

# The Global Open Healthcare Access Map

Improving Access to  
Healthcare Facilities  
through Open Geoinformation



  
**HeiGIT**

HEIDELBERG INSTITUTE  
FOR GEOINFORMATION  
TECHNOLOGY

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[HeiGIT.org](http://HeiGIT.org) [uni-heidelberg.de/gis](http://uni-heidelberg.de/gis)

# HeiGIT gGmbH : Heidelberg Institute for Geoinformation Technology



## Smart Mobility

Location-based Services  
& Navigation

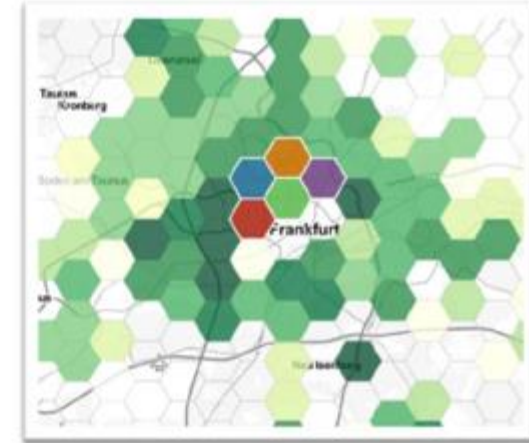
- e.g.
- Emergency Routing / Navigation
  - Healthy / Pleasant Routing
  - Specialized Wheelchair Routing
  - POI service



## Geoinformation for Humanitarian Aid

Supporting Disaster management  
& Sustainability

- e.g.
- Disaster Routing / Logistics
  - Improving OSM data
  - Damage assessment / Exposure Modeling
  - Healthcare Access
  - Mobile Crowdsourcing (MapSwipe)



## Big Spatial Data Analytics

Data Mining &  
Machine Learning  
using open GI

- e.g.
- OSM data quality (analysis & improvement)
  - Data products via machine learning
  - Predictive Analytics
  - Maps (e.g. climate protection map)

## APIs



/directions

/isochrones

/matrix

/geocoding

/poi

/maps

/optimization



## Clients / libs

openrouteservice-py



openrouteservice-r



QGIS: ORS Tools



JavaScript



VROOM

Disaster Routing

[maps.openrouteservice.org](https://maps.openrouteservice.org)

[openrouteservice.org](https://openrouteservice.org)

Sign up for free!

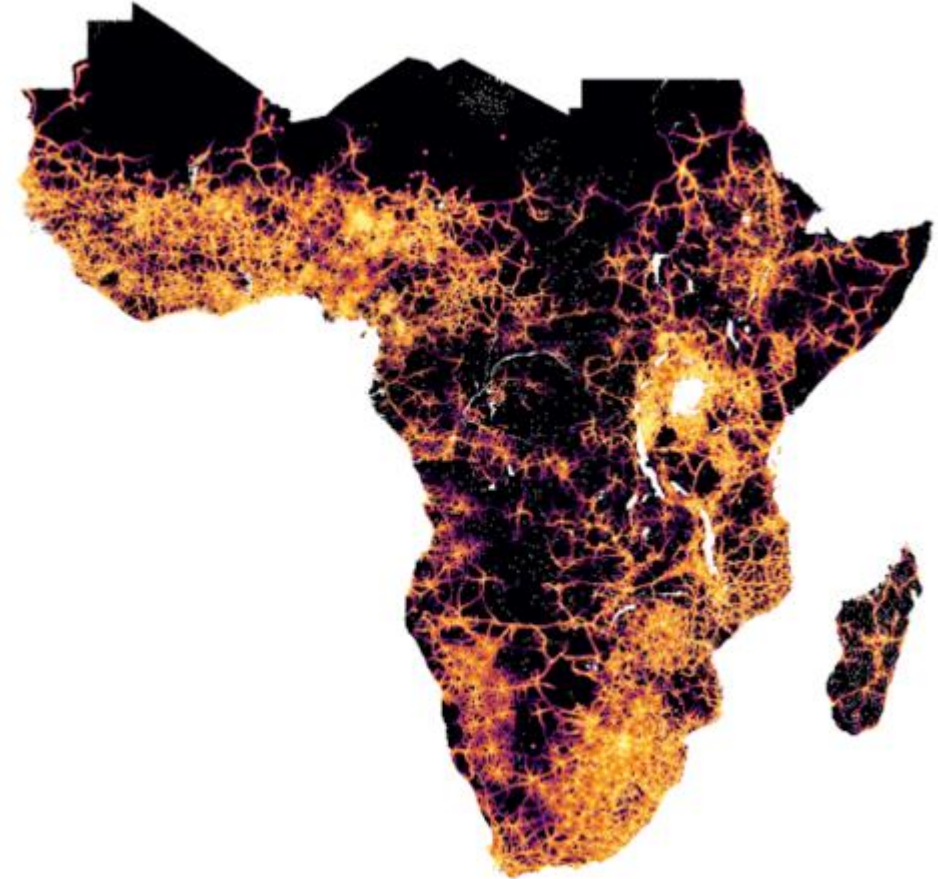
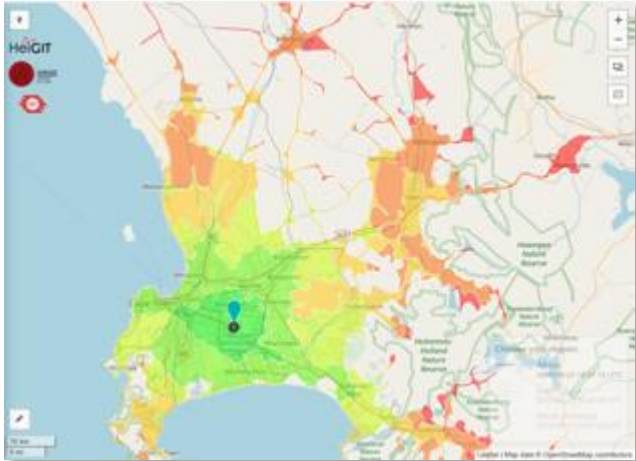
Neis, P. & Zipf, A (2008): OpenRouteService.org is three times “Open”: Combining OpenSource, OpenLS and OpenStreetMaps. GIS Research UK (GISRUK 08). Manchester.

# Covid-19 accessibility to healthcare in SS Africa

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## Access of **Population 60+** to primary healthcare facilities

- Healthsites.io
- OSM street network
- Statistics for each country

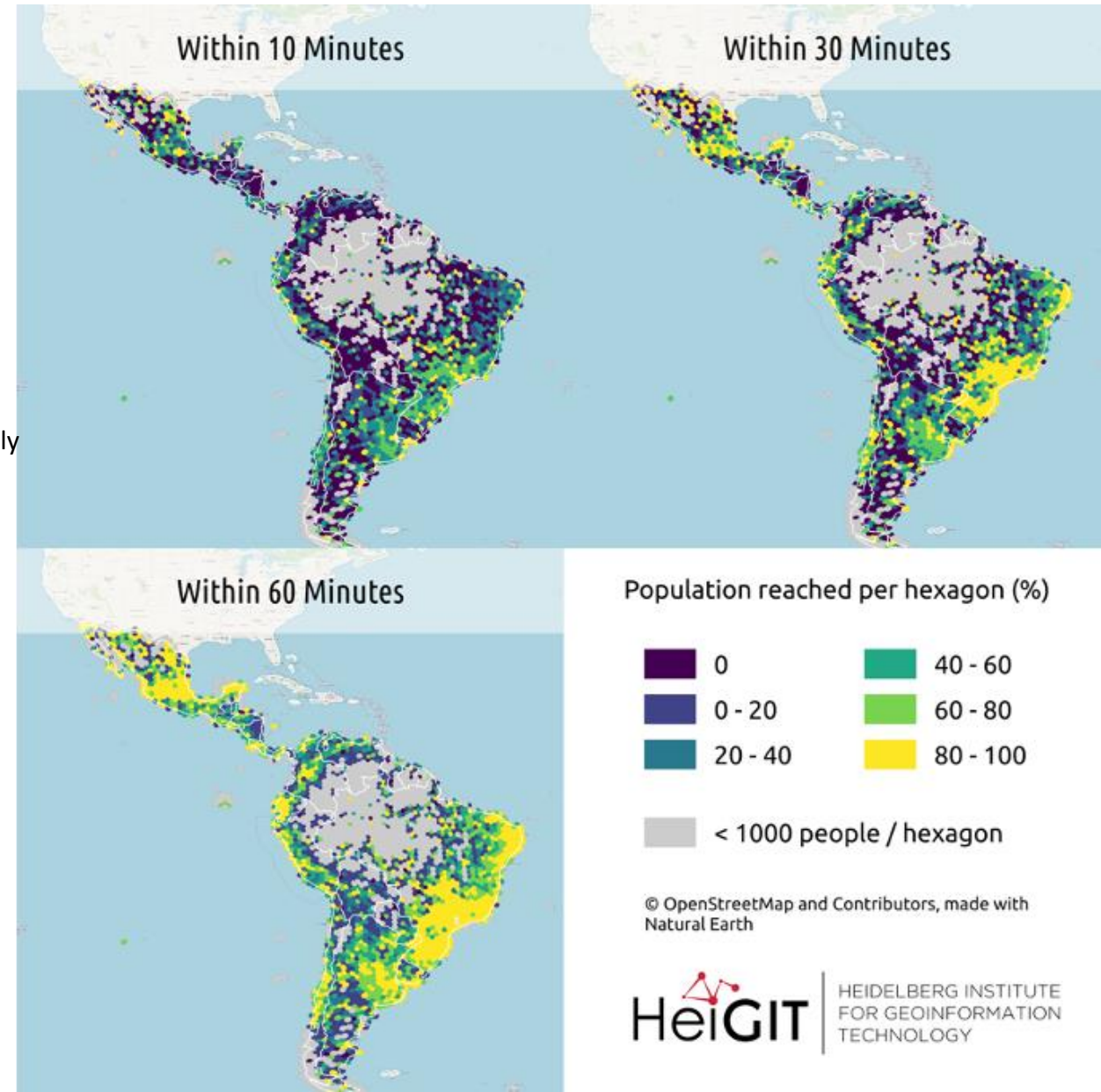
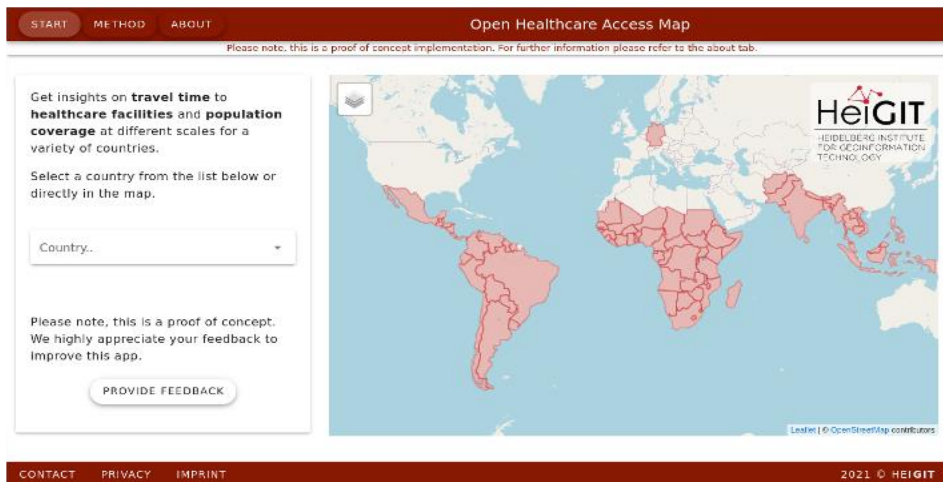


Geldsetzer, P.; Reinmuth, M.; O Ouma, P.; Lautenbach, S.; A Okiro, E.; Bärnighausen, T.; Zipf, A. (2020): Mapping physical access to health care for older adults in sub-Saharan Africa and implications for the COVID-19 response: a cross-sectional analysis The Lancet Healthy Longevity. [https://doi.org/10.1016/S2666-7568\(20\)30010-6](https://doi.org/10.1016/S2666-7568(20)30010-6)

# Global Open Healthcare Access Map

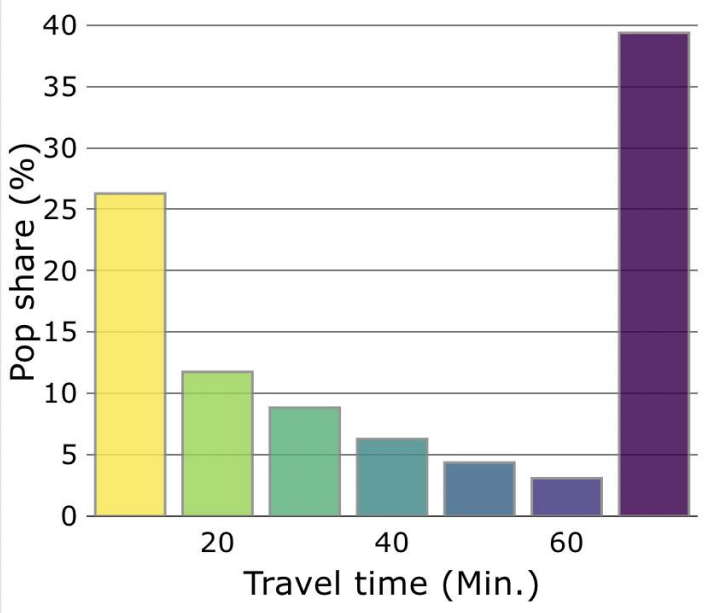
[https://apps.heigit.org/healthcare\\_access](https://apps.heigit.org/healthcare_access)

- Access to health facilities / share of population
  - Primary healthcare / secondary / both types
- Different scales & units
  1. Country
  2. First admin level (State, district)
  3. Second admin level (district, province) some countries only
  4. Hexagons (ISEA3H, zoom level 8)



Please note, this is a proof of concept implementation. For further information please refer to the about tab.

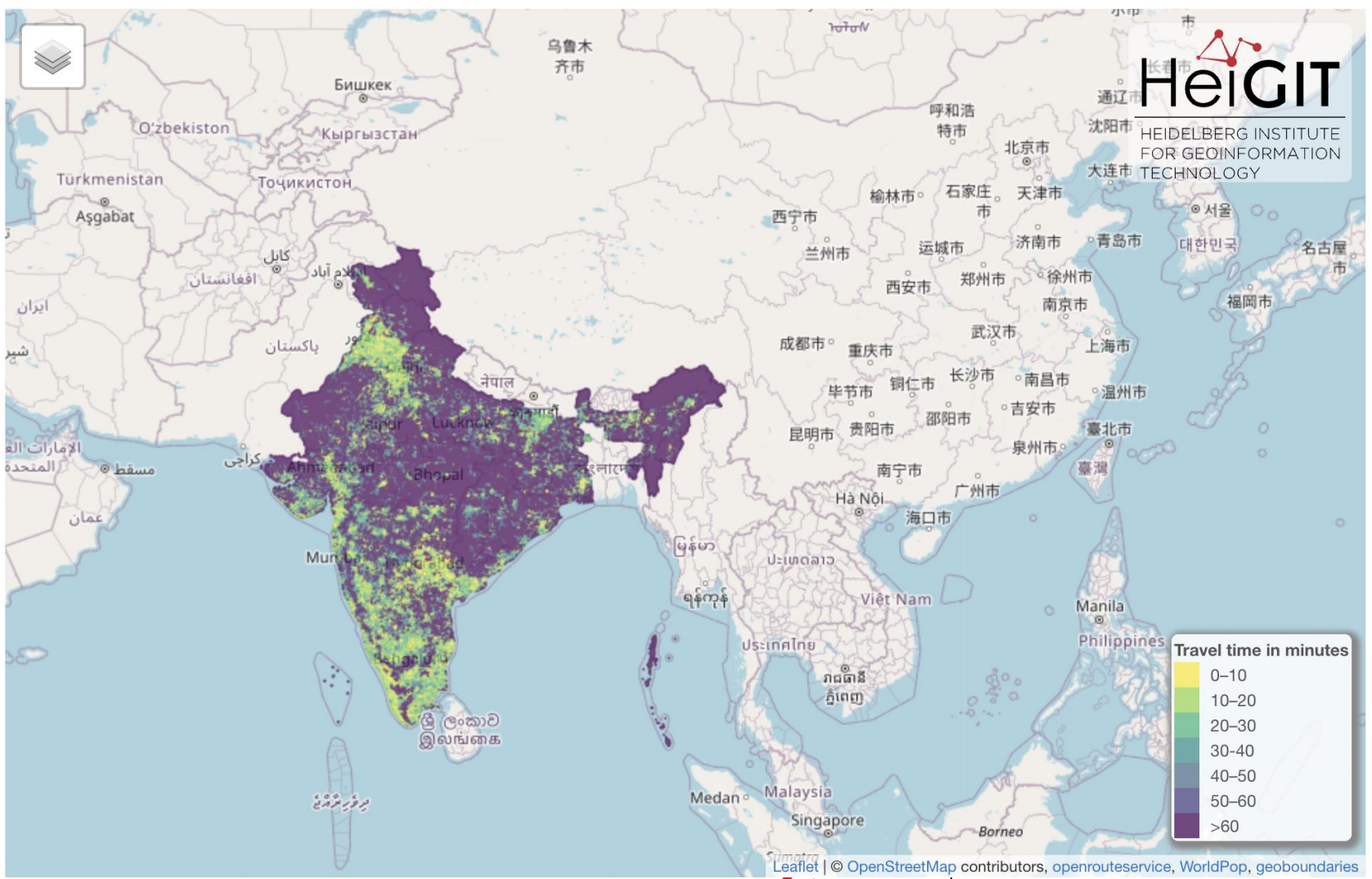
COVERAGE BY TRAVEL TIME



659,569,468 (46.88 %) people live within less than 30 minutes travel time (motorized) to the next facility.

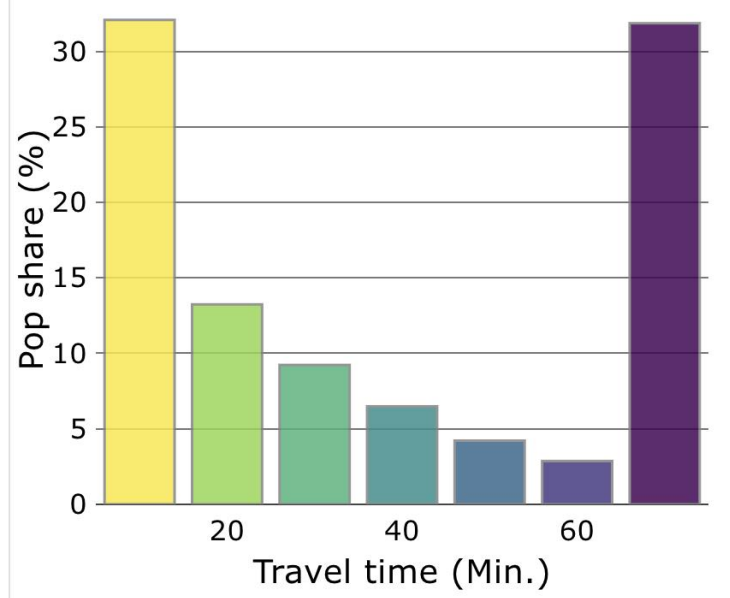
853,117,495 (60.63 %) live within less than 60 minutes travel time to the next facility.

554,030,258 (39.37 %) live further away than 60 minutes travel time to the next facility.



Please note, this is a proof of concept implementation. For further information please refer to the about tab.

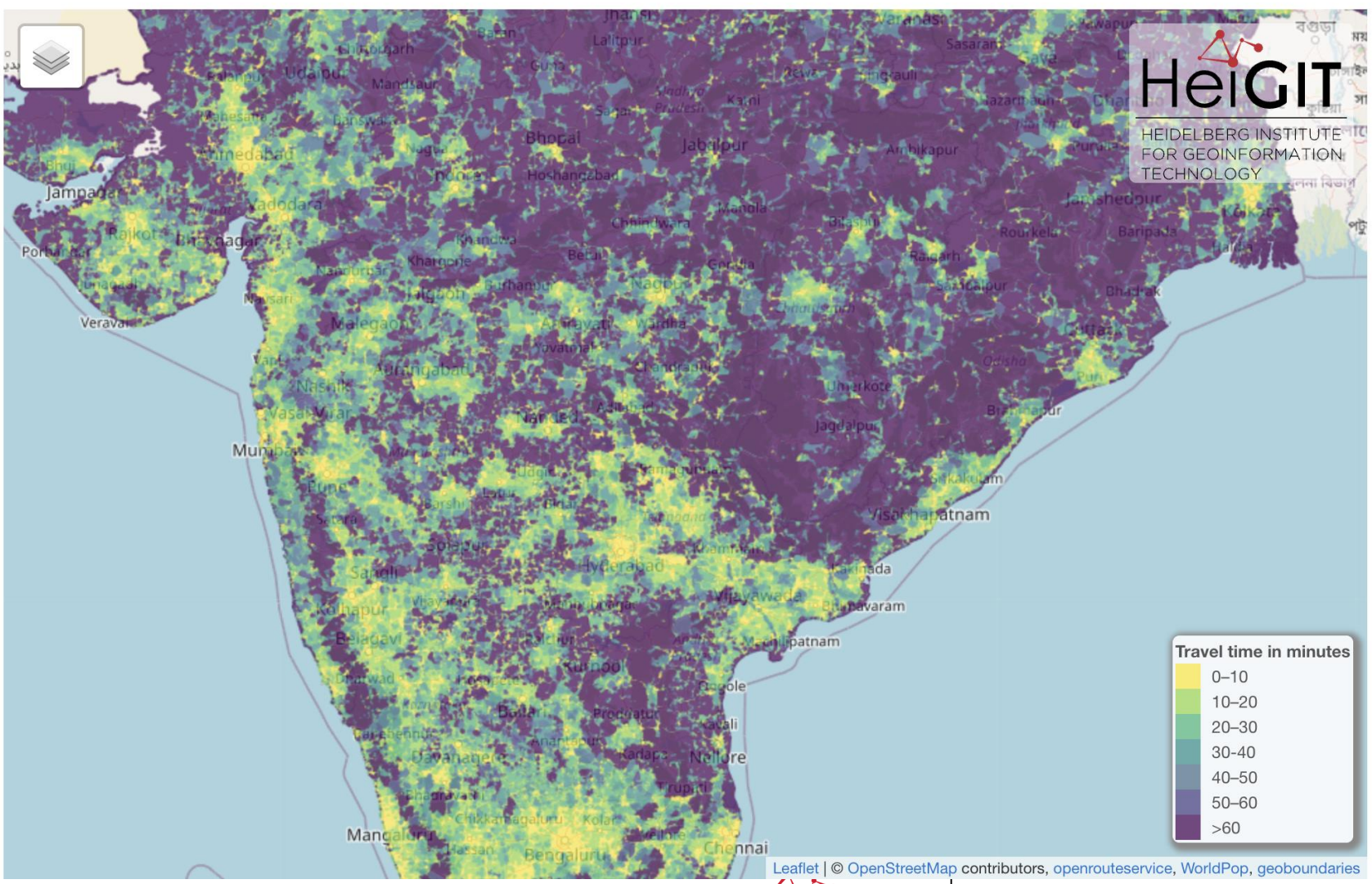
COVERAGE BY TRAVEL TIME



767,664,017 (54.55 %) people live within less than 30 minutes travel time (motorized) to the next facility.

958,809,843 (68.13 %) live within less than 60 minutes travel time to the next facility.

448,335,866 (31.86 %) live further away than 60 minutes travel time to the next facility.



Please note, this is a proof of concept implementation. For further information please refer to the about tab.

### LAYER CONTROLS

Select the scale of interest ?

National

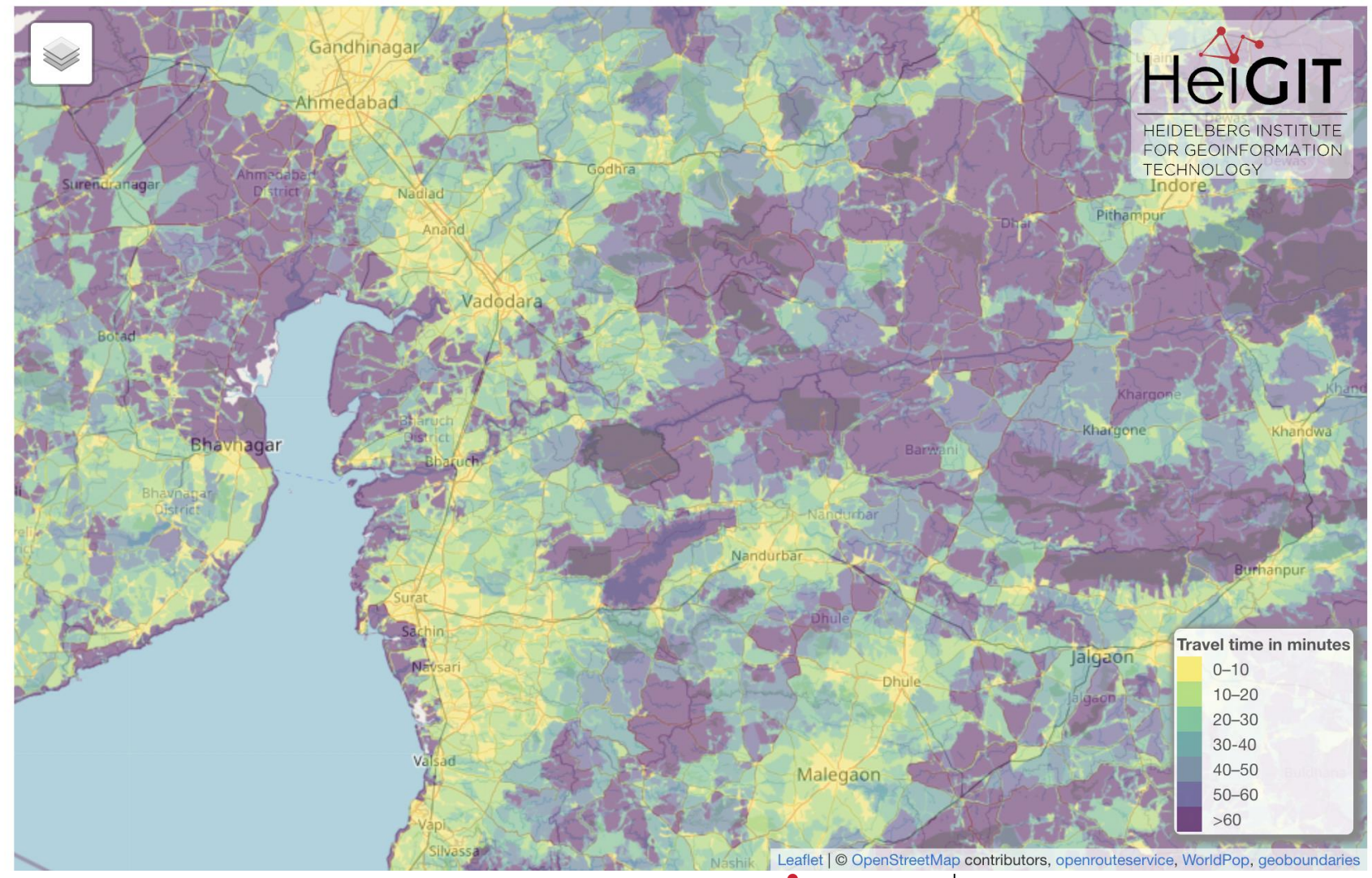
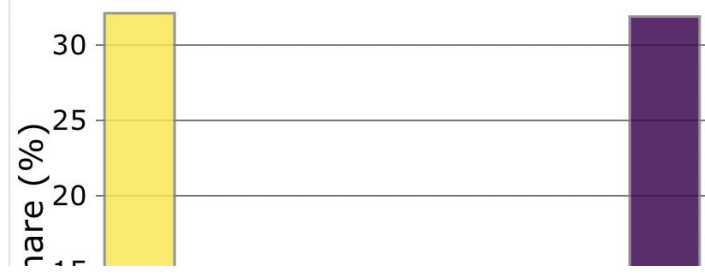
Select the type of facilities ?

Both types

Layer Opacity  Overlay Facilities

BACK TO OVERVIEW

### COVERAGE BY TRAVEL TIME





# Open Healthcare Access Map

Please note, this is a proof of concept implementation. For further information please refer to the about tab.

### LAYER CONTROLS

Select the scale of interest ?

National

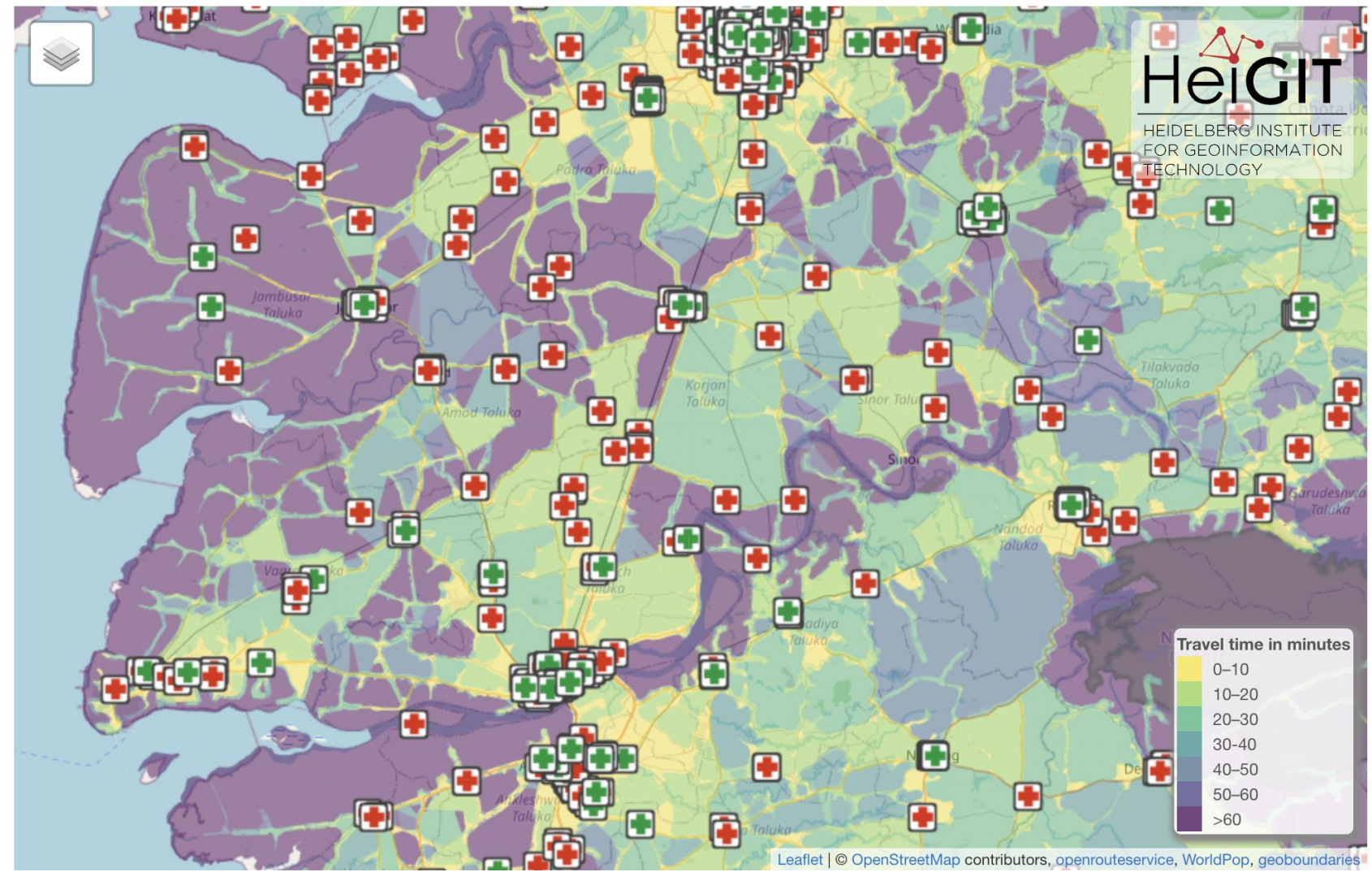
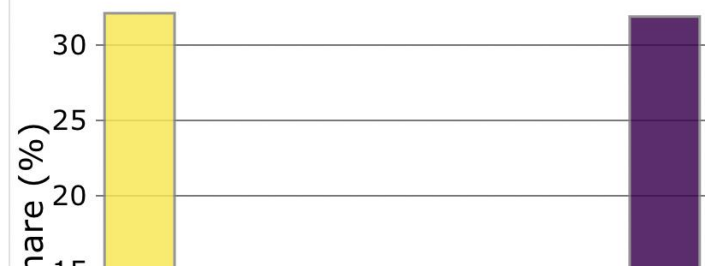
Select the type of facilities ?

Both types

Layer Opacity  Overlay Facilities

BACK TO OVERVIEW

### COVERAGE BY TRAVEL TIME



Leaflet | © OpenStreetMap contributors, openrouteservice, WorldPop, geoboundaries

Please note, this is a proof of concept implementation. For further information please refer to the about tab.

India

LAYER CONTROLS

Select the scale of interest ?

National

Select the type of facilities ?

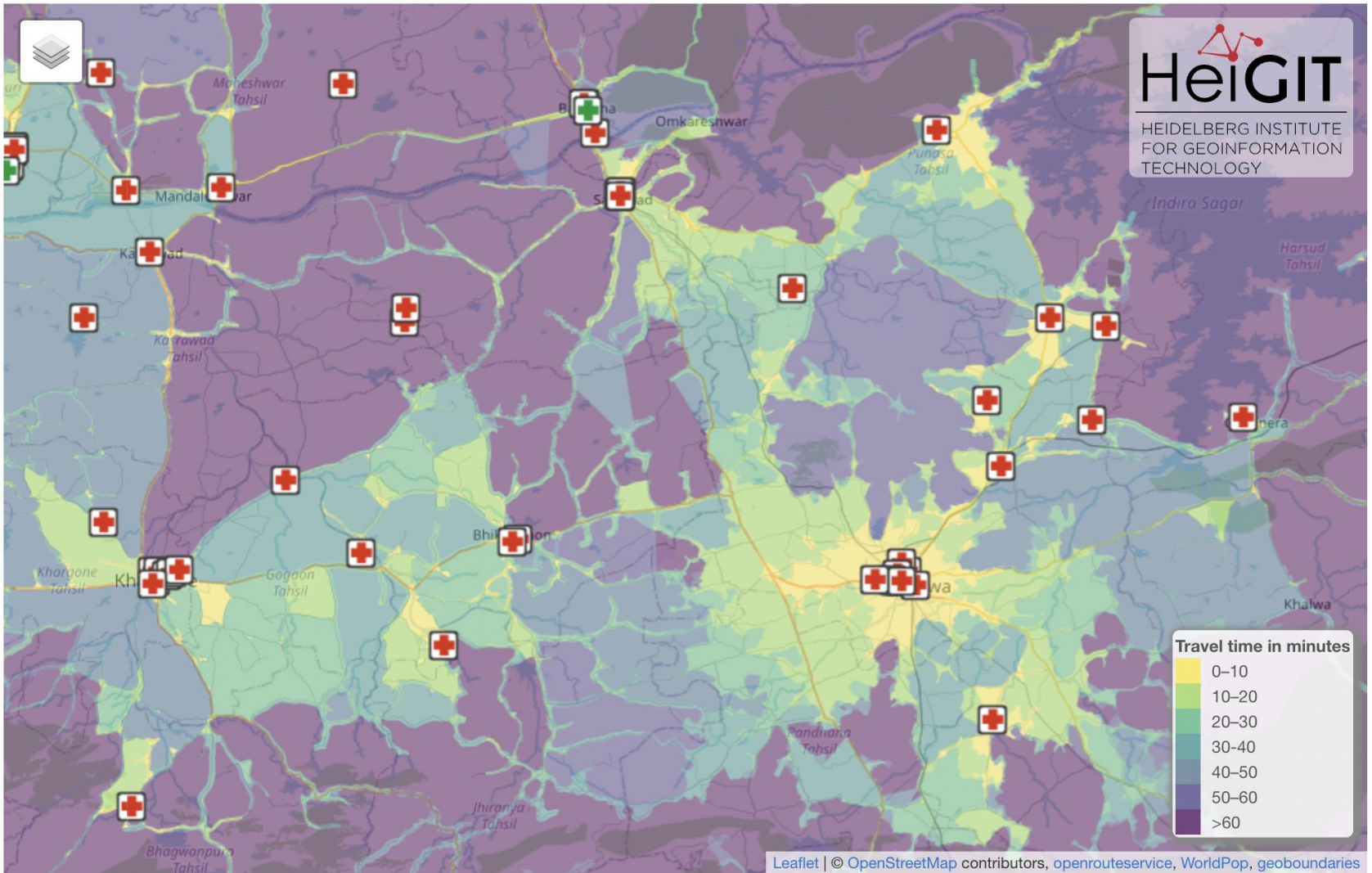
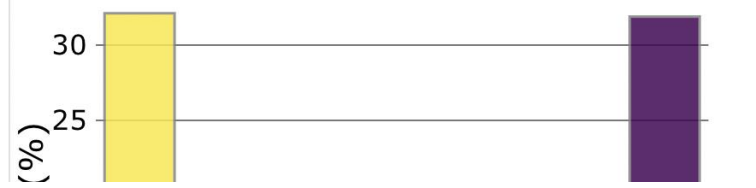
Both types

Layer Opacity Overlay Facilities

BACK TO OVERVIEW

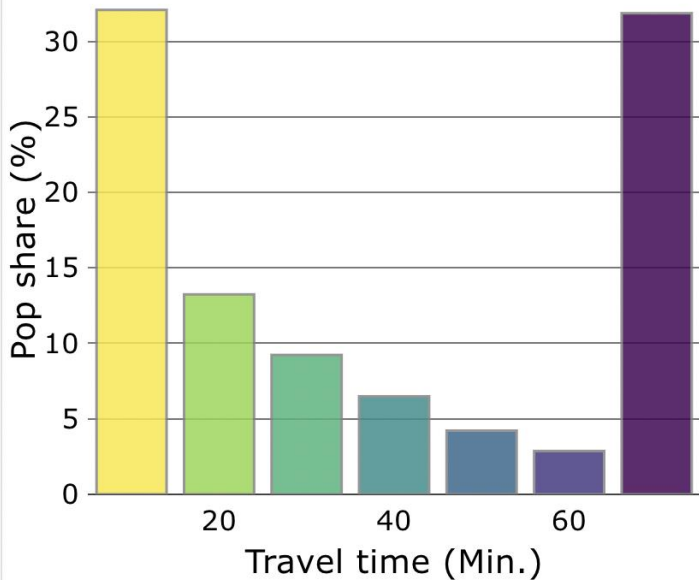
COVERAGE BY TRAVEL TIME

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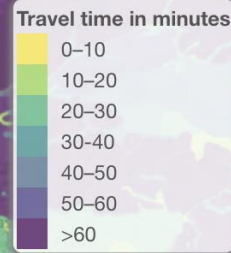
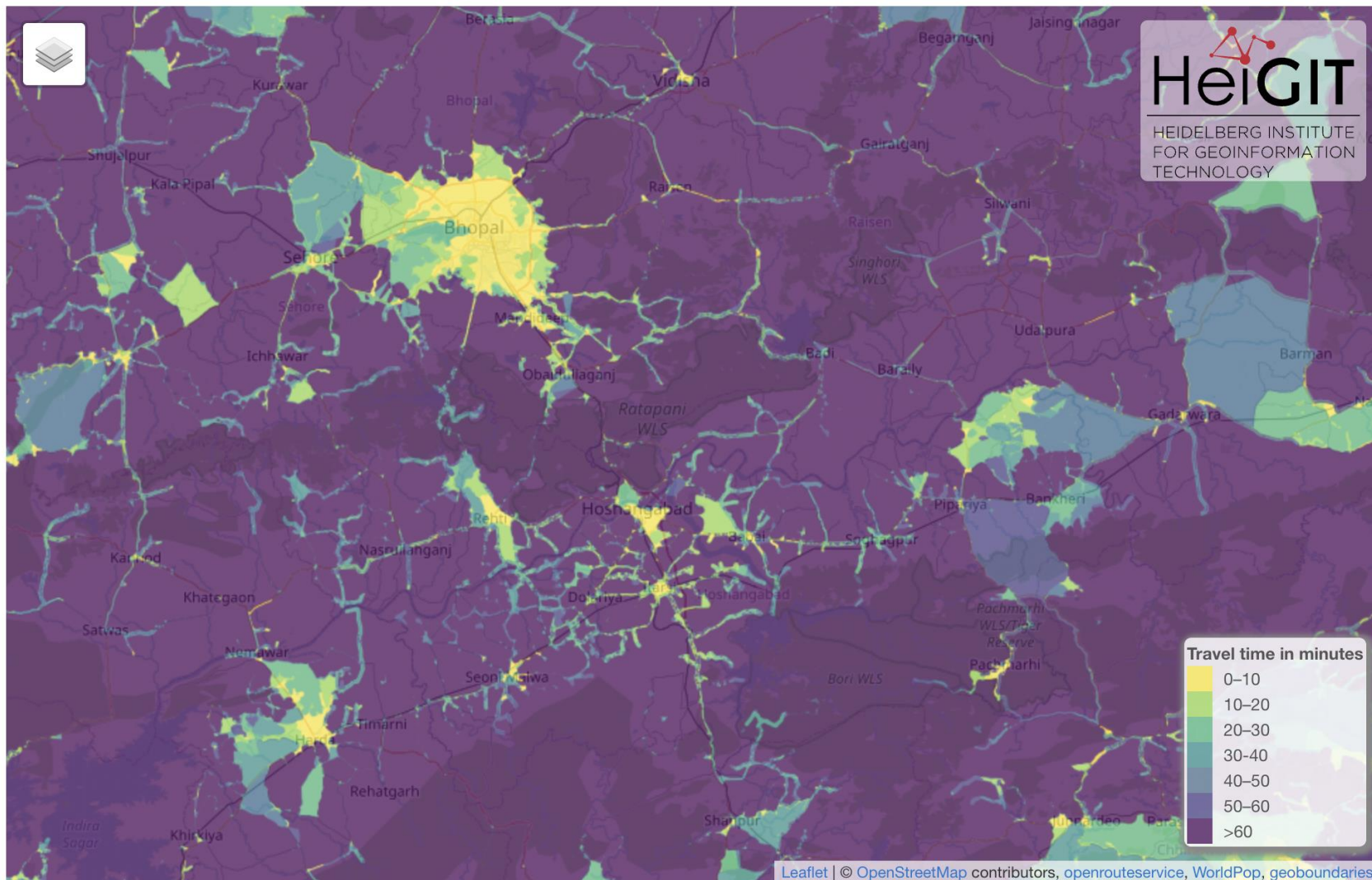
COVERAGE BY TRAVEL TIME



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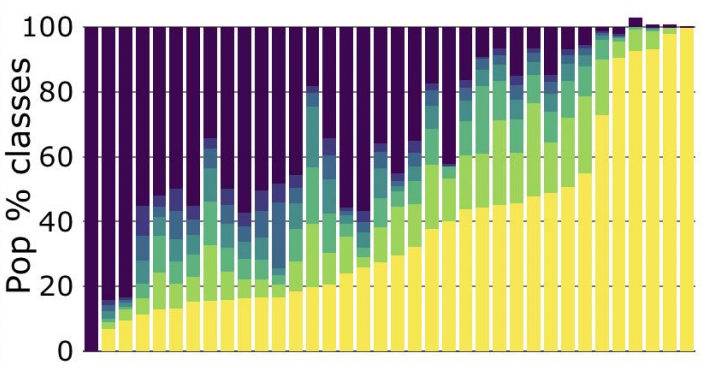
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Please note, this is a proof of concept implementation. For further information please refer to the about tab.

BACK TO OVERVIEW SWITCH TO HISTOGRAM

COVERAGE WITHIN ADMIN UNITS



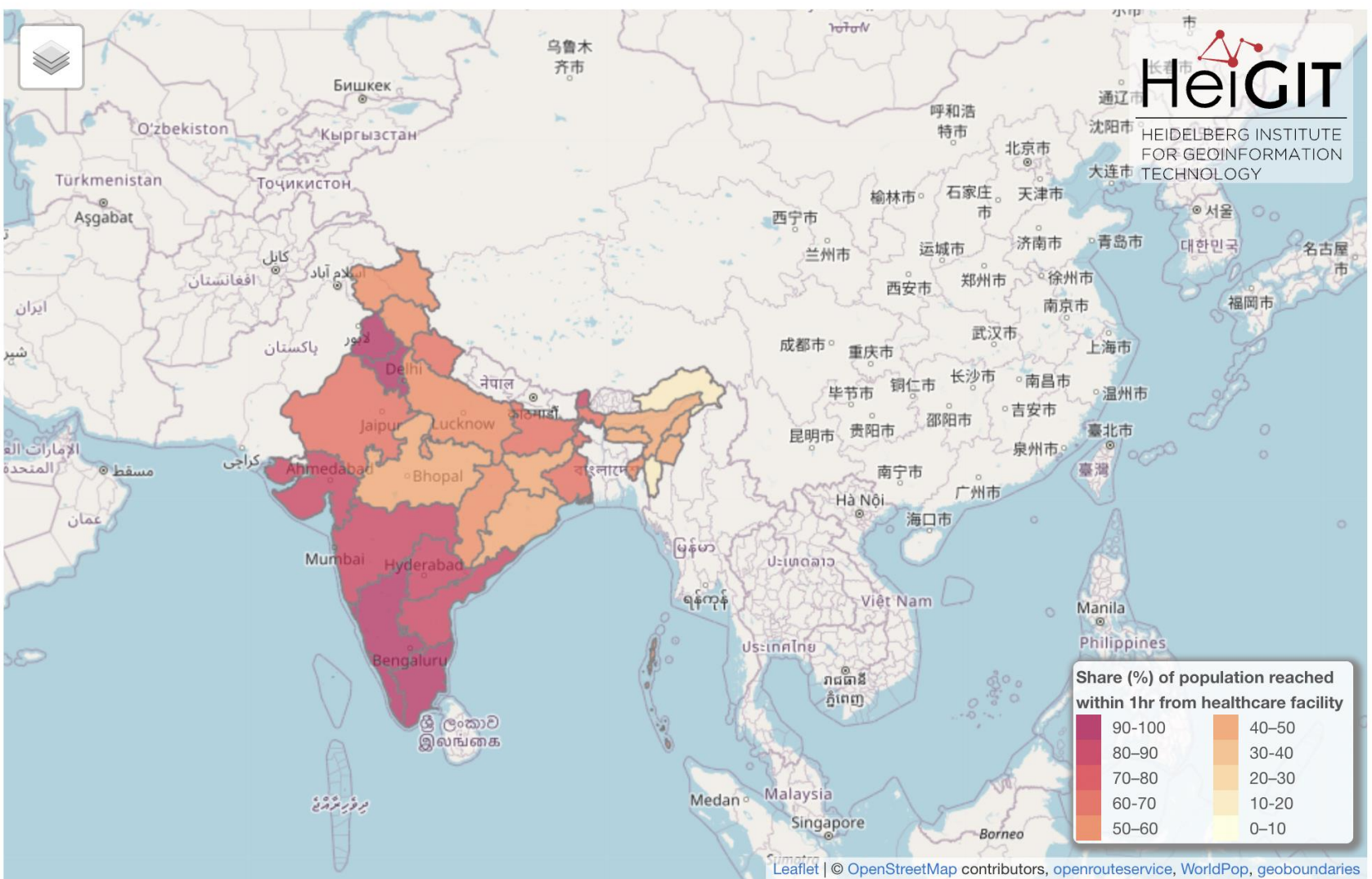
Units (admin level 1)

Travel time in minutes

- >60
- 60
- 50
- 40
- 30
- 20
- 10

Within 30 minutes travel time, 18 / 36 unit(s) cover more than 50% of people.

Within 60 minutes, 26 / 36 unit(s) cover more than 50% of people. 10 unit(s) cover less.

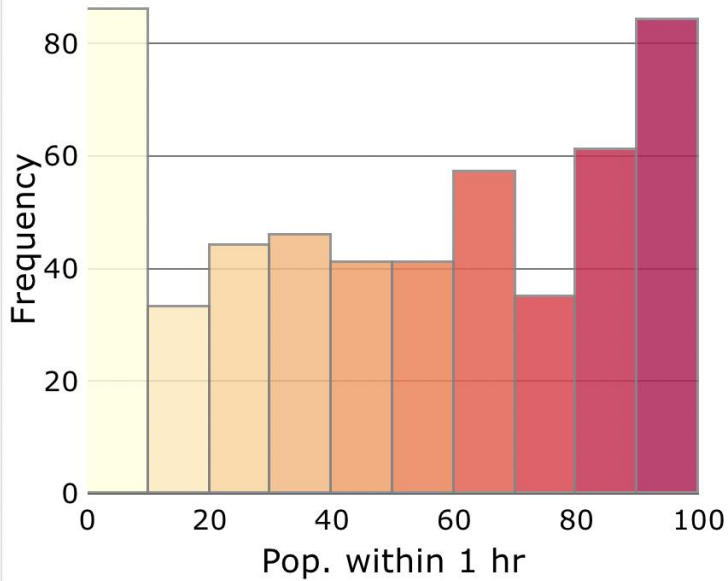


Share (%) of population reached within 1hr from healthcare facility

90-100	40-50
80-90	30-40
70-80	20-30
60-70	10-20
50-60	0-10

Please note, this is a proof of concept implementation. For further information please refer to the about tab.

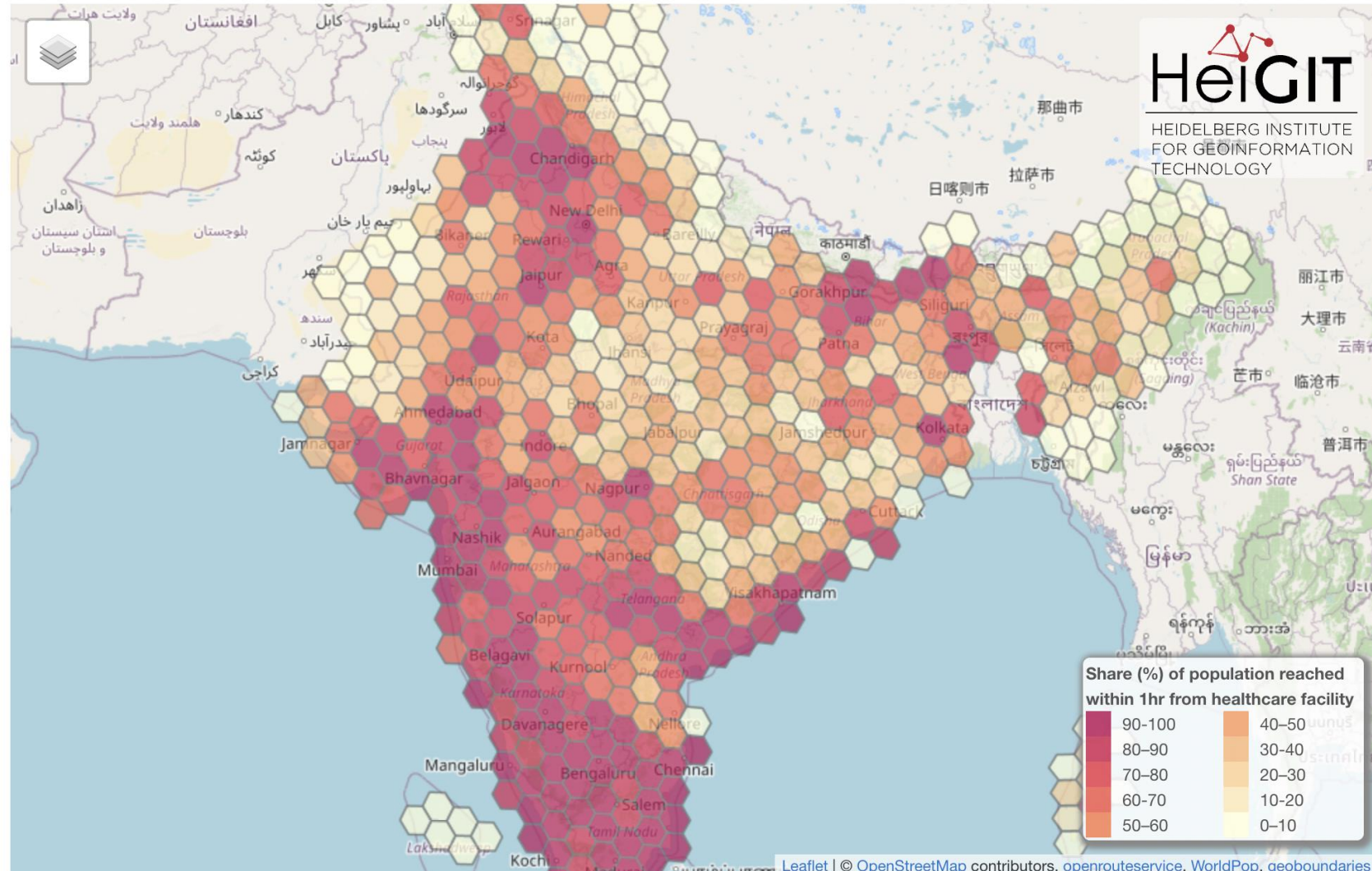
### COVERAGE WITHIN HEXBINS



Within 30 minutes travel time, 198 / 528 unit(s) cover more than 50% of people.

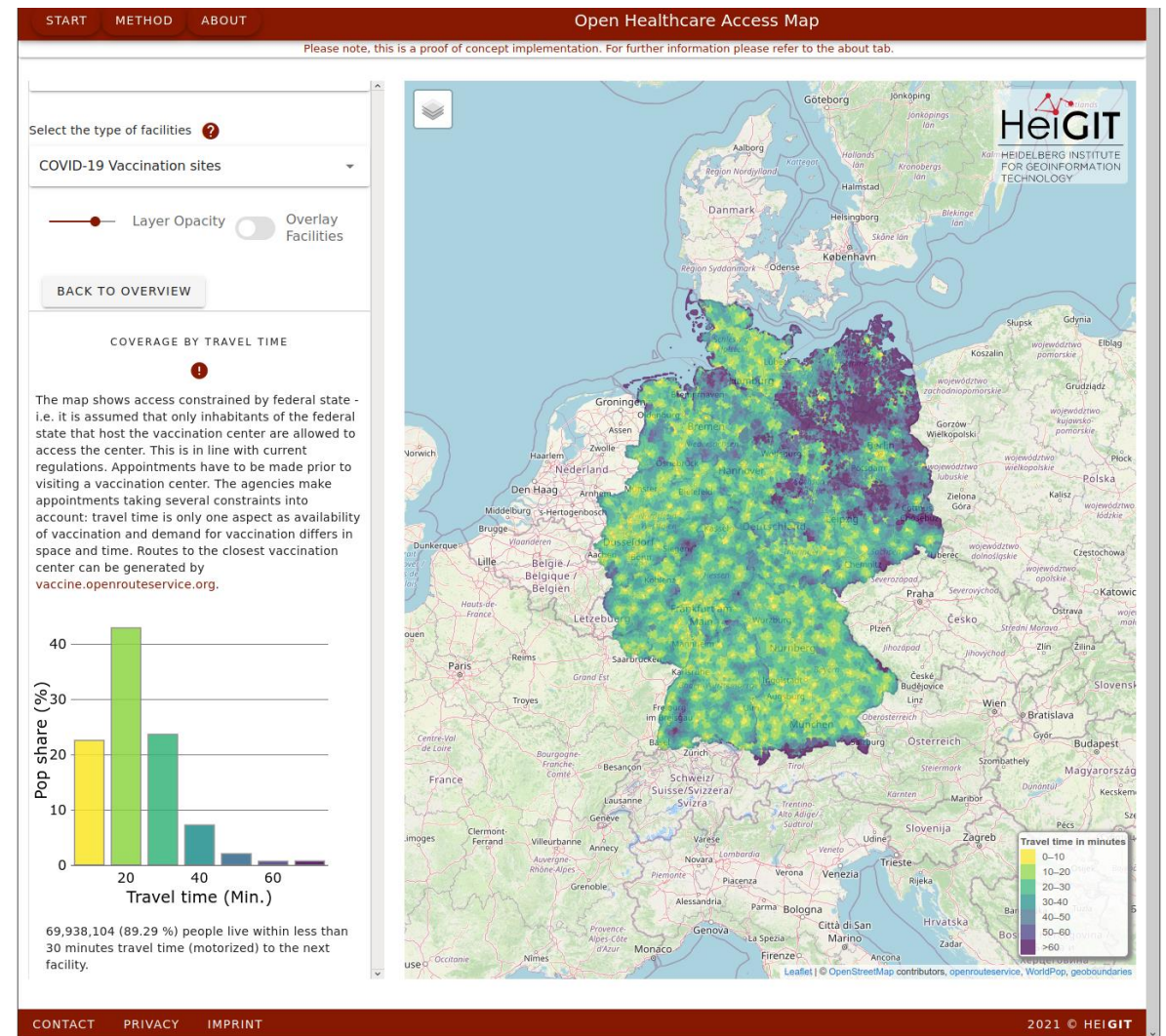
Within 60 minutes, 278 / 528 unit(s) cover more than 50% of people. 250 unit(s) cover less.

385 / 528 unit(s) cover more than 25% of people. 143 unit(s) cover less.



# Healthcare Accessibility COVID 19 temporal vaccination centers

- Travel time to closest COVID-19 vaccination center
  - per federal state (German rule)
  - ORS & OSM vaccination center sites
- Majority of population in less than 30 minutes driving time but regional differences



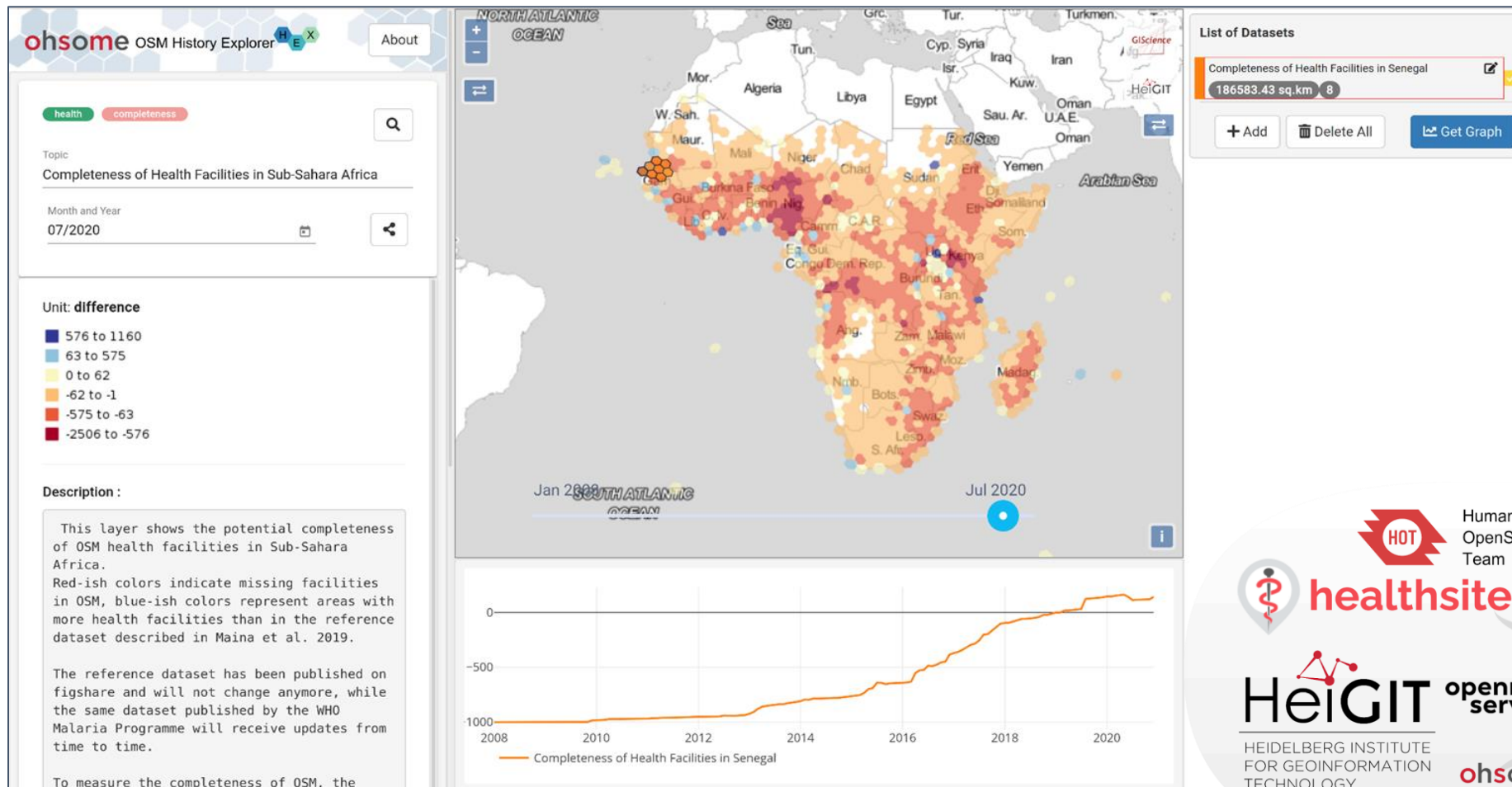
# OSM Data sources

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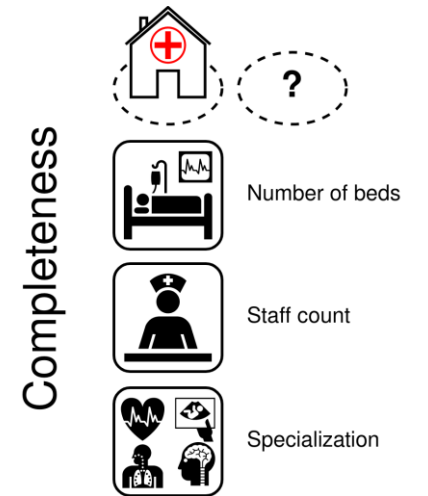
Here is a list of all healthcare related tags used in this application:

Facility Type	Relevant Tags	Description
Primary care	<pre>{amenity,healthcare}=doctors {amenity,healthcare}=clinic healthcare=midwife healthcare=nurse healthcare=center amenity=health_post</pre>	Provision of ambulant, preventive care as well as monitoring and check-ups. E.g. health centers, general practitioners and clinics.
Secondary and tertiary care	<pre>amenity=hospital or healthcare=hospital</pre>	Provision of inpatient care.
COVID-19 Vaccination Centers	<pre>vaccination=covid19</pre>	(Temporary) medical facilities for mass vaccination against COVID-19

# Completeness of Health Facilities in Sub-Sahara Africa



## Kemri vs OSM



<http://ohsome.org>

<http://giscienceblog.hd.de/2020/04/17/osm-completeness-of-health-facilities-in-sub-sahara-africa>

heigit.org --- uni-heidelberg.de/gis



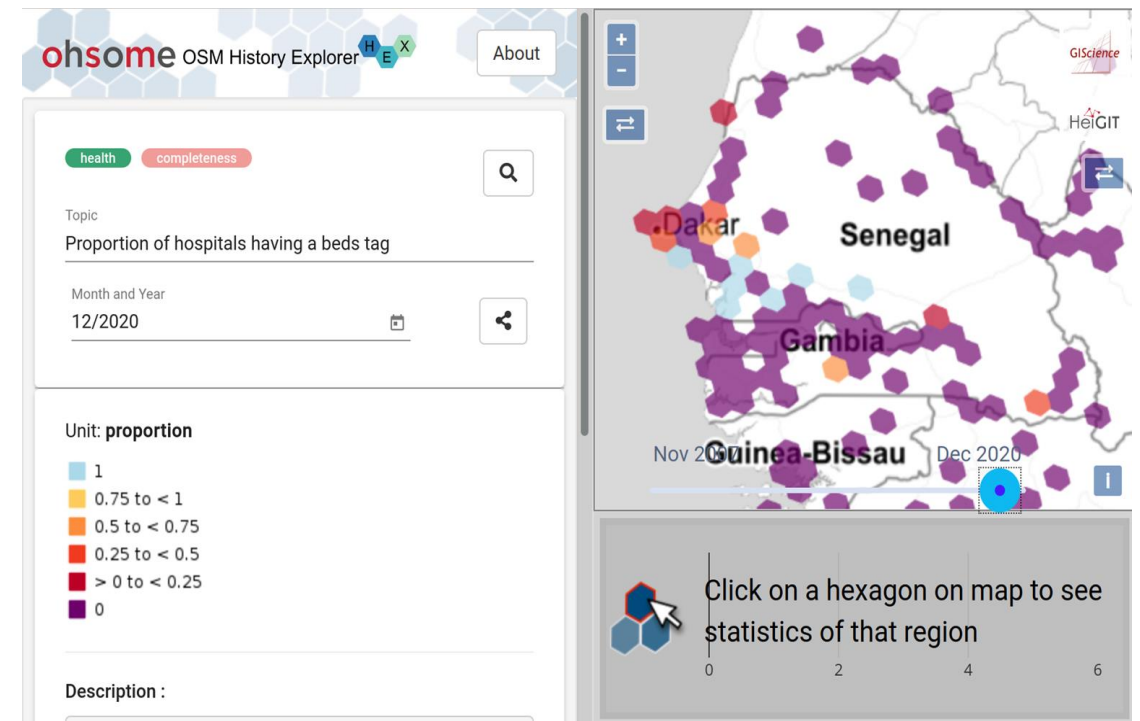
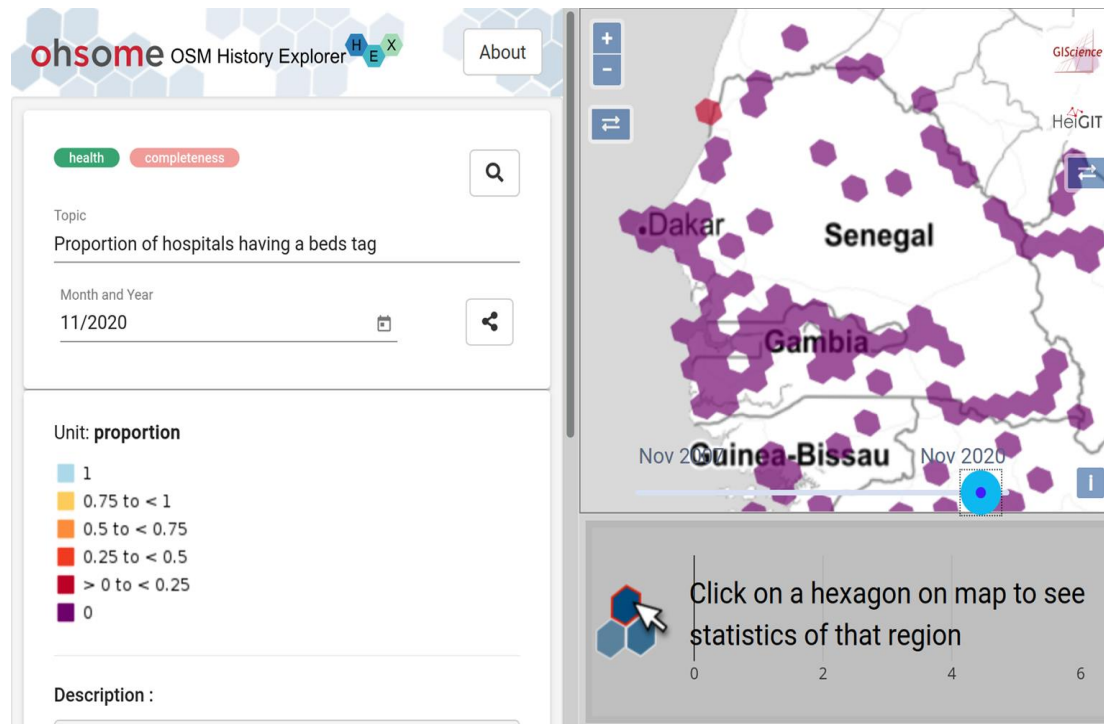
# Example: Healthcare in Subsahara-Africa (hospitals with bed tag)

ohsome  results 

<http://ohsome.org>

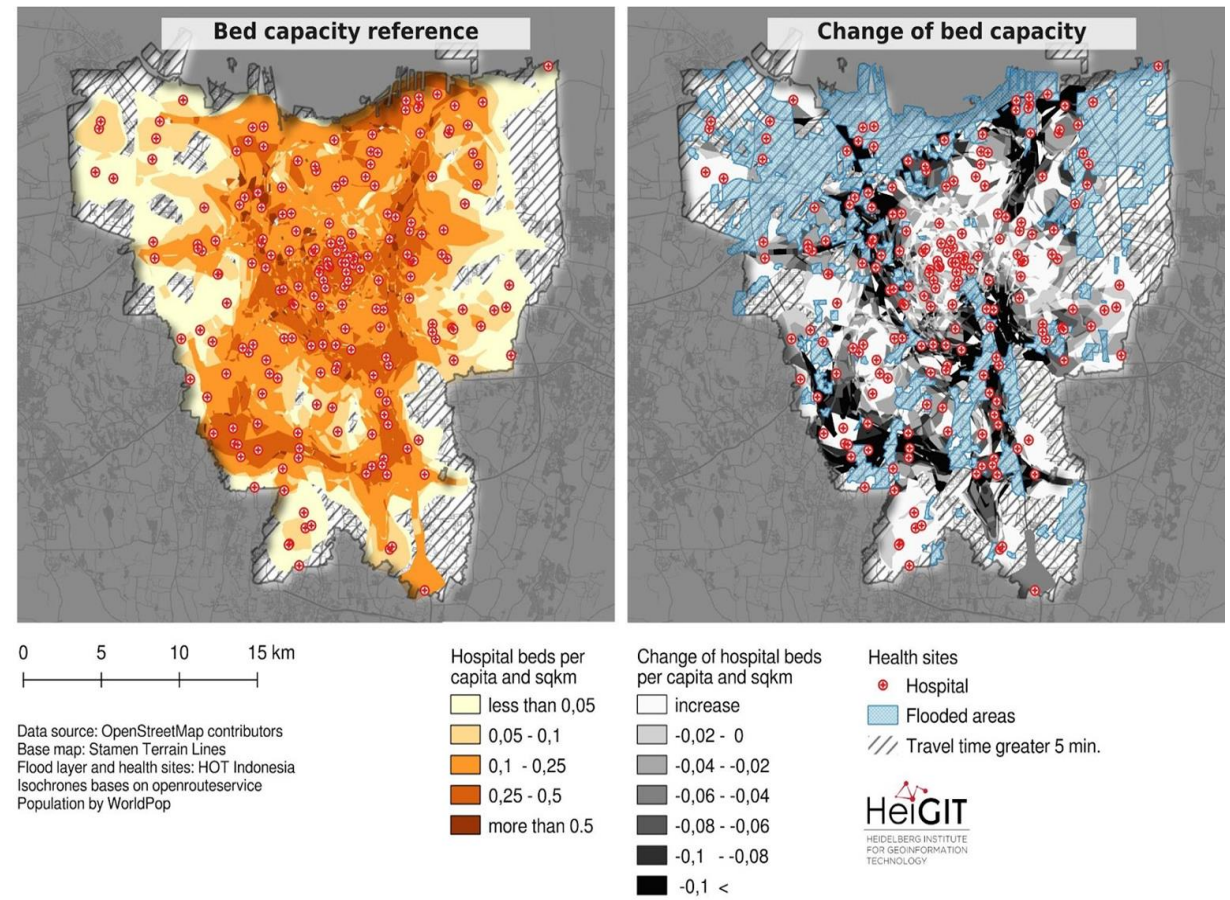
November 2020 - before the campaign

December 2020 - after the campaign



# Healthcare Accessibility after disasters

- *How resilient / vulnerable is the infrastructure in face of disaster?*
- **Example impact of 2013 flood event on road network connectivity & access to health sites in Jakarta**
- Analysis of effect of flood on
  - accessibility to hospitals & clinics
  - demand (population) & supply (bed capacity) relationship
- Accessibility assessment based on ORS

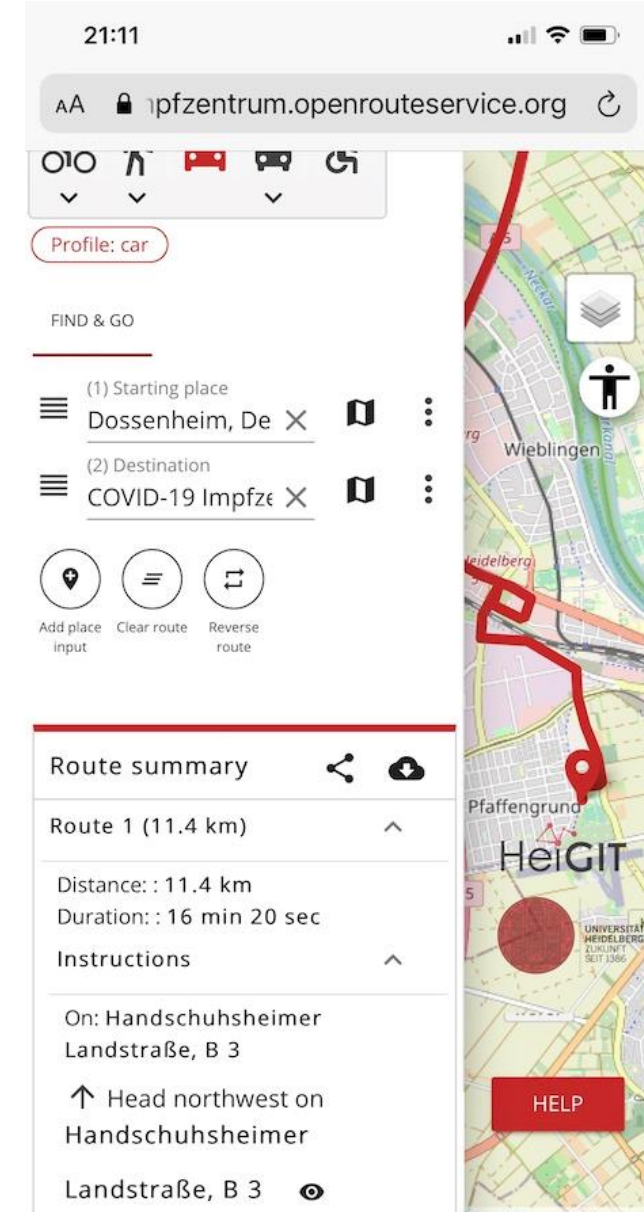
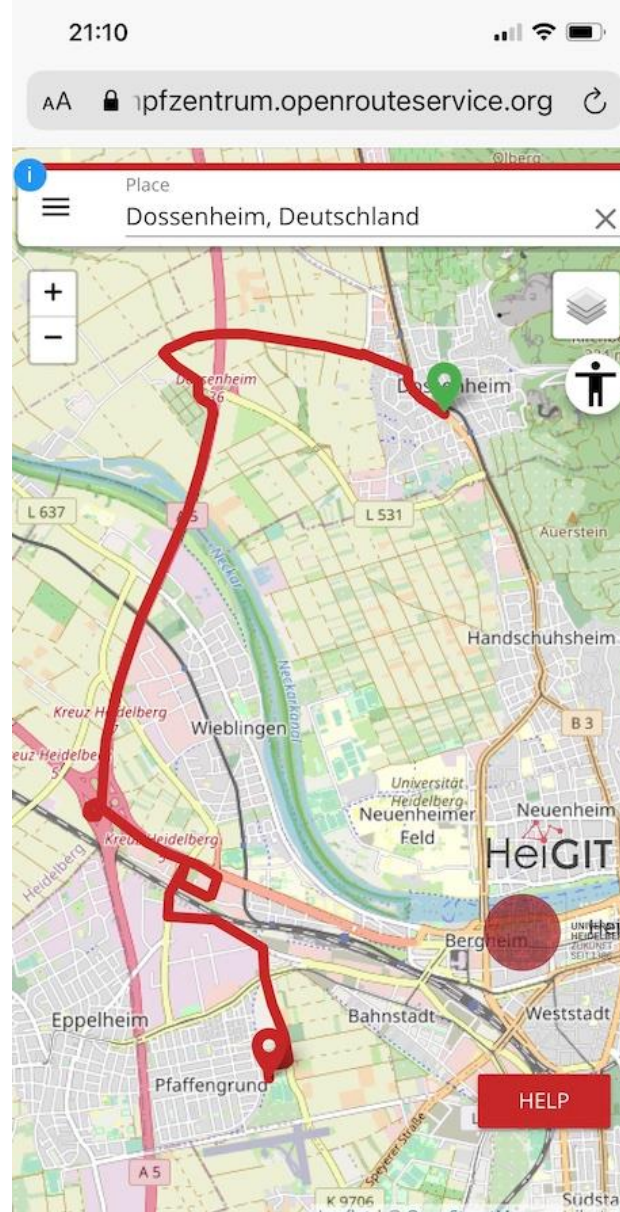


Klipper, I.; A. Zipf, S Lautenbach (2021): [Flood Impact Assessment on Road Network & Healthcare Access at the example of Jakarta, Indonesia.](#)

AGILE GIScience, 2,4, doi.org/10.5194/agile-giss-2-4-2021

# Covid-19 Vaccination Center Routing App

- OSM
- ORS
- Germany
- mobile client



# Wheelchair routing in openrouteservice

Generated routing network parameters and corresponding OSM tags.

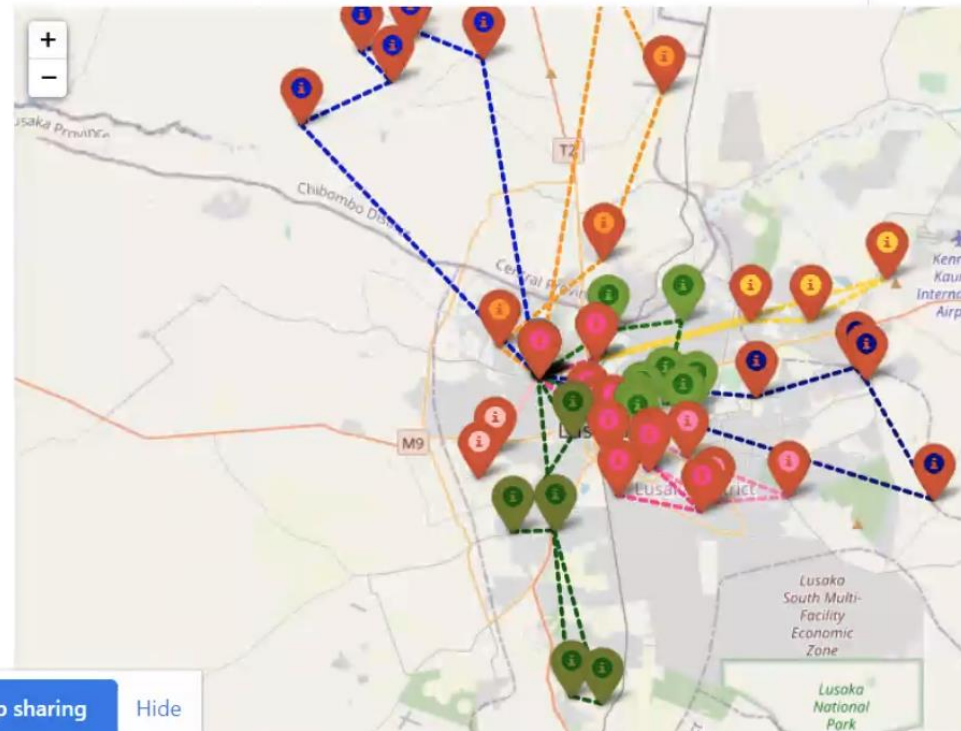
Parameter	OSM Coding (key = value; if several values possible, they are separated by a " " or by a note)
Type of street	<i>highway = living_street<sup>a</sup></i>
Sidewalk	<i>footway = left right yes no both</i> <i>sidewalk = left right yes no both</i>
Sidewalk Width	<i>sidewalk(:left :right):width = *</i>
Sidewalk Surface	<i>sidewalk(:left :right):surface = paved<sup>b</sup></i>
Sidewalk Smoothness	<i>sidewalk(:left :right):smoothness = good<sup>c</sup></i>
Sidewalk Slope/Incline	<i>sidewalk(:left :right):incline = *</i>
Sidewalk Curb/Kerb	<i>sidewalk(:left :right):sloped_curb(:start :end) =</i>
Lighting	<i>lit = yes no</i>
Tactile Paving	<i>tactile_paving = yes</i>
Steps	<i>step_count = *</i>
Step Height	<i>step:height = *<sup>d</sup></i>
Ramp	<i>highway = steps</i> <i>ramp = yes</i> <i>ramp:wheelchair = yes</i> <i>ramp:stroller = yes</i>
Handrail	<i>handrail(:left :right :center) = yes no left right both center</i>
Crossing	<i>highway = crossing or footway = crossing</i> <i>crossing = traffic_signals uncontrolled island</i> <i>traffic_signals:sound = yes no</i> <i>traffic_signals:vibration = yes no</i> <i>supervised = yes no</i>
General Access	<i>foot = yes no, wheelchair = yes no</i>




# USAID - Global Health Supply Chain

- Use ORS (Matrix API) in own Logistics-Software „Last Mile Optimization“
- Distribute goods (Medicine) von Frachtzentren zu recipient  
medical value ca. 120 Mio US\$ p.a. in Sambia, to >1.800 clinics, health facilities
- Pilot Sambia: ZAMMSA Challenge: **DATA**  
**Summary Statistics**

9	131	92.2%
Routes	Volume (m³)	Utilization
56	400	59
Stops	Distance (KM)	Fuel (L)
		Cost (ZK)



- ✓ AIDS Health Care Foundation Chifundo (4.92 cubic meters)
- ✓ Arakan Camp Hospital (0.69 cubic meters)
- ✓ Bauleni Urban Health Center (4.58 cubic meters)
- ✓ Bwafwano Home Based Care (0.47 cubic meters)
- ✓ Chainda Urban Health Center (0.33 cubic meters)
- ✓ Chaisa Health Centre (4.54 cubic meters)
- ✓ Chazanga Urban Health Center (4.39 cubic meters)
- ✓ Chelstone Urban Health Center (4.10 cubic meters)
- ✓ Chest Diseases Laboratory (0.73 cubic meters)
- ✓ Chilenje 1st Level Hospital (0.76 cubic meters)
- ✓ Chimanga Clinic (4.08 cubic meters)
- ✓ Chreso Ministries-Lusaka (3.13 cubic meters)

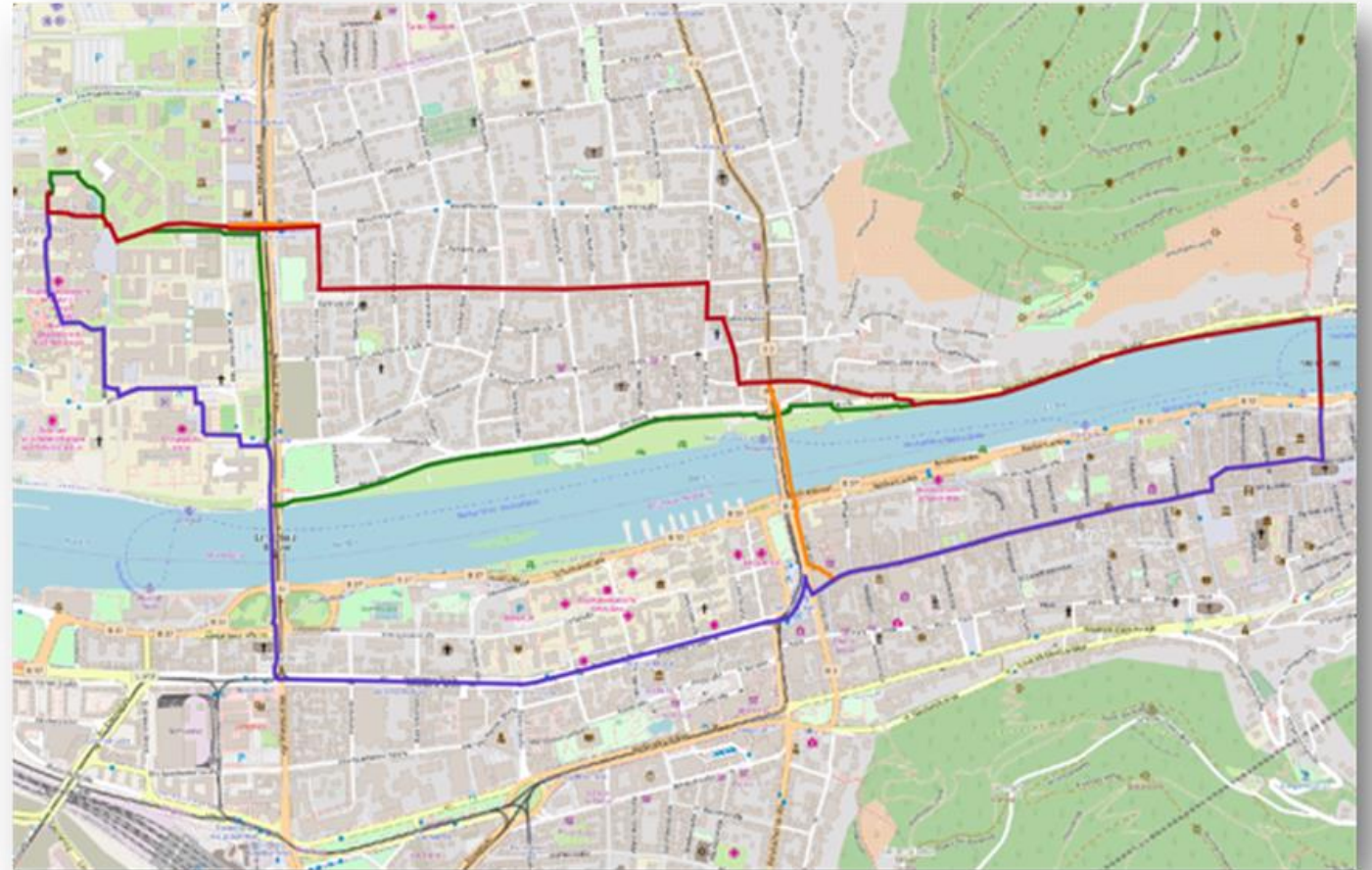
# DisasterORS (Mozambique avoid flooded areas, Ahrtal, Copernicus)

The screenshot displays the openroute service interface. The search bar shows the start point as 'Dernau, RP, Germany' and the end point as 'Bad Neuenahr-Ahrweiler, RP, Germany'. The route details section indicates a distance of 17.1 km and a duration of 27 min 53 s. The map view shows a red route from Dernau to Bad Neuenahr-Ahrweiler, with a blue-shaded area representing a flooded region. The interface also includes a 'Routendetails' section and a 'Wegbeschreibung' section.

The right side of the image shows a map of Mozambique with a red route from Dondo to Tanklam. A red box titled 'Response to Cyclone Idai' provides instructions on how to avoid flooded areas by drawing polygons around them. The map also shows a 'Choose your region' dropdown menu with options for Africa, Indonesia, and South America.

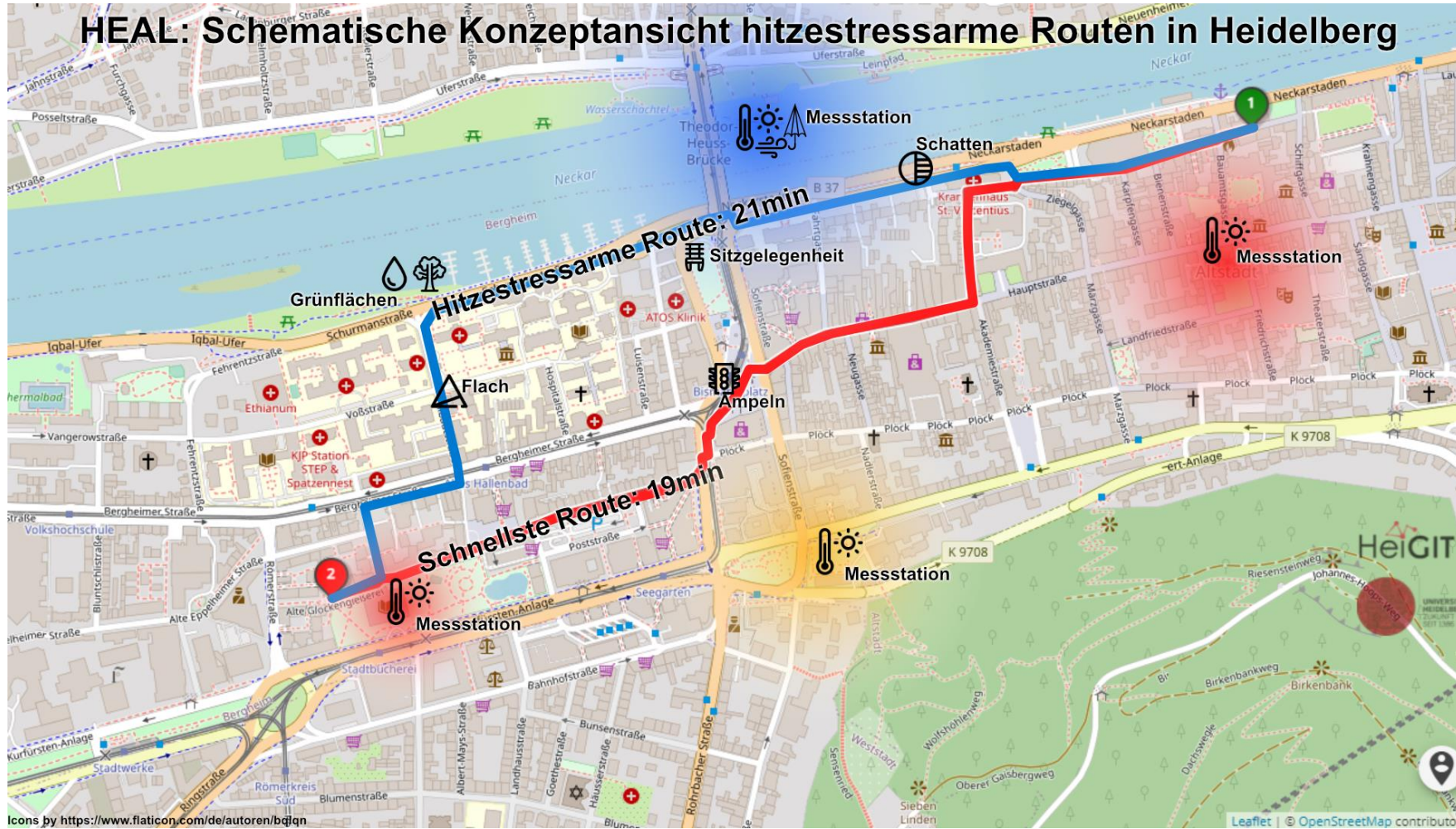
# Healthy routing with ORS

- Prefer shorter routes  
1/10 score    5/10 score    10/10 score
- Prefer streets with green areas  
2/10 score    10/10 score
- Prefer streets with social places  
1/10 score    5/10 score    10/10 score
- Avoid noisy streets  
2/10 score    10/10 score



Novack, T., Wang, Z., Zipf, A. (2018): A System for Generating Customized Pleasant Pedestrian Routes Based on OpenStreetMap Data.  
Sensors, 2018, 18, 3794.

# HEAL – Heat stress avoiding routes





# Solar Radiation index of streets in Heidelberg

Model using **buildings only**



1.July, 12 pm

Model using **buildings + vegetation**

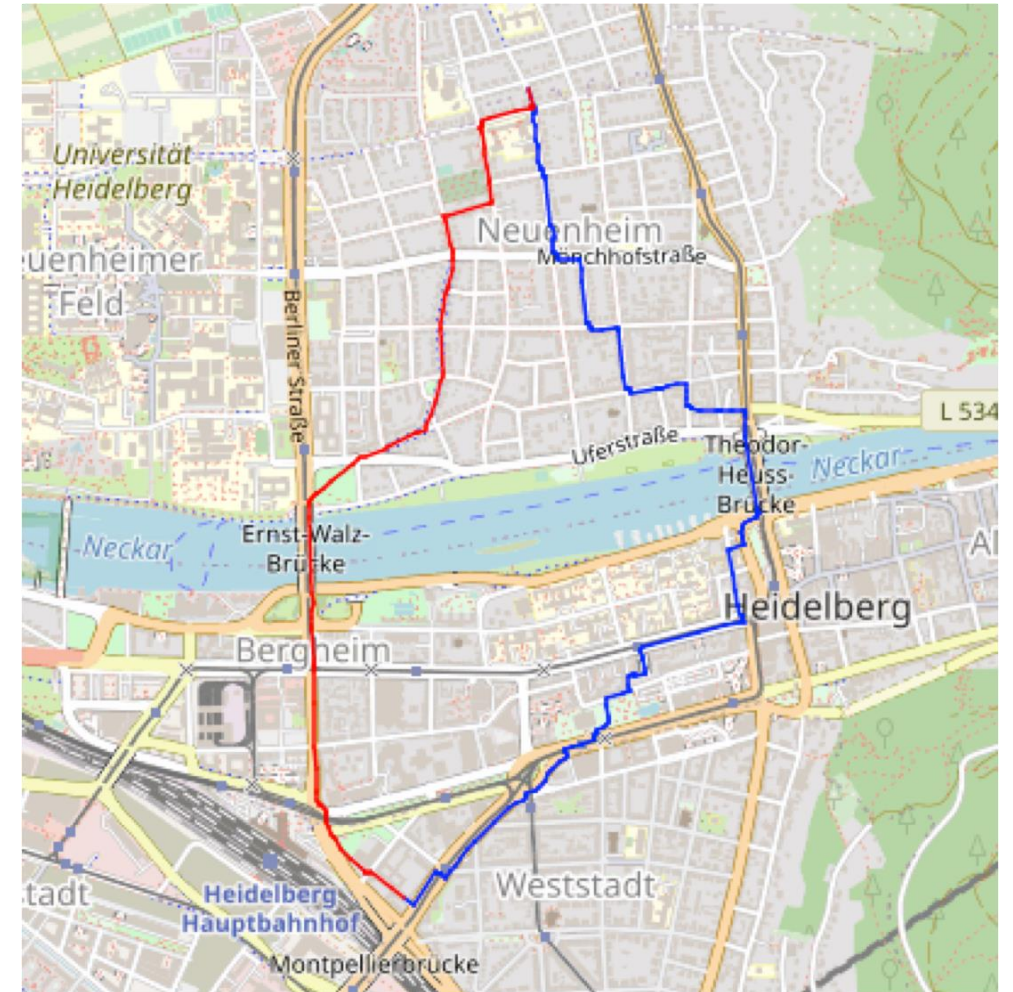
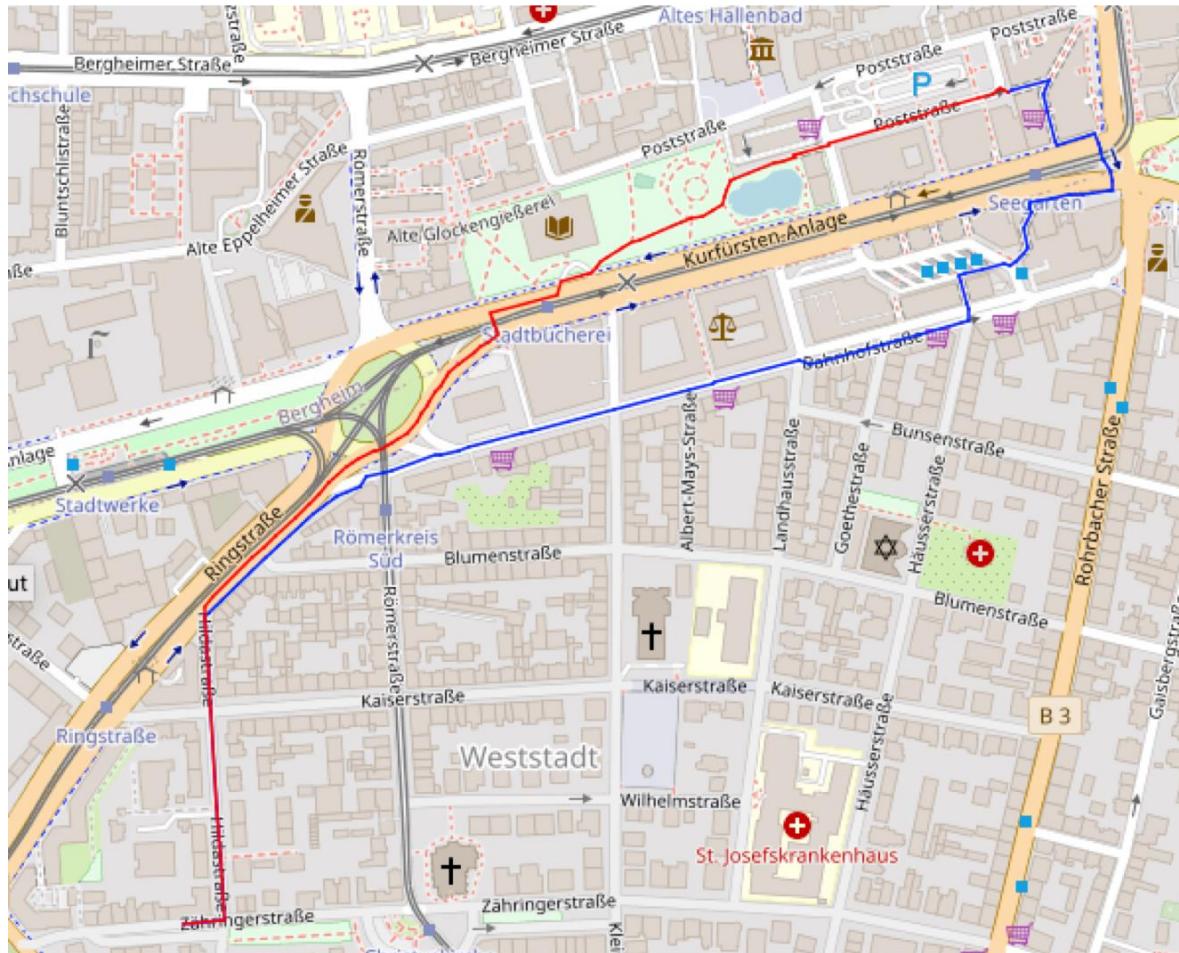


1.July, 12 pm

Solar radiation Index [%]

- 0
- 25
- 50
- 75
- 100

# Shadow route versus shortest route (HD)



Shadow route



Shortest route

[heigit.org](http://heigit.org) --- [uni-heidelberg.de/gis](http://uni-heidelberg.de/gis)



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TECHNOLOGY

# Thank you! Questions?

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**Feel free to share your needs & requirements.**

**Ideas for improvement welcome!**

**We love to collaborate!**

**Thank you!**

Prof. Dr. Alexander Zipf

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[zipf@heigit.org](mailto:zipf@heigit.org)

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