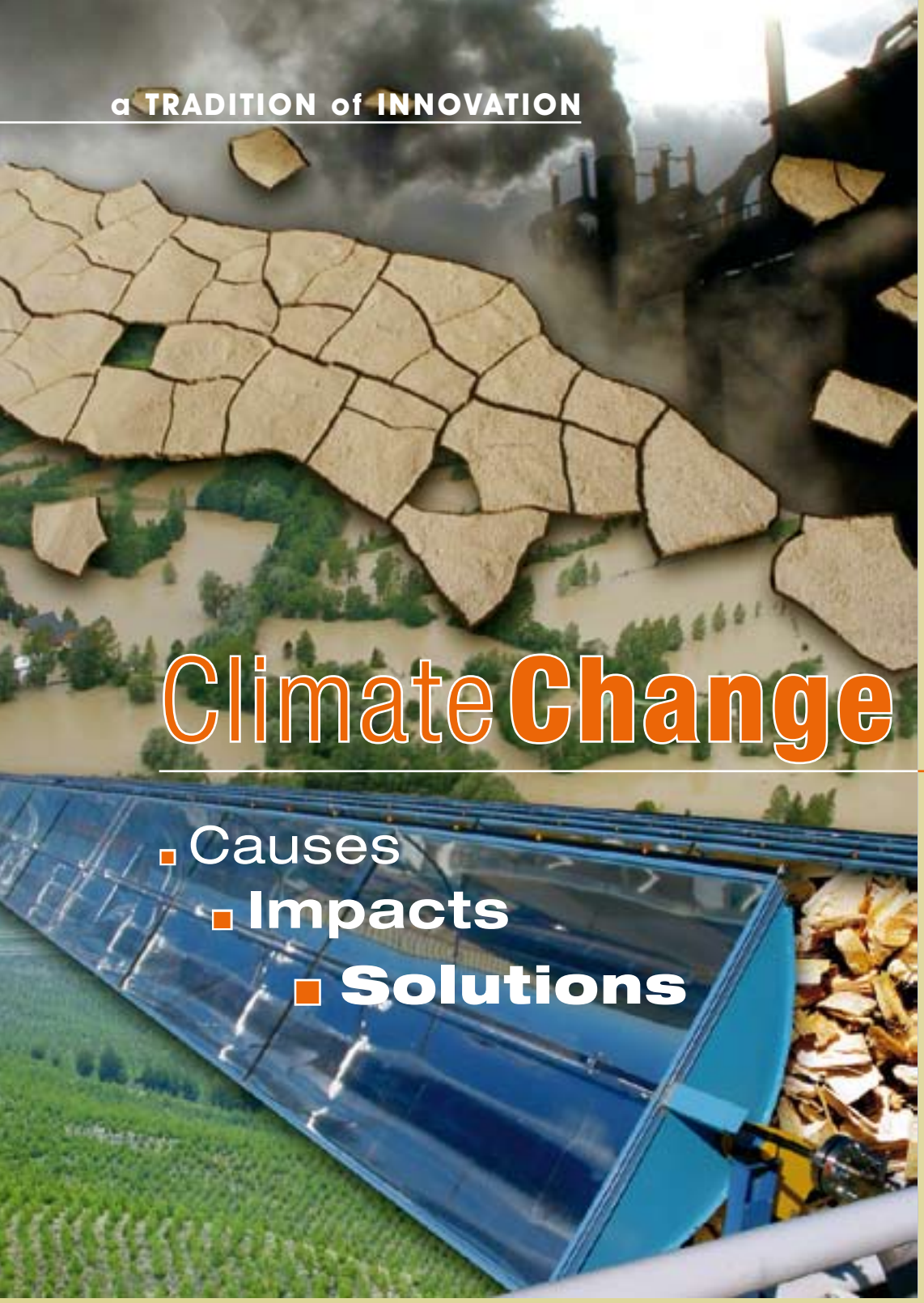


a TRADITION of INNOVATION

JOANNEUM RESEARCH

Climate Change

- Causes
- Impacts
- Solutions

JOANNEUM RESEARCH

Working group on climate change research

The objectives of the working group are to analyse causes and impacts of climate change, and to develop options and strategies for climate change adaptation and mitigation.

JOANNEUM RESEARCH Forschungsgesellschaft mbH

Dr. B. Schlamadinger • **Dr. F. Prettenthaler**

Elisabethstraße 5, 8010 Graz • Elisabethstraße 20, 8010 Graz

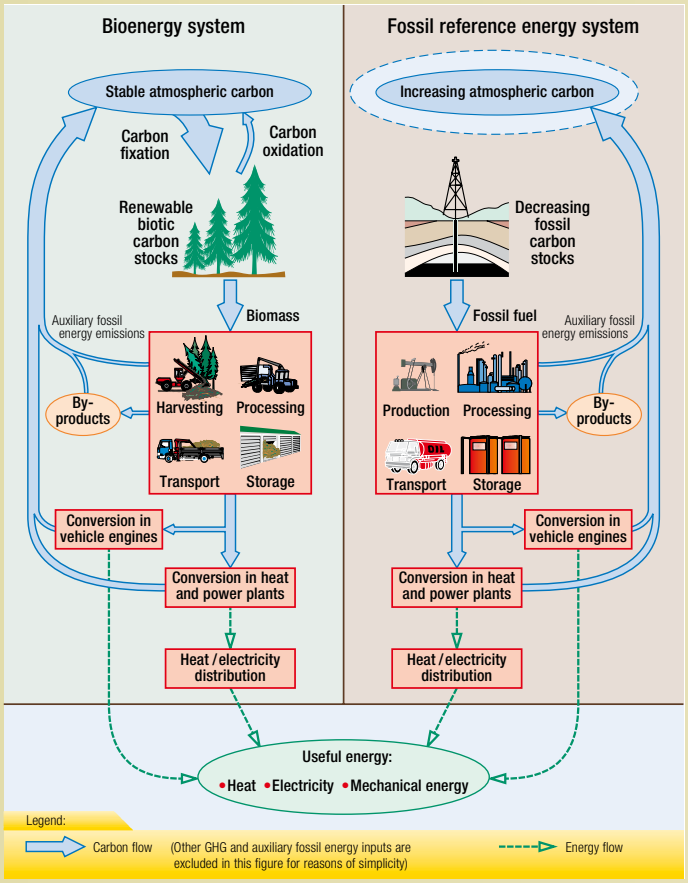
Phone +43 316 876-1340 • Phone +43 316 876-1455

Fax +43 316 8769-1340 • Fax +43 316 8769-1455

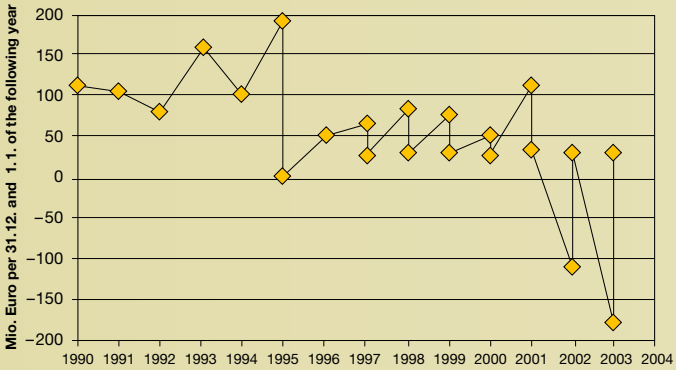
bernhard.schlamadinger@joanneum.at • franz.prettenthaler@joanneum.at

www.joanneum.at/climate

Climate **Change**
analysing causes and impacts



Life cycle analysis – comparison of GHG emissions from bioenergy and fossil fuel energy systems



Reserves of the Austrian Emergency Fund with dramatic declines in 2002 and 2003 due to the compensation for the August 2002 flood (1995: ad hoc legal transfer of funds to the federal budget)

Concentrations of atmospheric greenhouse gases (GHGs) and their radiative forcing have continued to increase over the last few decades as a result of human activities, largely fossil-fuel use and deforestation. Our assessments of the driving forces and mechanisms in the energy and land-use sectors, as well as the impacts of climate change on humans, ecosystems, and the economy, cover the following core topics:

Greenhouse Gas Inventories and Balances

- Preparation and application of methodologies for national and regional emission budgets. Example: “Multi-Source Inventory Methods For Quantifying Carbon Stocks and Stock Changes In European Forests – CarboInvent” (www.joanneum.at/carboinvent, www.carboeurope.org).

- Coordination of, and contribution to, various working groups of the Intergovernmental Panel on Climate Change (IPCC). Example: IPCC Good Practice Guidance for Land use, Land-use Change and Forestry (Guidance for reporting under the Kyoto Protocol).

- Life cycle analyses of bioenergy and biomass-based products (for example, solid, gaseous and liquid biomass fuels; wood products). Focus on development of methodologies and models, and their application in case studies. Examples: “Clear Views on Clean Fuels” (www.viewls.org); IEA Bioenergy Task38 (www.joanneum.at/iea-bioenergy-task38).

Economy

- Evaluation of the economic impacts of extreme weather events and changing climatic conditions on companies, regions and economic sectors at a regional/national scale.

- Economic vulnerability assessments by region and economic sector. Sectoral databases to serve these analyses are maintained.

- Analysis of economic drivers of GHG emissions; study of emission variations due to macroeconomic developments on a sectoral basis.

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Climate**Change**
analysing causes and impacts

Water Cycle

- Investigation and modelling of the impact of land use and climatic changes on water balance and water quality.
- Detection of past climate changes and age dating of water using isotope techniques (laboratory for hydrochemistry and environmental isotopes).

Agriculture and Forestry

- Effects of land cover change on the energy balance of the earth surface.
- Identification of responses by trees to extraordinary warm winter temperatures.
- Strategies against aggressive neobiota ("invasive species") which are supported by climate change.

Risk Mapping and Analysis

- GIS based vulnerability assessment of surface and subsurface/aquifer water systems.
- Risk assessment of extreme hydrological events (e.g. floods and droughts).

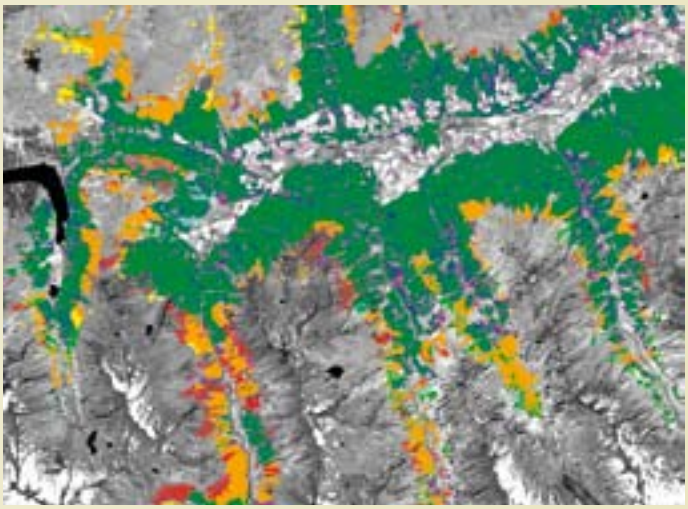
Remote Sensing

- Development and application of remote-sensing methods to monitor forest parameters.
- Detection of large-scale disturbances in forests (e.g. windthrow areas).

Windthrows affect the carbon dynamics of forest ecosystems, Source: P. Zajaczkowski

Pasterze glacier and Großglockner in September 2001 (Austria)

Floods affecting business infrastructure (Austria)



Classification of forest stands in an alpine region using satellite data

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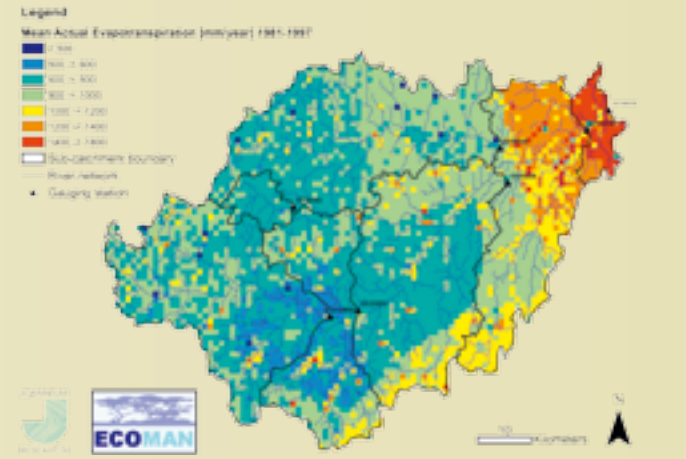
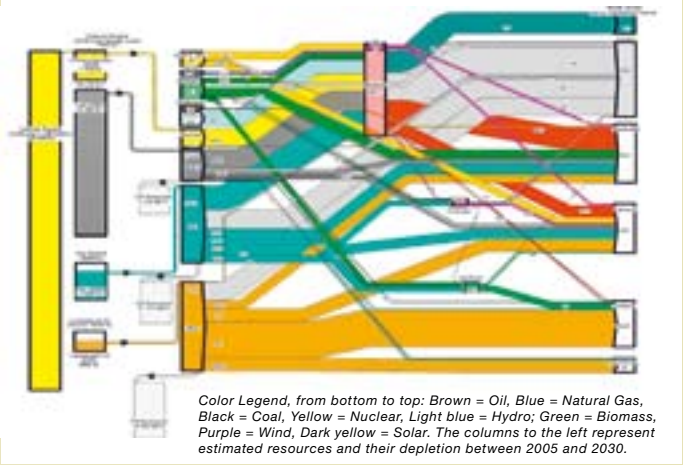
Climate**Change** solutions – advice for policymaking

Tree nursery for a CDM reforestation project (Uganda)



Water losses from evapotranspiration depend highly on land use, climatic conditions and their changes: Mean actual evapotranspiration (mm/y) of the subtropical catchment area of Rio Cachoeira (Bahia, Brazil). Source: www.uatla.pt/ecoman



Projected global flows of energy in the year 2030 (data from International Energy Agency, World Energy Outlook 2005), and associated depletion of fossil-fuel resources

There is consensus now about the need to both reduce human interference with the climate system, and to adapt to already "committed", i.e. unavoidable climate change.

The former can take many shapes, including binding emission-limitation agreements with emission trading such as the Kyoto Protocol, or other strategies that will lead to the adoption of technologies with low GHG emissions. Research focuses both on the international agreements and developments, as well as on ways for implementation at national, regional or local levels. Adaptation to climate change is especially important in a country with many fragile ecosystems, and economic sectors highly vulnerable to changes in temperature and precipitation.

International

- Participation in international panels related to climate policy (Afforestation/Reforestation Working Group of the CDM; Kyoto Protocol Compliance Committee; IPCC; Observer role in the UN Climate Convention).

- Research into climate policy options after the Kyoto Protocol's first commitment period (post 2012). We are at the forefront in the development of post-2012 policy options for agriculture and forestry (key topics are bioenergy/land-use interactions, and the avoidance of emissions from tropical deforestation).

National and Sectoral

- Research on optimal economic solutions for climate change mitigation and adaptation in sectors such as tourism, water and energy supply, the beverage and food sector, agriculture etc.

- Research on the potentials, costs and necessary incentives for energy systems with low GHG intensity.

- Methodology for optimising climate strategies while accounting for other environmental benefits, energy security, and economic growth objectives.

- National and regional assessments of biomass-based strategies for GHG mitigation. Example: EU Bioenergy Network of Excellence (www.bioenergy-noe.com).

- Design and optimal implementation of R&D and innovation policies for national Kyoto Protocol compliance.

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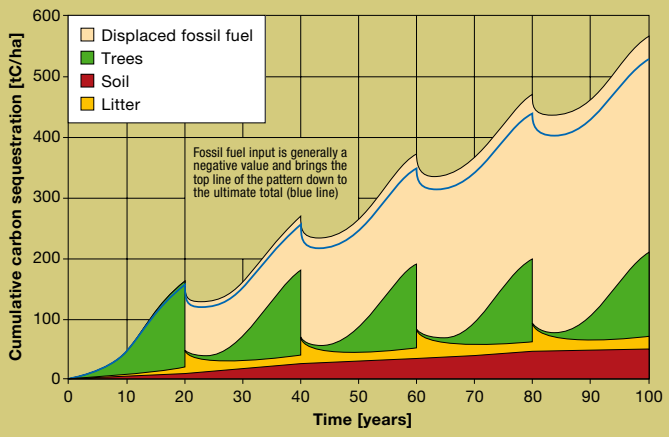
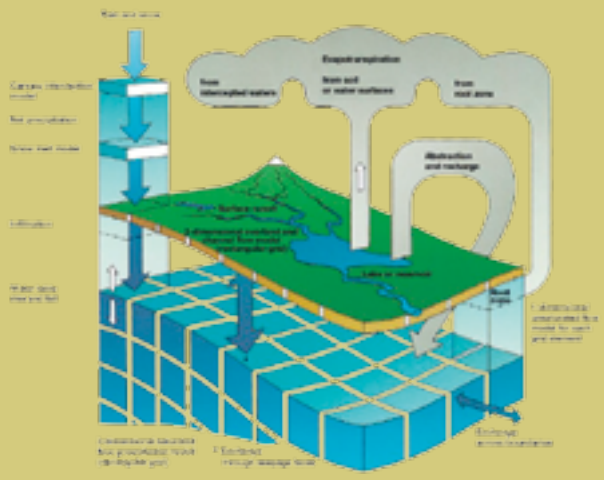
Climate**Change** solutions – support for implementation



Graz/Oak Ridge Carbon Accounting Model – results for a carbon sequestration project using short rotation forestry on agricultural land, Source: www.joanneum.at/gorcam.htm



Simulation of the water flows as a means of land-use planning under changing climate, Source: www.dhi.dk

Global overview of emission trading systems, Source: www.seaat.org

This cluster of research topics includes the development and application of tools and methods to assess and optimise measures aimed at reducing GHG emissions and adapting to climate change.

Computer Models

- Models of carbon dynamics in forests or other ecosystems (www.joanneum.at/gorcam.htm).
- Multi-sectoral and multi-regional econometric models and Computed General Equilibrium Models. Analyses of shocks from climate change induced extreme weather events but also policy shocks such as new taxes, emission trading or new investments necessary to adapt to climate change, e.g. in the water and tourism sector.
- Development and application of GIS-based Decision Support Systems for the solution of land and water use conflicts. Validation of planning measures and forecasting of their impact.
- Design of basin wide integrated management concepts for sustainable use of water resources according to the European Water Framework Directive.

Emissions Trading, Kyoto Protocol Project Mechanisms and GHG-Offset Projects

- Information and consultancy for companies to help them use the flexible mechanisms of the Kyoto Protocol (Joint Implementation and Clean Development Mechanism).
- Development of baseline and monitoring methodologies, and project design documents for projects that reduce GHGs. Example: the world's first afforestation/reforestation methodology in the CDM (reforestation of degraded land).
- Assessing the impacts of emission trading and other climate policy options on economic sectors.

Weather Risk Management

- Consultancy on managing and hedging weather related risks (for example on earnings) for companies in the tourism, water and energy supply, beverage and food industries and agriculture.

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Climate**Change** solutions – technologies and industrial applications

Combustion chamber of a biomass furnace (Austria)

Biomass gasifier in Güssing (Austria)

Hydrogen testing facility and filling station at the Hydrogen Center Austria, Source: HyCentA

Industry is adversely affected by high energy costs and limits on their greenhouse gas emissions (energy or carbon taxes). The business impacts of these burdens can be minimised in two ways: first by the adoption of energy efficient technologies and low GHG intensity fuels and technologies (e.g. the use of renewable energy carriers).

Low Greenhouse Gas Technologies

- Possibilities for implementation and optimisation of solar energy in industry.
- Studies into the use of hydrogen based renewable energy.
- Development of small-scale (3–300 kW) biomass boilers and furnaces (e.g. for pellets) and combined heat and power plants.
- Supporting developers of technologies with low GHG emissions towards enhancing their sales through Clean Development Mechanism and Joint Implementation project opportunities.

Energy and Greenhouse Gas Efficiency in Industry

- Studies into the GHG benefits of fuel switching in the cement industry.
- Energy flow analyses and efficiency improvements for energy-intensive processes in industry.
- Energy efficiency in production processes by pinch technology; optimising heat integration into discontinuous production processes.

Management of Economic Risks

- Analysing options to transfer climate risk from households and firms to the capital market by using insurance, weather derivatives or emergency funds.

Climate**Change** causes, impacts and solutions

Activities at JOANNEUM RESEARCH focus on the following main topics

JOANNEUM RESEARCH
Forschungsgesellschaft mbH
Steyrergasse 17
8010 Graz, Austria

ISO 9001:2000 certified

JOANNEUM RESEARCH
is one of the leading research centres in Austria conducting cutting-edge research for businesses and industry, government agencies and non-government organisations. With over 380 highly qualified employees JOANNEUM RESEARCH has an excellent reputation as an innovative partner and cooperates on numerous projects in Austria and worldwide.