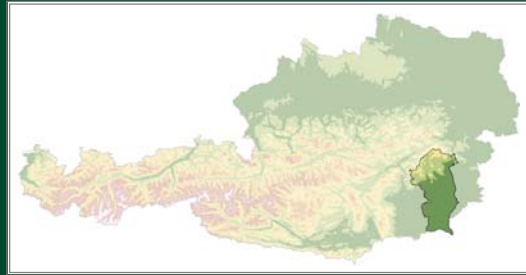


Adaptation in the Water Supply Sector of Eastern Styria (Austria)

I. Oberauer^{2,4}, F. Prettenhaler^{2,4}

A. Dalla-Via¹, A. Gobiet^{3,4}, R. Kurzmann², M. Steiner^{2,5}, H. Truhetz^{3,4}, N. Vetter^{2,4}, G. Zakarias²

Workshop on "Adaptation to the Impacts of Climatic Change in the Alps"



Wengen, October 2006

¹Institute of Water Resources Management, Joanneum Research Forschungsgesellschaft, Graz
²Institute of Technology and Regional Policy, Joanneum Research Forschungsgesellschaft, Graz
³Institute for Geophysics, Astrophysics, and Meteorology, University of Graz
⁴Wegener Centre for Climate and Global Change, University of Graz
⁵Department of Economics, University of Graz



Outline



- Introduction
- Climatology
 - Climate regions and stations – dynamic downscaling
 - Climate change projection on Eastern Styria
- Hydrology
 - Hydrological characteristics of Eastern Styria
 - Hydrological prospects
- Economics
 - The need for adaptation
 - Economic threats for Eastern Styria
 - Supply-side adaptive strategies
 - Demand-side adaptive strategies
- Take home message

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

- Project motivation
 - quantitative estimation of expected exposure and adaptive strategies to global change impacts on water provision in Eastern Styria
 - Eastern Styria representative for “dry” regions
 - rising temperature
 - less precipitation (east end of the Alps)
 - shallow aquifers
- Client: Austrian Academy of Sciences
- Project end: 2006

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling
climate change projection on Eastern Styria

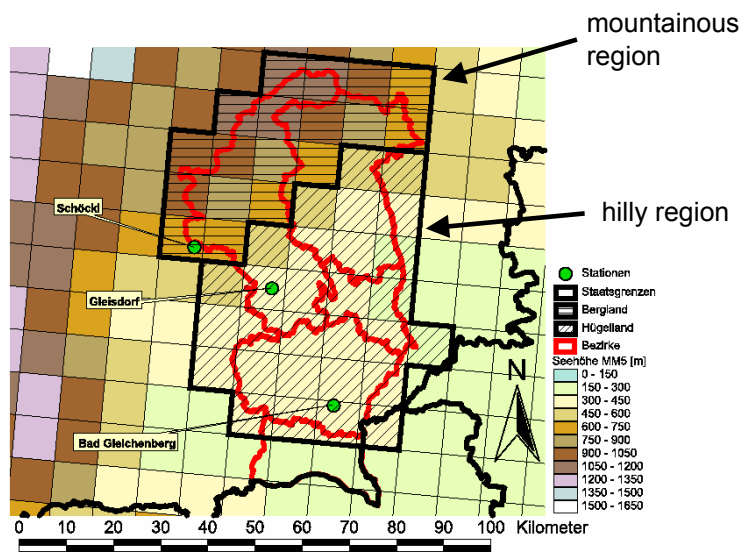
HYDROLOGY

hydrological characteristics of Eastern Styria
hydrological prospects

ECONOMICS

need for adaptation
economic threats for Eastern Styria
supply-side adaptive strategies
demand-side adaptive strategies

TAKE HOME MESSAGE



CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling
climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria
hydrological prospects

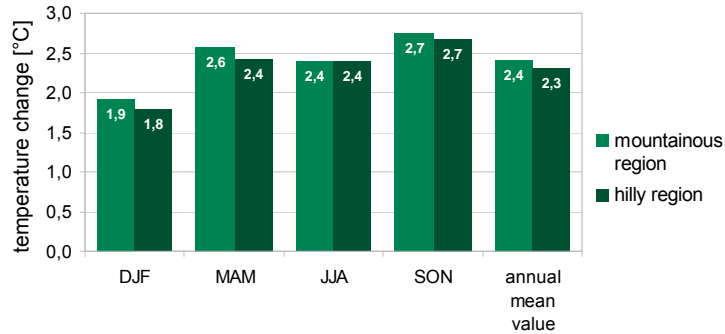
ECONOMICS

need for adaptation
economic threats for Eastern Styria
supply-side adaptive strategies
demand-side adaptive strategies

TAKE HOME MESSAGE

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

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria
hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

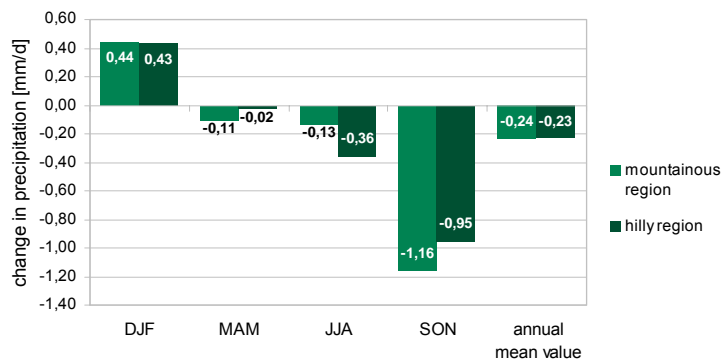
demand-side adaptive strategies

TAKE HOME MESSAGE

5

Climate change projection (II)

- Scenario on seasonal **precipitation** 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

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria
hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

6

- Eastern Styria is characterized by a relatively high share of private water wells
- Diminishing mean groundwater tables and increasing peak demand for municipal water in drought periods (e.g. summer 2003)
 - disproportional effect of drought periods caused by lower groundwater tables in private wells
 - increasing demand for connections to the municipal water provision
- Adaptation in the past
 - external water
 - construction of further public wells (Unteres Murtal)

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

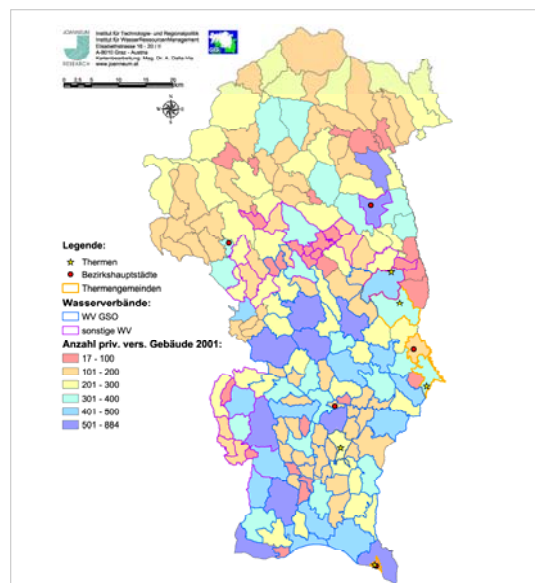
supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

7

Number of buildings provided by private wells in 2001



CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

8

- Climatologists expect increased future rates of drought periods in the 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

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

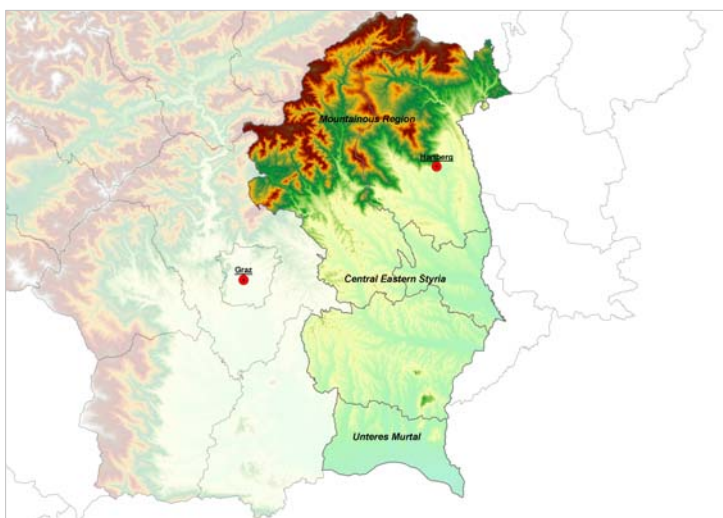
economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

9



CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

10

- Groundwater resources
 - **deep groundwater:** target is sustainable use but partially falling pressure trends → no big additional resources
 - **springs:** only in the mountainous region; no additional springs with higher capacity for public water supply known
 - **shallow groundwater:** groundwater levels and permeability to low for public water supply in hilly region
- Drought periods (e. g. summer 2002 and 2003)
 - decreasing groundwater resources
 - increasing demand (irrigation etc.)
 - temporary water scarcity
- Forms of adaptation strategies
 - supply-side adaptive strategies
 - demand-side adaptive strategies

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME

MESSAGE

11

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

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME

MESSAGE

12

Supply-side adaptive strategies (I)

- Adaptive strategies on the supply-side
 - connecting all regional pipe networks (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

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling
climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria
hydrological prospects

ECONOMICS

need for adaptation
economic threats for Eastern Styria
supply-side adaptive strategies
demand-side adaptive strategies

TAKE HOME MESSAGE

13

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)

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling
climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria
hydrological prospects

ECONOMICS

need for adaptation
economic threats for Eastern Styria
supply-side adaptive strategies
demand-side adaptive strategies

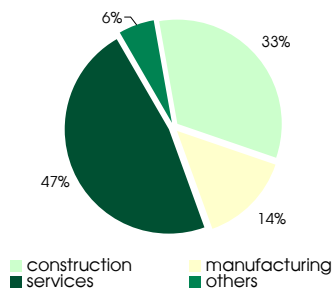
TAKE HOME MESSAGE

14

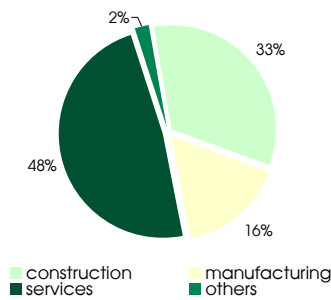
Supply-side adaptive strategies (III)

Allocation of additional gross value added among industries in Austria

The regional pipe network case



The pipeline case



CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

15

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: $\varepsilon_p = \frac{\% \Delta Q}{\% \Delta P} = -0,25$

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

16

Demand-side adaptive strategies (II)

	Increase in price*	Water saving technologies in households*	Water saving technologies in hotels
Current water demand [m ³ /year]	9,215,000	9,215,000	850,000
Annual water savings [m ³ /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)

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

TAKE HOME MESSAGE

TAKE HOME MESSAGE

TAKE HOME MESSAGE

TAKE HOME MESSAGE

TAKE HOME MESSAGE

17

Take home message

- Climate scenarios show a dark picture of future temperature and precipitation patterns in Eastern Styria
- Raising pressure on municipal water suppliers concerning higher demand of existing consumers as well as increased number of connections
- 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

CONTENTS

OUTLINE

INTRODUCTION

CLIMATOLOGY

climate regions and stations – dynamic downscaling

climate change projection on Eastern Styria

HYDROLOGY

hydrological characteristics of Eastern Styria

hydrological prospects

ECONOMICS

need for adaptation

economic threats for Eastern Styria

supply-side adaptive strategies

demand-side adaptive strategies

TAKE HOME MESSAGE

TAKE HOME MESSAGE

TAKE HOME MESSAGE

TAKE HOME MESSAGE

TAKE HOME MESSAGE

18