HOPE – Human mObility PrEdiction

Supported by:

In cooperation with:

WROCŁAWSKI INSTYTUT ZASTOSOWAŃ INFORMACJI PRZESTRZENNEJ I SZTUCZNEJ INTELIGENCJI

The Wroclaw Institute of Spatial Information and Artificial Intelligence

Commercialization of state-of-the-art scientific concepts related to the geospatial domain

- Est. 2012
- ~30 employees
- 1 Prof., 2 PhDs, 2 PhD candidates
- Offices: Wroclaw, Warsaw, Poznań

- AI (deep learning, ANNs)
- Graph databases
- Semantic web
- Entity and relation extraction

- Geospatial analysis
- Image analysis (EO)
- Aviation geomatics
- Digitization

Droneradar

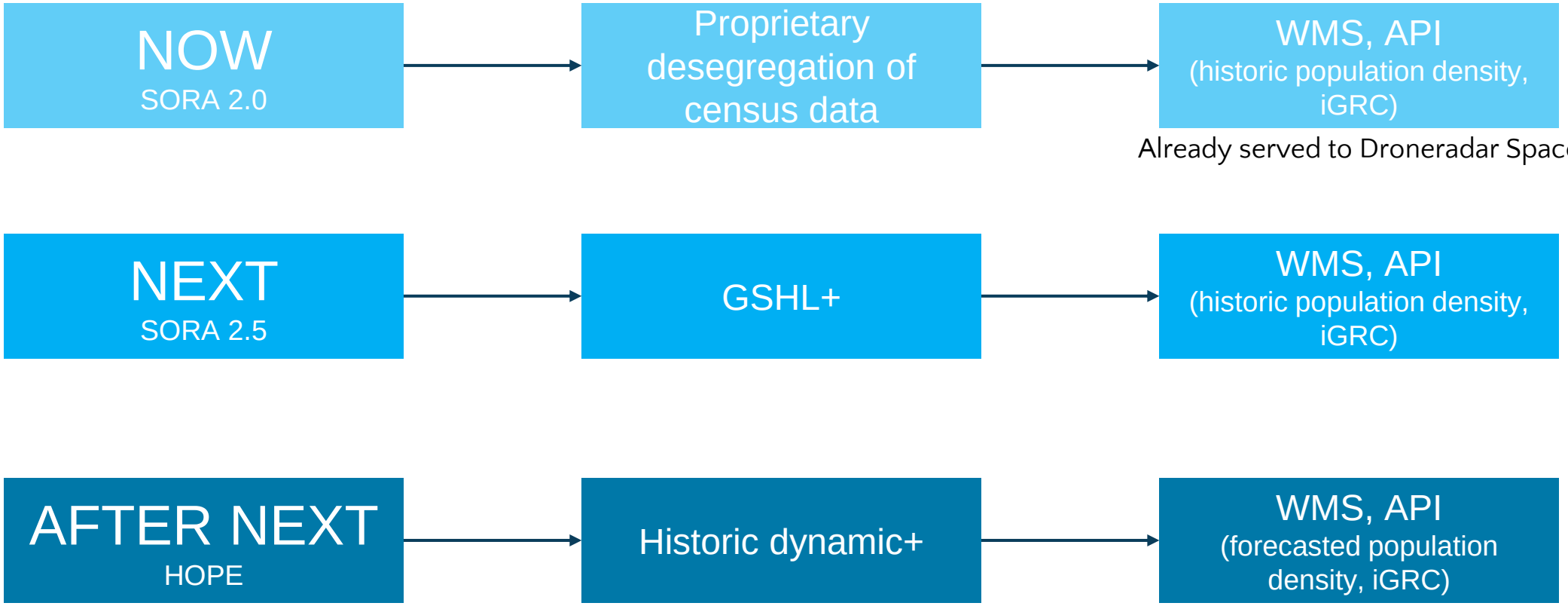
- 10 emploeyes
- Located in Warsaw/Poland

- Aviation related IT projects and platforms

- Droneradar mobile
- Droneradar Space (in consortium with WIZIPISI)

Where are we now and where are we heading in terms of population modeling

Timeline


NOW
SORA 2.0
Proprietary desegregation of census data
WMS, API
(historic population density, iGRC)
Already served to Droneradar Space
NEXT
SORA 2.5
GSHL+
WMS, API
(historic population density, iGRC)
AFTER NEXT
HOPE
Historic dynamic+
WMS, API
(forecasted population density, iGRC)

HOPE – assumptions

HOPE – Technical parameters

- Output spatial resolution – 10m x 10m
- Temporal resolution:
  - Daily changes – 1h/0,5h
  - Weekly changes and bank holidays
  - Seasonal changes
- Population density categorisation not worse than required by SORA
- Integrated sheltering layer (-> M1)

- Delivery: web service (WMS/API)
- Designed with SORA automation in mind

- Prototype service for Wroclaw, pre-production in 18 months

Technical overview

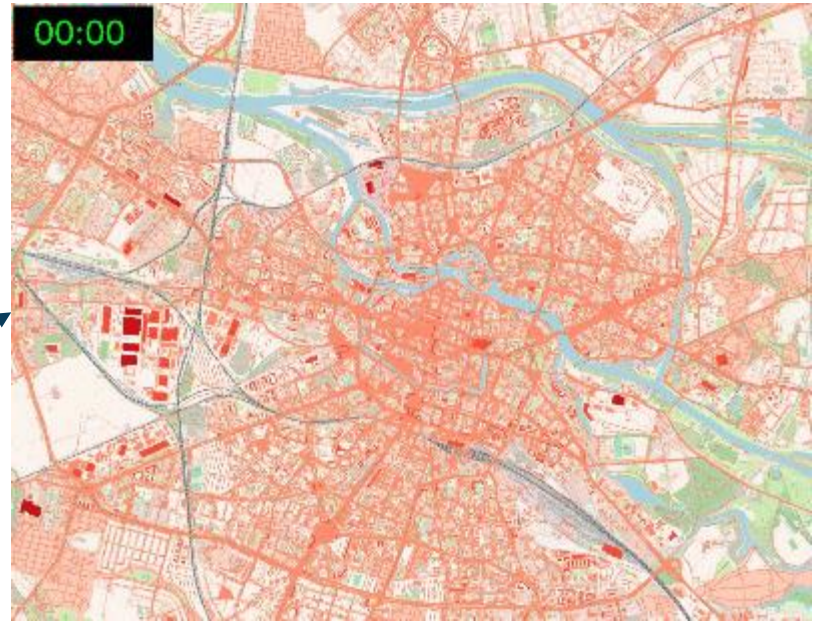
Maximum, most probable in the given area at the given time, **forecasted congestion of human** beings categorized in quantitative classes.

Quantitative Population Value (ppl/km2)	< 25	< 250	< 2,500	< 25,000	< 250,000	> 250,000
Qualitative Description	Rural	Sparsely Populated	Suburban	Urban	Dense Urban	Assembly of people 10,000 is the minimum number of people to qualify for assembly of people

Populated area

- Census data
- Topographic data
- Open data (POIs)
- Satellite data
- CCTV
- Other/*GNSS/5G**

AI assisted statistical model



Dynamic population density forecast

Population modelling hell

Modelling grid cell: entire Earth

16 people/km2

Intrinsic UAS Ground Risk Class						
Max UA characteristics dimension		1 m	3 m	8 m	20 m	40 m
Max cruise speed		*25 m/s*	*35 m/s*	*75 m/s*	*150 m/s*	*200 m/s*
Maximum iGRC population density (ppl/km²)	Controlled ground area	1	2	3	4	5
	< 25	3	4	5	6	7
	< 250	4	5	6	7	8
	< 2,500	5	6	7	8	9
	< 25,000	6	7	8	9	10
	< 250,000	7	8	9	10	11
	> 250,000	7	9	Category C Operations (Not part of SORA)		

Table 2 – Intrinsic Ground Risk Class (GRC) Determination

Modelling grid cell: 1m x 1m

1 000 000 people/km2

Intrinsic UAS Ground Risk Class						
Max UA characteristics dimension		1 m	3 m	8 m	20 m	40 m
Max cruise speed		*25 m/s*	*35 m/s*	*75 m/s*	*150 m/s*	*200 m/s*
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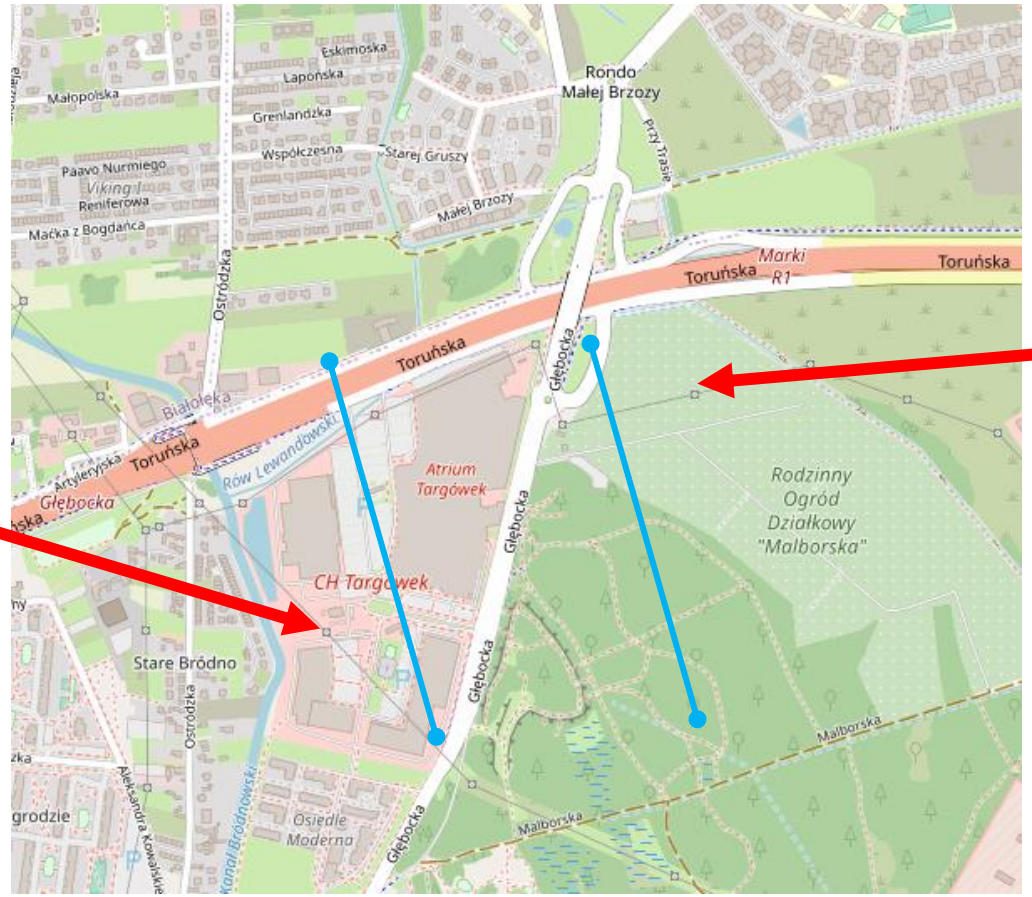
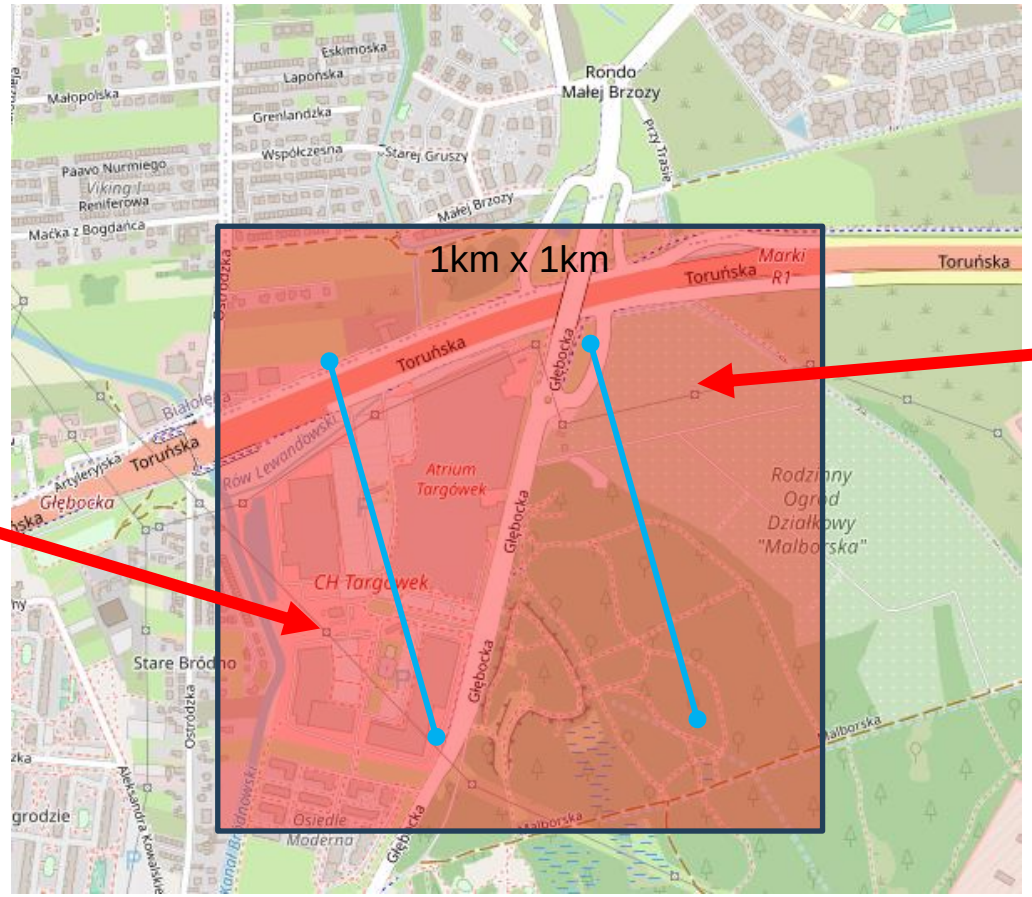
	< 250	4	5	6	7	8
	< 2,500	5	6	7	8	9
	< 25,000	6	7	8	9	10
	< 250,000	7	8	9	10	11
	> 250,000	7	9	Category C Operations (Not part of SORA)		

Table 2 – Intrinsic Ground Risk Class (GRC) Determination

Population modelling hell cont.



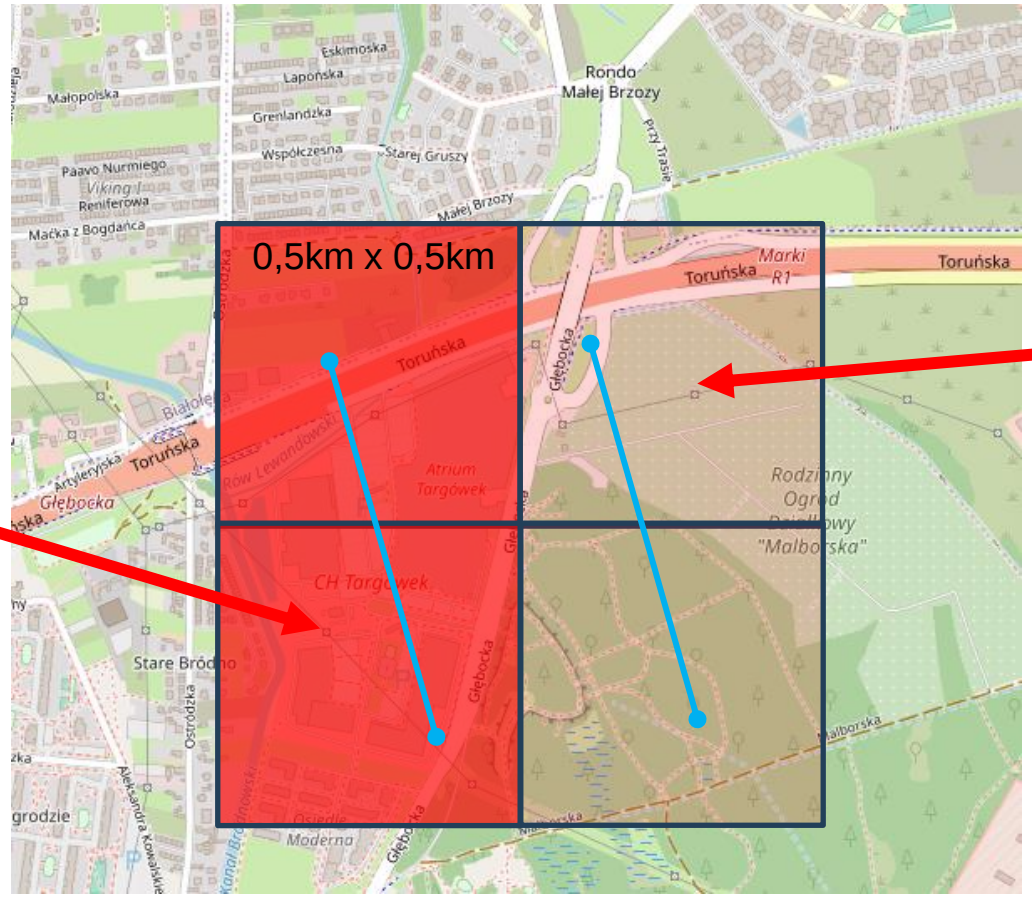
Population modelling hell cont.



Flight A -> iGRC 6

Flight B -> iGRC 6

Population modelling hell cont.

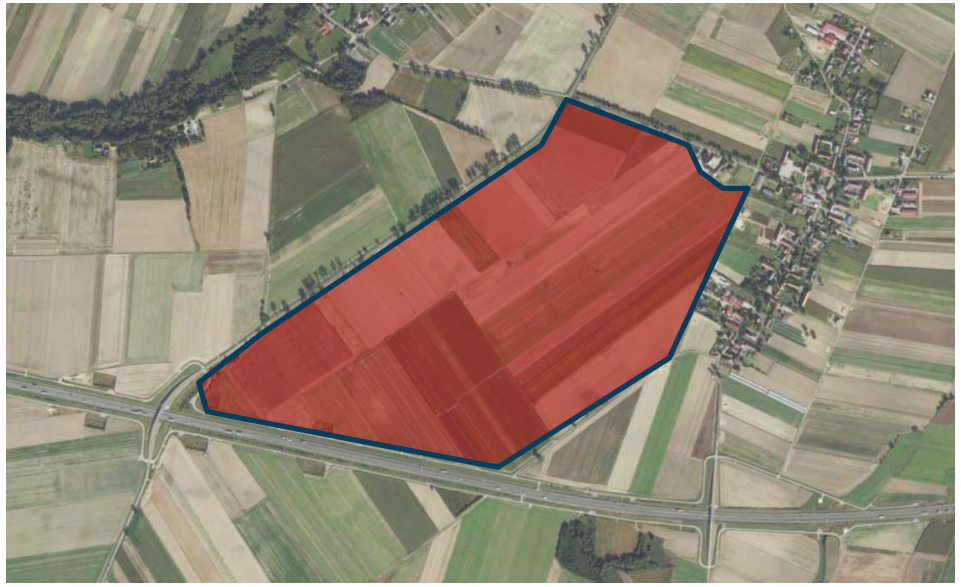


Flight A -> iGRC 5

Flight B -> iGRC 7

Our solution – functional clusters

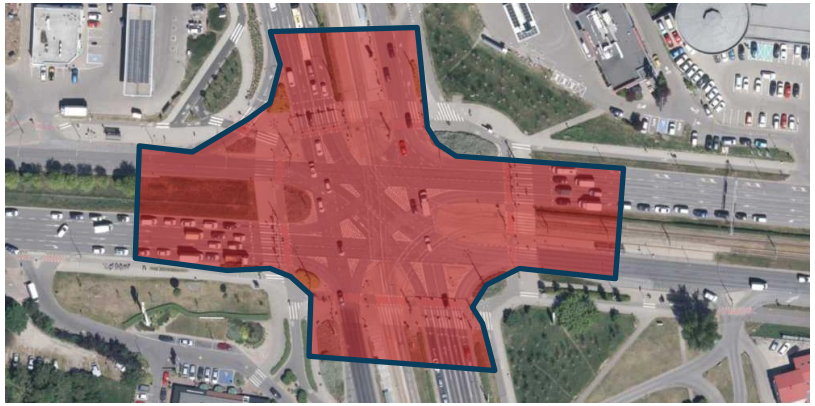
Suburban build-up area



Continous cluster of arable land

Car park

Office park



Major junction

Tram stop

Rasterization still is required

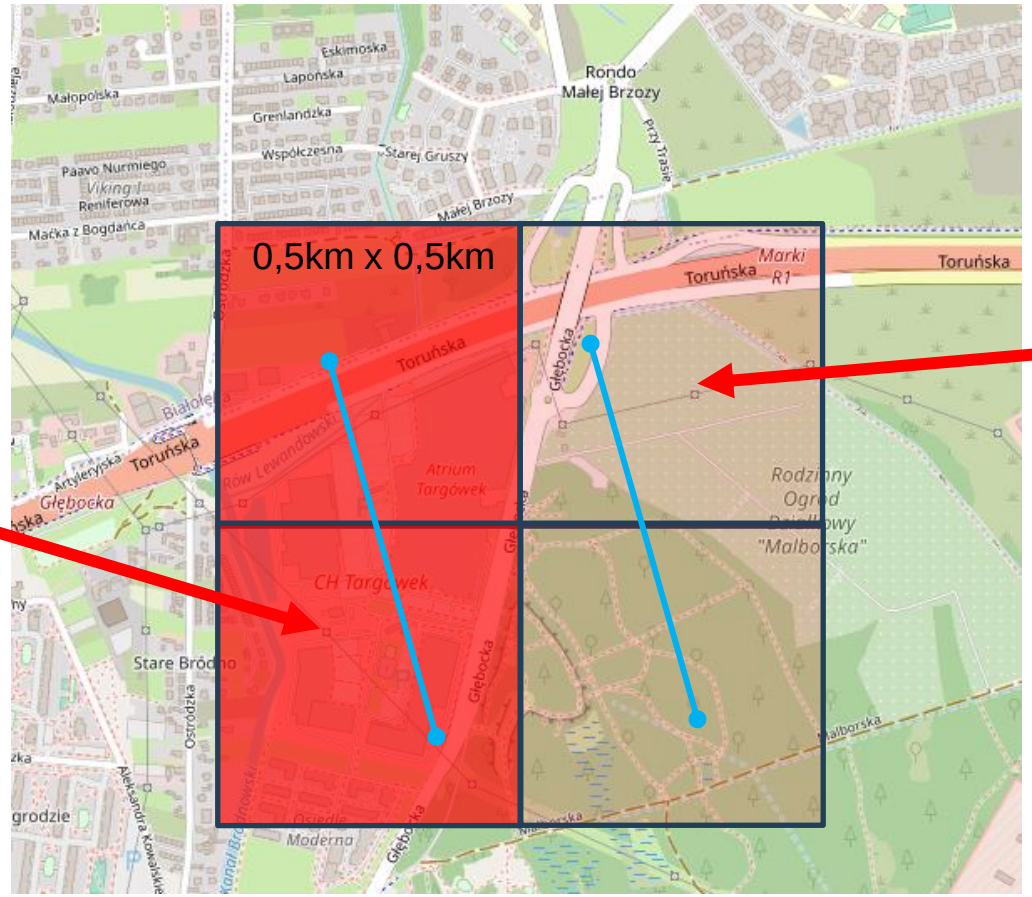
- Performance consideration
- Conformance to the standard web services (WMS)

- Our experiments show that 10m x 10m is a maximum grid size required to reflect buildings without closing spaces between them

Output raster grid size ≠ modelling cluster size

Temporal considerations

10:00AM



Flight A -> iGRC 5

Flight B -> iGRC 7

Temporal considerations

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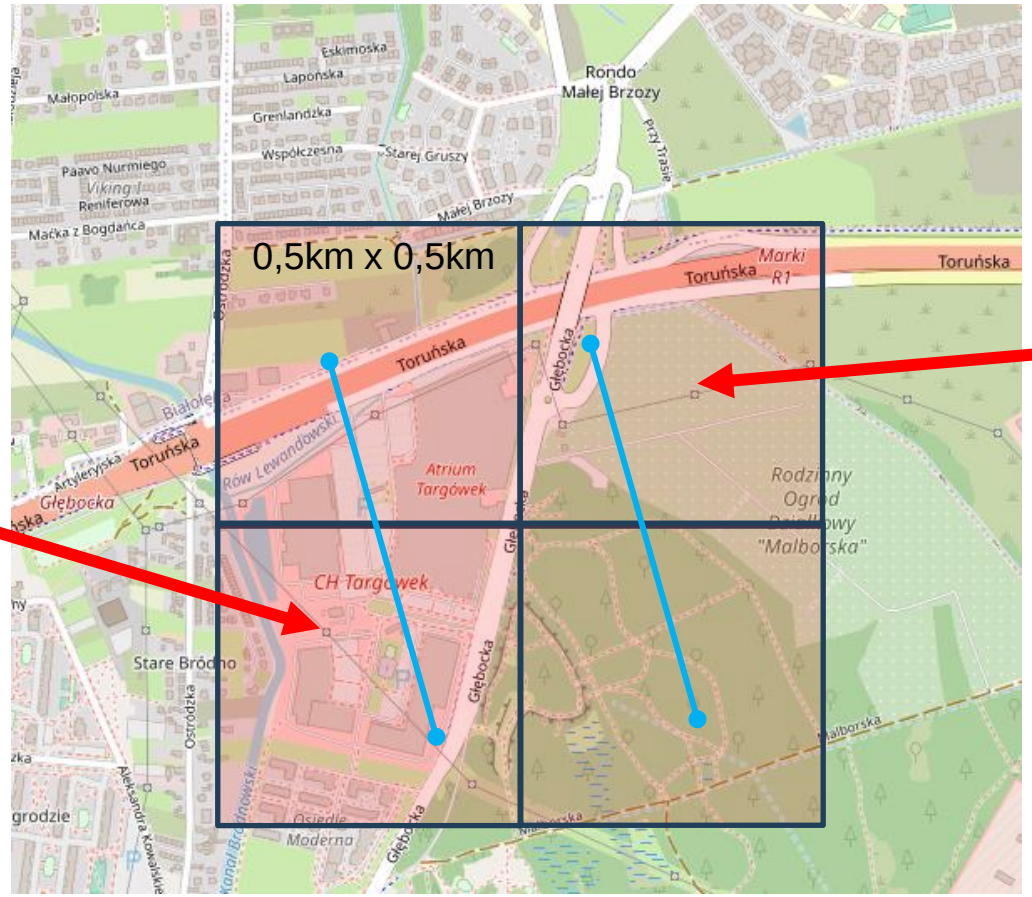
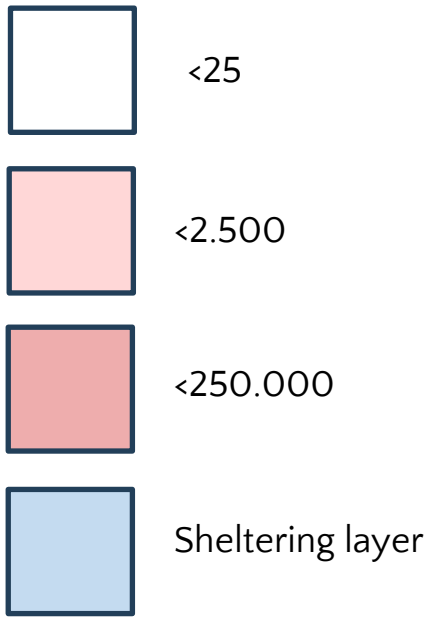
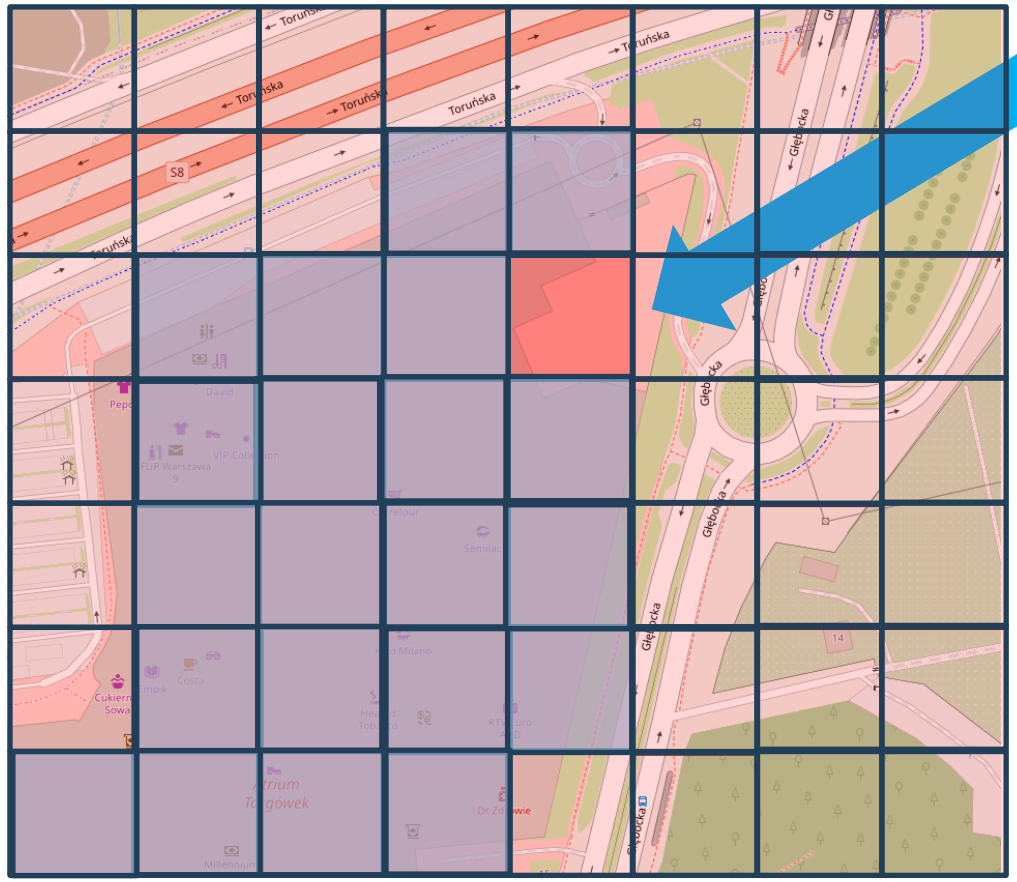


Flight A -> iGRC 5

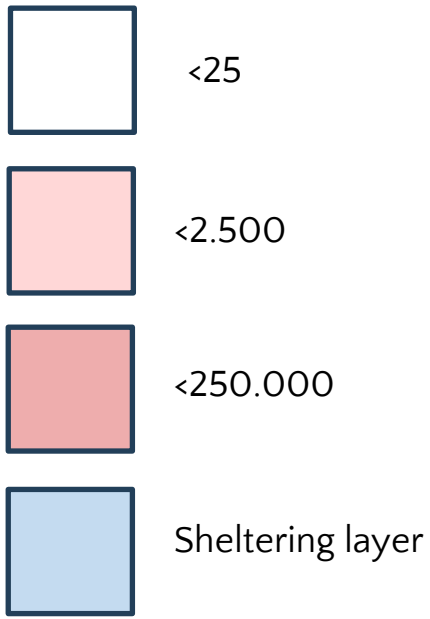
Flight B -> iGRC 5

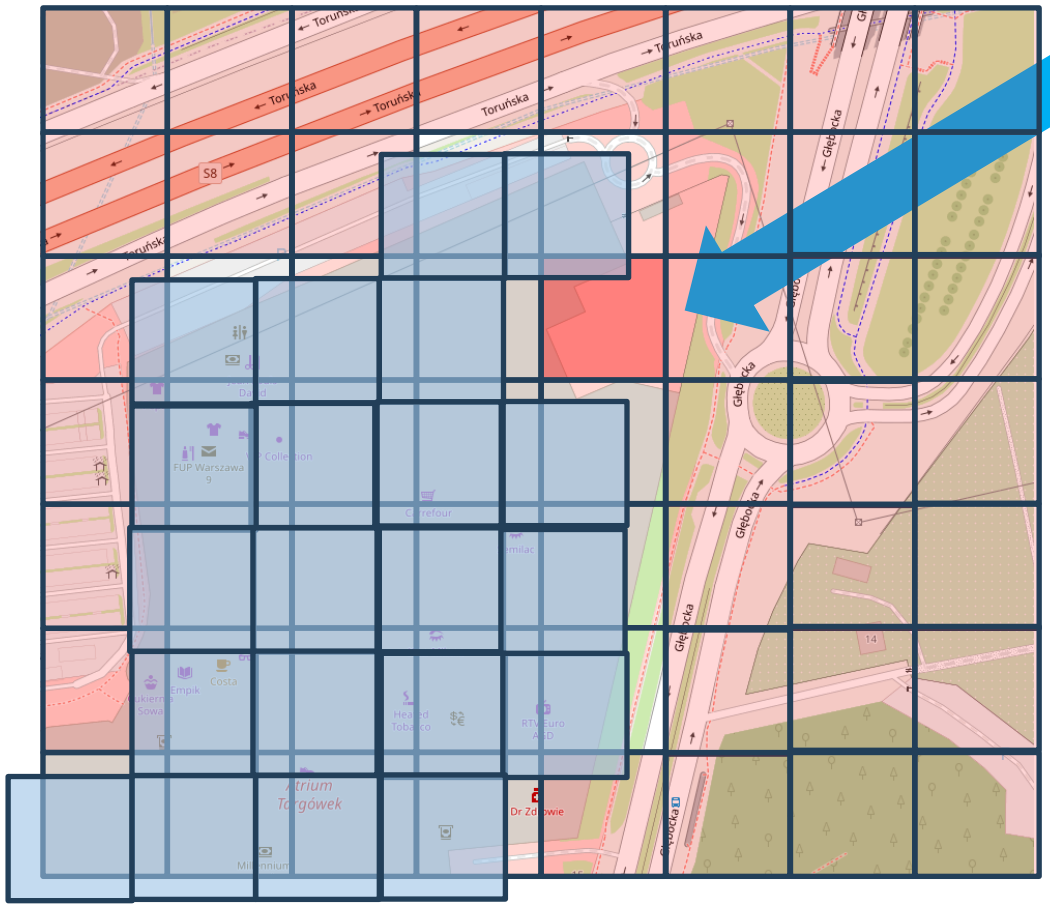
Sheltering considerations -> M1





Sheltering considerations -> M1

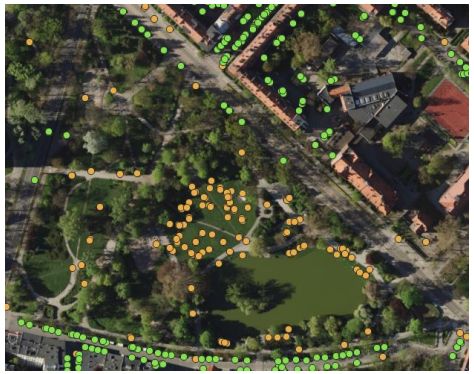


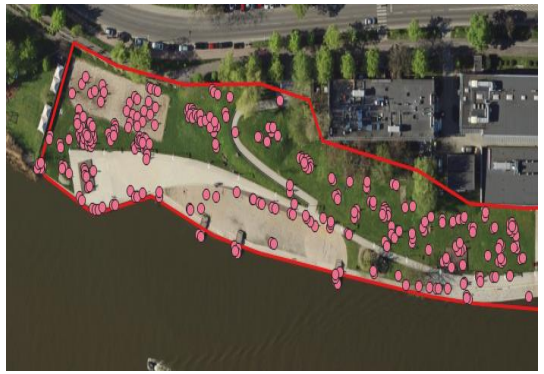


Shopping mall main entrance

Callibration & ground truth sources

AI based detection of unsheltered population on vhr imagery



AI based detection of population and cars on CCTV cameras




Demo

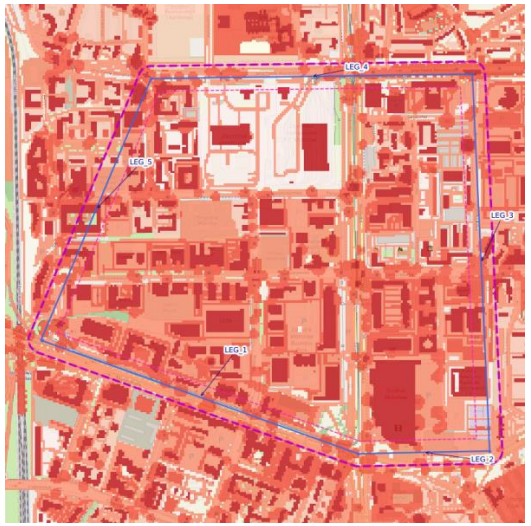
Census vs HOPE service

CENSUS 1sqkm grid

Static residency data

iGRC	Flight geography	Ground Risk Buffer
iGRC 1 quota	0.0%	0.0%
iGRC 2 quota	0.0%	0.0%
iGRC 3 quota	0.0%	0.0%
iGRC 4 quota	0.0%	0.0%
iGRC 5 quota	0.0%	0.0%
iGRC 6 quota	100.0%	100.0%
iGRC 7 quota	0.0%	0.0%
iGRC 8 quota	0.0%	0.0%
iGRC 9 quota	0.0%	0.0%
iGRC 10 quota	0.0%	0.0%
iGRC 11 quota	0.0%	0.0%
no part of SORA quota	0.0%	0.0%

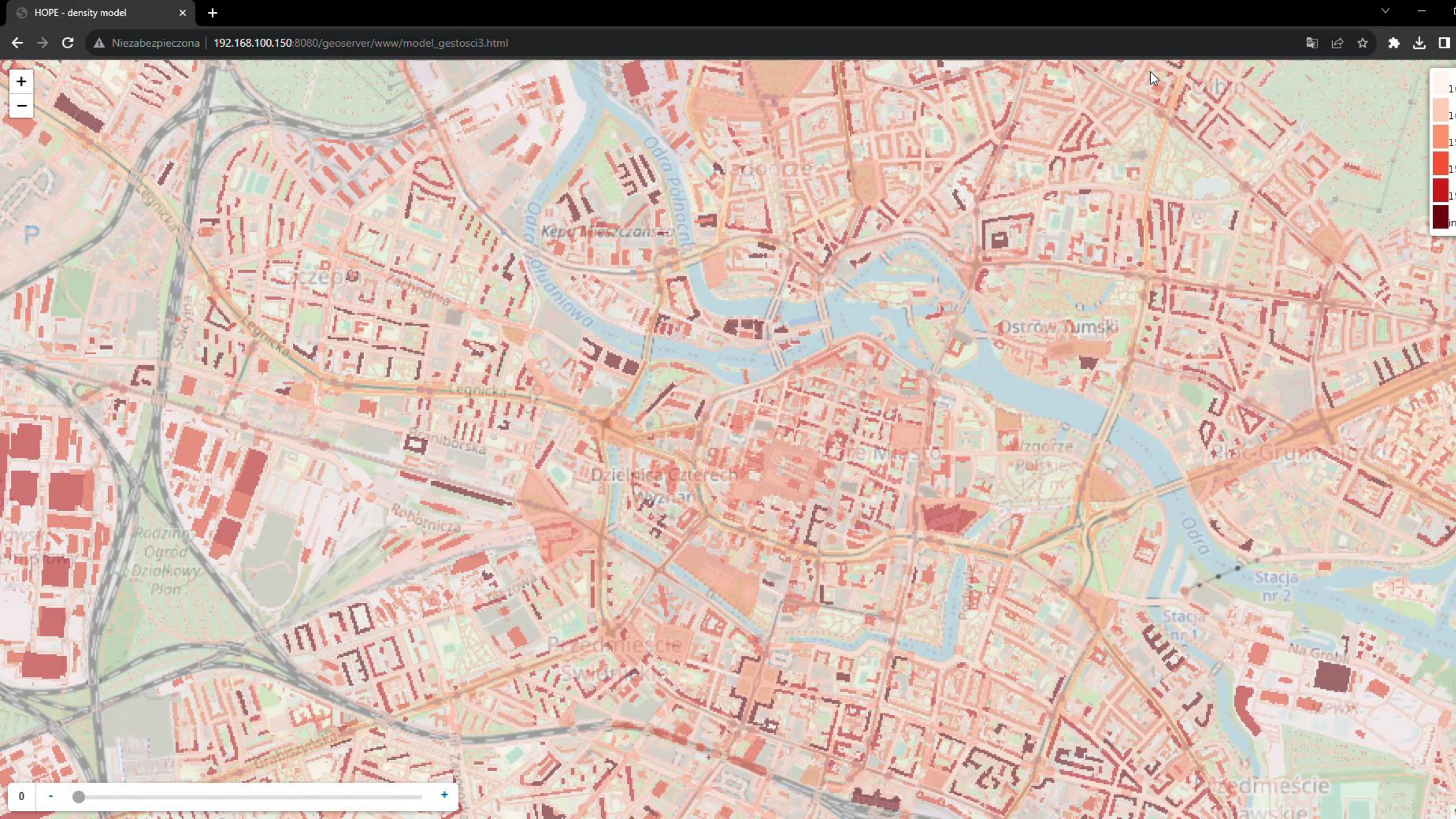
2022-06-27 08:30 (Monday)



iGRC	Flight geography	Ground Risk Buffer
iGRC 1 quota	0.0%	0.0%
iGRC 2 quota	3.7%	0.0%
iGRC 3 quota	3.4%	0.0%
iGRC 4 quota	40.7%	8.6%
iGRC 5 quota	42.2%	41.3%
iGRC 6 quota	9.9%	50.2%
iGRC 7 quota	0.0%	0.0%
iGRC 8 quota	0.0%	0.0%
iGRC 9 quota	0.0%	0.0%
iGRC 10 quota	0.0%	0.0%
iGRC 11 quota	0.0%	0.0%
no part of SORA quota	0.0%	0.0%

2022-06-26 23:00 (Sunday)

iGRC	Flight geography	Ground Risk Buffer
iGRC 1 quota	0.0%	0.0%
iGRC 2 quota	7.3%	0.0%
iGRC 3 quota	5.0%	0.2%
iGRC 4 quota	84.5%	76.5%
iGRC 5 quota	0.0%	0.9%
iGRC 6 quota	3.2%	22.4%
iGRC 7 quota	0.0%	0.0%
iGRC 8 quota	0.0%	0.0%
iGRC 9 quota	0.0%	0.0%
iGRC 10 quota	0.0%	0.0%
iGRC 11 quota	0.0%	0.0%
no part of SORA quota	0.0%	0.0%


HOPE - density model
Niezabezpieczona
192.168.100.150:8080/geoserver/www/model_gestosci3.html
Legnicka
Robotnicza
Dzielnica Czterech
Ostrów Tumski
Stacja nr 2
Stacja nr 1
0

Final thoughts

Final thoughts

- We need to act fast if we want to avoid spreading of the grey zone
- We need the basic standard and accreditation proces
  - Audit of the:
    - population density modeling methodology
    - data sources credibility
  - Verification based on the qualitative samples
  - Synchronization of the sheltering shoud be required
- There will never be the absolute perfect data on population density – we need a framework to operate

Thank you for your time

HOPE team

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