



Simulating Impacts of Regional Planning on Land Consumption Patterns

using an Automated Retrospective Classification Approach
and a Scenario-based Urban Growth Simulation Model in
Western Germany from 1985-2030

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1. Monitoring of land consumption 1985-2020 based on automated retrospective classification
2. **Provision of data for local authority stakeholders**
3. Propaedeutic training of action taking for climate adaptation (young adults)
4. **Scenario-based, spatially explicit simulation of urban growth 2030**





Study area

- North Rhine-Westphalia

Data preprocessing

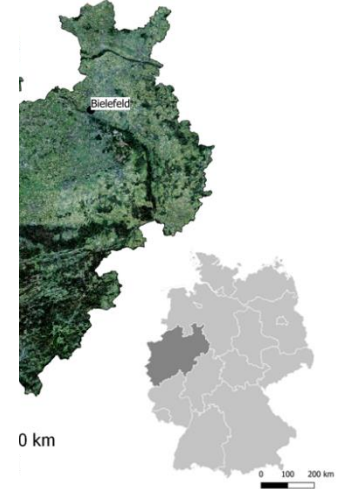
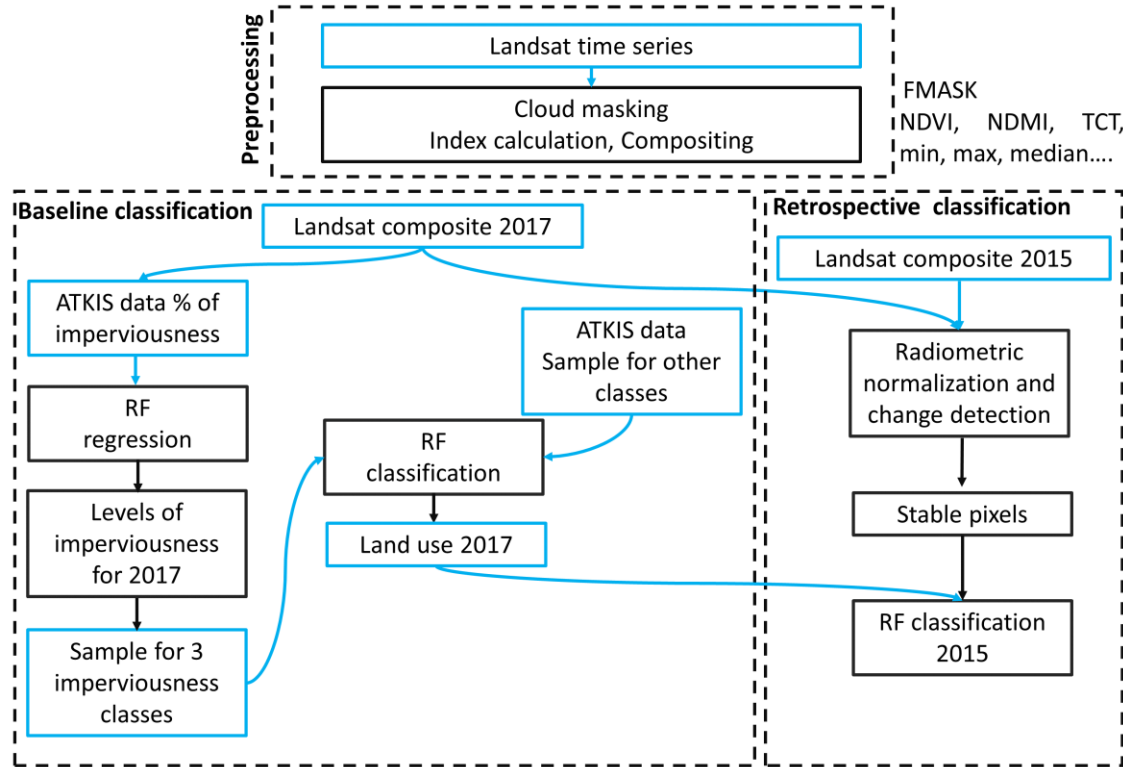
- Landsat cloud masking
- mosaicking
- index calculation
- calculation of ten

Estimation of imperviousness

- random forest (RF)
- Topographic-Cartographic

Land use classification

- RF classification (5 composites)
- Input for 2017 – S
- Input for former y



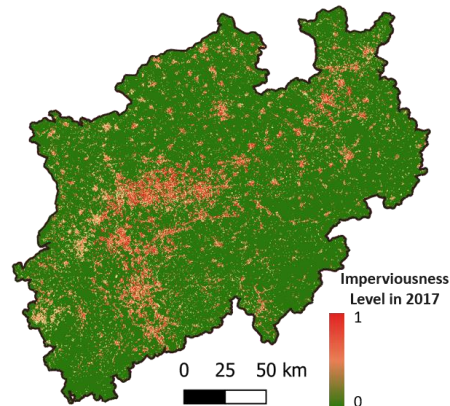
Ghazaryan et al. (2021)



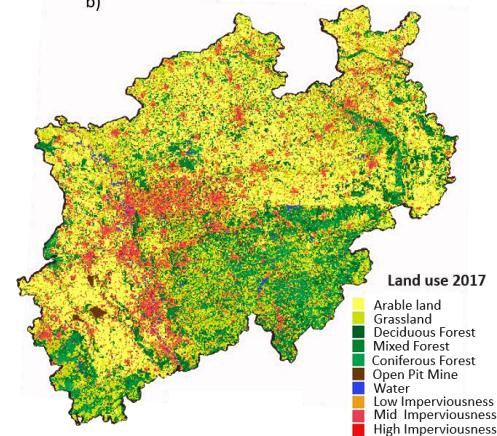


Classification Results 2017

a)



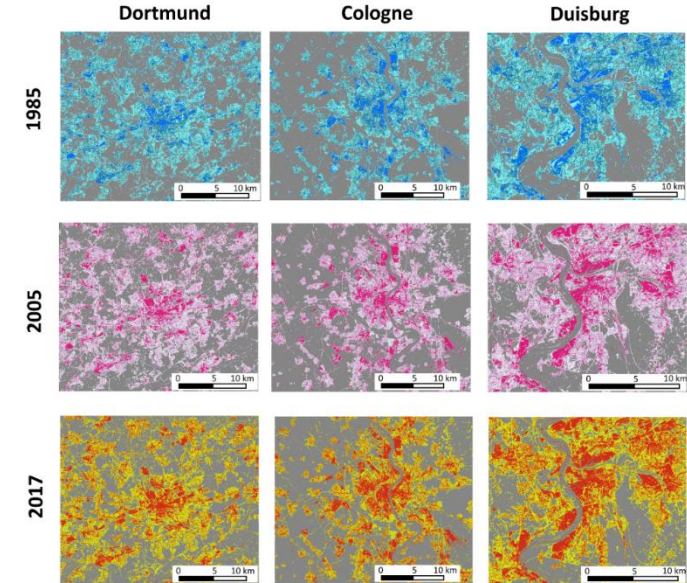
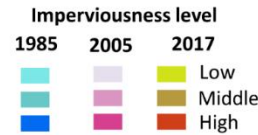
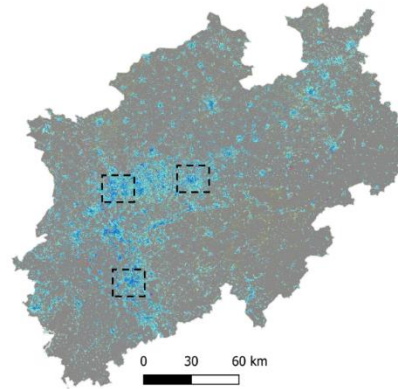
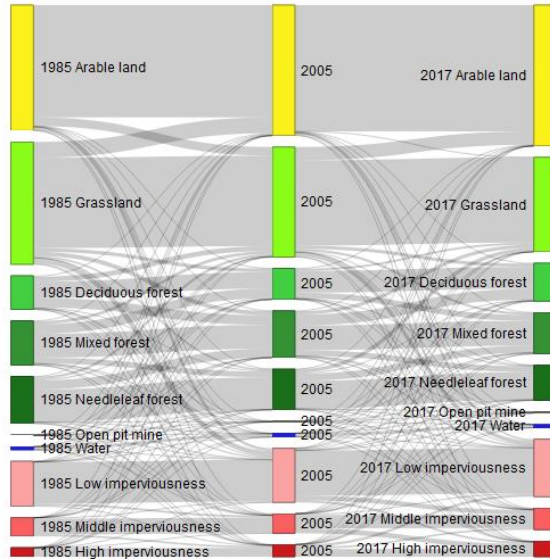
b)



Year	OA	PA for Low, Middle, and High Imperviousness Class	UA for Low, Middle, and High Imperviousness Class	Accuracies for Aggregated Urban Area		Accuracies for Aggregated Non-Urban Areas	
				PA	UA	PA	UA
2017	89.0%	89.3 90.5 94.4	89.4 90.5 94.4	96.3	93.04	92.7	96.2
2015	87.0%	77.9 93.9 90.1	81.5 90.7 90.1	94.6	91.3	90.9	94.7
2010	80.0%	62.9 77.9 90.5	69.3 83.2 87.5	93.1	90.7	91.2	92.3
2005	79.1%	82.9 76.2 89.9	78.2 92.4 82.6	94.8	92.1	94.6	96.7
2000	80.2%	63.1 78.1 90.2	69.1 83.5 87.8	93.1	96	96.2	93.3
1990	75.3%	54.9 67.6 90.1	65.1 79.7 80.8	91.3	95.8	95.8	91.4
1985	77.3%	61.1 69.8 87.4	74.5 75.7 82.9	87.7	95.9	96.1	88.3

Ghazaryan et al. (2021)





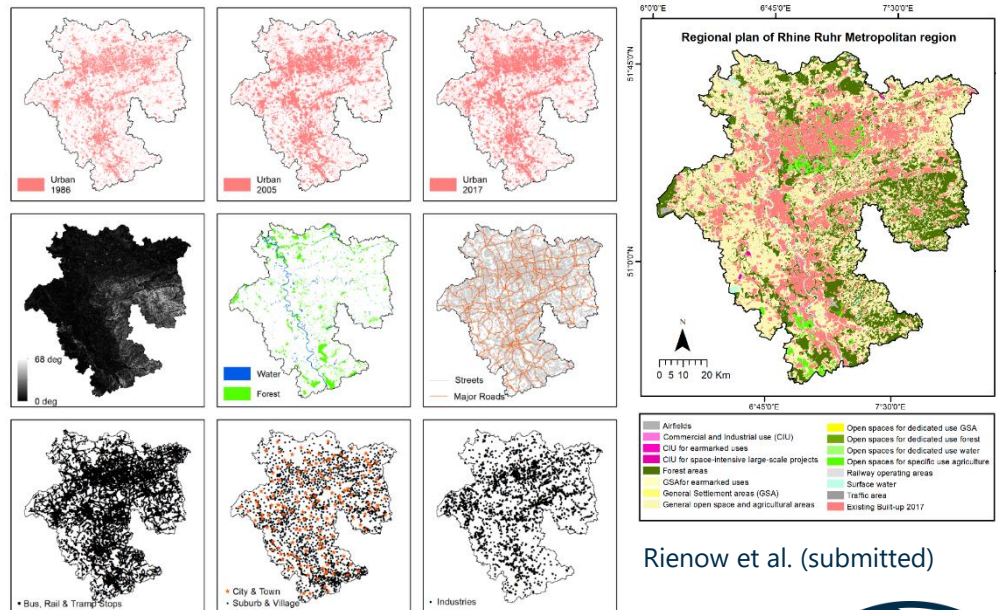
Sankey plot for land-use changes observed

Changes in imperviousness level



SUSM: a scenario-based urban growth simulation model using remote sensing data

- Input data module** processes the user-supplied data, urban extent maps, digital elevation maps and transportation networks
- Scenario development module** facilitates the development of future urban development scenarios
- Transition potential module** estimates the suitability of non-urban pixel to be transformed into urban by weighing the site-specific urban growth driving factors
- Allocation module** is responsible for estimating area of future urban growth and simulating the urban growth
- Validation module** assesses the simulation capability of SUSM



Rienow et al. (submitted)

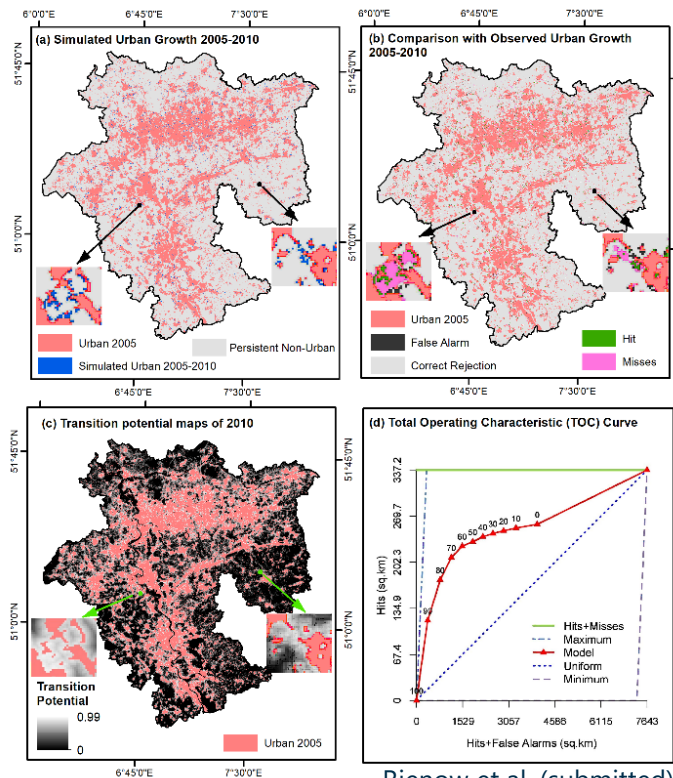
Kantakumar et al. (2019)





Validation

Simulated Urban growth	Observed Urban growth			
	2005-2010		2005-2017	
Urban	Urban H = 77.89 km ²	Non-Urban FA = 86.31 km ²	Urban H = 229.46 km ²	Non-Urban FA = 110.08 km ²
Non-Urban	M = 86.80 km ²	CR = 7392.15 km ²	M = 107.70 km ²	CR = 7195.91 km ²
Validation Metric	Score	95% C.I.	Score	95% C.I.
Producer's accuracy (Sensitivity)	47.30%	[36.61%, 57.99%]	68.06%	[59.30%, 76.82%]
User's accuracy (Precision)	47.44%	[39.50%, 55.39%]	67.58%	[62.46%, 72.71%]
Overall accuracy	97.74%	[97.4%, 98.08%]	97.15%	[96.78%, 97.54%]
Specificity (True negative rate)	98.85%	[98.6%, 99.10%]	98.49%	[98.21%, 98.78%]
Matthews correlation coefficient	0.46	--	0.66	--
Figure of fit	0.31	--	0.51	--
AUC	0.76	--	0.84	--

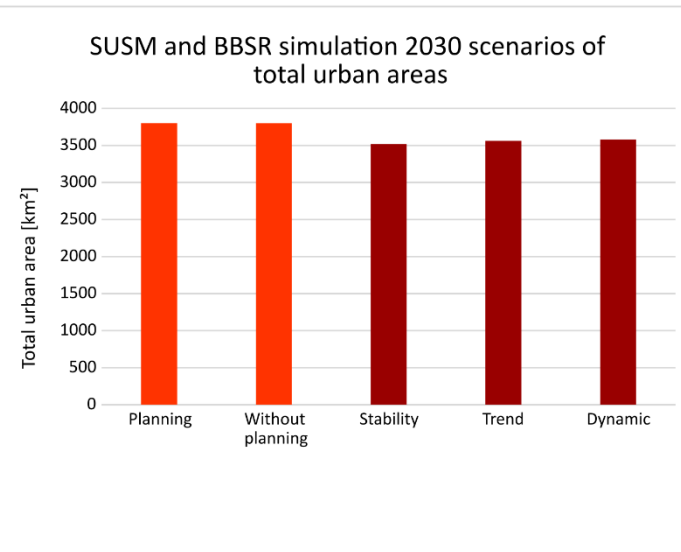
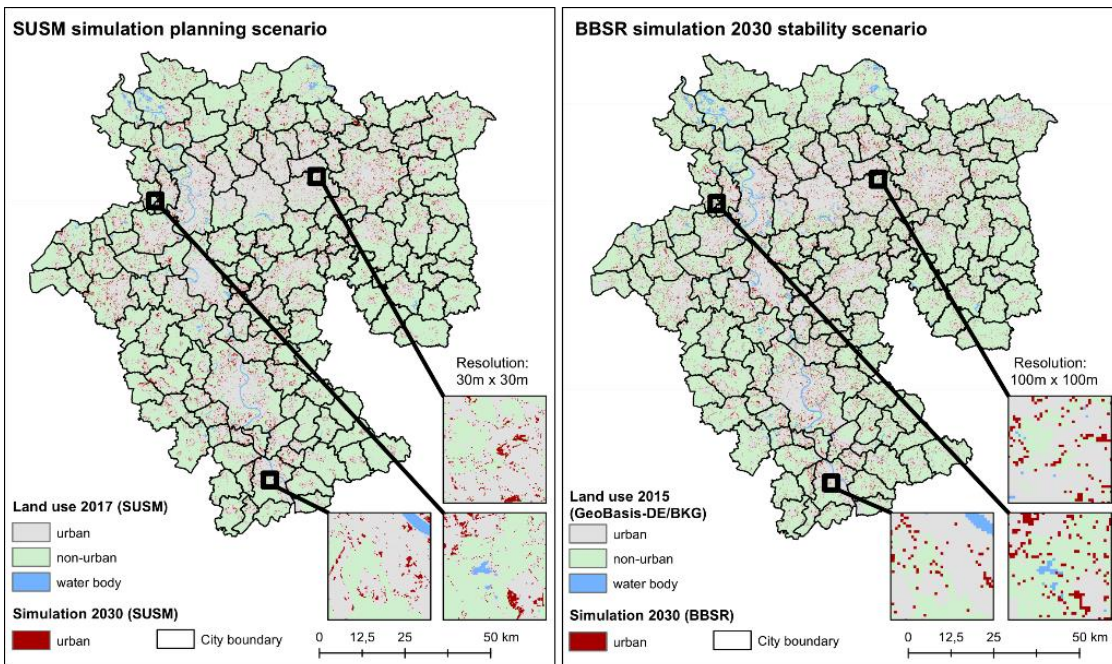


Rienow et al. (submitted)





SUSM and BBSR comparison



Rienow et al. (submitted)

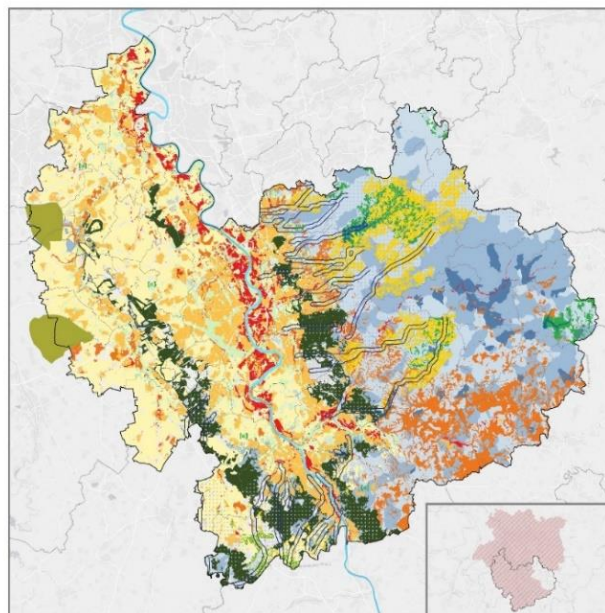




Climate Change Prevention Strategy

Planning Information map: Climate change prevention strategy

Rhine-Ruhr metropolitan region: Rhine Area



Planning information categories

- Agricultural areas with predominantly high drought stress risk
- Post-mining landscape with climate adaptation potential
- Reservoirs used for drinking water supply
- Forests in the catchment area of drinking water reservoirs
- Open spaces with thermal compensation function
- Forest belt with medium to high multifunctional compensation function and drought stress risk
- Settlements with high thermal loads and special flood risk
- Cold air catchment areas with medium to high importance
- Cold air pathways with medium to very high importance
- Low water risk at the Rhine
- Risk of late frost in the focal area of regional fruit growing
- Late frost risk in other small-scale fruit growing areas
- Agricultural and grassland areas within the cold air catchment areas
- River basins with very high potential for flash floods
- River basins with high potential for flash floods
- River basins with medium potential for flash floods
- Settlements with high thermal loads
- Forests with medium to high drought stress risk
- Cologne/Bonn region
- Territorial boundaries
- Modeling area

Rienow et al. (submitted)





Future land consumption compared to population growth

With Plan

Without Plan

Land consumption rate
2017-2030

- <0
- 0-0.04
- 0.04-0.07

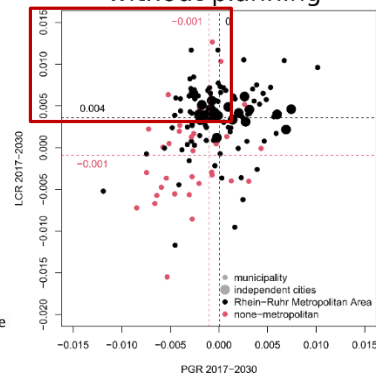
Population growth rate
2017-2030

- < -0.028
- 0.028-0
- 0-0.001
- 0.001-0.01

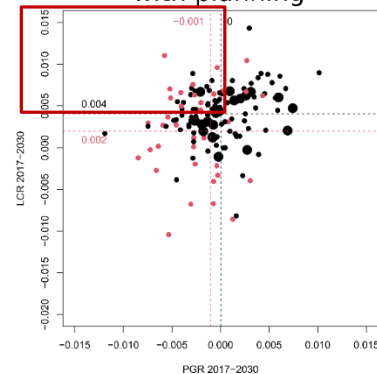
LCRPRG
2017-2030

- <0
- 0-1
- 1-10
- >10

without planning

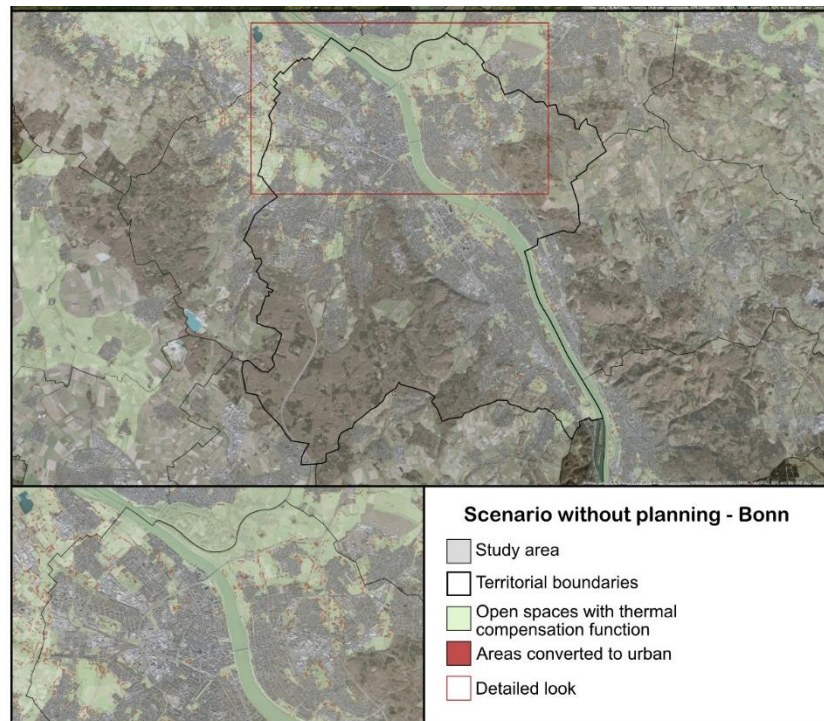
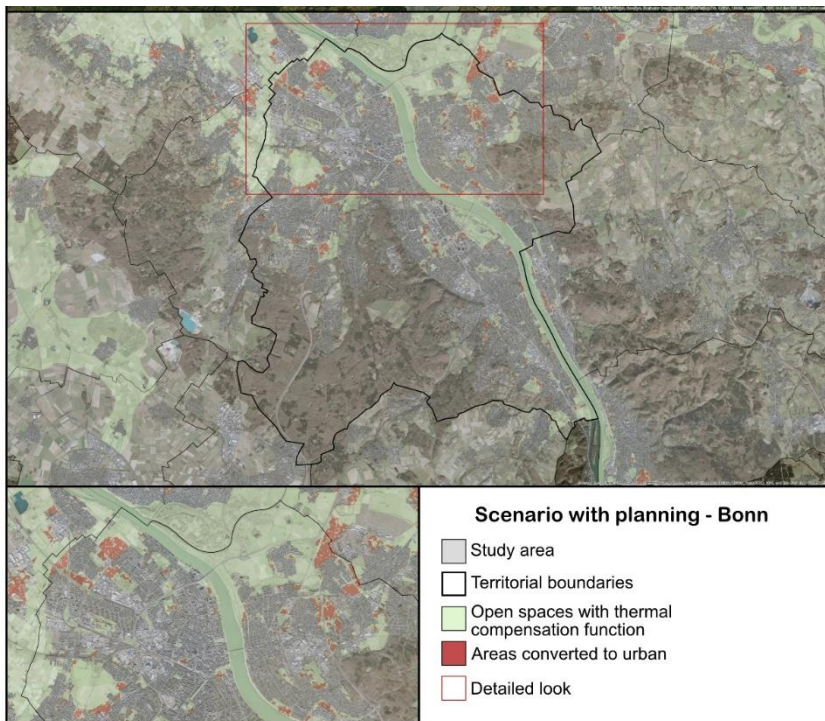


with planning



Rienow, A., Kantakumar, L.N., Ghazaryan, G., Dröge-Rothaar, A., Stickel, S., Trampnau, B., Thonfeld, F. (submitted): Modelling the spatial impact of regional planning and climate change prevention strategies on land consumption in the Rhine-Ruhr Metropolitan Area 2017-2030. Landscape and Urban Planning.



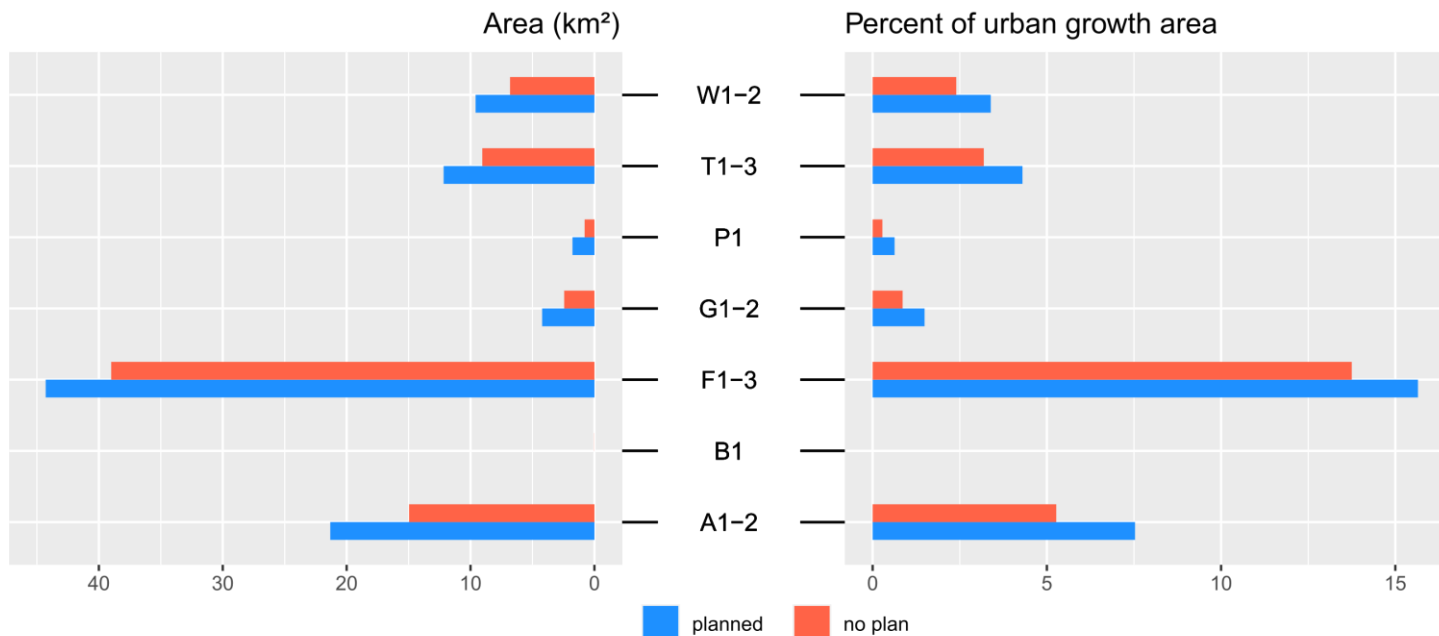


Rienow et al. (submitted)





Urban growth in climate change prevention strategy categories 2030



Rienow et al. (submitted)





Rienow (submitted)

Type	Count
Good Practice Examples	
Water bodies	6
Trees	72
Meadows	40
Vertical green	32
Reduced traffic	3
Green island	19
Other	27
Need for Action	
Too hot	61
Too sunny	26
Too dry	33
Too wet	4
Too stuffy	6
Other	19
Ideas	
Suggestions	42



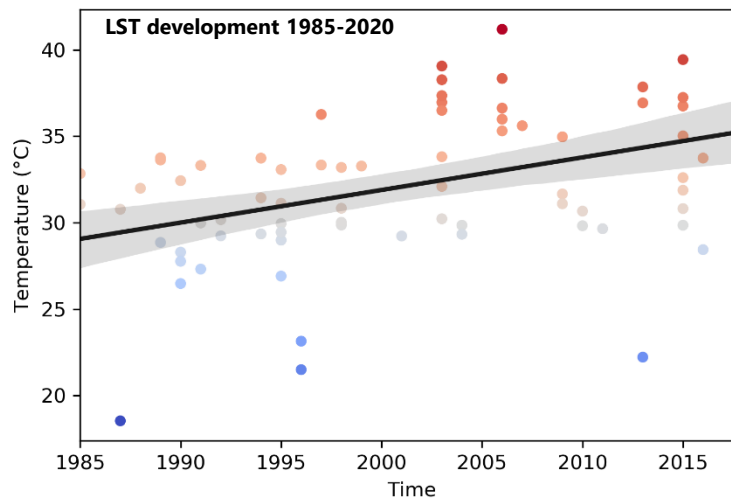
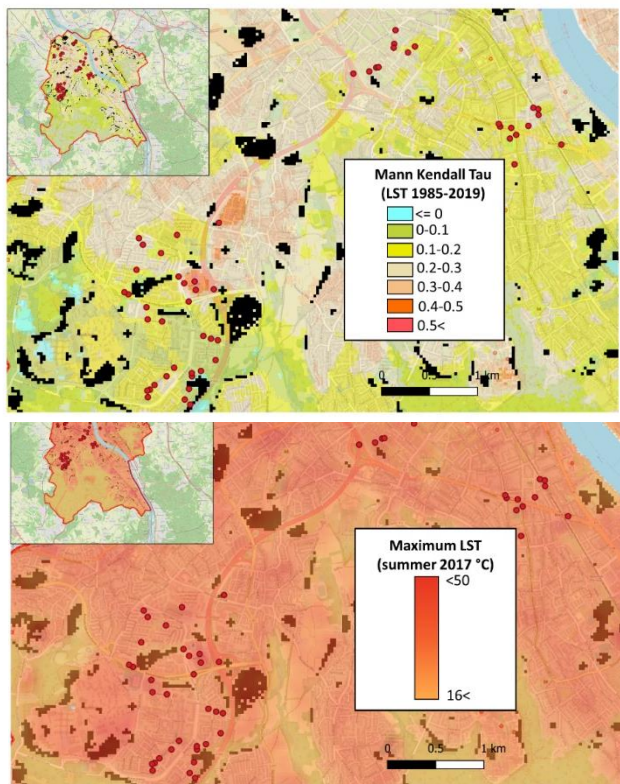
} e.g. solar panels, green roof, „Grüne Insel“, trees,
wild flower meadow

Crowd mapping of climate change adaptation





Urban growth 2030, LST development and crowd mapped thermal stress



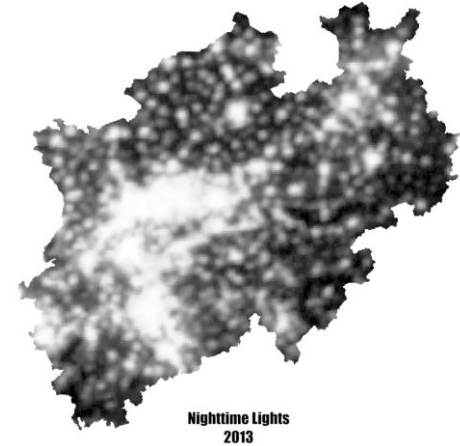
Rienow et al. (submitted)





What's next?

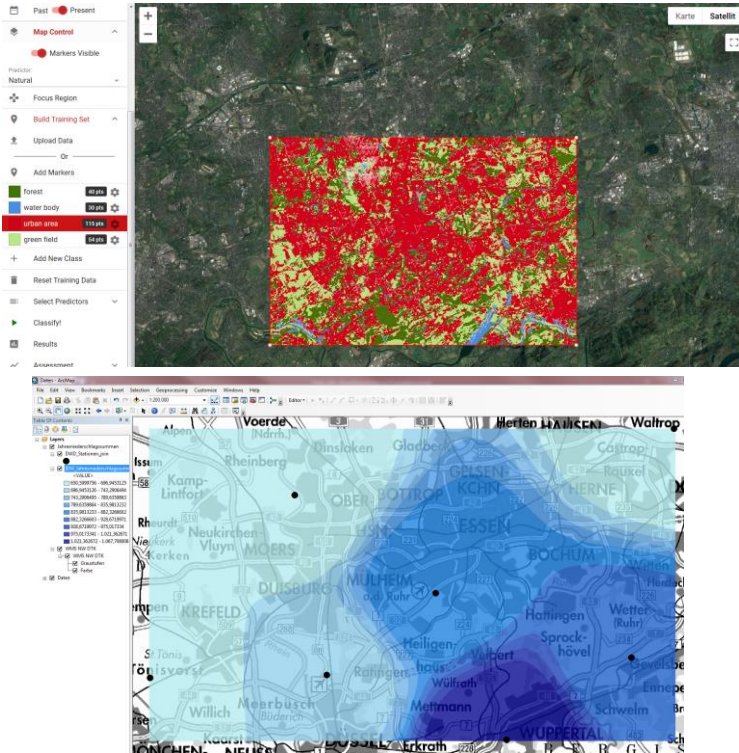
- Organisation of exchange events between authorities and citizens
- Implementation of the full framework in GEE
- Model optimisation & integration of additional datasets (e.g. Nighttime Lights)
- Combine with socio-economic data in regard to investigate climate justice





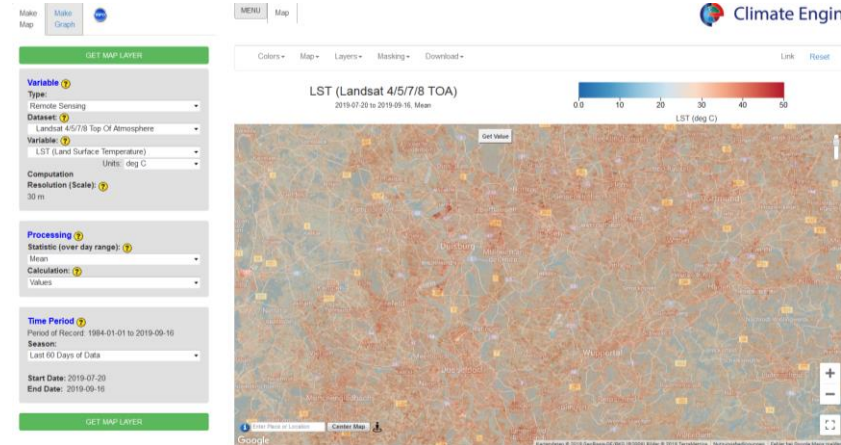
Thank you very much!





Mobilization of Cit(ies)zens – Educating “In-Betweeners”

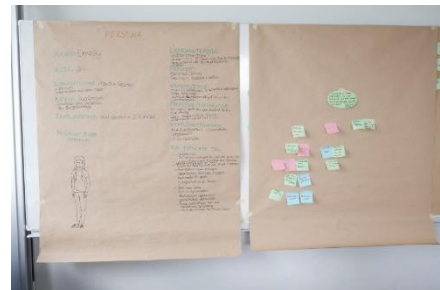
Classification (Remap), Interpolation of precipitation (ArcGIS), surface temperature measurement (Climate Engine), Urban LUCC Modeling (XULU/ SLEUTH)





Mobilization of Cit(ies)zens – Educating “In-Betweeners”

Field trip, design-thinking-
method, creating a sustainable
city



WILA Bonn e.V., (Eds.) (2020): Handlungsleitfaden.
Bonn. http://klimalandschaften-nrw.de/images/Leitfaden_Gute_Ideen_gegen_den_Klimawandel_KLIMNET_web.pdf



