GC IMPACT on TOURISM and WATER SUPPLY

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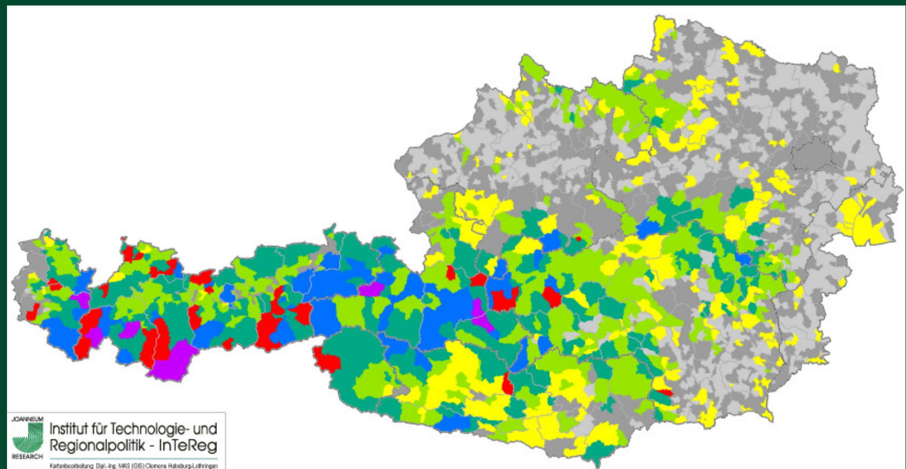
VCCT 2007 - Side Event
Impacts of climate change in the Alpine region and possible adaptation measures



VIENNA, AUGUST 27, 2007

JOANNEUM RESEARCH – Graz
Institute of Technology and Regional Policy (InTeReg)

OUTLINE

→ **Motivation and Problem Statement**
  - Vulnerability Concept & Adaptation Policy

→ **Methods**

→ **Results**
  - Economic Cluster Analysis
  - Climatological Cluster Analysis

→ **Future Work/Outlook**

→ **Summary**

JOANNEUM RESEARCH

MOTIVATION AND PROBLEM STATEMENT

- → Economic vulnerability to demand shocks arising from weather and climate variability
- → Investigate how weather related demand shocks impact the vulnerable tourism sector and other related sectors
- → Combination of climatological and economic research
- → Regional climate change → regional economic impacts
- → Use the vulnerability concept for adaptation policy

Vulnerability Concept useful for adaptation policy?

→ Pragmatic working definition

CONCEPT OF REGIONAL ECONOMIC VULNERABILITY (Tourism)		
EXPOSURE	**SENSITIVITY**	**ADAPTIVE CAPACITY**
•Relative Height (sea level) •Precipitation regime	•Employment concentration in the tourism sector •Invested capital (proxy: Hotels, conveying capacity)	•Economic diversity (HH-Index) •Economic strength (equity capital ratio) •Risk transfer mech. •Technical adaptation options •Alternative tourist attractions

METHODS

→ **Definition of indicators (vulnerability concept)**

→ **Economic Cluster Analysis**

- groups of communities whose socio-economic and geographical characteristics point at similar vulnerability to external shocks on the tourism sector
- Focus 1st step: sensitivity + exposure-connected variables

→ **Climatological Cluster Analysis**

- Precipitation regions
- Focus 2nd step: exposure

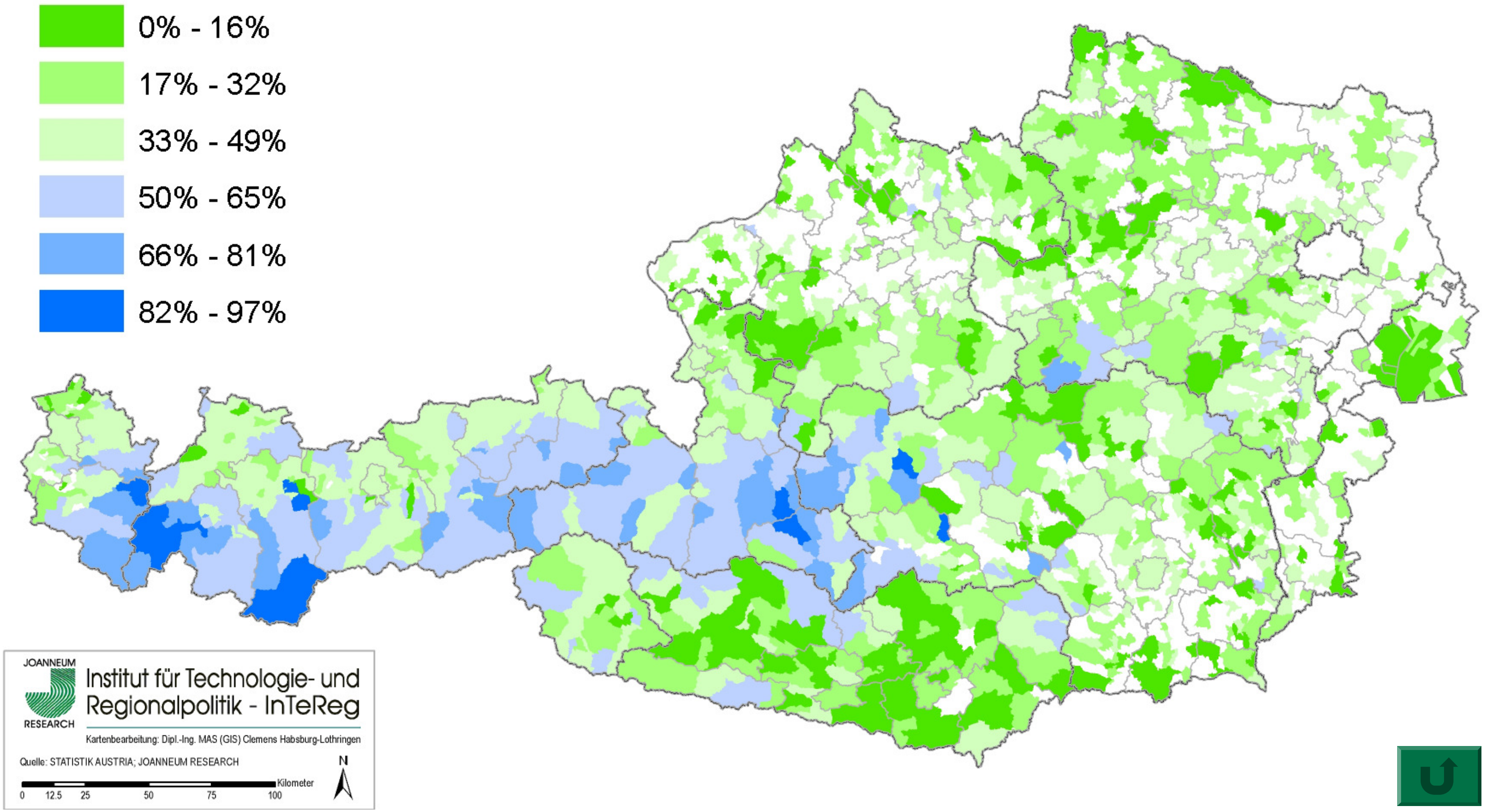
→ **3rd step: include adaptation**

Cluster analysis – definition of indicators

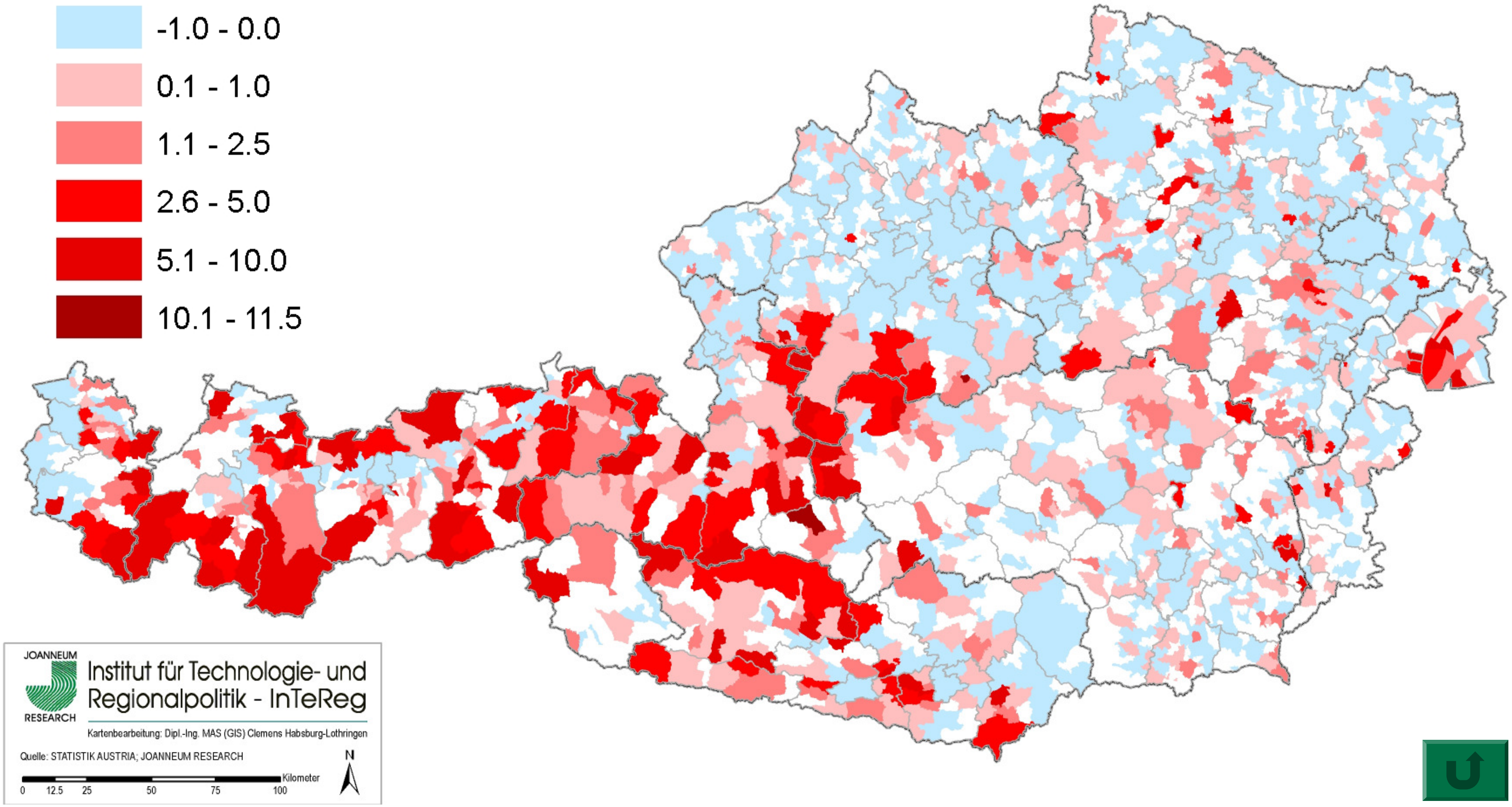
→ **variables utilized**

Share of overnight stays in the winter season Ø 2000-2005
Concentration of Employment in the tourism sector
Tourism density (overnight stays/inhabitant) Ø 2000-2005
Highest elevation
Max. conveying capacity

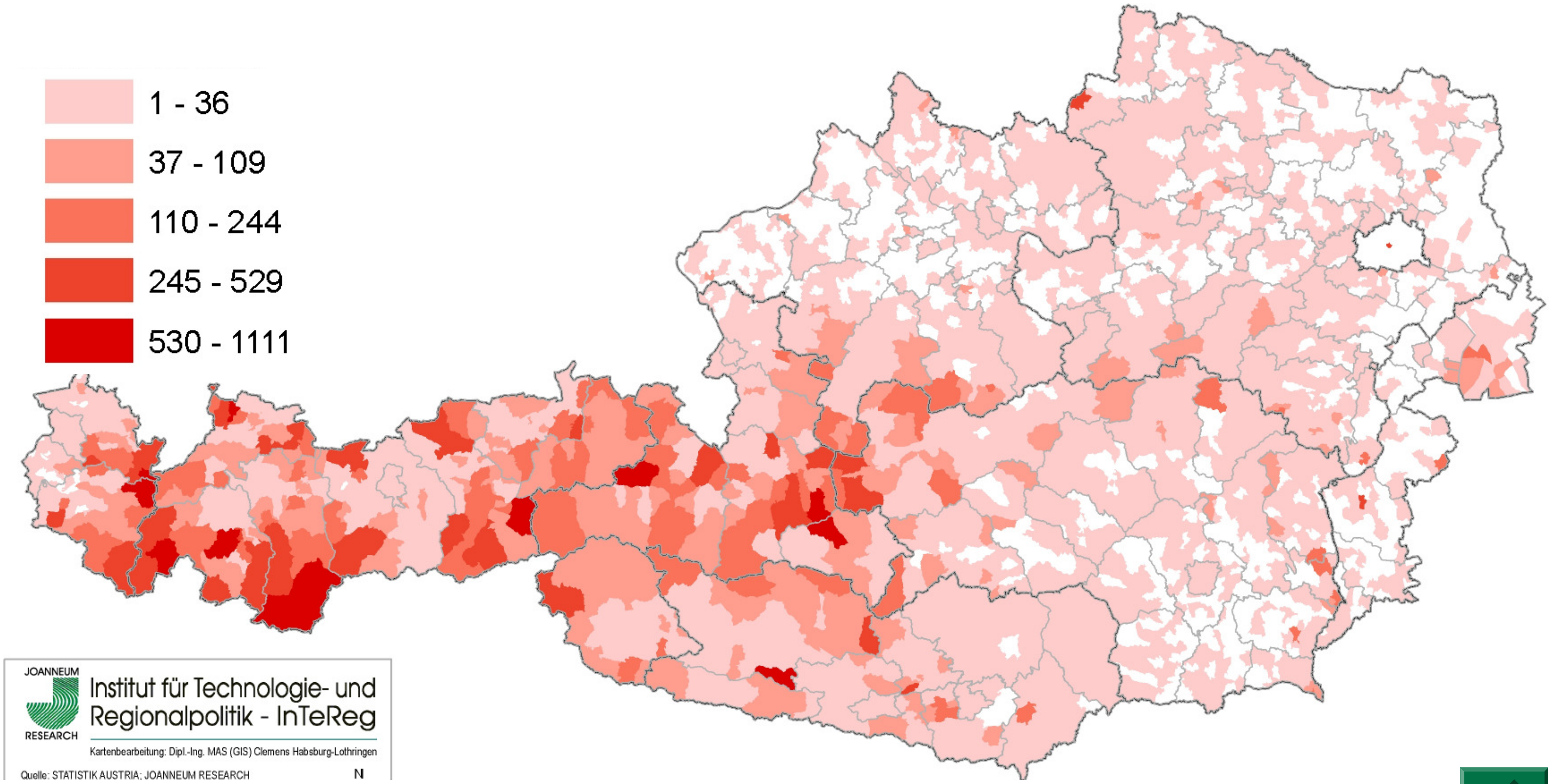
Share of overnight stays in the winter season



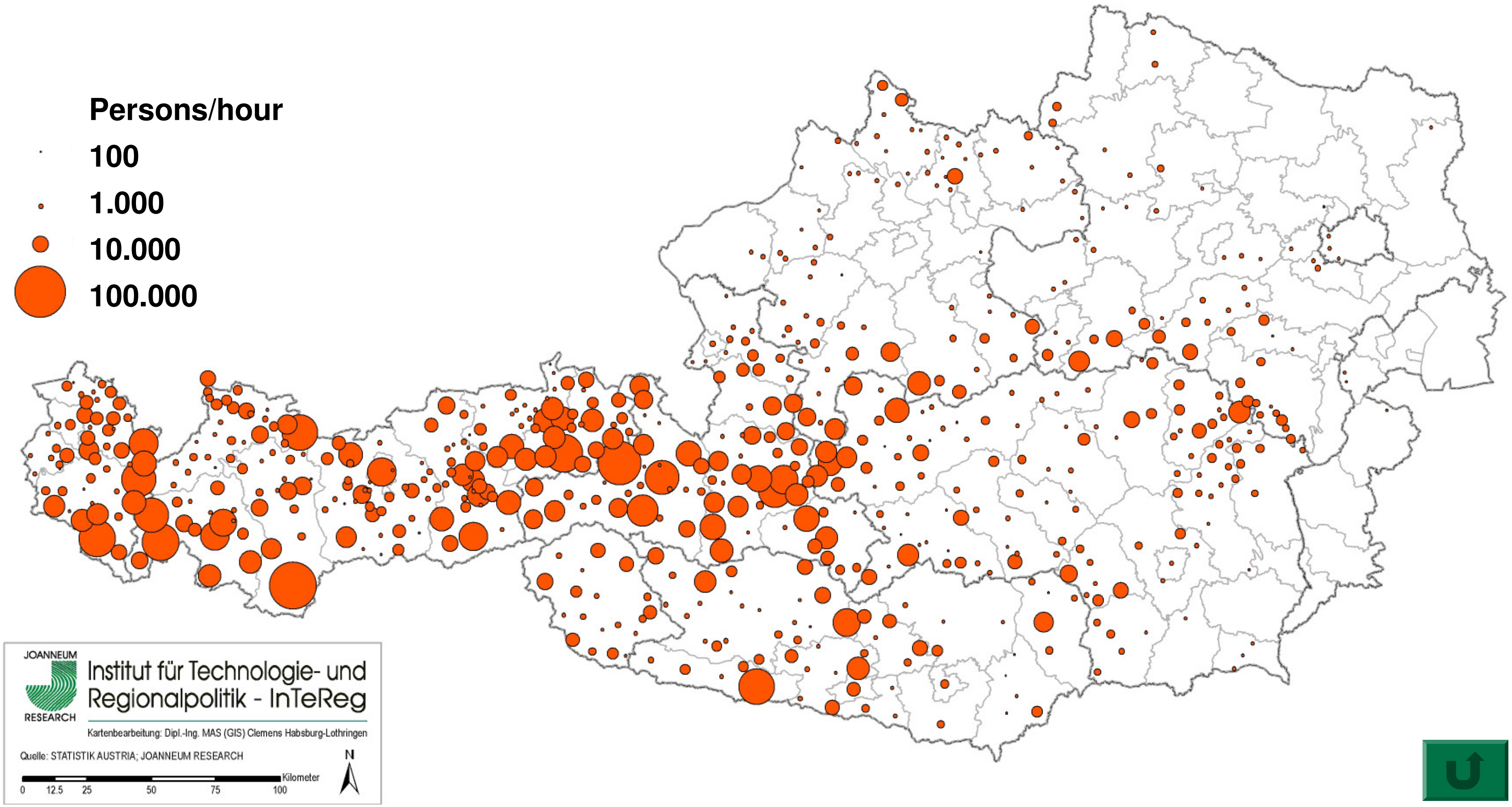
Concentration of Employment in the tourism sector



Tourism density (overnight stays per inhabitant)



Maximum conveying capacity (pers./h)



RESULTS – 1st step

→ **Cluster Analysis 1**
- Focus on tourism in general (both seasons)
- Later step: find alternatives or possible new attractions

→ **Cluster Analysis 2**
- Focus on winter tourism
- Division in two groups of communities
- Criterion: ski-lift infrastructure
- Allows for more detailed information

→ **Climatological Cluster Analysis**
- Focus on winter half-year

Cluster Analysis 1

2.375 Austrian communities

Cluster Analysis

Cluster Analysis
Share of overnight stays in the winter season Ø 2000-2005
Concentration of Employment in the tourism sector
Tourism density (overnight stays per inhabitant) Ø 2000-2005
Highest elevation
Max. conveying capacity

No Tourism			Summer/all-year		Winter		
no/day tourism	no/day/ city tour. low alt.	no/day/ city tour. high alt.	summer tourism	all-year tourism	tourism-dependent	winter tourism	Top 9 winter resorts

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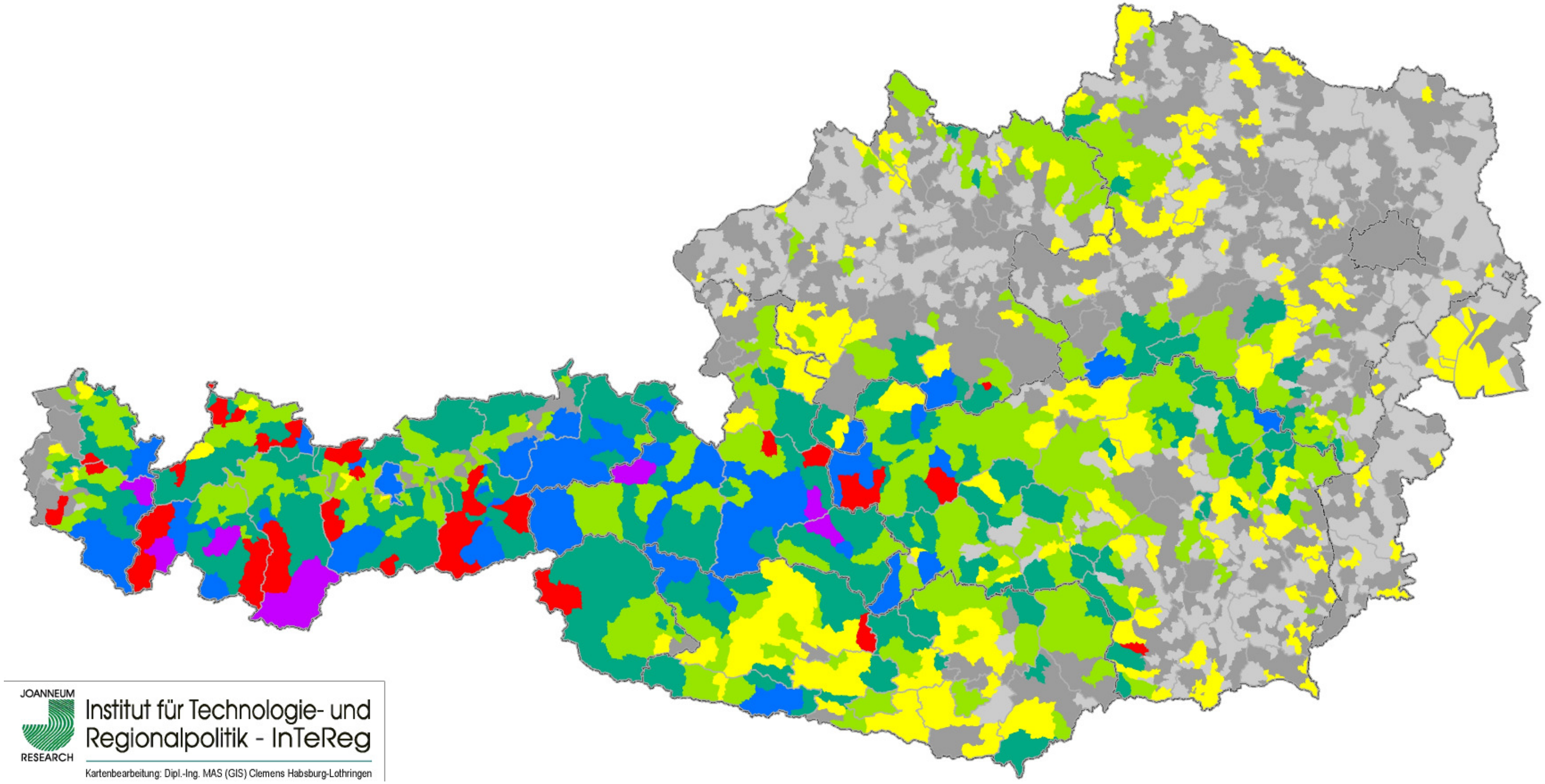
Cluster Analysis 1

No Tourism			Summer/all-year		Winter		
no/day tourism	no/day/ city tour. low	no/day/ city tour. high	summer tourism	all-year tourism	tourism-dependent	winter tourism	Top 9 winter resorts
723	616	358	292	255	35	69	9



RESULTS – 2nd step

→ **Cluster Analysis 1**

- Focus on tourism in general (both seasons)
- Later step: find alternatives or possible new attractions

→ **Cluster Analysis 2**

- Focus on winter tourism
- Division in two groups of communities
- Criterion: ski-lift infrastructure
- Allows for more detailed information

→ **Climatological Cluster Analysis**

- Focus on winter half-year

Cluster Analysis 2 – focus on winter

2.375 Austrian communities

Winter sports infrastructure – ski-lifts

Comm. with ski-lifts	Comm. without ski-lifts
Cluster Analysis	**Cluster Analysis**
Tourism density summer/winter (overnight stays per inhabitant) Ø 2000-2005	Tourism density summer/winter (overnight stays per inhabitant) Ø 2000-2005
Concentration of Employment in tourism	Concentration of Employment in tourism
Sea level + Difference of max./min. sea level	Sea level + Difference of max./min. sea level
Max. conveying capacity cable cars/tow lifts	
Sea level upper/lower terminus	

Clusters (communities with ski-lifts):

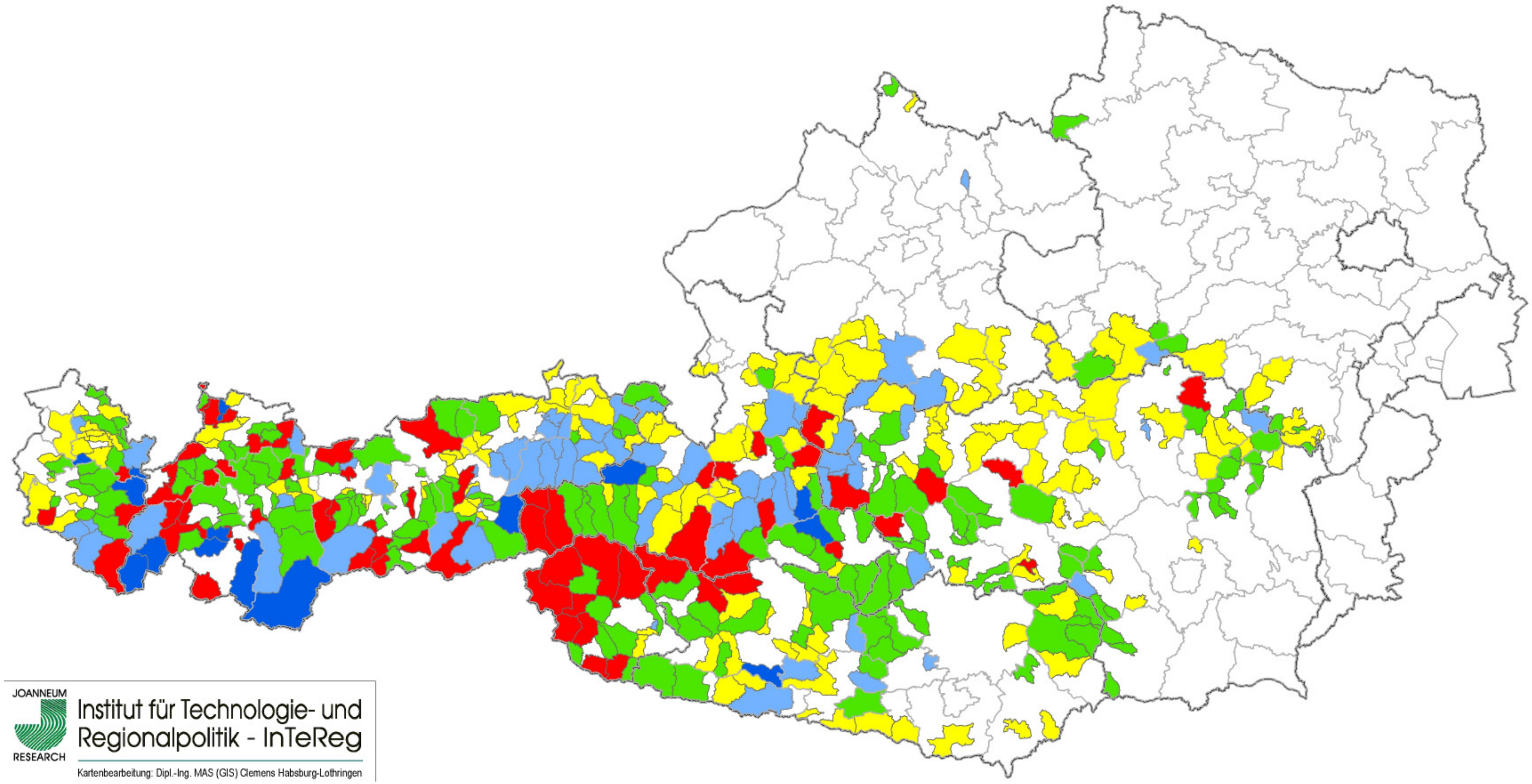
No/city/ summer	Hiking with winter	All-year	Tourism-dep.	Winter	Top winter resorts

Clusters (communities without ski-lifts):

No tourism	Summer/ all-year higher alt.	Summer	Spa tourism, Top summer resorts

Cluster Analysis 2 – focus on winter

No/city/ summer tour.	Hiking with winter season	All-year tourism	Tourism-dependent	Winter tourism with summer s.	Top Winter
167	149	162	66	66	15



Cluster Analysis 2 – focus on winter

Variables		all	No/city/ summer	Hiking + winter	All-year tourism	Tourism-depend.	Winter + summer	Top Winter
Tourism density WI	μ	**13**	**2**	**9**	**17**	**98**	**57**	**515**
	σ	102	7	21	29	66	81	246
	CV	784	322	227	167	68	142	48
Tourism density SO	μ	**11**	**4**	**15**	**19**	**70**	**39**	**163**
	σ	46	11	26	20	44	45	95
	CV	404	290	175	107	62	115	58
Concentration of Employment	μ	**0,2**	**-0,2**	**0,3**	**0,9**	**5,2**	**1,4**	**7,7**
	σ	3,6	1,9	1,8	2,9	2,8	2,8	1,2
	CV	-	-	-	-	-	-	-
Sea level	μ	**770**	**540**	**643**	**913**	**1.134**	**808**	**1.295**
	σ	268	165	134	174	202	181	189
	CV	35	30	21	19	18	22	15
Difference of max/min sea level	μ	**1.181**	**492**	**1.387**	**1.374**	**1.644**	**1.457**	**1.465**
	σ	585	283	337	472	487	503	444
	CV	50	57	24	34	30	35	30

Cluster Analysis 2 – focus on winter

Variables		all	No/city/ summer	Hiking + winter	All-year tourism	Tourism-depend.	Winter + summer	Top Winter
Max. conveying capacity cable cars	μ	**2.445**	**56**	**361**	**924**	**3.091**	**12.032**	**21.143**
	σ	6.255	255	910	1.985	3.914	9.044	16.240
	CV	256	454	252	215	127	75	77
Max. conveying capacity tow lifts	μ	**2.966**	**904**	**2.063**	**2.457**	**3.963**	**9.026**	**9.317**
	σ	3.670	704	2.005	1.948	2.747	5.108	7.886
	CV	124	78	97	79	69	57	85
Sea level lower terminus	μ	**882**	**603**	**758**	**1.141**	**1.221**	**803**	**1.282**
	σ	316	182	161	244	222	192	290
	CV	36	30	21	21	18	24	23
Sea level upper terminus	μ	**1.309**	**721**	**1.062**	**1.495**	**1.837**	**2.137**	**2.343**
	σ	665	237	312	370	452	964	461
	CV	51	33	29	25	25	45	20
Number of communities		**625**	**167**	**149**	**162**	**66**	**66**	**15**

RESULTS – 2nd step

→ **Cluster Analysis 1**
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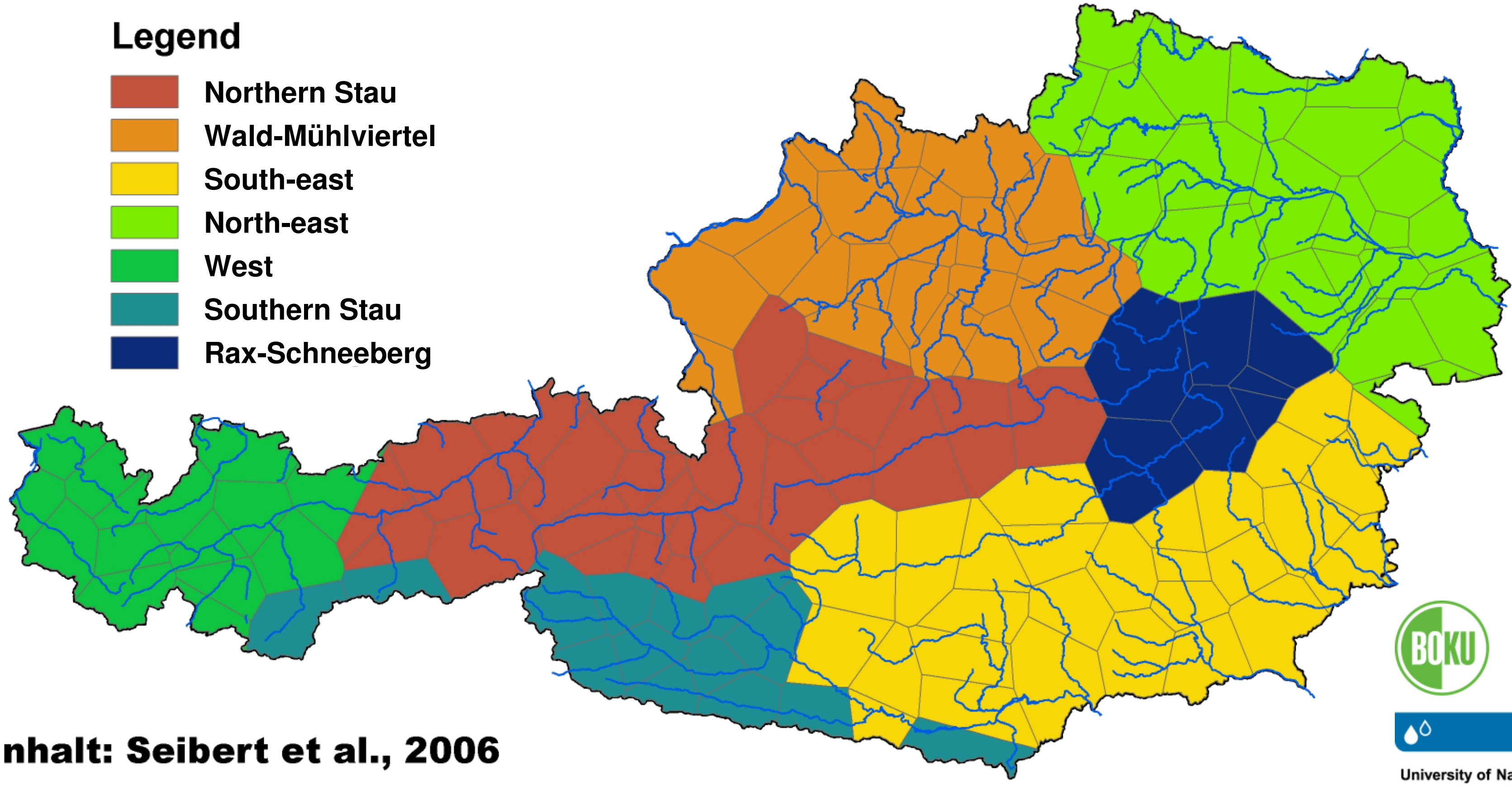
- Focus on winter half-year

Climatological Cluster Analysis

Precipitation regions in the winter half-year in Austria



Inhalt: Seibert et al., 2006
Layout: Formayer 2006

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FUTURE WORK/OUTLOOK

- → Selection of representative regions (communities)
- → Daily snow model, run at 3 different sea levels → situation of the skiing slopes
- → Determine the associated shifts in demand
- → Quantify the <u>direct</u> impacts on the regional tourism sector
- → Quantify the <u>indirect</u> impacts on the economy of the entire region (Macroeconomic effects on level of federal states)
- → Consider adaptation options
- → Focus on summer tourism

Determining winners & loosers (OECD 2007)

- Under present climate conditions, 609 out of the 666 (or 91%) Alpine ski areas in Austria, France, Germany, Italy, and Switzerland naturally snow-reliable.
- remaining 9% already operating under marginal conditions.
- The number of naturally snow-reliable areas would drop to 500 under 1 °C, to 404 under 2 °C, and to 202 under a 4 °C warming of climate.
- Rising of the snow line:
  - Temp. Increase of 2 °C to 2050: Snow reliability only above ~1.500m
  - T increase of 3 °C : ~1.800m

…water supply

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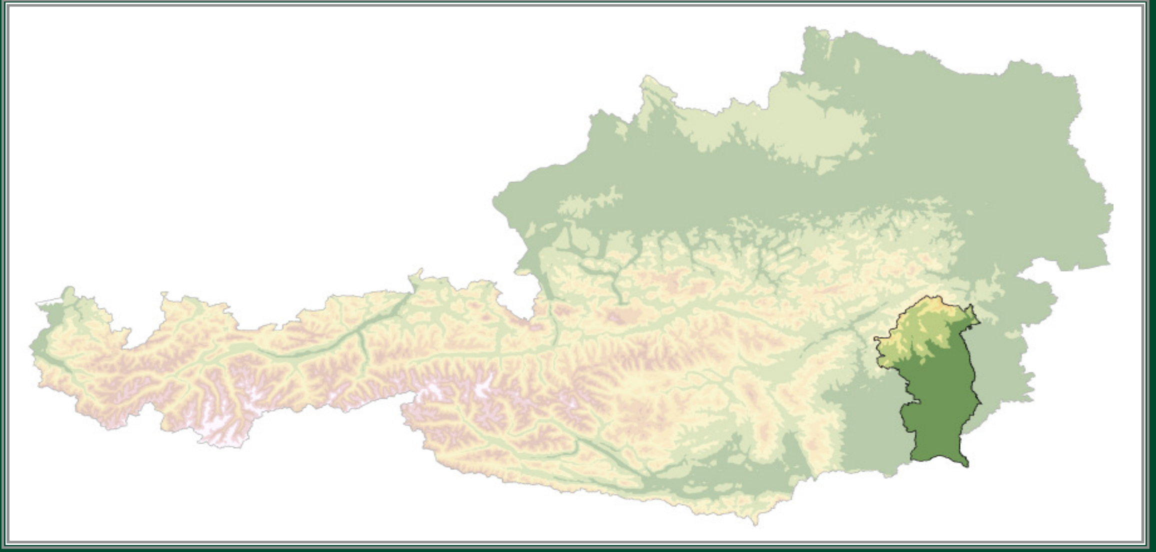

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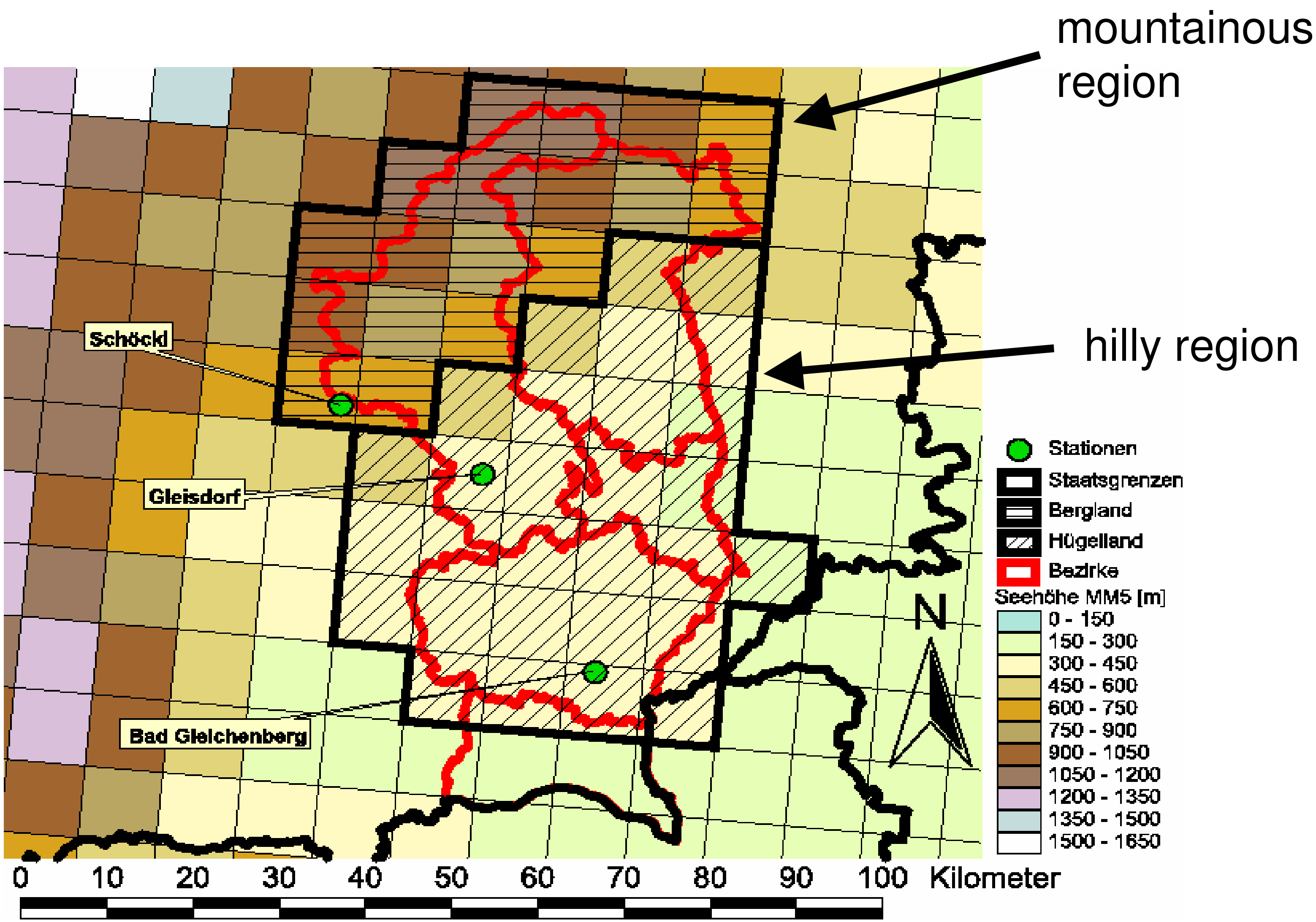
[4]Wegener Centre for Climate and Global Change, University of Graz

Overview

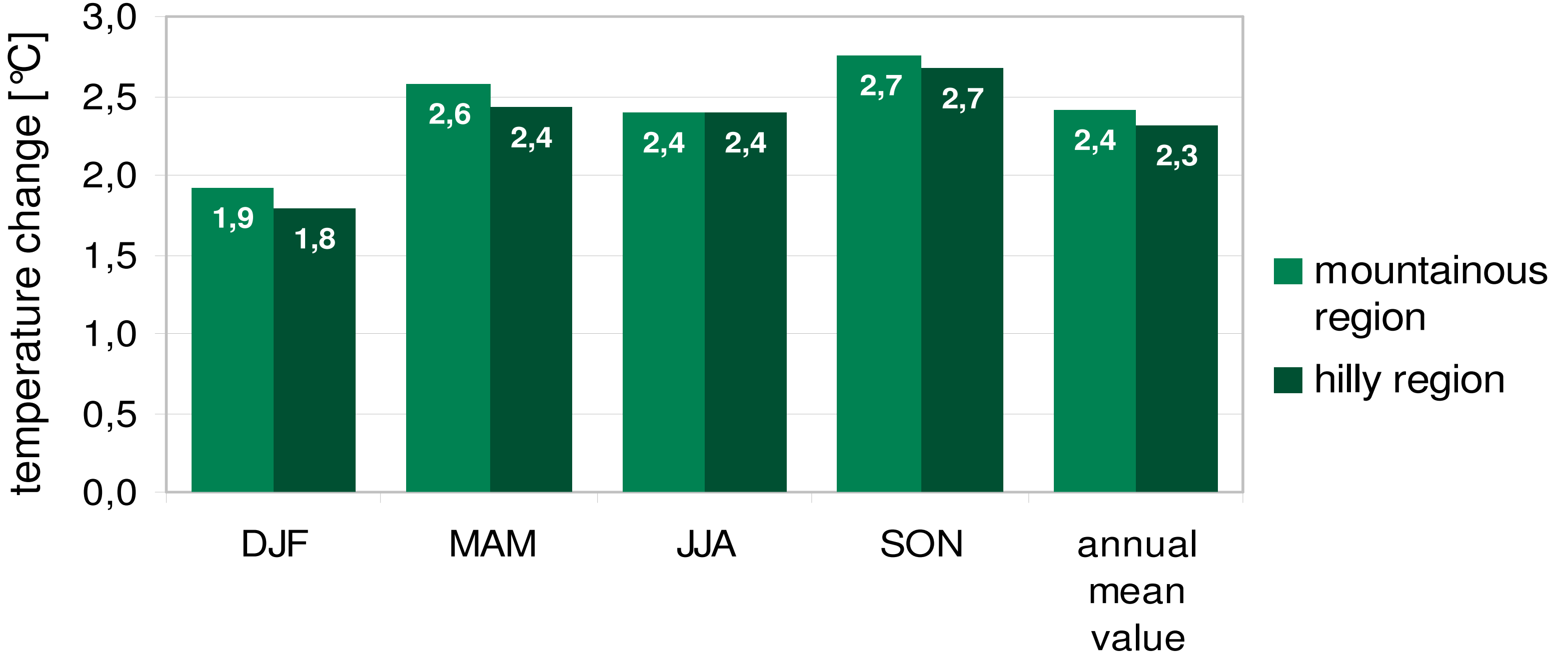
- → Austria only uses 3% of its Freshwater ressources
- → There are regions suffering from water scarcity
- → Some of which with high economic growth
- → Examined water intensive industries
- → Thorough hydrological modeling of the region
- → Calculated macroeconomic losses from Water supply disruptions

Climate regions and stations – dynamic downscaling (MM5 – 10 km grid)



Climate change projection (I)

→ **Scenario on seasonal** temperature **change comparing 1981 to 1990 and 2041 to 2050**

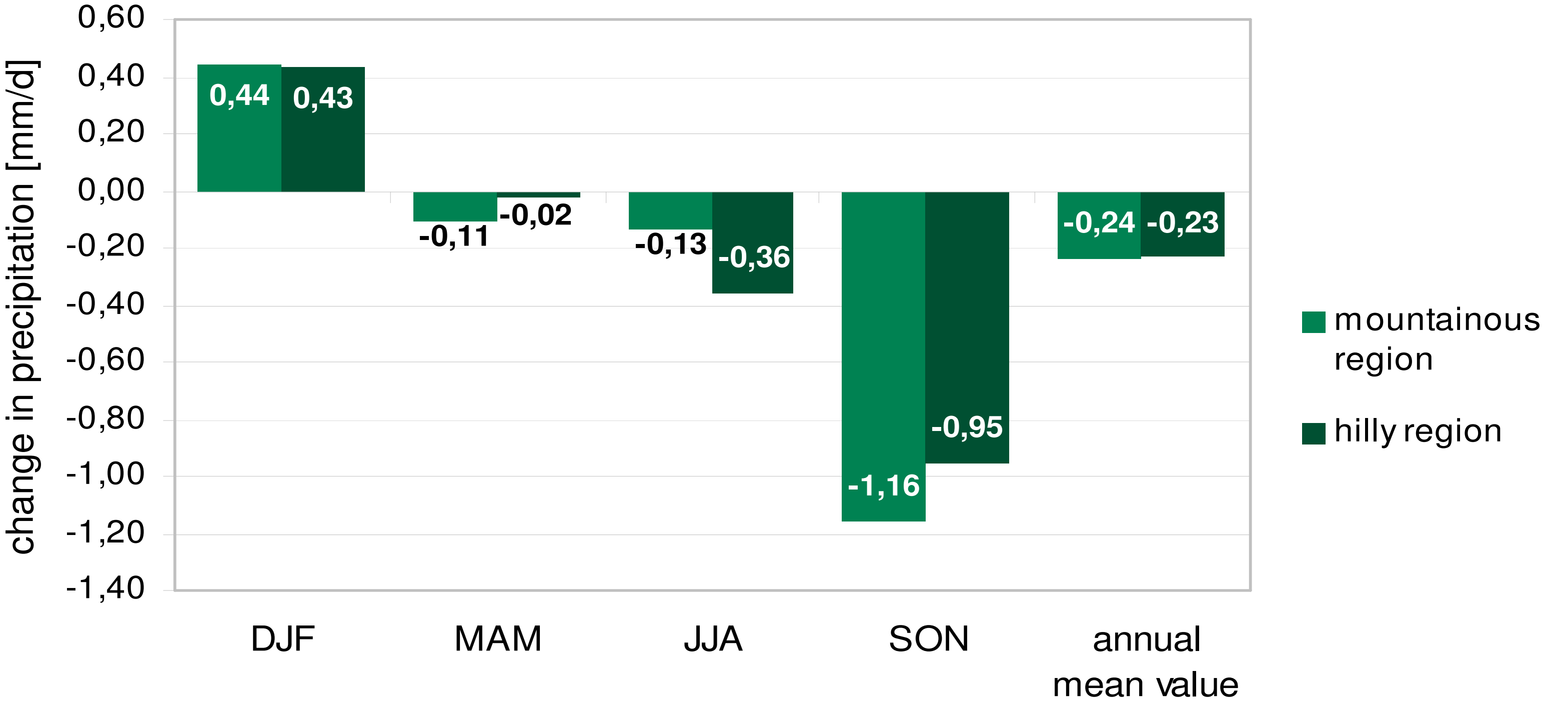


DJF: December, January, February
MAM: March, April, May

JJA: June, July, August
SON: September, October, November

Climate change projection (II)

→ **Scenario on seasonal** precipitation **change comparing 1981 to 1990 and 2041 to 2050**



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Hydrological prospects

→ **No. of drought periods will increase in future**

→ **Increasing pressure**

- further decrease of mean groundwater tables of private and public wells
- further connections to municipal water supply
- rough expectations concerning additional peak demand: 200 l/s
- central Eastern Styria: relatively low mean groundwater tables and low permeability
  → relatively high pressure
- Unteres Murtal: higher mean groundwater tables and higher permeability → relatively less pressure

Economic threats for Eastern Styria

→ **Economic data on water intensive industries**

- employees: 20 700
- annual production value: € 2.7 Billion
- annual gross value added: € 1 Billion

→ **2-week loss of production caused by water scarcity**

- loss in production value: € 105 Million
- loss in gross value added: € 40 Million

→ **Most affected industries**

- metal industry (PV: € 21 M, GVA: € 7 M)
- food production (PV: € 24 M, GVA: € 8 M)
- tourism industry (PV: € 21 M, GVA: € 9 M)

Supply-side adaptive strategies (I)

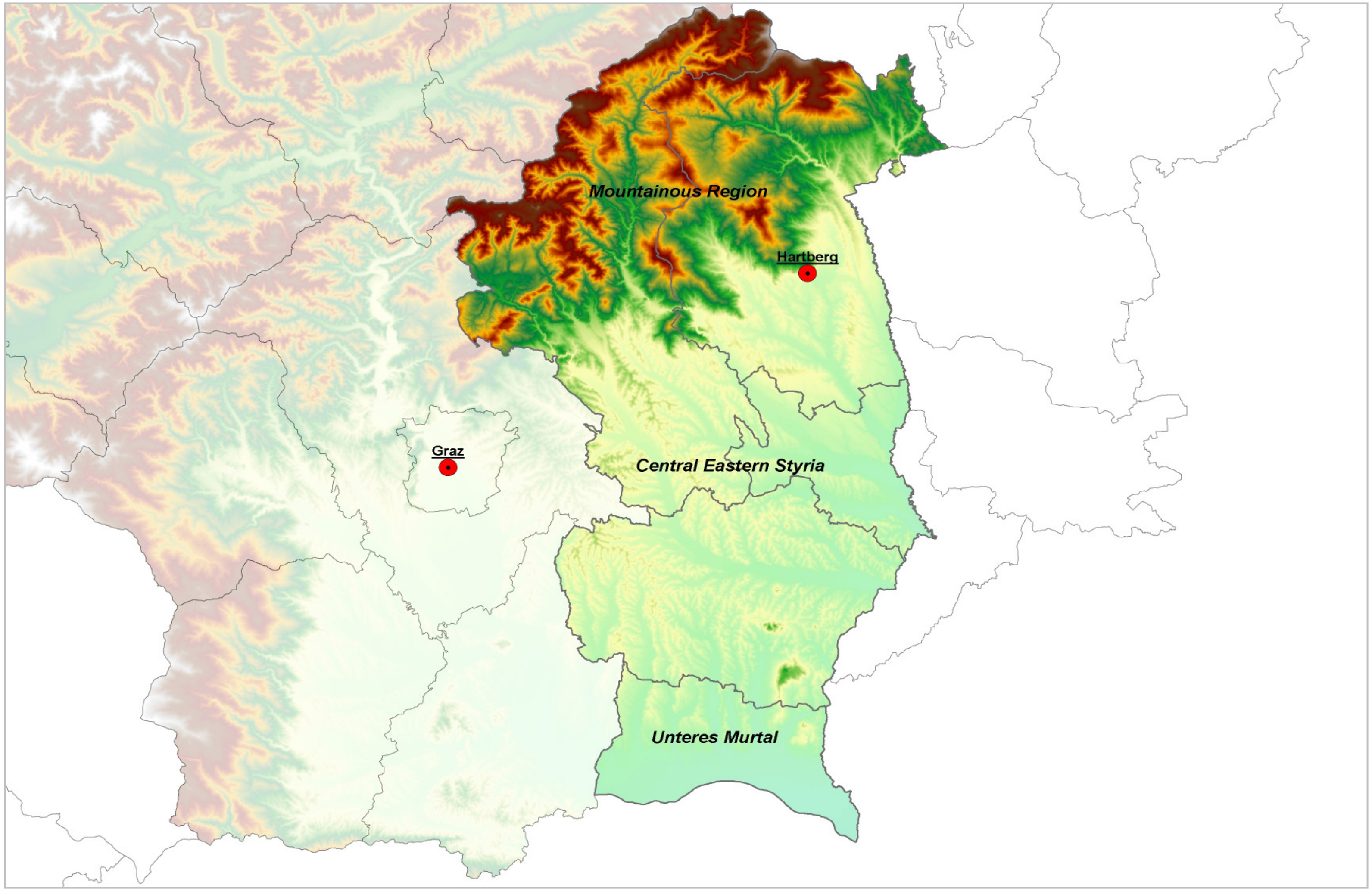
→ **Adaptive strategies on the supply-side**
- connecting all regional pipe networks (risk pooling)
- investment in a pipeline that connects Graz (supplied by pipeline from abundant alpine springs) to Hartberg

→ **Assessment of**
- direct
- indirect
- induced

effects of the investment on the national **economy**

→ **Assessment method**
- MultiREG: multiregional and multisectoral econometric model

Regions in Eastern Styria



Supply-side adaptive strategies (II)

→ **Macroeconomic effects on the national economy of an investment in a regional pipe network and a pipeline**

(Values in million Euro; sum of values within the considered time period from 2004 to 2008)

	Regional pipe network	Pipeline
Direct investment	**47,3**	**13,1**
Additional production value	**84,8**	**23,1**
Additional gross value added	46,8	12,7
Additional employment	**810**	**210**
Additional water capacity	**not available**	**212 l/s**

(loss of gross value added of water intensive industries for a 2 weeks breakdown = € 40 Million)

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Demand-side adaptive strategies (I)

→ **Assessed options**

- expansive water price policy
- implementation of water saving technologies in households
- implementation of water saving technologies in hotels

→ **Water saving technologies**

- devices for showers
- toilettes
- water taps

→ **Method used: cost efficiency analysis**

→ **Water price elasticity of demand:** $\varepsilon_p = \frac{\%\Delta Q}{\%\Delta P} = -0{,}25$

Demand-side adaptive strategies (II)

	Increase in price*	Water saving technologies in households*	Water saving technologies in hotels
Current water demand [m³/year]	9,215,000	9,215,000	850,000
Annual water savings [m³/year]	1,671,000	1,671,000	180,000
Annual water savings [%]	18	18	21
Needed water price increase [%]	73	-	-
Total costs [€]	-	3,500,000	1,950,000

*Comparison of demand-side strategies with the supply-side option of the pipeline (for a 25 percent load of the pipeline ≈ 53 l/s = 1,671,000 m³/year)

Take home message

- → **Comparing with supply-side adaptive strategies, demand-side options reveal to be insufficient**
- → **Rough predictions of hydrologists about additional future water demand in times of peak load is about 200 l/s**
  - → Demand-side options are a good contribution, but can not cover expected demands
  - → Realization of supply-side adaptive strategies necessary