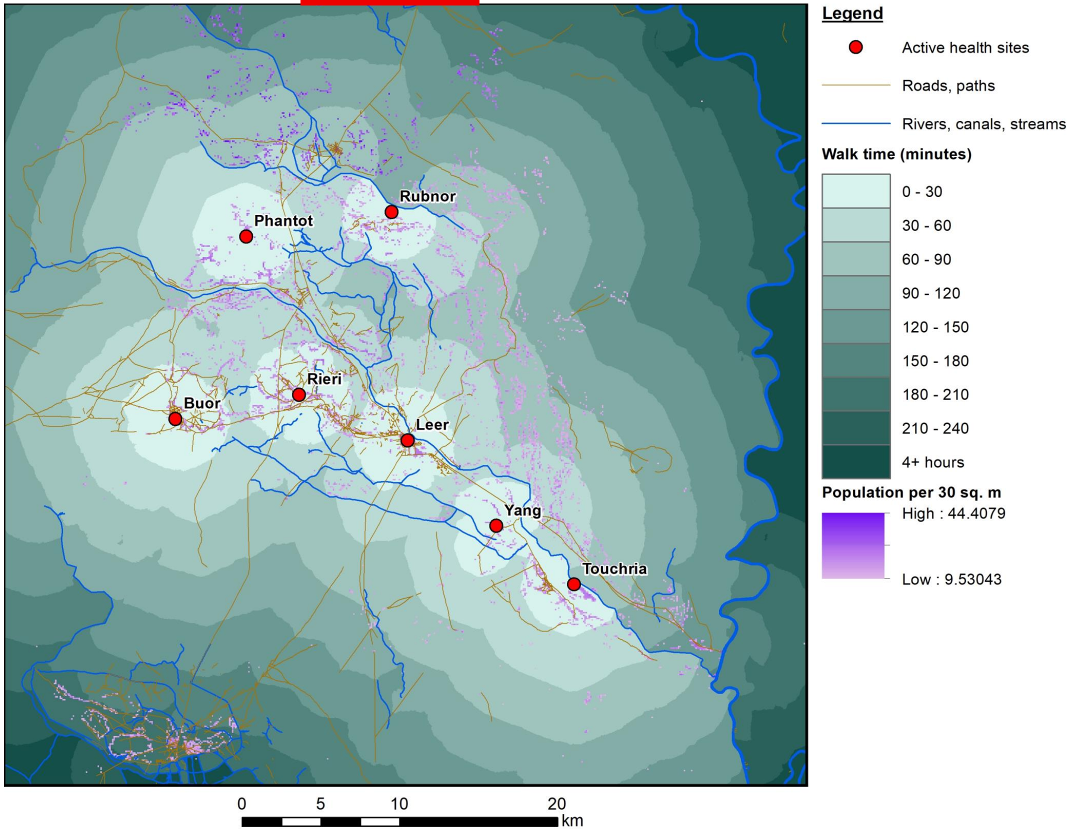
Leer region, SSD
Walking only



Example Scenarios – Current accessibility

Leer region, SSD
Walking only

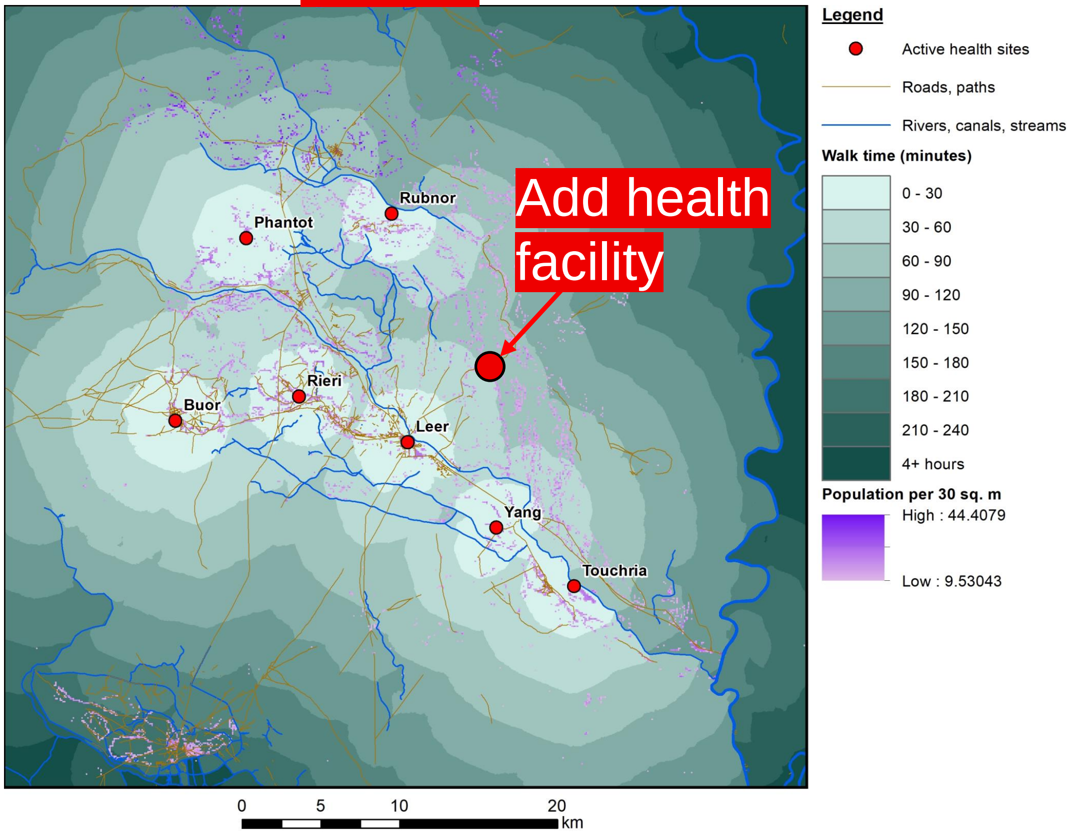
Current



Example Scenarios – add facility

Leer region, SSD
Walking only

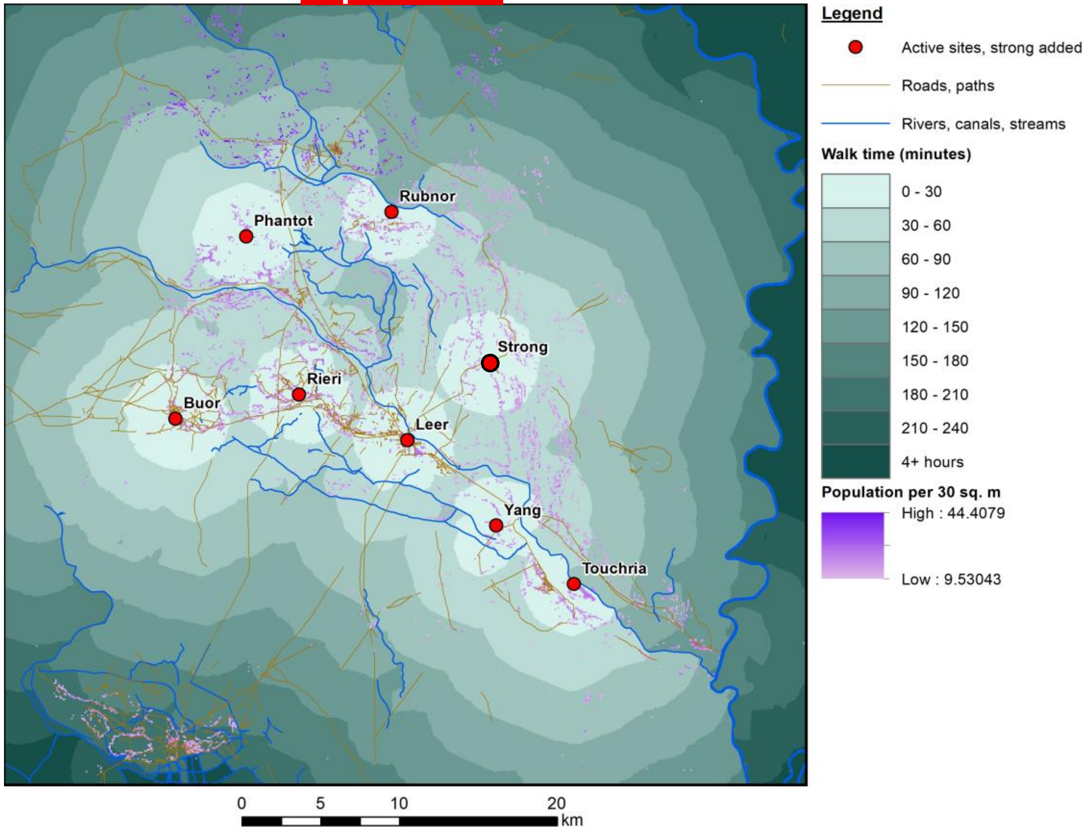
Current



Example Scenarios – add facility

Leer region, SSD
Walking only

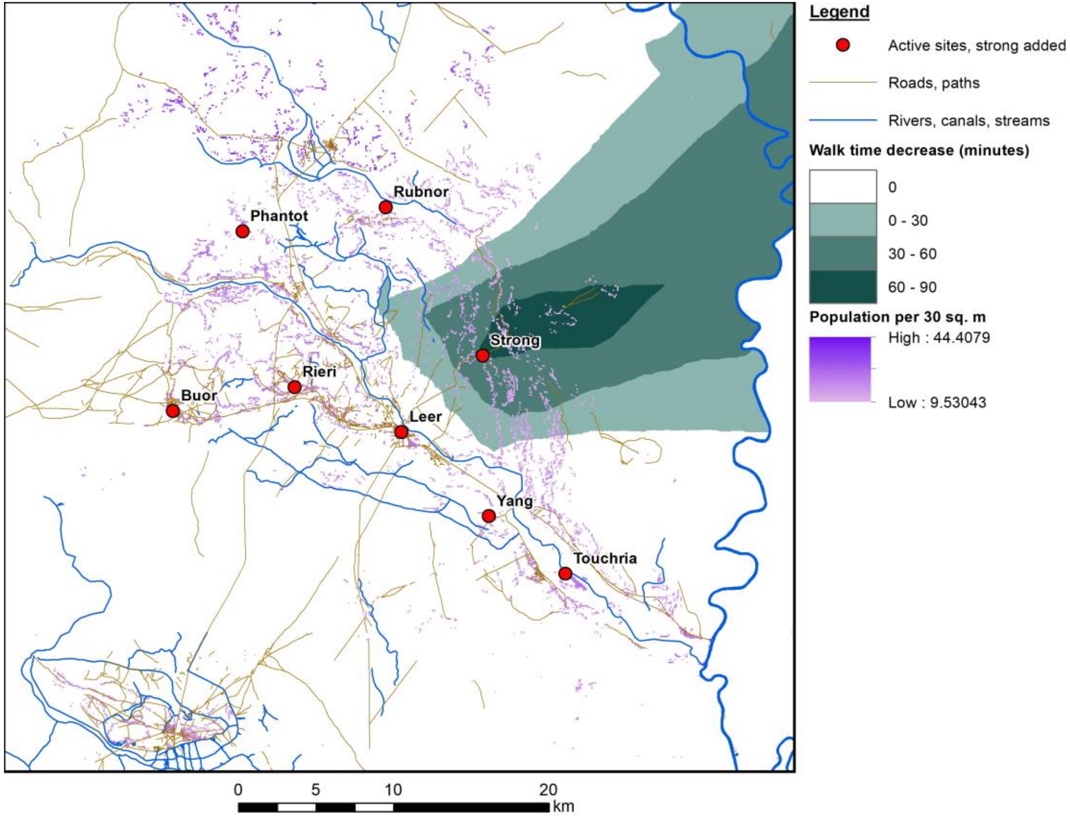
Updated



Example Scenarios – add facility

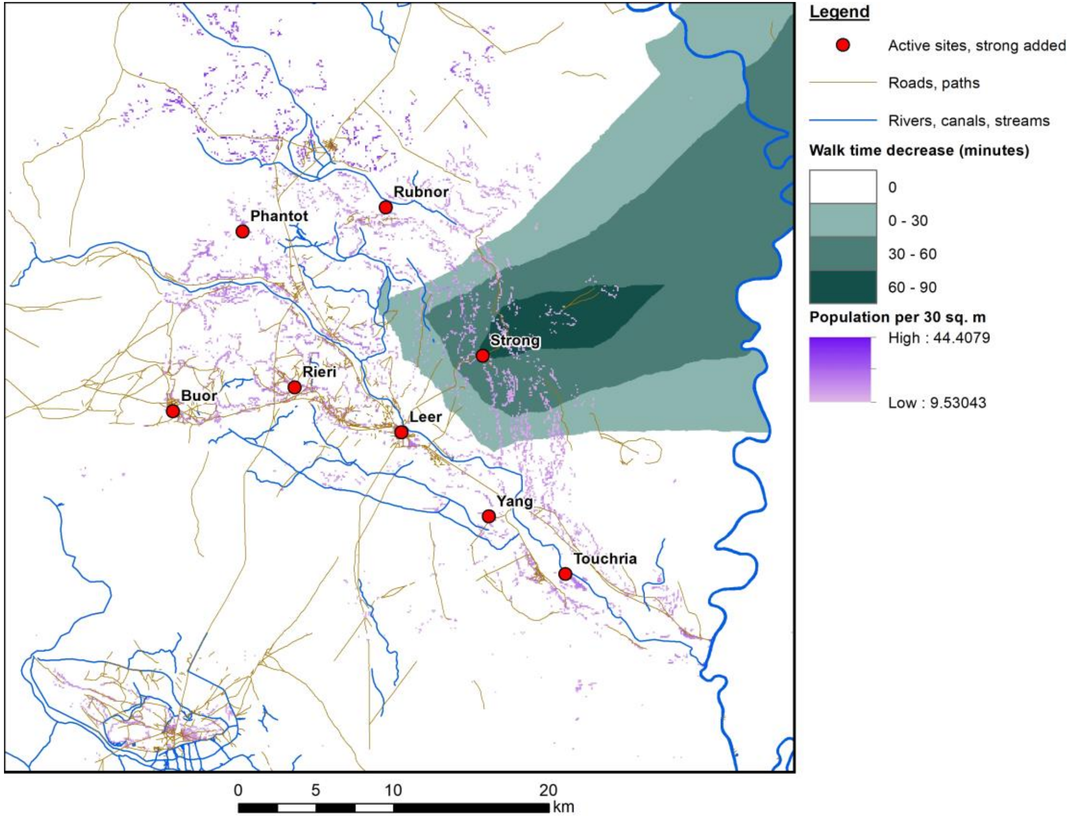
Impact

Leer region, SSD
Walking only



Example Scenarios – add facility

Impact



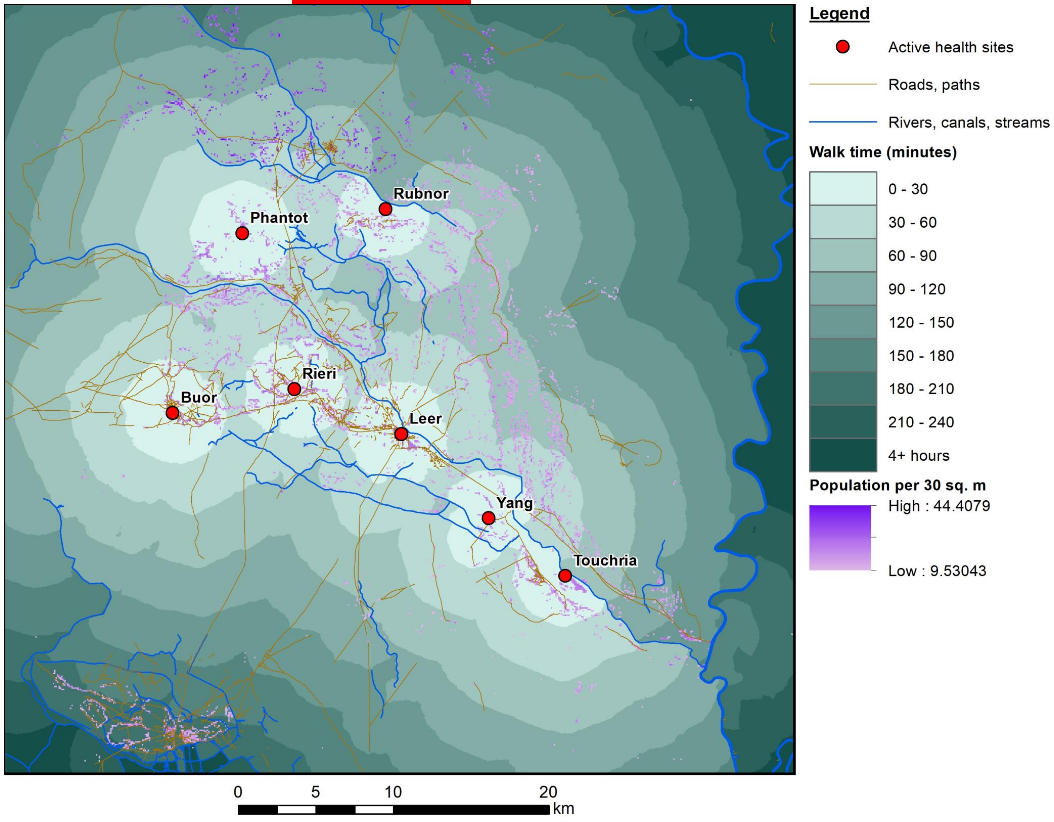
Leer region, SSD
Walking only

Total population benefitting	**19009**
Average walk-time decrease per person	35 minutes

Example Scenarios – remove facility

Leer region, SSD
Walking only

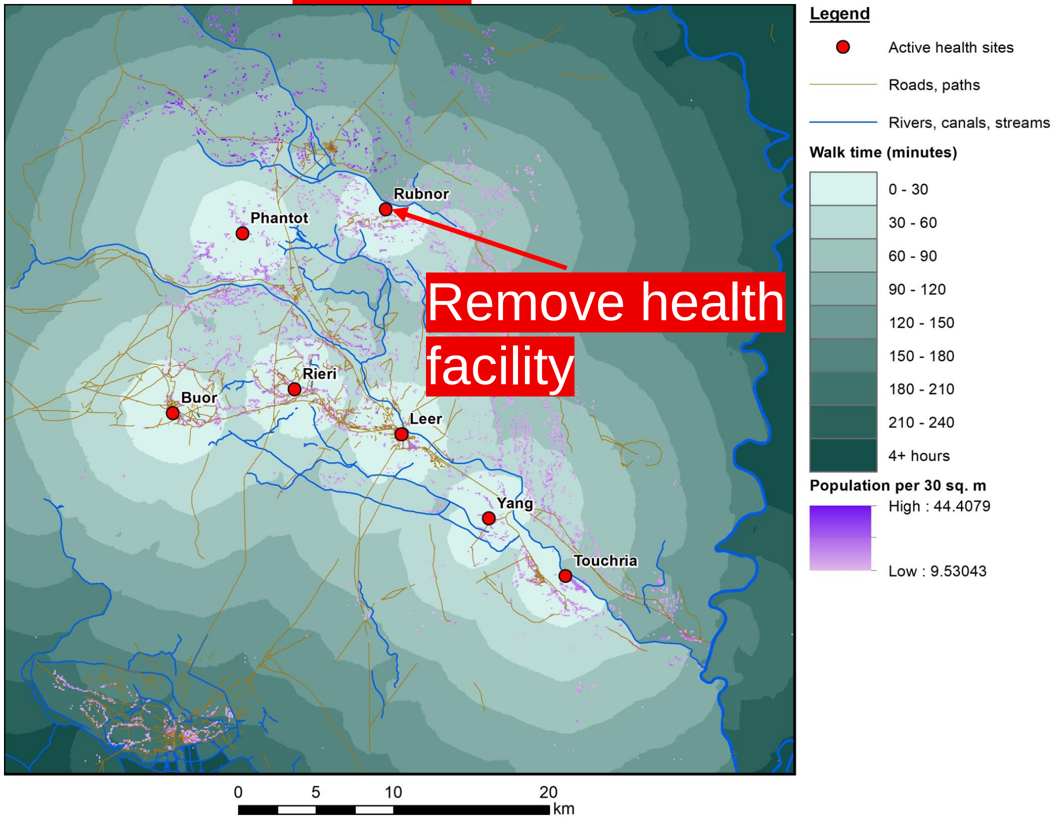
Current



Example Scenarios – remove facility

Leer region, SSD
Walking only

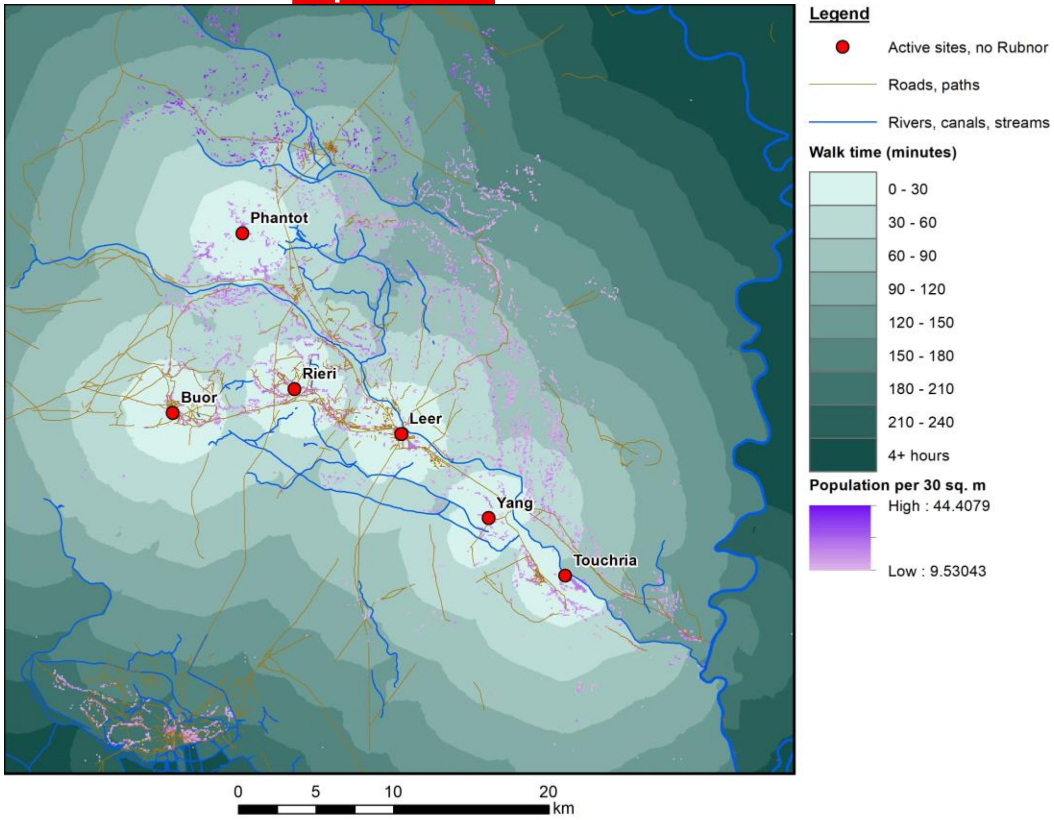
Current



Example Scenarios – remove facility

Leer region, SSD
Walking only

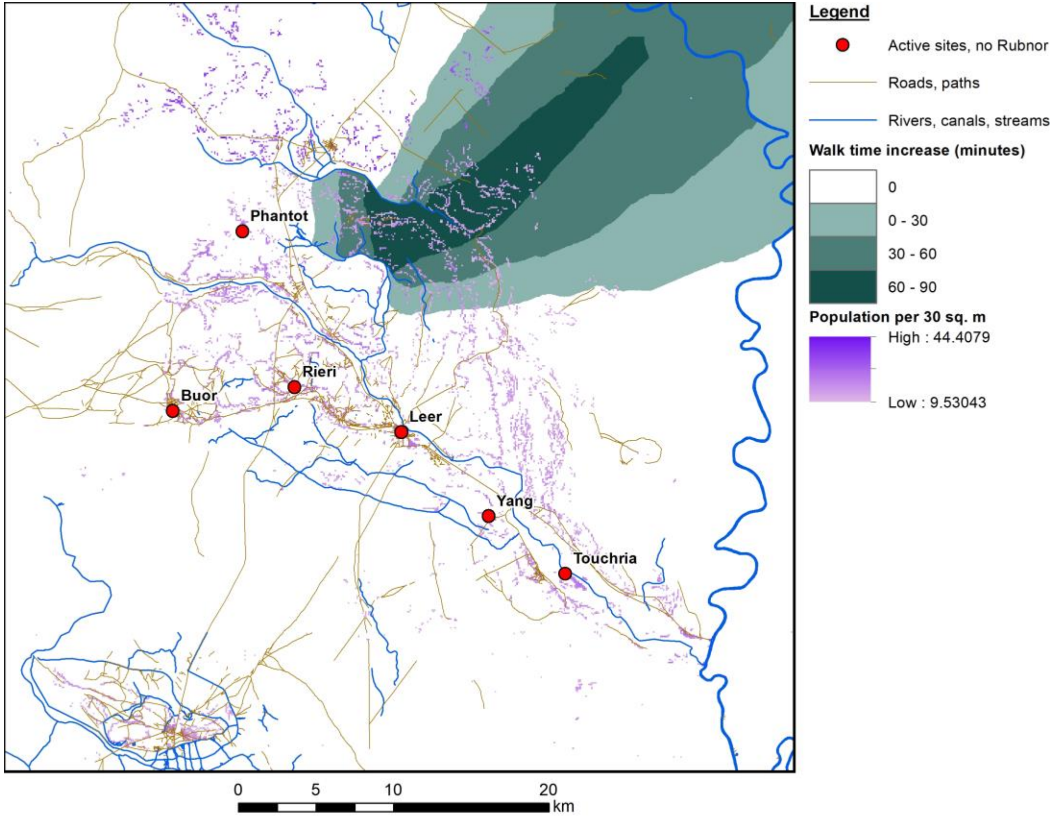
Updated



Example Scenarios – remove facility

Leer region, SSD
Walking only

Impact

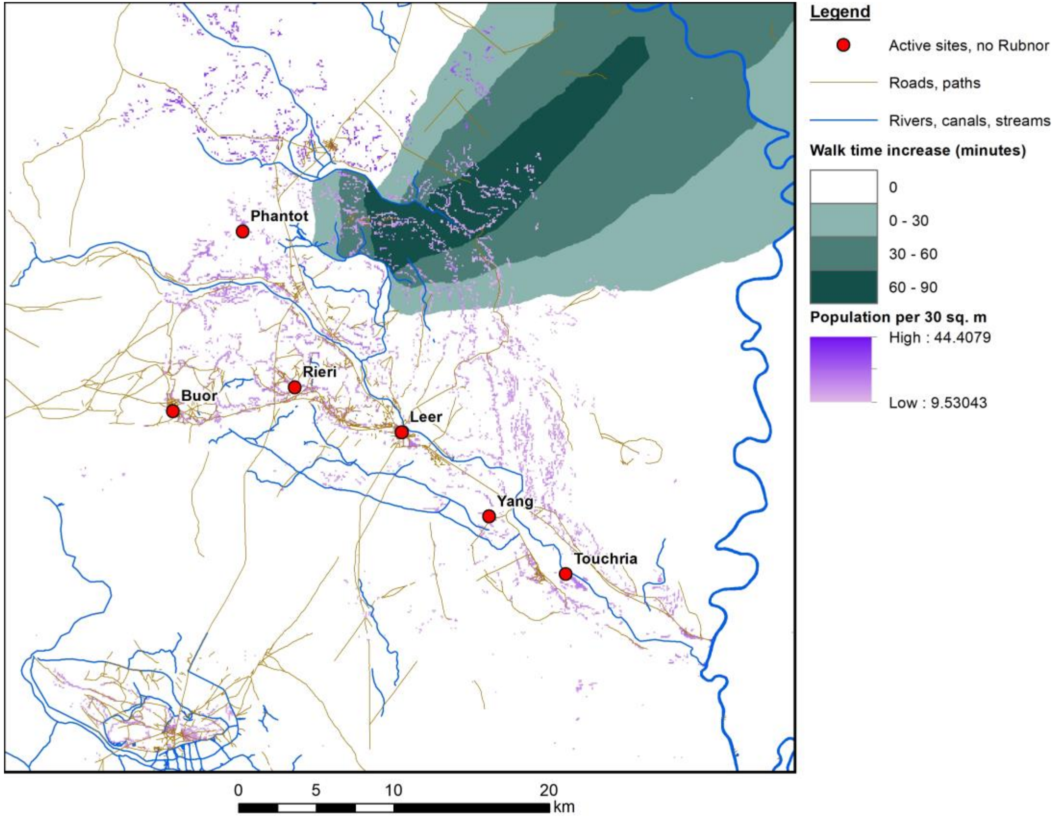


Example Scenarios – remove facility

Impact

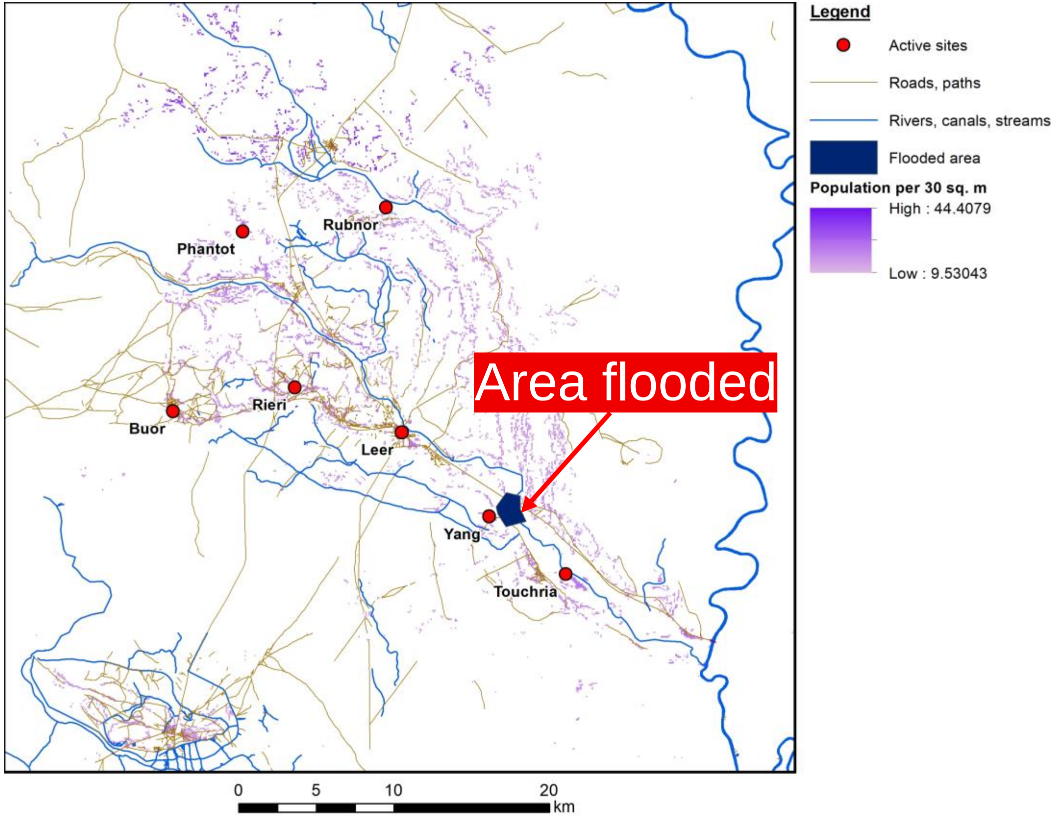
Leer region, SSD
Walking only

Total population affected	**25529**
Average walk-time increase per person	44 minutes



Example Scenarios – area flooded

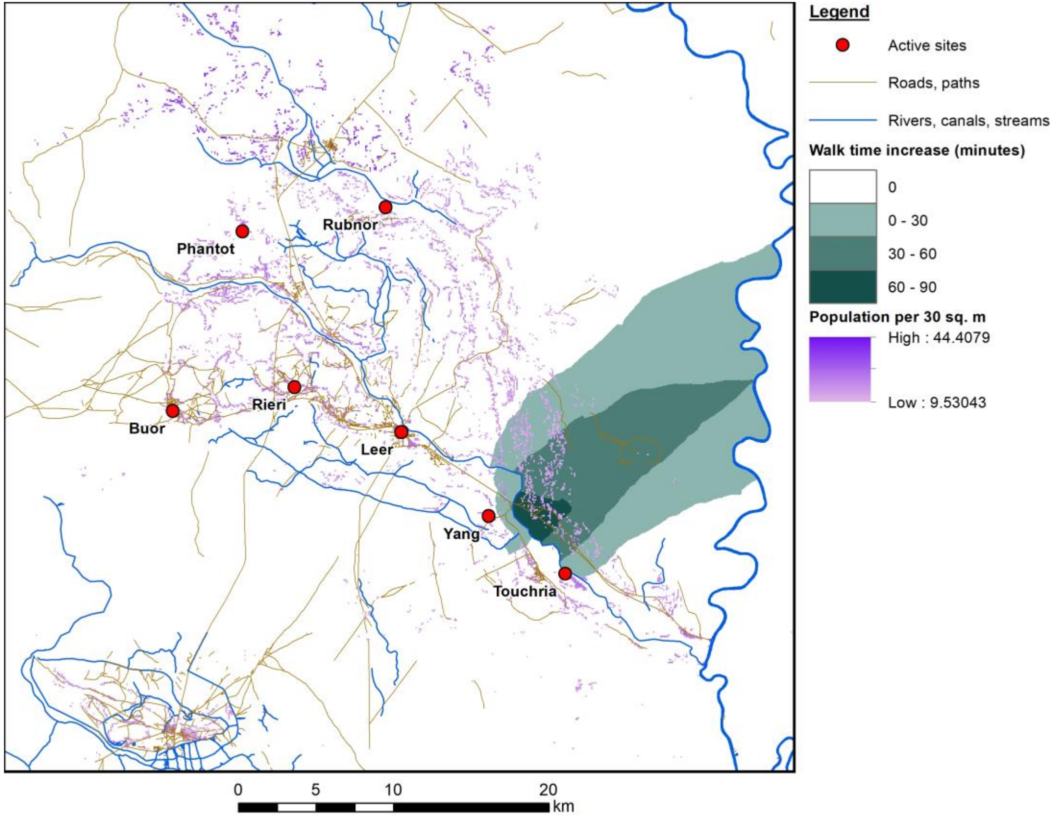
Leer region, SSD
Walking only



Example Scenarios – area flooded

Impact

Leer region, SSD
Walking only

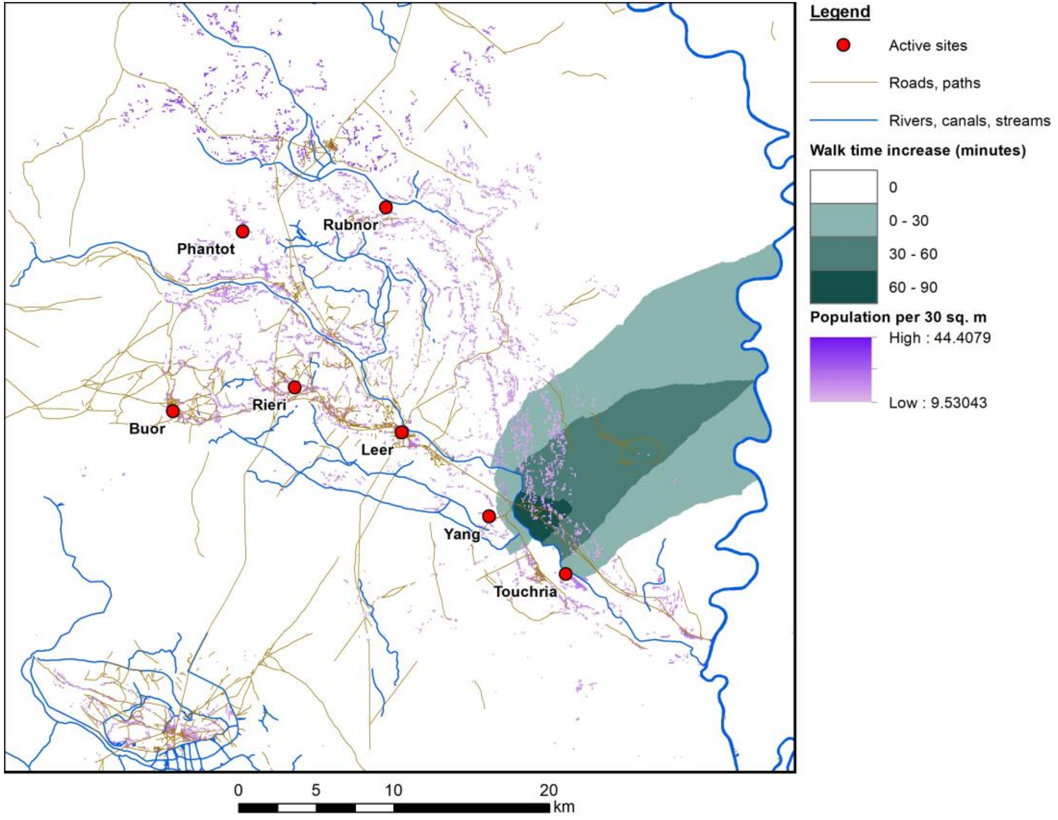


Example Scenarios – area flooded

Impact

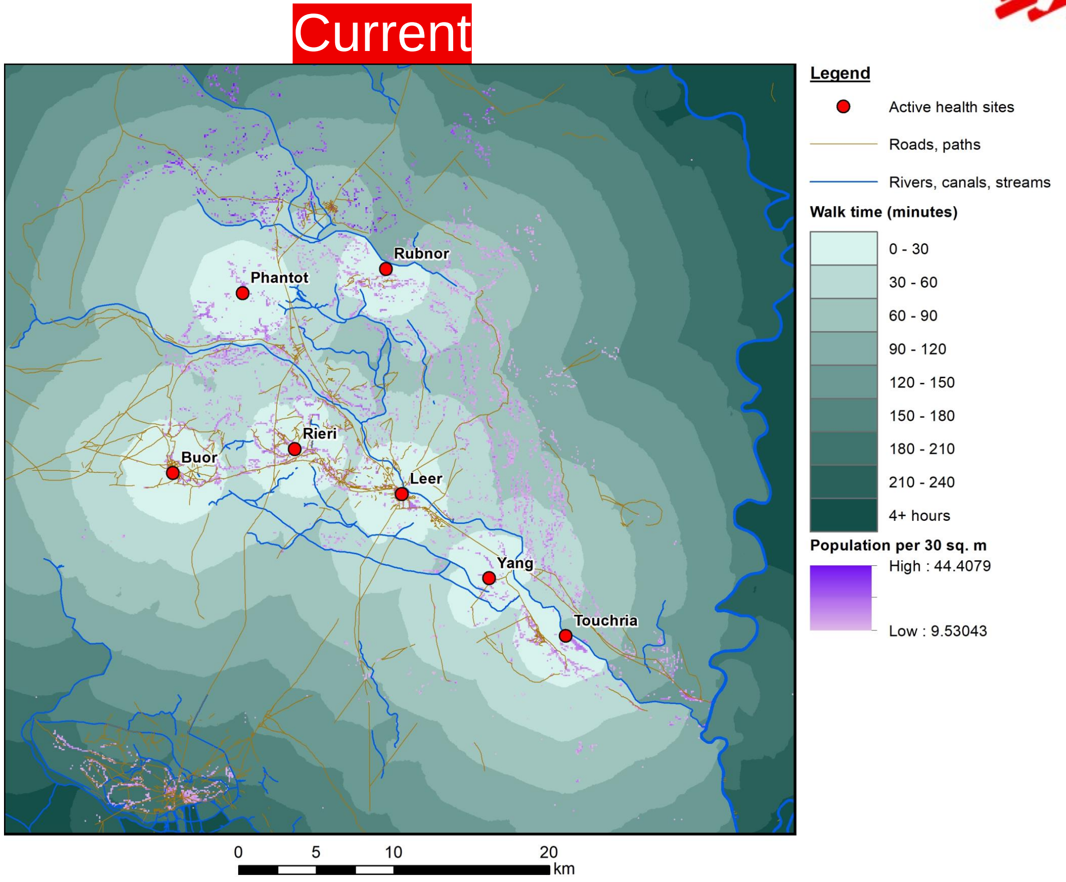
Leer region, SSD
Walking only

Total population affected	13005
Average walk-time increase per person	32 minutes



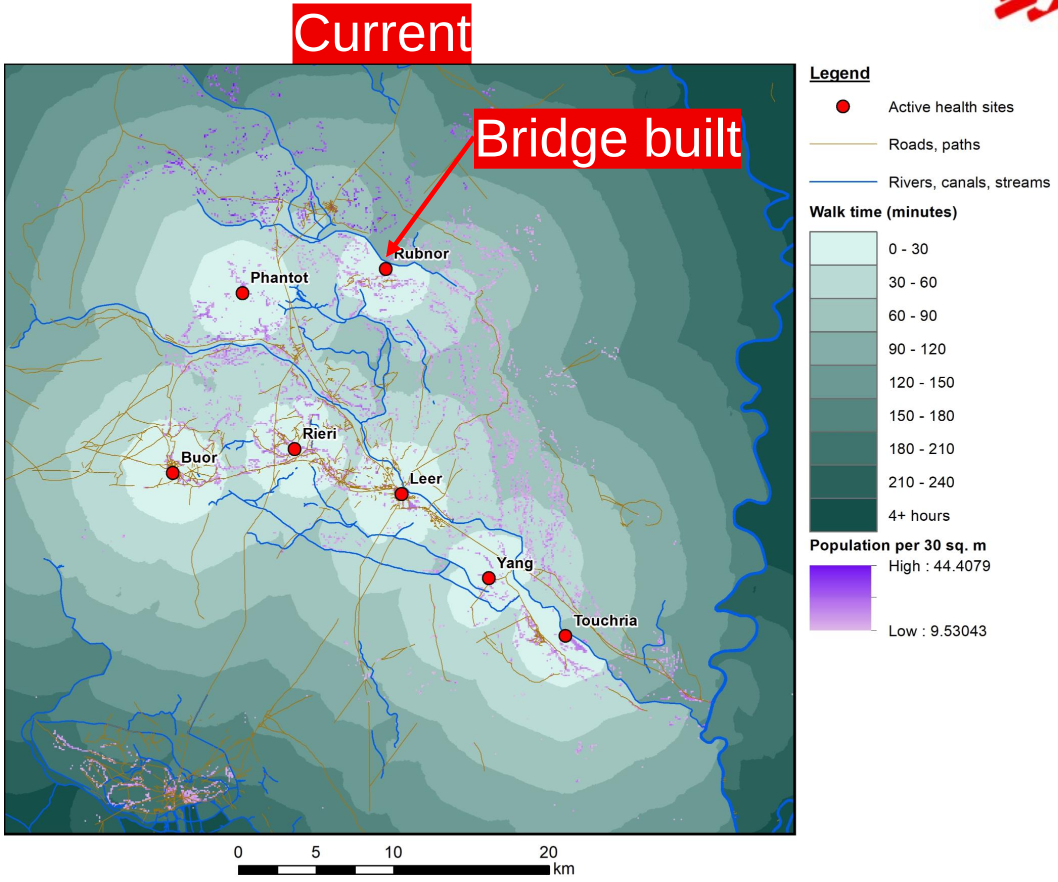
Example Scenarios – bridge built

Leer region, SSD
Walking only



Example Scenarios – bridge built

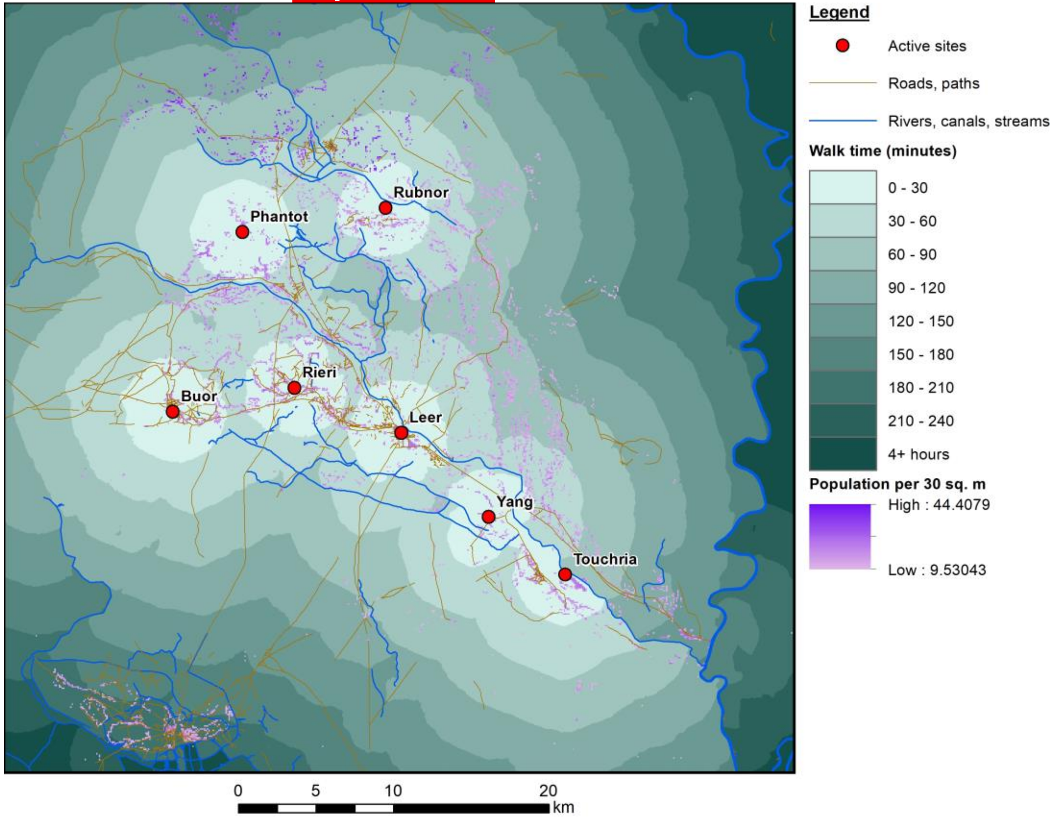
Leer region, SSD
Walking only



Example Scenarios – bridge built

Leer region, SSD
Walking only

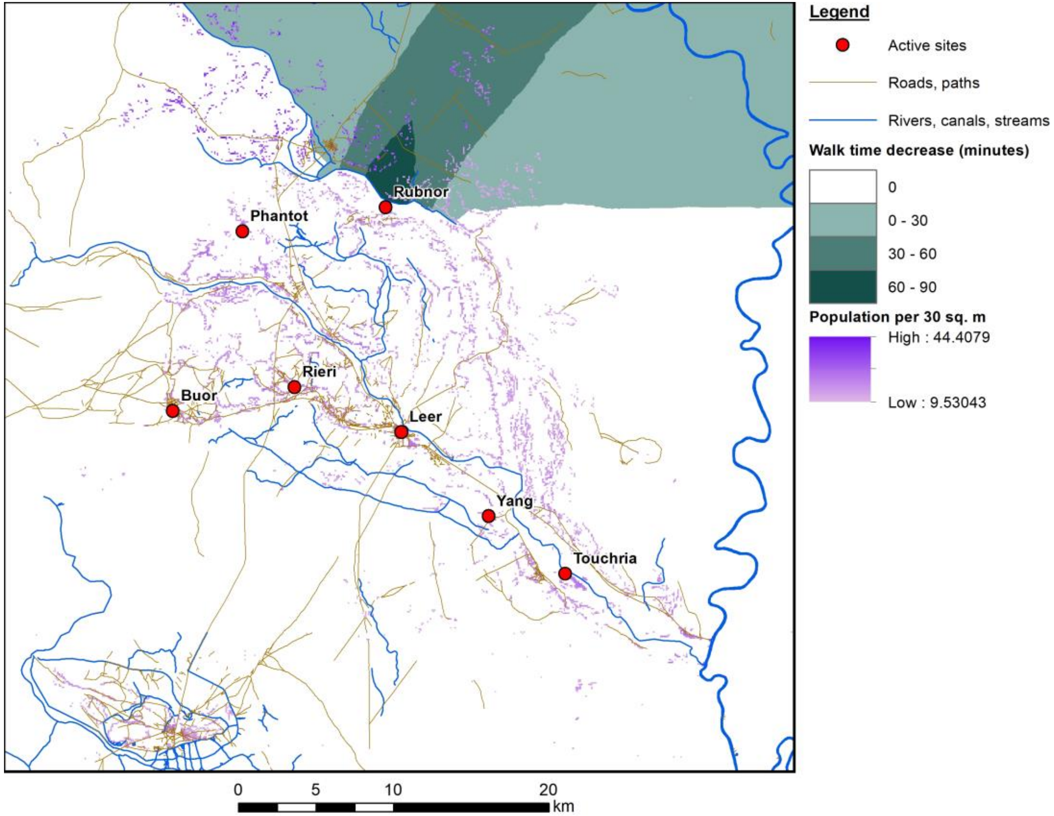
Updated



Example Scenarios – bridge built

Impact

Leer region, SSD
Walking only

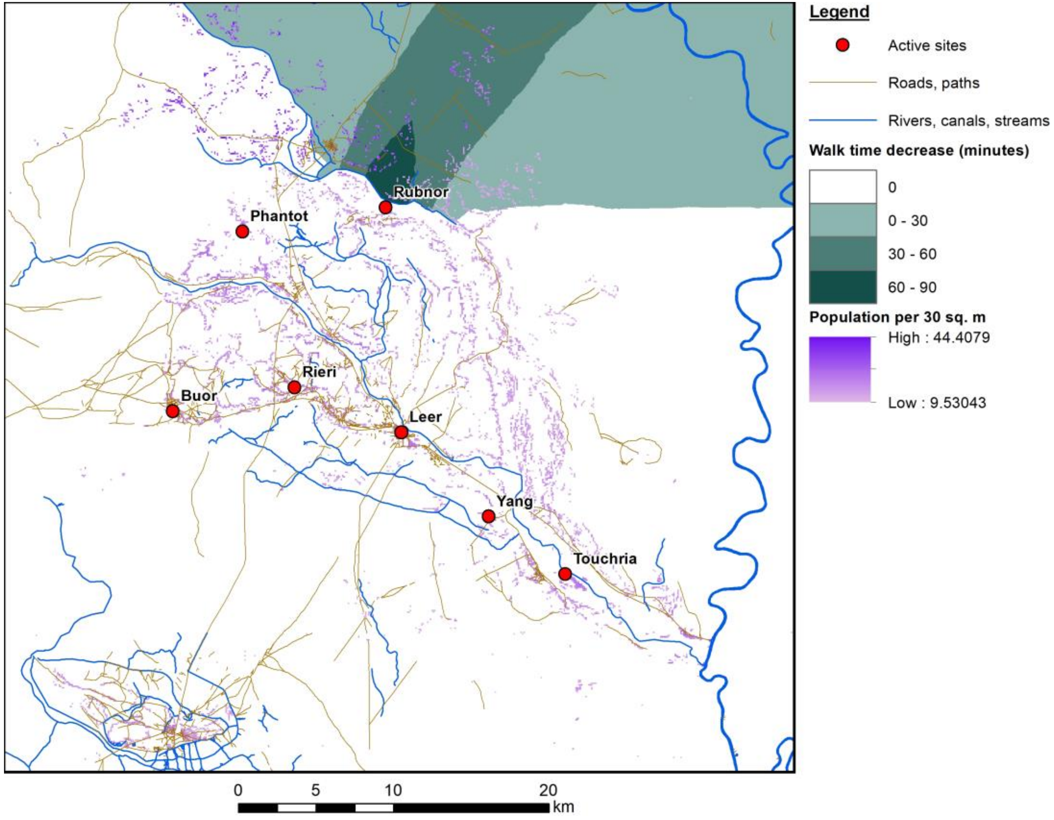


Example Scenarios – bridge built

Impact

Leer region, SSD
Walking only

Total population benefitting	**19088**
Average walk-time decrease per person	31 minutes



Future challenges

Gravity effects on catchments

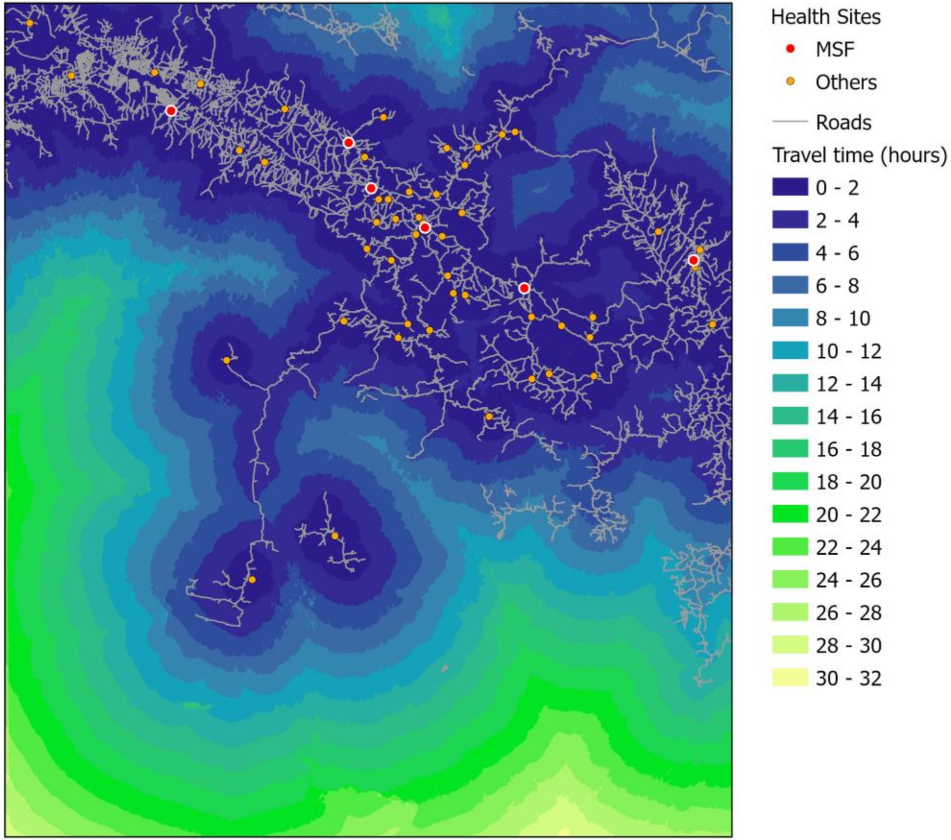
- Not all sites are equal!
- Some sites may be more desirable to visit
  - Example: in South Sudan people will walk twice as far to reach an MSF facility compared to a ministry of health facility – better treatment, medication, equipment
- The question is: how much longer are people prepared to travel to reach an MSF site compared to a MOH site?
- What factors influence preference?
  - Treatment: needs-based
  - Capacity
  - Reputation
  - Private versus public

Future challenges

Gravity effects on catchments

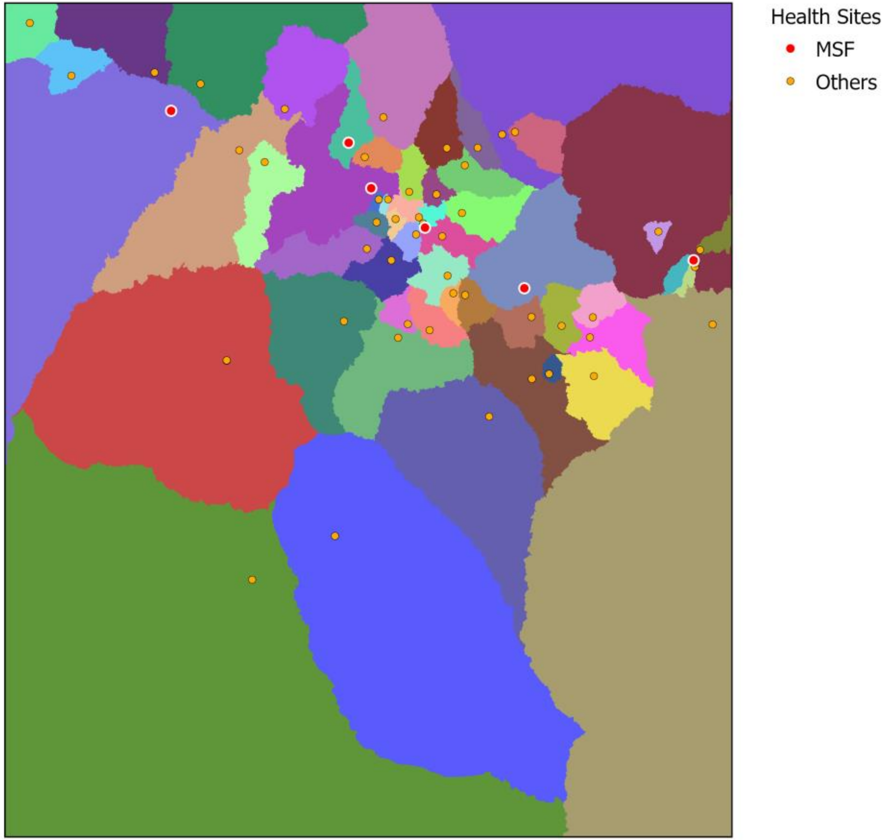
- How to model?
- Ratio example
  - People may be willing to travel 20 minutes instead of 10 to their preferred location
  - But are they willing to travel 2 hours instead of 1?
  - Same ratio, 2:1
- Time matters
  - Not just the ratio that matters, but also the actual travel time to the nearest and preferred

Gravity – early results



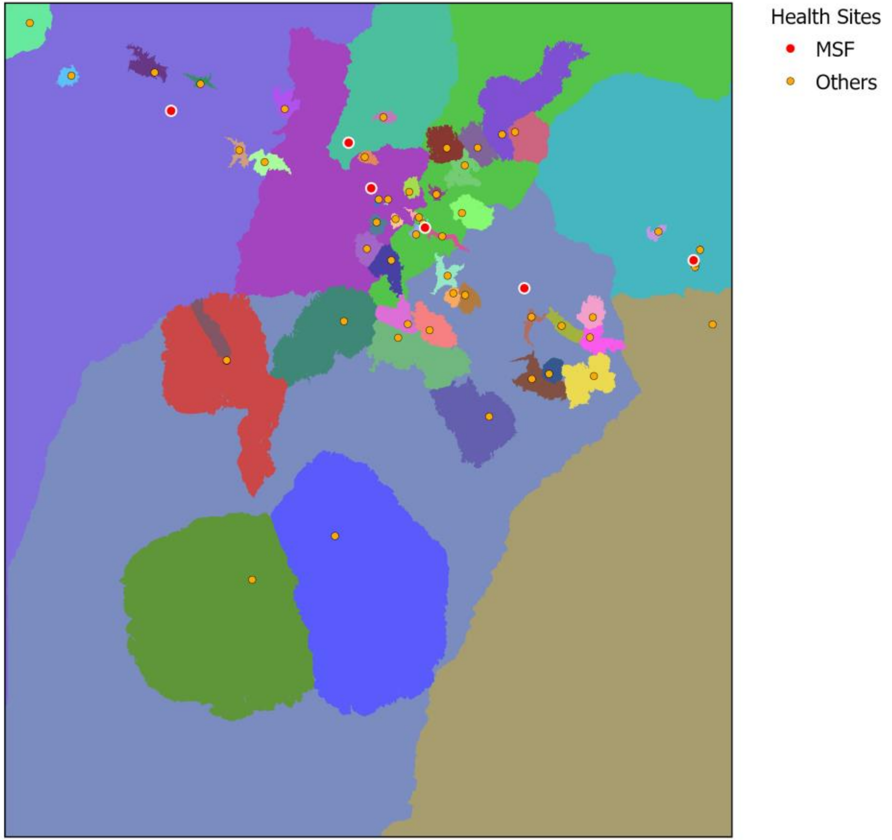
Travel time to health sites

Gravity – early results



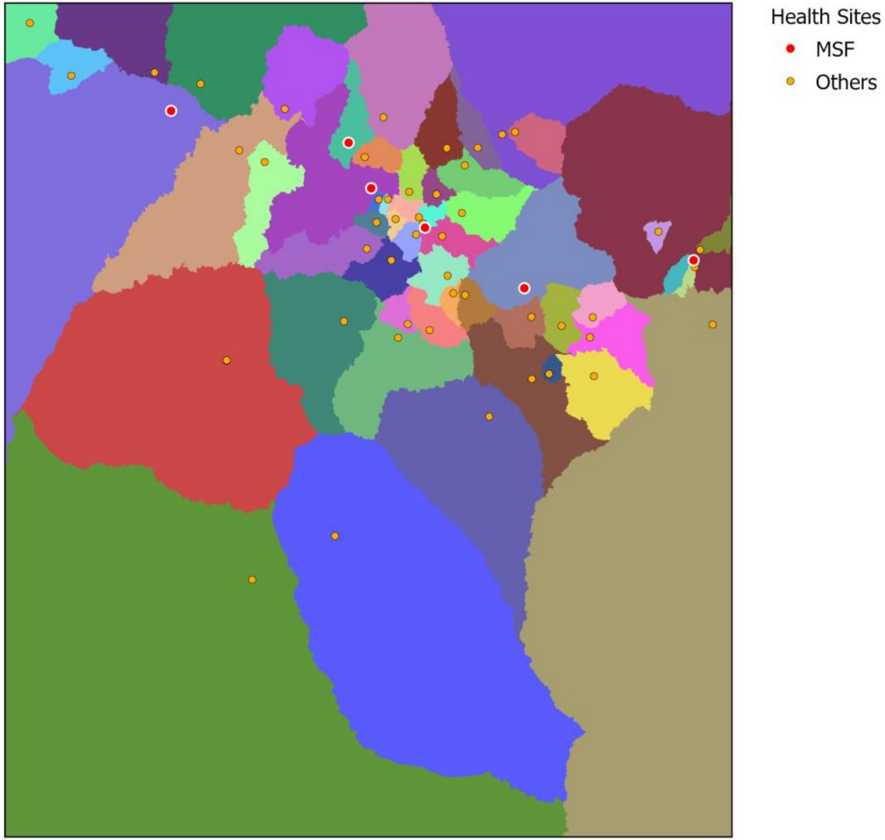
Catchments

Gravity – early results



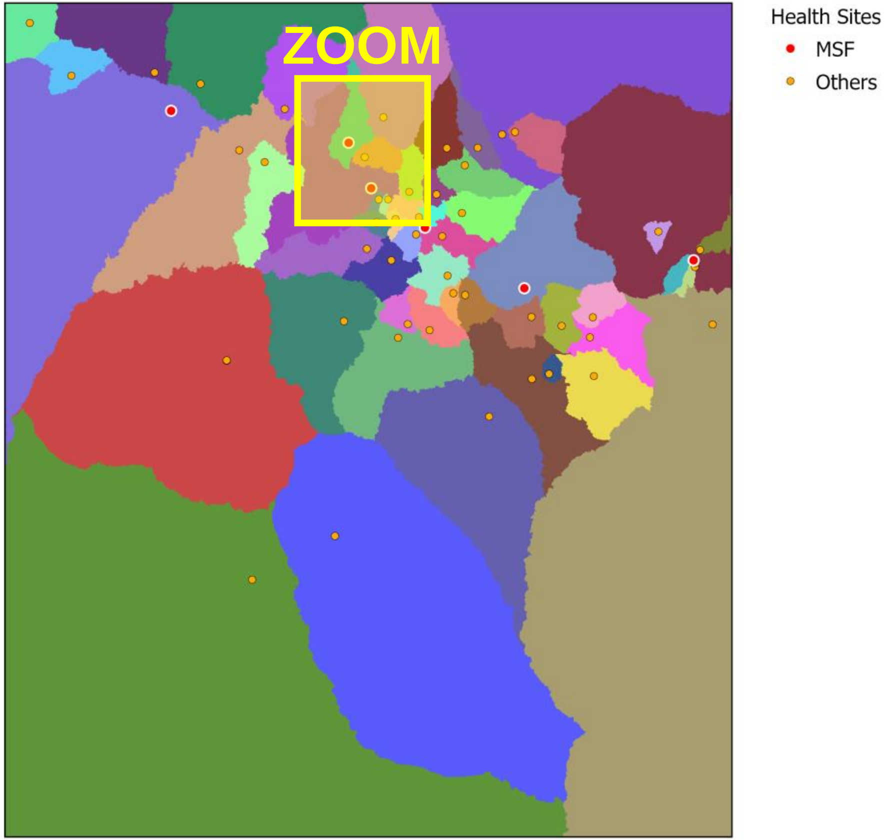
Catchments
- People willing to travel twice as long to MSF sites

Gravity – early results



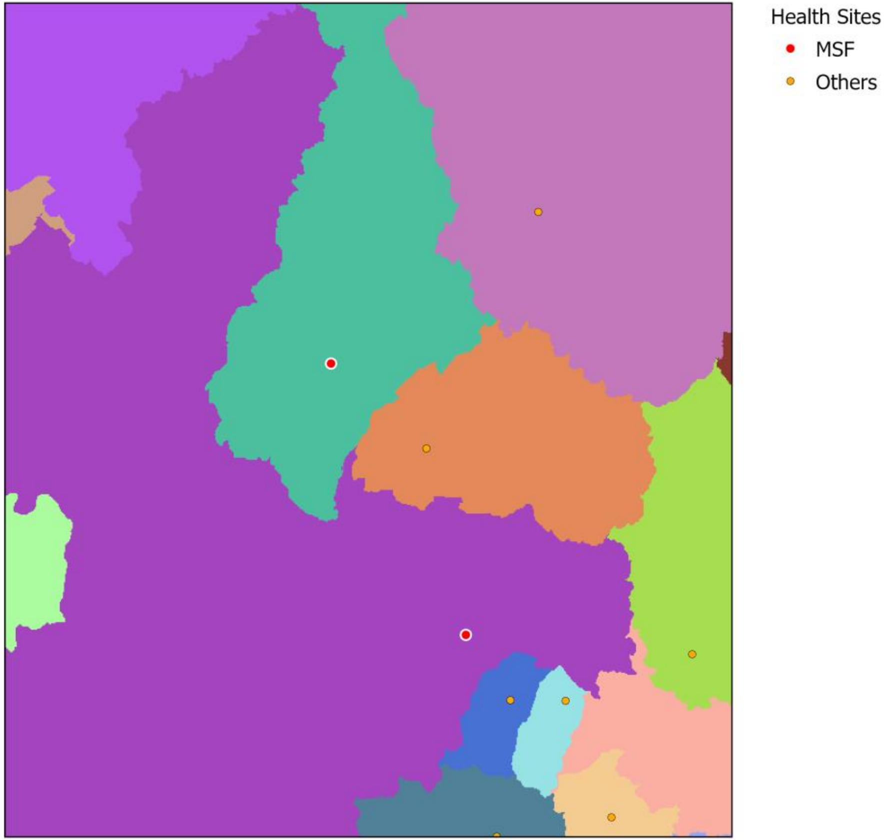
Catchments

Gravity – early results



Catchments

Gravity – early results



Catchments

Gravity – early results

Catchments
- People willing to travel twice as long to MSF sites

Thank you!