Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

REFINA

Bilateral German-Polish REFINA workshop
'Research and model projects on suburbanization and land consumption'

Development of a remote sensing based land barometer for sustainable land use management

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November 6-7, 2009
Gdansk (Poland)

PV

DLR

GFZ POTSDAM

WEGNER STADTPLANUNG

Metropolregion Rhein-Neckar
Der Verband

LEIPZIG

Content

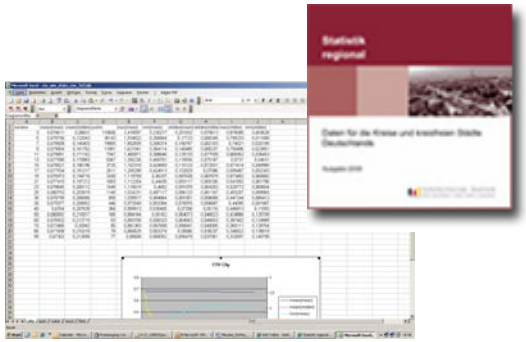
- Background and motivation
- Land barometer tool
  - Concept
  - Output
- Results
  - Regional level
  - Local level
- Feedback and conclusions
- Outlook

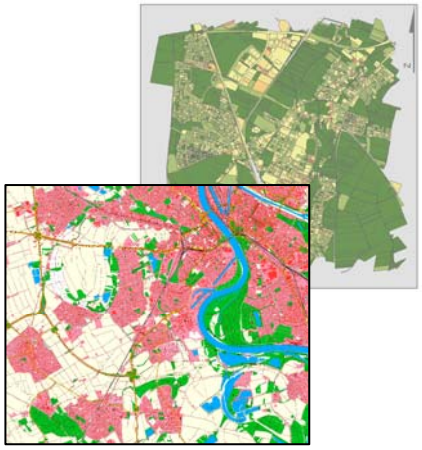
Background and motivation

- Funding priority II: Analyses, methods and assessment concepts
  - Indicator-based set of methods for assessing the sustainability of land management
    - Data pool (national, regional, communal)
    - Catalog of indicators
    - Software prototype (generation and visualization of indicators)
  - Application and evaluation of methods through model regions and stakeholders
    - Feasibility, continuaty
    - Informative value
    - Range of possible applications
  - Analysis of determinantes
    - Action plans
    - Adaptation strategies

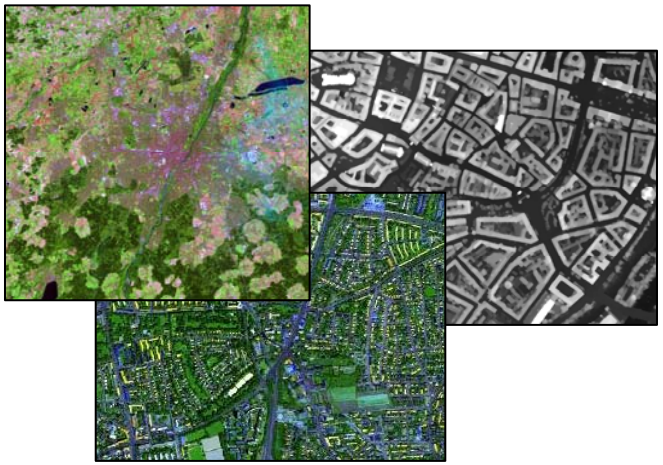
Land barometer tool

- Concept: Data pool
  - Statistics
    - National: Statistik regional
    - (Local: Statistik communal)



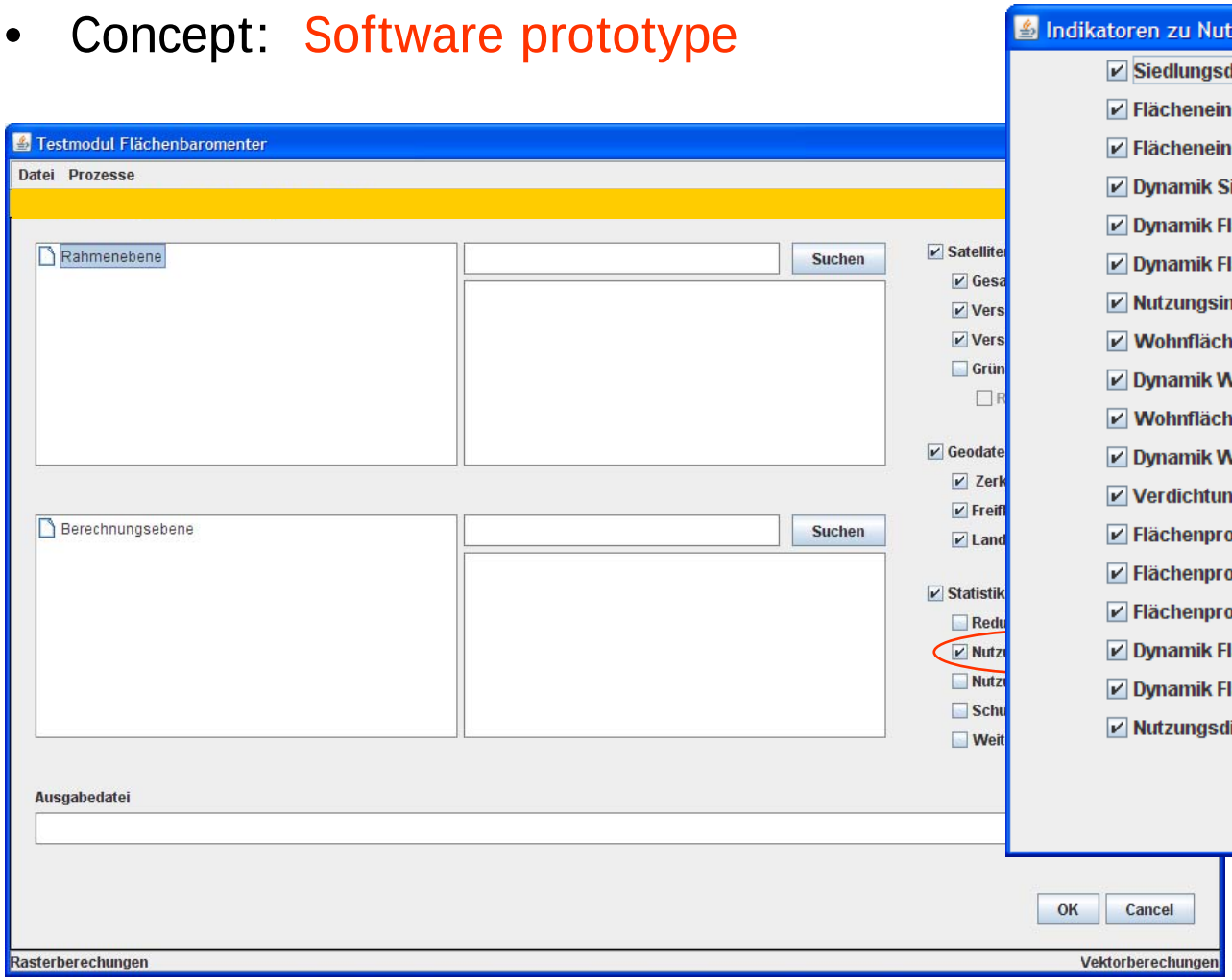


  - Geoinformation
    - National: German Official Topographic Cartographic Information System (ATKIS)
    - (Local: parcel, building block)
  - Remote sensing
    - National: Landsat
    - (Local: HyMap, HRSC, Ikonos, aerial images)



Land barometer tool

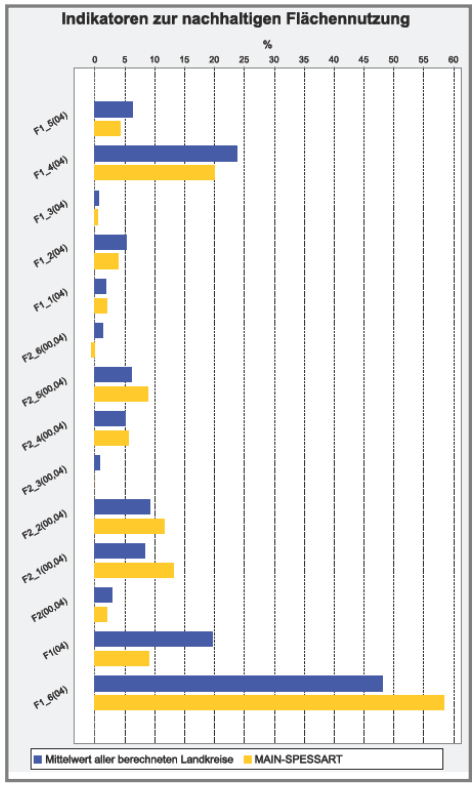
- Concept: Software prototype





Land barometer tool

- Concept: Software prototype

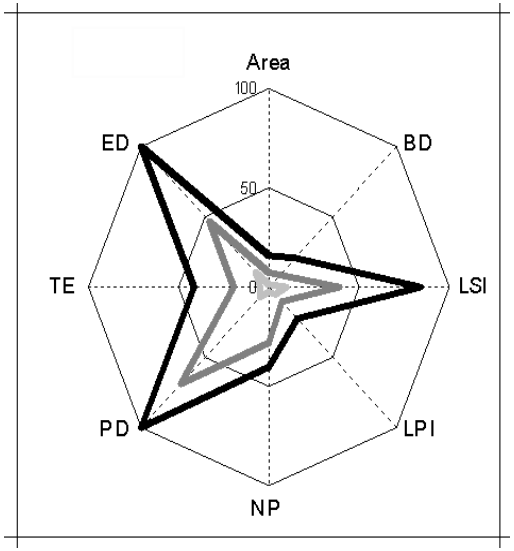


Werte der berechneten Landkreise					
	Mittelwert	Standardabweichung	Minimum	Maximum	MAIN-SPESSART
F1_5	6,24	3,76	3,15	14,50	4,19
F1_4	23,67	6,14	16,31	33,78	19,93
F1_3	0,56	0,28	0,35	1,39	0,37
F1_2	5,20	2,15	3,23	9,70	3,91
F2_6	1,25	1,16	-0,52	3,55	1,96
F1_1	1,79	0,64	0,76	2,89	-0,52
F2_5	6,10	5,88	-3,77	15,14	8,80
F2_4	5,06	2,18	1,72	8,84	5,62
F2_3	0,82	4,08	-9,09	9,76	0,00
F2_2	9,13	6,90	2,22	29,44	11,48
F2_1	8,38	9,59	-8,82	31,25	13,04
F2	2,91	1,25	0,93	5,86	1,98
F1	19,56	15,62	9,02	55,14	9,02
F1_6	48,01	12,58	27,86	62,52	58,30

Aufzählung der berechneten Landkreise:ASCHAFFENBURG(Stadt),MAIN-SPESSART,BADKISSINGEN,WUERZBURG(Stadt),MILTENBERG,SCHWEINFURT(Stadt),HASSBERGE,ASCHAFFENBURG,KITZINGEN,WUERZBURG,RHOEN-GRABFELD,SCHWEINFURT

F1_5 (04) : Flaechennutzung_GuF-Flaeche_Gewerbe_Industrie %
F1_4 (04) : Flaechennutzung_GuF-Flaeche_Wohnen %
F1_3 (04) : Flaechennutzung_Friedhofsflaeche %
F1_2 (04) : Flaechennutzung_Erholungsflaeche %
F2_6 (00,04) : Dynamik_Flaechennutzung_Verkehrsflaeche %
F1_1 (04) : Flaechennutzung der Betriebsflaeche (%)
F2_5 (00,04) : Dynamik_Flaechennutzung_GuF-Flaeche_Gewerbe_Industrie %
F2_4 (00,04) : Dynamik_Flaechennutzung_GuF-Flaeche_Wohnen %
F2_3 (00,04) : Dynamik_Flaechennutzung_Friedhofsflaeche %
F2_2 (00,04) : Dynamik_Flaechennutzung_Erholungsflaeche %
F2_1 (00,04) : Dynamik_Flaechennutzung_Betriebsflaeche %
F2 (00,04) : Dynamik_Flaechennutzung %
F1 (04) : Flaechennutzung %
F1_6 (04) : Flaechennutzung_Verkehrsflaeche %

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Output in form of diagrams or tables

Land barometer tool

- Output
  - Static and dynamic indicators for quantitative und qualitative characterization of land consumption
    - Reduction
    - Conservation and preservation
    - Structure
    - Efficiency
  - 61 indicators with 23 core indicators
  - Time periods of data
    - Statistics: 1996, 2000, 2004 (regional); 2000, 2004 (communal)
    - Geoinformation: 2005
    - Remote sensing: 2000, 2006 (national); 1985 – 2005, 2006 (communal)

Land barometer tool

- Output

Indikatoren zu Reduktionszielen		**Indikatoren zu Nutzungseffizienzzielen**			
1	Flächeninanspruchnahme 2 (R1_2)	1	Entdichtung im Wohnungsbau (N6)	Indexwert (=1)	$\frac{\sum \text{fertigestelle EFH/DH}_t + \sum \text{fertigestelle EFH/DH}_{(t-1)}}{\sum \text{fertigestelle MFH}_t + \sum \text{fertigestelle MFH}_{(t-1)}}$	Statistik regional, lokal
	Dynamik Flächeninanspruchnahme 2 (R2_2)	2	Flächenproduktivität 1 (N9_1)	Tsd. €/ha	$\frac{\sum \text{Bruttowertschöpfung}_t}{\sum \text{SuV-Fläche}_t}$	Statistik regional
2	Bodenversiegelung (R4)	3	Flächenproduktivität 2 (N9_2)	Tsd. €/ha	$\frac{\sum \text{Bruttowertschöpfung}_t}{\sum \text{Einwohner}_t} : \sum \text{SuV-Fläche}_t$	Statistik regional
3	Flächenbedarf (Z1)	5	Dynamik Flächenproduktivität (N10_2)	%	$\frac{\sum \text{Flächenproduktivität}_t}{\sum \text{Flächenproduktivität}_{(t-1)}}$	Statistik regional
	Dynamik Flächenbedarf (Z2)	6	Nutzungsdichte (N11)	Personen /ha	$\frac{\sum \text{Einwohner}_t + \sum \text{sozVers_AO}_t}{\sum \text{GuF-Fläche}_t}$	Statistik regional, lokal
Indikatoren zu Erhaltungs- und Schutzzielen		**Basisindikatoren**			
1	Durchgrünung des Siedlungsraumes (E3)	1	Flächennutzung (F1)	%	z.B. $\frac{\sum \text{GuF-Fläche Wohnen}_t}{\sum \text{SuV-Fläche}_t} \times 100$	Statistik regional, lokal
Indikatoren zu nutzungsstrukturellen Zielen		2	Dynamik Flächennutzung (F2)	%	z.B. $\frac{\sum \text{GuF-Fläche Wohnen}_t - \sum \text{GuF-Fläche Wohnen}_{(t-1)}}{\sum \text{GuF-Fläche Wohnen}_{(t-1)}} \times 100$	Statistik regional, lokal
1	Zerklüftungsgrad (S4)	3	Siedlungsdichte (N1_1)	EW/km	$\frac{\sum \text{Einwohner}_t}{\sum \text{SuV-Fläche}_t}$	Statistik regional, lokal
		4	Flächeneinsatz 1(N1_2)	m²/EW	$\frac{\sum \text{Siedlungsfläche}_t}{\sum \text{Einwohner}_t}$	Statistik regional, lokal
2	Landschaftszerschneidung (S10)	5	Flächeneinsatz 2(N1_3)	m²/EW	$\frac{\sum \text{Verkehrsfläche}_t}{\sum \text{Einwohner}_t}$	Statistik regional, lokal
3	Effektiver Freiflächenanteil (S12)	6	Siedlungsdichte (N2_1)	%	$\frac{\sum \text{Siedlungsdichte}_t - \sum \text{Siedlungsdichte}_{(t-1)}}{\sum \text{Siedlungsdichte}_{(t-1)}} \times 100$	Statistik regional, lokal
		7	Dynamik Flächeneinsatz 1 (N2_2)	%	$\frac{\sum \text{Flächeneinsatz 1}_t - \sum \text{Flächeneinsatz 1}_{(t-1)}}{\sum \text{Flächeneinsatz 1}_{(t-1)}} \times 100$	Statistik regional, lokal
		8	Dynamik Flächeneinsatz 2 (N2_3)	%	$\frac{\sum \text{Flächeneinsatz 2}_t - \sum \text{Flächeneinsatz 2}_{(t-1)}}{\sum \text{Flächeneinsatz 2}_{(t-1)}} \times 100$	Statistik regional, lokal
		9	Flächeninanspruchnahme 1 (R1_1)	%	$\frac{\sum \text{SuV-Fläche}_t}{\sum \text{Gesamtfläche}_t} \times 100$	Statistik regional, lokal
		10	Dynamik Flächeninanspruchnahme 1 (R2_1)	%	$\frac{\sum \text{SuV-Fläche}_t \ \sum \text{SuV-Fläche}_{(t-1)}}{\sum \text{SuV Fläche}_{(t-1)}} \times 100$	Statistik regional, lokal

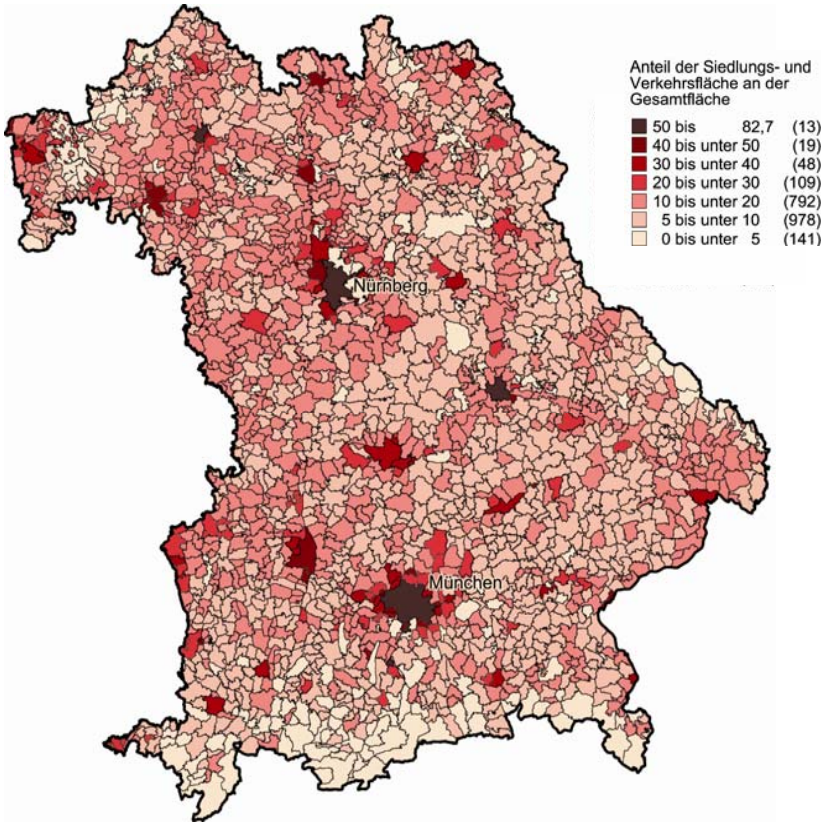
List of core indicators

Content

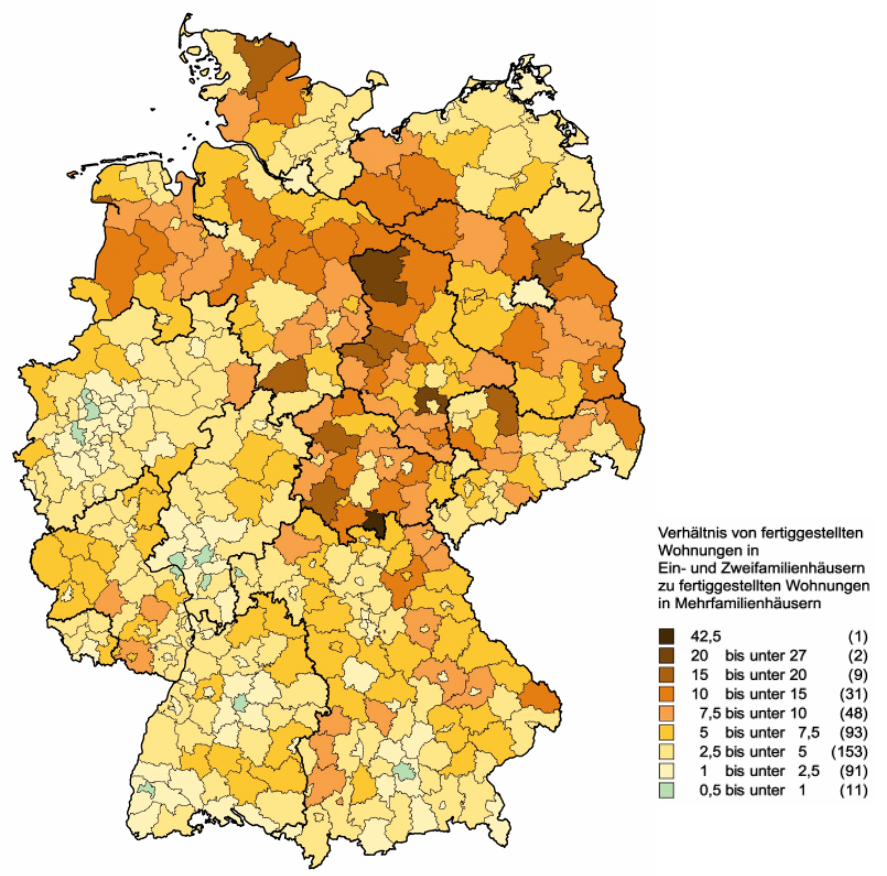
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Results

- Regional level: Statistics



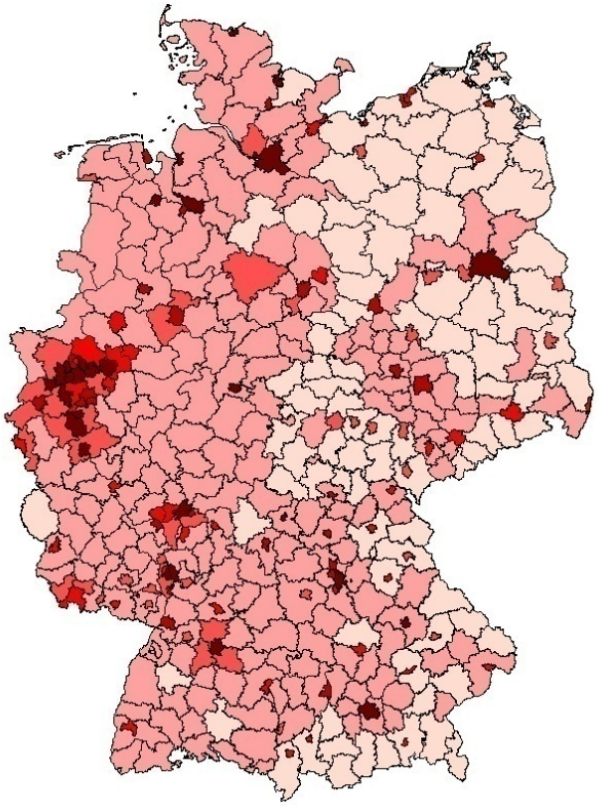
R1_2 land consumption (Bavaria) 2004

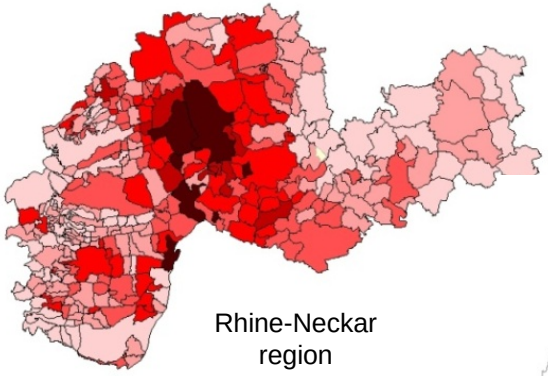


N6 spatial decentralization (housing) 2001-2004

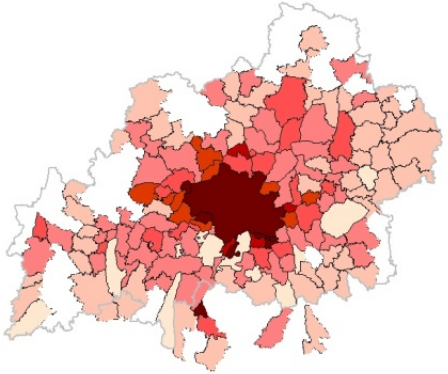
Results

- Regional level: Geoinformation (ATKIS)

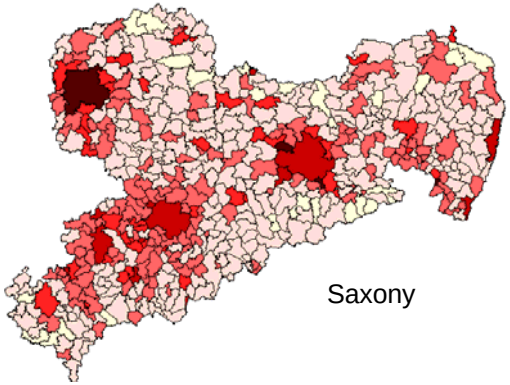




Rhine-Neckar region



Munich region

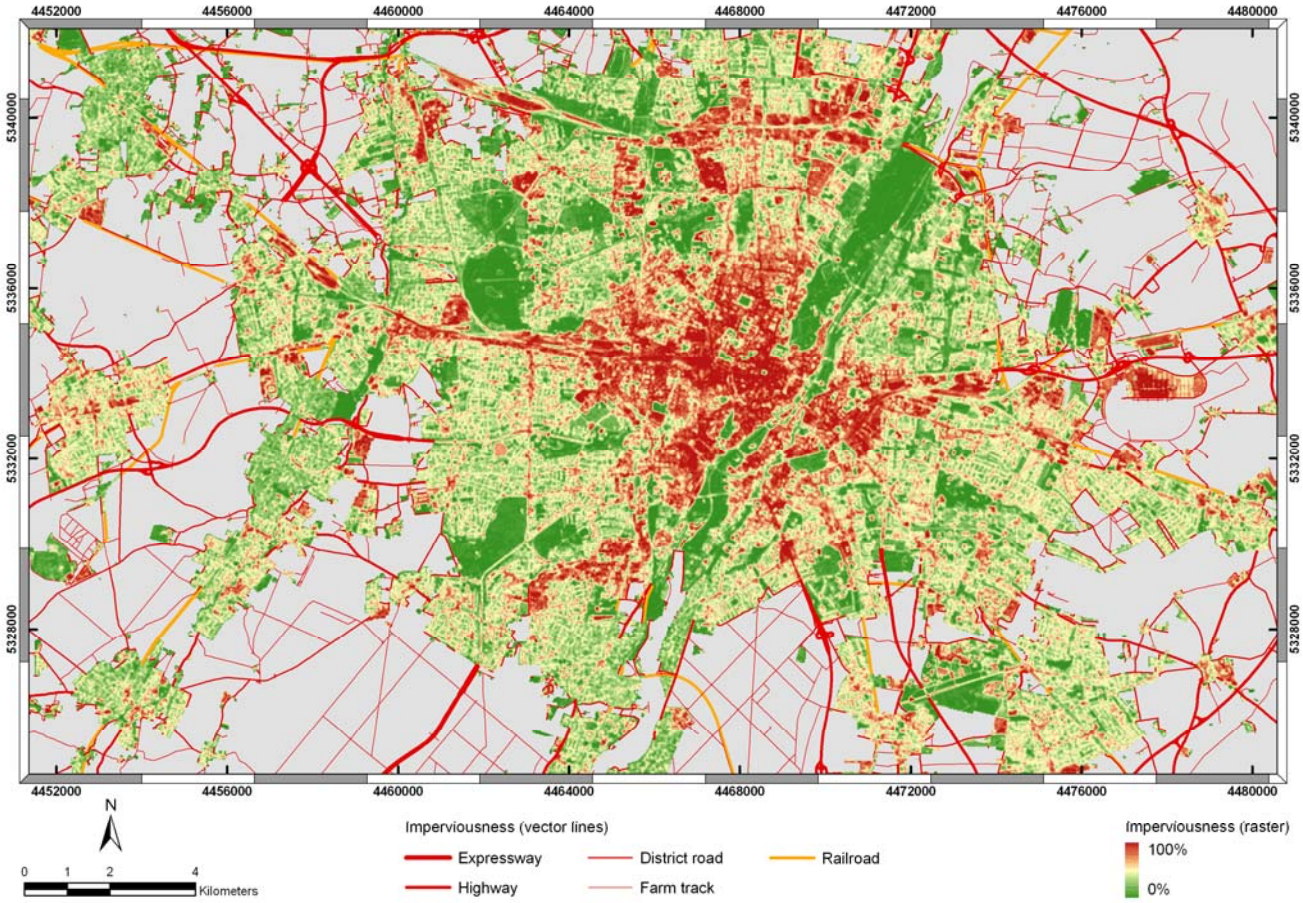


Saxony

S10 fragmentation index 2004

Results

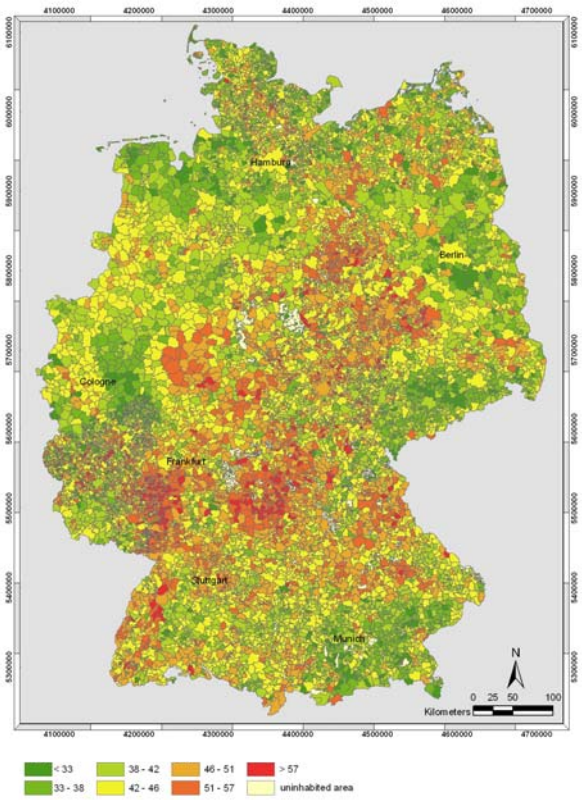
- Regional level: Remote sensing



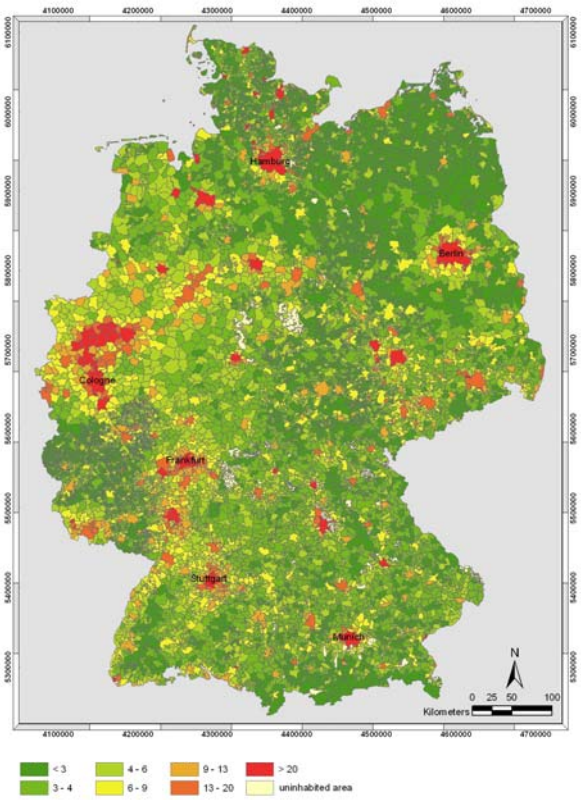
Results

- Regional level: Remote sensing

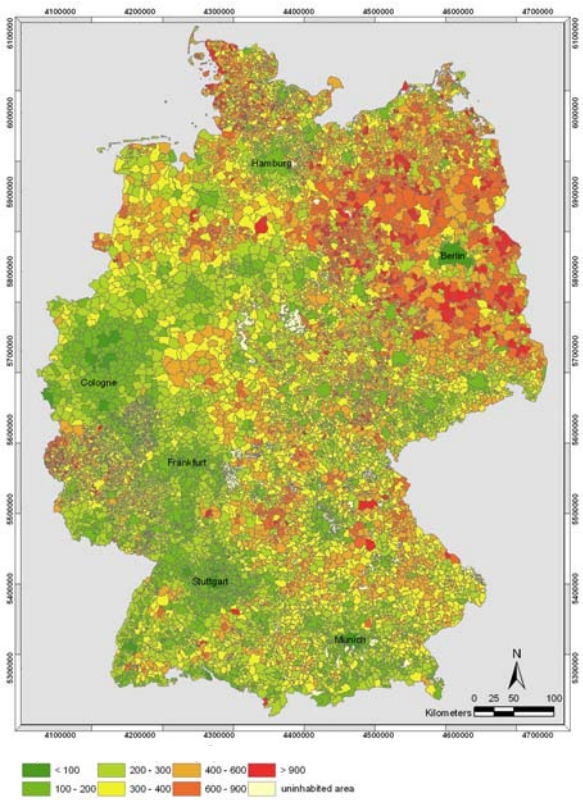
R4 soil sealing (per SaT)



Impervious surface per municipal area [%]

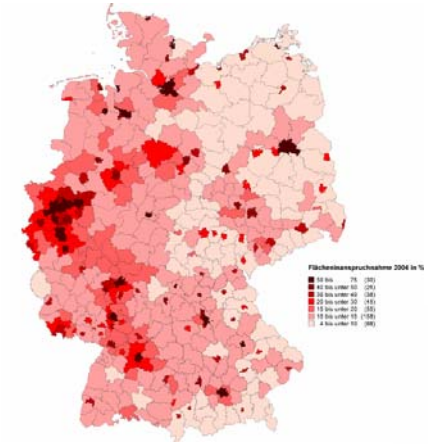


Impervious surface per person [m2]

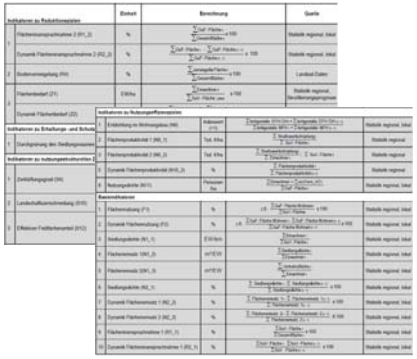


Results

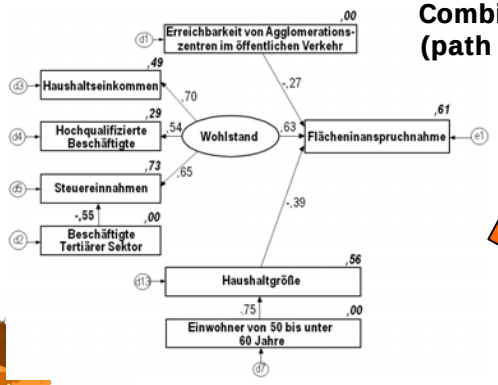
- Regional level: Analysis of determinants



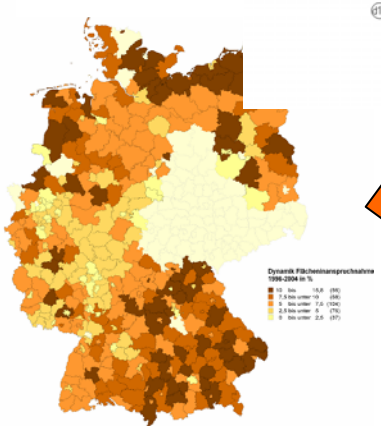
R1_2 Land consumption 2004



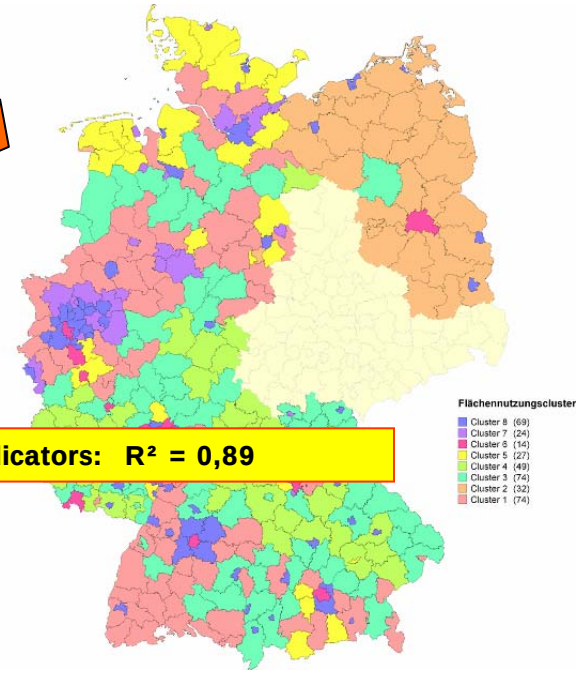
61 indicators



Combined factor and cluster analysis (path analysis)



R2_2 Dynamics of land consumption 1996 -2004

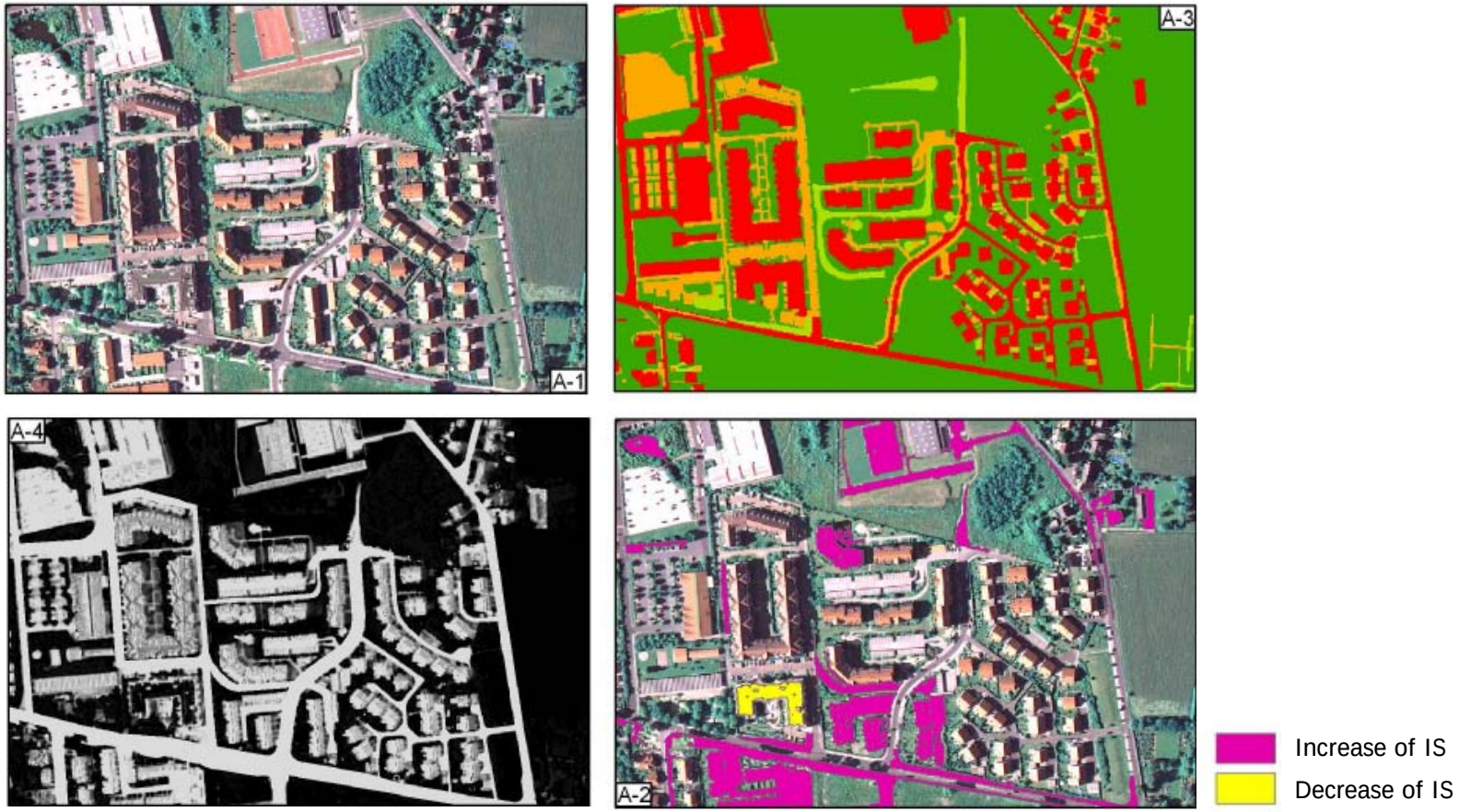


Soil sealing => indicators: R^2 = 0,89

Land use structure can be characterized on the basis of 8 clusters

Results

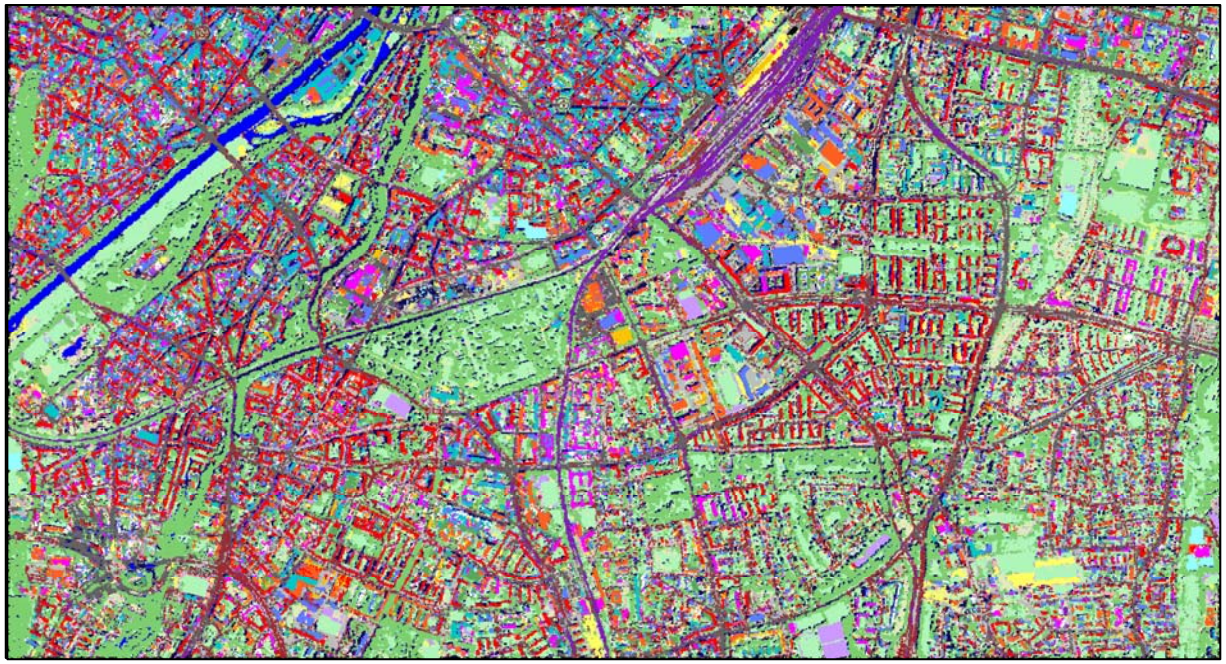
- Local level: Aerial images (soil sealing)



Modeling based on aerial image and comparison to cadastral data

Results

- Local level: Hyperspectral data (land cover)

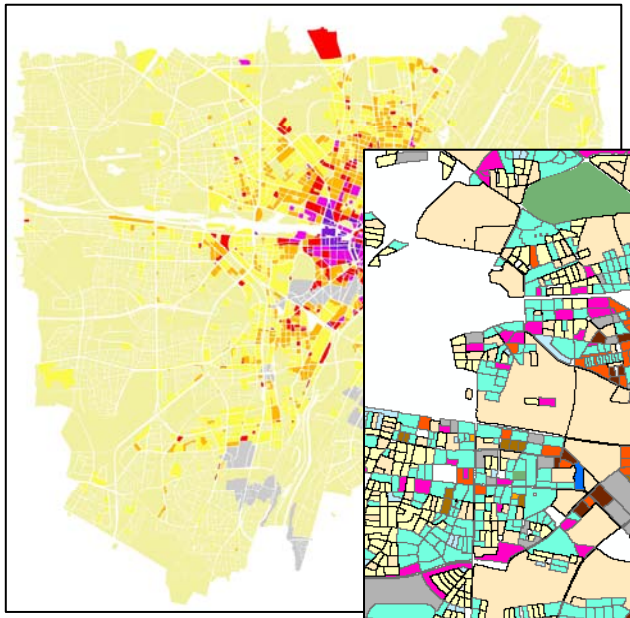


Subset of HyMap image (Munich, Germany)

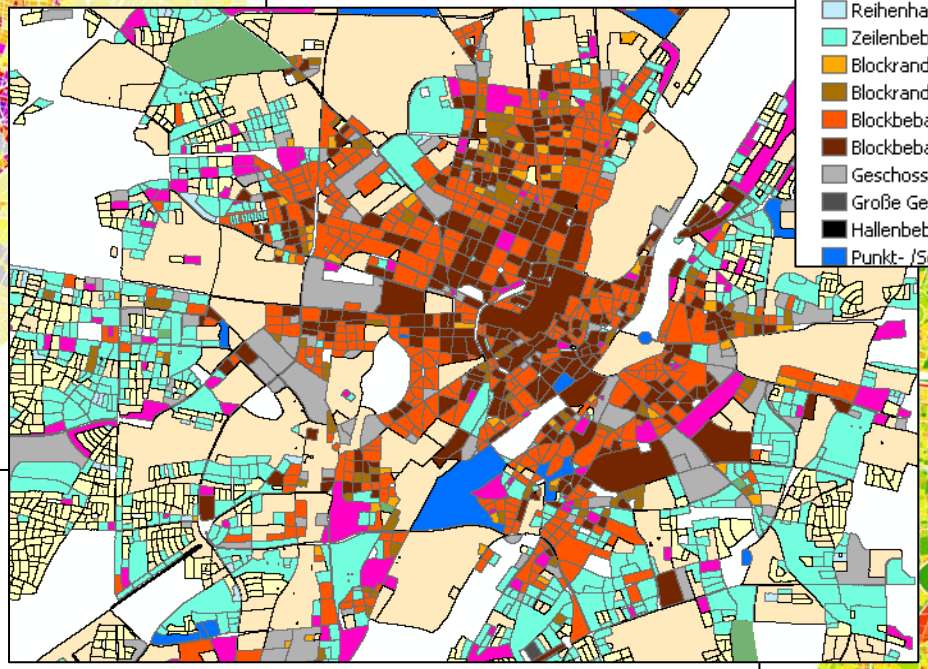
- Roofing tiles
- Roofing concrete
- Roofing metal
- Roofing bitumen / tar
- Roofing synthetic / glass
- Vegetated roof
- Roofing gravel
- Unknown
- Concrete
- Asphalt
- Tartan/ synthetic turf/polyethylene surfaces
- Loose chippings
- Railway tracks
- Sand/soil
- Trees
- Lawn
- Water
- Shadow
- Unclassified
- Cloud cover, GPS-error

Results

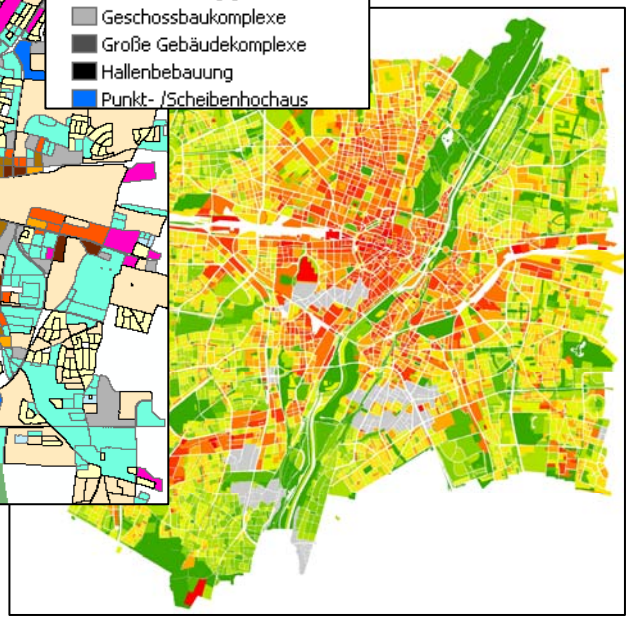
- Local level: Hyperspectral & height data (urban morphology)



Building volume [m³]



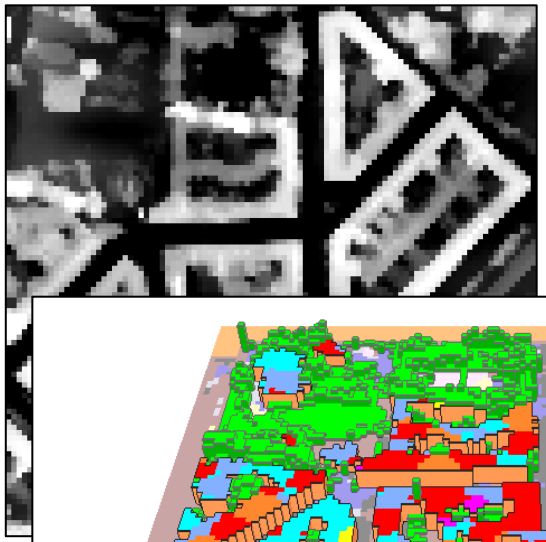
Definition of urban structural types

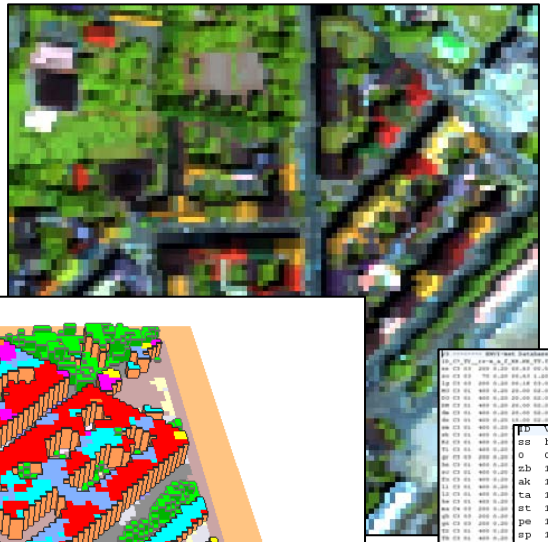


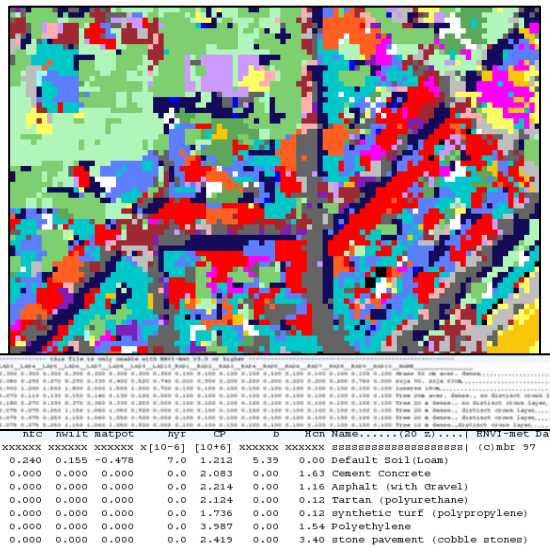
Impervious surface [%]

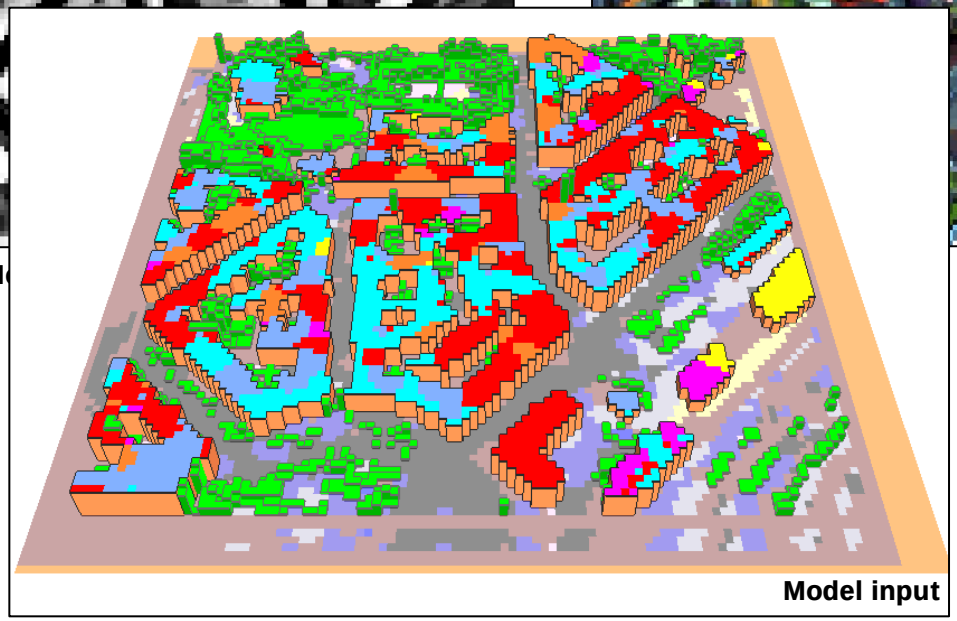
Results

- Local level: Hyperspectral & height data (urban micro-climate)









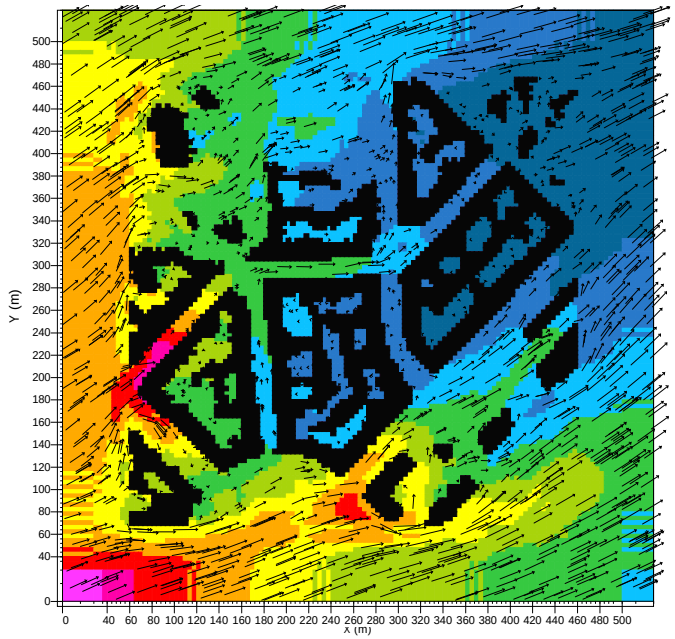
Model input

ID	V	RS	nLC	RMile	MatPot	Hyr	CP	D	HCn	Name.....(20 S).....	ENVI-met Datafile
ss	b	xxxxxx	xxxxxx	xxxxxx	xxxxxx	x[10^6]	[10^6]	xxxxxx	xxxxxx	ssssssssssssssssssss	(c)mbr 97
0	0	0.451	0.240	0.155	-0.478	7.0	1.212	5.39	0.00	Default Soil(Loam)	
zb	1	0.000	0.000	0.000	0.000	0.0	2.083	0.00	1.63	Cement Concrete	
ak	1	0.000	0.000	0.000	0.000	0.0	2.214	0.00	1.16	Asphalt (with Gravel)	
ta	1	0.000	0.000	0.000	0.000	0.0	2.124	0.00	0.12	Tartan (polyurethane)	
st	1	0.000	0.000	0.000	0.000	0.0	1.736	0.00	0.12	synthetic turf (polypropylene)	
pe	1	0.000	0.000	0.000	0.000	0.0	3.987	0.00	1.54	Polyethylene	
sp	1	0.000	0.000	0.000	0.000	0.0	2.419	0.00	3.40	stone pavement (cobble stones)	
cp	1	0.000	0.000	0.000	0.000	0.0	1.764	0.00	1.10	concrete pavement	
zz	1	0.000	0.000	0.000	0.000	0.0	2.000	0.00	1.00	Brick pavement	
bc	1	0.000	0.000	0.000	0.000	0.0	1.546	0.00	0.36	brick chippings	
lc	1	0.000	0.000	0.000	0.000	0.0	1.546	0.00	0.36	loose chippings/gravel	
sd	0	0.395	0.135	0.0068	-0.121	176.0	1.463	4.05	0.00	Sand	
le	0	0.451	0.240	0.155	-0.478	7.0	1.212	5.39	0.00	Default Soil(Loam)	

Data base (soil, plant, roof)

Results

- Local level: Hyperspectral & height data (urban micro-climate)



Air temperature [K]

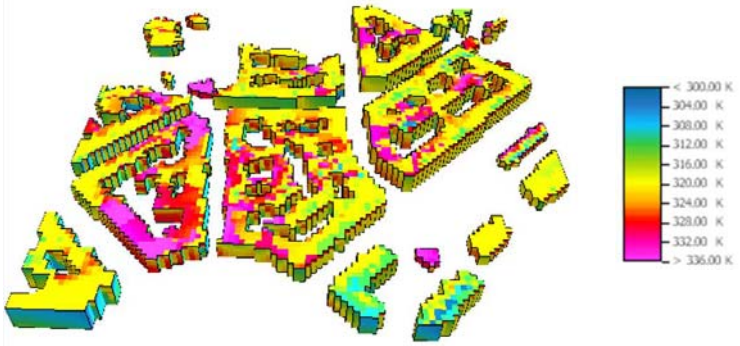
- < 293.1
- 293.1 – 293.6
- 293.6 – 294.0
- 294.0 – 294.5
- 294.5 – 295.0
- 295.0 – 295.4
- 295.4 – 295.9
- 295.9 – 296.3
- 296.3 – 296.8
- > 296.8

Wind speed [m/s]

17.06.2007 15:00

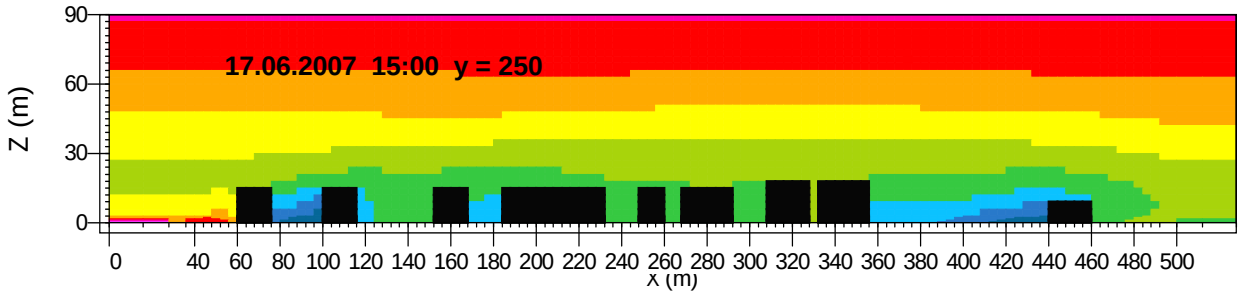
z = 1.5m

Facade temperature [K]



Rel. Humidity [%]

- < 58.9
- 58.9 – 60.1
- 60.1 – 61.4
- 61.4– 62.6
- 62.6 – 63.9
- 63.9 – 65.1
- 65.1 – 66.3
- 66.3 – 67.6
- 67.6 – 68.8
- > 68.8



Content

- Background and motivation
- Land barometer tool
  - Concept
  - Output
- Results
  - Regional level
  - Local level
- Feedback and conclusions
- Outlook

Feedback and conclusions

- Remote sensing-supported information system for assessing the sustainability of urban development
  - Focus on core indicators
  - Set of methods and prototype software for processing and analysis of specific statistical data, geoinformation and remote sensing imagery (regional, communal, local)
- Assessment by model regions and stakeholders
  - Broad range of applications with focus on planning, consulting and monitoring
  - Quantitative interpretation of indicators facilitates assessment of sustainability in land consumption
  - Effect of qualitative factors not yet well-known
  - Synoptic interpretation of indicators required
  - Expertise inevitable for interpretation
  - System is most applicable at regional and national scale
  - Frequent up-dating possible (statistics, ATKIS, satellite data)
  - Remote sensing techniques show high potential for spatially detailed analyses (building block, parcel) and derivation of enhanced indicators (urban micro-climate)

Content

- Background and motivation
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Outlook

- Refina funding priority
  - Land barometer
    - Further evaluation by model regions and project partners
    - Consolidation of software prototype and compilation of user guide
    - Provision of indicators via Web-interface (BBSR)
    - Integration of qualitative factors and analysis of determinants
- Future plans
  - Transfer of land barometer to North America (Canada)
  - Enhancement and adaptation to energy- and climate-related issues



Thank you for your attention!

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