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GeoAI for automatic detection of Solar PV in the Netherlands

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- Motivation and objective
- Data
- Method
- Results
- Ongoing work

Motivation

Energy transition

The goal is clear, but how do we reach this goal?

Netherlands is divided in Regional Energy Strategy (RES)

They all have to create a plan to switch to sustainable energy

Solar PV has a major role in the energy transition

<u>Which data is missing currently</u>

- How much energy is already being generated with PV?
- Where on the rooftops is still solar potential left?

BAG Basisregistration Adresses and Buildings

Open datset that contains 10 million buildings

Aerial images

Open data: 8-10cm resolution RGB, 1 year cycle

We create a height model and true ortho’s out of these images

BRT Basis Registration Topography

Top10NL, 1:10.000 dataset
Very rich in attributes values.

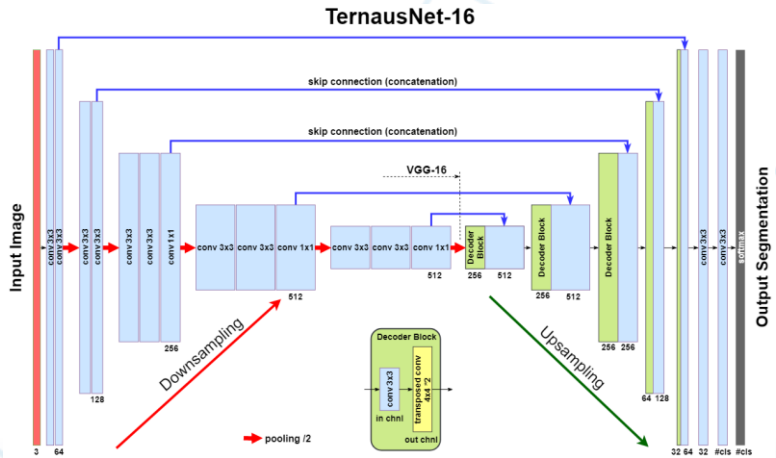
We use this dataset to remove greenhouses and tanks

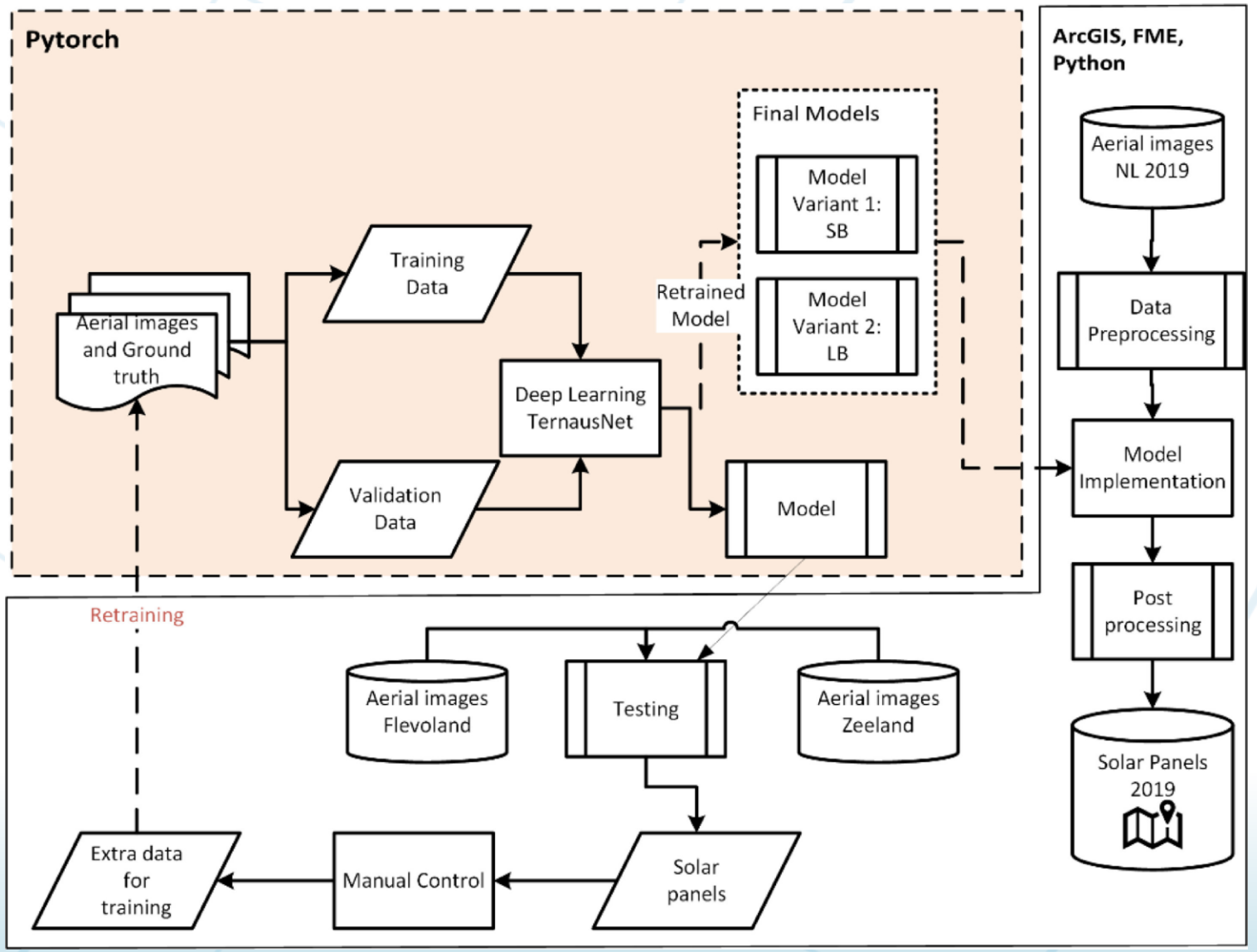
10:00

Method

Input data: True ortho's + ortho's 10cm (10cm), BAG (buildings), Top10NL

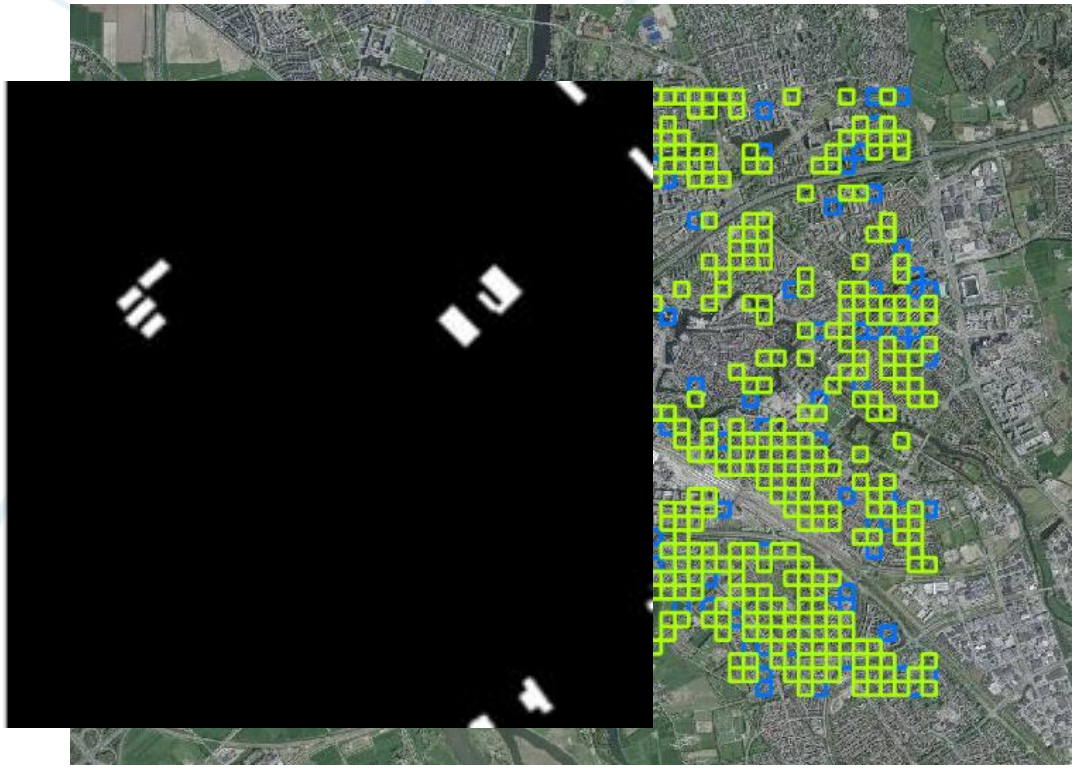
Software: Algorithm = UNet16 (two variants), ArcGIS, FME, python





10:00

Training



650 tiles training (100m x 100m)
150 tiles validation

Results

Postprocessing : Standard scripts in 2 steps

Results from the algorithm

Postprocessing step 1: Remove small shapes and everything that is outside the BAG footprint

Source: Kausika, B.B.; Nijmeijer, D.; Reimerink, I.; Brouwer, P.; Liem, V. GeoAI for Detection of Solar Photovoltaic Installations in the Netherlands. *Energy and AI* **2021**, *6*, 100111, doi:10.1016/j.egyai.2021.100111.

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Results

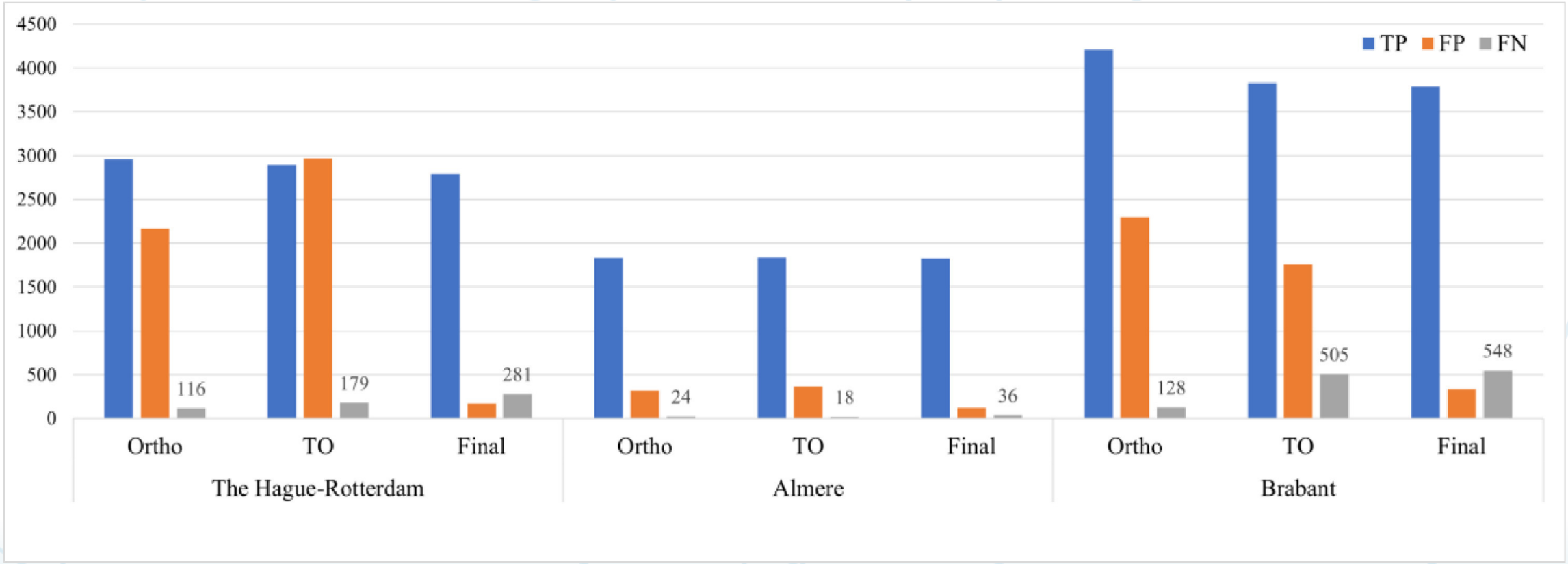
Postprocessing step 2: Assigning panel to the building

Postprocessing (custom): selections based on area and combination of Ortho and TO results

GeoAI for automatic detection of Solar PV
Source: Kausika, B.B.; Nijmeijer, D.; Reimerink, I.; Brouwer, P.; Liem, V. GeoAI for Detection of Solar Photovoltaic Installations in the Netherlands. *Energy and AI* **2021**, *6*, 100111, doi:10.1016/j.egyai.2021.100111.


Solar Panels
Building Footprint
Without PV
With PV

Results


4500
4000
3500
3000
2500
2000
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TP
FP
FN
116
179
281
24
18
36
128
505
548
Ortho
TO
Final
Ortho
TO
Final
Ortho
TO
Final
The Hague-Rotterdam
Almere
Brabant

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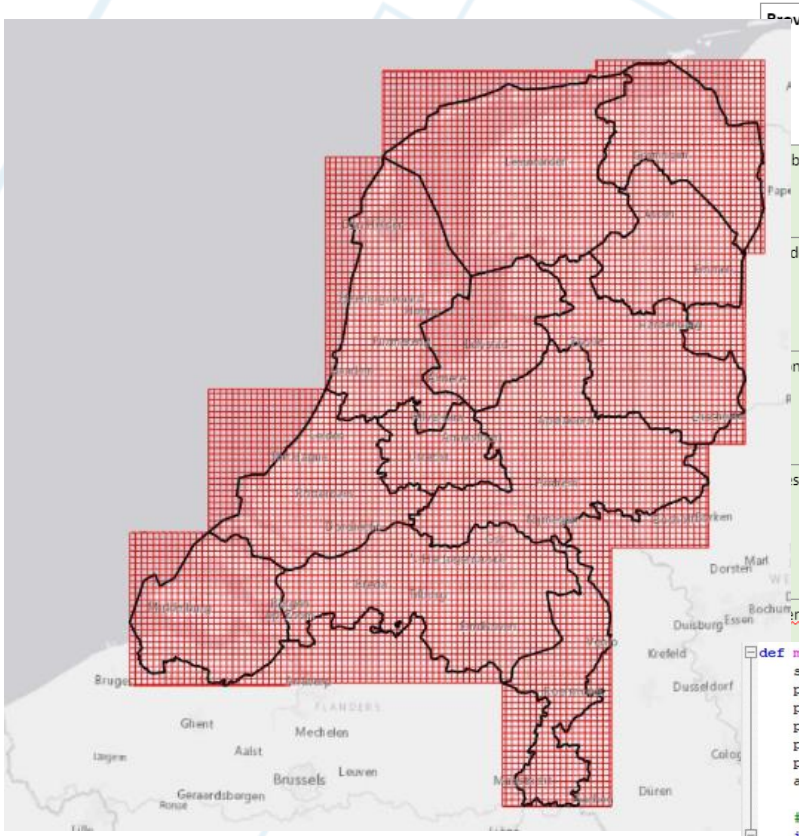
10:00

Scaling up for the entire country

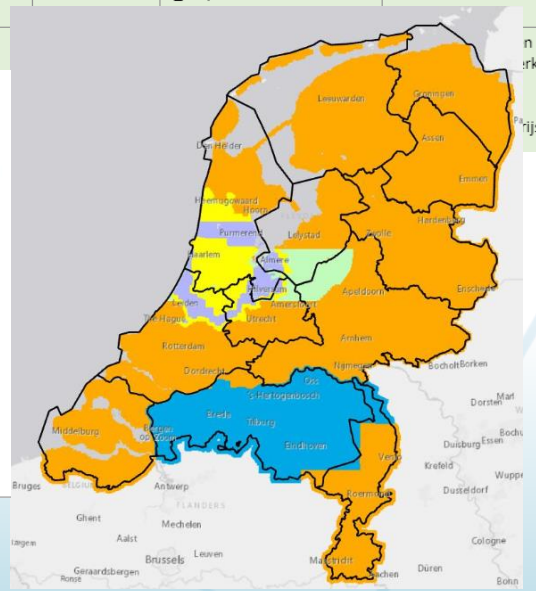


Provincie	Onderdeel	Bron O/TO	Knippen: PC?/tijd	MoveAndSelect.py (BAG selectie) Tijd	Upload en naar blob	Aantal BAG tiles	Voorspellen 13_be & z2_be: heavy-0/heavy-1	wld-files	Check aantal in 13_be&z2_be tegen tiles	Raster2vector_2.fmw 13_be	Raster2vector_2.fmw z2_be	shape
burg	Standaard	TO (DSM20)	dt023350 2/ ~8u	Niet bijgehouden	x	76181	Heavy0, 15 uur	x	x	10 min. downloaden Op blob-storage: /resultaten-zonnepanelen/Limburg/13_be_shape/	10 min. downloaden Op blob-storage: /resultaten-zonnepanelen/Limburg/z2_be_shape/	x
derland	Standaard	TO (DSM20)	dt023350 2/ ~18u	Niet bijgehouden	x	168059	Meerdere crashes, heavy0 en 1. Doorlooptijd niet realistisch. Crashes verbetert/opgelost met find_png.py	x	x	3 uur 38 min Op blob-storage: /resultaten-zonnepanelen/Gelderland/13_be_shape/	22min laden, loopt + 4 uur Op blob-storage: /resultaten-zonnepanelen/Gelderland/z2_be_shape/	x
ningen	Standaard	TO (DSM20)	dt021892 8/ ~7u	Niet bijgehouden	x		Heavy0 , 10 uur (+45 min wld files kopieren) 51061 tegels	x	x	<15min laden data , + 1 uur 2 min Op blob-storage: /resultaten-zonnepanelen/Groningen/13_be_shape/	10 min laden, + 56 min Op blob-storage: /resultaten-zonnepanelen/Groningen/z2_be_shape/	x
sland	Standaard	TO (DSM20)	Dt021892 8/ ~8u	683 s	3u 8 min x	67736	Heavy0, 9.5 uur (en +/-1,5 uur voor kopieren wld files)	x	x	15 min laden data + 1 uur en 12 min Op blob-storage: /resultaten-zonnepanelen/Friesland/13_be_shape/	12min laden + 1 uur 10 min Op blob-storage: /resultaten-zonnepanelen/Friesland/z2_be_shape/	x
rijssel	Standaard	TO (DSM2	Dt021892 8/ ~8u	Niet bijgehouden	3u 3 min	92206	Heavy 0, plm 14 uur	x			rijssel/z2_	x

```python
def main():
    start = time.time()
    parser = argparse.ArgumentParser()
    parser.add_argument("-in","--input", help="Filepath to input folder",required=True)
    parser.add_argument("-out","--output", help="Filepath to output folder",required=True)
    parser.add_argument("-shape","--shapefile", help="Masking shapefile (including filepath)",required=True)
    parser.add_argument("-nproc","--processes", help="Nr of processes run concurrently", default=3)
    args = parser.parse_args()

    #arcpy.env.workspace = args.output
    if not os.path.exists(args.output):
        os.mkdir(args.output)
        print("Ceated folder: {}".format(args.output))
    fnames = fnmatch.filter(os.listdir(args.input), '*.tif') #filter directory for tif file
    flist = []
    for f in fnames:
        flist.append({"fname":f,"in_path":args.input,"out_path":args.output,"mask":args.shapefile})

    p = multiprocessing.Pool(processes=int(args.processes))
    for i,_ in enumerate(p.imap_unordered(final, flist),1):
        print('Finished {}/{}\n'.format(i,len(fnames)))
    p.close()
    p.join()
```



8236 blocs

625 tiles per bloc = 5.147.500 tiles

4TB input data

10:00

Results

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Data for policy makers

Farea_4	Mean_Slope	source	Total_opp_pv	bag_met_PV	pv_tov_pand	pv_tov_zp	zp_tov_pand
1537,2	4,951045	AHN	2914,21	1	59,84197	75,83164	78,91425
462	15,679163	AHN	1693,55	1	78,99651	146,6277	53,87557
576,4	23,700667	DSM	1595,36	1	65,23901	110,712	58,92678
2038,9	10,643588	AHN	1546,75	1	9,192373	30,34479	30,29308
828,9	2,154017	AHN	1138,53	1	48,78777	54,94173	88,7991
1128,3	12,621652	AHN	980,66	1	24,34795	34,76593	70,03393
827,7	16,53241	AHN	956,63	1	40,4764	46,23076	87,55296
772,5	17,043879	AHN	914,93	1	40,69146	47,37502	85,89222
332,4	16,308017	DSM	642,83	1	50,87767	77,35619	65,77065
512,6	15,408579	AHN	604,93	1	44,39344	47,20484	94,04425
282,6	21,228635	DSM	599,17	1	45,84476	84,80821	54,05698
1132,1	19,306963	DSM	574,74	1	1,037634	20,30704	5,109728

Still improving (Why?)

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10:00

Still improving

Solar potential

Still improving

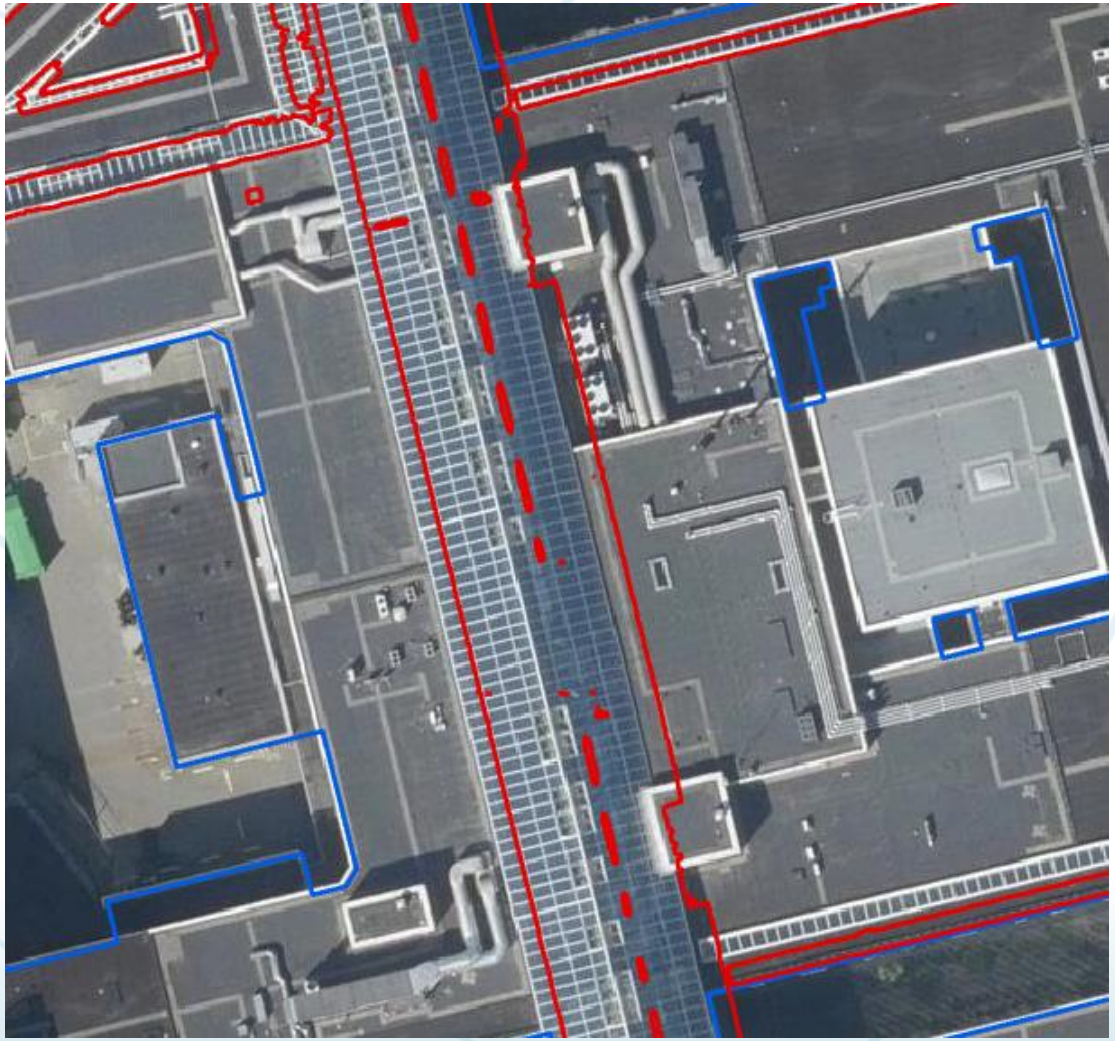
<u>To do list:</u>

More training data, especially from areas with bad performance

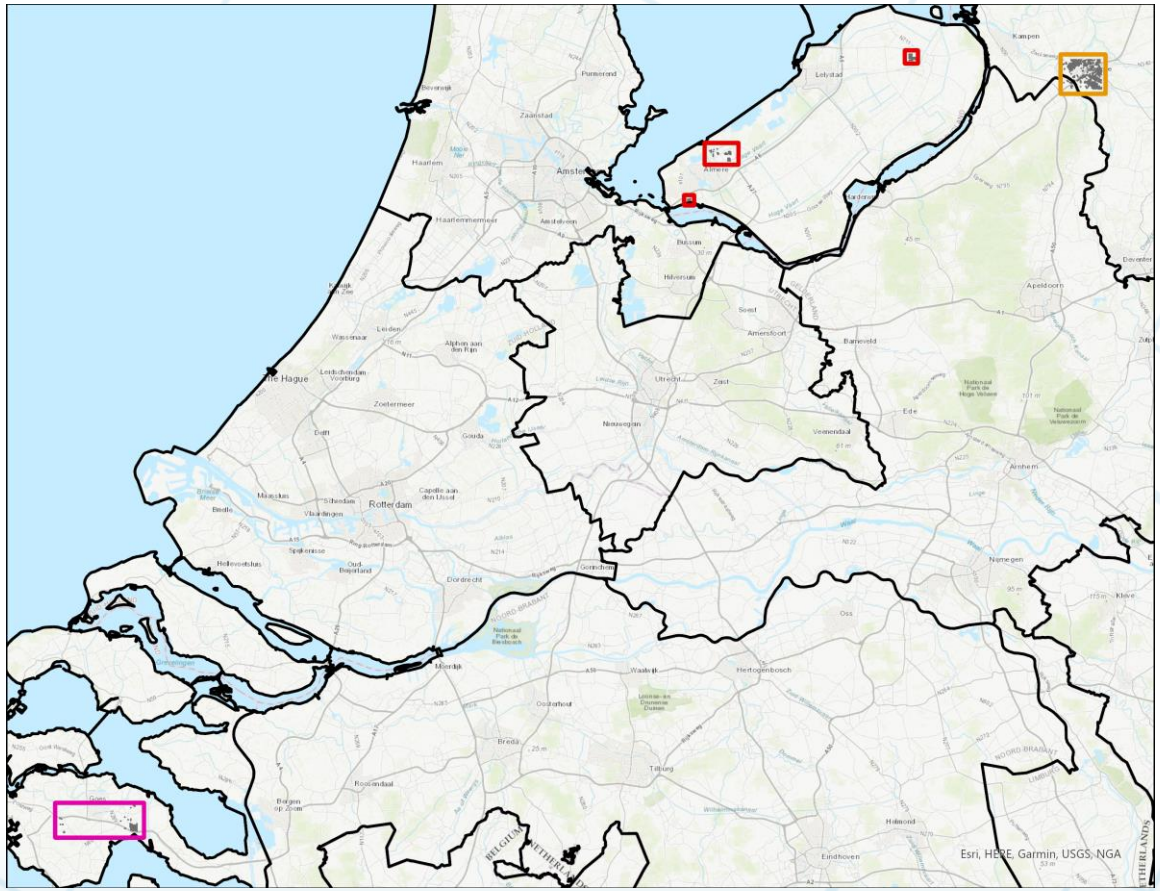
Correction rooftops with slope

More balanced training set by experience and K Means calculation in advance

Guarantee quality by monitoring



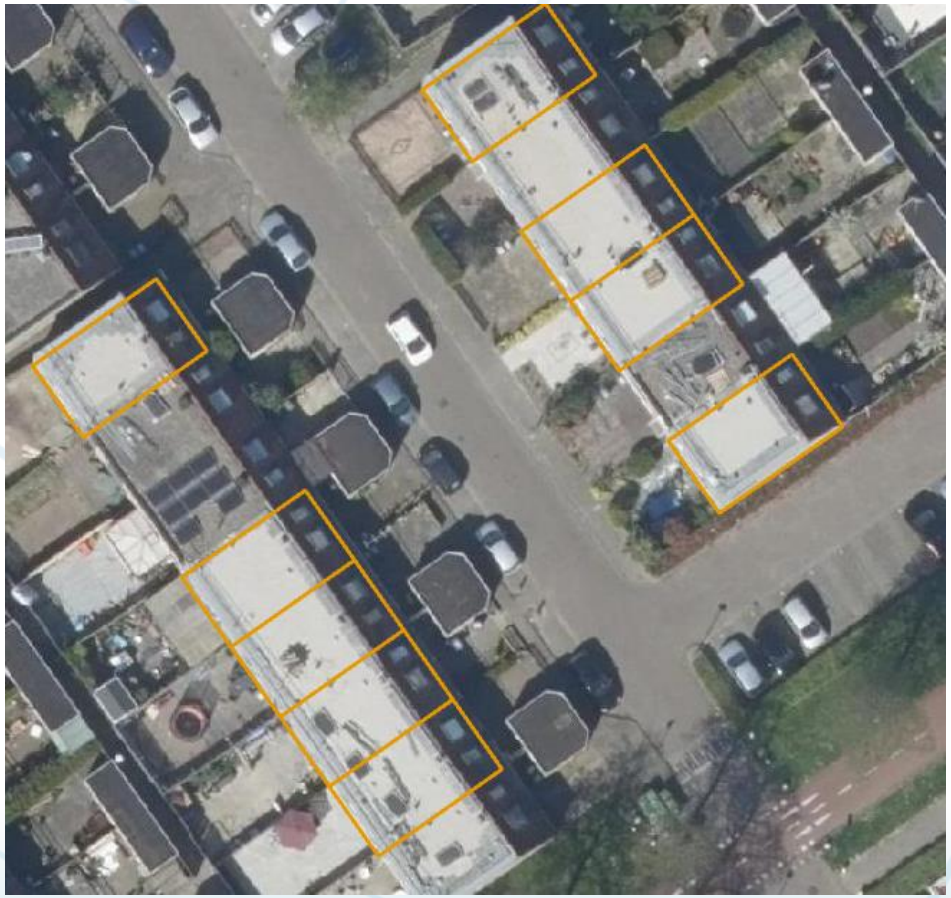
Development 2021 - 2022



1e training : Zwolle, Almere andZeeland (industrie)

2e training: ~8000 panelen ortho+3600 panelen TO from Den Haag-Rotterdam and Brabant

Monitoring



Monitoring

Thank You!