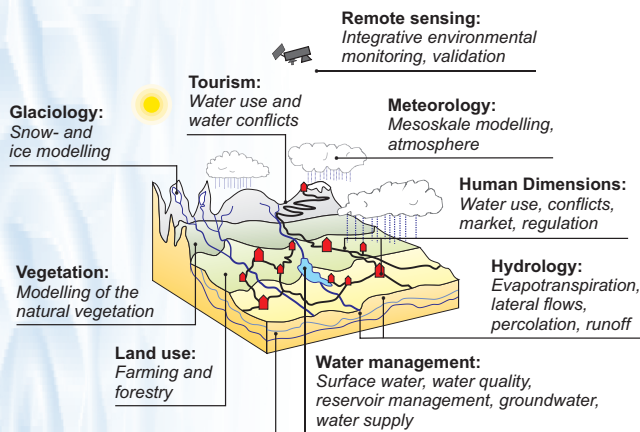


GLOWA - Danube: Impact of Global Change on the Upper Danube

Global Climate Change will increasingly have regional impacts on the water resources. More frequent floods, low flows and droughts, the retreat of glaciers and of snow cover in the Alps as well as changes of the natural and agrarian vegetation particularly in the Upper Danube watershed will be likely consequences of Climate Change. They will influence strongly the future development of the region. In order to facilitate the most effective planning of future investments for decades (e.g. in energy management, farming, tourism, industry), an intensive examination of the regional consequences of Climate Change is necessary.

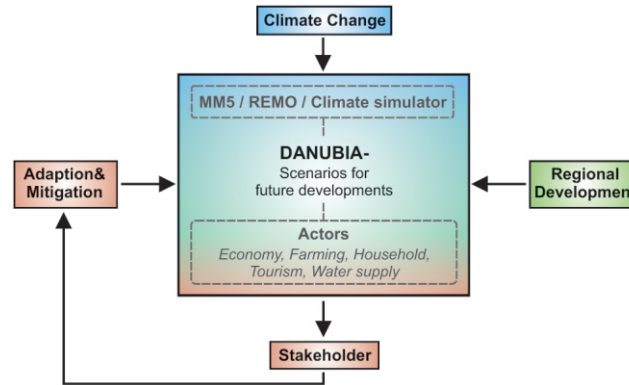
GLOWA-Danube (www.glowa-danube.de) is a research and development program focusing on the comprehensive analysis of the future of water resources of the Upper Danube. In GLOWA-Danube the impact of Climate Change of a broad range of sectors is investigated. Furthermore the project identifies and simulates strategies for adaptation to and mitigation of the consequences of Climate Change and tests their effectiveness. In GLOWA-Danube a team of researchers from different natural and socio-economic science disciplines work closely together in an interdisciplinary, university-based competence network since 2001.



Aspects of integration in GLOWA-Danube

Aim of GLOWA-Danube

The aim of GLOWA-Danube is to investigate with different scenarios the impact of change in climate, population and land use on the water resources of the Upper Danube and to develop and evaluate regional adaptation strategies. For this purpose the decision support system DANUBIA was successfully set up within the first and second project stage (2001-2006).



Model of the scenario-based decision support system DANUBIA

DANUBIA - an integrative decision support system

DANUBIA is a coupled simulation model. It includes for the first time model components for natural science as well as socio-economic processes and their interactions. With the intension of being predictive DANUBIA uses results of regional climate models for predictions on Climate Change. Physical and physiological components describe natural processes (hydrology, hydro-geology, plant physiology, yield, and glaciology). For the simulation in the included sectors (farming, economy, water supply companies, private households and tourism) DANUBIA uses deep multi-actors models which represent the decisions of the involved actors based on the structure of societies, their framework as well as their interests. All components of DANUBIA run parallel on an inexpensive LINUX-cluster.

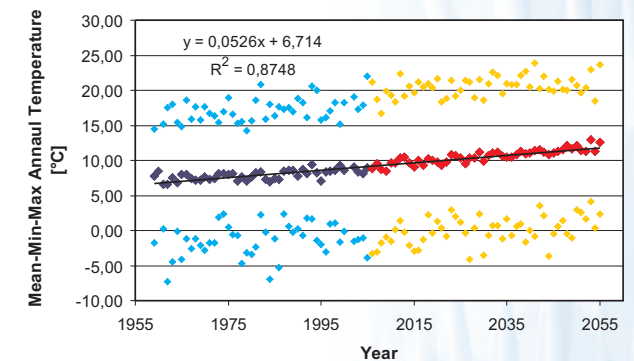
DANUBIA was carefully and successfully validated with comprehensive data sets of the years 1970-2005 and is now available in the third stage of the

project for common use for project researchers and stakeholder.

DANUBIA will be made available as “Open Source” at the end of the third project stage in 2010 and will particularly serve decision makers from policy, economy, and administration as tool for a foresighted planning of water resources against the background of Global Change.

Investigation area: The Upper Danube

DANUBIA is applied to the watershed of the Upper Danube. The Upper Danube with its more than 10 million inhabitants and an area of 77.000 km² is one of the largest and most important alpine watersheds in Europe. With its strong relief and the altitudinal gradient of up to 3.600 m, the Upper Danube is particularly vulnerable to Climate Change. These conditions also lead to a remarkably broad range of influencing factors on the water resources. The watershed includes glaciers as well as temperate lowlands, which are intensively used by agriculture. The Upper Danube in addition is characterised by a complex and intensive use of the water resources for hydropower, farming (possibly future irrigation) and tourism (e.g. snow cannons). The watershed of the Upper Danube therefore combines in an exemplary way a lot of water use problems of Central Europe.

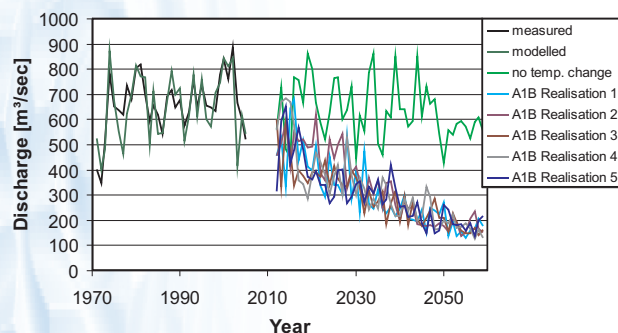


The temperature increase at the Upper Danube: past and future

The future of the water at the Upper Danube

Scenario runs with DANUBIA are based on the findings of the IPCC and use results of regional climate models as well as statistical ensemble approaches for the estimation of the future regional Climate Change in the Upper Danube watershed. The analyses show that the average air temperature at the Upper Danube has already increased by approx. 1.5 °C in the last 30 years. The IPCC-A1B scenario expects a further intense Global Warming in the next 50 years.

First results of scenario ensembles with DANUBIA already show that droughts in summer will broaden and that the low flow discharge of the Upper Danube will decrease strongly in the future years. Further scenario runs will include changes of glaciers, snow cover, and winter tourism, use of water reservoirs, consequences for water supply and water use as well as impacts on farming, tourism, households and industry.



Scenarios for the development of low flow at the gauge Achleiten, Upper Danube

Project partner:

Coordination:

Department of Geography, Prof. Dr. W. Mauser/
Dr. S. Stoeber, LMU Munich

Hydrology/ Remote Sensing:

Department of Geography, Prof. Dr. W. Mauser,
LMU Munich

Stakeholder participation:

IFOK-Institute for Organisational Communication,
Dr. H. Buettner, Bensheim

Meteorology:

Institute for Meteorology, PD Dr. G. Zaengl,
LMU Munich

Groundwater/ Water Supply:

Institute for Hydraulic Engineering, Dr. R. Barthel,
University of Stuttgart

Water Resources Management:

LFU-Environmental Protection Agency of Bavaria,
BD H. Weber, Hof

Glaciology:

Institute for Meteorology and Geophysics,
Prof. Dr. M. Kuhn, University of Innsbruck and
Bavarian Academy of Sciences and Humanities

Regional Climate Modelling:

Max-Planck-Institute for Meteorology, Dr. D. Jacob
MPI Hamburg

Ecosystems/Plant Ecology:

Institute for Geographie, Prof. Dr. K. Schneider,
University of Cologne

Environmental Psychology:

Center for Environmental Systems Research, Prof. Dr. A. Ernst,
University of Kassel

Environmental Economics:

Ifo Institute, Dr. J. Wackerbauer,
Institute for Economic Research at the University of Munich

Agricultural Economics:

Institute for Farm Management, Prof. Dr. S. Dabbert,
University of Hohenheim

Tourism Research:

Department of Geography, Prof. Dr. J. Schmude,
LMU Munich

Informatics:

Institute for Informatics, Prof. Dr. R. Hennicker,
LMU Munich

Human Capacity Building:

Institute for Hydraulic Engineering, Prof. Dr. H. Kobus,
University of Stuttgart

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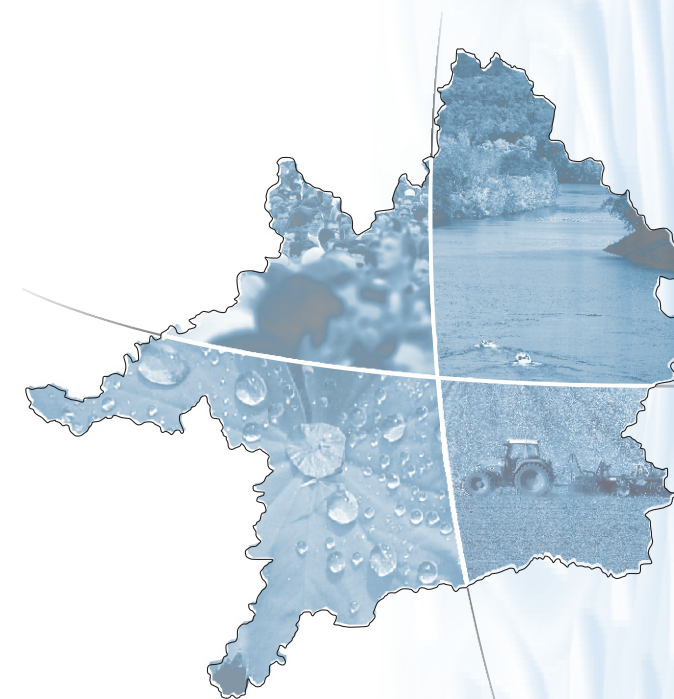
Ministry of Science,
Research and the Arts,
Baden-Wuerttemberg

Contact person:

Prof. Dr. Wolfram Mauser
Dr. Sara Stoeber
Department of Geography
Chair for Geography and Remote Sensing
Ludwig-Maximilians-University Munich LMU
Luisenstr.37
80333 Munich
Germany
Tel. +49 (0) 89 / 2180 - 6684
Fax:+49 (0) 89 / 2180 - 6675
E-mail: s.stoeber@iggf.geo.uni-muenchen.de



Integrative Techniques, Scenarios and Strategies for the Future of Water in the Upper Danube Basin



A research project in the context of GLOWA,
an initiative of the Federal Ministry
of Education and Research BMBF