

**Climate Change in South-
Eastern European Countries IV:
Adaptation strategies for
economy & society
Zagreb, October 19-20, 2009**

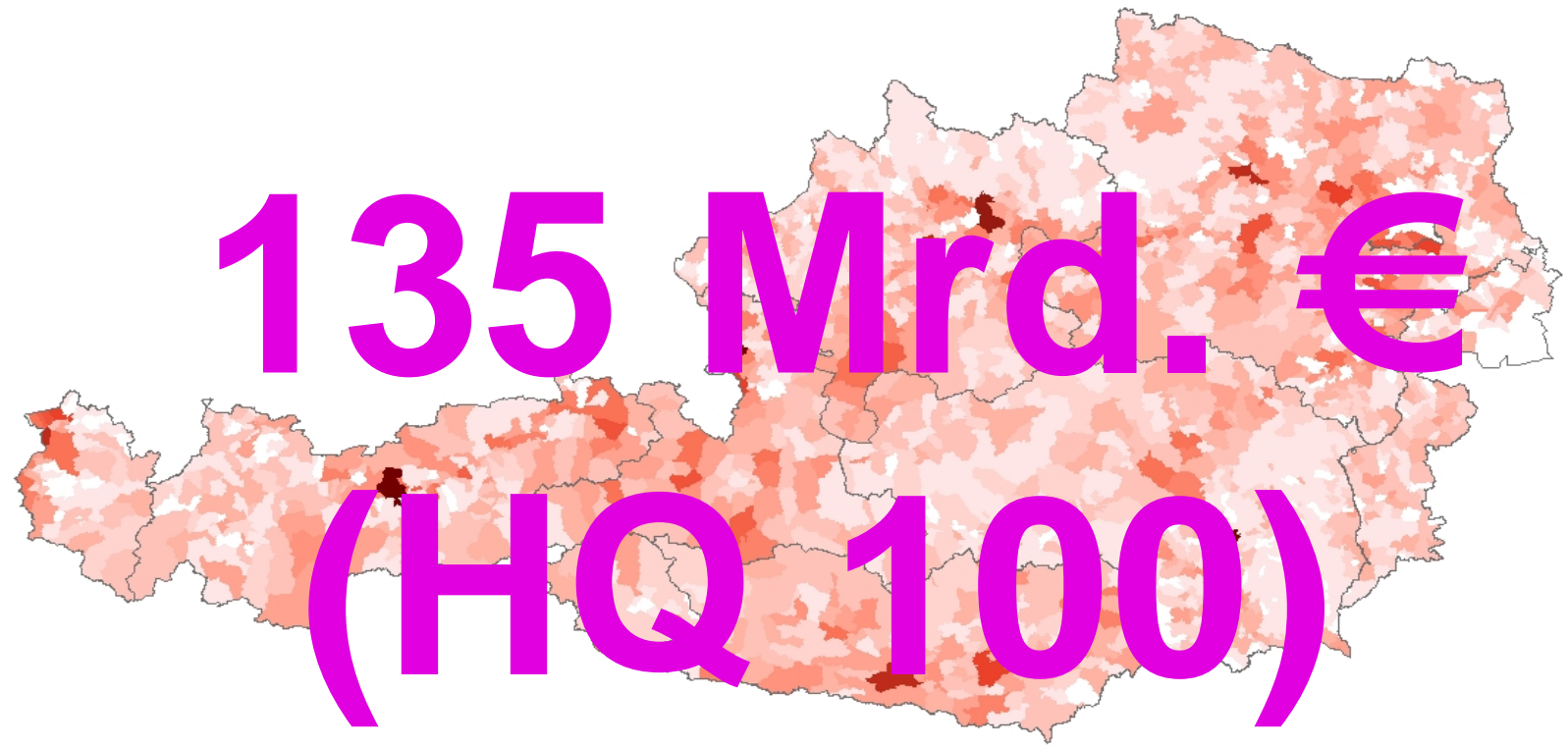
How to estimate the Economic Impacts of Climate Variability and Extreme Weather Events

**Christoph Töglhofer
Franz Pretenthaler**

**Institute of Technology and Regional Policy, Joanneum Research and
Wegener Center for Climate and Global Change, Univ of Graz**

- **Introduction**
- **Relevance of Regional Economic Modeling for Issues of Adaptation to CC**
- **Modeling for exemplary sectors**
 - **Building sector**
 - Normalized Damage Analysis
 - **Winter Tourism**
 - Snow Sensitivity

Extreme Events: Flood Risks and the building stock (HORA: HQ 100)



HQ100 Wohnimmobilien	11 - 25	151 - 250	1.001 - 1.500
Verkehrswert in Mio. €	26 - 50	251 - 500	1.501 - 2.500
bis 5	51 - 100	501 - 750	2.501 - 5.000
6 - 10	101 - 150	751 - 1.000	5.001 - 9.500

JOANNEUM RESEARCH

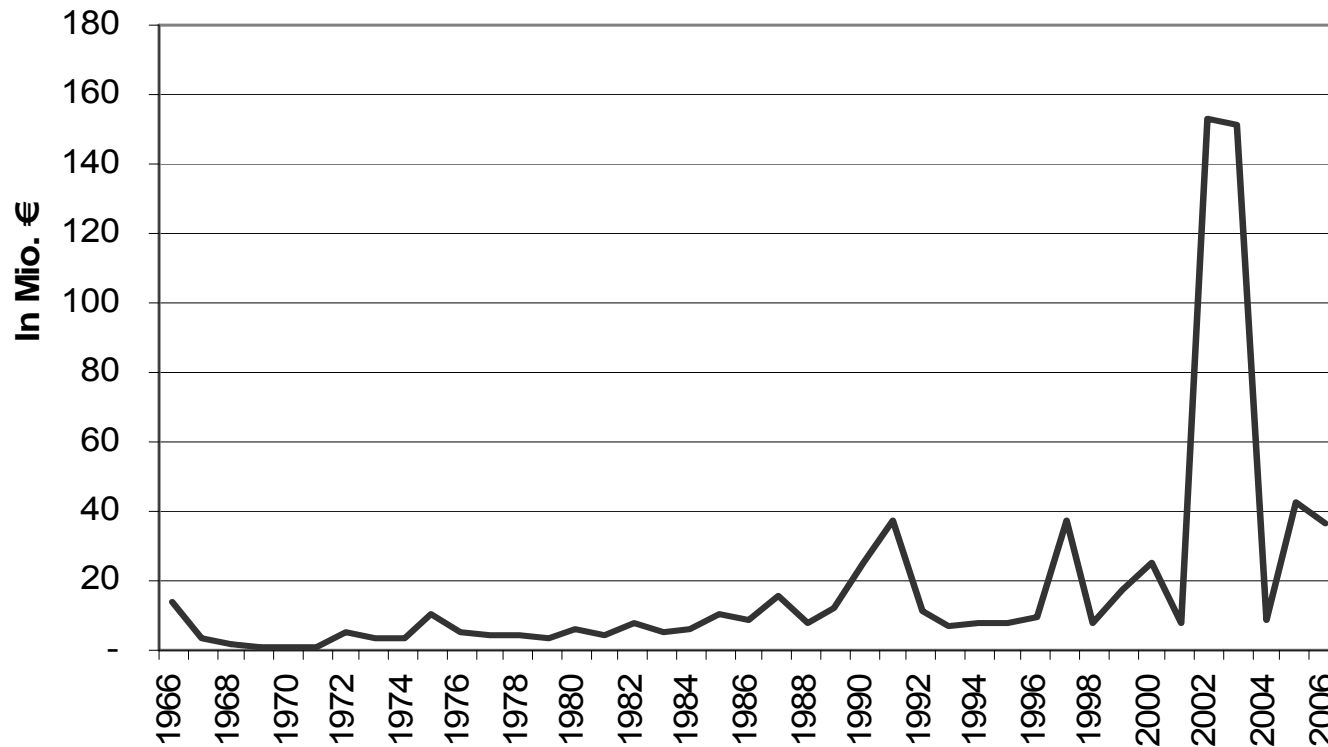
GIS-Bearbeitung: DI MAS (GIS) Clemens Habsburg-Lothringen
 Projektleitung: Dr. Franz Pretenthaler
 Institut für Technologie- und Regionalpolitik
 JOANNEUM RESEARCH

Quellen: Gebäude- und Wohnungszählung 2001 (Statistik Austria)
 HORA (LFRZ)
 Berechnungen: JOANNEUM RESEARCH

0 25 50 100 Kilometer

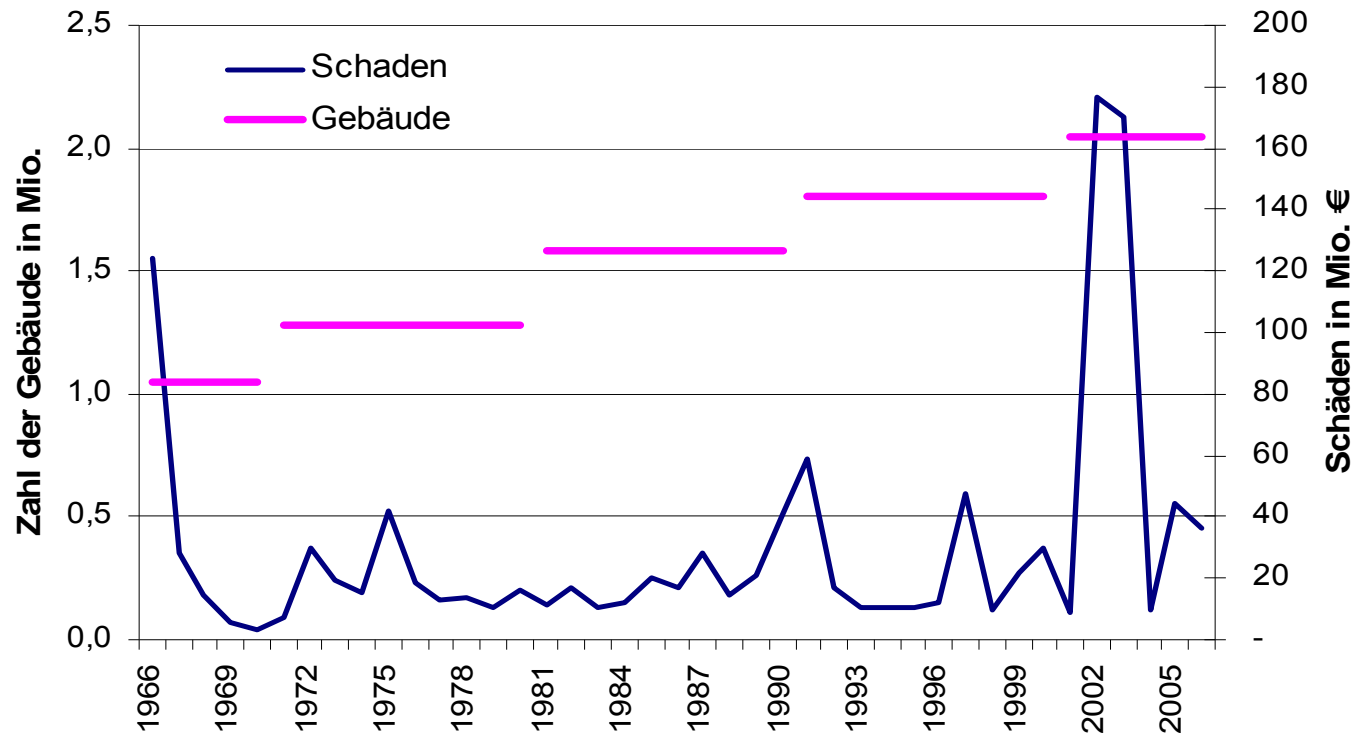
Extreme Events: Claim Analysis CatFund

■ Catastrophe Fund – Claims of Private Entities

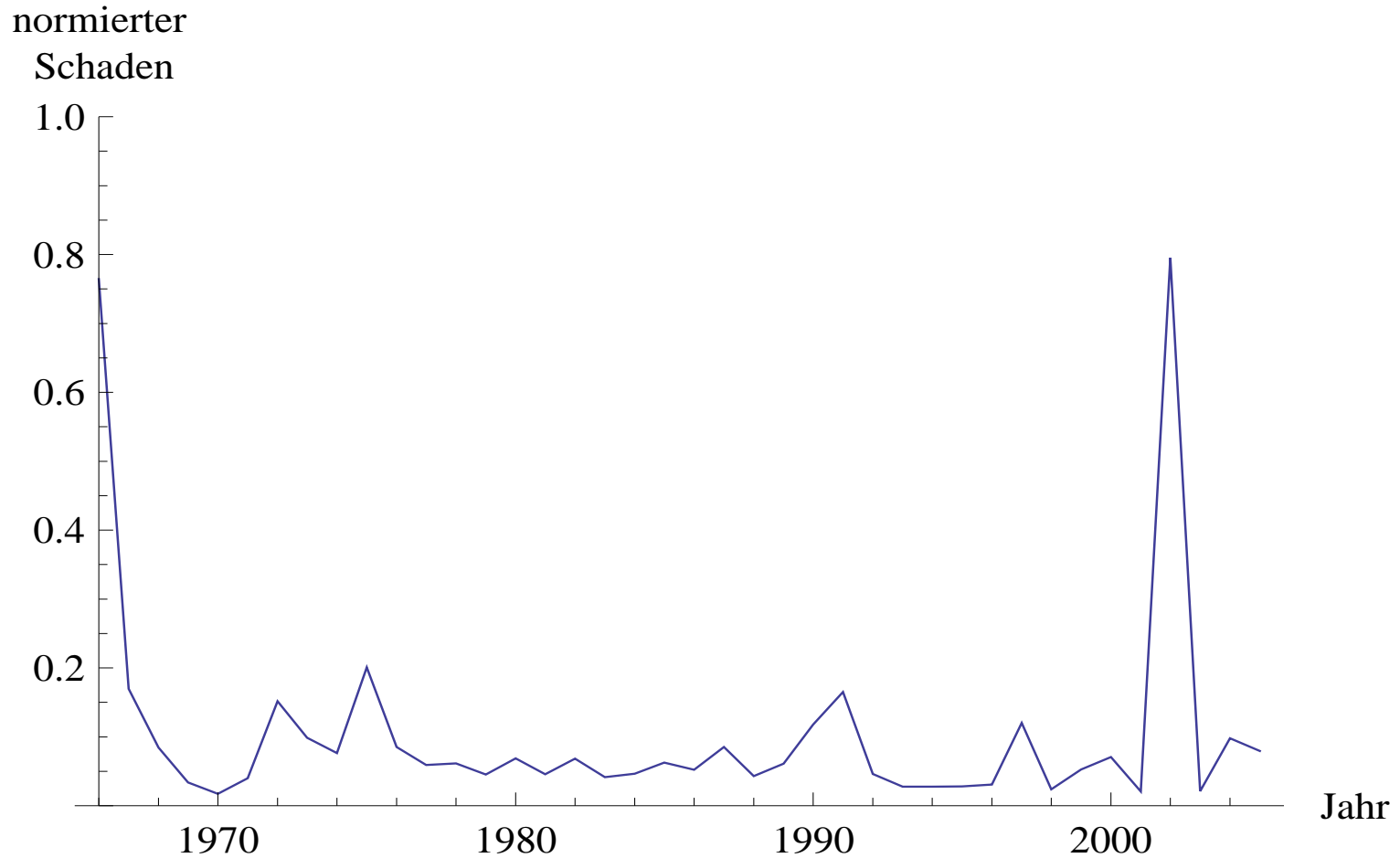


Extreme Events: Claim Analysis CatFund

- Adapted to Building Cost Index
- Level of Building stock



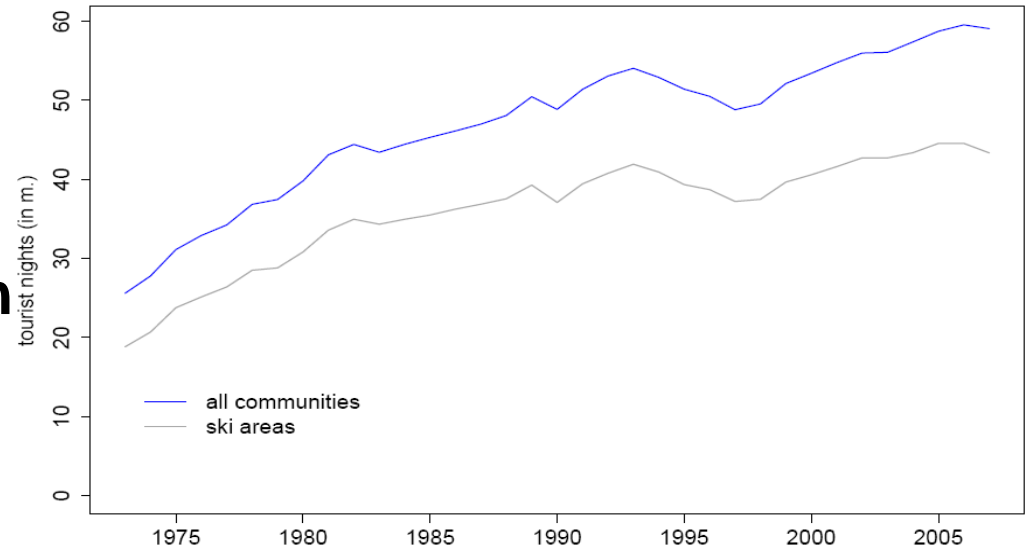
Extreme Events: Claim Analysis CatFund



Winter tourism in Austria

■ Some tourism facts (2005)

- **40 billion Euro in direct and indirect value added (16.5 percent of the GDP)**
Smeral & Laimer (2006)
- **120 million tourist nights**
- **60 million tourist nights in the winter season**
 - **>40 million in ski areas**



Data source: Statistics Austria

Climate Variability and Winter Tourism

- The ski industry is identified to be extremely vulnerable to climate change
- Climate induced changes in physical indicators (ski season length, snow making conditions) are well examined
- In comparison, the relationship between tourism demand and past weather conditions is poorly understood
 - However, this would be essential for assessing (long-term) economic vulnerability and (short-term) financial risks in more detail

Some implications for climate impacts and adaptation research

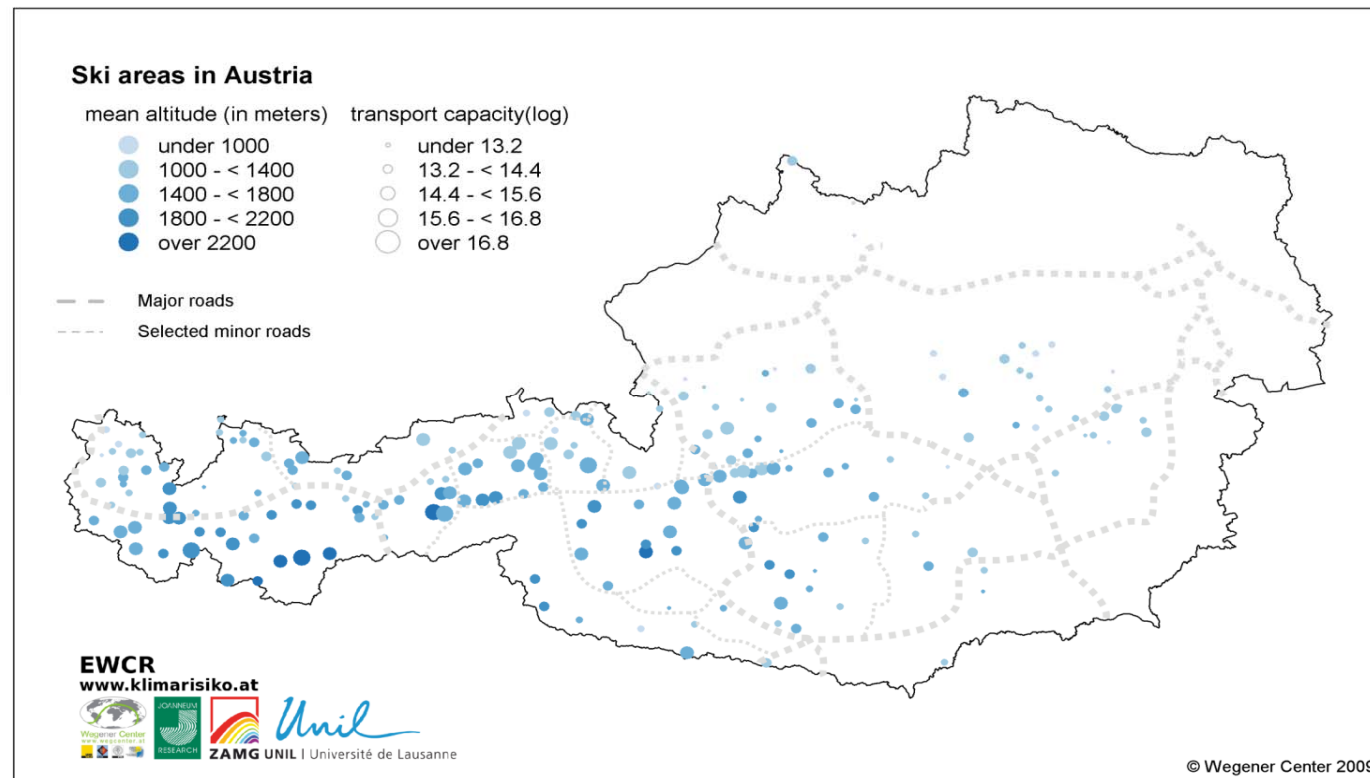
- MAIN THESIS: For modeling economic climate change impacts (with and without adaptation) **in the future** we better need to understand the relationship between (short-term) climate variability and economic activities and how it changed over time **in the past**
 - For estimating impacts an economic perspective is important
 - For estimating the relationship between (short-term) climate variability and economic activities we need to think about appropriate methodological approaches
 - Estimations should give implications both on the LOCAL and on the AGGREGATE level
 - Focusing on losers only might be misleading and overexaggerate effects
 - Impacts might (and frequently do) change over time (Adaptation)
 - Interactions between weather and other economic effects are important

Can economic impacts be estimated from current studies?

■ Example:

- **Thresholds in Vulnerability Studies e.g. Snow reliability line**
 - Alternative concepts?
- **Size effects**

- Relationship between mean altitude and size
 - <1200 m:
28 % of areas,
8 % of capacities
 - <1500 m:
66 % of areas
39 % of capacities



Some implications for climate impacts and adaptation research

- MAIN THESIS: For modeling economic climate change impacts (with and without adaptation) **in the future** we better need to understand the relationship between (short-term) climate variability and economic activities and how it changed over time **in the past**
 - For estimating impacts an economic perspective is important
 - For estimating the relationship between (short-term) climate variability and economic activities we need to think about appropriate methodological approaches
 - Estimations should give implications both on the LOCAL and on the AGGREGATE level
 - Focusing on losers only might be misleading and overexaggerate effects
 - Impacts might (and frequently do) change over time (Adaptation)
 - Interactions between weather and other economic effects are important

Estimating the weather sensitivity of tourism demand

- **Approaches in the ‘climate research literature’**
 - Analogue approach
 - Time-series and regression models
 - tourist nights (national/provincial)
 - Ski area visitors (Case study level)
 - Other methods grounded in economic theory (Pooled Travel Cost Method etc.)

- **Some approaches in the ,tourism demand modeling and forecasting literature‘**
 - Causal econometric models**
 - Autoregressive distributed lag model
 - Error correction model
 - Panel data methods
 - Non-causal econometric time-series models**

- General Models for each of the ski areas
 - Autoregressive Distributed Lag (ADL) Model
 - Logarithmic specification

$$\begin{aligned} \log \text{ nights }_t &= \beta_0 + \beta_1 \log \text{ nights }_{t-1} + \beta_2 \log \text{ nights }_{t-2} + \beta_3 \log \text{ nights }_{t-3} \\ &+ \beta_4 \log \text{ snow }_t + \beta_5 \log \text{ snow }_{t-1} + \beta_6 \log \text{ beds }_t + \beta_7 \log \text{ beds }_{t-1} + \beta_8 \text{ SBtcap }_t + \beta_9 \text{ SBtcap }_{t-1} \\ &+ \beta_{10} \log y_t + \beta_{11} \log y_{t-1} + \beta_{12} \log pp_t + \beta_{13} \log pp_{t-1} + \varepsilon_t \end{aligned}$$

- Specific Models
 - All subset approach
 - Model selection by Bayesian information criterion (BIC)
- Diagnostic testing of Specific Models
 - autocorrelation, misspecification, heteroscedasticity and normality
- Estimation of “snow sensitivity” for a standard deviation change in snow days:

$$\text{snowsens} = \beta_4 \text{sd}(\log \text{ snow}) = \frac{\% \Delta \text{ nights}}{\% \Delta \text{ snow}} \text{sd}(\log \text{ snow})$$

Some implications for climate impacts and adaptation research

- MAIN THESIS: For modeling economic climate change impacts (with and without adaptation) **in the future** we better need to understand the relationship between (short-term) climate variability and economic activities and how it changed over time **in the past**
 - For estimating impacts an economic perspective is important
 - For estimating the relationship between (short-term) climate variability and economic activities we need to think about appropriate methodological approaches
 - Estimations should give implications both on the LOCAL and on the AGGREGATE level
 - Focusing on losers only might be misleading and overexaggerate effects
 - Impacts might (and frequently do) change over time (Adaptation)
 - Interactions between weather and other economic effects are important

Estimating the snow sensitivity of tourism demand

- **Autoregressive distributed lag models**
 - **Dynamic regression model**
 - **Lags of dependent and independent variables**
 - **Applied in Agnew and Palutikof (2006) and Bigano et al. (2005)**
- **Our approach**
 - **Local scale (ski areas)**
 - **Seasonal tourist nights for Austrian municipalities**
 - **Snow indices from snow cover model (localized data from temperature and precipitation measurements)**
 - **Large number of cases (n = 185 ski areas) and a substantial number of observations (t = 34 seasons)**
 - **Inclusion of economic (GDP, price indices) and supply side variables (beds, transport capacities)**

Estimates from the ADL models

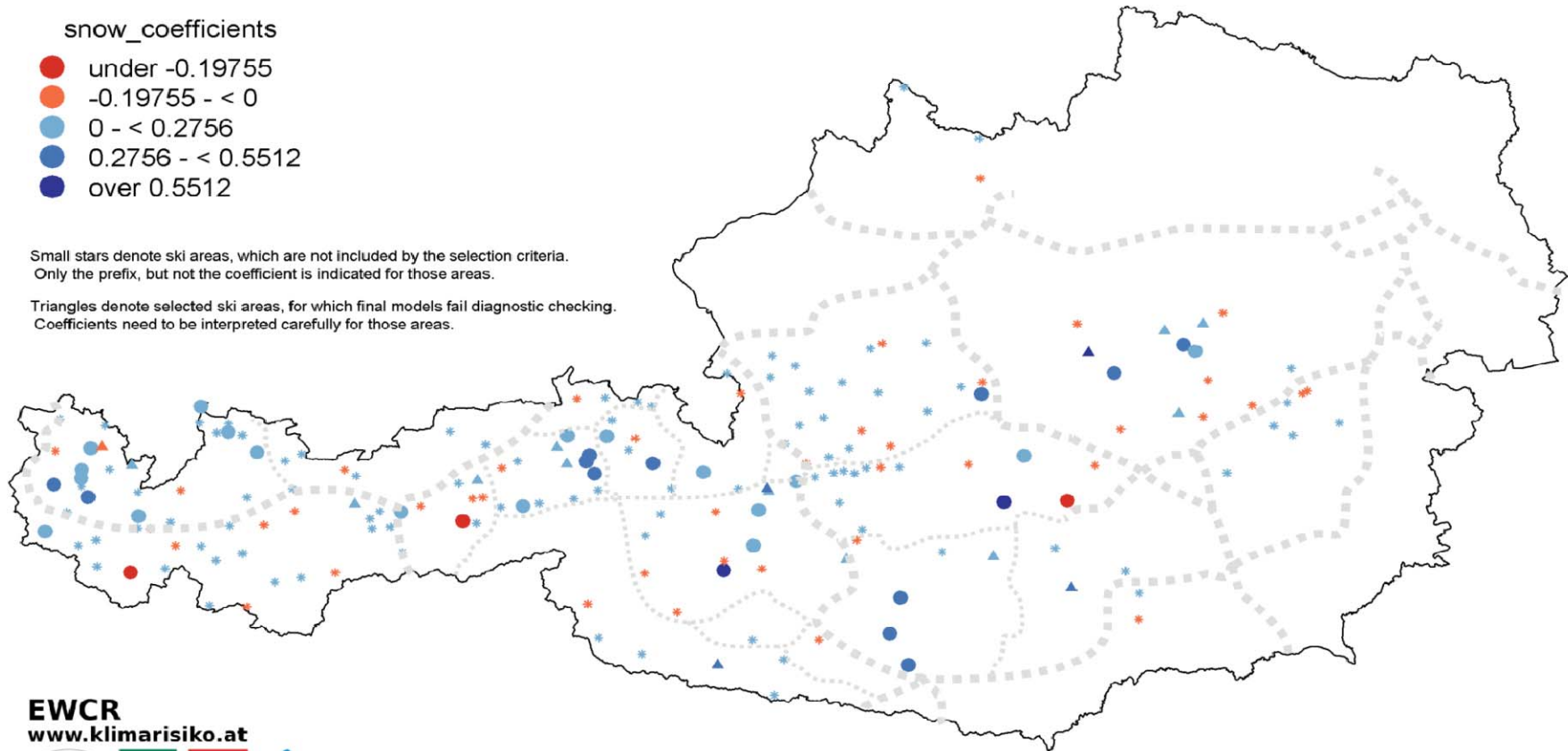
Impacts on tourist nights in Austrian ski areas

snow_coefficients

- under -0.19755
- -0.19755 - < 0
- 0 - < 0.2756
- 0.2756 - < 0.5512
- over 0.5512

Small stars denote ski areas, which are not included by the selection criteria. Only the prefix, but not the coefficient is indicated for those areas.

Triangles denote selected ski areas, for which final models fail diagnostic checking. Coefficients need to be interpreted carefully for those areas.



EWCR
www.klimarisiko.at



© Wegener Center 2009

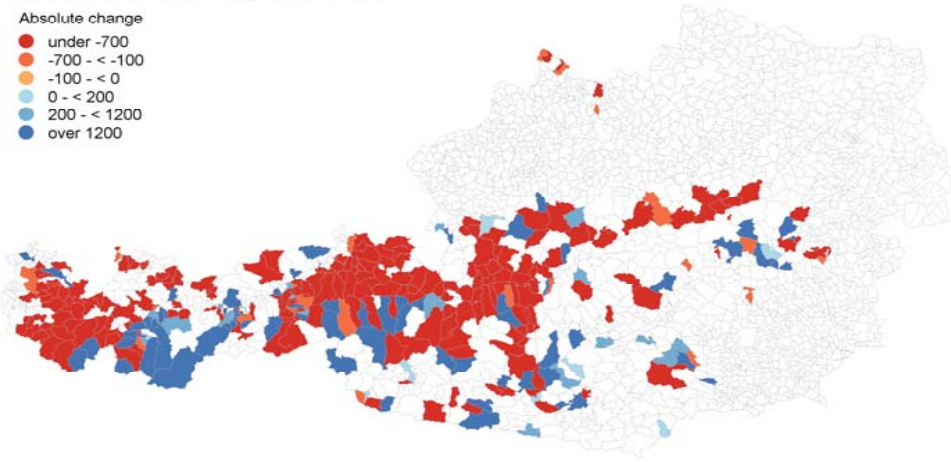
Some implications for climate impacts and adaptation research

- MAIN THESIS: For modeling economic climate change impacts (with and without adaptation) **in the future** we better need to understand the relationship between (short-term) climate variability and economic activities and how it changed over time **in the past**
 - For estimating impacts an economic perspective is important
 - For estimating the relationship between (short-term) climate variability and economic activities we need to think about appropriate methodological approaches
 - Estimations should give implications both on the LOCAL and on the AGGREGATE level
 - Focusing on losers only might be misleading and overexaggerate effects
 - Impacts might (and frequently do) change over time (Adaptation)
 - Interactions between weather and other economic effects are important

Winners and Losers: 1989/90 and 2006/07

Winter season 1989/1990 compared to 1988/1989

Development of tourist nights in Austria

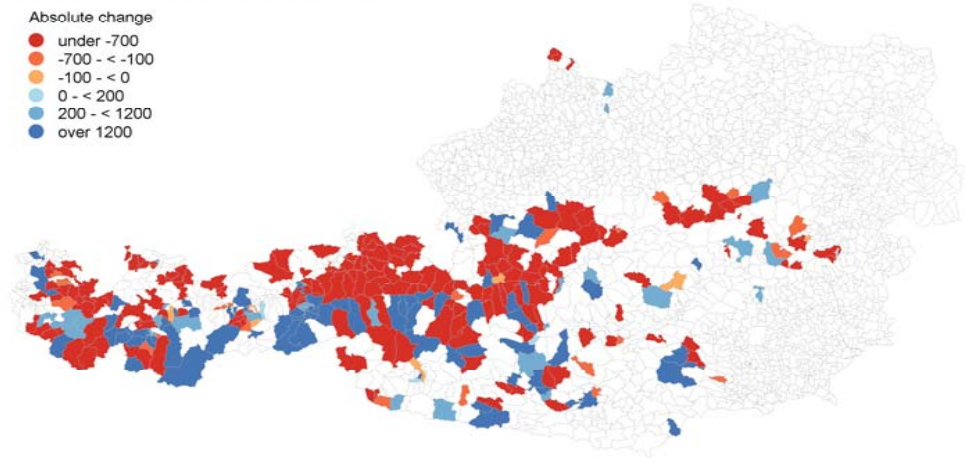


Data source: Statistics Austria

© Wegener Center 2009

Winter season 2006/2007 compared to 2005/2006

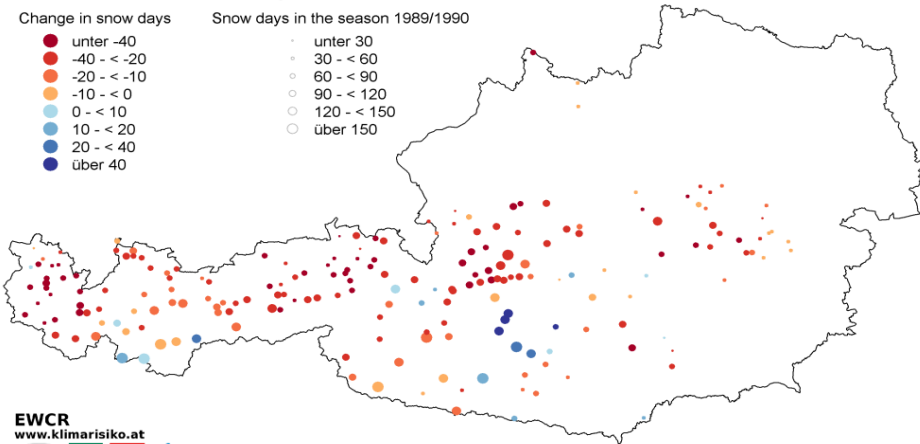
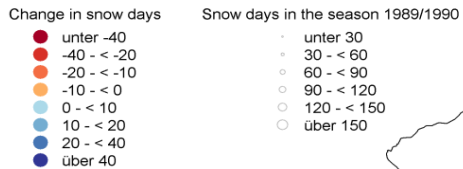
Development of tourist nights in Austria



Data source: Statistics Austria

© Wegener Center 2009

Winter season 1989/1990 compared to 1988/1989



© Wegener Center 2009

	Total	Ski	Non-Ski
1989/90	-3.2%	-5.6%	+5.3%
2006/07	-0.8%	-2.7%	+4.9%

- Non-ski areas profit from poor snow conditions
- Winner-loser-pattern also for ski areas
 - higher lying and comparatively favoured areas benefit

Some implications for climate impacts and adaptation research

- MAIN THESIS: For modeling economic climate change impacts (with and without adaptation) **in the future** we better need to understand the relationship between (short-term) climate variability and economic activities and how it changed over time **in the past**
 - For estimating impacts an economic perspective is important
 - For estimating the relationship between (short-term) climate variability and economic activities we need to think about appropriate methodological approaches
 - Estimations should give implications both on the LOCAL and on the AGGREGATE level
 - Focusing on losers only might be misleading and overexaggerate effects
 - Impacts might (and frequently do) change over time (Adaptation)
 - Interactions between weather and other economic effects are important

Weather sensitivity varies over time

- **A widespread assumption: Constant sensitivities**
 - **However, snow sensitivity of tourism demand might not be constant due to changes in the:**
 - Levels and variability of the snow indices
 - Adaptation level of the tourism industry (e. g. by snow making or the increased supply of non-weather related activities)
- **Can changes be observed in our data?**
 - **Panel data estimations** (Eigner, Toeglhofer, Prettenthaler, 2009)
 - **Indications that the snow sensitivity is substantially lower for the last decade (1995-2006) than for previous years**
 - **Effects need to be evaluated further for individual areas.**

Some implications for climate impacts and adaptation research

- MAIN THESIS: For modeling economic climate change impacts (with and without adaptation) **in the future** we better need to understand the relationship between (short-term) climate variability and economic activities and how it changed over time **in the past**
 - For estimating impacts an economic perspective is important
 - For estimating the relationship between (short-term) climate variability and economic activities we need to think about appropriate methodological approaches
 - Estimations should give implications both on the LOCAL and on the AGGREGATE level
 - Focusing on losers only might be misleading and overexaggerate effects
 - Impacts might (and frequently do) change over time (Adaptation)
 - Interactions between weather and other economic effects are important

Interaction between climate and economic activities

- For understanding the interaction between the climate and economic activities it is important to examine the relationship between supply factors (such as weather conditions) and demand
- Other parameters (such as equity reserves, cost efficiency, etc.) need to be included as well, especially in times where economic contraction might foster cut-throat competition among ski areas,
- It is also important to understand the short-term financial risks of climate variability on the micro-data level

Thanks for your attention!

Christoph Töglhofer
Franz Prettenthaler

Wegener Center for Climate and Global Change
University of Graz, Austria
and
JOANNEUM Research
Institute of Technology and Regional Policy

christoph.toeglhofer@uni-graz.at
franz.prettenthaler@joanneum.at

www.wegcenter.at
www.joanneum.at/rtg
www.klimarisiko.at

& the EWCR Team

Hansjörg Albrecher
Franz Eigner
Andreas Gobiet
Judith Köberl
Elisabeth Koch
Dominik Kortschak
Armin Leuprecht
Roland Potzmann
Wolfgang Schöner
Matthias Themessl
Markus Zahrnhofer



Additional Material

Meteorological Data

- **Data from snow cover model instead of measurement stations**

(Data source: Austrian Central Institute for Meteorology and Geodynamics)

- **Snow indices**

- Snow days (thresholds: 1 cm and 30 cm), mean snow cover
- Mean and lowest altitudes of ski areas
- Natural and ‘artificial’ snow indices

Source: Themessl, Gobiet & Toeglhofer 2009

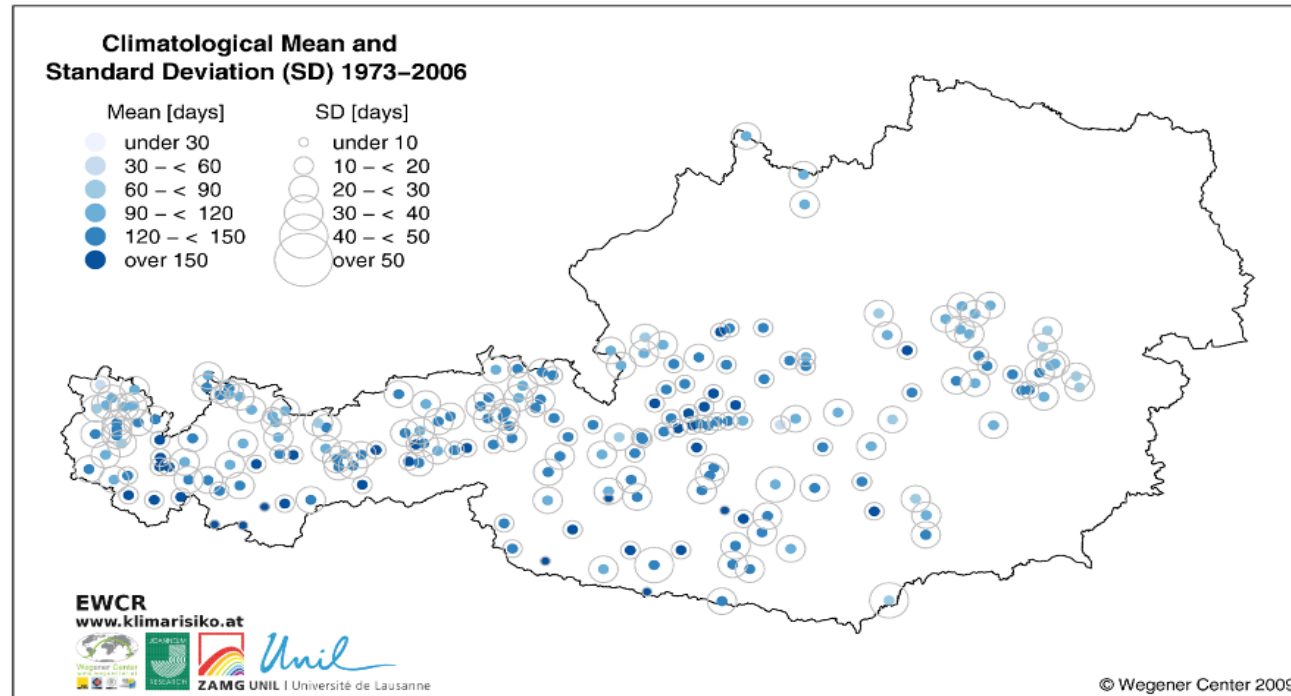
- **Our Choice:**

- **Snow days (>1 cm)**

- **Mean altitudes**

- **Natural snow**

- **Other indices for evaluation purposes**



■ Outlook for future vulnerability of winter tourism studies:

- Have better regional scenarios
- Use detailed sensitivities (well understood now)
- Focus on the sensitivity varying effects of adaptation