

Managing Alpine Future II

International Conference 2011

21 - 23 November 2011, Congress Innsbruck

▲ “Inspire and drive sustainable mountain regions”



Abstracts

Organizers

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Managing Alpine Future – Inspire and Drive Sustainable Mountain Regions

Johann Stötter, Axel Borsdorf, Eric Veulliet

Managing Alpine Future 2007 – a commitment to a vision

Four years have past since the first Managing Alpine Future Conference was held in Innsbruck.

This first conference was targeted at stakeholders from academia, governments, non-governmental and civil society organisations, international organisations and the private business sector and aimed to stimulate and foster the interdisciplinary cooperation among these. A common concern about the indisputable fact of Global Climate Change with its manifold challenges to human-environment systems, especially in mountain regions, provided the context.

As an initiative of the University of Innsbruck, the Austrian Academy of Science, and the alpS-Centre for Climate Change Adaptation Technologies, “Managing Alpine Future II” (21 – 23 November 2011, Innsbruck) will pursue the way paved by the first conference and probe deeper in order to inspire and drive sustainable mountain regions.

We hope that the discussions initiated four years ago will be pursued and continue on the premises that:

- **Mountains are inseparable human-environment systems**
- **Mountains are especially vulnerable to Global Change**
- **Mountains are of global importance**

Most contributions to the conference are published in a commercially available proceedings volume. All participants of the conference will receive a copy. The key-notes will be published separately in the following year. This collection of all abstracts informs on the contents of the presentations in a concise format, facilitates orientation during the conference and serves as a quick reference of the wide range of topics that were covered.

In contrast to the first Managing Alpine Future conference little restriction with respect to the thematic focus of the submissions was given. In reflection of the inter- and transdisciplinary approach papers are only loosely allocated to thematic areas. However, seven foci have been defined which build the chapters of this book, and define the session topics of the main conference:

- **Climate Change: from palaeo-climate to climate modelling**
- **Natural Resources and Ecology: from alpine meadows to ecosystem services**
- **Tourism and Energy: from mobility to snow-making**
- **Society and Culture: from education to migration**
- **Ethics and Politics: from consumer behaviour to multi-level governance**
- **Spatial Planning: from hazard zoning to land use changes**
- **Hydrology: from flood retention to integrated water resource management**

Whereas the keynotes will focus on the general aspects, the other presentations mostly concentrate their perspective on case studies across the mountains ranges of the world. All European mountain regions are represented with examples of the Alps, the Scandes, the Hebrides and Iceland The Andes are examined in Bolivia and Chile, in Asia the Himalaya, the Central Mountain Ranges and the Turkish Black Sea Mountains are analysed and further case studies again deal with the New Zealand and the Japanese Alps. Some papers include a comparative perspective.

Managing Alpine Future – Inspire and Drive Sustainable Mountain Regions

cont.

Acknowledgements

Many collaborators of IGF, alpS and the Institute of Geography contributed to the organization of the conference. We thank Michiko Hama, Steffen Link, Matthias Monreal, Angela Scheiffelle and Katharina Schröer for their cautious planning of the conference, Kati Heinrich and Valerie Braun for their careful editing and lay-outing of the proceedings volume despite considerable time pressure. We are indebted to the staff members of the three organizing bodies for their support prior and during the conference. The Scientific Committee formed by outstanding European mountain researchers supported us conceptualizing the conference and reviewing the papers. Many thanks to Eckart Ehlers, Peter Greminger, Bernd Hansjürgens, Bruno Messerli, Martin Price, Roland Psenner, Jakob Rhyner, Thomas Schaaf, Thomas Scheurer, Dominik Siegrist, Jörg Stadelbauer, Ulrich Strasser, Ulrike Tappeiner, Annegret Thieken, Hannelore Weck-Hannemann and Friedrich Zimmermann!

Most importantly we want to thank all presenters for their manuscripts and presentations. We hope you found inspiration and fruitful debate by sharing your thoughts.

Without the support of the University of Innsbruck and its rector Tilmann Märk, the Austrian Academy of Sciences, the Federal State of Tyrol and the City of Innsbruck the conference would not have been financed. We owe thanks to the Austrian Academy of Sciences Press for including the book into its programme. The Austrian UNESCO Commission took over the patronage of the conference. For this we are grateful and honoured.

The mandate of the conference is to “inspire and drive sustainable mountain regions”. We hope all conference participants and all readers of this book will be inspired in this sense and contribute to a sustainable mountain future, not only for the sake of their unique natural wonder but foremost for the benefit and welfare of the millions of people that dependent on resources and ecosystem services for their daily life and that are provided by the great mountains of the world.

Scientific Committee

(04.11.2011)

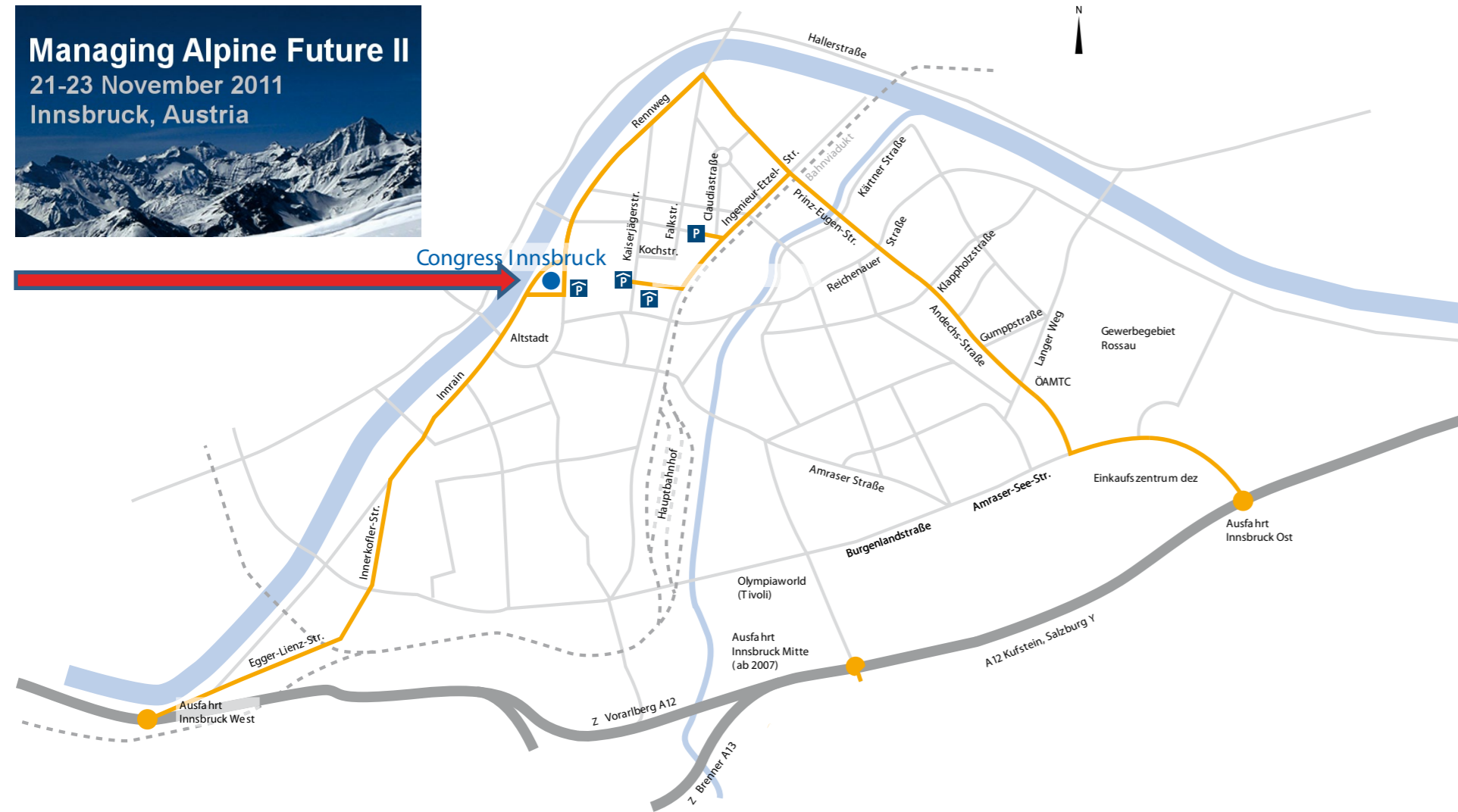
- Prof. Dr. Axel Borsdorf, Institute of Mountain Research: Man and Environment, Austrian Academy of Sciences; University of Innsbruck
- Prof. em. Dr. Eckart Ehlers, University of Bonn
- Dr. Peter Greminger, Federal Office for the Environment FOEN, Berne
- Prof. Dr. Bernd Hansjürgens, Helmholtz Center for Environmental Research - UFZ, Leipzig
- Prof. em. Dr. Bruno Messerli, University of Bern
- Prof. Dr. Martin Price, University of the Highlands and Islands, Perth
- Prof. Dr. Roland Psenner, University of Innsbruck
- Dr. Jakob Rhyner, United Nations University, Bonn
- Dr. Thomas Schaaf, Man and the Biosphere (MAB) Programme, UNESCO, Paris
- Dr. Thomas Scheurer, ISCAR International Scientific Committee on Research in the Alps, Bern
- Prof. Dr. Dominik Siegrist, Commission Internationale pour la Protection des Alpes CIPRA
- Prof. em. Dr. Jörg Stadelbauer, University of Freiburg
- Prof. Dr. Johann Stötter, University of Innsbruck
- Prof. Dr. Ulrich Strasser, University of Graz
- Prof. Dr. Ulrike Tappeiner, EURAC, Bolzano and University of Innsbruck
- Prof. Dr. Annegret Thieken, University of Potsdam
- Dr. Eric Veulliet, alpS, Innsbruck
- Prof. Dr. Weck-Hannemann, University of Innsbruck
- Prof. Dr. Friedrich Zimmermann, University of Graz

Organizing Committee

(04.11.2011)

- Prof. Dr. Axel Borsdorf, Institute of Mountain Research: Man and Environment, Austrian Academy of Sciences, Innsbruck; Institute of Geography, University of Innsbruck
- Dr. Michiko Hama, alpS – Centre for Climate Change Adaptation Technologies, Innsbruck; Institute of Mountain Research: Man and Environment, Austrian Academy of Sciences, Innsbruck;
- Steffen Link MSc., alpS – Centre for Climate Change Adaptation Technologies, Innsbruck
- Matthias Monreal MSc., alpS – Centre for Climate Change Adaptation Technologies, Innsbruck; Institute of Mountain Research: Man and Environment, Austrian Academy of Sciences, Innsbruck;
- Mag. Stefan Ortner, alpS – Centre for Climate Change Adaptation Technologies, Innsbruck
- Angela Scheiffelle, alpS – Centre for Climate Change Adaptation Technologies, Innsbruck
- Katharina Schröer BSc., alpS – Centre for Climate Change Adaptation Technologies, Innsbruck
- Prof. Dr. Johann Stötter, Institute of Geography, University of Innsbruck; Institute of Mountain Research: Man and Environment, Austrian Academy of Sciences, Innsbruck; alpS – Centre for Climate Change Adaptation Technologies, Innsbruck
- Dr. Eric Veulliet, alpS – Centre for Climate Change Adaptation Technologies, Innsbruck
- Sophie Edlmair, alpS – Centre for Climate Change Adaptation Technologies, Innsbruck

Location Map



Twitter Guide for Managing Alpine Future II

What is Twitter?

Twitter is a form of free micro-blogging, which allows you to send and receive short public messages called tweets. Tweets are limited to 140 characters and can include links to blogs, web pages, images, videos and other material online. You can tweet from your computer, smart phone or tablet.

Why should Managing Alpine Future II participants use Twitter?

- Twitter can add extra value to the conference in several ways:
- External communication: Twitter can provide those users who could not attend the conference with details of what is going on.
- Internal communication: Twitter allows the instant exchange of impressions or insights among conference participants.
- Additional communication: Twitter can stir discussions among participants, which otherwise would not happen.

What to tweet?

- Details of talks and sessions of the Managing Alpine Future II Conference.
- Your observations or interesting ideas.
- Information on new publications, website updates, new blogs, videos, announcements, comments as they come up during presentations or a conversation during coffee break.

Setting up your Twitter account

- Go to www.twitter.com and follow the instructions to get an account.
- Start tweeting! Type a short note in the window "What is happening?" using the hashtag #MAF2011 somewhere in the text so that we will be able to find your tweet later.
- To read other MAF participants' comments, type #MAF2011 in the search window.
- Note: Many European keyboards do not include the hash mark (#). You can type it pressing "Alt" and "3".
- To build your own Twitter community you can follow others ("Following") and others might want to follow you ("Followers"). Try to connect to the MRI-Europe Tweets: http://twitter.com/#!/mri_europe

Using Twitter during "Managing Alpine Future II"

Submit your thoughts whenever they occur to you, during the talks or afterward. There are wi-fi connections in the Conference Center enabling you to send messages at any time. The European Program of the Mountain Research Initiative (MRI-Europe, led by MRI Berne and IGF Innsbruck) will review the tweets and consider them as a major data stream associated with the Managing Alpine Future II Conference.

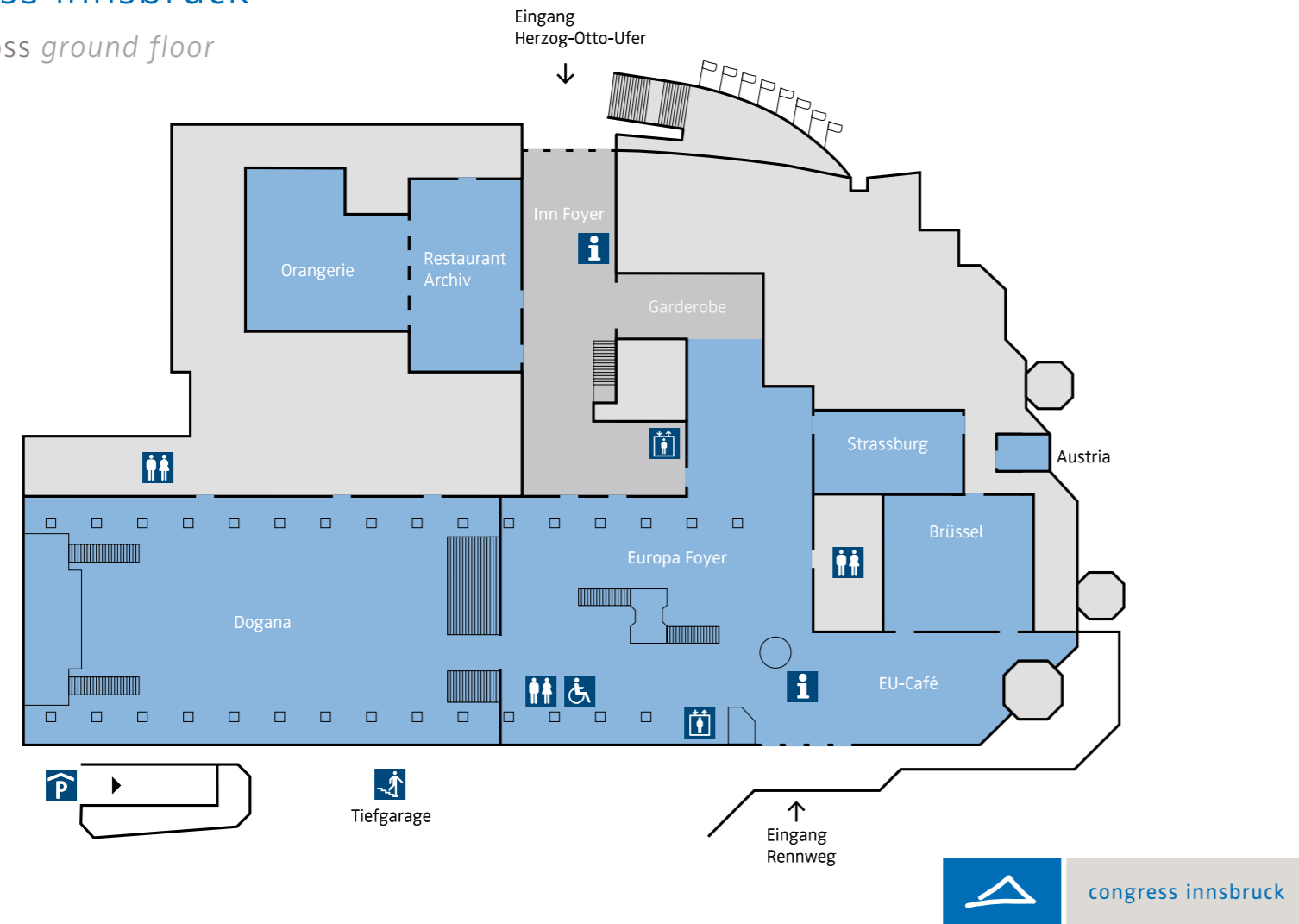
For more information contact: astrid.bjoernsen@uibk.ac.at

See example: <http://twitter.com/#!/search/TEDxbrussels>

Floor plans

congress innsbruck

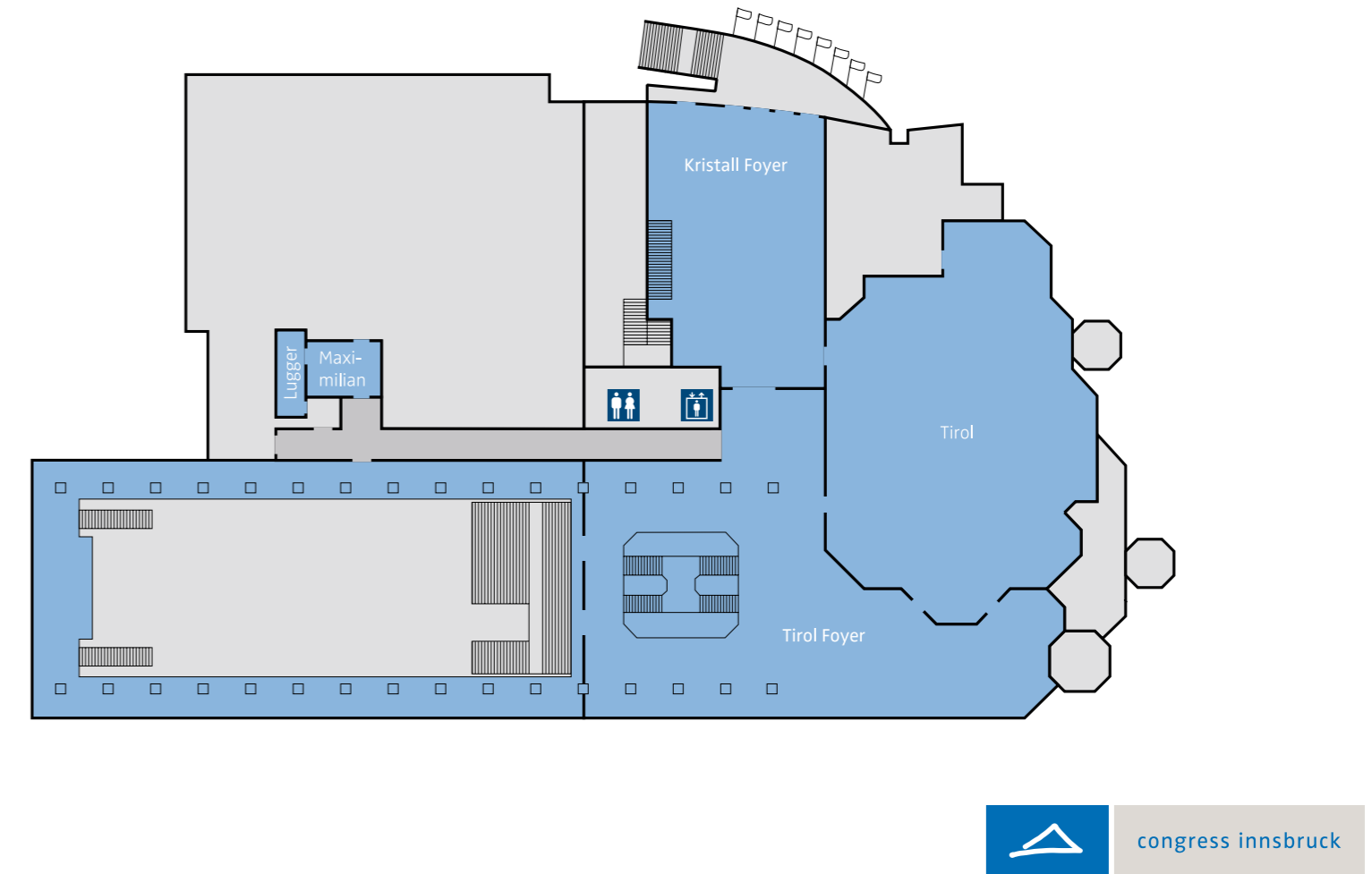
erdgeschoss *ground floor*



Floor plans

congress innsbruck

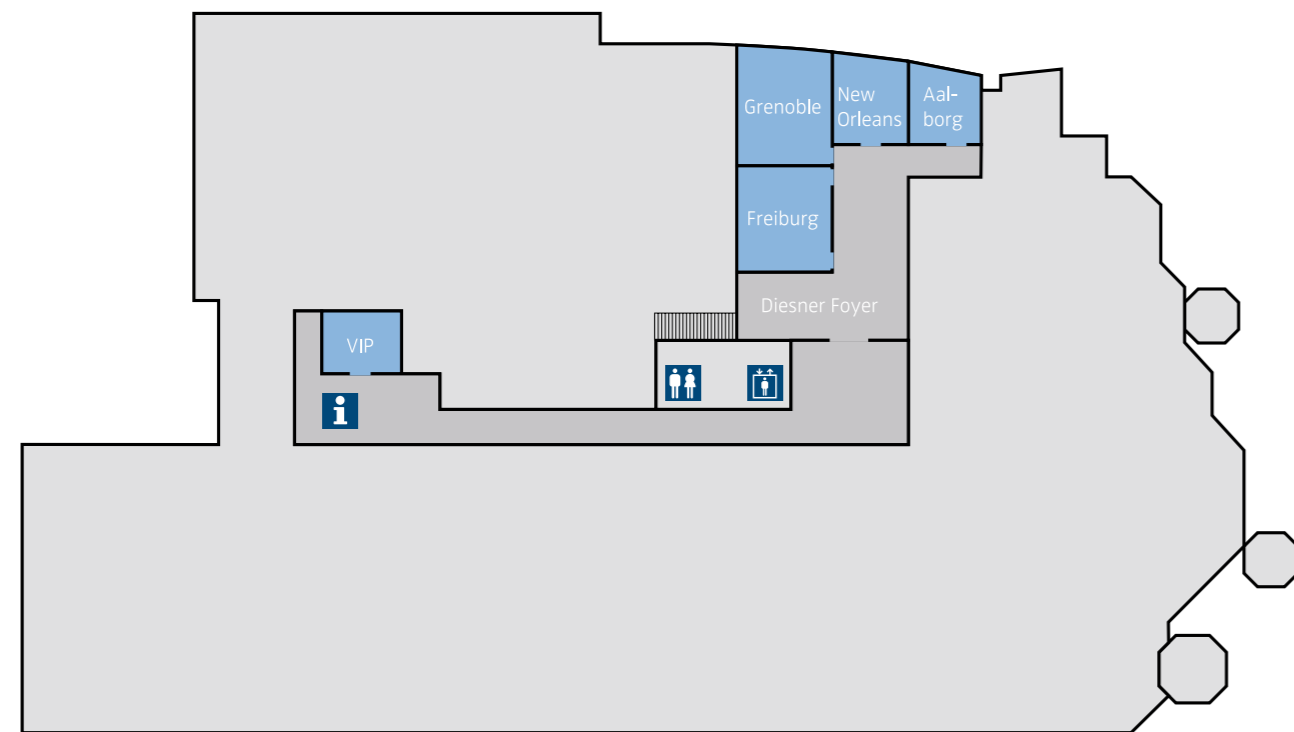
1. obergeschoss *first floor*



Floor plans

congress innsbruck

3. obergeschoss *third floor*



Conference Programme

agenda

Managing Alpine Future II
21-23 November 2011, Innsbruck

Session Schedule

Sunday, 20 November

Monday, 21 November

Under the patronage of
 UNESCO
 United Nations Educational, Scientific and Cultural Organization
 Österreichische UNESCO-Kommission
 Austrian Commission for UNESCO
 OAW
 Österreichische Akademie der Wissenschaften
 universität innsbruck
 alp-S

from 09:00
 FIELD TRIPS: Hydro Power, Stubai Valley, Mass Movements (as booked)

from 09:30 REGISTRATION
Optional: free guided city tour
13:00 -14:00 WELCOME & CONFERENCE INTRODUCTION From Managing Alpine Future 2007 to Managing Alpine Future II 2011
14:00 -15:00 PLENARY I Mountains in an Uncertain World From Salzburg-Obergurgl 1972 to 2012 and Beyond Jack Ives, Carleton University
15:00 - 15:30 COFFEE BREAK
15:30 -16:30 PLENARY II The Challenge of Long-term Climate Change Mojib Latif, Leibniz Institute of Marine Sciences
16:30-17:00 PLENARY DISCUSSION
17:00 -19:00 POSTER SESSION including wine tasting
19:00 onwards TYROLEAN EVENING (included in conference fee) including National Launch of the UNISDR World Disaster Reduction Campaign 2010-2015: Making Cities Resilient: "My City Is Getting Ready"

Conference Programme

Tuesday, 22 November

08:30 - 10:10 & 10:40-12:00 MORNING SESSIONS

Room	Freiburg	New Orleans	Aalborg	Grenoble	tba
	Hydrology	Society & Culture	Spatial Planning	Natural Resources & Ecology	
08:30	<i>Keynote: Rolf Weingartner</i> Water and Global Change in Switzerland - From Understanding to Action	<i>Keynote: (tba)</i>	<i>Keynote: Peter Greminger:</i> Risk Dialogue As a Must for Risk-based Spatial Planning.	<i>Keynote: Martin Price:</i> The World's Mountain Forests: Values and Challenges.	
09:10	Analysing Changes in Flood Risks in an Alpine Catchment. <i>A. Thieken</i>	Alpine Agriculture - Risks and Options of Future Water Scarcity. <i>K. Wagner</i>	Applicability and Appropriateness of Hazard Prevention in Mountain Areas: Hazard Zone Planning in the Autonomous Province Bolzano South Tyrol. <i>C. Hoffmann</i>	Mountain Forestry – Challenges. <i>M. Jandl</i>	
09:30	Assessing the Impacts of Climate Change on Flood Frequency in an Alpine Watershed. <i>C. Dobler</i>	Climate Change and the Vulnerability of Mountain Regions: Concepts and Methods Towards an Integrated Assessment. <i>S. Kienberger</i>	Communication in Alpine Risk Governance: Unifying Internal and External Perspectives. Hazard Zone Planning in the Autonomous Province Bolzano South Tyrol. <i>S. Link</i>	Forest Fire Research and Management Options in Austria: Lessons Learned from the AFFRI and the ALP-FFIRS Networks. <i>H. Vacik</i>	
09:50	Threats Versus Visions: an Integrative View on the Alpine River Systems. <i>S. Muhar</i>	Climate Change and Consumer Behavior: Adaptation Strategies Based on Adaptation Intention. <i>U. Proebstl</i>	Integral Prevention of Natural Hazards Thanks to the Compulsory Building Insurance. <i>M. Feltscher</i>		

10:10 - 10:40 COFFEE BREAK

	Freiburg	New Orleans	Aalborg	Grenoble	tba
	Hydrology	Society & Culture	Spatial Planning	Natural Resources & Ecology	
10:40	Water Balance and Global Change: Future Perspectives for Alpine Farming. <i>G. Leitinger</i>	Destinations as Place Development in Norwegian Mountain Areas? <i>T. Skjeggedal</i>	Climate Change Impacts in the Bolivian Andes: from Water Shortage to Human Displacements. <i>R.A. Kaenzig</i>	AlpFUTUR – An Inter- and Transdisciplinary Research Programme on the Future of Summer Pastures in Switzerland. <i>R. Boeni</i>	
11:00	MontanAqua: Approaching Water Stress in the Alps. Transdisciplinary Co-production of Water Management Options in the Crans-Montana-Sierre Region, Valais. <i>F. Schneider</i>	The Individual and the Perception of Conflict, Communication, and Consensus at Mountainous Protected Areas in Iceland and Japan. <i>H. Jónasson</i>	Land Use Change in Yaylas of the Eastern Black Sea Mountains, Turkey. <i>M. Somuncu</i>	Land Use and Biodiversity: An Indicator-set Supporting Sustainable Development <i>J. Rüdiger</i>	
11:20	Securing Hydrological Ecosystem Services Through Catchment-wide Land-Use Management. <i>A. Gret-Regamey</i>	Investigation Concerning the Evolution of the Term „Comfort“ in Contemporary Alpine Consumer Architecture. <i>A. Flora</i>	The Charter of Rosengarten. Lobbying for Stronger Landscape Policies. <i>L. Ponticelli</i>	Establishing the Environmental Conservation and Sustainable Development in the Mountain Society of the Pamir. <i>T. Watanabe</i>	
11:40		The Alps: Creative Summits or Fanciless Valleys? <i>J. Scharting</i>	Participation in Mountain Forest Management and Its Impacts. <i>D. Himmler</i>	Leaf and Ecosystem Response of Mountain Grassland Gas Exchange to Soil Water Availability. <i>G. Wohlfahrt</i>	Global Initiatives Program Workshop (on invitation only)

12:00 - 13:20 LUNCH

Conference Programme

13:20 - 15:00 & 15:30-17:30 AFTERNOON SESSIONS

	Freiburg	New Orleans	Aalborg	Grenoble	tba
	Tourism & Energy	Society & Culture	Spatial Planning	Natural Resources & Ecology	
13:20	<i>Keynote: Bruno Abegg</i>	The Demographic Impact of New Developments in the Italian Alps. <i>E. Steinicke</i>	The "Alpenplan" as a Spatial Planning Tool for Steering Development in the Bavarian Alps - a Critical Appraisal. <i>H. Job</i>	Lichens in the Alps and Environmental Change. <i>M. Grube</i>	
13:40	Will Alpine Summer Tourism Benefit from Climate Change? <i>S. Brezina</i>	Dimensions of Demographic Change. Challenges for the Alps. <i>A. Borsdorf</i>	Adaptation Strategies in an Alpine Community - Future Sustainability and Territorial Community Plans (PTC) in Trentino. <i>C. Orsatti</i>	Effects of Summer Drought on Carbon Dynamics in Mountain Grassland. <i>M. Bahn</i>	
14:00	The Effect of Snow-making on Water Flow in Major Streams of the Krkonoše Mts. National Park. <i>S. Brezina</i>	The Landscape-language Relation in the Raetho-Romanic Alps. A factor producing and Developing the Territory. <i>L. Ponticelli</i>	Challenges and Opportunities for the Sustainability of Mountain Areas in Chile. <i>C. Marchant</i>	Vegetation on Alpine Rockglaciers: A Case Study From the Ötztal and Stubai Alps (Tyrol, Austria). <i>L. Rieg</i>	
14:20	Glaciers, Snow and Ski Tourism in Austria's Changing Climate. <i>A. Fischer</i>	Do we Need Gender Equality for Sustainable Regional Development? <i>M. Schmitt</i>	Designing Sustainable Pathways: The Case of the Scottish Hebrides. <i>I. Mose</i>	Structure and Regeneration Patterns of Austrocedrus Chilensis in Timberlines at the Northern Distribution on the Cachapoal River Basin, Chile. <i>A. Promis</i>	
14:40	Effects of Climate Change of Future Snow Conditions, Winter Tourism and Economy in Tyrol and Styria. <i>U. Strasser</i>			Connectivity Analysis of Riverine Landscapes. <i>A. Bou-Vinals</i>	Global Initiatives Program Workshop (on invitation only)

15:00 - 15:30 COFFEE BREAK

	Freiburg	New Orleans	Aalborg	Grenoble	tba
	Tourism & Energy	Ethics & Politics	Climate Change		
15:30	Australian Snow Tourist's Perceptions of Climate Change: Implications for the Queenstown Lakes <i>D. Hopkins</i>	<i>Keynote: (tba)</i>	<i>Keynote: Helga Kromp-Kolb</i> Climate Change - From Global Scale to Regional Mountain Scale		
15:50	Alpine Airports as Gateways for Growing Incoming Ski Tourism: Relevance and Spatial Impacts. <i>T. Behnen</i>		Climate Change Adaptation in a High Mountain Environment, Developing a Monitoring Expert System for Hazardous Rock Walls. <i>I. Hartmeyer</i>		
16:10	Ecotourism as a Sustainable Adaptation Strategy for the Effects of Climate Change in the Himalayas - Examples from the Indian State of Uttarakhand. <i>H. Pechlaner</i>	HD-Film and Social Media Use as a Tool for Policy Makers, NGO Members and Researchers Focusing on Methodological Possibilities and Examples from the Nepal Himalaya. High Alpine Changes. <i>H. Künkel</i>	The Quantification of Changes in the Alpine Cryosphere and Periglacial Environment Based on ALS Data. <i>R. Sailer</i>		
16:30	Regional Tourism Systems in Times of Climate Change: How can you Empirically Measure Anthropospheric Adaptation to an Imminent <i>R. Wyss</i>	Life eQuality? Teenagers Inspiring Research into Quality of Life. <i>L. Keller</i>	Climate Change Center Austria - Vision, Mission and Structure <i>Johann Stötter</i>		
16:50		The Blind Spot: The Discourse About Urban Sprawl in the Context of Particularism. <i>M. Perlik</i>			
17:10		Social Capital as a Key Source for Sustainable Development in Protected Mountain Areas: Experiences from the Großes Walsertal Biosphere Reserve.			

Conference Programme

Wednesday, 23 November

08:30 - 10:10 MORNING SESSIONS

Freiburg	New Orleans	Aalborg	Grenoble
Tourism & Energy 08:30 Relative Regional Vulnerability and Resilience of the Austrian Winter Tourism Industry. <i>R. Steiger</i> 08:50 The Vulnerability of Swiss Alpine Tourism to Climate Change – An Analysis of Its Causes, Its Magnitude, and Its Spatial Heterogeneity. <i>C. Matasci</i> 09:10 Renewable Energy in Alpine Areas – Desired, Ignored or Rejected? How Winter Sports Tourists Perceive Renewables in Five Austrian Skiing Areas. <i>A. Jiricka</i> 09:30 Climate Change and Winter Tourism: A Stakeholders Perspective in the Tyrol Region. <i>E. Trawöger</i> 09:50 Impacts of Climate Variability and Change on Tourism in Austria. <i>C. Toeglhofer</i>	Ethics & Politics Mountains as a "Geographic Specificity": Findings of the ESPON Applied Research Project GEOSPECS on the Situation of Mountain Areas in Europe. <i>D. Borowski</i> Costs of Alpine Hazards – Principles, Research Gaps and Recommendations. <i>A. Thieken</i> Looking at Mountains from Near and Afar. Coherence and Disparities in Definition, Identification and Characterization of Mountains and Mountain Communities in Norway from a Domestic and a Pan-European Observation Platform. <i>T. Arnesen</i> Climate Change Response Measures: Think One Step Forward! <i>A. Ullrich-Schneider</i> Peace through climate change adaptation – innovative paths in the Biosphere Reserve Cinturón Andino, Colombia <i>A. Borsdorf</i>	Climate Change Changes in the Glacial and Periglacial Environment of the European Alps and the Central Asian Mountains and their Socio-Economic Implications: a Comparison. <i>M. Mergili</i> Global Warming and Biosphere-Anthroposphere Shift in Mountain Regions of Kyrgystan. <i>A. A. Aidaraliev</i> Aspects of Climate Change in High Mountains of the Balkans. <i>K. Grunewald</i> Changes in Monsoon Pattern and its Impact on Water Resources: Community Responses and Adaptation. <i>P.C. Tiwari</i>	

10:10 - 10:30 COFFEE BREAK

10:30-11:30 PLENARY III

The Anthropocene

Paul Crutzen, Nobel Prize Laureate, Max-Planck-Institute for Chemistry

11:30 - 12:00 POSTER & SCHOOL PROJECT AWARDS

12:00 - 13:30 LUNCH

Conference Package includes:

"Alpine Future" - Presentations of the next generation: Projects of Tyrolean HTLs (Higher Technical Education Schools), exhibition throughout the conference

"Biber Berti und seine Freunde" - Educational youth activities concerning climate change consequences (Alpine Space Project AdaptAlp).

Tyrolean Evening

Public Evening

Conference Kit including hard copy of programme incl. abstracts

Partners



Supported by:



Poster Presentation

POSTER PRESENTATIONS (poster exhibition will be shown throughout the conference)

Spatial Planning

R.B. Singh
G. Scaglione
B. Thoeni
A. Pfanzelt
 Rainfall Variability in Nanda Devi Biosphere Reserve, Indian Himalaya.
 Reinventing A 22.
 "Alpenpark Europa - Vision 2030".
 BEYOND USE - Phenomena Embedded in Abandoned Objects in the Alpine Territory between the Allgäu Region and Lake Garda.

Hydrology

T. Barth
M. Rode
C. Promper
C. Kormann
H. Klug
 Hydrometeorological Monitoring and Modeling in Mountain Catchment. An Application in the French Alps (Belledonne, Isère, 38).
 Assessing Coupled and Decoupled Sediment Fluxes in the Johnsbachtal Valley as a Tool for River Management and Renaturation.
 Analysis of Changing Channels in an Anthropogenic Influenced High Alpine Catchment.
 Potential Future Water Scarcity in the European Alps: a Case Study in Tyrol, Austria.
 Interactive Analysis of Alpine Climate Change and Water Consumption to Discover Regions Prone to Water Scarcity in a WebGIS.

Climate Change

V.P. Uniyal
T. Nagler
C. Briese
M. Spross
M.C. Nautiyal
H. Stötter
C. Mitterer
M. Bremer
 Long Term Ecological Monitoring Initiatives for Conservation of Gaumukh Glacier, Western Himalaya, Uttarakhand India.
 CryoLand – GMES Service Snow and Land Ice.
 Radiometric Calibration of Airborne Laser Scanning Data for the Analysis of Alpine Cryosphere and Periglacial Environment.
 Quantitative Analysis of Local Snow Accumulation Patterns on an Alpine Glacier Surface Derived by LiDAR Data.
 Effect of Elevated CO2 on Diverse Plant Species of Alpine Broad Leaved Growth Forms.
 Ten Years of ALS Measurements in the Hintereisferner Region (Ötztal Alps, Austria) – A Review and an Outlook.
 Ground-penetrating Radar: a Potential Method to Forecast Snow Avalanches in a Changing Climate.
 FoCALS- Forest Change Assessment Using Laser Scanning, a Conceptual Framework for Area Wide Monitoring of Mountain Forests.

Natural Resources & Ecology

M. Fernandez
M. Obrjejetan
A. Promis
R. Schuster
O. Buchner
L. Rieg
O. Sass
R. Bottarin
K. Berdyugin
A. Bockreis
 Closing Nutrient Cycles in Alpine Regions by the Use of Wood Ash.
 Long-term Sustainable Revegetation of Technical Slope Stabilization Systems in the Alpine Region.
 Species Diversity on Austrocedrus Chilensis Dominated Timberlines at the Northern Distribution on the Cachapoal River Basin, Chile.
 Impact of Climate Warming on Growth of Conifers Exposed to a Dry Inner Alpine Environment.
 Heat Tolerance of Alpine Plants – What are the Limits?
 Vegetation on Alpine Rockglaciers: A Case Study from the Ötztal and Stubai Alps (Tyrol, Austria).
 The FIRIA Project: Towards Assessing Future Wildfire Hazard in Austria.
 Assessing Nitrate Vulnerability Related to Agricultural Activities: Specific Considerations for Mountain Catchments.
 Anthroposphere and Biosphere Relationships in the Urals Region.
 Relevant Climate Impact of the Tyrolean Solid Waste Management.

Tourism & Energy

M. Mayer
S. Erber
C. Gonseth
S. Tischler
L. Ponticelli
V. Dovbenko
T. Lang
Y.L. Lee
C. Bauer
 Determinants of Nature Tourists' Spending Behaviour in the Alps - Results and Implications from Simmental and Diemtigtal (Switzerland).
 Alphouse in Andelsbuch
 Analysis of the Sensitivity of Ski Tourism Demand to Climate Change in Switzerland.
 Integrated Traffic and Mobility Concepts for Alpine Tourism Areas – the Example of Wolkenstein, Italy.
 The Dolomites Lavaze Pass. Negotiating Tourism Development and Landscape Diversity.
 Research of Ways for the Carpathian Mountains Region Development.
 Classification of Winter Tourism Regions and the Regional Effects of Climate Change.
 Multidisciplinary Assessments of Trail degradation for Framing Future Trail Management: Examination in Shei-Pa National Park, Taiwan.
 Climate Change and Alpine Summer Tourism - Chances and Strategies in Vent and Obergurgl.

Society & Culture

P. Fritzmann
M. Bacher
U. Schirpke
B. Uniyal
P. Kurz
 Quantifying Changes in Alpine Land Use Using Remote Sensing Data - A Case Study at Bregenzer Wald, Vorarlberg.
 Which Landscape do We Want in the Alps – and Can We Afford It?
 How Sustainable is Your Municipality? Monitoring Environmental, Social and Economic Aspects in South Tyrol, Italy.
 Livelihood Dependence on Natural Resources in Alpine Pastures by Women of Garhwal Himalaya, Uttarakhand, India.
 Mountain Pasturing Plans for Upper Austria – Creating a Tool for Adaptive Management of Cultural Landscapes and Natural Resources in Alpine Regions.

Ethics & Politics

L. Füreder
 PROSECCO.ALPS - PROglacial Stream Ecohydrology and Climate Change Over the ALPS.

Keynote Speaker

Hydrology

Prof. Dr. Rolf Weingartner, University of Bern

Water and Global Change in Switzerland – From Understanding to Action

Society & Culture

(tba)

Spatial Planning

Dr. Peter Greminger, Federal Office for the Environment of the Swiss Confederation, Bern

Risk Dialogue As a Must for Risk-Based Spatial Planning

Natural Resources & Ecology

Prof. Dr. Martin Price, University of the Highlands and Islands, Perth

The World's Mountain Forests: Values and Challenges

Tourism & Energy

Dr. Bruno Abegg, University of Applied Sciences, Chur

Will Alpine summer tourism benefit from climate change? A review

Ethics & Politics

(tba)

Climate Change

Prof. Dr. Helga Kromp-Kolb, University of Natural Resources and Life Sciences, Vienna

Climate Change – From Global Scale to Regional Mountain Scale

Analysing changes in flood risks in an alpine catchment

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In the last 50 years, the number of big natural disasters at least doubled worldwide, while in the same time period the resulting damages increased by factor eight. Of all natural hazards, floods are responsible for the largest economic losses worldwide. One important factor for increasing losses is the ongoing settlement and economic development leading to a continuous increase in assets in flood-prone areas. In several regions, climate change might contribute to an increase in flood losses due to an augmentation of flood frequencies and magnitudes. In the perspective of the catastrophic floods in 1999, 2002 and 2005, which caused in Austria damage of approximately 35 Million Euro, 2445 Million Euro and 515 Million Euro, respectively, the research project FloodTimeS was established, which has three main objectives:

- to examine the impacts of climate change on flood frequencies and magnitudes thus quantifying the hazard potential for the 21st century,
- to investigate and quantify shifts in the damage potential particularly the development of settlement along river reaches and
- to develop risk time series for the 21st century.

An overall aim of this project is to minimize flood risks by giving recommendations about appropriate adaptation to policy-makers and local administrations. As an example, the Austrian

part of the catchment of the river Lech was chosen as investigation site. The estimation of future flood risks is based on a process and modelling chain that assesses potential future developments of the flood hazard and its impacts. This includes regional modelling of climate change (i.e. downscaling of GCM results) as well as land use and socioeconomic development, rainfall-runoff relationships, definition of potentially flooded areas by hydraulic modelling, quantification of values at risk and estimation of potential losses as final parameter. With respect to the flood impact the development of the number of people living in flood-prone areas and the growth in extent and value of settlements and infrastructure at risk are investigated. By this it is possible to quantify the potential damage along the reaches of the river Lech in the area of Reutte (Tyrol, Austria) for different scenarios. By considering different levels of precaution, conclusions for risk management options can be drawn from the study. Thus FloodTimeS meets the demands of: i) a modern risk-based natural hazard management; and ii) a future-oriented management of climate change induced effects on human-environment systems in the Alps.

In the presentation, the concept of the project as well as preliminary modelling results with regard to changes in the flood hazard and their uncertainty, land use scenarios and first estimates of potential flood losses will be presented.

Assessing the impacts of Climate Change on Flood Frequency in an Alpine Watershed

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The water balance of Alpine rivers is characterized by the combination of higher precipitation induced by orographic effects, reduced evapotranspiration rates caused by relatively low mean temperatures, and temporary storage in form of snow or ice. Global climate change may lead to a modification of these factors and thus may have considerable impacts on the hydrological behaviour of mountain watersheds. The aim of this investigation is to assess the impacts of climate change on frequency and magnitude relationship of floods thus quantifying the hazard potential for the 21st century. The catchment of the river Lech (~1,000 km²) in the northern limestone Alps was selected as study area.

The impacts of climate change were assessed by following a classical 'one-way' approach from global to local climate information, and eventually to the hydrological model. In this investigation two General Circulation Models (GCMs), namely ECHAM5 and HadGEM2, were used to simulate current and future climate. In order to bridge the gap between the coarse GCMs output and the needs for local climate information, downscaling methods are usually applied. However, most methods are able to reproduce the mean behaviour of the variables and fewer methods allow to reasonable downscaling of extreme events. In this study the Expanded Downscaling (EDS) technique was applied. EDS is a further development of mul-

tipple linear regression concept and is particularly suited to the simulation of extreme events like floods. Initially, EDS was calibrated (1979-2000) by establishing a statistical relationship between observed atmospheric fields, taken from the ECMWF (European Centre for Medium Range Weather Forecast) reanalysed dataset and local climate data. The validation period (2001-2005) that was determined in this way shows the quality of the process by comparing observed and simulated local climate and hydrological data. Finally, EDS was derived from the large-scale AOGCMs output.

The climate simulation data was used to drive the semi-distributed hydrological model HQsim to examine possible changes in flood hazards. When forcing the hydrological model with downscaled climate data from the ECMWF dataset, a good agreement between observed and simulated average and extreme runoff was detected. Changes in flooding were assessed by comparing statistics of current and future runoff series. Projected shifts in the occurrence of peak flows during winter and summer will be presented and the resulting changes in the frequency-magnitude relationship of floods will be discussed. An analysis of the uncertainties in the projections will show the reliability of the obtained results.

Threats versus visions: an integrative view on the Alpine River Systems

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The major river systems of the Alps with their diverse topographic and biogeographic characteristics support unique riverine landscapes colonized by a specific fauna and flora, which is highly endangered through the ongoing exploitation of their water resources.

Public awareness hand in hand with new, innovative legal framework conditions at international and regional level stimulate to address river management in a more ecologically sustainable way. The scientific community has supported that by developing methods to identify criteria for setting priorities in river conservation and restoration.

However, up to now water and nature protection policy failed to consider local, regional and even national problems in the wider context of the Alpine Arc as a unique and interdependent system. This is due to (1) thinking and acting in administrative units and not in a functional context, (2) the lack of river related, consistent base data for the whole Alpine Arc and, related to that, (3) missing adequate research approaches, targeted towards data compilation and analyses with a holistic approach.

To cope with these topics our project aims to provide applicable strategies for the conservation of ecologically sensitive riverine systems at a supranational level. This 'Alpine Arc wide' view is crucial as it is a prerequisite to identify typical, rare and endangered riverine systems or species in the context of the entire alpine area and hence helps to avoid short term, single-case decisions without knowledge of 'the whole'.

In this paper we present an overview of the environmental status of the Alpine rivers systems with regard to the main human pressures. This new data set provides area wide, spatially explicit information on the crucial impacts due to hydropower generation, land use and flood protection, reflected in altered morphological characters and hydrological regimes, reduced floodplain areas and fragmented habitats.

These results are complemented by further investigations addressing key riverine species e.g. grayling or tamarisk, to describe the vulnerability of riverine ecosystems affected by different pressures. Based on this assessment, we will discuss different methodological approaches to identify ecologically sensible river stretches by a set of hydro-geomorphological and biological criteria. Bringing together different disciplinary views the project is aiming at the development of a harmonized concept for setting priorities in river conservation, which will meet the requirements of an Alpine Arc wide perspective.

The results are intended to stimulate cross-linking and cooperation between various actors including the EU administration. Thus the project outcomes will assist to strengthen the 'position of the Alps' and particularly increase the recognition of an ecologically unique and highly sensitive region within supra-national programs and implementation activities (e.g. Water Framework Directive, Habitats- and Birds Directive/Natura 2000, Convention on Biological Diversity).

Water balance and global change: future perspectives for alpine farming

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Climate and land-use changes affect the water balance of mountain grasslands. Depending on topography, soil type and land use, changes in productivity take place and could result in further economic pressure for alpine farming. Sustainable productivity rates depend on a balanced use of water by plants, high water storage capacities of soils, and topographical characteristics of managed areas.

Measuring evapotranspiration (EVT) for different land-use types and plant communities at varying sea levels helps us to understand changes of water availability in a future environment. Linked with transplantation experiments, this method is promising to cover most forecasted scenarios. Although the mentioned approach is well established, our study is innovative in so far as the field work as well as data analyses was supported by more than 50 pupils from a secondary school for agriculture and food industry within the Sparkling Science project SPA/01/2007/133/A/Klimawandel, funded by the Austrian Ministry for Science and Research (BM.W.F). Hence, a huge number of field measurements could be conducted simultaneously, covering a whole alpine valley.

In our study site Stubai Valley (300km², Tyrol, Austria) 24 sites on 8 different altitudinal transects (valley bottom, hillside, and sub-alpine/alpine region) ranging from 900m a.s.l. up to 2400m a.s.l. were equipped with weather stations recording microclimate. Additionally,

24 lysimeters have been installed on each site and data on EVT, infiltration capacities, leaf conductivity and soil wetness was collected in summer 2009 and 2010. Moreover, soil and vegetation analyses on all selected plots complete the comprehensive data pool.

Results revealed increasing EVT rates for the Alpine Standard Vegetation transplanted to lower altitudes and decreasing EVT rates for the Intensive Standard Vegetation when transplanted to higher altitudes. Intensively used meadows in the valley bottom were faced with water stress and thus lower or equal transpiration rates compared to lightly used meadows. Regarding management, cutting had a more severe effect on EVT, soil wetness as well as deep seepage in all altitudes. In other words, even if plant communities change, land management could influence water balance and finally catchment yield to a great extent.

To conclude, if air temperature increase and changing precipitation regime lead to longer dry periods, productivity of intensively used meadows will decrease significantly unless irrigation takes place. Alternatively, adapted management in low altitudes and intensification of meadows in higher altitudes could compensate for temperature increase and reach higher productivity rates due to a more balanced use of water. In the light of our results, alpine meadows and pastures could be the future capital of alpine farming and abandonment of currently non-profitable areas should be avoided.

MontanAqua: Approaching water stress in the Alps. Transdisciplinary co-production of water management options in the Crans-Montana-Sierre region, Valais

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Both climate change and socio-economic development will significantly modify the supply and consumption of water in future, and consequently fuel existing conflicts or create new conflicts of interest. Dry valleys in the Alps will be particularly affected, as it must be assumed that in these regions the general water supply will become even scarcer and seasonal distribution may change significantly. Against this background, the main objective of the transdisciplinary MontanAqua project is to develop strategies for moving towards more sustainable management of water resources in the study area, Crans-Montana-Sierre (Valais), together with the actors involved.

The development of options for more sustainable water management in the study area is based on a transdisciplinary approach aimed at co-production of knowledge among researchers, policy makers, public administration and civil society organizations. The interdisciplinary work of scientists is thus embedded in a social learning process with key stakeholders. This enables the simultaneous co-production of target knowledge (values that indicate which direction to take), systems knowledge (understanding how the system functions currently, and under different scenarios) and transformation knowledge (measures conducive for changing the system in a certain direction).

In doing so, researchers are evaluating co-ordination and adaptation of water demand to water availability under changing biophysical and socioeconomic conditions. The research

component is divided into three work packages (doctoral theses) and one synthesis package (post-doc).

WP1: Available water resources are measured and modeled in and for the different altitudinal zones, from the Plaine-Morte glacier down to the Rhone Valley.

WP2: The study and modeling of water use focuses on drinking water, energy production, agri- and viticulture, and tourism.

WP3: Decision-making related to water use is studied through socioeconomic structures, incorporating various levels from the municipality to the canton.

The synthesis package (SP) investigates how the disciplinary aspects addressed by the three work packages are involved in shaping a multifunctional landscape that is the core of regional development. By showing how the multifunctionality of landscape is modified under different climate change scenarios and socio-economic development options, it will be possible to highlight future actor-specific claims on landscapes and make them accessible for discussion and planning. Thus, the concept of multifunctional landscape is perceived as bridging concept between different disciplinary research approaches, as well as between scientists' and stakeholders' knowledge.

The aim of the talk is to present the conceptual approach of and experiences with transdisciplinary co-production of water management options in the Crans-Montana-Sierre region.

Securing hydrological ecosystem services through catchment-wide land-use management

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Land use in catchment areas strongly influence water quantity, quality, location, timing of flow and thus related services such as drinking water, flood protection, recreation and hydropower to name a few. The integrity of the terrestrial ecosystems to provide hydrological ecosystem services (HES) is key to many economic sectors such as agriculture, energy, insurance, tourism and the water sector. Yet, human activities and global climate change are jeopardizing the ability of ecosystems to deliver HES, which results in increasing economic costs due to flooding, water scarcity or decreased water quality. Besides a mitigation approach, this calls for adaptation measures related to land-use management to foster the regulating and insurance services that ecosystems provide.

In this contribution, we present first results of the Swiss National Research Project HydroServ assessing the full value chain of HES provided by terrestrial ecosystems under climatic and socio-economic changes. The case study encompasses the catchment area of the river Kleine Emme in central Switzerland, a region which includes the Unesco Biosphere Entlebuch. While there is a strong settlement pressure in the lowlands of the Kleine Emme, increasing abandonment of Alpine pastures as well as a the disappearance of high moorlands due to oxidation and vegetation regrowth characterize upstream areas. Land-use decisions are modeled using

a GIS-based Bayesian Networks explicitly accounting for stakeholder preferences. Results of the land-use decisions are used as input to a coupled eco-hydrological model that simulates changes of the hydrological response to the land-use changes and climate change forcing. Finally, people's preferences for HES in the downstream area are assessed using a discrete choice experiment using 3D visualizations showing changes in the landscape of the catchment area, the measures in the downstream area and the impacts of flood occurrences in the downstream area. The loop between supply and demand for HES services is closed by suggesting new policy instruments.

Considering spatial interactions between land-use decisions and HES in a catchment area provides key information to design innovative instruments for the public and private sectors and institutional regulations for securing the provision of HES under climate and land-use changes. Such an approach linking hydrological, ecological, and economical models and allowing for feedback from changing socio-economic and political conditions to land-use and adaptation to climate change will provide an important step towards sustainable integrated water management.

Alpine Agriculture – Risks and Options of Future Water Scarcity

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Outline and Objectives

The Federal Institute of Agricultural Economics takes part in the EU Alpine Space project “Alp Water Scarce”, under coordination of Mountain Institute, University of Savoy (FR). The subproject of the Federal Institute of Agricultural Economics tackles the role of agriculture in an integrated water management system for strengthening the awareness of water consumption in agriculture. It outlines the risks for agriculture and water systems in climate change scenarios and show options for an adapted land use to increase the efficiency of water usage and to avoid water scarcity and its negative consequences for agriculture. Focus is on a regional scale, which enables to get an overview of priorities for adaptation strategies and measures in various alpine regions.

Method

A general risk evaluation defines potential impacts of certain combinations of agricultural land use and regional natural conditions through developing corresponding indicators of the topics agricultural land use, livestock husbandry, soil conditions and climate. A concrete risk characterisation is done on the example of several Alp Water Scarce pilot regions in Austria, Slovenia, Italy, France and Switzerland, including climate change scenarios (Wagner and Neuwirth 2010). This will lead to potential adaptation strategies and measures for agriculture that will be integrated in overall strategies for mitigation of water scarcity (detailed project information: www.alpwaterscarce.eu).

Results

Results concern classifications of agricultural crops (crop coefficients), livestock husbandry (guideline values per livestock units) and soils (capacity of available water) due to their influ-

ence on water demand. The proportion of classified categories in the concerned pilot regions result in specific patterns of risk classes. They vary very much in the pilot regions. Especially the high share of water demanding grassland in mountainous areas contributes to higher risks there, for example in the Styrian Randgebirge or Koralpe, in French Tarentaise or in Slovene Julian Alps. High water consuming intensive livestock categories - for example chicken fattening - are located in valley grounds for the most part. But also dairy cattle have a high water demand. The regions Styrian Randgebirge, Carinthian Koralpe and Slovene Dravsko-Ptujsko show highest risks in livestock concerns. Flatlands and valley floors with mostly better conditions of soils allow higher rates of water saving and compensation of dry periods. Scenario assumptions for climate change and also for agricultural development have been drawn for the year 2050 to assess the changing risk patterns.

The current agricultural policy measures are evaluated with regard to its influence on water consumption. Together with the results of the risk assessment regional specific strategies are drafted and comprised with results of other disciplines to an integrated water management system to be adapted to or to avoid future water scarcity respectively.

References

Wagner, Klaus and Neuwirth Julia. 2010. Agricultural Indicators and Risk Model Development for Water Scarcity. Working Paper WP6, WP8 - EU-Alpine Space project Alp Water Scarce. Vienna: Federal Institute of Agricultural Economics.

Climate Change and the vulnerability of mountain regions: Concepts and methods towards an integrated assessment

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Within the policy domain climate change, strategies for adaptation are of central interest. This is not only due to national endeavours, but also reflects current efforts from the European Commission to establish a climate change directive. To support efforts in modelling and predicting future climate change trends on a more detailed scale and with reduced uncertainty, the assessment of the vulnerability and the identification of intervention areas are crucial. The concept of vulnerability has been widely used to cover this domain, but has still not brought up a universally agreed definition among the climate change community and the disaster risk reduction domain.

In this paper we present a modified vulnerability framework which has been developed in the EU FP-7 project MOVE (Methods for the Improvement of Vulnerability Assessment in Europe), with a dedicated link to climate change adaptation. Experiences were gained from a study carried out in the Salzach river valley, where vulnerability was mapped in a spatially explicit manner on community and catchment scale. The method of mapping 'spatial meta-indicators' was developed within the FP-6 project BRAHMATWINN focusing on future trends on climate variables relevant for alpine river systems. From a methodological perspective, the underlying concept used to spatially model vulnerability is the geon concept, which has been developed at the Centre for Geoinformatics (Z_GIS). This method allows the spatial representation of such integrated indicators in homogenous units. The integration of various sub-domains of the complex spatial phenomenon under consideration and the flexible expert-based weighting is an asset that allows this method to be used for different policy-related realms. Here, we will focus on strengths which are relevant for and will challenge an integrated assessment of climate change relevant policy options and what is required to allow an informed decision making.

Climate change and consumer behavior: Adaptation Strategies based on Adaptation Intention

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Climate change will lead to new environmental conditions in many alpine winter sport destinations. Even if the motivations of the visitors remain the same climate change will inevitably influence their behavior. At the same time, tourism destinations try to influence visitor behavior by implementing adaptation strategies and offering new products. The adaptation intention is influenced by several framing conditions, such as the social discourse on climate change, presented adaptation strategies and incentives:

- Stehr and von Storch (1995) highlight the challenges for consumers to understand the topic of climate change and its possible consequences.
- Previous research on alpine skiing has discussed various mitigation and adaptation strategies for ski area management. According to Unbehaun et al. (2008) ski destinations may consider to: (1) invest into technical adaptation such as artificial snow-making, (2) offer non-snow dependent indoor and outdoor activities, and (3) invest into an all-season tourism product.
- Potential tourists are informed about these strategies as well as marketing incentives by respective tourism regions. Famous examples are the promotional campaign based on the "snow guarantee by Frau Holle" by the province of Tyrol, which emphasized the enormous snow making capacity in the region during the 2009/2010 season. An individual region's adaptive capacity may also include incentives and special offers such as a rebate for early bookings.

While all these factors influence the visitors' decisions, the exact role and the relevance of the discourse, the various adaptation strategies or the incentives for the consumer are still rather unclear.

Against this background we developed an adapted "Model for Proactive Tourist Adaptation to Climate Change" (based on Grothmann and Patt's, MPPACC, 2005) which is helpful to understand the influencing factors and the individual decision making process towards adaptation intention. In this context the alpine destinations are facing two main challenges: tourists encounter a rather unique decision context, as their decision to visit is completely voluntary, and predicting visitor reactions to climate change enters uncharted waters, i.e. the clients have not encountered these situations before.

In order to illustrate the advantages of a consumer oriented approach we applied a choice experiment to a winter sport destination in Austria. The applied decision support tool adapted to needs of destinations and entrepreneurs identifies in several examples opportunities for directing their demand even under conditions of climate change. This approach seems to be suitable for a proactive destination management under the conditions of climate change.

Grothmann, T. and Patt, A., (2005), Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change*, 15:199-213.

Stehr, N. and von Storch, H., 1995. The social construct of climate and climate change. *Climate Research* 5: 99-105. Inter-Research.

Unbehaun, W., Haider, W. and Pröbstl, U., (2008), Trends in winter sport tourism: Challenges for the future. *Tourism Review* 63:1, 36-47.

Destinations as place development in Norwegian mountain areas?

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Norway has seen a significant growth in second homes development in mountain areas the last decades, based mainly on access to skiing activities and preferable alpine skiing. An important part of this process is the emergence of “mountain recreational villages”, intensively developed in resortlike agglomerations including hotels, apartments, second homes and accompanying service functions. Most of these new villages are spatially separated from existing rural settlements, while first generation’s tourist destinations normally became integrated in existing rural settlements. The purpose of this paper is to illuminate planning processes for destination development and place development in mountain recreational villages, and to discuss how these processes could be improved by focusing mountain recreational villages as places.

Main approach in the paper is theoretical and based on concepts about places, master planning for tourist destination development and municipal planning for place development. There exist two main concepts of place. First, place as a location, which sees place as principally a closed material framework in which economic and social processes unfolds. The second concept emphasises that places must be defined on basis on how different people subjective experience and are attached to the place in different ways, their “sense of place”. Places are open and related to other places through mobility. These two understandings are not mutually exclusive, and we will argue that development of destinations would be improved by applying the concept of places as subjective, open and relational.

The tourism industry presents its wishes for destination development through so-called “master plans” for their activities. Such “master plans” are comprehensive plans with strong focus on adaption to tourist markets and on economic development. Norwegian municipalities are, according to the Planning and Building Act, committed to make municipal master plans including a social as well as a land use element including the entire municipality, often more detailed for defined parts of the municipality. These plans are often conducted applying a place development perspective, focusing urban design and participation from the inhabitants. Place analyses are important instruments in these processes, both in a physical, social and cultural understanding.

The two planning processes have in common that they often are concerning the same area, the place, and they both usually build on a narrow and one-dimensional understanding of the place. The concept of place is seldom discussed, and “inhabitants” is used as a common category, although most of the mountain recreational villages have three different stakeholder groups: inhabitants, tourists and second home owners. These groups could have fundamental different demands to place development, but not necessarily conflicting. We will state that higher attention of the concept of place in the planning processes and better coordination and cooperation between the tourism industry’s master plans and the comprehensive municipal planning processes, certainly will improve the place development processes.

The Individual and the Perception of Conflict, Communication and Consensus at Mountainous Protected Areas in Iceland and Japan

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The research takes a human perspective of stakeholders on issues related to mountainous protected area management and presents a communicative model to manage conflicts and create consensus. A closed questionnaire is used to evaluate the opinion of stakeholder concerning the themes of conflict, communication, and consensus.

The main survey in this research focuses on the Daisetsuzan National Park in Japan and the Vatnajökull National Park in Iceland with the aim to formulate a suited conflict management approach that can be used in protected area management in general. This research has been presented as a part of the M.Sc. thesis (1). The explorative survey in this reserach builds upon researcher’s method of “3C’s” (conflict, communication, and consensus) as a possible technique in PA conflict management. The statements in the survey try to examine the subjective relationship of the self and life, as Abt described (2), and incorporate the four realms defined by Jónasson (3) in order to access the human perspective of the stakeholders’ perception of the 3C’s.

The findings suggest that despite difference in cultures a communicative approach to conflicts in protected area management may support forming consensus regarding the issues at stake. The results of the survey showed that in 31 of 37 cases (83,8 %), participants in the survey answered similarly to statements concerning the 3C’s (CONF, COM, CONS) in the perspicive of the four realms (intra-, inter-, supra-, and transpersonal) (see Figure 1).

References

- (1) Schaller, H. (2010). Dealing with Volcanic Terrains: Conflict, Communication and Consensus Building among Stakeholders of Protected Areas in Iceland and Japan. Magister Scientiarum, University of Iceland Reykjavik. Retrieved from <http://hdl.handle.net/1946/6328>
- (2) Abt, T. (1989). Progress Without Loss of Soul: Toward a Wholistic Approach to Modernization Planning (B. L. Matthews, Trans.). Wilmette: Chiron Publ., U.S.
- (3) Jónasson, H. I. (2005). In a land of a living God: The healing imagination and the Icelandic heritage. (Unpublished Thesis (Ph.D.), Columbia University, New York.

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Oral presentation by Dr. Hautur Ingi Jónasson

Investigation Concerning the Evolution of the Term “Comfort” in Contemporary Alpine Consumer Architecture

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The increase in the human conception of comfort is a central moment for each progressional process of civilisation. Therefore - on the assumption that our society system requires structural and ecological corrections – an ethically characterised approach to comfort offers can provide possibilities to influence the system for a more sustainable society. The aim of the current investigation is the definition of dependence between space and production of needs, or in other terms: In what respect are the needs of consumers a function of the spatial, social and cultural context? Do humans in different social environments change their respective consumer behaviour because their needs are changing? Is this knowledge a model for a new sustainable economy?

The reference chain of progress, production, need, consumption and comfort represents an oracle of the modern society. If terms such as “reduction” and “retraction” determine our future actions, this also means a lowering of the comfort shaped by technology and capital. And it also questions the paradigm of capitalism in its current form. Therefore, the distribution centres of goods and services will be the crucial scenes for the future orientation of society. They are the Cambrian of the system. Only those who reinvent themselves will survive.

The investigation highlights various forms of consumption, in the catchment area of an alpine shopping mall. The principle of Joseph Schumpeter's “Creative Destruction” thereby finds its physical evidence in the evolution of capitalistic consumer-architecture. The evolution of the

type is primarily shaped by aspects of comfort and the mass. Both terms are parameters, which, capitalistically regarded, depend on the degree of mechanisation and standardisation. These regularities are the subject of the investigation.

With the aid of field studies, consumption areas are recorded and examined for their comfort offer.

In the process the study is distinguished in 4 different forms of consumption: urban, rural, mobile and electronic onsumption.

The aim of the study is to create a catalogue that documents the mechanisation degree, the contextual integration, the social environment, the scale, the global interdependence and finally the comfort offers of the compared alpine areas.

Virulent lifestyle phenomena, such as “karma consumption”, “LOHAS” or “flashmobbing”, are also taken into consideration with regard to their sustainable effectiveness.

Partners:

Field study “Urban“: Shopping Mall DEZ in Innsbruck, Austria

Field study “Rural“: “Grown Mall” of Malles, Italy

Field study “Mobil“: Service Areas at the Autostrada del Brennero, Italy

Field study “Digital“: E-commerce-Space

The Alps: creative summits or fanciless valleys? Culture and creativity as potential drivers for regional development in alpine border regions – The example of the “Alpine Rhine Valley”

J. Scharting

Due to globalization processes, towns and regions are experiencing intensified global competition. “Soft” location factors such as education or the natural environment are becoming increasingly important. Especially, factors like culture and creativity influence the regions and form innovative and creative milieus. These milieus are “breeding grounds” for technical and social progresses and generate images of cities and regions, which strengthen their positioning in the global competition and attract highly qualified employees.

These developments also affect the Alpine arc in many ways. The Alps are increasingly becoming influenced by and depended on the non-alpine metropolitan areas, such as Munich, Zurich, Milan or Vienna (cf. Bätzing, Borsdorf). In order to prevent that the alpine regions split up into suburban areas of these metropolises, it is important to maintain their alpine identity. Developing creative milieus and strengthening cultural networks are possible strategies to hinder this process and to support sustainable regional developments. At this stage, very few studies exist concerning cultural and creative industries in the alpine space. Therefore a lot of questions have to be answered concerning the future management of alpine regions: can a creative class (cf. Florida) arise in alpine regions? Which contribution can culture and creativity make to a sustainable development in the Alps? And how can its creative capability be strengthened?

This paper for the “Managing Alpine Future II International Conference 2011” deals with first results of a doctoral thesis, carried out at the Geography Department at the University of Innsbruck. The aim of this thesis is to figure out the relationships between culture, creativity and regional development in an alpine border region. Furthermore the dissertation seeks to

develop visions and strategies for a sustainable, cultural development. Related to the “Alpine Rhine Valley” (Liechtenstein, Switzerland and Austria) as investigation area, the research interest focuses on four main questions:

- How do culture and creativity influence space and how does space affect culture and creativity?
- Which actors influence the creative milieus and for which purpose? Do any transnational cooperative efforts or social networks exist?
- How does the external frontier of the EU influence the creative milieus?
- What are the cultural potentials for a sustainable development / a creative environment and which conditions have to be created to succeed this?

In the theoretical part of this paper these reflections are integrated into the concepts of regional governance and sustainable development. Direct and indirect effects of culture on regions are analysed as well as opportunities and barriers of cooperation in the cultural field. Subsequently, methodological considerations are presented. The dissertation proposal uses diverse methods of empirical regional research. In the sense of a regional governance approach, different actors and actor groups as well as their influence on the region are focused. Finally, the paper presents initial results of empirical studies in the border region of the “Alpine Rhine Valley”. The four main research questions concerning relevant actors, the influence of the frontier on creative milieus and cultural networks as well as the cultural potentials for a sustainable development will be answered.

New Demographic Developments and their Cultural Impact on the Italian Alps

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After WWI the Italian Alps were characterized by a massive depopulation that lasted well into the 1970s. While in-migration until a few years ago concentrated mainly around central Alpine areas, now more and more municipalities in the Italian Alpine region show in part remarkable influx and thereby population gains. These newcomers (amenity migrants) – representing “urban refugees” from outside the Alpine region – influence the local culture, not least with regard to the seven linguistic minorities that are settled in the area. This results first and foremost in the disappearance of the minority languages in everyday life, and the maintenance of the ethnic diversity is seriously threatened.

Dimensions of Demographic Change. Challenges for the Alps.

Axel Borsdorf, Innsbruck

Population is the main driver of any spatial development. The dynamics, structure and distribution as well as the mobility influence the economical, structural and ecological change everywhere, and therefore in the Alps, too.

Based on alpine-wide data, gathered, harmonized and aggregated in the DIAMONT project (Alpine Space I) it will be shown, that demographic change bears dangers and opportunities. Aging, marginalization of remote areas, urbanization of the valleys and societal change are the main challenges for policy and planning. Following the vision of the European Spatial Development Perspective (ESDP) to realize polycentric and balanced urban systems together with an urban-rural partnership also in the Alps it will be asked if the Alps are well prepared to such a policy and how a theory-practice discourse on these principles can be realized.

The Landscape-language Relation in the Raetho-Romanic Alps: A factor Producing and Developing the Territory

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proposal for an oral presentation.

Through a transdisciplinary approach, the paper analyses the relationships between the logical structures of the local language of the Romance Alps and the organisational structures for inhabiting the mountainous structure of this Alpine landscape. The aim of the paper is to focus the imagination of the territory imprinted in the local language as a factor producing a territory on the one hand, and the interference between its representations from inside and from outside as a factor capable to orienting its development on the other hand.

Brief description

Contemporary landscape studies call for new and original interpretations allowing a direct and profound approach to perception and building practices of a specific space. Thus there could be no better analytical tool than the local languages. There is in fact a close link between the mental representation of space where a population live and the representation of itself. The identity of a landscape is given, first, from the domain of the space where you live, put to use through practices whose efficacy is validated by experience. This fact stands very clearly in the territories inhabited by cultures of oral tradition: language and space exist and make sense only if you “practice” them. Speaking the local language is like to put in place a process of representation of space, which is fed by the projection of oneself on the territory. This virtuous circle between spatial representation and self-representation is a real process of production of the territory.

The main objective of the paper is to clarify the exact analogical relationships between linguistic and landscape structures typical of some Alpine areas inhabited by Rhaeto-Romance language minorities. The valleys in the Dolomites provide an excellent case study in this context. In fact we find a language here with a predominantly oral tradition, the expression of a very strong material culture which is however identified with a territory and a population totally immersed in the contemporary world. The premise of the study is the hypothesis that the nature of relationships created by language is the same as those developed by the settlement culture. To prefix, name, determine/terminate and geo-refer are the four relationship strategies with space implemented by the logical structures in speech and by the organisational structures for inhabiting the landscape. There is in fact a close analogy between these relationship “experiences“, but the catalyst that causes them to interact is the strong symbolic meaning - individual and collective - that is continuously projected onto the landscape. The Rhaeto-Romance settlement culture is thus imprinted on its language and its landscape in the same way.

The research is conducted with the collaboration of the linguists of Lia Rumantscha and of the Ladin Cultural Institutes of Trentino and Südtirol.

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Do We Need Gender Equality for Sustainable Regional Development?

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At the beginning of the 21st century, challenges for rural areas in Alpine regions have risen as a result of young women obtaining very good qualification levels. They tend to leave regions that do not provide adequate job opportunities or they refuse to return to these regions after having completed higher education. One of the consequences is a growing “surplus of men” in the important age groups for forming partnerships and starting a family. Austrian experts participating in a DELPHI

study within the INTERREG IIIB Project DIAMONT were much more sceptical about the cultural and socio economic than about the ecological sustainability of the Alpine regions (Bender 2006). A similar tendency has been registered in Italy. The Trentino is the Italian region with the greatest male/female imbalance (Zucca 2006). Environmental economist Alessandro Gretter concludes that without women it will be almost impossible to prevent the depopulation of mountain villages, all the more so as women are more interested than men in training that is useful for sustainable development (Gretter 2007).

Financial support alone does not seem to account for the unbalanced demographic patterns, sociocultural aspects seem to play a role as well (Zucca 2006). Lars Keller (2006) developed 50 indicators to compare quality of life in the Alpine region. They measure economic strength, employment, biodiversity and environmental protection, as well as health, leisure and gender equality. He is convinced that gender equality has to be taken into account if we want to

avoid half the population feeling disadvantaged and looking elsewhere for more congenial circumstances. In the Alpine regions gender relationships are still hierarchical but there are egalitarian tendencies: in spite of the patriarchal designs for succession and the dominant ideal that men strive to attain, anthropologist Sylvia Yanagisako (2002) found an increasing number of daughters in management positions in the Como region silk industry, Italy. In the ARGE ALP countries (Arbeitsgemeinschaft Alpenländer) the traditional division of labour into male breadwinner / female housekeeper has weakened as women’s participation in the labour market has increased. At the same time women still have to carry the main load of house and care work. There are however indications for hope that the contradictions and conflicts which exist between the postulated equality of men and women in the workplace and the way families actually organize themselves will decrease (Appelt/Jarosch/Resch 2003).

Given the increasing uncertainties of a globalized economy, the paper will discuss

- if the identified gender equality tendencies are at risk;
- if there exist measures on a regional level to realize the EC Women’s Charta 2010 on building a gender perspective into all policies;
- which other available resources might contribute to the quality of life in rural areas and as a consequence would also secure endogenous regional development.

Applicability and Appropriateness of Hazard Prevention in Mountain Areas Hazard zone planning in the Autonomous Province Bolzano South Tyrol

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In the Autonomous Province Bolzano South Tyrol, Italy, situated in the middle of the Alps, 86 % of its provincial area is located above 1,000 meters above sea level. Of the 109,767 ha (14.8 % of the total provincial area) potentially appropriate for permanent settlement only 733 ha cannot be considered due to the potential event of avalanches and hydro-geological hazards. This and other restrictions are reducing the potential permanent settlement area to 48,814 ha. From those 21,096 ha are currently settled. Due to the geomorphology and the high relief-energy in mountain regions people are exposed to danger by flooding, avalanches, landslides, or rock-falls, strongly varying in their intensity and frequency. To protect people and infrastructure facilities better, the regional government is currently introducing Hazard Zone Plans (HZP) for municipalities. It represents a spatial planning instrument that overrides the currently applied Urban Land-use Plan (ULP) in terms of hydro-geological threats. Existing instruments, tools and databases from the involved authorities (torrent control, civil protection etc.) are used and implemented in the HZP. For South Tyrol the impact of the HZP on Climate Change (CC) and vulnerability in settled areas was analysed within the Alpine Space Project CLISP – CC Adaptation by Spatial Planning.

The paper introduces the applicability and appropriateness of the South Tyrolean HZP. It

describes the technical, spatial and bureaucratic consequences for municipalities and focuses on conflicting situations and economic restrictions for affected home owners and proprietors due to the delineated hazard-zones. Using guided interviews, quantitative evaluations and qualitative estimations from experts could be obtained. Awareness raising, technical and legislative possibilities for CC adaptation, its flexible and efficient applicability as well as the legal character and optional recommendation were assessed. In combination with the already elaborated guidelines and principles for implementing the HZP, different statements could be derived regarding its strengths and weaknesses.

Although the delineation of hazard zones may have negative impacts for several proprietors and home owners that may initiate conflicts, the HZP is a valuable instrument. As hazard zones with higher degrees of vulnerability are facing higher construction and servicing costs, it forces authorities to apply appropriate spatial planning strategy. Thus communal-decision-makers benefit from the HZP guideline. It helps them to communicate the objectives of the HZP and ULP to citizens, who are not able to assess natural hazards as they think in different time periods or cannot imagine their spatial extents.

Communication in Alpine Risk Governance: Unifying Internal And External Perspectives: Hazard Zone Planning in the Autonomous Province Bolzano South Tyrol

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The contribution of Christian Hoffmann, European Academy Bolzano, introduces and assesses the applicability and appropriateness of the currently applied Hazard Zone Planning (HZP) scheme in South Tyrol. To reach a holistic view, this contribution adds further perspectives on the topic of applied risk governance.

Communication amongst all involved actors is the key element for collaboration and realization of any complex project, particularly in risk governance. Our study focuses on the combination of internal and external communicative aspects in HZP. The Goal of our study is the assessment and further on the improvement of the practicability and feasibility of communication structures in HZP in order to raise its acceptance, satisfaction and efficiency. This should result in lower risk in long term.

The results are derived from data of two interconnected surveys covering all levels of communication in HZP. This unifies the multiple actors' perspectives. Data on internal communication - the experts view - is derived through participating observations of 13 coordination meetings among representatives of municipalities, provincial administration bodies and civil engineers. The general public is the final target group of HZP. They are in the end affected by its consequences on the ground. A standardized questionnaire was applied in eight communities on more than 400 persons to assess the external - or laymen's - sight on the HZP scheme. Several findings are obtained by the comparison of both perspectives: Essential factors for information and participation are acquired; communication channels to overcome the "last mile" are identified and the feasibility of participative elements in HZP is assessed. The overall status quo of communication in HZP is carved out by identifying similarities and distinctions of the different perspectives of all involved actors on the same topic. Based on the identification of hindrances and development goals in the area wide application of the HZP a comprehensive communication concept is developed. This helps tackling and overcoming the challenges in the practical application of a sophisticated risk based planning concept on the ground, such as the HZP scheme.

Integral prevention of natural hazards thanks to the compulsory building insurance

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Prevention is better than cure. Forest, space planning and protective systems are the three pillars, which support the building insurance against elementary damage in favour of the population.

The prevention of natural hazards is the most important issue for the building insurances for the next years. A rise of elementary damages is the result of climate change and an increasing sealing of the soil.) The SWISS umbrella association of the real estate insurance designs has developed a comprehensive elementary damage protection concept. An action plan helps to support communication, incentive schemes, engineer standards and their law implementation. In the canton of Graubünden the real estate insurance company coordinates the prevention efforts of the different administrative departments as the office for space planning, the department of forests, the bureau for natural hazards and the department of civil security with its requests.

The prevention of natural hazards is a public law duty since only the public can embrace such a job integrally. "In elementary prevention every individual acts very differently based on his own hazard conditions, different assessment of his prevention and the requirement to assure. If the elementary damage assurance would be optional, the alpine inhabitants for example would tend to assure for avalanches, but not for flash floods and the inhabitants of the valley would tend to do the opposite, which would lead to a lack of solidarity. We can see the result of such conditions in countries with free choice of assurance where in endangered regions you only get very expensive or no insurance coverage at all. The consequences are high premiums and deductibles as well as lack of coverage up to market failure and subsidiary state liability. Without public constraint (pressure) the elementary damage prevention would degenerate also to an individual instrument of prevention without social solidarity" (Dr. M. Fischer, alumnus president of VKF, Swiss confederation of real estate insurances)

Our recipe for integral natural hazard management is best shown by the building insurance triangle, consisting of prevention, intervention and insurance. From the view of an insurance company low premiums seem to negate high security. Prevention, intervention and insurance have a positive interdependency only possible on a market with special monopoly and compulsory positions. In order to fulfill our legal mandate of "protect and insure" we are required to prevent damages by putting in place elementary damage protection and to consult and set up consultations. In case of natural events our fire departments rescue people and try to prevent or at least keep damages as low as possible. Even though the canton of Graubünden features some special circumstances such as buildings made of wood and urban sprawl, our policyholder have to pay the fifth lowest insurance rates in the whole country. Compared to private insurance companies, which obtain real estate insurance in seven Swiss cantons, the rates for our policyholders are just as high as 50 %. This fact is the result of the excellent work of our experts and fire fighters as well as the low administrative expenses, which are only possible because there is no need for expensive sales and marketing activities.

In addition to the widely spread land use regulation and efforts to prevent natural hazards by the public authorities also support keeping elementary damages low at all time. Because of the climate change and an increasing sealing of the soil it has to be taken special account to the elemental prevention area yet. All Swiss real estate insurance companies are currently working on the implementation of a comprehensive concept to prevent elementary damage. That is why the real estate insurance authority of the canton of Graubünden (GVG) is working hard to keep the idea of an economic precaution at a high level.

Climate change impacts in the Bolivian Andes: from water shortage to human displacements?

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This research explores the impact of climate change on population migration in the mountainous regions of Bolivia. In the Andean region, one of the most noticeable effects of global warming is glacial retreat. Significant acceleration in glacial melting has been observed since the 1980's, and it is predicted that many low-altitude glaciers will disappear completely within the next ten years. One of the main consequences of this process is a decrease in water supply due to the reduction of glacial runoff, especially during the dry season. Glacial runoff is vital to the region, supporting local ecosystems as well as providing drinking water and water for farming and energy production. At the moment, mountain communities are facing seasonal water shortages, which threaten the livelihood of their inhabitants. Migration is often chosen to cope with these worsening conditions. Despite the interest in the connection between climate change and migration over the last twenty years, the amount of empirical research on the issue remains limited. The term "environmental refugee" has been widely used in both political and academic contexts which has given rise to numerous debates amongst academics. There are uncertainties concerning the actual mechanisms at play, the number of persons affected, and the geographical zones concerned. The main debate is taking place between those who stress the direct impact of the environment on population flows and those who rather insist

on the social, economic, and political contexts in which such flows occur. Different disciplines bring in their respective inputs to the literature. This study provides insights about the nexus between climate change and migration in Latin America, with a special focus on the mountainous region of the Bolivian Andes. In Bolivia, migration as an "ex-situ" adaptation strategy may help to lessen household's vulnerability by diversifying the sources of income, but it may also induce some adverse effects. In the community of origin, the most vulnerable (old and very young persons) are left behind, leaving them more dependent on the income of the migrants. In the destination area (major cities), neighborhood conflicts can emerge between residents and arriving migrants. Competition for land, jobs, and/or access to services can aggravate social tensions. These processes must also be considered in the specific Bolivian context where climate change issues are particularly politicized. We assess these migration processes and challenges mainly through qualitative methods, using semi-structured interviews and questionnaires with migrants, nonmigrants and experts. This information provides a better understanding of the interactions between environment and migration, thus allowing governments and civil society stakeholders to develop appropriate legal and policy frameworks.

Land Use Change in Yaylas of the Eastern Black Sea Mountains, Turkey

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Turkey is a generally mountainous country, lying in Mediterranean segment of Alpine orogenic belt. The Eastern Black Sea Region with mountainous shoreline has a population of 2.6 million people and covers a land area of 39,203 km² - 5.1 % of Turkey. The Region has high altitude with rough terrain and limited agricultural activities and large number of yaylas (Yayla: a temporary settlement in mountain pastures; plural: yaylas). Therefore, animal husbandry and transhumance has become an important economic activity in this area since long time. However, a great increase in tourism activities and seasonal amenity migration has been observed in these yaylas especially since 1980s onward. The yaylas once primarily used by local people as mountain pastures in summer for grazing activities until the 1980s have now been used for recreation/tourism purposes and turned into holiday resorts. The aim of present study is to evaluate land use change in the yaylas of the Eastern Black Sea mountains during

years of 1973-2004 and to highlight resultant risks on ecosystem. For this purpose, four different types of sample have been taken based on research in 30 yaylas from three provinces of the Eastern Black Sea Region. Land use change in the yaylas has been evaluated using aerial photographs analyzed by application of geographic information system (GIS) and maps of each yayla (for the years 1973 and 2004) have been produced. As a result of the analysis it has been determined that the number of houses in the yaylas has increased by 152.5 % (from 5322 to 8116), during years of 1973-2004. A significant increase has also occurred in road network in the yaylas during the same period. The road network has increased by 137.3 % (from 375 km to 515 km). As a result of these changes mountain pasture ecosystem is being underpressure with the passage of time. Also, these changes in land use of yaylas have economic and social effects. Therefore it is necessary to formulate adequate policy to overcome this issue.

The “Charter of Rosengarten”. Lobbying for stronger landscape policies

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The paper discusses a case-study in the Dolomites.

The Rosengarten mountain represents one of the ‘icons’ of the Dolomites. Its reputation of exceptional beauty is universal, as thousands of people testify coming from all over the world to visit it every year. However the fame of the area is also its greatest enemy: in fact a progressive consumption of the place is evident, not only physical but particularly cultural. The access of mass tourism to high altitudes opens spaces to the consumer society which were originally perceived to be ‘mystical’ places, full of symbolic meanings. The substitution of a rural-alpine culture, intimately linked to the places and of necessity the expression of a local system, by a tourist-entrepreneurial culture, which by definition is imported and refers to a global economic system, leads to a trivialisation of use, an impoverishment of the symbolic meanings and therefore to a general wearing down of the places. The local people perceive that the excessive specialisation in tourist activity in the area risks weakening the strong tie – physical and mental – which determines the sense of belonging that they have with their territory.

The “Cordanza per l Ciadenac” (a local expression that means “Charter of Rosengarten”) born of this need of cultural reappropriation. It is a written agreement that involves all the stakeholders whose have responsibility on the region: majors, community organizations, collective properties, alpine clubs and the main representatives of the economic categories (e.g. cableway managers, hotel and refuge owners, farmers, tourist operators, etc.). With this agreement all the interested parties commit themselves to cooperate to put in place a shared plan for the

sustainable development of the Rosengarten mountain. This plan, as a result of the Charter, is in fact promoted and implemented through a bottom-up participatory process and has the aim to provide local people an additional instrument to get more bargaining power against the political decisions concerning the landscape of their mountain region.

The so called “Rosengarten Landscape Plan” interests in fact the whole dolomitic massif, which is a cultural interface between the Ladin (an ancient Alpine-Romance culture) and German world and the entire region of Vajolet Valley. It aims to create a local tourist model with a strong identity (through interventions of landscape governance, regeneration and interconnection of open spaces, and redemption of the Ladin cultural matrix), capable of attributing new contemporary meanings to one of the most famous mountain landscapes in the world. In order to make that, the project has focused in particular on the definition of the “cultural carrying capacity” of the area, through the implementation of methods already in use in similar situations (such as VERP, applied in the Yosemite National Park).

The Plan is developed by a working group made of planner, landscape architects, geologists, forest and natural scientists, the mayors of the communes and all the representatives of the collective properties and of the economic categories. The authors are the scientific coordinators of the working group.

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Participation in Mountain Forest Management and its Impacts – Possibilities and hindrances of group building processes within and along participation groups

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Participation of the public in decision-making processes in environmental planning has been growing in importance, particularly for complex and controversial projects. Constantly changing ecological, economical and social conditions mobilise the increasingly individualised society in making its voices heard in public decision-making. Recently, the terms like “risk dialogue”, “sensitive land management” and the need for “self responsibility” entered the natural hazard management arena. Especially, mountain forest management is increasingly confronted with the challenge of handling a plurality of interest groups and their claim on mountain and alpine forests. Examples are the increasing heterogeneity of forest owner interests (higher percentage of forest owners without farming background), intensification of recreation use and new modes of nature conservation (Natura 2000). Sectoral programs like Hunting plans, Natura 2000 - management plans, protection forest management and torrent control normally ignore these heterogenic und often conflicting interests.

Therefore, Tyrol and Bavaria increasingly rely on common decision-making processes with interested stakeholders to increase the quality of mountain forest management plans. In 2002 Tyrol initiated the “protection forest platform” as a starting point for regional and local initiatives to build a broad cooperative alliance of stakeholders. So far they established 14 local “protection forest partner communities”. In the State of Bavaria the “mountain forest offensive” has started in 2008 to enhance the adaptation of mountain forest to climate change. Several projects have been initiated in private and communal forests not only by applying silvicultural measures but also by solving conflicts with hunting, grazing and tourism.

The established local projects in Tyrol and Bavaria are using a variety of participation strategies, mostly the information and consultation methods are used. Only a few approaches

operate with more intensive and time-consuming participation strategies, where shared power between all participants is the basic requirement for mutual partnerships. To evaluate these matters we first developed a categorical system of participation goals in environmental planning based on literature, which is the foundation for continuative research of participation impacts. In our contribution, we present the results of two case studies in Hinterstein (Oberallgäu) and Oberammergau (Garmisch-Partenkirchen) with a focus on the possibilities and hindrances of group building processes within and along participation groups.

In long-term participation processes trust between the participants develops with an increasing understanding for the interests, values and norms of the different actors. As a result, some participants are influenced by this communication driven participation process, and it becomes possible to build up a new reference group. This group building process is influenced by changes of the membership, which can hinder especially the implementation of group decisions in the continuation phase. The amount of “core group” members decreases and a gradual disintegration process starts, because of losing their experiences and background knowledge about the real participation process. Additionally, new members interfere with the existing group system. Finally, it is not only important to recognise all actor groups and their formal leaders previously, it is also relevant to note the development of the formal leaders’ behaviour during the process and their real power to make decisions which can be influenced by virtual leaders and the information flow within their member groups. Especially undemocratic top-down leading member group systems can get in conflict with the deliberative communication style of the participation group.

The ‚Alpenplan‘ as a Spatial Planning Tool for Steering Development in the Bavarian Alps – a Critical Appraisal

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In 1972, the Bavarian government implemented the “Alpenplan” (AP, Plan for the Alps), thus creating a novel spatial planning tool for regulating land use and infra-structural development in a highly complex environment. Its central objective was to balance the spatial needs of the tourism industry with traditional land uses while keeping large tracts of ecologically valuable Alpine spaces intact.

As part of the “Landesentwicklungsprogramm Bayern” (Program for the spatial development of Bavaria), the AP has since become an integral part of Alpine spatial planning. Increasing land-use demands in the Bavarian Alps, the recent dynamics in the tourism markets and a current debate on the future of spatial planning in Bavaria set the context for a critical assessment of the AP.

In this paper, we analyze the evolution of the AP as a planning strategy in the 1960s and 1970s, and review case studies to evaluate its mechanism in regulating Alpine land uses.

The AP’s central mechanism is zoning the entire Bavarian alpine space (ca. 5,500 sq. km) according to pre-existing land-uses, environmental sensitivity and suitable future development:

- Zone A (1,890 sq. km, 34 %) includes most areas with substantial pre-existing land uses (valley floors, tourist resorts, etc.) and is zoned “generally suitable” for further infrastructure development (e.g. ski lifts). Zone A provides an arena for skiing tourism and other mass-market forms of recreational land uses.
- Zone B (1,260 sq. km, 23 %) serves as buffer zone. Proposed infrastructure projects require an individual review of potential impacts. Most infrastructures required for land uses such as forestry and agriculture are permitted.
- Zone C (2,350 sq. km, 43 %) is designated as protected area generally not suitable for any infrastructural development. Only touristic uses that require few infrastructures are possible in Zone C.

Literature

JOB, H. (2005): “Die Alpen als Destination – Eine Analyse in vier Dimensionen”. In: Mitteilungen der Österreichischen Geographischen Gesellschaft 147. Jg. (2005), S. 113-138.

BAYERISCHES STAATSMINISTERIUM FÜR WIRTSCHAFT, INFRASTRUKTUR, VERKEHR UND TECHNOLOGIE (Hrsg., 2006): “Landesentwicklungsprogramm Bayern”. München

PAESLER, R. (2003): “Probleme der Tourismusentwicklung in Gebirgsregionen – vom Öko zum Event- und Abenteuer-tourismus”. In: Mitteilungen der Geographischen Gesellschaft München 86 (2002/2003), S. 253-269.

SPEER, F. (2008): “35 Jahre Alpenplan in Bayern. Ein genialer Schachzug für den Naturschutz”. In: Alpenvereinsjahrbuch 132 (2008), S. 282-287.

Adaptation strategies in an alpine community – future sustainability and territorial community plans (PTC) in Trentino

C. Orsatti

In the last 40/50 years Alpine communities have been endangered and went through an economic down turn with a decline of many assets. In a time of resource scarcity and material constraints adaptation strategies need to take into account alpine communities' ability to dwell within the territory that has been centenary. It needs to take into account inhabitants' ability to find common strategies for survival to global economic and environmental change in territories where the environment is crucial for survival. It is important communities find rules and ways for maintaining and transforming territorial resources. The territory and its identity are central to the social, ecological, economic sustainability of the alpine peoples living in a specific area. That is why it is important to look at local development practices and the ways in which inhabitants identify with their territory and relate to it constructively in the perspective of a sustainable future. Development models have consequences for social, ecological and economic sustainability and the carrying capacity of systems. The ways in which inhabitants dwell within the territory, their identity in place and space, the ways in which they use, produce and distribute resources and "living" space as a space of existence, inform their future lives. In an age of resource constraints and climate change the organization of present and future living spaces can happen creatively according to sustainable visions and futures. There have been two administrative and political processes in the autonomous

alpine region of Trentino in the last couple of years: the constitution of administrative public local entities with associative structure at a trans-local level: the Valley Communities with political, administrative economic resources and power and the transformation of 6 Councils into a unique stronger Council within one of these associative structure, the Council of Ledro. These processes imply a restructuring of location and boundaries but also the communities rethinking of their identity as individuals and community participants in relation to their own future as inhabitant of the valley and stakeholder of a new Community (whether in the unique Council or the trans-local structure represented by the "Valley Community". The territorial plans of the Valley Communities PTC (which since 2010 had to be done by each of the 14 "Valley Communities" including the Council of Ledro that is part of the Basso Garda Valley Community) are documents with which the new born communities needs to define the strategy for a sustainable development at a sovra council level (not anymore at a council level) through the appropriate use of typical alpine resources. How is this process of adaptation happening? The paper will discuss the ways in which this transformation is happening in the specific alpine context of Trentino and the possibility of facilitating the shift of "boundaries" (not only geographical but cultural) from the level of the council to the level of the sovra council through anthropological tools categories and practices.

Challenges and opportunities for the sustainability of mountain areas in Chile

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Chile is a land of mountains. Its eastern border is formed by the Andes with a range extending over than 4000 km and reaching altitudes above 6000 meters. On its western flank extends the Cordillera de la Costa, which is smaller, reaching altitudes between 900 and 3000 meters. This particular geographic situation implies a series of challenges and opportunities that need to be identified, classified and analyzed in a systematic and transdisciplinary research in order to project plans and programs to ensure the sustainability of these territories.

Mountain areas represent 24 % of the planet's surface and about 26 % of the world population live in or near to them (Meybeck et al 2001). Nowadays, many risks and threats related to climate change are highly perceptible in mountain areas (Price & Neville 2003, Huber et al 2005, Debarbieux & Price 2008) and are major challenges for the sustainability of these areas. These risk are manifested in loss of biodiversity, changes in the cryosphere produced by rising surface temperature, and increased the pressure for land uses (Messerli & Ives 1997; Borsdorf et al. 2010).

To Chile, mountain areas are a key factor from a territorial and geopolitical perspective. The relevance of this type of relief is manifested in several ways: first of all, the Andes influence the human settlement. From an environmental perspective, are source of many environmental goods and services and they are a hot spot with high levels of biodiversity and endemism. From an economic perspective, many important resources and economic activities with a deep impact on the national economy come from the Andes, such as copper mining and the generation of hydroelectric power. From a cultural point of view, the Andes are place of settlement of diverse ethnic groups, such as the Aymaras, Quechuas, Mapuches y Pehuenches (Latorre et al. 2003, Núñez, 2008).

Despite the strategic role that mountain areas play for the country, they received little attention from political and governmental authorities. This situation produces that these areas are affected by many problems, such as sparsely population and slow economic development, which increase its status as marginal areas and constitute an ideal scenario for the occurrence of environmental conflicts that threaten the sustainability of them. This trend is reinforced by the lack of a multidisciplinary mountain research approach. However, in a scenario of rapid and complex global changes, mountain research in Chile must provide adequate knowledge, that allows a better understand of the dynamic and processes that take place in mountain areas.

This research aims to identify "mountain communes" in Chile, in order to analyze the current situation of them in the three dimensions of sustainability: social, environmental and economic. In this sense, it is possible to postulate the existence of different stages of development and dissimilar levels of sustainability. The identification and analysis of these differences is the key to create, promote and implement plans and programs that can benefit these territories and/or neutralize the negative trends existing or future. Methodologically, a definition of "mountain communes" was elaborated according to the Chilean reality, considering physical and anthropogenic factors. Subsequently, a set of sustainability indicators was defined, in order to characterize the current status of these key factors in these municipalities. Finally, challenges and opportunities for each mountain commune were identified.

Designing sustainable pathways: The case of the Scottish Hebrides

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Many rural peripheries throughout Europe, many of which are mountain landscapes on the inner and outer fringes of the continent, up until recently have been regarded backward, underdeveloped, and shrinking, and thus have been classified rather homogenously as “losing areas” within the context of spatial development at large. However, as rural areas presently are undergoing significant processes of structural change, including economic, social, cultural and political adjustment in the context of globalisation, a much more diverse picture of rural peripheries in Europe is emerging.

The archipelago of the Hebrides west of the Scottish Coast provides an outstanding example of recent restructuring of a “classic” European periphery. Against the background of an ecologically fragile mountain-seascape the population of the islands finds itself increasingly involved in fundamental debate about appropriate ways of sustainable future development. Not least contrary to original suggestions for large-scale development (e.g. wind farming or mineral resources extraction) many development projects particularly address the natural assets and the cultural traditions of the islands. Local land-ownership, community businesses, and participatory planning appear to be decisive “tools” for the design of sustainable pathways as indicated by an increasing number of promising projects.

Mountain forestry – challenges

Robert Jandl, Forest Research Center Vienna

The maintenance of stable mountain forests is crucial because they achieve numerous ecosystem services such as soil stabilization, protection against natural hazards, carbon sequestration, conservation of biodiversity, and serve as important income-source for their owners. Multiple environmental and socio-economical developments challenge forest owners in deciding how mountain forests are to be managed in the future. For instance, climate change is expected to increase forest productivity due to longer growing seasons. However, potential threats such as migration of bark beetles to high-elevation ecosystems and extended drought periods call for more intensive forest management. We present modeling results for different forms of forest management under different climate scenarios and estimate the associated efforts (costs) required for forestry. Based on the estimate we will scrutinize whether the traditional view of forestry providing abundant public goods is still valid or whether a substantial deviation from this paradigm needs to be expected.

Forest Fire Research and Management Options in Austria: Lessons Learned from the AFFRI and the ALP-FFIRS Networks

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An increasing probability of forest fires in Austrian alpine ranges, as hypothesized by Gossow et al. (2008) at the first conference “Managing Alpine Future”, could meanwhile better be evidenced for several aspects – thanks to the FWF-supported “Austrian Forest Fire Research Initiative” (AFFRI) and to the EU INTERREG Alpine Space supported project “Alpine Forest Fire Warning System” (ALP-FFIRS). In this contribution the lessons learned from both interdisciplinary forest fire research projects for fire management will be presented. An important prerequisite for the intensified forest fire studies in Austria was an improved documentation of such events. Fire record data were some years ago still rather incomplete and biased (for instance, with respect to fire damage compensation claims). Since 2002, the Austrian fire fighting brigades started to document their fire attacks on their web sites, which improved data access more general. However, the causes of ignition are often unknown. Like elsewhere, also in Austria anthropogenic forest/wildland fire causes are dominating. But also naturally ignited forest fires, predominantly by lightning strikes, play a remarkable role – up to 40 % in the summer months in the last decade on average. These findings are most relevant in the three (so far) evidenced forest fire “hot spots” in Carinthia, Lower Austria, and Tyrol as well. Fire ignition depends often on specific fire weather windows and on fuel conditions respectively: there are years with more spring fire probability, and years with more summer fires; 2003

offered both. In adapting existing modelling approaches for Central European conditions the mountainous topography requires particular attention to a spatially explicit prediction of fuel load, besides other important fuel characteristics such as load, bulk density, fuel particle size, heat content, and moisture of extinction. However, the data sources for this characterisation are often limited which reduces the chances for prediction. Additionally the interpretation and communication of fire danger warning levels based on fire weather indices (FWI) are critical for fire management activities and raising awareness of the public. A number of indices have been developed so far, and many of them are currently applied in operational conditions. The research activities aim to identify appropriate approaches for calculating FWI and characterising fuels in different eco-regions of the mountain forests. They will serve as a basis for the further development of a fire hazard model for mountain conditions taking into account the complex interactions between weather, vegetation, topography and socio-economic factors. Based on these and future findings, we will support involved fire fighting brigades with more accurate information about fire intensities and fire behaviour. Consequently foresters in hot spot areas should become more interested in prophylactic measures focusing on silvicultural and technical measures in order to reduce the susceptibility of mountain forests.

AlpFUTUR – an inter- and transdisciplinary research programme on the future of summer pastures in Switzerland

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Introduction

Alpine summer pastures are a distinctive feature of the cultural landscape of many European countries. In Switzerland, they make up about one third of the agricultural land, contribute to farm income and provide public goods. Available data indicate that land use of alpine pastures continues to develop in contrasting ways, with intensification and either extensification or abandonment. Future development of Alpine pasture use and the consequences for, e.g. the prevention of natural hazards or the diversity of cultural landscapes and species, is investigated in the inter- and transdisciplinary research program-me AlpFUTUR, which runs from 2009 until 2013. Its 20 coordinated research projects address socio-economic, agronomic and biological research issues in six test regions covering the major geographical and socio-economic regions of Swiss summer pasturing. AlpFUTUR is accompanied by an advisory board with 20 representatives of major mountain farming stakeholders.

Objectives

The aim of AlpFUTUR is to show prospects on the future use of Swiss alpine pastures for the next 10 to 40 years. AlpFUTUR will assess the need for potential adaptations of policy measures: Is there need for more, less or other incentives and controlling measures? It analyses costs and operating efficiency and proposes improvements for the economic effectiveness of summer pastures: Can profitability be increased by innovation, better marketing or new management practices? AlpFUTUR estimates the future demand for summering: How many and which kind of livestock will spend the summer in the alpine zone? What is the position of private and common property owners? Will there be enough competent and motivated staff? Finally, AlpFUTUR evaluates cultural landscape values of summering pastures and focuses on their future use: How will summering pastures develop? How are the current developments perceived and how can public expectations be met?

Results

First results indicate that summering is not only economically driven, but highly motivated by tradition, livestock and reliable staff. Subsidies help to maintain summering, although they have little influence on the ongoing bipolar development. Possible developments described in various scenarios can be referred to when defining the objectives of policy strategies. Production of cheese on site is often more cost-effective than bringing the milk to the valley. A number of summer farms produce certified and value-added “alp cheese” and direct selling is common for distribution of alpine dairy products, even though in small quantities at a time. Additional economic potential is assumed in offering tourism services on summer farms. Further results will be available by the end of 2011.

Conclusions

The regular exchange between project collaborators allows us to gather profound knowledge, co-ordinate ongoing activities, develop common scenarios and exchange available results, which are continuously integrated in ongoing research. A book synthesising the findings of the individual projects will be published and the major findings will be made available for a larger public in a film. Practical results will be elaborated in individual projects, such as recommendations for improving the quality of pastures or best practice examples for introducing new products from alpine summer farms. Policy analysis and recommendations will be made available directly to the local and national administration.

Land use and biodiversity: an indicator-set supporting sustainable development

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The main aim of the Convention on Biological Diversity (CBD), adopted by nearly all nations worldwide in Rio de Janeiro 1992, is to stop the world wide biodiversity decline. Nearly twenty years later this aim is still far from being reached. The European Alps represent one of the most diverse regions on Earth due to the complex topography with wide bio-geographical gradients and a long lasting history of manifold anthropogenic land use. The sustainable use and protection of the natural resource biodiversity in this region is not only a desirable aim but at the same time a tremendous social and political challenge.

The trans-disciplinary project “A toolbox of models of a sustainable economy”, which is a cooperation between the Austrian Institute of Economic Research (WIFO), the University of Natural Resources and Applied Life Sciences in Vienna (BOKU), the Institute of Ecology at the University of Innsbruck and the Institute for Alpine Environment at the European Academy in Bozen/Bolzano, aims to develop tools that can be offered to stakeholders and decision makers aiding to better meet the challenge of sustainable development. One tool developed within this project, is an indicator set related to biodiversity. This indicator set should help to enhance the understanding, quantification and communication of the complex interactions between

anthropogenic land use and environmental or ecological conditions. The estimated indicators should not only qualify and quantify the influence of current and possible future land use scenarios for the whole Austrian state but also be applicable at a relative small spatial scale. Most of the existing international and national indicators used to assess and monitor aspects of biodiversity are limited by their spatial resolution and by the fact that they are based on more or less representative samples for huge administrative areas. The collected data normally allow conclusions on the whole assessed area but do not permit interpretations in a spatially explicit way or for regional or even local units. The indicator set presented here has been calculated on the basis of a high resolution naturalness map of Austria and has been produced using the best nationwide available land use data from different sources. The resulting indicator set allows spatially explicit evaluations at different spatial scales – from national to local.

In a further step the developed biodiversity indicators can be used together with other indicators calculated in this project to evaluate sustainability of future land use scenarios. This helps to assess not only the consequences of changing political frameworks but also of changing environmental conditions, for example caused by climate change.

Establishing the environmental conservation and sustainable development in the mountain society of the Pamir

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The mountain societies in Kyrgyzstan and Tajikistan heavily rely on livestock husbandry as a primary industry. Herders have acquired the freedom to graze their livestock since the countries' independence in 1991. As a result, overgrazing is believed to have caused land degradation (soil erosion). A number of international organizations address this issue and implement projects to mitigate further degradation. Transformation of livestock husbandry since 1991, however, has not been sufficiently researched in the countries. This study, while focusing on livestock husbandry in the transboundary region of southern Kyrgyzstan (Alai valley) and northern Tajikistan (Karakul area), aimed (1) to examine the recent transformation of the mountain society, (2) to identify existing environmental issues, and (3) to discuss the establishment of a possible framework for the sustainable development of the society. This study first mapped the summer and winter grazing areas in the Alai valley before and after 1991. Certain remote grazing areas have disappeared after 1991. Some of the slope surfaces near the villages and roads experience soil erosion. It is speculated that the soil erosion has been occurring since 1991 owing to the disappearance of governmental control over grazing. However, our interview surveys with the local residents show that the soil erosion has not necessarily occurred after 1991: soil erosion on many slopes had occurred much before, even in the 1950s. Further, the interview surveys revealed that the study areas have more serious environmental issues. One of the most serious issues is wolf depredation on livestock. We,

therefore, conducted questionnaire surveys on the wolf depredation from 2008–2010 (468 households in the Alai valley and 97 households in the Karakul area). Results of the questionnaire survey demonstrated that 67.8 % of the respondents in the Alai valley and 82.5 % in the Karakul area experienced actual wolf depredation on their livestock. The percentage of residents who felt the increase in the number of wolves after 1991 was 87.5 % and 89.7 % in each area. This increase seems to be a result of the disappearance of the governmental supply of guns and ammunition to local hunters after 1991. On the other hand, officers in the army and the National Security Agency equipped with automatic guns have practiced the illegal hunting of ibex in the valley, and thus, there has been a decrease in the prey of the wolves in the mountains. This in turn increased the threat of wolf depredation on livestock in the society. In the Karakul area, argali is a target of illegal trophy hunting by foreign hunters and illegal meat hunting by local residents. In conclusion, currently, the largest environmental issue in the study areas is not land degradation, but the transformation of the livestock–wildlife relationship. Both controlling wolves and conserving wildlife are urgent environmental issues. Wolf control should be included as a nature conservation strategy. Further, wildlife is also important as an ecotourism resource, which may strengthen the society's sustainability. International organizations should focus their attention on these aspects, which are strongly related to severe poverty after 1991.

Leaf and ecosystem response of mountain grassland gas exchange to soil water availability

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Climate change is expected to impact the Alpine region by increasing the frequency and intensity of drought events resulting in a negative impact on ecosystem water resources. The response of mountain grassland CO₂ and H₂O exchange to natural fluctuations of soil water availability was evaluated during 2001-2010. The physiological performance of mountain forb and graminoid plant species under progressive soil water shortage was explored in a laboratory drought experiment. Our analysis showed that during the 10 year study period the natural occurrence of moderate and severe dry periods did not lead to substantial reductions in net ecosystem CO₂ exchange and evapotranspiration. These results were confirmed in a laboratory experiment where all surveyed grassland plant species were insensitive to soil drying until extremely low soil water contents, which never occurred in the field during the 10 year study period, were reached. Re-watering after a short term experimental drought allowed for a fast and complete recovery of the gas exchange of the investigated plant species. It is concluded that the present day frequency and intensity of dry periods does not substantially affect the functioning of the investigated grassland ecosystem. The observed “water spending” strategy employed by the surveyed mountain grassland species is thus expected to continue to provide a cooling feedback on climate warming in the foreseeable future, but may have negative consequences on runoff and deep seepage and thus the water supply in the Alps and the surrounding areas.

Lichens in the Alps and environmental change

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The Alps comprise the largest natural and semi-natural landscape complex in Central Europe. Since few decades changes in the vegetation are attributed to climate change. So far no studies of the possible impact of climate change have been undertaken with lichen symbioses which is one of the most ubiquitous life form of high altitudes. On different types of substrates present in the Alps, lichens form extensive and diverse biological surfaces, which also serve as reservoir for a broad range of other microorganisms. Most lichen species are highly adapted to specific ecological situations. Lichens are therefore sensitive and early microbial indicators of environmental change. The Alps are among the best studied regions of the world with respect to lichen biodiversity, comprising more than 2000 species. Geographic data of lichens present in the Alps are continuously improved. We plan to develop an on-line information system about Alpine lichens of use for experts and amateurs. We present information about apparent consequences of environmental change on lichen diversity, which is a proxy to biological change in general.

Effects of summer drought on carbon dynamics in mountain grassland

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(in collaboration with the EU-FP7-Carbo-Extreme project and the research group of Andreas Richter, University of Vienna)

Mountain ecosystems are considered as particularly vulnerable to disturbance and are exposed to comparatively fast changes in climate and land use. Climate projections suggest that besides warming future climates involve an increased occurrence of extreme weather events, including extended periods of drought. Effects of such extreme events on ecosystems and their greenhouse gas balance are not yet well understood, and are currently assessed a.o. by the EU-FP7-project Carbo-Extreme, which aims to provide a Pan-European synthesis of the terrestrial carbon cycle under climate variability and extremes. Mountain grasslands cover about 8 % of the terrestrial surface and hold 15 % of the carbon (C) contained in soils. As contribution to the Carbo-Extreme project and a related project funded by the Austrian Science Fund (FWF) we studied effects of sustained summer drought on the C dynamics of a mountain meadow at 1820 m in the Austrian Central Alps. Drought was simulated in a factorial experiment comparing in situ control plots with plots from which rainfall was experimentally excluded. Aboveground net primary production, net ecosystem exchange of CO₂ (NEE), gross primary productivity and ecosystem respiration showed a consistent reduction with increasing progression of drought. Drought diminished canopy photosynthesis more strongly than ecosystem respiration. After the third subsequent year of simulated summer drought

memory effects on NEE were observed, that were likely due to shifts in the abundance of species. Belowground net primary production was not consistently affected by drought. Soil respiration and related CO₂ emissions from the soil were significantly reduced by drought, though they only responded only when a critical threshold of soil moisture was exceeded towards the end of the drought period. Autotrophic (i.e. root and rhizosphere) components of soil respiration showed a stronger decrease than heterotrophic (i.e. bulk soil microbial) components. The first rainfall event after the simulated drought triggered a peak in soil CO₂ emissions which lasted for several hours and was, surprisingly, more pronounced for autotrophic than for heterotrophic components. Detailed analyses of mechanisms underlying the observed changes, as based on in situ isotopic labeling studies and model analyses of the production and diffusion of CO₂ across the soil profile are currently being elaborated. We conclude that 1) summer drought may potentially alter the carbon balance of alpine grassland towards decreasing the C sink strength, 2) component processes are governed by different critical thresholds, and 3) repeated drought may induce memory effects on the C dynamics in mountain grassland.

Vegetation on alpine rockglaciers: A case study from the Ötztal and Stubai Alps (Tyrol, Austria)

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This study analyses and compares the vegetation cover and patterns on four different active rockglaciers, located in the Ötztal and Stubai Alps (Tyrol, Austria). Due to the special edaphic and climatic conditions, rockglaciers are environments hostile to plant growth, but still show some vegetation cover and are inhibited by different species, of which most are also typical for scree slopes. Vegetation cover can be used alongside other methods to determine the status of activity of rockglaciers or differences in activity at different parts of a rockglacier. Over longer terms, changes in vegetation patterns and cover can be used as indicators for changes in the activity of rockglaciers. Field work was conducted at Äusseres Hochebenkar, Innere Ölgrube, Inneres Reichenkar and Schrankar. Total vegetation cover as well as the cover of each distinct species was assessed in squares of 3x3m along several longitudinal and transversal transects on each rockglacier. In addition, the percentage of fine-grained material (silt, clay and sand combined) was assessed, the size of the boulders and the diameter and exposition of the biggest thalli of Rhizoarpon geographicum were measured in each square. For comparison, adjacent stable areas were also mapped. In total, over 600 squares were mapped during August and September 2010. The results were analysed with regard to the floristic composition in each study area and the differences between the four areas. The relation of the total vegetation cover and the cover of each species to the availability of fine grained substrate was also investigated, as well as the

relation of the size of the lichen thalli to the size of the boulders and the estimated age and flow-structure of the rockglaciers. In total, 23 different species were mapped. The vegetation composition of the different investigated rockglaciers was only similar in so far, that several species (*Poa laxa*, *Cerastium uniflorum*, *Saxifraga bryoides*, *Oxyria digyna* and *Geum reptans*) occurred frequently at all study sites. But various other species were only found at some or at one of the study areas or even just in one area of one of the rockglaciers, leading to different vegetation patterns. Vegetation cover generally increases with an increasing availability of fine-grained substrate, but can not be explained by that variable alone, since other factors, especially surface instability and the micro-climatic conditions are also very decisive. Differences in size and abundance of lichens are also obvious. The rockglaciers Inneres Reichenkar and Schrankar show lower frequency and thalli-sizes of *Rhizocarpon geographicum* than the ones at Äusseres Hochebenkar and Ölgrube, what might indicate differences in age or movement, but can also be due to different sized boulders or differing micro-climatic conditions. Altogether, results show that vegetation cover and composition on different rockglaciers are diverse and inhomogeneous, even in a delimited area of the eastern Alps.

Structure and regeneration patterns of *Austrocedrus chilensis* in timberlines at the northern distribution on the Cachapoal river basin, Chile

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The shade-intolerant coniferous *Austrocedrus chilensis*, a vulnerable species by IUCN, occurs in Chile from 32° 39' S to 44° S, between 2,400 and 250 m of altitude. At the northern distribution, within the Mediterranean-type climate, *A. chilensis* occurs mainly as scattered monotypic populations (between 900 and 2,400 m. a.s.l.). These populations are probably remnants of stands established in the Holocene, during wetter periods. Historically, the structure of these timberlines on the Central Chilean Andes have been modified by the effects of natural hazards (i.e., earthquakes, volcanism, landslides, avalanches, rockfalls), land use changes, grazing, selective logging, and fire. Moreover, tree-ring chronologies revealed a drought trend on this area, a possible effect of the climate warming.

We evaluated the structure and regeneration patterns of eight populations distributed throughout the Cachapoal river basin (~34° S; 1,270-1,659 m. a.s.l.).

At each population, three plots (20 x 50 m) were randomly distributed to measure structural tree attributes. All seedlings and saplings (< 5 cm DBH) were counted, the regeneration strategy (seed production or vegetative regeneration), the diameter at the root collar and the height of each individual were determined.

A. chilensis showed an uneven-aged structure in all of the analyzed populations. The density and the basal area ranged between 76 - 856 trees ha⁻¹ and 5 - 37 m² ha⁻¹, respectively. Many trees showed a multi-stem clump structure with a density between 4 and 509 stems ha⁻¹. The

clump structure may be the effect of disturbance agents (e.g. logging, rockfalls) or a reproductive adaptation (i.e. layering). Standing dead trees ranged between 0 to 167 stems ha⁻¹, and many of them belonged to the multi-stem clump structures.

The regeneration processes were seed germination and cloning of trees by sprouting or layering. In all the studied populations, scarce seedlings and saplings germinated from seed were found (between 3 and 133 plants ha⁻¹), with diameter at the root collar and height between 0.1-11.0 cm and 38-300 cm, respectively. A closer look at seedling establishment showed that *A. chilensis* often germinated on small convexities or concavities in the soil surface or near to rocks. At the same time scarce resprouting of *A. chilensis* plants was found, with densities between 0 and 117 plants ha⁻¹, diameters at the root collar between 0.2 and 15.0 cm, and heights between 15 and 400 cm tall.

Global warming and land use changes have been recognised as the mayor problems affecting high altitude environments. Therefore, more information about the structure and regeneration patterns of *A. chilensis* populations, particularly at its northern distribution, is necessary to obtain a better grasp of the natural dynamics of the timberline dominated by this species. Such knowledge will provide the basis for conservation and restoration strategies of these remnants populations.

Connectivity Analysis Of Riverine Landscapes

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The European Alps, with its high mountain regions represent a sensitive ecosystem which acts as a hotspot of biodiversity. Our approach aims at the enhancement of ecological connectivity of running waters across the Alpine range. The specific role of riverine landscapes arises in connecting aquatic and terrestrial habitats and therefore functioning as habitats, dispersal and migration routes and corridors for animals and plants.

We defined the riverine landscapes (river, floodplain and surrounding area) for the whole Alpine range. In order to visualise the human and natural impact on the landscape level, the effective mesh-size, as an index for landscape fragmentation was calculated. Barriers, obstacles in the longitudinal, lateral, vertical and temporal dimensions of river systems, being potentially effective for selected key species of the riverine landscapes (i.e. bullhead, fish otter and tamarisk) were identified. To place the species aspect in the spatial analysis a habitat suitability model was defined for these focal species. In overlaying the results of potential habitats and their fragmentation as well as barriers, the existing connectivity is visualised and quantified by the proximity index.

Results showed that the identified Alpine riverine systems were highly fragmented. This is mainly linked to human activities in the valleys but is also reaching higher areas (e.g. by hydropower development). The natural habitats of the selected key species are delimited, fragmented or even lacking in many river segments. Analysis on the landscape level including biological distribution of riverine organisms identified human land use and activities to denature Alpine landscapes and habitats by an alarming degree. Natural occurrence, movements and migration of most riverine species are expected to be destroyed.

The effect of snow-making on water flow in major streams of the Krkonoše Mts. National Park

Pavel Tremel and Stanislav Brezina

Krkonoše Mts. are the only National Park in the Czech Republic which includes the subalpine altitudinal zone. Due to their height the mountains are also under heavy touristic pressure especially when regarding the tourism linked to the down hill skiing.

In last decades the downhill tracks have become to be covered by artificially made snow more and more frequently.

Detrimental effects of snow making on vegetation and on water resources as well as on socio-economic characteristics of mountain regions have been often suggested.

Despite this many Assessments of the environmental impacts of snowmaking in particular sites in the Krkonoše Mts. found no significant effect. This may be at least partially due to inappropriate evaluation of cumulative effects of snow making on the environment on the regional spatial scale and due to the lack of evaluation of its effect under the conditions of global climate change.

This is why we conducted a study of joint effects of snowmaking in all the ski-resorts in the Krkonoše Mts. on water flow in major regional streams presently and in the near future (in the year 2025). We simulated the effects of snow making under several scenarios differentiated in the intensity of development of winter tourism and in the intensity of climate change.

We did not find significant cumulative effects of snow making on water flow in major streams in the Krkonoše Mts. In majority of the predicted situations the snow making will not remove more than 10 % of the immediate water flow from the major streams. The only exception is the most pessimistic scenario for the river Labe in which snow making was predicted to remove more than 30 % of the immediate water flow.

The results suggest that the cumulative effects of snow making on water resources are not the major threat in the Krkonoše Mts. It is more appropriate to concentrate on the impact of water consumption on water flow in smaller and more vulnerable streams. Further, we urgently need long-term studies about the effect of artificial snow on plant and animal composition of mountain grasslands. Finally, we need to acquire suitable conceptual framework for assessment of socio-economic impacts of artificial snowmaking.

Glaciers, snow and ski tourism in Austria's changing climate

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This study illustrates the relevance for and impact of changes in the cryosphere on ski tourism in Austria. The results of several case studies in the Ötztal and Stubai valleys on snow reliability, snow production, and mass balances in glacier ski resorts are summarized.

Climate data from Obergurgl (1936 m) in the Ötztal valley is analyzed with respect to the amount and duration of natural snow cover and the possibility for snow production. A case study on Mittelbergferner focuses on the impacts of glacial recession on a ski resort and possible adaptation measures. From long term glacier inventory and short term mass balance data, the effect of operating ski resorts on glaciers is investigated. At Obergurgl, the probability of both snow cover and snow production is >80 % from December to March and decreases significantly in the months before and after this peak season. The interannual variability of snow cover and production is low during the main season and higher in other months. Year to year differences are larger than any long term trend. Glacier ski resorts have to adapt to shrinking glacial area and falling glacier surface. Covering the glacier reduces ablation by 60 % and results in significantly less volume loss compared to uncovered parts of the glacier. Neither the comparison of mass balance of groomed to ungroomed areas nor the comparison of long term volume changes of 10 ski resort glaciers with 100 surrounding glaciers showed evidence for an impact of the operation of ski resorts on the glaciers.

Oral presentation will be held by Martin Stocker-Waldhuber

Effects of climate change of future snow conditions, winter tourism and economy in Tyrol and Styria (Austria): CC-Snow, an interdisciplinary project

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The interdisciplinary project CC-Snow aims at utilizing a series of future climate scenario simulations to determine the effect of climate change on natural and artificial snow conditions and their effects on tourism and economy in the provinces Tyrol and Styria (Austrian Alps). A sophisticated interface is developed to provide adequate climate model output for two snow models at different scales. At the local scale, the deterministic snow model AMUNDSEN is applied for the test sites Kitzbuehel and Schladming. The resulting high resolution snow cover pattern time series are used to train the regional scale, conceptual snow model SnowReg to be applied for Tyrol and Styria. Both snow models provide simulation results for snow reliability in the respective scales and regions, and are applied for historical as well as future scenario periods. For the interface of the natural sciences modelling approach and the socio-economic analysis, a set of indicators are derived to describe, e.g., snow reliability conditions, potential of future artificial snow production or attractiveness of the winter landscape. By analysis of the indicators at provided from the scenario model runs at both scales, the consequences of regionalization and potential effects on tourism and economic structure are investigated. Integration of stakeholders is fostered from the beginning in terms of an active participation process which helps in the formulation of the indicators, and in the common analysis of the results. The presentation focuses on the outcomes of the first project phase, i.e. the modelling of climate, snow cover and the set of indicators at the two scales. On top of that, an outlook is given for the concept of integration, i.e. the use of modelled indicators for the socio-economic analysis. CC-Snow is funded by ACRP (Austrian Climate Research Program).

Australian snow tourist's perceptions of climate change: implications for the Queenstown Lakes region of New Zealand

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This qualitative research has emerged from the sustained discussion of the future of winter alpine tourism in the Australasian context. The ski industries of Australia and New Zealand are intertwined, with research requiring trans-Tasman cooperation (Hendrikx, 2010). When analyses are conducted at a national scale, they fail to incorporate this complex interdependent relationship. Australians account for over 35 % of skiers in New Zealand, although this figure rises to 64 % for some individual ski fields (NZ ski, 2010). The increasing number of Australians choosing New Zealand for snow-based tourism has been attributed to relative financial costs, the allure of an 'overseas' holiday and snow reliability. These reasons are connected, and will become increasingly so, with the climate change problematic. Physical sciences in the form of climate modelling have forecast 'significant impacts' for Australasian skiing (IPCC, 2007, Hennessey et al, 2004, Hendrix, 2010, Hendrix & Hreinsson, 2010), with prospects for Australia particularly dire, consequently placing New Zealand in a relatively positive position.

Our paper follows on, and complements the climate modelling and forecasting provided by the IPCC (2007), Hennessey et al (2004), and Hendrikx & Hreinsson (2010), using qualitative methods to gain greater understanding of the potential behavioural adaptations available to Australian snow tourists in New Zealand. The depth, nuances and complexities of tourist's perceptions and knowledge will be sought through semi structured interviews in the

Queenstown Lakes region on the South Island of New Zealand during the winter season 2011. Although physical sciences can provide understandings of biophysical vulnerabilities, they neglect the sociocultural context of vulnerability and often frame it as an outcome of specific changes. Therefore the objectives of this research are; 1. To understand the way vulnerability is framed and perceived by demand-side stakeholders, 2. Recognise the types of knowledge which inform actors about climate change vulnerability, 3. To identify the types of behavioural adaptations which are available to Australian tourists and implications these could have for New Zealand's ski industry.

This paper represents part of a wider collaborative research project addressing the vulnerability of snow-reliant industries as a result of forecast climatic changes. It will identify a range of possible behavioural adaptations for demand-side stakeholders which will have applicability beyond the Australasian context. We will discuss the socio-economic, developmental, institutional and governance implications for alpine regions, as individual ski fields within a destination will face varying degrees of vulnerability resulting from climatic and behavioural changes. Therefore the opportunities and threats posed locally to individual ski fields and nationally to the wider ski industry will be highlighted and discussed with relevance to the global ski industry. Preliminary findings will be presented including scope for further applicability and development.

Alpine airports as gateways for growing incoming ski tourism: relevance and spatial impacts

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More and more ski tourists travel by plane to the Alps, most of which are from the British Isles, Scandinavia, the Netherlands, Germany and Russia. They not only fly to circumalpine hubs and perialpine airports but especially to intraalpine airports. This paper will discuss first results from expert interviews and passenger surveys that were conducted at the international airports in Salzburg and Innsbruck. During the winter weekends these airports must manage temporary overloading at the airside and at the landside. The increase in air and land traffic also leads to protests by local residents and to communication problems. Another remarkable result of the empirical research is that flights for ski tourists not only substitute for other means of transportation, but induce entire new journeys.

Ecotourism as a Sustainable Adaptation Strategy for the Effects of Climate Change in the Himalayas – Examples from the Indian State of Uttarakhand

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The Himalayas have been considered one of the emerging tourism markets in Asia with the highest potential for growth, alongside Sri Lanka, Laos and Vietnam (Shackley, 2006). In the Indian state of Uttarakhand the mountains themselves are the biggest attraction, providing the backdrop for adventure tourism (mainly trekking and rafting as well as some wintersport activities like heli-skiing) and spiritual tourism, including pilgrimages to Haridwar, the Char Dham and Yoga (especially in Rishikesh, the “Yoga capital of the world”). Nature and wellness tourism are also starting to develop in some areas of the state. However, Singh (2007) has named several main problems for the tourism industry in Uttarakhand: (1) the state has not been developed as a destination brand and there are no coordinated marketing efforts (especially in the international market), (2) the infrastructure is only of low quality and (3) there are high taxes on tourism products. In order to tackle these problems large consulting projects in the Himalayas region have been initiated. Most important for Uttarakhand is the “Uttarakhand Tourism Development Master Plan” conducted by the UNWTO (2008), which sets the framework for the development processes at the local and regional level.

While those kind of action plans and development processes aim at short and especially mid-term results, there are also issues that have to be taken into consideration when looking at long-term prospects. One of the most important factors influencing the future of tourism in mountain areas is the process of climate change. In the Alps the first studies on how to respond to climate change have been conducted in the mid-1990s in order to look at possible adaptation strategies to avoid or at least attenuate the negative effects of this process.

Abegg (1996) has formulated four different approaches to tackle the problem:

1. Transform outdoor-activities into indoor-activities.
2. Move the activities to different (more secure) places.
3. Modify the activities.
4. Create new activities.

In the proposed paper we will look at the fourth option, the creation of new activities or better new market segments and strategies to develop such products. The keyword is Ecotourism and its value as a sustainable adaptation strategy towards climate change in the Himalayas. Taking into consideration the specifications of the climate in the Himalayas the following questions will be tried to be answered: What are the basic factors needed to create Ecotourism products that are suitable to withstand the challenges of climate change in the Himalayas? What strategies are needed to ensure stakeholder inclusion in a sustainable development process? How can such products be marketed and what should be the target markets for such products? Based on the latest models on climate change in the Himalayas (Erikson 2009) and the concept of strategic product development (Pechlaner/Herntrei/Konfink 2009) several destinations and attraction points in the Indian state of Uttarakhand will be evaluated for their suitability to develop Ecotourism as a product in order to adapt to the challenges of climate change. The data needed for the study will be collected during a project in Uttarakhand conducted in cooperation with the Gesellschaft für Technische Zusammenarbeit (GTZ) during the first quarter of 2011.

Regional tourism systems in times of climate change: How can you empirically measure anthropospherical adaptation to an imminent geospherical pressure?

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Climate change has had an increasing effect upon the geospherical composition of alpine environments over the last thirty years or so, an impact factor that is expected to increase both in number as well as in magnitude (Beniston 2003, Becken & Hay 2006, Scott et al. 2008). The risk which regional tourism systems in the Alps are confronted with range from landslides and debris flow to increasing water scarcity and extreme precipitation (Beniston et al. 2007, OcCC 2007). Based on the well established concept of regional vulnerability (IPPC 2007) – built up of climate change exposure, sensitivity and adaptive capacity – we propose a novel approach on how to conceptually grasp and empirically measure the adaptive capacity of complex socio-economic systems by making use of alpine tourism as a field of application. The conceptualization and measurement of socio-economic adaptation capacities has not yet proceeded much beyond the level of an accurate descriptive analysis (Füssler & Klein 2006, Adger et al. 2009, Adger 2003). Based on the concepts and theories stemming from economic geography and institutional economics (Hodgson 2002, Dörny 2005, Yeung 2005), we will propose an empirically oriented research agenda to a) depict the economic governance-structure of the local tourism production system, b) evaluate the adaptive capacity of the

individual actors within the system and c) analyze the degree of change within the network under different climate scenarios. On the one hand, this will allow us to evaluate whether or not climate thresholds exist with respect to the implementation of adaptation measures – levels of impact above which the willingness to implement adaptation measures increase disproportionately – and whether or not the reluctance or a disproportionate willingness to implement adaptation measures is spatially aggregated in the system, with other words, whether people who have a high willingness to adapt have stronger economic ties to other such actors, or not.

In terms of the broader social relevance of our proposed research agenda, we intend to give a empirically-founded hint to some pressing issues in the management of climate change effects upon regional tourism systems, such as, how certain structural reforms regarding the composition of regional tourism production systems may affect the system's adaptive capacity, which sectors within the respective tourism systems lag behind in terms of adaptive capacity and which players would be most worthwhile to direct policy initiatives at in order to increase the adaptive capacity of the whole regional system.

Relative regional vulnerability and resilience of the Austrian winter tourism industry

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Climate change has been identified as one of the major challenges for the alpine winter tourism industry due to its high dependency on the climate-sensitive resource snow. Ski areas worldwide have already adapted to snow-scarce winter seasons by installing snowmaking facilities. Nevertheless, the use of snowmaking has so far been largely neglected in climate change impact assessments for Europe.

It was found that even for comparably small regions (e.g. Tyrol/Austria) climatic characteristics can vary considerably resulting in different ski season lengths at the same altitude. Thus localized climate (change) data is required to consider climatic heterogeneity.

In this paper, results of a ski season and snowmaking simulation model ("SkiSim 2.0") for 228 ski areas in Austria are presented. The objectives are twofold: (i) to identify the impact of climate change on ski season lengths in Austria for the 21st century, and (ii) to discuss the relative vulnerability of the Austrian winter tourism industry.

A warming of 2°C (approximately in the 2050s, depending on the emission scenario) is a tipping point for the Austrian winter tourism industry. By then, current snowmaking technology will not suffice to maintain a sufficiently long ski season in the majority of ski areas. The degree of impact differs significantly between the provinces. Though the impact of climate change on ski areas is generally high in the 2°C scenario, the relative vulnerability of ski areas in the Western provinces (e.g. Tyrol, Salzburg) is lower than for ski areas in the Eastern and Southern provinces (e.g. Carinthia, lower Austria). Though the absolute changes of ski season length in the West viewed in isolation would also mark these ski areas as losers, the lower losses compared to the Eastern provinces might lead to a spatial shift of demand from East to West resulting in a low relative vulnerability.

The results have shown that additionally to the absolute changes of ski season length, relative vulnerability should also be considered. Therefore, an application of the SkiSim 2.0 model for the Alps could contribute to an understanding of potential spatial shifts of demand for skiing tourism.

The vulnerability of Swiss Alpine tourism to climate change – an analysis of its causes, its magnitude, and its spatial heterogeneity

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Mountainous regions are among the most exposed to climate change. Many impacts are responsible of this, as for example snow pack reduction, glaciers and permafrost melting, more frequent and intense natural hazard events, landscape changes or changes in water availability. Furthermore, these impacts do not only affect the mountain environment, they also touch its society and its economy.

This is also true in the Swiss Alpine region and for the Swiss Alpine tourism sector. In Switzerland, tourism plays a key role, being the social and economic backbone of many of its mountain regions. Nonetheless, impacts and their effects on the sector have only been partially studied. Moreover, this has often been done merely looking either at Switzerland in its whole or at a local case studies level, and often looking only at one impact. Researches assessing the relative vulnerability of regions in regards to various impacts are rarer. In this work, we analyse the spatial heterogeneity and the magnitude of the vulnerability of 62 Swiss alpine regions in relation to tourism. We selected 72 indicators describing the exposure, the sensitivity and the adaptive capacity of each of these areas. We analysed in particular the impacts generated by changes in climate suitability for tourism activities, snowpack reduction, glaciers melting, permafrost melting, natural hazards, water scarcity and changes in landscape and

scenic beauty. Indicators were assembled by mean of a Multicriteria Analysis carried out by gathering experts' advice. The obtained results allow identifying the most important drivers influencing vulnerability. They moreover permit to assess spatial heterogeneity in vulnerability. Finally, they allow recognizing hotspots - areas where the implementation of adaptation measures is more crucial. The ultimate goal of the study is to raise stakeholders' awareness and interest for climate change related issues, and to allow the comparison with their own subjective perceptions of vulnerability in their region. It could also allow to better direct efforts and investments. To sum up, results could be an aid towards a better understanding of vulnerability and towards the initiation of adaptive processes in vulnerable regions. Early results seem to indicate a particularly high vulnerability in the southern part of Valais, in the Surselva and in the Mittelbünden regions. High altitude regions are visibly more affected than lowlands. Moreover, preliminary results also highlight the importance of snowpack reduction in defining the exposure of Swiss Alpine regions. Glaciers and permafrost melting, as also changes in landscape beauty, do also play a relevant role. In addition, according to experts, a high adaptive capacity, and in particular a high acceptability of adaptation processes play an important role in the reduction of the region's vulnerability.

Renewable Energy in alpine areas – desired, ignored or rejected? How winter sports tourists perceive renewables in five Austrian skiing areas

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Energy supply and climate protection are two of the most discussed topics in our society. Conciliating the technical and environmental aspects of energy production is becoming increasingly important, especially in the winter tourism sector.

Picking up on the current issue of ecological and sustainable tourism in the Alps, this study determines the extent to which the implementation of renewable energy solutions and the aim of energy autarky are relevant for the image and marketing possibilities of a winter sports tourism destination. It also ascertains the current level of environmental awareness towards green energy among alpine winter tourists.

This current survey is part of an interdisciplinary research project centred around an integral view on renewable energy (with an emphasis on biomass) in the Alps – encompassing everything from the technical optimisation of energy production to its relevance for tourism. One of the central points is a detailed analysis of feasibility for the region, both in technical and touristic respect, taking into consideration the image benefits and recognition value of an energy-neutral or strongly renewable-energy-focussed tourism in the Alps.

During the winter season of 2010/2011, winter sports tourists (n=1100) were surveyed in 5 big Austrian skiing regions. The survey areas were selected with a view to covering a diversity of winter sports markets – from the luxury segment to the family destination, from areas with a strong international orientation to those mainly frequented by domestic tourists. Thus, the study allows comparisons to be drawn between different tourism segments and tourist nationalities regarding perception, appreciation and acceptance of renewable energy in the alpine region.

The results shed light on tourists' awareness for renewables in the Alps and the extent to which they have an influence on holidaying behaviour – if any. The study ascertains how strongly tourists' decision for a certain destination is influenced by renewable energy and environmental services compared to other factors. Furthermore, the study also researches alpine tourists' sensitivity towards changes to a region's natural heritage and the landscape. This offers valuable feedback for the marketing of environmental services and reflects the perception of change in the sensitive alpine region.

Climate Change and Winter Tourism – A Stakeholder’s Perspective in the Tyrol Region

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With its dependency on natural resources winter tourism is among those economic segments most affected by the impacts of climate change. Due to their present focus on ski and snow many Alpine destinations will be facing challenges posed by modifications of current temperature and precipitation patterns. To remain competitive, tourism destinations need to establish and implement risk management tools routinely taking climate change into account. It has been the aim of the study to obtain insights into the perception of climate change among stakeholders in winter tourism and the present significance of climate change in risk management in the investigated area of Tyrol.

So far no detailed climate change perception analysis has been carried out in the research area. The study uses a qualitative approach with guide-lined in-depth expert interviews combining open and semi-open questions. About a third (n = 11 out of 36) of all Tyrolean tourism region CEOs and the CEOs of the corresponding cable car companies were included in the sample. The interviews were analysed using a multi-stage coding process supported by the text analysis software of MAXQDA.

The results show that at this stage climate change is not perceived as a substantial threat and thus not a driving force in risk management so far. The interviews revealed a strong feeling of distrust among tourism officials concerning climate projections and a lack of communication of scientific results to stakeholders. Temperatures too high for producing snow as well as damage by extreme weather events are ranked among those risks with a possible likelihood and catastrophic consequences, while the lack of natural snow is assessed as a risk with only insignificant to moderate consequences. The main focus currently lies on iterative technical adaptation processes with the aim of maintaining today’s services, whereas strategic adaptation processes are still lacking behind.

Along with further findings the results will help to define and develop a sustainable risk management in winter tourism in the area, recognizing the complementarity between local knowledge and scientific investigation.

Impacts of climate variability and change on tourism in Austria

Judith Köberl, Andreas Gobiet, Georg Heinrich, Armin Leuprecht, Franz Prettenthaler, Christoph Töglhofer

The paper at hand aims at quantifying the potential impacts of climate change both on winter and summer tourism in Austria, using a two-step approach. Firstly, the historical weather sensitivity of tourism demand is quantified by means of dynamic, multiple regression models. Secondly, the estimated sensitivities are used to project a baseline of tourism demand under current climatic conditions as well as under climate change conditions as indicated by four different regional climate models until 2050. Results suggest negative climatic effects on winter tourism, whereas impacts on summer tourism are less clear in their direction and smaller in their extent.

HD-Film and Social Media Use as a Tool for Policy Makers, NGO Members and Researchers focusing on High Alpine Changes. Methodological Possibilities and Examples from the Nepal Himalaya.

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Changes in the mountains of the world – climatic and anthropogenic ones - are objective at least for those who are directly confronted by them. Prompt transmitting and quick reaction strategies are necessary for sustainable reactions and prevention-programmes.

Mountainous regions - by nature - often have a problem of direct linking with policy makers based in the capitals and lowlands. Traceability of mountain issues in the lowlands is difficult. Scientific multimedia usage in this respect can facilitate change. By using modern media the “transfer-time” between the empirical data capture, the scientists’ interpretations and the policy makers’ decisions can be limited to the absolute minimum and make quick reactions possible.

The other big benefit of multimedia integration is the possibility of reaching a huge number of people and sensitizing them for scientific or environmental topics.

Successful examples of scientific multimedia usage will be shown by insight into a three-month research expedition to some of the remotest areas of the Nepal Himalaya, where the author tried to use filming and media marketing as a tool for transferring and promoting of the research content. The background of the idea was to make the abstract results of the research interdisciplinarily comprehensible und transfer it to the public via social media.

In 2012 an advanced project will take place on the topic of climate change in the Northern Pakistan Karakorum mountains. The appending media concept will be presented.

The presentations will show how multimedia can be integrated into high alpine research and environmental education. Different concepts and possibilities of media usage will be presented alongside stunning insights into the changes of mountain life in the Himalayas.

The author started working as freelance science journalist in 2009 and founded his own mountain-media-label “HK Mountain Projects” in 2010. Besides he is working on a physical geographical PhD-thesis on the “Typology of Traditional Mountain Routes of Nepal Himalaya” at the Institute of Geography, University of Göttingen, Germany.

“LIFE eQuality?” – Teenagers’ Inspiring Research into Quality of Life

Lars Keller, Alexander Schober

Driving sustainable mountain regions seems impossible without knowing what the young generation finds important about QOL at present and for the future. “LIFE eQuality?” is a joint project by the Institute of Geography at Innsbruck University and the students and teachers of schools in Bavaria, the Engadin, Northern and Southern Tyrol. The co-operation concentrates on research in the field of quality of life (QOL) performed by teenagers themselves. The article at hand focuses on the core ideas and concepts of the project, and offers a glimpse into some preliminary results and the main “products” to be expected in the final phase of the project.

The blind spot: The discourse about urban sprawl in the context of particularism

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There is a broad consensus in the European planning debate that the expansion of habitat areas and the phenomenon of urban sprawl do not satisfy the claims of sustainability and should be replaced by inner densification of the bigger cities. This debate exists since the mid1990s. 1100'000 Google entries prove its significance.

The ongoing sprawl reflects the weakening of regional development and spatial planning in the last years and helped arguments of market-liberal incentives to get accepted (e.g. tradable certificates). The obvious failure of densification makes it necessary to scrutinize the phenomenon basically: What is urban sprawl? Why should urban sprawl be negative?

Examples of Switzerland and Japan show that urban sprawl at first is a question of perception and of scale which delivers sometimes paradox results: Ongoing construction in periurban areas increases the sealed surfaces, but may be estimated as inner densification. On the other hand the depopulation of peripheral regions with a thinned infrastructure seems to be an ecological blessing. This contribution argues in three directions:

- An analysis of the direct repercussions of biophysical changes alone has some shortcomings, as prospering regions with high pressure of settlement-activity also have the means for ecological compensation. The repercussions of sprawl are rather indirectly and affect places far away (by a global spatial division of labor, mobility and resource consumption).
- Arguments of landscape aesthetics conceal the normative aspects of perception and particular interests of the propagating actors and rather deflect from the problem instead of solving it.
- Market-driven economic incentives pursue not only the proclaimed ecologic objectives but are rather looking for higher land use efficiency in terms of a high valorization.

One can state that spatial paradigms rely (like other paradigms) on social relations with asymmetric power to define and to execute. The 1990s brought up the renaissance of the cities.

Agglomerations and metropolitan regions have become the dominant spatial organization which hosts now the majority of population. This majority defines prevailing patterns of taste, aesthetics and the ecological priorities ("wolves instead sheep"). In short: land use questions are normative questions.

To solve biophysical and regional problems of sprawl it is pleaded to enlarge the grid of analysis under two aspects:

- The system knowledge about urban sprawl with its biophysical and social aspects has to be enlarged on its repercussions on a wider scale.
- The target knowledge has to consider the underlying interests of actors. This includes the actual paradigm of spatial densification with its social repercussions.

The contribution is based on the results of the project "Scenarios for a sustainable development of the built environment in Switzerland", done in the frame of Swiss National Research Programme 54 (PERLIK, WISSEN, SCHULER et al. 2008) and on the works about amenity migration/multilocal dwelling (PERLIK, 2011).

PERLIK, M. (2011): New inhabitants between landscape adulation and positional good. *Rev. Géogr. Alpine* vol. 99(1) (accepted)

PERLIK, M./WISSEN, U./SCHULER, M. et al. (2008): Szenarien für die nachhaltige Siedlungs- und Infrastrukturentwicklung in der Schweiz. NFP 54. Zürich.

SCHULER, M./ PERLIK, M. (2011): Räumliche Disparitäten. In: SCHNEIDER-SLIWA R. (ed.): Schweiz. Darmstadt. (forthcoming)

SCHULER, M./ PERLIK, M./ PASCHE, N. (2004): Nicht-städtisch, rural oder peripher - wo steht der ländliche Raum heute? Bern.

Social Capital as a Key Source for Sustainable Development in Protected Mountain Areas: Experiences from the Großes Walsertal Biosphere Reserve

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Sustainable development in protected areas demands the continuous involvement of local stakeholders and citizens. But while this rule exists on paper and constitutes a central paradigm of sustainable development since the Rio Conference, implementation and enforcement often appears to face a number of significant challenges. Therefore, the existence of deeper forms of voluntary involvement can be considered a decisive factor for successful sustainable development contexts and strategies. Strong ties between individuals, an atmosphere of trust and mutual respect, and the willingness to make a contribution to developments with uncertain individual benefits altogether constitute sources an awareness of and emphasis on social capital can involve for the regional networks of a protected mountain area. The Großes Walsertal Biosphere Reserve (BR) seems to have been aware of the significance of deeper forms of involvement right from the start. As argued by this paper, the experiences made clearly mirror the contribution embarking upon strong ties and other aspects of social capital meant for the region. Furthermore, future benefits for human relations as well as the Biosphere of the valley arising from an emphasis on social capital will be outlined and suggestions on how to improve these efforts will be issued.

Mountains as a “geographic specificity”: Findings of the ESPON Applied Research Project GEOSPECS on the situation of mountain areas in Europe

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The two-year (2010-2012) ESPON Applied Research Project GEOSPECS (Geographic Specificities and Development Potentials in Europe) aims to provide a solid assessment of the current situation and trends in areas with geographic specificities, i.e. mountains, islands, sparsely populated areas, coastal zones, outermost regions, border areas and inner peripheries. The contribution for the conference “Managing Alpine Future” will focus on results for mountain areas. Within the scope of the project, mountain areas are analyzed in a comprehensive way: delineation and mapping – based on coherent criteria – forms the first step. Second, data on the structures and trends in mountain areas are collected and analyzed. This includes data on

- demographic processes (age and gender structure of the population),
- economic processes (activity structure, accessibility of services of general interest, development of information and communication technologies, etc) and
- environmental processes (adaptation requirements with regard to climate change, the exploitation of natural resources, protected areas, air quality, etc).

In a third step, these issues are being explored in more detail in case studies. Areas for case studies in mountains are the Highlands and Islands (UK) and the Jura (France, Switzerland). The contribution will present first results from the GEOSPECS project. As the project is ongoing, not all results are yet available, but work will have significantly progressed by the time of the conference. Envisaged elements of the presentation will be:

- maps of mountain areas in Europe (delineation according to municipalities)
- statistical findings on social, economic and environmental trends in mountain areas
- more detailed findings from the case study areas
- if relevant, comparisons with other areas with geographic specificities.

Costs of Alpine hazards – principles, research gaps and recommendations

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In the last 60 years, about 150 catastrophic events caused approximately US\$ 51 billion direct losses in Austria, France, Germany, Italy, Slovenia, and Switzerland according to the CRED EM-DAT database. A part of these damages were triggered by alpine hazards, like different kinds of flooding, landslides or avalanches. Still, the empirical basis for reliably estimating costs and economic effects caused by alpine hazards is weak. More profound data and methods are however needed for a sustainable management of hazards and risks in mountain regions also in respect to global change.

In order to i) compile state-of-the-art methods for cost assessments in Europe, ii) to analyse and assess these methods in order to identify best practice methods as well as theoretical and practical knowledge gaps and iii) to synthesise the resulting knowledge into recommendations for assessments of the costs of natural hazards and identify further research needs, the European Coordination activity ConHaz – Costs of Natural Hazards was launched in 2010. This contribution will show the main project outcomes with regard to data about costs of alpine hazards and assessment methodologies. The analysis is based on an extensive literature

review, interviews and questionnaires as well as exchange among practitioners, researchers and stakeholders on an inter- and transdisciplinary workshop.

A first review shows that assessment techniques vary strong over countries in the Alpine arc and a multiplicity of analyses exists for mountain hazards, but generally accepted, comprehensive and European-wide methods for Alpine risks are still missing. In addition, nearly all known methods are static, i.e. they neglect the effects of dynamic systems like human and environment interactions and global change. In the field of Alpine risks, indirect effects or decline in regional welfare is poorly investigated, whilst the direct effects are well analysed. Also, the annual costs for public safety, like mitigation measures, emergency planning or warning are less analysed, due to the involvement of diverse administrative bodies on all levels which leads to scattered information and data sources. First recommendations include an improvement of methods for cost-benefit-analyses with regard to indirect costs, costs of emergency actions and intangible effects as well as a need for a better and harmonized documentation of event and damage data.

Looking at mountains from near and afar: Coherence and disparities in definition, identification and characterization of mountains and mountain communities in Norway from a domestic and a pan-European observation platform

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Being a mountain community is essentially defined as what? Referring to Wittgenstein there is no essence to look for here. Wittgenstein's point is that we don't need an essential definition because we use 'mountain' successfully as a word emerging from "forms of life" - roughly the culture and society in which it is used. Different culture and society settings provides different observation platforms. This is why mountain research has to reflect the culture and the society that has enclosed a landscape form in their "form of life".

The paper presents recent work to define, identify and characterize mountain areas and mountain communities in Southern Norway from a domestic perspective. The analysis follow a methodology compatible with a pan-European analysis commissioned by the European Union (EU), but with threshold-values tweaked to adapt to a Norwegian "form of life".

The analysis commissioned by EU define, identify and characterize mountains and mountain communities in Norway from pan-European observation platform and include approx. 93 % of mainland Norway as mountain areas. The tweaked model chosen in our work include only 42 % of the landmass in Southern Norway as defMountain Area , that is roughly half of the area defined as mountains from the pan-European observation platform. defMountain Municipalities are defined as municipalities with at least 50 % of their territory as defMountain Area. 77 defMountain Municipalities are identified. The domestic observation platform render a more homogenous look at mountains in Norway than the pan-European does. In our domestic study

mountain communities is seen more challenged than domestic non-mountain-regions. This message gets lost in the broader picture brought forward by looking at mountains from afar, from a pan-European perspective. The domestic study concludes that: Population potential analysis reveals that the defMountain Area and its defMountain Municipalities as a group lags substantially behind the country average. Their trend is clearly negative compared to non-mountains areas. Accessibility analysis to selected public services shows that defMountain Municipalities vary in accessibility, with large subgroups of defMountain Municipalities suffering from a pronounced difficult accessibility times. Demography, labour market and industrial structure shows that defMountain Municipalities as a group experience a negative demographic development pretty much in contrast to the average municipalities outside the defMountain Area. The analysis of population potential, accessibility, demography and labour market reveals disparities within groups of defMountain Municipalities, but on average municipalities outside the defMountain Area faces a pronounced less difficult development situation. The paper then discuss coherence and disparities between the two platforms from which to observe mountains and mountain communities. Understanding of culture and society must be referred to the correct observation platform to apply the results meaningfully and within its proper limits. We then discuss what consequence this has for how the political and administrative machinery can integrate them in policy making.

Climate change response measures: think one step forward!

Wolfgang Pfefferkorn, Aurelia Ullrich

International Commission for the Protection of the Alps, CIPRA

Climate change is a fact, and it is particularly noticeable in the Alps. Politics, the economy and society have started to take measures either to adapt to changes in the climate or to mitigate them. The broad spectrum of measures includes snow guns, glacier films, avalanche baffle installations, renewable energies, passive houses and more public transport. They are all direct or indirect responses to climate change and its assumed impact. Yet not all the projects and technologies make sense and are sustainable. What sort of impact do they have on nature and the environment? What are their social and economic repercussions? Could it be that the ecological consequences of some climate programmes are even more severe than the impact of climate change itself? The CIPRA cc.alps project offers answers to these questions.

Oral presentation will be held by A. Ullrich-Schneider

Peace through climate change adaptation – innovative paths in the Biosphere Reserve Cinturón Andino, Colombia

Axel Borsdorf

Biosphere Reserves are designed to act as model regions of sustainable development. However, for decades sustainable development was impossible because of violent conflicts (guerilla and paramilitary activities, land right conflicts between indígenas and campesinos) in the Colombian Biosphere Reserve Cinturón Andino, and specifically in the Río Piedras/Puracé region. These conflicts and an irresponsible treatment of the natural resources endangered the water and energy supply for large parts of Colombia, biodiversity and many other ecosystem services of the “water tower” of Colombia. Furthermore the impact of climate change effects (drought, floods, soil erosion) also threaten the region. By cooperation of institutions of indigenous people and campesinos it not only pacification was reached in the Río Piedras/Puracé region but also a common effort to fight climate change effects by organic farming and environmental protection. The presentation includes a description of the conflict potential as well as an analysis of the climate change adaptation measurements, realized by indígenas and campesinos in the region. It can be proved that a peaceful coexistence and collaboration is possible through common efforts to face the challenges of climate change. Thus, the Cinturón Andino Biosphere Reserve can be regarded as a real model region of sustainable development.

Climate Change Adaptation In A High Mountain Environment Developing A Monitoring Expert System For Hazardous Rock Walls

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Introduction

The understanding of slope stability in high alpine rock walls is critical, particularly within the context of climate change. Numerous rock fall events in the Alps point to an increase of such hazards, probably as a direct response to changing climatic conditions. During the extremely hot summers of 2003 and 2005 a large number of rock fall events were triggered from steep bedrock areas underlain by permafrost, leaving massive ice visible in the exposed detachment zones. Investigations that corroborate these observations have demonstrated that warming of (permafrost) ice in rock joints can result in reduced slope stability. Permafrost warming and thaw are therefore considered to be a decisive mechanism through which climate change influences the occurrence of natural hazards.

Study Objectives

We investigate how slope stability in high alpine rock walls responds to climatic changes on short and medium term time scales. Comprehension of these responses is the basic prerequisite for the development of adaptation strategies for potentially affected population and infrastructure. With respect to changing climatic conditions we identify and analyse factors controlling slope stability in steep bedrock, most notably freeze/thaw and permafrost dynamics. The fundamental goal of the study is to achieve a better understanding of processes operating in high alpine rock walls. In this context we develop a general decision-support-system for slope stability assessment in steep bedrock. The decision-support system is drawn up as a transferable framework, implying that modules of the system are applicable to rock walls in other mountain regions.

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Study Area

The study area is situated at the Kitzsteinhorn, located in the Hohe Tauern mountain range. It is made up of rocks of the Glocknerdecke, primarily consisting of limestone-micaschists and greenstones. The infrastructure existing within the study area (ski-slopes, ski-lifts etc.) is directly affected by alterations of rock stability. The study area covers approximately 35.000m² extending from the top of the Schmiedingerkees glacier (2.950m) to the summit of the Kitzsteinhorn (3.204m).

Monitoring Concept & Applied Methods

Based on a combination of geophysical and geotechnical methods, surface and subsurface conditions are monitored. To investigate the subsurface thermal and geological situation five boreholes with depths between 20 and 30m were drilled. Each borehole will be equipped with temperature loggers allowing precise measurement of ground temperatures. In addition up to 50 temperature loggers will be installed to gather information on near-surface ground temperatures. Information on the subsurface situation will furthermore be gained through ERT (Electrical Resistivity Tomography), GPR (Ground Penetrating Radar) and Reflection Seismology. First ERT measurements show particularly promising results as ERT is very well suited to depict frozen and unfrozen subsurface regions. A permanent ERT-array will be installed in June 2011. Changes occurring at the surface (e.g. displacement of rocks, movement of rock joints) will be detected through the application of TLS (Terrestrial Laser Scanning) and the installation of fissurometers. Additional information will be gained from aerial photo analysis, measurements of the basal temperature of the winter snow cover (BTS) and the analysis of various meteorological data.

The quantification of changes in the alpine cryosphere and periglacial environment based on ALS data

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Creeping mountain permafrost, best represented by rockglaciers, is basically defined by its thermal conditions, material properties and its internal deformation. Rockglaciers typically creep at surface velocities of a few centimetres up to a few meters per year. In recent years, high resolution remote sensing methods gained attention for measuring surface deformations of rock glaciers. Optimal investigations of rockglacier creep requires: (i) area-wide surface and detailed information to account for 3D effects, (ii) in view of the low deformation rates, the application of precise high-resolution mapping techniques, and (iii) long-term monitoring for documentation of slow temporal changes at a sufficient level of accuracy.

Within the project C4AUSTRIA (Climate Change Consequences on the Cryosphere – funded by Austrian Climate Research Programme (ACRP), Österreichischer Klima- und Energiefonds) Airborne Laserscanning (ALS) data are applied to detect, quantify and analyse deformation rates of rockglaciers and adjacent periglacial elements, situated in four cirques in the Ötztal and Stubai Alps: Schrankar, Reichenkar, Hochebenkar and Ölgrube. Beside the base ALS data (2006) two ALS campaigns are scheduled in C4AUSTRIA. One of them was carried out in 2009, the second will follow in autumn 2011. In autumn 2010 an additional ALS campaign was realized within an alpS Centre for Climate Change Adaptation Technologies project MUSICALS (Multiscale Snow/Icemelt Discharge Simulation into Alpine Reservoir). Thus, at the moment at least three (a fourth campaign is available for the Reichenkar rock glacier) ALS data sets can be used to quantify and analyse changes in the cryosphere and the adjacent periglacial environment. Analogue aerial stereoscopic images from 1953, 1969, 1973, 1977, 1990 and 1997 and subsequent products are added to extend the time series. As a first, the multi-temporal ALS and photogrammetry digital terrain models (DTM) are subtracted from

each other to quantify volume changes of cryosphere elements (e.g. rockglaciers) and periglacial phenomenon (e.g. dead ice). Further, the respective ortho-images or the shaded reliefs (gained from photogrammetric aerial image processing as well as the ALS DTM) are used to calculate surface velocities of selected rockglaciers over the entire period from 1953 to 2010. If any (in general field observations in rockglacier areas started later than aerial photography), in-situ data (e.g. dGPS) are used to validate the volume changes and displacement rates, gained from ALS and photogrammetric information. Considering measurement errors, we can summarize: i) that the use and combination of photogrammetry and ALS allows high quality area-wide monitoring and quantification of rockglacier surface kinetics, (ii) that the geometric accuracy of our input data and applied methods is appropriate to calculate rockglacier surface velocities with low deformation rates and even low volume changes, (iii) that the combination of digital photogrammetry and ALS is a promising tool for a long term monitoring of rockglacier dynamics.

Under the assumption that permafrost surface changes are detectable by multi-temporal ALS data, modellers, stakeholders and decision-makers will benefit from the monitoring results and a sincere data analysis. C4AUSTRIA provides on one hand reliable information about climate change consequences in the cryosphere and periglacial environment and on the other hand a comprehensive methodological base for further investigations.

Acknowledgements: The ALS data series was compiled on base the ACRP (Austrian Climate Research Program) C4AUSTRIA (project number: A963633), the kind contribution of the Tyrolean Government (surveying department) and the alpS – Centre for Climate Change Adaptation Technologies project MUSICALS. We are very grateful for the valuable support

Climate Change Centre Austria – Vision, Mission and Structure

Johann Stötter, Helga Kromp-Kolb, Michael Staudinger, Karl Steininger, Josef Hochgerner, Angela Köppl, Sabine McCallum, Nebojsa Nakicenovic, Franz Prettenthaler, Sebastian Helgenberger

The Climate Change Centre Austria (CCCA) is a coordinating facility with the aim of fostering and strengthening climate research in Austria. In this context, the term “climate research” encompasses the scientific examination of climate change, its physical, political, economic, cultural and social causes and consequences, climate mitigation and adaptation strategies and identification of vulnerabilities and capacities.

The Climate Change Centre Austria does not carry out any research itself, but acts as a coordinating institution for Austrian climate research, promoting the research goals of its members (focusing on all aspects of climate research) in line with a strategic concept. The Climate Change Centre Austria sees itself as a point of contact for research, politics, media and the public in questions of Austrian climate research. This will strengthen trust between members and stakeholders, remove language barriers and, as such, is conducive to a sustainable climate dialogue in Austria.

In the medium term, the Climate Change Centre Austria will operate the following service facilities: (i) the permanent CCCA secretariat, (ii) the Climate Data Centre Austria and (iii) the Climate Service Centre Austria.

The vision of the Climate Change Centre Austria is sustained, high-quality Austrian climate research that is internationally distinguished and anchored in society. To fulfil the meta-goal captured within the vision, three focal points – the mission of the Climate Change Centre Austria – have been developed, for the realization of which strategic goals have been formulated:

1. To strengthen the climate research landscape in Austria;
2. To facilitate the development of a new generation of researchers and supporting knowledge transfer;
3. To advise policy and politics and society.

Changes in the glacial and periglacial environment of the European Alps and the Central Asian mountains and their socio-economic implications: a comparison

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The European Alps as well as the Central Asian high-mountain systems are experiencing substantial environmental changes. Such involve glaciers, glacial lakes, permafrost, the entire hydrologic cycle and the ecosystems. The work presented tries to compare recent changes in the two areas and their socio-economic impacts, focusing on two particular aspects:

- development of glaciers and glacial lakes. Whilst glaciers are important sources of water, some glacial lakes are potentially hazardous in terms of outburst floods (GLOFs).
- observed and projected development of permafrost: melting of permafrost may lead to increased susceptibility of debris or rock slopes to mass movement processes.

Primary research was concentrated to Central Asia, with a strong focus on the Pamir (Tajikistan): changes of glaciers and glacial lakes of selected areas were quantified with satellite imagery (1968 to 2009) and in the field. Most of the glaciers are in a stage of retreat which, however, does not occur uniformly, but in a spatially and temporally differentiated way. Numerous glacial lakes have formed or enlarged in the forefields of retreating glaciers. 172 glacial lakes were detected in the South-Western Pamir alone, most of them are growing, some are potentially hazardous. In 2002, sudden drainage of such a lake has triggered a catastrophic debris flow. Comparatively few glacial lakes have formed in the Alps, but hazardous situations exist as well.

Potential permafrost areas were delineated by applying resp. adapting an empirical approach developed for the European Alps. Based on IPCC scenarios, projections of future permafrost distribution were worked out. Whilst huge areas in Central Asia are affected by permafrost retreat, high-mountain regions there are sparsely populated and no reliable reports of damag-

ing mass movement events are known. The affected area is comparatively small in the Alps, but several cases where mass movement processes related to permafrost retreat have caused damages have become evident.

The extent of the glacial and periglacial environment is significantly larger in Central Asian mountains than in the European Alps, both in absolute and relative terms:

- if glaciers and permafrost per se are considered worth of conservation, the Alps are much more threatened. In Austria, for example, much of the glacier surface and most of the permafrost may disappear until the end of the 21st century;
- from a more practical point of view, larger problems are supposed to arise in Central Asia. Besides the formation of hazardous glacial lakes, huge areas may become free of ice and permafrost, and therefore susceptible to mass movements. In the European Alps, the potentially affected area is comparatively small, but the concentration of economic values at high elevation is much higher.

Central Asian mountain communities are much more vulnerable to environmental changes than those in the European Alps: on the one hand, water resources from high-mountain areas are highly important in the predominantly arid Central Asia, on the other hand, the socio-economic systems there are less capable to buffer negative effects. Targeted and well-planned action is required in order to foster adaptation of the mountain communities to the reported and expected changes.

Global Warming and Biosphere-Anthroposphere Shift in Mountain Regions of Kyrgyzstan

Aidaraliev A.A.

Progressing degradation of biosphere – deforestation, decrease of biodiversity, desertification, salinization, waterlogging, loss of humus; progressing degradation of anthroposphere - environmental pollution, drug dealing, religious and national extremism, migration and social disintegration of local societies and general crime growth are both the characteristic features of present Kyrgyzstan, and are mainly caused by two factors: land use and global warming. Some research suggests that global warming poses an even greater threat to biological diversity than land use (Sala et al. 2000, Thomas et al. 2004).

Global warming causes not only climate change but also the correlated chain, transformation of all systems of human life support: economic, ecological, social, political and cultural. The anxiety of world society is caused by the consequences of global climate change; that is clear. The climate is a key factor defining environment conditions of living organisms: temperature regime, humidity, pressure, soil composition, water content, biodiversity etc. It is obvious that environmental changes will entail a number of cardinal, and for some regions of the Earth, disastrous consequences. The World Bank came to the conclusion in its report "Adaptation to climate changes in the countries of Europe and Central Asia"- 2009 (page 37) that the countries of Europe and Central Asia are exposed to considerable threat due to climate change: rise of average temperature by 0,5° is observed in Central Asia and by 1,6°- in the south part of Siberia.

It should be remembered that natural climate changes occurred in geology history of our planet more than once. Associated transformations of environment resulted in deep reconstruction of biocoenose structure, disappearance of whole species and classes of animals and plants; and in human society- to the great migration of people, wars, change of farming forms and life style, ruin of civilizations.

For the last 40 years the mountain area covered by forests decreased, e.g. by half in the Kyrgyz Republic. Natural restoration of forests does not go on. Grasslands around villages are trampled down due to overgrazing and faraway summer grasslands are used not enough or are not used at all and covered by weeds. The area of cultivated land (about 7 % of the total territory) catastrophically decreased due to desertification, bogging or construction.

Soil erosion draws in 70 % of mountainous areas. The area of glaciers and eternal snow is decreased. The number of surface and underground water is decreased as well as the quality of the water becoming worse. Landslips, snow-slips, floods and other disasters are becoming more frequent (for the last 50 years) on the tops of mountains because of soil erosion and man-caused impact.

Market approach of the mankind to a biodiversity of mountain ecosystems also has adverse consequences. Uncontrolled and excessive gathering of wild-growing and curative grasses, mushrooms, wood threatens a biodiversity of mountain territories. Injurious destruction of flora and fauna in these territories is promoted by absence effective state and public control. As a result, in Kyrgyzstan 11 kinds of animals have already disappeared, under the threat of disappearance there are 92 more kinds of animals and 65 kinds of plants. A destruction of nature and mountain resources might be irreversible.

In many respects the level of poverty of Kyrgyzstan population has a tendency to lowering but still it is high on the base of the before mentioned factors. For example, according to the information of the National Statistic Committee of the KR the general level of the poverty was 31,7 % in 2008, and level of extreme poverty was 6,1 %.

Aspects of Climate Change in High Mountains of the Balkans

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With an innovative archive and method network, consisting of dendroecology work in treeline ecotones, physical and chemical investigation of firn and ice-layers of a glacieret as well as its surrounding and the analyses of climate data, a set of interpretation and coupling approaches were applied and advanced. We realised the glaciological, pedological and dendrological examinations predominantly with regard to climate, particularly in historical time spans.

The climate variability for the last ~ 15,000 years can be described with the help of cirque-lake-sediments, peat bog profiles and fossil soil developments/charcoal. The Pirin Mountains region is well researched in this regard. The results confirm a relative climatic stability during the past 10,000 years, however clear changes in the tree population of the timberline were observed as a result of climate modifications and vegetation-historical developments. Optimal conditions for vegetation and soil development existed during the Sub-Atlantic and the Early Middle Ages, which nowadays lie significantly above the timberline. There is an obvious synchronicity with times when social development flourished (during the first and second Bulgarian state). Climatic pessima occurred during the Subboreal and the “Little Ice Age”. During that time, the cultural-historical development in Bulgaria was at a standstill.

Numerous small glaciers, glacierets and perennial snow/firn patches exist in mountain areas of the Balkan's. They respond quickly to weather extremes. However, despite the trend towards warmer years since the late 1970s, some glaciers still survive - even after some of the hottest summers on record. The dominance of local climate effects on accumulation and ablation, such as avalanching and shading, is likely to insulate them from the effects of regional climate effects.

A secured reconstruction of climate and landscape development requires geoarchives with a high temporal resolution. In this study we compared *Pinus heldreichii* from ecologically different sites located close to each other in the Bulgarian Pirin Mountains. This tree is a conifer, growing up to 1,000 years. Generally, this species only occurs on the Balkan Peninsula and in

the southern part of Italy. The spectrum of parameters comprises tree ring width (total, early and late wood), wood density (minimum and mean early wood density, mean and maximum late wood density) as well as stable isotopes ($\delta^{13}C$, $\delta^{18}O$). *Pinus heldreichii* demonstrate a mixed climate signal, influenced by both high summer temperatures and periods with low precipitation. Mild winters have a positive growth effect. So it is possible to obtain precise data for the past periods with both, extremely dry or cold years. The series of tree ring width correlate with individual climate parameters and indicate colder climate conditions at the timber line ecotone between the 15th and mid-19th century.

Existing historical climate records gathered in the area have been researched, checked and statistically examined. The mountainous climate has been characterised and trends in the evolution of temperature and precipitation since 1931 have been outlined. A seasonal temperature increase, longer vegetative periods, and shorter, warmer winters with less snow were observed in mountainous regions of the Balkans, particularly in the Rila-Pirin region. Furthermore, the intra-annual variability of precipitation has shifted. There is also a decreasing trend of the snow-rain ratio.

This type of climate change could also have socio-economical consequences, such as the reliability of snow cover in the Bulgarian ski resorts and the sustainability of the water supply in the currently booming Bansko ski resort, situated at the foot of the northern Pirin Mountains. Being a regional “water tower”, a significant modification in the southwestern Bulgarian mountains water resources would also be a far-reaching impact on the water reservoirs and the irrigated agriculture in northern Greece.

Grunewald, K., Scheithauer, J. (2011): Landscape development and climate change in Southwest Bulgaria (Pirin Mts.), 1st Edition, Springer Verlag, Heidelberg, p. 244

Changes in Monsoon Pattern and its Impact on Water Resources: Community Responses and Adaptation

Dr. Prakash C. Tiwari

The Indian monsoon has shown sweeping changes both in terms of inter-seasonal variability and distributional pattern of rainfall over the last 15-20 years decreasing number of rainy days as well as the amount of rainfall, increasing incidences of extreme weather events, particularly, droughts, dry spells; cloud bursts etc. and disrupting hydrological system in Himalaya. As a result, regime of water resources is changing in terms of discharge, volumes and availability in the region. Himalaya being tectonically alive, economically underdeveloped and one of the most densely populated mountain is highly vulnerable to these changes that may cause substantial decrease in availability of water, and consequently increase the proportion of water, health, food and livelihood insecure people in large part of Asia primarily dependent on subsistence agriculture.

Main objective is to analyse changes in Indian monsoon and assess its impacts on regional hydrology and water resources, and interpret community responses and adaptation practices to these changes with a case illustration of Kumaon Himalaya in India.

Number of rainy days and amount of rainfall has been taken into account for observing the changes in monsoon pattern that were analyzed through (i) interpretation of long-term meteorological data; (ii) rate of groundwater recharge and status of reserved water has been examined using standard hydrological techniques supported by available published literature; and (iii) information pertaining to water discharge in springs and streams and their status were collected through long-term hydrological monitoring; (iv) community responses

and adaptation were analyzed and documented through empirical investigation and primary surveys carried out in 25 % villages.

Study revealed that number of rainy days has declined by 25 % and annual rainfall has decreased by 40 % during last 30 years. The frequencies of droughts incidences of dry spells have increased by 21 %. Consequently, groundwater recharge has reduced by 19 % and water discharge in streams and springs has diminished by 35 %. Nearly, 45 % natural springs have gone dry and perennial streams are disappearing at an alarming rate of 4.5 km/year. Consequently, as many as 60 % villages are facing great scarcity of water for all purposes, irrigation potential has reduced by 15 %, and the agricultural productivity has declined by 25 % rendering the traditional subsistence agricultural and food systems highly vulnerable to long-term impacts of climate change. It is expected that these observed changes in monsoon behaviour may cause 45 % decline in food productivity in Himalaya and adjoining lowlands by 2050. The study indicated that local people have been trying to respond and adapt to these changes through their traditional ecological knowledge and experiences. It was observed that local communities are replenishing water sources through water conserving forestry and horticultural practices, cultivating less water requiring and drought resistant crops, harvesting of rainwater through community participation, altering traditional cropping pattern and adjusting crop rotation, cultivating abandoned land, relocating agriculture.

Rainfall Variability in Nanda Devi Biosphere Reserve, Indian Himalaya

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The paper analyses the trends of climate variability together with spatial pattern and its driving forces in Nanda Devi Biosphere Reserve (NDBR). The paper uses secondary sources of data regarding rainfall and topography. The rainfall data for two meteorological stations i.e. Joshimath (western NDBR) and Munsyari (NDBR) were collected from Indian Institute of Tropical Meteorology, Pune. Instrumental observations pertaining to rainfall for all the six surface observations in NDBR viz. Mana, Badrinath, Joshimath, Tapovan, Ghangaria and Munsyari were collected from IMD Lucknow and IITM Pune. The first five observatories are located in the Garhwal Himalayan part of NDBR and the sixth in the Kumaon Himalayan part. Though, all the observatories suffer large data gaps and four observatories have been closed way back. Joshimath and Munsyari are the two observatories for which long term observations are available i.e. 1958-2005 and 1957-2005 respectively with some data gaps. The variability of rainfall was calculated using co-efficient of variation method, whereas the trends of the rainfall was analyzed using slope analysis. The characteristics of topographic features like orientations and elevations etc. were studied from topographical maps of Survey of India, Landsat satellite images and other published relevant research papers. The analysis of characteristics of rainfall shows that there are major differences in rainfall of both the meteorological stations.

The normal rainfall in Munsyari (2636 mm) is more than that of Joshimath. The reserve has strong monsoon effect on rainfall pattern. About 80 per cent of annual rainfall occurs over a short period of two months (July and August) indicating a strong monsoon influence. It is a well established fact that the climate has changed over the period of time across the world. However, experiences have been different e.g. a few areas have experienced climate cooling and a few climate warming. NDBR is located in the high altitude Himalayan region NDBR has experienced the decreasing trend of rainfall. The deficit has mainly been contributed sharp decline of monsoon and post monsoon rainfall. The eastern part, on the other hand, has experienced increased rainfall except of winter seasons. The variability analysis of rainfall indicates that the rainfall in the western part is more stable over the years and within a year relative to the eastern part. The eastern part has highly erratic rainfall. The climate change influences the ecosystem and its components. The glaciers, vegetation and natural hazards are the first elements of earth's ecosystem to face these changes. Also, these are the very first indicators to report the climate change. A little change in temperature and rainfall is clearly reflected in the shrinkages and advancement of glaciers, change of greenness of vegetation, the succession and loss of species and changing magnitude and frequency of the natural hazards.

Reinventing A22

Arianna Scaglione

Non printable abstract.

ALPENPARK EUROPA VISION 2030

DI Dr. Birgit Thöni

In view of massive socio-demographic, economic and climate changes in alpine areas, the spatial development a major challenge is made. For there is an imbalance exists in the alpine area events, especially as disparities between declining rural regions such as Osttirol, and the ever-growing urban regions, such as outweigh the Inn Valley. The Spatial Development tried this calamity of a progressive resolution process through part repair counter, without seeking a holistic approach methodically and thus achieve even without long-term results.

This fact, that are increasingly shrinking regions of dominance of urban regions over which offer people urban infrastructure and atmospheres, calls for the development of visionary new spatial development concepts. Call even after Tolstoy concepts that an "island" as Osttirol can make it an attractive habitat. It is therefore necessary parameters, methods and frameworks be developed, which guarantee the quality of space for the people and preserve the "city" before an overload in terms of density and infrastructure.

In this sense, the investigation "Alpine Park Vision Europe 2030" in a narrative and literary methods of identified design of a hypothetical future vision and a possible answer for the space development in the alps, where the principle of sustainable development in accordance with ethical principles, respectively, is investigated within a minimal dimension of ethical reasoning, evaluated and applied to the region of Osttirol. Basis of the investigation are a critical analysis

of reality, the representation of the development trend and the generation of ethically argued quality criteria. The contrast scenario "Alpine Park Vision Europe 2030" reaches out for regional planning perspective, the problems of depopulation, aging and isolation in a rural area and places the resulting loss of mobility, identity and authenticity in the center. Through minimal ethical challenge models are developed and subsequently set practices, ensures that the (life) space of the population and will strengthen the regional identity. The result is a holistic and macroscopic view of the area, which goes through the "innovative" methodological link Scenario-ethics-integrated sustainability triangle to the model "Micropolregion" or "Micropoles", to overcome the prevailing cognitive dissonance in the room.

This contrast-scenario is only one possible future of many futures for an alpine region, which, however, to this day due to lack of implementation structures, such as a regional governance, even in extremely abstract settles. Despite all the postmodern society demands in light of the socio-demographic and environmental problem area in the alpine area and continually update their human-natural models, which run through a rational and ethical assessment of interdisciplinary data and new interpretation of causality tests, even visions.

BEYOND USE – Phenomena embedded in abandoned objects in the Alpine Territory between the Allgäu Region and Lake Garda

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Die Dissertation "Beyond Use" untersucht brachliegende Objekte (stillgelegte Skilifte, Hotelruinen, Militäranlagen des 1. Weltkrieges) im Alpenen Raum. Basierend auf dem phänomenologischen Ansatz werden die entfunktionalisierten Figuren hinsichtlich ihrer Beziehung zur umgebenden Natur analysiert und kategorisiert. Durch diese Herangehensweise können die Gebäude systematisch "neu" betrachtet und eingeordnet werden. Das Forschungsergebnis soll als alternativer und kritischer Beitrag die wissenschaftliche Entwicklung von Zukunftsszenarien unterstützen.

Der Untersuchungsgegenstand ist das "Phänomen", welches in dieser Arbeit aus der spezifischen Situation/ Beziehung zwischen Objekt und Natur hervorgeht. Ziel dieser Untersuchung ist es, die beobachteten Phänomene klassifizieren und typologisieren zu können.

Im Fokus dieser Arbeit steht dabei die Thematik der Landschaft mit Schwerpunkt auf Sehen und Interpretieren dieser. Ausgehend von den in der zweiten Hälfte des 20. Jahrhunderts von John B. Jackson propagierten "Sehen" in Mustern, kommen weitere Diskussionen im Umgang mit ehemaligen Industrieanlagen, vor allem in der theoretischen Betrachtung der "Dritten Landschaft" vom französischen Landschaftsarchitekten und Philosophen Gilles Clément hinzu. Diese theoretischen Überlegungen über das Terrain werden anhand der entfunktionalisierten Gebäude im Alpenen Raum untersucht. Die Erstellung der neuen Typologien beruht auf umfangreichen Analysen und Bearbeitungsschritten. Dazu wurden unter Anwendung eines zirkulären Ansatzes Maßnahmen entwickelt, anhand dieser die Kategorisierung und Typologisierung durchgeführt wurde. Die Typologien sollen eine neue Betrachtungsweise der Branchen inklusive ihrer speziellen Erscheinungen generieren.

Die dokumentierten Fallbeispiele befinden sich in den Ostalpen, entlang der von Norden nach Süden verlaufenden Achse vom Allgäu/Deutschland über die Fernpassroute Richtung Innsbruck/Österreich – Brenner, bzw. über den Reschenpass – Stilfser Joch/Italien und von Bozen/Italien ab entlang des Etschtals bis zum Südende des Gardasees bei Verona/Italien.

Autor:

Architekt Dipl.-Ing. Dr. techn. Alexander Pfanzelt

(Dissertation an der Fakultät für Architektur 2011)

Hydrometeorological monitoring and modeling in mountain catchment. An application in the french Alps (Belledonne, Isère, 38)

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Nowadays, the understanding of the hydrological processes in mountain areas is a great challenge in the perspective of the climatic evolution and his impacts and consequences on the alpine population and society. Thus, the phenomena of flash flood or low water level event, will be probably more frequency and more intense that today. In this perspective, an hydrometeorological observational network has been installed on a small mountain catchment in the Belledonne massif in French Alps. In this communication, we will present the main results and we focus on two specifics points: the characteristics of the local meteorology (temperature and snow) very variable with the elevation and the aspect of the catchment and the snow cover evolution and its particularity.

The mountain meteorology is very complex to integrate in the simulation model, but it is essential to correctly model the water balance. Thus, we installed a meteorological observation network on the catchment operational since October 2009. This network is composed of 40 temperature sensors (22 in the air and 16 in the soil) with a maximum sampling of elevation and aspect and a high spatial and temporal resolution. In addition of these sensor, we installed at the same time 3 traditional meteorological stations with greater accurate temperatures sensor, rain gauges and cumulative snow gauges. Using this equipment we are able to calculate different local orogenic and spatial gradient for the temperature and precipitations. The strong spatial variability of our temperature sensors allows calculating hourly temperature maps all over the catchment.

Among all parameters of mountain hydrometeorology, one very important to understand is probably the snow. Thus, we develop during this research program an original sensor able to create snow cover map from simple automatic terrestrial photography. These images come from two camera installed on the catchment since October 2009. We will present briefly the techniques of acquisition and treatment and the capacity of the system to generate snow cover maps to obtain different information of spatial and elevation variation of the snow. Indeed, the local variation of quantity of accumulating snow or melting snow can be observe and quantify with this system and allow feeding different snow stock models in the future.

All sensors placed on the catchment will allow better observing and analyzing the spatial variability of hydrometeorology of mountain catchment according to the elevation, the localization or the exposure. Moreover with the quantity of sensors and the sampling step we possess a very high density network and a high spatial and temporal resolution of all these parameters. This density and this resolution of the network is expected to compensate the uncertainty lied to meteorological measurement within mountainous region.

Thus, we used these results for study the spatial heterogeneity of hydrometeorology of mountain catchment and better understand the essential rule of the snow in hydrological processes in mountain. This model take place in a more large project to create a reliable hydrological modeling of the hydrology on mountain catchment with the goal to cooperate in the water resources management especially in conditions of flash flood and water scarcity events.

Assessing coupled and decoupled sediment fluxes in the Johnsbachtal valley as a tool for river management and renaturation

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Alpine rivers have undergone significant changes over the two last centuries. Human activities have modified their geometry through engineering measures to gain land for agricultural purposes and settlements, as well as through active mining to exploit gravel resources. Their sediment and water transfers have also been altered by hydro power plant construction, control works on high-gradient streams, and land-use changes. The resulting river morphological changes have led to abiotic (e.g., river bed degradation and narrowing) and biotic (e.g., longitudinal and lateral disconnection) disruption. The current critical management situation (channel instability problems, flood effects, biodiversity decrease) has made river restoration a major issue in the Alps and their surroundings.

Effective sediment management requires profound knowledge on the sediment cascade in the headwaters. In most cases, the sources and (temporary) sinks of sediments are unknown and the river system is treated as a “black box”. In our planned project we intend to develop a conceptual model of coupled and decoupled sediment routing in the Johnsbachtal system (Nationalpark Gesäuse), to quantify the most prominent sediment fluxes and sediment sinks. Our applied methods are associated to the geomorphic process chain from source to sink.

Sediment input from rockfalls will be investigated using ERT survey lines and further moisture measurement techniques, to monitor the effects of moisture on frost weathering by frost events. TLS measurements are carried out to determine the spatial distribution of rock fall rates. Quantifying erosion and debris flow processes will be achieved by means of yearly TLS surveys. Combining diachronous surveys (cut-and-fill analysis) enables to locate areas of mass loss and accumulation. The precedent mapping and the ALS overview surveys ensure that the measured processes are representative for wider areas. The thickness and structure of important sediment bodies at the slopes and in the valleys will be investigated using GPR. The results of all steps of quantification will be transferred to the entire study area (Johnsbach catchment) using the mapping results and GIS analyses. Measuring bedload transport in the Johnsbach will be achieved using a mobile basket sampler and geophone installations. The output will be a sediment budget model of the Johnsbachtal. The step towards application comprises the analysis of current management problems (amount of “missing” sediment) and the possible consequences of artificial barriers being altered or removed. Changing sediment fluxes in response to climate change have to be considered.

Analysis of changing channels in an anthropogenic influenced high alpine catchment

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Global change in high alpine regions does not only imply climate change but also change due to anthropogenic factors. The increasing mobility of people and expansion of settled and frequented areas, respectively, implies pressure also on remote areas like high alpine regions. Consequently, a balance between functionality of the landscape and the changing processes has to be found in order to ensure sustainable development. However, not all changes are purely anthropogenic caused but these changes interact with natural factors, processes and thus sources of changes are difficult to distinguish.

The relief energy in high alpine regions makes surface processes happen faster and more destructive than in other regions. The changes due to environmental change may include increased number of landslides, bed load transfer and also changing channel processes. Facing this challenge a detailed analysis of the landscape over time is necessary to understand what happened in the past thus take actions for future maintenance.

The investigation area is the Idbach catchment in Ischgl, Tyrol. The geology of this catchment being diverse plus the high relief energy makes surface processes very dynamic and active. This presentation focuses on the change of channel processes under increasing

anthropogenic influence on the hydrological system. Remote sensing is used to monitor and highlight the channel processes thus monitor the on- and off-site anthropogenic interference in the environment. A multi-temporal analysis of aerial photographs plus field mapping for the present situation is conducted. To allow a comparison between the different periods the results are mapped into ArcGIS. Qualitative analysis as well as a statistical analysis of areas and lengths supports these results.

The results show that the length of anthropogenic influenced channels increased up to 40 % among the total number of channels during the investigating period. Over the same time period a decrease of torrents in the catchment can be observed. Thus, the results show clearly that channel processes change over time and that anthropogenic interference has also side effects. In order to keep up the function of these channels - hence the sustainable functionality of the landscape - a detailed understanding of the channel development is necessary. This analysis is a first step towards sustainable future management of high alpine catchments, concerned with anthropogenic interference.

Interactive analysis of alpine climate change and water consumption to discover regions prone to water scarcity in a WebGIS

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Since the beginning of systematic monitoring of meteorological phenomena in the year 1861, many scientific studies underpinned that increasing climate change has happened in the last two centuries. These findings are based on comprehensive existing climate related data assets. Although notable amounts of data have already been prepared digitally, data accessibility for the public is still extremely limited. To let the society experience climate change and its trends from past records, we established a web platform prototype (<http://maps.geo.sbg.ac.at:8080/aws/>) to improve the access to spatial data for public sector bodies, private companies and citizens in the Alpine area in order to provide decision support and awareness rising. Analysis of climate change for a defined time period is possible by listing tables of e.g. daily temperature and precipitation values or to view an on demand graph on temperature or precipitation trends.

Seasonal shifts, where a high number of both deluges and droughts have been noticed in a regional context, have been observed in the Alpine area in recent years. Seasonal decrease and uneven distribution of precipitation and groundwater recharge patterns are already the case in the southern, western, eastern Alps, and central alpine valleys. In the Austrian Alps,

+200 years' time series indicate in certain regions increasing temperatures and decreasing precipitation as well as significant decrease of groundwater recharge in the order of 25 % in the last 100 years. To localise Alpine regions prone to water scarcity we compared water availability with water consumption at a certain time period of the year. Based on Eurostats statistics at NUTS 2 and 3 administrative regions we analysed water consumption e.g. from society and tourism, indicating the spatially explicit water consumption.

Further developments will cluster, integrate and keeping alive the findings of climate and Alpine Space related projects and makes datasets, results and aggregated knowledge available to the expert community, decision-makers, and practitioners. We consider aspects of data organisation, data harmonisation as well as semantic and technical interoperability in order to produce seamless geospatial information and to improve the data access for the wide community of different user groups. The accessibility of digital climate data for better (re)usage and exploitation will be one of our focal aspects implemented in a Web Processing Service (<http://geo.researchstudio.at/nbglive/>).

Long Term Ecological Monitoring Initiatives for Conservation of Gaumukh Glacier Western Himalaya, Uttarakhand India

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Conservation of biodiversity in upper catchments of Himalayan rivers, crucial watersheds and threatened high altitude ecosystem entail landscape level planning and inter-disciplinary approach for long term ecological monitoring in the trans boundary ecosystem. In north part of Uttarakhand state of India, the areas has been designated as Gangotri landscape, makes an appropriate case for such a trans boundary conservation planning. It is extremely rich in biodiversity, socio-cultural milieu and trans-boundary historical linkages. The people of this landscape share several commonalities including worship of principal deity, Lord Shiva, in various forms. Though, this region harbours a large number of rare, threatened and endangered species of flora and fauna, very little efforts have been made to conserve such species at a landscape level. The area with one of the high altitude protected area Gangotri National Park (GNP), much of the area support alpine and cold desert of Himalayan ecosystem. The GNP (lat. 78°45' to 79°02' east and 30°50' to 31°12' north) is located in the upper catchment of Bhagirathi river named as Ganga which originate from the Gaumukh glacier located inside the park. The Gangotri, after which the park has been named, is one of the holy shrines of Hindus. The northeastern park boundary is located along the international boundary with Tibet. It falls under the biogeographical zone – 2A west Himalaya and covers an area of 2,390 sq km.,

including a considerable stretch of snow-clad mountains and glaciers. The park area forms a viable continuity between Govind National Park and Kedarnath Wildlife Sanctuary. The landscape with high ridges, deep gorges and precipitous cliffs, rocky craggy glaciers and narrow valleys. There is a high variation in the elevation gradients from 1,800 to 7,083m, which in turn reflects in the diverse biomes, from subtropical communities to alpine meadows. So far 15 species of mammals, 150 bird species and more than 200 species of butterflies, moths and other insects have been documented from the landscape. This includes some of the rare and charismatic mammalian and bird's species such as snow leopard (*Uncia uncia*), black bear (*Selenarctos thibetanus*), brown bear (*Ursus arctos*), musk deer (*Moschus chrysogaster*), blue sheep (*Pseudois nayaur*), Himalayan tahr (*Hemitragus jemlahicus*), Himalayan monal (*Lophophorus impejanus*), koklass (*Pucrasia macrolopha*) and Himalayan snowcock (*Tetraogallus himalayensis*). Large number of religious tourists is visiting the glacier every year and causing high impact on the floral and faunal diversity including glacier ecosystem. For the first time inter-disciplinary approach was adopted for long term ecological monitoring design for the conservation of biodiversity of the landscape and protection of glacier.

CryoLand – GMES Service Snow and Land Ice

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|---|---|
| (1) ENVEO IT GmbH | (7) NORUT AS |
| (2) EOX IT Service GMBH | (8) Administratia Nationala
de Meteorologie R.A. |
| (3) Finish Environmental Institute SYKE | (9) GAMMA RS AG |
| (4) Finish Meteorological Institute | (10) Swedish Meteorological and
Hydrological Institute |
| (5) Kongsberg Satellite Services AS | |
| (6) Norwegion Computing Center | |

“CryoLand – GMES Service Snow and Land Ice” is a 4 year project supported by the 7th Framework Programme of EC, which started in February 2011 and is coordinated by ENVEO. ENVEO. The developing, implementing and validating a standardized and sustainable service on snow and land ice monitoring as a Downstream Service within GMES in a value added chain with the Land Monitoring Core Service. It will receive Earth observation satellite data input directly from the Sentinel GMES Space Component. CryoLand will be a service to provide geospatial products on seasonal snow, glaciers, and lake / river ice derived. The project will build upon, integrate and widen structural and technical capabilities of the project partners who have long term experience in running operational and pre-operational services on snow and ice. Users will play a key role in the definition of service requirements and in the validation of the satellite derived products and services. Snow and ice products in near-real time delivery will be supplied with pan-European coverage, as well as with national and regional coverage as required by the users. The project developments will build upon tools and processing

lines that are available at the partner institutions for generating snow and ice products. The portfolio of snow and ice products will be improved and augmented in order to better match the user requirements. The product processing lines will be automated. An important part of the project will be the design, development and implementation of a network services system for CryoLand that will ensure interoperability of the infrastructure by compliance with INSPIRE and GEOSS, and by integration with the Land Monitoring Core Service, the GMES Space Component Coordinated Data access System as well as the required in-situ and reference data access. Full end-to-end tests and verification will be performed for the products and services in pre-operational environments, based on rigorous procedures and protocols for testing, validation and qualification. During the second phase of the project full performance demonstration of the system and comprehensive promotion and dissemination work is planned in order to prepare for the transition to a self-sustained operational snow and land ice monitoring service.

Radiometric calibration of airborne laser scanning data for the analysis of alpine cryosphere and periglacial environment

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In the last years airborne laser scanning (ALS) became a standard technology for the acquisition of topographic data. Due to its ability to accurately and densely sample the terrain surface it became a widely used technique for the generation of digital terrain models. For the analysis and classification of the topography, geometric criteria derived from the acquired 3D point cloud are typically used. Moreover, ALS systems deliver the amplitude of each echo (often referred to as intensity) in addition to the 3D position. In contrast to standard discrete echo ALS systems, advanced full-waveform ALS systems allow to digitise the whole return signal and they are therefore additionally able to estimate the echo width of each acquired 3D point. Based on these additional physical observables (amplitude and echo width (either observed or estimated)) the return power of the target can be calculated. This allows, next to an analysis of the geometry, a radiometric interpretation of the observed surface.

In order to study the radiometry acquired by ALS sensors a correction of the point-wise influencing factors (e.g. range, angle of incidence, surface characteristics, atmosphere, etc.) has to be performed. By using reflectance values of in-situ surfaces within the area of interest, e.g. determined with a RIEGL (RIEGL Laser Measurement Systems GmbH, Austria) reflectometer and Spectralon® targets, radiometric calibration enables to convert the amplitude and echo width into absolute radiometric values which describe the characteristics of the observed surface. With the help of this radiometric calibration the gained radiometric values can be compared between different flight strips, different flight missions, and even different sensors (if the used laser wavelength is identical). With this procedure, classification becomes independent of individual sensor and mission parameters.

Within the project C4AUSTRIA (Climate Change Consequences on the Cryosphere – funded by Austrian Climate Research Programme (ACRP), Österreichischer Klima- und Energiefonds)

ALS data are applied to analyse radiometric information gained from ALS data for the classification of the cryosphere and periglacial environment. Within C4AUSTRIA two ALS campaigns are scheduled and next to the geometric information the calibrated radiometric values will be compared. In this contribution, the results of absolute radiometric calibration stemming from the first ALS campaign carried out in 2009 will be presented. Next to the practical workflow of the whole radiometric calibration procedure the results of the rock glacier Hochebenkar, located about 5 km south of Obergurgl (Ötztal Alps, Tyrol, Austria), will be presented. Next to a study of the relative accuracy of the calibrated radiometric values, the resulting radiometric image mosaic (calculated from multiple ALS strips) will be analyzed. It will be shown that the study of the radiometry allows to classify different ice and surface types. Based on these results, it will be demonstrated that calibrated radiometric information from ALS data can be used to support the documentation of the actual status of these complex cryosphere and periglacial environments.

Under the assumption that permafrost surface changes are detectable by multi-temporal ALS data, modellers, stakeholders and decision-makers will benefit from these radiometric classifications. C4AUSTRIA provides on one hand reliable information about climate change consequences in the cryosphere and periglacial environment and on the other hand a comprehensive methodological base for further investigations.

Acknowledgements: The ALS data series was compiled on base the ACRP (Austrian Climate Research Program) C4AUSTRIA (project number: A963633), the kind contribution of the Tyrolean Government (surveying department) and the alpS – Centre for Climate Change Adaptation Technologies project MUSICALS. We are very grateful for the valuable support.

Quantitative analysis of local snow accumulation patterns on an alpine glacier surface derived by LiDAR data

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Alpine glaciers have an important amount on freshwater storage which implies functions in terms of freshwater reservoir itself, energy economics or natural hazards. Thereby, investigations of dependencies and the stability of annual recurrence of snow accumulation patterns on alpine glacier surface can provide knowledge about relationships between glacier mass balance and topography.

Further snow redistribution in high mountain catchments leads to both, stable as well as infrequent accumulation due to gravitational and wind induced snow transport. These redistribution effects and hence potential melt surface in ablation season influence directly the discharge regime of the subsequent channel.

Due to the technological improvements of airborne laser scanning (ALS), monitoring on surface elevation changes in remote high alpine regions has gained more attention in a lot of studies. Thus, due to higher accuracy compared to photogrammetric DEMs, there are further possible applications with high resolution DEM, especially with the presence of multi temporal data. In order to monitor snow height, ALS provides, beside the necessary accuracy and a wavelength of ~1000nm for glacier surface, data to apply quantitative methods.

Against this background, relationships between surface elevation change and the influence of topographic parameters are estimated by using linear regression models. For fitting the mod-

els, the explanatory variables slope, wind shelter, and curvature were used. Afterwards, the corresponding residuals are plotted into one map applying the rule of best fit value. In that case, the residual maps allow a visual impression of the influence of topographic parameters on the snow height distribution in the test site Kesselwandferner (KWF) (Tyrol, Austria). These calculations are made over the snow accumulation periods of the years 2001/02, 2002/03 and 2006/07. It has to kept in mind that the according surface elevation changes integrate effects of mass accumulation/mass ablation and glacier dynamics. Particularly at KWF glacier dynamics are of a very strong rate.

Hence, additional glaciological investigations on horizontal and vertical velocities of KWF could explain part of calculated residuals. This leads to an improved quality assessment of the residual maps. Further, (i) extraction of stable accumulation zones, (ii) zones dominated by precipitation amount and (iii) infrequent snow loads gain insight into snow cover heterogeneity induced by local climate and topography. Grid based analysis of multi annual snow accumulation patterns can provide a basis for assessments on future high mountain catchments hydrology and its impacts on human utilized resources, e.g. hydro power, under changed climate conditions.

Effect of Elevated CO₂ on Diverse Plant Species of Alpine Broad Leaved Growth Forms

M. C. Nautiyal^{}, Ashish K. Chaturvedi*

Climate change which is characterized by global warming has debatably greater, rapid and impulsive impact on alpine regions than in lowland areas. For studying the growth responses of different growth forms of alpine broad leaf species in enriched CO₂ environment, an attempt was made in alpine region of Tungnath in Garhwal Himalaya, India using Open Top Chambers (OTCs). In the present study, we selected different growth forms viz., mat forming forbs (*Plantago major* Linn.), rhizomatous forbs (*Rumex nepalensis* Spreng.), stoloniferous forbs (*Picrorhiza kurrooa* Royle ex Benth.) and prostrate creeping dwarf shrubs (*Skimmia laureola* Hook. F.). Seedlings of all these growth forms were grown at ambient (330±50µmolmol⁻¹) and elevated CO₂ (650±50µmolmol⁻¹) condition and seasonal study was conducted with the view to i) assess morphological changes in alpine growth forms grown under elevated CO₂, ii) understand photosynthetic behavior of selected species of different growth forms subjected to CO₂ enrichment, iii) know the effect of elevated CO₂ on the dry matter allocation of selected alpine species.

Overall, study revealed that responses of alpine species under elevated CO₂ were species specific. Out of four studied growth forms, three growth forms viz.: rhizomatous forbs (*Rumex nepalensis*), stoloniferous forbs (*Picrorhiza kurrooa*) and prostrate creeping dwarf shrubs (*Skimmia laureola*) have revealed positive sign in growth, morphological behavior, increased photosynthesis expressed per unit area and increased starch content in leaves which was associated with higher final biomass after 90 days of CO₂ enrichment. Whereas one growth form i.e. mat forming forbs (*Pantago major*) have shown a negative response of elevated CO₂ as growth and morphology was stunted in this species due to CO₂ enrichment, also photosynthesis was lowered in leaves of elevated CO₂ grown plants. Shoot and root dry matter accumulation of different growth forms also increased under elevated CO₂ excluding mat forming forbs. Root biomass showed greater increase than shoot biomass in selected species under elevated CO₂ condition.

This work from alpine region of India will provide a preliminary picture on some of the morphological and physiological aspects of selected species of alpine growth forms under elevated CO₂. Therefore it will also provide the methodology, strategy and complexity for the future research in relation to climate change in alpine regions. It will also be helpful in predicting the future of alpine plants to changing climate.

Ten Years of ALS Measurements in the Hintereisferner Region (Ötztal Alps, Austria) – A Review and an Outlook

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Since ten years the Institute of Geography at the University of Innsbruck has organized ALS campaigns in the Hintereisferner region (Ötztal Alps, Austria). Starting in 2001, 20 ALS flights have been carried out so far, leading to a worldwide peerless ALS data series. According to the glaciological focus of the underlying projects, one ALS flight was managed at the end of each hydrological cycle (October 1st to September 30th). Five flights (two flights in 2002, one flight in 2003, 2009 and 2011) out of the series were done at the end of the accumulation period (beginning of May). Additionally five ALS campaigns (three in 2002, one in 2003 and 2008 respectively) are used to increase the knowledge of the spatial behaviour of the glacier ice bodies in the Hintereisferner region during the ablation period.

The presentation is subdivided in three parts. Part 1: Details about the entire available data series are given, comprising measurement details (e.g. sensor types, point densities, purpose of flight, funding agencies) as well as information on the reliability and the degree of accuracy. Part 2: A sincere analysis of the ALS data calls for an extensive method development. This gives a comprehensive overview of the so far developed related methods and database structures, used for the analysis of the ALS data series. Part 3: The mentioned unique data series results in a large variety of high mountain related process information. It will be focused on glacial mass balance studies in the Hintereisferner region, because this was the initial purpose of the ALS related projects at the Institute of Geography at the University of Innsbruck. Furthermore we give a short overview of side-effects, which are obtained by a detailed data analysis and which primarily concern geo-morphodynamic processes, observed in mountainous periglacial environment.

The deduced extraordinary negative glacier mass balance values, which have been observed throughout the ten years ALS period, reflect the generally ascertained global warming signal in high alpine regions. A detailed analysis of the ALS mass balances – the most promising of geodetic mass balance methods - will be presented on an annual time scale, as well as the total mass balance over the entire period (2001 to 2011). Finally, the unique and outstanding data set enables sincere statements on process related analysis potentials, attained by the ALS technique, with particular consideration of the spatial capabilities in high alpine regions. In this respect ALS mass balance studies or the mentioned analysis of high alpine process effects provide excellent climate change indicators. Our presentation will highlight i) the pros and cons and ii) limitations as well as further capabilities of an ALS based process research in high alpine terrains.

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Ground-penetrating radar: a potential method to forecast snow avalanches in a changing climate

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Wet-snow avalanches threaten communication lines and mountain communities. Their formation is poorly understood as are the snowpack processes leading to wet-snow instability. Climate change might influence the timing, magnitude and phase – liquid or solid – of precipitation in mountainous regions. Precipitation, snow stratigraphy and its interaction with percolating water are thought to play a vital role in determining periods with wet-snow instability. Research on wet-snow avalanches mostly focused on linking meteorological parameters with periods of avalanche activity and thus information on the internal wet snowpack are rare. Until now, properties about percolating water within the snow cover are estimated by traditional snow pit observations or more recently measured with dielectric devices. Both methods are destructive or highly influencing the snow stratigraphy and thereby the percolation behaviour. In the present study, we used an upward-looking groundpenetrating radar system (upGPR) to monitor snowpack evolution on a daily or whenever necessary hourly ba-

sis to obtain information on wet-snow properties without disturbing the snowpack above the antennae. We focused on the one hand on determining the volumetric liquid water content (θ_w) by calculating the relative permittivity of the wet snow above the radar antennae and on the other hand on the advance of a wetting front and the wet snow stratigraphy. Results were compared to in-situ measured permittivity, modelled wetting front advances and measured outflow at the bottom of the snowpack. The upGPR system was capable to clearly monitor the advance of a wetting front and the respective arrival time was similar to that recorded with a nearby lysimeter. Possible weak wet layers consisting of a high liquid water content ($\theta_w > 6\%$) were detected within the radar signals by multiple reflections.

However, determining the exact amount of liquid water for each layer separately was not yet possible. The presented method represents an independent monitoring method which will for the future facilitate danger assessment of exposed infrastructure in mountainous regions.

FoCALS – Forest Change assessment using laser scanning, a conceptual framework for area wide monitoring of mountain forests

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Large areas of the Alps are covered by forests, protecting infrastructure and settlements against natural hazards, delivering timber, and representing a renewable resource in the sense of sustainable economical usage. Considering the potential of forests as carbon dioxide storage they play an important role for climate change mitigation. Due to topographic variations and the mixture of species it is difficult to apply area-wide assessment methods to forests in mountainous regions. Common operational strategies in forest management are primarily based on (i) statistical information extrapolated from local samples or (ii) low spatial resolution area-wide geodata. However, the high diversity of forest stands considering growth stadium and species distribution and their high spatial variability require data acquisition strategies and data sets, which are able to capture the different site conditions in spatially high resolution on regional and local scale. Laser scanning has shown to fulfil these demands by acquiring high resolution three dimensional data of terrain, forest structure, and tree crown characteristics. We propose the concept FoCALS (Forest Change Assessed by Laser Scanning), which is a comprehensive approach exploiting laser scanning data for (i) forest stand delineation and characterisation in full-waveform (FWF) airborne laser scanning (ALS) data, (ii) plot sample acquisition using terrestrial laser scanning (TLS), and (iii) change detection analysis considering phenological changes, forest growth, and human activities (logging and planting). Parameters derived from multitemporal TLS and ALS data are used for the monitoring of temporal changes (i.e. to quantify the effects on mountain forest growth) and their influence on biomass estimations. Changes are detected based on differing 3D point cloud geometries. The approach is expected to deliver information on various scale-, time- and interpretation levels. The comparison of multi-temporal 3D canopy information derived from point clouds differs from earlier change detection approaches using 2.5D raster data and is expected to provide a deeper insight into volumetric structure of the forest and its canopy layers. The proposed concept should help to improve and support decision making for an optimized sustainable management of forest resources and renewable energy concepts by considering natural and human impacts, which cause changes on vegetation. The aim is to be able to contribute to the standardization of efficient forest management and to provide results, giving deeper insight into the temporal behaviour of vegetation parameters derived from TLS, ALS and FWF technologies.

Closing nutrient cycles in alpine regions by the use of wood ash

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Alpine meadows are a cultural, social, and agricultural wealth and they are part of the traditional Tyrolean landscape. Alpine meadows have been affected by management activities such as timber harvest, livestock grazing, tourism, and urban development. In these areas, soil has a main function in the ecosystem supporting plant growth, retaining water and acting as nutrient pool. Currently, the amount of wood combusted in heat and power plants and thus the production of wood ash are steadily increasing. To a large extent, the wood ash is deposited in waste dumps

despite its potential as a fertilizer or fertilizer supplement, interrupting the nutrient cycle. However, field studies on this topic are scarce. In a grassland field experiment in Gumpenstein, Austria, we are studying the effect of diverse wood ash formulations on yield, hay quality and soil microbiological and chemical properties. The experimental field will be distributed in 64 plots (4 replicates for each of 16 variants) with a total area of 813 m² (12,7 m² subplot area).

1. Non-fertilized (Control)
2. Non-fertilized + Calcium Carbonate
3. Non-fertilized + Biomass Ash
4. Compost
5. Cow manure

6. Cow manure + Biomass Ash mixed (3 Applications)
7. Cow manure + Calcium Carbonate mixed (3 Applications)
8. Cow manure + Calcium Carbonate
9. Cow manure + Biomass Ash
10. Non-fertilized + SANOFERT (Vermiculite, Wood ash, Alginit, Humin acid)
11. Anaerobic sludge + SANOFERT (Vermiculite, Wood ash, Alginit, Humin acid)
12. Non-fertilized + Biomass Ash Compost 12 %
13. Non-fertilized + FerTirol HK (Biomass Ash Compost 6 %)
14. Anaerobic sludge
15. Anaerobic sludge + Biomass Ash
16. Anaerobic sludge + Biomass Ash mixed t (3 Applications)

Soil acidity, electrical conductivity, total carbon, total nitrogen, basal respiration of microorganisms and microbial biomass carbon, ammonium, nitrate and nitrification were measured. Genetic analyses were performed to investigate the distribution of Ammonia Oxidizing Archaeas and Bacteria. The aim of the study is to pave the way for a meaningful recycling of high quality ash as soil fertilizer, this way nutrients originally stored in alpine forest will be recycled, avoiding nutrient deficiency and reducing fertilizing and waste managing costs.

Long-term sustainable revegetation of technical slope stabilization systems in the Alpine region

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Due to a lack of available space and land use change in alpine areas the gradual expansion of infrastructure networks led to an increase of steep-slope constructions. This fact comes along with the need for instant slope protection and erosion control to ensure long-term slope stabilization and reduce the erosive potential of surface runoff or wind. Innovative civil engineering structures using technical facilities for structural safety such as grids, mats or nets are applied more and more. Further increase of surface erosion protection respectively slope stability is achieved by combining technical facilities with the benefits of an adequate vegetation layer. However, extreme locations such as steep slopes provide exceptional environmental conditions particularly with regard to water availability, extremes in temperatures and temperature variations, soil conditions or nutrient supply. Especially the biological system component is highly affected by the effects associated with climate change, whereby alpine vegetation can be used as biological indicator for ecosystem changes by monitoring plant migration, local vegetation change or the spread of invasive plants. All these facts constitute a major challenge and require integrated comprehensive strategies to keep up long-term functionality of revegetated technical constructions which meet ecological compatibility and economical requirements. However there is still a lack of knowledge to install efficient

and sustainable vegetation layers covering technical slope protection structures. Closing this knowledge gap is subject matter of a research project within the frame of alpS – Centre for Climate Change Adaptation Technologies.

Key objectives are the determination respectively the identification of the main selection criteria and its implementation into planning and execution processes (decision support matrix, developing further design standards). Apart from studies on existing locations (positive examples and malfunctioning or failed systems), small-scale (experimental, adaptable) investigation sites are set up as well as large-scale on-site constructions. That way, a high level of variability is gained covering multiple application fields for specific technical products in combination with soil bioengineering techniques. Beside environmental respectively geological properties, various vegetational parameters such as coverage, species composition, biomass and root development or structural features will be determined and analyzed within the scientific scope of the project. At the conference the strategic planning of the research activities will be presented as well as construction details of the study sites and first results of measurement and monitoring.

Plant Species Diversity on *Austrocedrus chilensis* dominated timberlines at the northern distribution on the Cachapoal river basin, Chile

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Mediterranean-type climate are found in five regions across the world, occupying less than 5 % of the planet surface. It has been suggested that these ecosystems likely will experience the greatest change in biodiversity because of land-use changes, climate change, nitrogen deposition, biotic exchange and elevated carbon dioxide concentration. Moreover, nowadays there is a concern that there is a relationship between biodiversity and ecosystem functioning stability and changes on biodiversity may endanger ecosystem processes, however.

Austrocedrus chilensis (Cupressaceae) is a southern coniferous species that occurs in Chile from 32° 39' S to 44° S. It has been classified as vulnerable species by IUCN and near threatened by the Chilean checklists. At the northern distribution *A. chilensis* is found within the Mediterranean-type climate, mainly as scattered monotypic populations at the timberline (900 - 2,400 m. a.s.l.). It has been subjected that these populations are probably remnants of stands established during wetter periods of the Holocene. Natural hazards (earthquakes, volcanisms, landslides, avalanches, rockfalls), land-use changes, grazing, selective logging and fire have historically affected these forest ecosystems. Furthermore, a climate warming trend has been projected. Therefore, changes on the plant species diversity may undermine the ecosystem functioning of these timberlines *A. chilensis* stands at its northern distribution.

The objective was to describe the vascular plant species diversity *A. chilensis* populations

growing at timberline on the Cachapoal river basin (~34° S; 1,270-1,659 m. a.s.l.). The following questions were established: What is plant species diversity of these timberlines? Are there other endangered vascular plant species? Does the vascular plant species more related to the Sclerophyllous shrublands or to the alpine region? What could be the effect of the historical human impact on the vascular plant species diversity? Do other abiotic variables (e.g. slope, aspect, canopy coverage) affect the plant species diversity between the *A. chilensis* stands? To response the questions eight *A. chilensis* stands occurring at the timberline were selected. At each stand three plots (20 x 50 m) were randomly distributed to measure structural tree attributes. Furthermore, all vascular plant species were noted, sampled and then identified. Preliminary a total of 94 vascular plant species were found, which belong to 74 genus and 44 families. From a geographic distribution point of view of the vascular plants 26.6 % are endemic species to Chile, 68.1 are autochthonous species to Chile and Argentina and 5.3 are allochthonous species. According to Raunkiaer's life-form system the phanerophytes accounted for 46 % of all species, the hemicryptophytes for 28 % and then therophytes and epiphytes. Besides *A. chilensis* there would be other 8 vascular plant species with a conservation status at a national or regional scale in Chile.

Impact of climate warming on growth of conifers exposed to a dry inner Alpine environment

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Climate sensitivity of tree growth will effect the development of forest ecosystems under a warmer and drier climate by changing species composition and inducing shifts in forest distribution. We applied dendroclimatological techniques to determine impact of climate warming on growth of three native and widespread coniferous tree species in the European Alps (Norway spruce, *Picea abies*; European larch, *Larix decidua*; Scots pine, *Pinus sylvestris*). Selected species differ in phenological and successional traits and grow intermixed within a dry inner Alpine environment (750 m a.s.l., Tyrol, Austria). Time series of annual increments were developed from ≥ 120 mature trees. To identify the climatic factors most closely associated with variations in tree growth, we calculated multiple regression and Pearson-correlation functions for the common interval from 1911–2008 using yearly tree-ring indices and monthly and seasonal climate variables (precipitation, temperature) from a nearby meteorological station. Species-specific growth response to recent climate warming was analysed by means of moving response functions. Major findings of our study were: (i) current May-June precipitation was the environmental factor most strongly associated with growth of *Larix decidua* and *Picea abies* ($r = 0.462$ and 0.557 , respectively; $P < 0.001$), whereas *Pinus sylvestris* showed highest correlation coefficients with precipitation in spring (March-May; $r = 0.440$, $P < 0.001$). (ii) Multiple regression analyses revealed that May-June temperature most strongly limited radial growth of *Picea abies* ($r = -0.365$, $P < 0.001$). (iii) Moving response function coefficients showed increasing sensitivity of *Picea abies* to June precipitation and temperature and of *Pinus sylvestris* to April precipitation. (iv) Time series of basal area index indicate successional elimination of *Larix decidua* by *Picea abies*. Results suggest that growth of native conifers exposed to a dry inner Alpine environment is increasingly impaired by drought, which is most likely related to recent climate warming. We suggest that at low altitude in the Eastern Central Alps prolonged drought periods, as projected under continued climate warming, will lead to a shift in species composition to more drought-tolerant species.

Heat tolerance of alpine plants – what are the limits?

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High temperature is a significant abiotic stress factor for plant recruitment and survival in alpine life zones. High mountain plants have evolved heat cumulating growth forms, such as cushions and rosettes that already now in certain situations act as fatal heat traps causing occasionally heat damage to the plants. In the next decades in the background of global warming heat as a stress factor will gather even increasing importance.

While the mean global surface temperature increase was $+0.6\pm 0.2$ °C during the 20th century, in alpine habitats the temperature increase was found to be more than twice of that. Although plants may adjust their heat tolerance within short time-spans to some extent (e.g. up to 2.2 K h⁻¹ in *Saxifraga paniculata*), it is evident that on clear and calm summer days high solar radiation can cause substantial overheating of plants. Possible consequences range from reversible disturbances of the photosynthetic processes to lethal heat damage. Reversible and irreversible heat effects on plants will have great impacts on plant distributional ranges and entire ecosystems. Heat effects on vegetation could principally result in altered proportions of areas with bare soil affecting the risk of soil erosion.

For the assessment of the risk of heat damage the knowledge of the species-specific maximum heat tolerance is of great interest. Unfortunately, until now sufficiently appropriate measurement systems are missing. Additionally field studies are needed that allow studying

recuperation and repair processes being ecologically highly relevant. And many questions concerning the field dynamic of heat tolerance are still unsolved, for instance also the influence of solar irradiation. Due to these facts we designed and constructed a field portable heat tolerance testing system (HTTS.8) that allows determining maximum heat tolerance of plants directly in the field under the presence of natural solar radiation.

Alpine study sites within an altitudinal range from 2000 – 2800 m a.s.l were chosen to cover the subalpine as well as the subnival ecotone. At all sites extended micrometeorological data were recorded to document the actual frequency and extent of heat stress in alpine plant species.

First results related to the performance of the HTTS.8 and to the extent of heat stress and to the maximum heat tolerance of the investigated plant species are presented.

This research project will contribute to our understanding of the capacity of high alpine plants to survive in their natural habitats that will increasingly be affected by global warming. It will close existing gaps in our knowledge about the effects of heat on photosynthetic functions and on the cellular ultrastructure and vice versa, and on the other hand based on the results of maximum heat tolerance it will help to make predictions on the future destiny of high mountain plants and ecosystems and the calculation of future risks more reliable.

Vegetation on alpine rockglaciers – A case study from the Ötztal and Stubai Alps (Tyrol, Austria)

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This study analyses and compares the vegetation cover and patterns on four different active rockglaciers, located in the Ötztal and Stubai Alps (Tyrol, Austria). Due to the special edaphic and climatic conditions, rockglaciers are environments hostile to plant growth, but still show some vegetation cover and are inhibited by different species, of which most are also typical for scree slopes. Vegetation cover can be used alongside other methods to determine the status of activity of rockglaciers or differences in activity at different parts of a rockglacier. Over longer terms, changes in vegetation patterns and cover can be used as indicators for changes in the activity of rockglaciers.

Field work was conducted at Äusseres Hochebenkar, Innere Ölgrube, Inneres Reichenkar and Schrankar. Total vegetation cover as well as the cover of each distinct species was assessed in squares of 3x3m along several longitudinal and transversal transects on each rockglacier. In addition, the percentage of fine-grained material (silt, clay and sand combined) was assessed, the size of the boulders and the diameter and exposition of the biggest thalli of *Rhizocarpon geographicum* were measured in each square. For comparison, adjacent stable areas were also mapped. In total, over 600 squares were mapped during August and September 2010.

The results were analysed with regard to the floristic composition in each study area and the differences between the four areas. The relation of the total vegetation cover and the cover of each species to the availability of fine grained substrate was also investigated, as well as the

relation of the size of the lichen thalli to the size of the boulders and the estimated age and flow-structure of the rockglaciers.

In total, 23 different species were mapped. The vegetation composition of the different investigated rockglaciers was only similar in so far, that several species (*Poa laxa*, *Cerastium uniflorum*, *Saxifraga bryoides*, *Oxyria digyna* and *Geum reptans*) occurred frequently at all study sites. But various other species were only found at some or at one of the study areas or even just in one area of one of the rockglaciers, leading to different vegetation patterns.

Vegetation cover generally increases with an increasing availability of fine-grained substrate, but can not be explained by that variable alone, since other factors, especially surface instability and the micro-climatic conditions are also very decisive.

Differences in size and abundance of lichens are also obvious. The rockglaciers Inneres Reichenkar and Schrankar show lower frequency and thalli-sizes of *Rhizocarpon geographicum* than the ones at Äusseres Hochebenkar and Ölgrube, what might indicate differences in age or movement, but can also be due to different sized boulders or differing micro-climatic conditions.

Altogether, results show that vegetation cover and composition on different rockglaciers are diverse and inhomogeneous, even in a delimited area of the eastern Alps.

The FIRIA project: Towards assessing future wildfire hazard in Austria

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Global warming will cause increasing danger of wildfires in Austria, which can have long-lasting consequences on woodland ecosystems. The protective effect of forest can be severely diminished, leading to natural hazards like avalanches and rockfall. However, data on wildfire frequency and distribution are currently still sparse and incomplete for Austria. Long-lasting postfire degradation under adverse preconditions (e.g. very steep slopes) is a possible phenomenon, which is currently widely neglected.

The FIRIA project intends to compile historical wildfire data including information on fuel loads, fire weather indices (FWI) and recovery. The governing climatic and socio-economic factors of forest fire distribution will be assessed including fire vulnerability of different woodland communities in order to estimate and display the spatial distribution of currently fire-prone areas in Tyrol. Furthermore, the impact of climate change on the distribution and frequency of fires will be assessed. Finally, a focus is led at locating areas of enhanced natural hazards after wildfire-driven deforestation and infrastructure at risk using process models, followed by a catalogue of possible countermeasures. The highly interdisciplinary work will be tackled in a cooperation of three project partners.

Based on an improved and extended historical forest fire database, it will be possible to find out i) which woodland communities are particularly fire-prone, ii) which topographical positions are affected, iii) how fuel loads and forest management influence fire ignition, and iv) how long recovery takes after severe wildfires. This will allow to model a fire hazard for Tyrol under current and future climatic conditions (using available scenarios of climate change in Austria), locating hot spots according to different climate conditions. A digital map of fire hazard in Tyrol will be developed, factoring the basic disposition and possible natural and anthropogenic triggers. It will be possible to identify the location of the currently most endangered areas for natural hazards arising as a consequence of vegetation destruction and how these will shift and/or expand under climate change conditions. Finally, at the identified endangered spots, infrastructures at risk will be assessed and linked to existing hazard zone maps in order to provide a new basis for future planning. The results will contribute to the planning of adaptive measures including forest strategies, and forward-thinking adaptation of woodland species composition.

Assessing nitrate vulnerability related to agricultural activities: specific considerations for mountain catchments

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Diffuse water pollution can arise from agricultural use and urban environments, but it is difficult to determine exactly the origin of the pollutants and to quantify their contribution to water pollution at the regional scale (Defra, 2002). Nitrogen fertilizers or manure applied to farmland can be considered as non-point sources of nitrate (Ray and Member, 2001). However, the application of fertilizers is a necessity, especially in mountain regions, where agricultural land is limited and mainly concentrated to the valley bottoms. Aquifers with shallow water tables combined with permeable soils are particularly vulnerable to agricultural contamination. Moreover, irrigation facilitates nitrate leaching requiring a good fertilizer management to minimize pollution.

The EU has passed a series of directives for the protection of human health, with regard to solving water related issues. In particular, the nitrates Directive 91/676/EEC aimed at reducing the use of fertilizers in agriculture and imposes member states to identify nitrate vulnerable zones. Intrinsic vulnerability expresses the degree to which water bodies are exposed to the danger of contamination as defined by natural conditions (climate, geology, soils, hydrogeology) irrespective of the existence of pollution sources. Associating the concept of intrinsic vulnerability with the actual location of infrastructures or human activities related to groundwater exploitation, or that have repercussions thereon, makes it possible to define integrated vulnerability.

As mountains are very fragile ecoregions and sensitive to human activities and global change,

we developed a method for risk evaluation of nitrate contamination for the northernmost province of Italy, South Tyrol, located in the heart of the Alps. A major challenge consisted in defining alternative parameters to the scarce availability of hydro-geological and pedological information. Following a similar approach outlined in the IPNOA method (Padovani et al., 2002), two sets of factors were considered: (1) risk factors (number and size of agricultural and zootechnical farms and their distance to water courses) used to determine the amount of nitrogen applied to the land surface; (2) control factors (local climate, mean slope of cultivated land). Spatial data was combined with non-spatial information in a GIS environment in order to create a potential risk map at catchment scale. By classifying and overlaying the different parameters, risk classes of potential nitrate contamination could be calculated and spatially located.

In South Tyrol, nitrate concentrations in surface as well as groundwater don't exceed the EU limit of 50 mgr/l, and elevated values of elevated risk to nitrate contamination can be found in areas characterized by agricultural activities on steep slopes. Water vulnerability assessment, which is capable of delineating zones that are more susceptible to pollutants from diffuse agricultural sources at the catchment scale, is important for guiding the prevention activities for agricultural diffuse water pollution and encouraging sensitive farming by managing land in a way that is responsive to the ecological health of the water environment.

Anthroposphere and biosphere relationships in the Urals region

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Urals, the natural border between Europe and Asia, is stretching more than 2000 km in the meridional direction. It crosses a number of natural zones of typical tundra to steppe, which, combined with high-altitude zone in the region creates a unique variety of geographical environment conditions. This diversity results a high degree of species and ecosystem biodiversity on the Ural's part of the biosphere.

Recent biocenotic cover, which is dominated by forest communities, formed during the post-glacial period, but retained in its composition relic and endemic elements of flora and fauna, which significantly increase the biodiversity of the biota.

Development Urals anthroposphere has its own specific features. Until the XVII century the population of the region were few and mainly engaged in animal husbandry, hunting and fishing. These activities do not cause almost no damage to the nature of the region. The industrial development of the Urals begun in XVII century. The main development was received mining, metallurgical, chemical, timber industries. The largest scale of these industries have purchased in the Middle, in part of Southern and Northern Urals. Urals - one of the most industrialized regions of Russia, the bulk of whose population lives in industrial centers. Currently, industrial areas of the Ural region are characterized by a significant degree of disturbance of the biota, loss of a significant proportion of biodiversity, a high degree of environmental pollution. Many industrial conglomerates have reached a state of ecological crisis. Therefore the problem of biodiversity conservation in the Urals is more than topical in industrialized areas particularly. One of the main ways to solve the problem - the development of network of reserves, which is based in the Ural region on 15 nature reserves and national parks. Development and improvement of reserves network in order to maximize preservation of the individual components

of the biota of the Urals and biodiversity of the region as a whole, as well as to optimize the relationship of his anthropo- and biospheres was reflected in the decision of UNESCO on the establishment of the two, the World Network of Biosphere, Reserves. One of them is located in the North, the second in the Middle Urals.

The Middle Urals is the territory, where mountain-industrial complex have a most development. Therefore situated here Visimsky Biosphere Reserve can be a model for testing the mechanisms of building relationships anthropo- and biosphere to preserve biological diversity of the biota in terms of further development of existing socio-economic specialization anthroposphere. The territory of refuge - a single forest, which is situated in the middle part of the Ural Mountains, with elevations ranging from 400 to 699 m.

Since the turn of XVII-XVIII, as the industrial development of the region, the forests were in a versatile heavy-duty use. They were cut down for various purposes in large scale, repeatedly burned. Therefore, in the industrial areas of the Middle Urals are now dominated derivatives and quasi-indigenous forests as well as non-forest areas. Indigenous forests have survived in small isolated areas and make up about 1 % of the area of the region. To preserve the biodiversity of the biota of these samples was formed Visimsky Biosphere Reserve. But even in its territory primary forest ecosystems occupy about 6 % of the area and are concentrated mainly in the protected area. Almost all the rest of the territory is occupied by the derivative forests, at different stages of restoration successions. One of the main objectives of the existence of the reserve - the restoration of the original ecosystem diversity, a source of which must be preserved areas of primeval forests and monitoring of recovery processes in areas of refuge with varying degree of human influence.

Relevant climate impact of the Tyrolean solid waste management

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The solid waste management contributes to the global warming potential as well as other industrial sectors. All of them have to reduce this emissions and the first step is the quantification and evaluation.

Aim of the paper is the quantification of the relevant emissions of the Tyrolean solid waste management. As a first step an evaluation of the Tyrolean waste management is given. The evaluation should represent the quantity and quality of Tyrolean waste streams on the one hand and the different options for treatment (incl. recycling, disposal, etc.) and import and export on the other hand. Based on this, an assessment of the efficiency of the Tyrolean waste management system should be given. Depending on the current waste management system - handling and reuse of the various materials - the greenhouse gas emissions will be estimated. After calculation of the current greenhouse gas emissions and analyzing the waste management structure, the potential of greenhouse gas emissions reduction for the regional waste management system will be presented. This includes optimisation strategies for the future waste management system with the target to minimise the greenhouse gas emissions in Tyrol. Because of the regional conditions with Tyrol as a tourist region another focus should be on the amount of the greenhouse gas emissions according to the tourism. This could be indicated under the consideration of two different Tyrolean regions with different dimension of tourism. Associated with the global and national greenhouse gas emissions it must be the aim for a sustainable economical trade also in the field of waste management system. Obtaining carbon credits by saving fossil energy sources should be also part of the study.

Determinants of nature tourists' spending behaviour in the Alps – results and implications from Simmental and Diemtigtal (Switzerland)

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The Alps are one of the most traditional and most important tourism destinations in the world with an estimated number of about 370 million overnight stays and more than 60 million day-trippers per year (BÄTZING 2003, 156). Especially the economy of remote high alpine valleys depends heavily on winter and summer tourism both facing considerable challenges in the near future like strong competition of low-cost sea and sun destinations in the summer or possible negative impact of climate change on ski tourism. In order to choose the most effective tourism strategies to cope with these challenges it is decisive to have detailed information on the economic importance of different types of tourism. Recently nature-based tourism activities like (long-distance) hiking or snowshoeing are regarded as more sustainable alternatives for fordist mass-tourism. Yet the economic importance of these activities remains unclear or is even contested by empirical results (see VOGT 2008).

The regional economic impact of tourism highly depends on the spending behaviour of tourists (STYNES/WHITE 2006). So far quite few studies have explored the expenditure patterns of nature tourists in the Alps (RÜTTER et al. 1995, KÜPFER 2000). Furthermore, even fewer studies differentiated between outdoor activities, seasons and destination types. This paper tries to close this gap by identifying determinants of visitors' spending in alpine nature tourism by using a multiple regression analysis based on a sample of 1,314 interviews in two adjacent valleys in the Swiss Alps, Simmental and Diemtigtal. Most existing surveys have focused on a small and unsystematic selection of possible determinants. This paper however systemises drivers of expenditure tested in previous research by distinguishing between tourist-based, travel-based and destination-based variables.

The mean daily expenditure of nature tourists was higher in the winter than in the summer season, because visitors in the winter are mostly downhill skiers/snowboarders. Vacationists tend to spend more than day-trippers, but how much depends to a great extent on the price- and quality-level of the chosen accommodation.

The findings suggest that spending is only marginally affected by commonly tested tourist-based variables (e.g. income). The level of expenditure varies much more according to travel-based parameters – tourist activities and visitor types – confirming previous results. How-

ever, the strongest influence on the spending level seems to be related to often neglected destination-based factors. The survey points serving as a proxy for available facilities, their price (and quality) level, the range of outdoor activities and thus different types of nature tourism destinations are of particular importance.

The findings have two main implications for tourism practitioners: First, they support that several strategies are required to foster higher expenditure through upgrading the available tourist facilities to attract a higher price-level. Existing infrastructure should be used more effectively, because visitors already coming to the survey area need attractive opportunities to spend money in the region. Second, fordist mass-tourism activities like downhill-skiing have the largest effect on tourism expenditure, which means that they can probably not be replaced by less infrastructure-dominated niche activities such as snowshoeing concerning economic importance (MAYER et al. 2009).

References:

BÄTZING, W. (2003): Die Alpen. München.

KÜPFER, I. (2000): Die regionalwirtschaftliche Bedeutung des Nationalparktourismus. untersucht am Beispiel des Schweizerischen Nationalparks (=Nationalpark-Forschung in der Schweiz 90). Zernez.

MAYER, M., WASEM, K., GEHRING, K., PÜTZ, M., ROSCHEWITZ, A., SIEGRIST, D. (2009): Wirtschaftliche Bedeutung des naturnahen Tourismus im Simmental und Diemtigtal – Regionalökonomische Effekte und Erfolgsfaktoren. Birmensdorf, Eidg. Forschungsanstalt für Wald, Schnee und Landschaft WSL, Hochschule für Technik Rapperswil HSR.

RÜTTER, H., MÜLLER, H., GUHL, D., STETTLER, J. (1995): Tourismus im Kanton Bern. Wertschöpfungsstudie (=Berner Studien zu Freizeit und Tourismus Bd. 34). Bern.

STYNES, D.J., WHITE, E.M. (2006): "Reflections on Measuring Recreation and Travel Spending". In: Journal of Travel Research 45 (1), pp. 8-16.

VOGT, L. (2008): Regionalentwicklung peripherer Räume mit Tourismus? Eine akteur- und handlungsorientierte Untersuchung am Beispiel des Trekkingprojekts Grande Traversata delle Alpi (=Erlanger Geographische Arbeiten, Sonderband 38). Erlangen.

Alphouse in Andelsbuch

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As a partner in the Alpine Space Projekt Alphouse, we have had the opportunity to carry out an extensive analysis of the Bregenzerwald region, the Andelsbuch community and 6 typical buildings. We would like to present our intermediate results of this international project at your conference.

The analysis of the community was designed regarding renovation potential with the focal point on energy, and deals with the total heating needs of the community with the potential to reduce energy consumption by renovating buildings of all age groups. It conveys the possibility to install solar energy systems and the shade situation of the buildings. Other themes include an analysis of dilapidated balconies as well as garages that are possible thermal bridges for the whole community.

In the building analysis, six CAD plans were calculated and implemented according to the minimum, lawful standard in Austria, OIB Regualtion 6, and in addition using projected, passive house standards. We selected building types in diverse age groups and their frequency of distribution in Bregenzerwald. The buildings we chose include an old, wooden, farmhouse from the 1800s, two buildings from the 1960s, one from the 1970s and the most recently built house is from the 1980s. Size was also a factor in choosing the buildings where the typical, average residential building here has one to three apartments.

Furthermore, the results of the virtual renovation measures analyse primary energy and CO₂ emission. It shows, using outstanding examples with solutions for typical problem zones, that potential energy savings are attainable in Bregenzerwald. This also makes it possible to compare the two calculation programmes, Energieausweis, or "building energy pass", and PHPP.

Analysis of the sensitivity of ski tourism demand to climate change in Switzerland

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The ski sector is among the already and most evidently affected domains in relation to climate change in the Alpine and in the Prealpine regions. Ski domains are affected twice by climate change. On one side, changes in snowpack quantity, quality and duration will directly affect the length of the operating season. In the mid- and long- term, this can lead to the closure of ski resorts. On the other hand, these changes will also have an influence on the demand. This, by modifying the number of ski visits, the length of stays in ski resorts and the type of customers. These aspects are less known and the direction of the responses may change depending on the locations. The goal of this study is to assess the sensitivity of Swiss ski tourism to climate change from the demand side and to analyse how tourism demand will change because of changing snow conditions. We will in particular consider the following questions: 1/ in past winter seasons, what influence had snow conditions on skier visits in the different ski domains? 2/ how strong is the relation between snow conditions and overnight stays? 3/ does the share of foreign tourism in hotels and ski resorts change together with the changes in snow conditions? 4/ to what extent did the snowmaking capacity of the different ski resorts buffer the effects of adverse snow conditions? And finally 5/ did the lack of 'winter

atmosphere' in the lowlands affect the general number of ski visits and of overnight stays from Swiss people? Answers to these questions were sought by analysing the relationship between tourism demand (ski visits, overnight stays) and the snowpack conditions of four past winter seasons (2005/06 to 2008/09) for approximately 100 Swiss ski resorts. In particular, the winter season 2006/07 was the warmest winter on records and could therefore be an indication for the winters to come, whereas winter 2005/06 was rather a cold one. We developed panel data models which allow identifying and analysing the influence of snow conditions on the number of skier visits as well as on the origin and the number of overnight stays in ski resorts. Other variables thought to affect the tourism demand, such as the accessibility to ski domains, the accommodation capacity at the ski resorts, and the investments both in transport and snowmaking facilities were also considered. Results could be of particular importance in the preparation of adaptation strategies for the winters to come. However, it should be noted that this study does not allow detecting changes in visitations due to long periods of bad snow conditions (implying several persistent changes in habit) nor gauging the financial health of ski resorts and their consequences for supply under deteriorated snow conditions.

Integrated traffic and mobility concepts for alpine tourism areas – the example of Wolkenstein, Italy

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Objectives

Due to reasons resulting from the special topographic situation, tourism is one of the economic and regional key factors for alpine regions. On the other hand, extensive tourism produces high traffic especially during the winter season and therefore has considerable impacts on environmental and social issues. In the past, one measure to solve conflicts was to build bypasses around the settlement areas. But such single investments in infrastructure are very expensive and – if not part of a whole traffic and mobility concept – may not help to solve the problem sustainable. Due to lack of money, other necessary accompanying measures are not realized, so that the benefit out of the upgraded road infrastructure can't be fully achieved. The Different requirements can't be integrated, therefore the acceptance of the investment by the local people is often disputed.

Results

The community of Wolkenstein in Val Gardena, South Tyrol is preparing an integrated traffic and mobility concept to solve their traffic problems in the inner part of the valley. Recent

examples from other alpine communities with extensive tourism have been studied together with the local stakeholders to build up a widely excepted new traffic and mobility concept for the whole area, including the famous pass roads and the whole skiing circle around the Sella-Mountain. In the presentation, the worked out traffic and mobility concept is shown as one possible example for other alpine communities with similar problems. Besides showing the difference between the "single-project" approach and the integrated traffic- and mobility concept, the worked out methodology and public consultation process towards a new mobility strategy for the whole valley is shown.

Conclusions

Investments in infrastructure like a road bypass as a single measure are not the key factor towards a sustainable solution to the traffic problems in alpine tourism areas especially during winter time. The traffic concept has to be adopted towards an integrated mobility concept, including all relevant disciplines and providing information and measurements on short-term, mid-term and long-term investments.

The Dolomites Lavazé pass. Negotiating tourism development and landscape diversity

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The paper discusses the development and the regeneration plan of an existing mountain resort with deterioration problems due to the transit of motorised traffic and a consequent loss of appeal. The plan is developed according to an highly innovative model, based on sustainable planning, use of renewable energy sources (biomass, solar, geothermal) and public mobility systems (car-free areas, electric-powered transport systems, etc). The Lavazé pass (2,000 meters altitude) is an area of great landscape value and with an ancient tourist tradition, although on the decline. Beautiful and now relatively unfrequented, it extends into the heart of the Dolomites World Heritage Site - between the two component sites of Bletterbach Gorge and Latemar-Rosengarten massif - and offers a complete sequence of still intact landscapes, both Alpine and Dolomite. It is also a mountain pasture area (with an altitude of 2,000 metres), which has always been linked functionally to the stable settlements of its valleys. The woods, pastures, grasslands and many rural infrastructures which make up its landscape diversity, are held almost all in common and are still administrated by one of the oldest institutions for collective actions in the Alps, having gained administrative autonomy almost 1000 years ago. This institution correspond to a social-economic unit based on the concept that the commons are indivisible and inalienable. In fact its main interest is to guarantee the reproducibility of the natural resources which symbolically represent the community itself. For this reason its administrative boundaries also correspond to an ecosystem. The plan is based on function complementarity: i.e. it examines in detail the relationship between the resources of natural habitat (hydrology, morphology, vegetation) and those

of human habitat (soil use, settlement characters, relation spaces, road network). It has the purpose to reduce the environmental impacts and to develop energy chains, short and independent as much as possible. It has also the aim to represent a case study for the reduction of effects caused by mobility on Dolomite passes. Finally, the project places itself as example for re-establish the landscape and hiking continuity, linking different component sites of the Dolomites World Heritage Site.

The plan updates the collective management principles that these communities have traditionally developed: independent regulations and administration, sharing, mutual agreements and joint possession.

The basic concept is 'negotiation'. In fact the excessive specialisation in tourist activity in the area risks weakening the strong tie – physical and mental – which determines the sense of belonging that this community has with its territory. If this area continue to be inhabited (and imagined) only in the function of tourism, it will lose its role in determining the local cultural identity. The main principle is therefore to negotiate, that is to find points of agreement between these two different systems of values, considering landscape diversity as the common good of a specific community, and operating on tourism as a vehicle of local specificity rather than an instrument of global standardisation.

The authors are the scientific coordinators of an interdisciplinary working group made of planners, landscape architects, environmental engineers, geologists, renewable energy experts.

Research of Ways the Carpathian Mountains Region Development

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Questions of sustainable development of mountain areas get special value. They are extremely important in conditions of increase of anthropogenesis loading on ecological systems. Special properties of mountains in many cases promote both physical, and to spiritual healing of the person, here frequently because of inaccessibility find rescue many kinds of flora and fauna, they show an original well of rare minerals, wood, medical plants, mushrooms, berries and so forth. Natural mountain biodiversity and landscapes demand protection against intensive economic activities, unorganized tourists, which put a loss to the usual equilibrium natural condition of the given ecological systems. Also it is necessary to remember potential threats of natural cataclysms as flooding, earthquakes, hurricanes and so forth which are frequently characteristic for hilly terrains.

For the Ukrainian part of Carpathian Mountains questions of formation the balanced potential of development the given region are extremely actually. It is connected both to rather fast deterioration of ecology, and with direct threats of new natural cataclysms in connection with proceeding uncontrolled cuttings down of woods, default of the planned works on strengthening coast of the rivers, backlog in innovational and technological development. From this sight development of the effective economic mechanism of wildlife management is required on the basis of the concept of sustainable development. It is important for this purpose in cooperation with the countries of Carpathian Euro-region to provide synchronous actions on maintenance of beneficial influence on processes of restoration first of all recreational

functions mountain ecosystem. Also it is necessary to develop Strategy and to ratify the National program of development of the Ukrainian Carpathian Mountains and to find required financial resources for its realization. For this purpose it is important to organize processes of generating and search the perspective projects directed on formation of potential of social and economic development of region and to involve investors for their realization. Similar actions assume active participation of a science, public organizations and all interested parties. Their high level of interest in realization of such many-sided actions on a constant basis can be provided with the help of association the efforts in clusters which activity give conditions for display the initiative, and also create the competitive environment.

The development of Carpathian region should be considered in dynamics and as triune system - ecological, social and economic. Thus the priority should be given questions of ecology and maintenance of sustainable development. For this purpose it is necessary to provide change of approaches for conducting economic processes in the given district, having provided their reorientation on satisfaction of new requirements, both aboriginals, and the tourists who are having a rest and patients in the blessings missing by them first of all the non-material character. It is simultaneously important to provide increase of nature protection territories for maintenance of a necessary level of a biodiversity in region that will promote in turn to development of new forms of ecotourism and to attraction of necessary financial resources in region.

Classification of winter tourism regions and the regional effects of climate change

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Austria is a worldwide well-known destination for winter holidays. Most of the inner-Alpine regions have a strong focus on skiing-activities which are depending on the existence of snow. Regarding the latest results of research the availability of snow can no longer be assured for certain regions and elevations in Austria. Technical solutions by using snow making machines have become very important but also cost intensive for winter sports regions. Therefore our motivation is to investigate which winter sports regions in Austria are affected by changes in climate and are there actions/reactions of stakeholder within these regions?

The problem occurs that relying on two natural resources, the varying factor snow and a more or less unaffected unique landscape, the investments in tourism infrastructure are without foresighted adaption strategies medium and long term highly vulnerable. Taking a more differentiating approach, every single skiing destination faces an individual climatic, tourism and economical situation, which intensifies or mitigates the challenging effects of less snow reliability. Hence Austrian skiing destinations need to be seen in their regional context of an entire cluster of more peripheral or less competitive destinations, whose fate is closely linked to their respective top destinations with a well established tourism infrastructure and destination mix. In this respect only little research has been done to classify and delimitate winter tourism regions according to their specific supply structure and the diffusion effects of the top destination's image prone into the hinterland forming a typical core-periphery structure. Therefore it is necessary to display future climate scenarios and the sensitivity of winter sports regions finding out 1) typical winter sports regions in comparison to tourism regions in general, 2) which Austrian winter sports regions are vulnerable to the effects of climate change, 3) the inner structure of typical winter sports regions, Schladming (Styria) and Kitzbühel (Tyrol), and finally 4) the awareness of climate change and actions/reactions of stakeholder within the region.

Multidisciplinary assessments of trail degradation for framing future trail management: Examination in Shei-Pa National Park, Taiwan

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Park managers and researchers often practice inconsistent management in protected areas. This study, by adopting multidisciplinary assessment approaches, aims to develop framework for future trail management in protected areas. For this aim, we conducted social, geographical, and geophysical surveys in Shei-Pa National Park in Taiwan. The examined trail, called Sheishan trail, is 10.9 km in length from the trailhead to the summit of Mt. Shieshan (3,886 m). The Sheishan trail is one of the most heavily visited trails in Taiwan.

First, a questionnaire survey was conducted to understand hikers' perspective on crowding on the trail. The limit of crowding that hikers accept, i.e., social psychological carrying capacity, was 60 – 80 individuals surrounding them.

Second, a rapid trail-condition assessment method, which is often used by park managers elsewhere in the world, was developed for the same trail. The results revealed that the total length of 4,808 m faces management problems, i.e., root exposure, multiple trail, gully erosion, wet/muddy tread, trail expansion, sheet erosion, and running water. This study clarified the spatial characteristics of the problems, identifying root exposure to be the greatest (root exposure: 2,630 m long in total). The trail was classified into four types, so that the priority sections to future management treatment can be identified. The type 3 sections (2,000 m in total), which are defined to be sections with great problems but lacking measures, are given the first priority to be treated and monitored.

The third method that we adopted was repeat measurement of cross-sectional area of the eroded trail surface to estimate the actual erosion rates in the past, which is a method that physical geographers often use. The number of the total measurement sites attains 70 for the 10.9 km trail. The heaviest erosion occurs in the section between 3.5 km and 3.9 km (distance from the trailhead), and the average erosion from 2007 to 2008 was 85.7 cm² with the range from 10.8 cm² to 278.5 cm².

The forth method is a geophysical method: we used a dynamic cone penetrometer to detect thickness of soft surface deposits or soil to estimate the magnitude of future soil erosion. This estimate was detected at 69 sites in total. The average depth of the surface deposits was 94 cm, which indicates an average depth to be eroded in future.

In spite of extreme amount of precipitation, the soil erosion on the Sheishan trail in the past was in the similar range of the erosion on mountain trails in Hokkaido, Japan. The second method allows park managers and researchers repeatability through time. The third and forth methods above lead to future prediction of further soil erosion. Park managers will be appreciated the over all multidisciplinary assessment approaches to result in an integrated future management of mountain trails. It is suggested to involve multidisciplinary stakeholders to conduct these multidisciplinary assessment approaches for protected-area management.

Climate Change and Alpine Summer Tourism – Chances and strategies in Vent and Obergurgl

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For sustainable development in the Alps, especially in the sector of tourism, communication and environmental awareness rising is very important. To raise the awareness of tourists for environmental issues caused by climate change, it is necessary to lead the attention to concrete themes. To assure sustainable development it is necessary to change the awareness of the tourists. Therefore environmental education can be a step into the right direction.

Climate change will affect the future development of the tourism sector. Factors like weather, climate and landscape are the resource for outdoor activities, e.g. hiking, mountaineering, climbing, mountain biking and skiing. Thus the impacts of climate change pose a great challenge to alpine tourism. Therefore, chances need to be identified and made use of to balance potential negative impacts and to foster a behavioural change of the tourists.

Many studies deal with the changes in the winter tourism industry and try to find solutions and strategies to keep skiing tourism alive, but summer tourism has so far been largely neglected. This paper presents results from a survey (n=482) conducted in Vent and Obergurgl (Ötztal/Austria). The main objective of the survey was to find out if and how tourists would be willing to deal with the impacts of climate change in their holiday destination.

The majority of respondents showed interest in the topic and had the desire to see and experience environmental changes by themselves. The respondents were interested the most in the decline of the glaciers and extreme events like floods, droughts or forest fires. These topics can be used as an eye catcher to attract tourists to take part in guided theme hikes about climate change. The majority of respondents would also be willing to pay for information material or guided tours. Although such a product would not suffice to attract tourists to come to the Ötztal, it would be made use of as an additional offer and could thus contribute to the diversification of the summer tourism product portfolio.

The adaptation strategy of building theme trails about the consequences of climate change in the Ötztal could strengthen four season tourism and reduce the dependency on skiing tourism. Environmental education helps to show the tourists which influence their behaviour and climate change has on the environment. Thus they can start to rethink their behaviour. With that product the Ötztal can be a good-practice example for other destinations in mountain areas. Only what you see in real will change your mind.

Quantifying changes in alpine land use using remote sensing data – A case study at Bregenzer Wald, Vorarlberg

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Changes in land use also cause changes in the alpine landscape. For example, the abandonment of alpine pastures leads to reforestation of farming areas while the growth of residential areas often causes deforestation predominantly on the hillsides of valley regions.

In this study it was examined whether the changes and interactions of the landscape elements forest and buildings (residential areas) can be used to characterise development processes and changes of alpine land use. With the help of combined, multi-temporal remote sensing data (aerial images, ortho images and aerial laser scanning data) and different image analysis methods changes in these landscape elements are detected with high spatial resolution (cell size < 1m) in a mountainous region in Bregenzer Wald / Vorarlberg between the years 1950 and 2001. The results are interpreted and evaluated with statistic inventory data collected within the same period by the federal state of Vorarlberg.

Due to the high resolution of the input data even small objects such as alpine barns and small group of trees close to the tree line ecological system could be detected. Interactions between the detected landscape elements became apparent by the localisation of replacement areas. These replacement areas figured out a land use change pattern which is mostly dependant on the altitudinal level.

The study results evince that the developed work flow can be used for detailed detection of spatial and temporal changes in alpine land use. These results provide valuable information for regional planning measures and for silvicultural management strategies. Furthermore information related to climate change, such as tree line migration and the anthropogenic influence on the tree line is provided and can be used as input for regional climate change scenarios.

Which Landscape do we want in the Alps – and can we afford it?

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For a long time, the cultural landscape in the Alps was not much more than a “side effect” of the food production. But the dynamics of the last decades led to a situation, in which the social expectations regarding landscape and its functions (e.g. recreation, preservation of natural resources including biodiversity) detached widely from the exclusive agricultural use. Our study, which is conducted within the Interreg-IV-project “(Agri)cultural Landscape – Strategies for the cultural landscape of the future”, deals with the question, how the limits for negotiation processes of the future cultural landscape can be defined in the two research areas of Tyrol (A) and South Tyrol (I). To define the room for activity in this context, two different analysis methods were used: (i) a quantitative investigation in terms of an interrogation using a standardised questionnaire considering more than 3000 respondents to assess the perception and the expectations regarding the current and future landscape, and at the same time: (ii) qualitative group discussions with farmers to find out about the conditions they are exposed to.

The results show a clear trend: the respondents of the interrogation preferred naturalness and

nativeness and according to this, traditionally used landscapes have been rated in a positive way, while intensively used agricultural land and the rising urbanisation came off worse. The results of the group discussions showed, that constant (natural) factors (e.g. difficult working conditions) and socially constructed parameters play an important role regarding the farmer's room for action. In this context the socially constructed parameters go hand in hand with societal changes: on the one hand farmers suffer from problems as migration, missing working forces, etc., on the other hand they have problems to identify themselves with the role of a conservationist of cultural landscape respectively they often consider the payment for such activities as alms.

It can be summarised, that the society desires traditionally cultivated and extensively used landscapes and that they are also willing to support their maintenance through financial support. Whether this is enough for the maintenance of our traditional cultural landscape will depend to a great extent on the future social, economic and agricultural policy framework.

How sustainable is your municipality? Monitoring environmental, social and economic aspects in South Tyrol, Italy

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Indicators serve for monitoring and stimulating the sustainable development and for evaluating the effectiveness of undertaken actions. According to Agenda 21, municipalities play a major role for sustainable development. However, conditions and problems often vary noticeably from one municipality to another, and thus, different strategies must be implemented. An indicator set on municipality level, covering various thematic aspects, can offer a valid tool for the objective evaluation of sustainability. The bottom-up approach allows municipalities and citizens to establish meaningful dialogues to achieve sustainability, and the system serves to support public administration, decision-makers and other interested parties with political and planning decisions, and at the same time, it sets the actions on a high degree of transparency.

Therefore, the Institute for Alpine Environment of the European Academy of Bolzano/Bozen (EURAC), together with the Institute for Economic Research of the Chamber of Commerce of Bolzano/Bozen and in collaboration with the Environmental Agency of the Autonomous Province of Bolzano-South Tyrol, developed an indicator set for all 116 municipalities of the northernmost province in Italy, South Tyrol. The 74 indicators, taking into account important environmental as well as social and economic aspects, are adapted to the specific needs of mountain regions and at the same time still linked to the national and international level. The comprehensive central database facilitates dynamic monitoring as well as specific analysis of detailed questions. In mountain areas, a major constraint is the availability of environmental

data for sustainability monitoring, and it is necessary to adapt the already known indicators at international and inter-regional level to the particular features of mountain regions. Thus, special new indicators were developed, internationally published and regionally implemented. Since ecological systems rarely meet up with political boundaries, many indicators are not only based on statistical data, but are calculated within a geographic information system using complex spatial data and sophisticated algorithms. Data were collected since the year 2000 and the indicators are being updated annually, making them a more meaningful tool year after year.

In order to make the monitoring system accessible to the public, an internet portal was created and the freely accessible data can be used e.g. for presentations or public relation and provides also a useful tool for scientists and experts, making it easier to carry out specific investigations, to implement sustainability and to gain acceptance. High effort was put in developing interactive web-based tools to represent the indicators in different ways like graphs and maps in order to facilitate the understanding of the indicators and to offer advanced tools to assess and to monitor sustainable development. It allows, for example, to examine the development of individual values over the years or to compare municipalities with others. This innovative monitoring system allows to adopt independent and original ways towards achieving a balanced economic and social development of the population and, at the same time, caring for the environment to preserve the earth's life-support system.

Livelihood Dependence on Natural Resources in Alpine Pastures by Women of Garhwal Himalaya, Uttarakhand, India

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In Garhwal Himalaya, sustainable livelihood is mainly based on collection of natural resources, livestock grazing in alpine and other forested areas near village surrounds. Women of the region are playing vital role for use of natural resources because, sustainable livelihood is woman centered in Himalaya. Women made provisions for the basic necessities for family needs. The main work load of women consists of agriculture work, livestock rearing, fuel and fodder collection. The complex geographical conditions of Garhwal Himalaya have made the life of women very difficult. The basic needs of hill women practically revolve around land, water, forest and livelihood. Thus, deforestation, drying up of water and other natural resources, degradation of land to displacement of families have a direct bearing on them and are also most felt by them. Agriculture supported with livestock rearing is the economic mainstay in the region and hard efforts of women are almost on its centre. Even today, the rural women practice the old tradition of barter. Women have played and continue to play key role in the conservation of basic life support systems such as land, water, flora and fauna. They are visiting high altitude pastures for collection of medicinal plants and other natural resources for sustainable livelihoods and curing of community. A large number of medicinal plants have been used in traditional system of medicine which is found in Garhwal Himalaya. Different parts of these plants viz. leaf, stem, bark, root, tuber, flower, fruit, seeds, etc. have been used for curing different disease.

Mountain Pasturing Plans for Upper Austria – Creating a Tool for Adaptive Management of Cultural Landscapes and Natural Resources in Alpine Regions

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About 20 percent of Upper Austria is part of alpine areas. Smallholder agriculture, sideline farming and high quotas of servitude are characteristics of land-use in the lime stone-based alpine landscapes of Upper Austria. Mountain pasturing and the associated techniques and practice have been shaping the ecological balance of the area for generations. However, the past decades saw massive changes in Upper Austrian alpine landscapes. Abandonment in local agriculture and the proceeding withdrawal of mountain pasturing bring along an expansion of fallow land and scrub succession on former cultural grassland mosaics of many alps. Long-term implications of these processes not only comprise losses in biodiversity, but also negative impacts on soil- and water balance, growing risks of natural hazards and decay of alpine infrastructure and built environment. This is why local experts, stakeholders and eventually politicians identified an urgent need for action to develop strategies for a sustained, stable and adaptive landscape and natural re-source management.

A crucial issue thereby appears the question of re-organisation of mountain pasture management under the conditions of a) decreasing livestock-rates, b) employment of superior cattle breeds and c) declining workforce available in alpine agriculture. Adaptive management plans should help

- a) stabilizing cooperative pasturing economies on a generally lower level, regarding local spatial and temporal conditions and livestock developments and
- b) sustaining a sophisticated, ecologically diverse and economically variable pasturing system.

The poster introduces the pilot project “Mountain pasturing plans for Upper Austria”, a concept initiated by the agricultural department of the Upper Austrian federal state government. The project tracks a transdisciplinary approach to re-organisation of cooperative land-use and land-management in the alpine region. Taking the basic question of pasture management as an initial point, the project aims at elaboration of inter-coordinated strategies in cooperation with authorities in forest, game, water and preservation management. Goals of the generated plans cover several levels: First, they shall provide practical tools for agricultural land-users in organising their management. Second, they shall allocate argument and information for public authorities e.g. in questions of subsidies. And third they shall form a common ground of communication for all actors and experts involved in the discursive process.

The concept currently is proven in 21 selected case-study examples. The methodology of the project and selected experiences in the processes of development and implementation are highlighted in the poster. Generated knowledge shall form a foundation for application on forthcoming alps.

PROSECCO.ALPS - PROglacial Stream Ecohydrology and Climate Change Over the ALPS

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Mountainous regions have a critical role in the water cycle, storing water and releasing it, depending on cold/warm seasonal conditions. Glaciers and ice sheets are particularly relevant in terms of water resources since they store about 70 % of the world's freshwater. Glaciers show a generalized reduction around the world. Climate change in the Alps is expected to strongly impact the hydrology and ecology of freshwater ecosystems. Key effects include changes in the distribution, abundance and ecology of aquatic species in various trophic levels, dramatic alterations in their habitat (physical and chemical environment) and the processes that act on and within freshwater ecosystems. Interactions of climate variables, such as temperature and precipitation, with glaciers and freshwater ecosystems are highly complex, hence, direct and indirect impacts on ecosystems are often difficult to predict. The reasons for this are our still relatively poor understanding of the structure and function of proglacial river systems and their basic inter-relationships with climate and other environmental variables, as well as the paucity of long-term freshwater monitoring sites and integrated hydro-ecological research programmes. Our recent work has demonstrated that the fauna of alpine headwater streams is strongly adapted to the harsh environmental conditions and that under the scenarios of future alpine meltwater reductions the invertebrate assemblages will be altered and some of the aquatic species are vulnerable to extinction. The project PROSECCO.ALPS addresses these major research gaps through detailed multidisciplinary field investigations into: (a) alpine river system hydrology, (b) proglacial geomorphology and physicochemical habitat, and (c) aquatic macroinvertebrates, coupled with: (d) the application and further development of an invertebrate species traits method and (e) innovative modelling approaches, combining data from a, b, c, and d, to predict hydroecological dynamics and change under various climate scenarios.

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