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CONTINENTS UNDER CLIMATE CHANGE

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Abstracts of Lectures and Posters
of the Conference
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edited by:

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This PIK-Report represents the collected abstracts of lectures and posters for the Symposium “Continents under Climate Change” which took place on April 21-23, 2010 in Berlin. The editors are not responsible for the content of the contributions. Comments should be made directly to the authors.

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Preface

Climate Change and its subsequent impacts are amongst the most urgent problems that mankind has to face at present. The abstracts assembled in this volume pay an important contribution in uncovering the existing global problems. A number of lectures and posters to be presented at the international conference "Continents under Climate Change" from 21 to 23 April 2010 in Berlin form the basis of these abstracts. The conference "Continents under Climate Change" was planned as a special event of the Humboldt-Universität zu Berlin on its 200th anniversary. The conference was organised in close co-operation with the Potsdam Institute for Climate Impact Research (PIK) and the German National Academy of Sciences Leopoldina.
The authors, belonging to the worldwide leading scientists of their continents, give an expressive review of the climate change and its impacts taking place on their continents. For the first time, the reader can get a short and clear but well-founded picture of the changes that are already underway throughout the world.
The organizers wish to thank all those who contributed to the synthesis of this report.

Friedrich-Wilhelm Gerstengarbe	Wilfried Endlicher
(Potsdam)	(Berlin)

LECTURES

OVERVIEW

AMERICA

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ASIA

GENERAL ASPECTS

AUSTRALIA / POLAR REGIONS

EUROPA

OVERVIEW

A Tipping-Elements Expedition in the Footsteps of Alexander von Humboldt

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Keywords

Climate change – Tipping elements – Marine biological carbon pump – El Niño-Southern Oscillation – Amazon rainforest – Coral reefs – Boreal forests – Ocean methane hydrates – Yedoma permafrost – Tibetan glaciers – Alexander von Humboldt

Abstract

When Alexander von Humboldt set out to explore the American continent, he came across terrestrial and marine (eco-)systems that are considered tipping elements today. Small perturbations linked to climate change may trigger abrupt and/or irreversible change in these systems. If Alexander von Humboldt had undertaken his expedition in modern times, he might have studied potential tipping behaviour of the marine biological carbon pump, the Amazon rainforest, coral reefs in the Caribbean Sea, and the El Niño-Southern Oscillation (one of the major oceanic/atmospheric circulation modes on Earth). Likewise, when he later travelled across the vast plains of Russia, he might have been most interested in signs of approaching tipping points in boreal forests, permafrost soils, Tibetan glaciers, and marine methane hydrates off the Siberian coast. Here, we follow Alexander von Humboldt on a mental journey. We present recent scientific findings on the science of tipping elements that are located along his expedition routes. To conclude, we sketch a research agenda whose successful completion would provide society with the knowledge and tools required to handle the risks arising from tipping elements.

Climate – The Natural Resource and its Rapid Change

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Keywords

Global climate change – Tipping points – 2 °C goal – Technology development

Abstract

Our survival parameters, namely warmest summer month temperature above about 10 °C, enough fresh water from the skies or a river for food production by plants are nearly identical to the three key climate parameters solar irradiance, precipitation from clouds and atmospheric composition dominated by life on Earth. Hence, rapid climate change always has attacked many life forms.

Is ongoing anthropogenic global climate change rapid in comparison to the natural global climate change rate in the recent few million years? Yes, therefore global climate policy making in order to dampen the change rate is a necessity.

What would be needed to avoid tipping points like a rapid Greenland ice sheet melt or the loss of the sink "vegetation" for anthropogenic carbon? Taking into account the adoption of the precautionary principle, as e.g. followed by the European Union, the answer is: Much less than 2 °C mean global warming in comparison to the pre-industrial level. Hence, the maximum 2 °C goal taken note of at the 15th Conference of the Parties to UNFCCC in Copenhagen does not suffice.

The way out means only 350 parts per million by volume carbon dioxide in the atmosphere in the long run (22nd century), i.e. rapid internalization of external effects of fossil fuel use that then accelerates renewable energy use and technology development long before we run out of oil and coal. Whether it will be achieved without geo-engineering is not yet clear.

AMERICA

Climate Change and its Effects in North America

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Keywords

Climate-related impacts – Water resources – Livestock production – Sea-level rise – Environmental stresses

Abstract

The USGCRP Report: Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press: 2009 is the most recent credible assessment of climate change effects in North America. I will discuss the key findings cited below.

1. **Global warming is unequivocal and primarily human-induced:** Global temperature has increased over the past 50 years. This observed increase is due primarily to human-induced emissions of heat-trapping gases.
2. **Climate changes are underway in the US and are projected to grow:** Climate-related changes are already observed in the US and its coastal waters, including increases in heavy downpours, rising temperature and sea level, rapidly retreating glaciers, thawing permafrost, lengthening growing seasons, lengthening ice-free seasons in the ocean and on lakes and rivers, earlier snowmelt, and alterations in river flows. These changes are projected to grow.
3. **Widespread climate-related impacts are occurring now and are expected to increase:** Climate changes are already affecting water, energy, transportation, agriculture, ecosystems, and health. These impacts are different from region to region and will grow under projected climate change.
4. **Climate change will stress water resources:** Water is an issue in every region, but the nature of the potential impacts varies. Drought, related to reduced precipitation, increased evaporation, and increased water loss from plants, is an important issue in many regions, especially in the West. Floods and water quality problems are likely to be amplified by climate change in most regions. Declines in mountain snowpack are important in the West and Alaska where snowpack provides vital natural water storage.
5. **Crop and livestock production will be increasingly challenged:** Agriculture is considered one of the sectors most adaptable to changes in climate. However, increased heat, pests, water stress, diseases, and weather extremes will pose adaptation challenges for crop and livestock production.
6. **Coastal areas are at increasing risk from sea-level rise and storm surge:** Sea-level rise and storm surge place many U.S. coastal areas at increasing risk of erosion and flooding, especially along the Atlantic and Gulf Coasts, Pacific Islands, and parts of Alaska. Energy and transportation infrastructure and other property in coastal areas are very likely to be adversely affected.
7. **Threats to human health will increase:** Health impacts of climate change are related to heat stress, waterborne diseases, poor air quality, extreme weather events, and diseases transmitted by insects and rodents. Robust public health infrastructure can reduce the potential for negative impacts.
8. **Climate change will interact with many social and environmental stresses:** Climate change will combine with pollution, population growth, overuse of resources, urbanization, and other social, economic, and environmental stresses to create larger impacts than from any of these factors alone.
9. **Thresholds will be crossed, leading to large changes in climate and ecosystems:** There are a variety of thresholds in the climate system and ecosystems, which determine, for example, the presence of sea ice and permafrost, and the survival of species, from fish to insect pests, with implications for society. With further climate change, the crossing of additional thresholds is expected.
10. **Future climate change and its impacts depend on choices made today:** The amount and rate of future climate change depend primarily on current and future human-caused emissions of heat-trapping gases and airborne particles. Responses involve reducing emissions to limit future warming, and adapting to the changes that are unavoidable.

Regional Climate Change Scenarios in South America in the Late XXI Century: Projections and Expected Impacts

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Keywords

Climate change – Climate extremes – Biodiversity – Northeast Brazil – Vulnerability – South America

Abstract

Regional climate change projections for the last half of the XXI Century have been produced for South America, as part of the CREAS (***C****enarios* ***RE****gionalizados de Clima Futuro da* ***A****merica do* ***S****ul*) regional project. Three regional climate models were used to project climate change scenarios for the IPCC A2 high emission scenario for 2071–2100.

The projections show a consistent pattern of changes in circulation, rainfall and temperatures as depicted by the three models. There are indications that regions such of Northeast Brazil and central-eastern and southern Amazonia may experience rainfall deficiency in the future, while the Northwest coast of Peru-Ecuador and northern Argentina may experience rainfall excesses in a warmer future, and these changes may vary with the seasons. The three models show warming in the A2 scenario stronger in the tropical region, especially in the 5° N–15° S band, both in summer and especially in winter, reaching up to 6–8 °C warmer than in the present. Some experiences of applications on impact assessments using these climate change scenarios are also discussed.

Climate Change in Brazil: The Impacts of Different Actors on the Creation of the National Policy

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Keywords

Climate change – National policy – Brazil – Non-Governmental Organizations – Government commissions – Business initiatives – Climate governance

Abstract

The establishment of the National Policy on Climate Change has caused a change in Brazil's position concerning the adoption of greenhouse gas (GHG) reduction targets. Brazil still supports the application of the 'principle of common but differentiated responsibilities' and its implications in the way developed and developing countries must address climate change issues. However, for the first time, and shortly before the COP 15 in Copenhagen, the Brazilian government announced voluntary targets to reduce its GHG emissions (considering the business-as-usual scenario) to at least 36.1% (may reach 38.9%) by 2020 and included these targets in the law 12.187 of 2009 that established the National Policy on Climate Change.

The decision-making process that led to the development of the climate policy involved several actors. This paper studies specific government commissions, business initiatives, and NGOs as actors involved in this process, addressing their roles, their contributions, and the future challenges of climate governance concerning the national policy in Brazil. The Interministerial Commission on Global Climate Change and the Brazilian Climate Change Forum, which assist the Brazilian government in the implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, constitute the governmental boards addressed in this paper. Actions supported by the Center for Sustainability Studies at Fundação Getúlio Vargas (GVces) represent the business initiatives, and finally, the Climate Observatory, Vitae Civilis, and the Brazilian Forum of NGOs and Social Movements for the Environment and Development (FBOMS), which are three active organizations in the climate change arena, illustrate the role of NGOs. Thus, workshops, meetings, and events organized by these agents as well as petitions and documents handed to the President and the Minister of Environment with suggestions for the government's position at the COP 15 and for the improvement of the national policy were studied in order to determine the influence and impact of these actors in shaping the Brazilian National Policy on Climate Change.

It is argued that despite the growing involvement of NGOs and business initiatives in the discussions on a climate change policy, there are some key challenges in its implementation, such as the definition of concrete measures and reduction targets that will be adopted in each sector (industry, transport, construction etc) as well as the clarification of the financial resources that will be used to achieve GHG reductions. These challenges still need to be overcome by the government and climate governance in Brazil.

Urban Latin America under Climate Change – Do Adaptation Strategies of City-Regions Respond to the Challenges?

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Keywords

Latin America – Climate change – City-Regions – Local climate action

Abstract

Driven by a growing consensus that climate change is inevitable and predictions are probable, adaptation of cities to climate change has recently entered the academic and political debate as an essential and integral part of climate policy. Cities and city-regions are key sources of greenhouse gas emissions and at the same time highly vulnerable to the consequences of climate change. City administrations around the world are starting to initiate actions to both reduce emissions and to confront anticipated effects. Latin America, where the anticipated climate changes and their impacts are already being felt and observed across the region, is no exception. This paper attempts to draw first lessons from selected city-regions on how urban responses to climate change address the likely impacts such as increasing deficits in water supply or extreme events. Based on an analysis of official documents, expert interviews, literature reviews and statistical data, the presentation consists of three main parts. The first part presents an overview of the existing specific local climate conditions in four city-regions in Latin America (Bogotá, São Paulo, Buenos Aires and Santiago de Chile) and takes a closer examination of two of these (São Paulo and Santiago de Chile). The second part discusses the interacting processes between climate change and exposed urban functions, sectors and population in São Paulo and Santiago de Chile. It likewise analyses the state of 'formal' responses in the two cities. The fourth and final part compares the findings and provides some general conclusions on the constraints and challenges of local climate responses.

The brief presentation of climate change action in two Latin American city-regions provides insights on the current state-of-response at the local level. The selected city-regions highlight that identified future impacts add to already existing vulnerabilities that are connected to existing pressures like population and spatial growth and already high dependency on scarce resources. With respect to climate change response, the cases suggest a 'path dependency', in the sense that priorities formulated in climate action plans connect to previous local agendas. Likewise, action focuses on those problems that occupy a 'prominent' role in the public debate. These two aspects (continuity of the agenda and public relevance of the topic) seem to be important 'strategic' considerations for linking adaptation action with mainstream of local development. They are, perhaps, of higher significance in current practice to inform local policy than available knowledge on climate change and related impacts. With reference to the latter, the cases likewise confirm that there exist considerable uncertainties and gaps in knowledge about the future local climate trends and their likely effects in cities. With respect to linking likely climate change impact and response, the cases suggest that policy and practice of service delivery can no longer be disconnected from individual and collective preferences and consumption. A main strategy to confront the trend of growing resource scarcities will have to focus on adjusting consumption levels as a complement to reuse and recycling schemes. Although not new at all, this suggests the need to find strategies to intensify citizen involvement in local adaptation action.

Mountain Permafrost – A Valid Archive to Study Climate Change? – Examples from the Rocky Mountains Front Range of Colorado, USA

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Keywords

Mountain permafrost – Degradation – Climate change – Geophysics – Active layer – Natural fluctuation

Abstract

Mountain permafrost is highly sensitive to changing air temperatures because they affect the thawing depth of the annual active layer, as well as the time and speed of the refreezing process, mainly in the winter.

The Long Term Ecological Research Site (LTER) Niwot Ridge and the Critical Zone Observatory Site (CZO) Green Lakes in Colorado, USA, with their high alpine tundra climate and vegetation, offer ideal conditions to study changes of mountain permafrost. The sites provide high quality climate data, together with studies on permafrost since the 1970's, which make these places rather unique in the US. We present data from our studies on permafrost distribution using different geophysical techniques to portray the shallow subsurface. The data on permafrost and soil temperature are compared with existing models of permafrost distribution and possible thermal degradation, as well as with older data on the existence and distribution of permafrost at these sites.

At some locations, we find large differences when compared to the older data and the prognostic model. Sites formerly indicated as permafrost in the 1970's shifted towards sites with annual ice lenses today. We discuss the results and attempt to discern if the observed change is a direct consequence of the current rising air temperatures.

AFRICA

Challenges of Climate Change Impacts in Africa, Exemplified by the Case of the South African Water Sector: Where from? Where now? Where to in future?

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Keywords

Africa – South Africa – Climate change – Impacts – Surprises – Adaptation strategies

Abstract

To do justice to assessing projected impacts of climate change and the status of adaptation strategies across a continent straddling nearly 70° latitude on which administrative boundaries with strong colonial footprints cross natural and linguistic ones, and in which many individual countries already display vast physiographic and socio-economic diversity, is a task ending in a series of superficial "motherhood" statements which tend not to make meaningful contributions either to policy makers or to vulnerable communities of people or plants on the ground. Having illustrated these points, this presentation focuses on South Africa – a highly diverse country socio-economically and physiographically, with characteristics of the developed world juxtaposed upon characteristics of the lesser developed world. This country with huge hydro-climatic variability has nevertheless developed sophisticated and state-of-the-art water legislation the implementation of which is proving difficult.

It is against this backdrop that one asks "where now?" when climate change is superimposed onto the water scene. In appreciating the dynamics of climate change on the water sector, an appropriate physical-conceptual and daily time step hydrological model (ACRU) has been developed in South Africa, with this model able to account in detail for the landscape, as well as the channel and ecological components of the hydrological system under climate change when undertaking impact studies which then underpin adaptation strategies. Additionally, downscaling of daily output from the latest IPCC GCMs to over 2500 climate stations in South Africa has been linked to a configuration of nearly 6000 homogeneous hydrological response zones for impact assessments.

Key findings on projected climate change impacts are, first, those which one would expect from the literature. We have, however, been "conditioned" by the literature to expect certain impacts. Therefore, secondly, and more importantly from a water resource planning perspective for the future, are the large number of "surprises" which the latest South African research has exposed, and which the literature has not, to date, identified, e.g. on projected patterns of soil water stress, water temperature, different types of drought, sediment yields, design hydrology and on uncertainty under climate change.

Looking into the future, South Africa faces a number of key issues in climate change research and adaptation. First, there is a need to mainstream climate change challenges into co-ordinated national strategies. Secondly, and more specific to the water sector, is the need to formalise a climate change adaptation strategy using a 14-point set of principles which should stand the test of time. Thirdly, researchers need to address with more vigour second order impacts of climate change (e.g. impacts of extremes, groundwater recharge, and dynamics of projected changes in land use interwoven with effects of climate change), as well as third order impacts (including consequences of changes in water quality, terrestrial and aquatic ecological responses, conflicts over shared international waters and vulnerability of the poor). A fourth issue is to address climate change on complex operational catchments in South Africa, i.e. catchments which are already largely water engineered rather than natural hydrological systems.

The presentation concludes with a discussion on responsibilities of government, science, industry and commerce in a context of climate change and the water sector.

Impacts of Climate Change in Africa

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Keywords

Climate change in Africa – Food security – Water scarcity – Poverty – Human health and wellbeing

Abstract

The projected impacts by the IPCC of climate change in many parts of Africa are going to be severe. However, these impacts must be viewed in the broader context of the developmental challenges across the board; these relate to food security, human health and wellbeing, safe drinking water and sanitation, land degradation, and poverty. The most significant impact of climate change will be on the distribution of water throughout the African content. Parts of Northern Africa and Southern Africa are projected by the IPCC to be significantly drier by up to 20 % (in terms of the water run-off) by the year 2050. At the same time, some parts of the Sahel region are projected to get wetter. These changes to the water cycle will trigger further water scarcity in many of the impoverished parts of the African continent. Efforts for provisioning of safe drinking water and adequate sanitation could potentially be impacted by the water-resource scarcity, in addition to the existing challenges in mobilizing financial, human and institutional resources. As safe water and sanitation relate directly to mortality and morbidity rates, the impacts can be further extended to those on the public health systems and economic productivity of the workforce. The water scarcity can also impinge on food production and cropping patterns, and lead to adverse impacts on food security. This may be exacerbated by other extraneous factors like the growing cropping trends for biofuels production. While we do not fully understand how these factors interplay into human migration patterns observed in Africa, some recent studies argue that serious consideration should be given to the role of environmental challenges in these movements. As a consequence, climate change adaptation needs to be a major focus of the development efforts in Africa.

Impacts of Global Change on the Hydrological Cycle in West and Northwest Africa

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Keywords

Global Change – Climate change – Regional climate modelling – Downscaling methods – Impact modelling

Abstract

Africa is characterized by large natural climate variability, rapid land-use change, and high population dynamics. For example, West Africa presently belongs among the regions with the highest population growth worldwide. It is expected that this development will be associated with the highest rate of urban growth in the world for the next decades. Still, the majority of the population in this region depends on rain-fed agriculture. At the same time, tropical West Africa is known for its variable rainfall climate, often exceeding the rainfalls fluctuations of many other places on earth. While a high degree of uncertainty exists with respect to future rainfall trends in sub-Saharan West Africa, climate models agree on a significant drying and warming trend for subtropical North-West Africa until 2050.

The GLOWA-IMPETUS project (2000–2009) assessed the impacts of Global Change, i.e. of demographic growth, environmental changes (including climate and land use changes), and of global markets, on the hydrological cycle of two watersheds in tropical West (the Ouémé catchment in Benin) and subtropical North-West Africa (the Drâa catchment in Morocco). A multidisciplinary approach was adopted, involving natural, socio-economic, and health sciences. The first project phase (2000–2003) was dedicated to the comprehensive assessment of the status quo. In the second phase (2003–2006), qualitative and quantitative models were adapted or newly developed for both regions. Projections of future developments were derived from scenario calculations and from expert knowledge. In the last project phase (2006–2009), spatial decision support and information systems (SDSS/IS) are developed within a set of multidisciplinary "problem clusters". Problem clusters are meta-problems which require a multi-disciplinary analysis in order to allow for reliable projections for regional planning.

In the presentation, the past, present and projected climate development for Northwest and West Africa with a focus on rainfall and temperature variability in Morocco and Benin will be presented. Particular foci will be put on (a) the methods applied for regional climate projections, their results and uncertainties, as well as on (b) how the climate and socio-economic scenarios were combined to assess potential impacts on the hydrological cycle, crop yields, and land use in the Drâa and Ouémé catchments. The IMPETUS approach allowed for an evaluation of the respective roles of climate change versus demographic growth and socio-economic developments for the future freshwater and food availability.

How the Future Climate of the Southern African Region Might Look Like: Results of a High Resolution Regional Climate Change Projection

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Keywords

Climate change projection – Southern Africa – Regional climate model – Added value – Biodiversity

Abstract

The southern African region is known to be a biodiversity hotspot, but future climate change is likely to have a major influence on the biodiversity. To estimate the impacts of climate change on the biosphere high resolution climate information is needed for both current and future conditions. In the framework of the BIOTA South project we are therefore applying the regional climate model (RCM) REMO of the Max Planck Institute for Meteorology (MPI-M) over the southern African region. The model is integrated for a transient climate change simulation for the time period 1960 to 2100 at 1/2 degree and 1/6 degree horizontal resolution using a double-nesting approach. The 1/6 degree simulation is the first long-term climate projection for southern Africa on such a high horizontal resolution. The boundary forcing for the 1/2 degree projection is taken from a global ECHAM5/MPIOM IPCC A1B scenario simulation.

In the current study we will analyse the projected climate change signal of this high resolution RCM over the southern African region, thereby focusing on the Orange river catchment, which represents the major drainage basin of the southern African region and along the main BIOTA research transect, which spans from the north-eastern corner of Namibia to the Cape region in the South. We mainly will discuss changes in the rainfall characteristics, as these are of major importance with respect to the future water availability and therefore directly influence the future state of southern African ecosystems. Furthermore, we will highlight the added value one can observe when using a high resolution RCM in comparison to global climate model data.

Solar Signals in African Climate Since 1901

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Keywords

Climate variability – Africa – Solar-climate relations – Time series analysis

Abstract

Since the year 1900 the global climate has warmed by approximately 0.8 °C. Most of this warming is due to the rising concentration of carbon dioxide and other anthropogenic greenhouse gases. A noteworthy contribution of solar variability to recent warming is generally dismissed, because the responses to the solar 11-year cycle are too small to be detected unambiguously in observations. But – although there have been hundreds of studies during the last decades concerning climate response to the 11-year sunspot cycle – the influence of solar activity changes on the climate of the Earth is still characterised by a "low level of scientific understanding" (IPCC 2007). The present study may contribute to an improved assessment of sun-climate relationships with a regional focus on Africa.

The study is based on the monthly HadSLP2 data set; sea surface temperature data are taken from the HadISST1.1 dataset, and high-resolution precipitation and temperature data are provided by the Climatic Research Unit (CRU). These data have been updated and improved within the Potsdam Institute for Climate Impact Research (PIK). Some statistical relationships between solar activity and the climate of southern Africa have been identified since the beginning of the 20th century based mainly on different time series analyses (autocorrelation, spectral and wavelet analyses) in addition to simple correlation and composite analyses.

The analysis of SLP data gives spectral maxima on a decadal time scale for the southern edge of the St. Helena high pressure system above the central South Atlantic Ocean during all seasons, but most pronounced in southern winter. Further results indicate an expansion of the Hadley cell during periods of higher solar activity and a strengthening of the subtropical high pressure systems above the southern Atlantic and southern Indian Oceans at solar maxima.

Differences of SST-composites include only very small values in the lower latitudes; this might be due to two opposing effects: Higher solar activity raises tropical SSTs, but due to an enhanced evaporation at the same time, energy is removed from the surface, leading to lower SSTs. Further relationships can also be shown by correlation analyses, for example between the total solar irradiance and SST data (with time coefficients for the latter from a s-mode PCA): there are highly significant values ($r = 0.7$ at the 99 % confidence level) for particular centres of SST variation in the midlatitudes between 50° S and 60° S. Further results are based on time series analyses. For instance, spectral analyses applied to the time coefficients of SST PCs, representing the centre of SST variation in the southern equatorial Atlantic Ocean, confirm a highly significant (99 %) quasi-decadal signal for August.

A solar signal in South African winter temperatures reaches up to 1 K. Both composite and time-series analyses have shown robust relationships which might be explained by a direct radiation influence on the nearly cloud-free winterly high pressure system above central South Africa.

Precipitation in northern Namibia/southern Angola exhibits a striking quasi-decadal signal, and correlation analyses suggest a relationship with changing solar activity. Positive precipitation anomalies during the 'long rains' could be identified in East Africa during periods of increased solar activity. The increased precipitation might be caused by solar impacts on the Indian Ocean Dipole (IOD) which strongly influences the East African precipitation. Furthermore, a stronger Hadley circulation during periods of higher solar activity might lead to changes in the precipitation pattern. Finally, this precipitation pattern during solar maxima is remarkably similar to an El-Niño-induced pattern. Increased solar activity leads to higher evaporation over the nearly cloud-free regions in the subtropics, and this might also lead to lower SSTs. Stronger regional Hadley and Walker cells due to the increased atmospheric moisture content include a stronger upward motion in tropical latitudes and a corresponding intensified subsidence in subtropical regions leading to a reduction of the cloud cover and therefore to an increasing solar irradiance input. These surface feedbacks might explain how a small solar signal is amplified in local climate.

Downscaling of Future Climate Change for the Mediterranean Region

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Keywords

Climate Change – Mediterranean region – Precipitation – Temperature – Mean Values and Extremes

Abstract

The Mediterranean area has been characterised as a "climate change hot-spot" being highly affected by future climate change compared to other regions of the world. Dynamical and statistical downscaling results will be discussed for the supposed changes of temperature and precipitation concerning both mean values as well as extreme conditions.
The downscaling assessments show increases of mean temperature in the Mediterranean area during all months of the year with seasonal and regional variations of the corresponding amounts. For mean precipitation increases are only found in the northern and western Mediterranean area during high winter, whereas in other seasons and regions mostly decreases are assessed during the course of the 21st century. Regarding temperature extremes increases of extreme hot days and of heat waves in summer are projected as well as a decrease of the frost-day number in winter. Concerning rainfall-related extremes assessments indicate that more frequent and longer-lasting drought events will occur in the Mediterranean area. In contrast to this, heavy rainfall events show a general tendency towards decreases in the Mediterranean region during winter.

Climate Change and Land Use Conflicts in Northern Africa

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Keywords

Climate change – Land use – Farmer-herder conflicts – Northern Africa – Mali – Model framework

Abstract

For centuries, Arab nomads and African villagers alternately skirmished and supported each other as they raised livestock and tended fields under resource-constrained conditions. The delicate balance has been upset by drought, desertification, crop failure and wide-spread food insecurity, which forced increased migration of nomadic groups from adjacent countries into more fertile areas. This has contributed to the struggle for land as herders from the north migrated southward in the dry season in search of water sources and grazing for their cattle. The increased influx of competitors, combined with tougher living conditions during the drought, has led to clashes and tensions between the newcomers and the local farmers. In addition, a series of drought events affected the Northern African regions since the 1970s and the fight for the scarce resources has become more intense. The boundary between semi-desert and desert has moved southward, and will continue to move due to changing precipitation.

The predicted loss in agricultural land is expected to lead to a drop in food production. A reduced availability of water and land caused by climate change does not necessarily increase the conflict potential, but rather causes diverse feedbacks within and between the group of farmers and herders. A recent study concludes that the likelihood of violent conflicts will significantly increase in the coming decades as a result of warming in Africa.

To test such projections this paper first gives an overview of the region's conflict vulnerability. Here, conflict-related factors, including population growth, economic development and conflict history, are assessed and jointly discussed with current and expected climatic changes in the region. The overview shows that Northern Africa is expected to see a strong population growth in the near future, with Mali and Chad doubling and Niger even almost tripling their population by 2050. The economic situation expressed in per capita income draws a clear north-south picture. While the northern states are economically stronger, the poorest countries, namely Niger, Mali and Chad, are all located in the south of the considered region. The degree of human development mainly mirrors the economic situation with Libya being the only high developed nation. Niger is last on the human development rankings, closely followed by Mali.

Further, the conflict vulnerability analysis shows that 8 out of the considered 11 states have experienced armed conflicts in the period of 1989 to 2008. The vast majority of these armed conflicts were internal and of minor conflict intensity. Only in Algeria and Sudan conflicts were temporarily or mainly classified as war. Most armed conflicts of minor intensity took place in Chad followed by Niger, Egypt and Mali. The Climate projections for Northern Africa lack precision. However, the majority of studies suggest a continuation of the current trend of increasing temperature and decreasing precipitation which could lead to a significant increase of drought risk, especially for the western part of the considered region.

Secondly, the paper analyzes past and ongoing farmer-herder conflicts in different regions of Mali. In north-west Mali conflicts erupt between Fulani herders and local Soninké farmers over land and water. The inland Niger delta of Mali experiences violent conflicts because of Songhai farmers who move their rice fields continuously into the burgu growing areas used by the Tuareg to feed their livestock. It is discussed which role climate change plays in these conflicts.

Third, a model framework is built for analyzing the farmer-herder conflict in Northern Africa, taking into account key environmental and economic variables and feedbacks, including water and food, labor, income and migration. To reduce the chances for local conflicts over natural resources and to improve the conditions for peace, options for joint environmental management are discussed, considering that environmental factors are intertwined with a range of other social, political, and economic issues, which have to be addressed to ensure societal stability.

The paper concludes that conflicts between herders and farmers over resources are not directly caused by climate change. However, the conflict relevance of climate change in Northern Africa will likely increase due to an aggravation of resource scarcity. In Mali climate change is a contributing factor to conflicts. To deepen the understanding of such conflicts the presented model framework serves as a basis for further social network analysis and agent-based modelling.

Climate Change Adaptation in Africa and Asia: Challenges Ahead and Action Needed

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Keywords

Adaptation – Management – Asia – Africa – International Climate Change Information Programme

Abstract

It is widely acknowledged that climate change poses a serious problem in attempts to pursue the goal of poverty eradication and achievement of the Millennium Development Goals. As a result of this state of affairs, the search for practical, workable and cost-efficient solutions to climate change adaptation is now a world priority and one which links government and non-government organisations as well as development agencies in a way not seen before. But even though adaptation to climate change is a matter of great scientific relevance and of broad general interest, there are some problems related to its implementation.

This paper outlines some of the problems inherent to the implementation and management of climate change adaptation projects. By means of a survey involving a sample of adaptation projects currently being undertaken in Africa and Asia, the paper outlines the problems and the frequency with their occur as well as their roots and ramifications. The paper also lists a number of measures and instruments, which may be employed with a view to ensuring that climate change adaptation efforts may be integrated into mainstream socio-economic development and environmental protection efforts.

ASIA

Sustainability: Engaging in Global Change through Harmonious Adaptation in Asia

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Keywords

Climate change – Adaptation – Sustainability science – Low carbon society – Harmony with nature – Resource circulation – Higher education

Abstract

Responses to climate change impacts should be carried out holistically, integrating various solutions to ensure co-benefits and derive synergetic benefits. Sustainability science aims to offer such comprehensive and holistic solutions that encompass both social reforms and technological innovations, to establish a vision of a sustainable future. The vision for the future needs to resolve major global problems facing us today, namely; climate change, ecosystems deterioration and resource sustainability. This requires integrating approaches for a 'low carbon society', a 'resource cycling society' and a 'society that lives in harmony with nature'.

This paper describes sustainability science approach in understanding and responding to climate change through adaptation that is sustainable. For example how biofuels crop cultivation will compete with food crop cultivation and cause deforestation can be studied through analyzing various dimension of the problem through the use of tools such as ontology. A more fundamental solution to prevent production of biofuels competing with food production and leveling of forests and grasslands is the development of second-generation biofuels technology such as utilization of cellulose-type organic waste for biofuels production.

The paper discusses the different proposals made in Japan for combating climate change, and discusses potential solutions that integrate energy saving technologies with land use planning and behavioral change. Revitalization of traditional sustainable landscapes is one approach to promote intrinsic societal values that would ultimately influence behavior of individuals in reducing GHG emissions. These landscapes should be complemented with modern science and technology to make them vibrant communities. A proposal for compact cities that integrate several of these aspects to present a holistic approach is presented that not only aim at achieving a low carbon society, but also try to address aging population and other current societal needs.

Finally, the paper describes, initiatives to support adaptation, especially the establishment of a regional network of leading universities to work together in climate and ecosystems change adaptation research titled 'University Network for Climate Change and Eco Systems Adaptation Research'.

Climate Change in Indian Sub-Continent and its Impact on Agriculture

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Keywords

Climate change – Impact – Adaptation – Rice crop – Wheat crop

Abstract

India is a vast country and it is known as Indian sub-continent. The climatic types in the country vary from per-humid type in Chirrapunji to arid and extremely arid types of climate in Rajasthan. It has been found that the rainfall pattern in some parts of the country is changing and the changes are both positive in some areas and negative in other areas. It was observed that the rainfall pattern in Central part of India is decreasing while in Western and North Western parts of the Indian sub-continent it is in decreasing trend.

Looking into these observations an analysis of the 7 Sub-division temperature data for the period 1901–2003 and 29 meteorological sub-divisions rainfall data for the period 1871–2008 was analyzed to identify the areas where there are considerable changes in temperature and rainfall. It was found that the maximum temperature is increasing trend as compared to minimum temperature in West coast, North east and North-central sub-divisions of India especially during winter months than in summer months. As a case study an analysis of decadal growth rates wheat area for Chhattisgarh state in Central India was carried out and it was found that the growth rates have become negative during the decades 1981–90 and 1991–2000 inferring that the wheat zone is moving towards north in this part of India. In fact, this part of India is the southern limit of wheat zone of the country.

The impact of increased temperatures on rice production was studied using crop simulation models and it was found that an increase of temperature by 1 °C at reproductive stage can reduce the potential yield of rice from 9.35 t/ha to 8.89 t/ha under irrigated and from 8.93 to 8.43 t/ha under rainfed conditions. Similar effect was also found when the temperatures increase during maturity stage.

When the rainfall data for the period 1871–2008 was analyzed It was found that in 14 meteorological sub-divisions the rainfall trend changed from positive trend during the period 1871–1960 to negative during the period 1961–2008. In 4 sub-divisions the trend changed from negative to positive during the same period. Detailed analysis of monthly rainfall for Chhattisgarh sub-division was carried out and it was observed that in Chhattisgarh the rainfall had decreased from 35 to 0 per cent in different parts of the state during the period 1951–2000 as compared to the normal values of the period 1901–50. As a consequence of the changes in rainfall the climate type is also changing from moist sub-humid type to semi-arid in many places. It was also found that due to decreasing trend of rainfall, especially in October month, the farmer are slowly changing rice cultivation from long duration local genotypes to medium duration varieties in this state. This is the adaptation for climate change from the farmers side.

A Review of Low Carbon Cities in the Asian Region

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Keywords

GHG concentrations – Emission reduction targets – Shortages of water and food – Health risks – Low-carbon society

Abstract

"Global atmospheric concentrations of greenhouse gas have increased markedly as a result of human activities. In 2005, concentrations of carbon dioxide in the atmosphere exceeded by far the natural range over the last 650,000 years." – Dr. R. K. Pachauri

The statement above gives us a picture of the kind of damage, we the human race have been contributing towards the world's environment. The mitigation of greenhouse gas (GHG) emissions is not one that can be tackled alone by anyone or any country particularly. It requires the commitment and participation of all countries and individuals. In the Intergovernmental Panel on Climate Change (IPCC) Forth Assessment Report (AR4) in 2007 it states, that most of the warming of our climate is very likely due to the increase of GHG concentrations in the atmosphere resulting from human activities such as burning of fossil fuels in power stations for electricity and in vehicles as well as deforestation. Since carbon dioxide (CO_2) emission is one of the major contributors towards the GHGs, the focus here will be the measures taken to reduce CO_2 emissions.

Global development and environmental concerns have come a long way since the first climate change negations during Kyoto Protocol in 1997. Both developing and developed countries have taken it upon themselves to reduce their greenhouse gas (GHG) emissions, by setting national and regional emission reduction targets. According to the United Nations Framework Convention on Climate Change (UNFCCC), over the next decades, it is predicted that billions of people, particularly those in developing countries, face shortages of water and food and greater risk to health and life as a result of climate change. The Intergovernmental Panel on Climate Change (IPCC) reports that under business as usual (BaU) scenario, GHG emissions would rise by 25–90 percent by 2030 relative to 2000 and the Earth could warm by 3 °C this century.

This paper will review the efforts made by seven countries in the Asian Region in their move towards creating a living environment and lifestyle of a low-carbon society (LCS). The countries reviewed here are as follows: China, India, Indonesia, Japan, Korea, Malaysia, and Thailand. Low-carbon society (LCS) can be defined as a society that consumes sustainable and relatively low-carbon energy as compared with our present day practice to avoid adverse climate change.

Climate Variability and Glacier Response on the Tibetan Plateau with Focus on Recent Changes in the Western Nyainqentanglha Mountains

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Keywords

Climate variability – Glaciers – Tibetan Plateau – Field observations – Remote sensing

Abstract

The Tibetan Plateau is considered as one of the world's regions forming a tipping point in the climate system. A large number of glaciers are found in the high-mountain ranges on and at the borders of the Tibetan Plateau, contributing to the runoff from major Asian rivers. Climate variability and its consequences for glacial systems is thus of major interest both for scientists and human living in the affected drainage basins. Climate variability and subsequent glacier response has, for instance, led to changes in amount and seasonality of river runoff, formation of glacial lakes, glacial lake outburst floods (GLOF) and lake-level changes in large lakes like Nam Co.
Unfortunately, the Tibetan Plateau is also one of the world's regions where data from long-term climate and glacier observations are scarce. For instance, no climate records are available for Tibetan stations above 4'800 m a.s.l.. In combination with yet existing gaps in our present knowledge of glacier processes and climate-glacier interactions the lack of data is a source of uncertainty in assessing the consequences of climate changes for environment and human living.
The Intergovernmental Panel on Climate Change (IPCC) has recently been under public pressure due to an ongoing discussion on a statement referring to the disappearance of Himalayan glaciers within the next decades, and has consequently improved its review procedures to avoid referencing to publications of ambiguous quality. This problem that has negatively influenced IPCC's image as a world-leading institution demonstrates the importance of ongoing climatological-glaciological research on the Tibetan Plateau.
Both the Deutsche Forschungsgemeinschaft (DFG) and the German Federal Ministry of Education and Research (BMBF) have started or will soon start research programmes with substantial funds also allocated to climate and glacier studies. One of these research projects is entitled "Dynamic Response of Glaciers on the Tibetan Plateau on Climate Change (DynRG-TiP)", funded by the DFG since 2008 as part of the Priority Programme 1372 "Tibetan Plateau – Formation, Climate, Ecosystems (TiP). It is jointly carried by the research groups of the authors in close cooperation with researchers from the Institute of Tibetan Plateau Research (ITP) of the Chinese Academy of Sciences (CAS). The presentation will show new results from studies part of DynRG-TiP for the western Nyainqentanglha Mountains near Nam Co, where the ITP operates one of the best-equipped research stations on the Tibetan Plateau.

Trends of Weather Related Natural Hazards in Asia

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Keywords

Natural Catastrophes – Extreme Weather – Trends – Asia

Abstract

As extreme weather events affect the core business of insurance this industry has quite early addressed potential effects of global warming on natural catastrophe hazards. Today climate change is regarded as one of the largest risks for insurance industry. Munich Re's experts have been researching loss events caused by natural hazards around the globe for over 35 years. These losses are documented in the Munich Re NatCatSERVICE database currently documenting more than 27,000 single events.

In recent years we have seen worldwide and especially in Asia many natural catastrophes with records in intensities and losses such as e.g. the Mumbai flood in 2005, caused by the highest ever measured 24-hour precipitation in India or the snow catastrophe in China and the cyclone Nargis in Myanmar both in 2008. The analyses of the NatCatSERVICE data clearly show a dramatic increase in the number of weather related natural catastrophes in Asia, with growing losses. The trend curve indicating the number of loss relevant extreme weather events in Asia reveals an increase from about 75 events per year at the beginning of the 1980s to around 275 at the present time. In the last three decades Asia has been the continent with most of the natural catastrophes. 34 % of all events have occurred in Asia followed by 30 % in Northern America and 14 % in Europe. In terms of fatalities caused by natural catastrophes Asia is even more affected with 71 % of all such fatalities.

The main reasons for the sharp increase in losses from weather-related catastrophes are population growth, the settlement and industrialisation of regions with high exposure levels and the fact that modern technologies are more vulnerable to losses. As the rise in the number of natural catastrophes is largely attributable to weather-related events like windstorms and floods, with no similarly strong increase in geophysical events such as earthquakes, tsunamis, and volcanic eruptions, there is some justification in assuming that anthropogenic changes in the atmosphere, and climate change in particular, play a decisive role. There has been more and more evidence to support this hypothesis in recent years. The fourth status report of the Intergovernmental Panel on Climate Change (IPCC 2007) regards the link between global warming and the greater frequency and intensity of extreme weather events as significant. The report finds, with more than 66 % probability, e.g. that climate change already produces more heat waves, heavy precipitation, drought and intense tropical storms and that such effects will be growing in the future. According to a study of Goswami et al. (Science 2006) e.g., the number of days with precipitation of more than 150 mm/day has doubled in India since 1950.

The rise in global average temperatures significantly increases the probability of record temperatures. Higher temperatures also enable air to hold more water vapour, thus increasing the precipitation potential. Combined with more pronounced convection processes, in which warm air rises to form clouds, this results in a higher probability for more frequent and more extreme intense precipitation events. Already today such events are responsible for a large proportion of flood losses. In many coastal regions in Asia sea level rise caused by global warming will further increase the risks of flooding.

GENERAL ASPECTS

Observed and Projected Sea Level Rise, Impact on the Pacific and Indian Tropical Islands

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Keywords

Adaptation – Climate change – Climate refugees – Sea level rise – Vulnerability

Abstract

The global sea level shows an upward trend since the XIX middle century, with acceleration since the 1980's on the main effect of expansion by warming water and decrease continent water volume. This acceleration should continue in the future and adds to the major effects of marine submergence resulting of Hurricane (reduced pressure and strong winds pushing water towards the coast), in phase with a high tidal coefficient, will cause a major coastal flooding of the lower cost.

Using the latest satellite measurements, the sea level rise seems occurring at a faster rate than the estimated rise made for decades prior to the twentieth century using tide gauge measurements.

- The extreme range of recent sea level rise estimation of the International Panel of Climatic Change (2007) for the end of the XXI century is around the mean 39 cm) depending on scenario (values are the average difference between the 1971–2000 period and the 2071–2100 period). However, recent paper of GRINSTED and al. (2009) showed that the 2090–2099 IPCC projections of sea level rise are underestimated by roughly a factor 3.
- The response of tropical disturbances to global warming underscore the lack of convergence in the responses of different Global Circulation Models (GCM) used in the scientific community. This reflects the complexity of cyclonic activities (typhoon, hurricane…), which involves massive ocean-atmosphere coupled system mechanisms that can not be properly represented in the models currently available.

Sea Level Rise has different impacts on coastlines. Large dunes protect many coastal areas from direct attack of storms similarly to mangroves or wetlands which prevent from water penetration by increasing friction as well as blocking waves. In a context of rising sea levels, removal or damage of protective barriers leads to amplified vulnerability and this factor introduces an additional difference between regions subject to seasonal strong tropical disturbances, and those subject to winter storms on the margin of tropical areas, compared to those who are less affected by storms

In the Indian Ocean small island states, where flooding had already important economic consequences, heavy protection has often been the response (Seychelles, Maldives ...). In the Maldives archipelago (87 tourist islands and between 800 and 900 uninhabited islands) islands are characterized by small sizes (0.2 to 5 km^2 in general) and low altitudes (< 4 m in most cases). Similar to other archipelagos, these islands represent a type of sedimentary body, particularly vulnerable to flood risk. In this country, planning is exclusively designed for tourism, which may lead to important economic and environmental consequences. The natural uninhabited islands were traditionally used by the indigenous population because they provide first need materials. Damage to uninhabited islands may have an impact on the economic chain and the island environment

In the South-Pacific Ocean, the projected sea level rise for the end of the XXI century should be similar to the global average (0.35 meters). Many islands have small arable land and some already lack of fresh water. The Medias have largely used the case of Tuvalu to often hold climate change solely responsible for increase in flooding. The loss of land in Tuvalu was mainly the results of inappropriate human activities with coastal development and exploitation of aggregates. Recent satellite altimetry measurement and local tide gauge data don't confirm a rise in sea levels around Tuvalu islands. Rising sea level is certainly an aggravating factor, but it's not certainly the main factor. Consequence on Human activities and hurricanes are more responsible of damage on these islands where an important demographic growth rate is recorded and natural resources are limited.

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Continents under Climate AND Vegetation Change

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Keywords

Climate system – Vegetation change – Human impact

Abstract

Vegetation is an important component of the climate system. On the one hand, climate controls the biosphere and thus geographic vegetation patterns. Thereby it is important to keep in mind that climate change has an impact on all organismic levels, from genes to ecosystems. This implies that climate change does not simply induce a different ecosystem distribution, it also causes changes of the ecosystems themselves. On the other hand, all vegetation changes have considerable impacts on climate. The vegetation influences many geochemical cycles (including those of water and carbon), the albedo, the aerosol and BVOC production as well as the wind pattern and the momentum exchange between atmosphere and surface. Most importantly, the vegetation – like ice – may also act as a trigger mechanism in the climate system and may induce complex non-linear reactions of the climate system to external forcings. These complex vegetation-climate feedbacks are still poorly understood but looking into the earth history may help to understand at least their relative importance in the (natural and anthropogenic) climate dynamics.

About 50 million years ago the earth was in a global greenhouse phase with high pCO_2 concentrations of 1500 ppmv and more, continental ice and deserts were virtually lacking, forests were predominant all over the continents and the mean annual temperature was considerably (in Europe 12 to 15 °C) higher than today. Since that time the earth experienced a stepwise cooling with a corresponding reduction of forest cover and the stepwise appearance of grasslands and deserts. Sensitivity modelling studies clearly indicate that the stepwise "opening of the landscape" contributed considerably to the overall cooling. For instance, during the Upper Miocene (about 8 Ma ago) the globe carried about 25 % more forests than today. This reduction of the forest cover alone led to a decrease in global mean annual temperature of about 1 °C with a temperature decrease of more than 4 °C in Central and Northern Eurasia. The appearance of the Sahara desert in the Late Miocene-Pliocene induced an additional cooling (and aridification) not only in Africa but also in Central Asia, in North America and in the northern high latitudes. Another sensitivity climate modelling study showed that deforestation of the Tibetan Plateau (as it possibly happened in the Holocene) induces a temperature drop of 2 °C and a rainfall decrease of 200 mm. The lesson from these sensitivity studies is clear: Vegetation change – be it induced by climate change or anthropogenic landuse change – has a considerable impact on our future climate, i.e. temperature and rainfall patterns. The continental resp. regional effects of vegetation changes are particularly strong but via teleconnections also influence the global scale. Obviously, more research concerning the climate-vegetation feedbacks is needed and in projections of future climate change different land use scenarios should play a more important role. On the other hand, vegetation and landuse change also offer new options for mitigation and adaptation strategies.

Micro-CHP and Biogas – Innovative Gas Technologies to Protect the Climate

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Keywords

Cogeneration – Biogas plant – WhisperGen – Fuel cell – Electricity market – Heat market

Abstract

There is a need today, and in the future, for secure and highly efficient electricity generation with significantly lower greenhouse gas emissions. The strategy of the federal government underlines the outstanding importance of combined heat and power (CHP), or cogeneration, for the achievement of the energy and climate targets set by Germany to accomplish an 80 % reduction of CO_2 emissions by 2050. The Cogeneration Law, which aims to increase electricity cogeneration in the Federal Republic of Germany further to 25 % by promoting smaller plants, will set the trend. The realization of small scale cogeneration plants in the form of heating systems that generate electricity is feasible and can thus essentially contribute to the fulfilment of the above-mentioned targets.

GASAG as a company based in Berlin strongly supports the programmes to reduce the climate impacting emission of harmful greenhouse gases stated in the voluntary climate protection programme "Berlin verpflichtet" (Berlin obliges). By implementing the concept of decentralized power supply, the yearly CO_2 emissions in Berlin are to be reduced by over one million tons by 2015, which would also allow a considerable reduction in primary energy costs. To accomplish the defined CO_2 savings by 2015, GASAG is following various substrategies which form the basis for sustainable business models, also including partners from business as well as from science.

WhisperGen-micro CHP units provide such an innovative area of business. The programme for combating climate change of the Federal Ministry for the Environment of September 2008 underlines the importance of mini and micro CHP units for CO_2 reduction and resource conservation. GASAG is a distribution and sales partner of the WhisperGen manufacturer Mondragón Corporación (MCC) in Spain and will launch the micro CHP units on the German market. These have been field-tested on a large scale since early 2007. An intensive market launch is planned in the second quarter of 2010 through the GASAG affiliate DSE.

As the energy carrier natural gas is ecologically beneficial, the development of micro CHP units will also result in synergies with a potential of being used in fuel cells for the distributed provision of electricity and heat. To extend the value chain, GASAG is pursuing the development of oxide ceramic fuel cells with a robust system design, which give reason to expect economically viable high efficiencies. Such modular systems are suitable, in particular, for one- and two-family houses. Further advantages are the combined electricity and heat generation, the reduced energy costs and the use of a highly efficient and environmentally friendly technology. Current research and development activities in oxide ceramic fuel cells are focused on demonstrating technical feasibility, notably of the parameters service life and system availability.

A further significant success factor for meeting the set environmental targets is the generation and use of biogas from agricultural plants. Since 2009 GASAG has been feeding approx. 40 m kWh per year generated from biogas in natural gas quality at the Rathenow plant in Brandenburg into the natural gas grid. This biogas product first launched by GASAG is also sold at GASAG natural gas fuel stations. By 2015, a total of 14 biogas plants with a per-plant average of 2 MW electric power will be constructed first in Berlin and Brandenburg.

The company GASAG considers decentralized power supply as a great opportunity for the electricity and heat market. As an experienced energy supplier it intends to contribute its share to the protection of climate and environment. By 2015 the necessary investments will amount up to 1.5 b euros, strengthening in particular regional medium-sized businesses. Furthermore we consider this to be an important and necessary contribution to job protection and creation.

AUSTRALIA/POLAR REGIONS

Changes of the Climate System in the Polar Regions

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Keywords

Climate change – Ice sheets – Sea ice – Permafrost – Polar ecosystem – Krill

Abstract

Polar Regions have been considered remote and hostile for most of human history. Persistence of low temperature, dark winters, highly variable seasonal ice cover and a biological community well adapted to these environmental conditions are characteristics that have persisted over long periods. However, the polar system is not isolated and static. It has complex and dynamic connections to lower latitudes via ocean currents, atmospheric transport of heat, pollutants and aerosols, and ties to sub-polar ecosystems and communities. These leave a noticeable imprint on the polar system. In particular the Arctic shows clear signals of multiple impacts due to external influences, including climate change.

In the Arctic and at the Antarctic Peninsula the observed temperature changes are approximately twice as high compared to the global average. The rapid warming of the polar regions results in associated changes, such as melting of ice sheets on Greenland and Antarctica, reduction of sea ice, loss of permafrost regions, and alterations in the polar ecosystems. These changes have been documented over the last 3 decades and are predicted to continue. First indications of changes in the biological system have been found, but their extent and consequences are not well known. The observed and predicted climatic and environmental developments in the Polar Regions will lead to fundamental changes with global consequences.

The observed and projected changes in the Arctic and parts of the Antarctic are all indicating a rapid alteration of the polar system that precedes changes in other parts of the world. Reduction of ice sheet mass in Greenland and in Antarctica accelerates sea level rise. Loss of sea ice cover reduces the sun light reflection (i.e. increases energy uptake in the polar ocean) and alters ocean-atmosphere exchange processes of heat and moisture resulting in different precipitation patterns. Warming of permafrost accelerates emissions of greenhouse gases and poses a threat to future climate development. Therefore, changes in the polar system are not remote – they are relevant world-wide.

Climate change with its large impact in the Arctic has now led to a fundamentally different view of the North Polar Region. Reduction of sea ice and permafrost regions may provide easier access to the High North, opening possibilities for development and use of these areas and their resources. Therefore, heightened political and commercial interests are directed towards these new frontier regions.

In this talk, a broad overview of the most obvious climatic change impacts and effects in the polar regions is given. More detailed analyses of climate and environmental changes can be found in "Arctic Climate Impact Assessment "(ACIA 2005) and "Antarctic Climate Change and the Environment" (SCAR 2009). The emphasis in the talk is placed on changes occurring in the Arctic because of the rapid climatic shifts observed in this region. However, it needs to be stressed that Antarctica is also subject to some, if smaller, changes. Due to the vast expanse of Antarctica, these changes have the potential to impact the global system in the long run much more severely than any other changes elsewhere on Earth.

Impacts of Climate Change in Australia

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Keywords

Australia – Climate change – Global warming – Drought – Tropical cyclone – Heatwave – Bushfire

Abstract

Since the middle of the 20th century, the average Australian temperature has increased about 0.75 °C, similar to the warming observed globally. The warming has occurred across the country. Associated with this warming trend there has been a substantial increase in the number of hot extremes, and a decline in cold extremes such as frosts. In turn, these changes in temperature extremes have affected human health, reducing the threat of cold episodes but increasing the risk of deaths in unprecedented heat waves. The warming has caused spring snow depths to decline about 40 % over the past 40 years. Spatial trends in rainfall have varied across the country with drying along the south and east coast, and increasing rainfall in the northwest. The prolonged drought in southeast Australia has, with the widespread warming and unprecedented heat waves, contributed to increased bushfire risk. The warming has been attributed to anthropogenic actions, specifically increased greenhouse gas emissions, but the rainfall trends are more difficult to ascribe to a single cause. However, the rainfall decline in southern Australia is closely related to a strengthening of the subtopical ridge that lies across southern Australia. There is little evidence that the rainfall decline is the result of changes in the behaviour of natural modes of climate variability such as the El Niño – Southern Oscillation. Climate models project continued warming with continued drying along the southern coast.

Satellite Observations for Identifying Continental-Scale Climate Change over Australia

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Keywords

Radio occultation measurements – Tropical rainfall monitoring mission – Terrestrial water storage – GRACE – Climate change over Australia

Abstract

Australia's large extent and relatively low population density, as well as its range of climates, means that it is heavily dependent upon satellite observations to identify the extent and magnitude of climate change. This work examines three types of satellite missions that are used to assess different aspects of climate change.

The first involves the use of radio occultation measurements based on signals from Global Navigation Satellite Systems (GNSS) spacecraft made by low-Earth orbiting (LEO) satellites to identify changes in the height of the tropopause, a sensitive indicator of climate change owing to its response to temperature changes in the troposphere and lower stratosphere. The second deals with rainfall over Australia, as measured by the Tropical Rainfall Monitoring Mission (TRMM), in conjunction with other satellite- and ground-based observations. Such observations are invaluable, given the scarcity of ground-based observations over vast areas of Australia. While a comparison between the TRMM product and existing ground-based data is very good, there appears to be a decrease in the correlation between datasets, the reason for which is still being investigated. Finally, we examine the state of terrestrial water storage over Australia as determined from variations in the regional gravity field as measured by the Gravity Recovery and Climate Experiment (GRACE) twin-satellite mission. The loss of substantial volumes of ground water from the Murray-Darling River Basin in the southeast corner of the continent is very apparent, as is an increase over the northern parts of the country.

Together, such satellite missions provide a continental-scale picture of climate change over Australia, with temperature and rainfall variations, as well as water resources, able to be monitored, providing valuable information to natural resource managers and climate modellers who endeavour to predict future changes.

Climate Variability and Glacier Response at Vestfonna – A Case Study of Arctic Climate and Glacier Dynamics at Nordaustlandet, Svalbard in Recent Years

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Keywords

Glaciology – Glacier change – Climate variability – Modelling – Arctic – Svalbard

Abstract

Since 2008, and within the International Polar Year (IPY) 2007/2008 a joint project group comprised by the Technical University Berlin, the RWTH Aachen University and the University of Bonn in collaboration with other research groups from Scandinavia, Poland and the United States of America carries out field work related to the climate response of arctic glaciers ("Dynamic Response of Surface Energy and Mass Balance of Vest- and Austfonna (Nordaustlandet, Svalbard) on Climate Change") funded by the Deutsche Forschungsgemeinschaft (German Research Foundation, DFG).

The ice cap of Vestfonna on Nordaustlandet (Svalbard) at 80 °N extends between sea level and 630 m a.s.l. (above sea level) and covers an area of 2500 km². Hence, aside from the much larger and neighbouring Austfonna it is one of the largest ice masses of the European Arctic.

Since May 2008 several automatic weather stations and a net of ablation stakes are operated on Vestfonna. The data from these investigations are combined with remote sensing data regarding snow cover, surface velocity and altimetry as well as reanalyzed numerical weather forecast data (GFS, NCEP/NCAR) in order to model the relation between climate forcing and glacier mass balance. Data from two ablation seasons (2008 and 2009) with distinct weather patterns underline the importance of local meteorological and sea ice conditions as well as wind field patterns. The latter seemingly do strongly influence the redistribution of snow fall by wind drift.

A simplified surface melt model for Vestfonna combined with snow cover data retrieved from remote sensing data (MODIS) drastically shows that enhanced climate forcing by rising air temperatures would drive the mass balance of the ice cap substantially towards negative values. However, snow fall and related processes may considerably counteract this possible future development. Large scale synoptic patterns and sea ice cover also influence surface mass balance to a large extent since the inter-annual moisture flux towards the Arctic is dominated by these patterns.

Furthermore, it is hypothesized that the overall warming observed in the study region can be traced within near-surface ice temperatures on Vestfonna given that the insulating effect of the varying winter snow cover can be modelled accordingly.

This presentation will give an overview over current research and findings within the project "Dynamic Response of Surface Energy and Mass Balance of Vest- and Austfonna, Nordaustlandet on Climate Change" along the features outlined above.

Impact of Oceanic Warming on the Distribution of Seaweeds in Polar and Cold-Temperate Waters

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Keywords

Geographic distribution – Global warming – Sea surface isotherms – Seaweeds – Temperature

Abstract

Increase in mean annual sea surface temperature (SST) has been clearly identified along diverse coastlines in recent years. The global average SST increased by 0.78 °C during the last century. Within the last decade, the rate of temperature increase accelerated. The latest report of the Intergovernmental Panel on Climate Change presented long-term projections for climate change into the next century and emphasized that most of the observed warming over the past 50 years is attributable to human activities and that the atmosphere will very likely continue to heat up, in particular in polar regions.

Expansion and retreat of marine species along coastlines during times of temperature change have been documented over long time periods. During the short warm period in the first 50 years of the 20th century in the North Sea/English channel, seaweed migrations along the British and Britanny coastlines were documented. Publications comparing historical and present datasets partially document distributional changes of seaweed species, indicating the ongoing process and demonstrating a distributional shift of cold- and warm-temperate species to higher latitudes.

In addition to temperature, photoperiod may trigger crucial steps in the life cycles of seaweeds. Interaction of both factors narrows seasonal windows for reproduction or growth even more than temperature alone and thereby affects distributional limits as well. Other factors such as ice-scouring or biotic interactions (e.g. sea urchins, invasive algae) have a modifying influence and will finally determine the local distribution of seaweeds.

The main focus of the present study is to estimate prospective distributional shifts in cold-water key structural seaweeds from both hemispheres. We related temperature requirements and recent distributions of seaweeds to observed mean sea surface temperature (SST) isotherms for the periods 1980–1999 (Meteorological Office Hadley Centre's SST data set; HadISST) and to modelled temperatures for 2080–2099 Coupled Model Intercomparison Project 3 (CMIP3) database prepared for the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4) report based on moderate greenhouse gas emissions Special Report on Emission Scenarios – Scenario B1 (SRESA1B). Comparing modelled SSTs with the temperature requirements of seaweeds, we estimate broad biogeographical changes of selected key structural seaweed species in both hemispheres.

Under the SRESA1B scenario, North Atlantic polar to cold-temperate seaweeds investigated will extend their distribution into the High Arctic until the end of the 21st century, but retreat along the northeastern Atlantic coastline. In contrast, selected Antarctic seaweeds will probably not significantly alter their latitudinal distributions, as deduced from our presently incomplete knowledge of their temperature requirements. We identified several cold-temperate regions where seaweed composition and abundance will certainly change with elevated temperatures. Further on, the identified fundamental niches of seaweeds become modified by local temperature conditions and effects of multifactorial abiotic and biotic interactions.

Indisputably, the expected retreat and progression of macroalgal key species as so called 'ecological engineers' will provoke substantial and cascading effects in cold-temperate and polar transition areas with substantial consequences for biodiversity and whole ecosystem functioning. The multiple, complex and often unknown biotic relationships of cold-temperate and polar key species under elevated temperatures remain, however, a challenging topic that should receive more attention in future.

This study was recently published as Müller, R., Laepple, T., Bartsch, I. & C. Wiencke (2009) Impact of oceanic warming on the distribution of seaweeds in polar and cold-temperate waters. Botanica Marina, Special Issue Polar Benthic Algae 52: 617–638.

EUROPA

Changes of the Climate System in EUROPE

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Keywords

Holocene climate change – Neoglacial – Present day warming – Future temperature and precipitation changes – Risks and positive impacts of European climate change

Abstract

After the Holocene Thermal Maximum the European climate was subject to a progressive cooling of 2–3° C after about 4500 years BP. This cooler period, called Neoglacial, was mostly induced by the decreasing solar insolation in the Northern Hemisphere during the boreal summer due to orbital forcing. The Neoglacial lasted until the preindustrial period (~1750 AD). Its climate was characterized by changes between cooler periods with remarkable glacier advances in the higher European mountains and warmer sequences with temperate summers even in northern Europe. Beside the influence of natural climate variability, these multi-decadal to multi-century scale climate fluctuations were likely the result of changes in the natural forcing factors, such as solar activity changes or series of strong tropical volcanic eruptions. The most recent examples were: Bronce Age Optimum, Iron Age Cooling, Iron/Roman Age Warming, Dark Ages Pessimum, Medieval Climate Anomaly, Little Ice Age.

Present European climate is characterized by a remarkable warming and an increasing summer dryness, mainly in the Mediterranean area. These trends will continue in the 21st century, mostly due to the anthropogenic greenhouse effect. Warming will be most accentuated in northeastern Europe in winter and in the Mediterranean area in summer. In winter precipitation will likely increase in northern Europe. The trends for southern Europe are still questionable. At least for summer negative precipitation trends are indicated for this area.

These changes will cause both, negative and positive impacts on ecosystems and society. Water stress and high energy demand for cooling may cause severe problems in the Mediterranean area during summer. In the Alps the winter tourism will suffer due to the reduced snow cover duration. The coastal areas will be confronted with increasing coastal flooding. There is a big hope that the increasing water availability in northern Europe, the higher agricultural productivity and the decreasing energy demand in winter will help to compensate the negative effect of climate change, at least in selected areas of Europe.

From Utopia to Common Sense: Global Climate Policy that Could Work

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Keywords

2 °C target – Roadmap for stabilizing the climate – New climate rent – Carbon-free technologies – Global carbon market

Abstract

The international community has recognised the 2 °C target as a focal point of international climate policy. The negotiators struggle to make the required emissions reductions binding under international law and to agree on a burden-sharing among nations that is in line with this objective. Given the urgency of the problem, climate policy needs to take an honest view on the historical challenge ahead and develop a roadmap for stabilizing the climate system. While climate policies will diminish the rents of coal, oil and gas resource owners, they will create a new climate rent. This climate rent is reflected in the price of carbon and it arises due to the scarcity of the remaining atmospheric carbon budget. The enormous welfare reallocation implied by this transfer of rents lies in the heart of the political bargaining over a global climate deal. Technological innovation and the promotion of carbon-free technologies will be crucial to keep the reallocation volume within realistic bounds. A reasonable climate policy architecture thus needs to specify a binding overall carbon budget that is in line with the 2 °C target, spell out the regional allocation of this budget and create the institutional framework for a global carbon market.

Global Warming below 2 °C Relative to Pre-Industrial Level: How Might Climate Look Like in Europe?

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Keywords

Climate change projection – Europe – Regional climate model – Temperature – Precipitation

Abstract

Global climate scenarios have been analysed for global changes, but also for possible changes in regions. In addition, regional climate models (RCMs) were used to interpret the impact of global change in the region. Using RCMs as dynamical downscaling tools add many details in the horizontal pattern of possible changes. Commonly IPCC SRES scenarios, like A2, A1B and B1 were investigated. They all assume further increase in GHG emissions.

Within the European ENSEMBLES project, an aggressive mitigation scenario was developed which aims to stabilize eventually the anthropogenic radiative forcing to that equivalent to a CO_2 concentration at around 450 ppm during the 22nd century (Van Vuuren et al. 2007). This scenario was designed for attempting to match the European Union target of keeping global anthropogenic warming below 2 °C relative to pre-industrial level.

In this study results from an ensemble of regional transient simulations for 1950 to 2100 performed by the MPI-M regional climate model REMO (Jacob et al. 2007) with 0.44° horizontal resolution for Europe (using the ENSEMBLES domain) will be presented. Lateral boundary conditions as well as concentrations originate from simulations provided by the ECHAM5/MPI-OM coupled atmosphere-ocean model including the carbon cycle (Raddatz et al. 2007). With the global modelling system an ensemble of historical forcing experiments (1860–2000) was performed followed by a 450 ppm CO_2 (equiv) stabilization scenario provided by the IMAGE 2.4 integrated assessment model.

Regional pattern have been investigated with focus on changes in the hydrological cycle. The results are compared to those from downscaled SRES IPCC scenarios A2, A1B and B1 to define a range of possible changes which can be expected during this century.

Even under the E1 scenario for most parts of Europe, a warming of more than 2 °C in annual near surface temperature is projected until 2100 compared to 1961 to 1990, but only small changes in the annual total precipitation. For southern Europe a warming of approx. 3 °C is projected for summer and fall, whereas in northern Europe the strongest simulated warming is visible in winter with more than 4 °C over large areas in Scandinavia. These changes are still large, but considerable smaller than those projected for an IPCC A1B emission scenarios, for which the annual temperature signal of southern Europe is calculated to be larger than 4 °C and for example, the summer warming larger than 6 °C in parts of Spain. More details will be given in the presentation.

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Sea Level Rise and Coastal Protection – Adaptation Strategies for Sandy Coasts –

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Keywords

Climate Change – Sea Level Rise – Sediment Transport – Coastal Flooding – Coastal Protection

Abstract

Consequences resulting from future Climate Change may be one of the most severe threats for people and economies in many countries of the world. At present, IPCC (2007) is estimating a world-wide average sea level rise of less than 1.0 m within the 21st century. Other sources (e.g. Rahmstorf & Schellnhuber 2007) which are taking into account possible melting of the two main continental ice covers (Greenland and Antarctica), estimate significantly higher values especially over long periods.

Small Islands and low lying coastal regions are the most vulnerable areas against accelerated sea level rise. The main questions for these areas are, whether the natural morphological development of these low lying areas is fast enough to adapt to the sea level rise, or, whether coastal protection measures can protect the areas against flooding in the long-run.

Besides the problem of sea level rise, also possible general changes in the frequency and intensity of storms as well as general changes in the average wind field are discussed world wide.

In Germany, possible adaptation strategies for different regions are under discussion at present. An interdisciplinary research programme has been launched to assess threats and future possibilities related to climate change for regions (www.klimzug.de). One of the supported regions is the German Baltic Sea Coast (www.klimzug-radost.de). Possible positive and negative influences of climate change on coastal protection, tourism, harbours, environment, economic development and energy are analysed within the project.

With respect to the protection of the coast, possible future coastal protection strategies and also possible future coastal protection measure are analysed and assessed. The main questions are: i) which coastal protection strategy is the best for the future and ii) can we use the established coastal protection measures also for the future.

As a basis for the solution of these problems, first general analyses of possible future developments of the coast have been performed with the result that a sea level rise of approximately 1m may cause a coastal retreat of up to 100 m depending on the average slope of the coast. In addition, possible changes in the height of extreme events will result in additional erosion of coastal dunes or other cliff coasts during extreme events. Coastal protection works are designed for the present hydrodynamic conditions. Rising mean and extreme water levels in combination with changed wave impact will cause higher hydrodynamic loads and consequently the failure of coastal protection constructions.

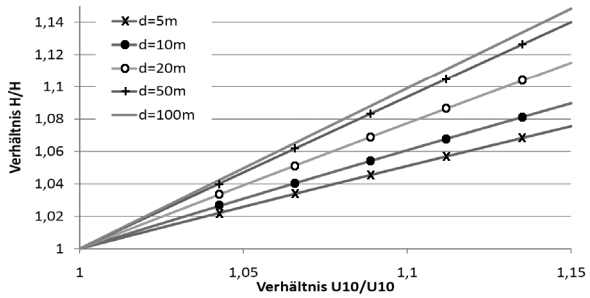

Fig. 1: Principle changes of significant wave heights for changed wind velocities

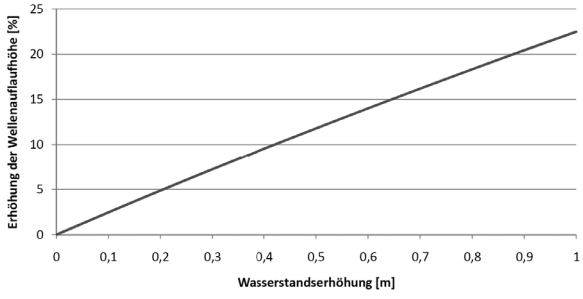

Fig. 2: Changes of wave run-up height of dykes as a function of the water depth at the foot of the structure (ex. d_0 = 2 m)

Fig. 1 and fig. 2 show the influence of changed water levels on the wave run-up height of dykes and the influence of changed wind velocities on the incoming wave heights exemplarily for typical conditions in the Baltic Sea. Additional first results of the RADOST-Project will be given in the presentation with special emphasis on possible future changes of sandy coasts due to sea level rise and changed hydrodynamic conditions. Furthermore, future methods and strategies to protect sandy coasts will be discussed, where retreat out of areas which cannot be protected in the future is the ultimate solution.

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Simulating the Future – Responses of Ecosystems, Key Species and European Provenances to Expected Climatic Trends and Events

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Keywords

Adaptation – Biodiversity – Climate change – Drought – Heavy rain – Ecological services – Extreme events – Manipulative experiments – Resilience

Abstract

Future climate change is expected to rapidly modify the long-term average and variation in temperature and precipitation regimes. The local climate that has been experienced by organisms and ecosystems does no longer exist. More frequent and more pronounced extreme weather conditions are expected in the near future (Jentsch & Beierkuhnlein 2008). Monitoring both future climate and the ecological responses will be important. However, monitoring can not supply the necessary insights for the design of adaptation strategies in time. Ecological modelling is heuristically limited due to the simple fact of hitherto not available evaluation and adjustment of results. Thus, the experimental simulation of climatic trends and events is urgently needed in order to identify responses of important communities and species that are exposed to a novel climate. Experimental approaches are artificial to some degree (Beierkuhnlein & Nesshoever 2006), but they can yield fundamental insights into crucial mechanisms of response to rapid climate change.

In the EVENT experiments (EVENT I to V, Jentsch et al. 2007), we simulate expected future climatic conditions including extreme weather events along a gradient ranging from highly standardized and replicated pot experiments over the manipulation of strongly controlled artificial plant communities (with defined number of specimen and with standardized substrate) to the manipulation of semi-natural established grassland communities on old-grown soils.

We are testing the effects of summer warming, winter warming, increased winter precipitation, recurrent extreme summer drought, excessive summer rain, and modified frost-thaw-cycles (Jentsch et al. 2009, Kreyling et al. 2008a, 2008b). In addition, we are combining different drivers in multi-factor experiments (e.g. land use intensity and warming or more extreme precipitation regimes). The main focus of the EVENT-experiments is on grasslands, but also shrubland (heath) on the community level and important tree species on the within-species diversity level are experimentally exposed to future climatic scenarios. The role of biodiversity – in terms of species richness and richness of various growth forms and functional groups – for the buffering of extreme weather events is of special interest for us.

Surprises occur! Total biomass did not respond as strongly as expected, but single species performance was very specific. For particular species, significant effects of drought, heavy rain and increased freeze-thaw cycles were found in parameters related to e.g. nutrient cycling, gas exchange, phenology and reproductive fitness. Biodiversity did both, buffer extremes in some cases and accelerate stress in other cases.

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Climate Change Effects on Vector-Borne Diseases in Europe

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Keywords

Adaptation – Climatic Extremes – Global Change – Global Warming – Public Health – Range Shift

Abstract

Activity phase, establishment and survival of ectothermal disease vectors are strongly connected with climatic conditions. Climate change is expected to be accompanied by the spatial expansion of vector-borne diseases to higher latitudes and altitudes (FISCHER et al. 2009a). Here, this emerging biorisk is highlighted for selected vectors in combination with the potentially transmitted diseases. The infectious disease leishmaniasis and the vectors, phlebotomine sandflies, occur in Southern Europe. Recent sandfly catches and autochthonous cases of visceral leishmaniasis in Central Europe indicate northward spread.

Knowledge about future habitat suitability for disease vectors in Europe is scarce. Climatic requirements need to be detected (FISCHER et al. 2009b). We aim at identifying the bioclimatic envelope that best describes the limits of the species' spatial ranges. Subsequently, the findings can be connected to future conditions by combining them with geographically explicit regional climate change simulations. Uncertainties are related to the meanderings of international politics and the influence of further environmental variables.

Additionally, biotic interactions and ecological complexity have to be considered. Migratory birds act as carriers for several viruses (e.g. West-Nile) over short and long distances. Empirical evidence suggests that climate change alters the speed, timing and characteristic routes of bird migration. Research on the potential reduction of bird migrations, resulting in reduced pathogen transport to higher latitudes is needed for risk analysis.

Beyond climatic drivers, the interplay with globalisation of trade and transport may support the spread of disease vectors. High invasive capacity in combination with global shipping transport of freights made the Asian tiger mosquito (*Aedes albopictus*) – originally native in South-East Asia – a "global player". This potential vector of various infectious diseases (e.g. Chikungunya, Dengue and West-Nile) is listed as one of the 100 "Worlds Worst Invaders". In 2007 *Aedes* caused a Chikungunya-epidemic in Northern Italy. Conceivably, climate change may provide suitable conditions in European cities with large seaports (e.g. Rotterdam or Hamburg). Imported disease vectors then could conquer easily further areas. However, the presence of vectors does not necessarily imply disease outbreaks. Additional factors such as a certain abundance of reservoir hosts and pathogen requirements (e.g. thermal constraints) have to be fulfilled.

As a matter of fact, European health care is challenged by novel threats and must be prepared. This calls for interdisciplinary research and interchange between policy and science in order to become proactive or if necessary to adapt surveillance systems in time (Fischer et al. 2009c). In terms of monitoring efforts, cooperation is needed across a wide range of disciplines: entomology, ecology, microbiology, virology, climatology, geography, and medicine. Efficient biosecurity control at European airports and harbours may reduce the risk of accidental introductions. Furthermore, regulations on the notification of vector-borne diseases vary between countries and have to be standardized in order to detect trends in the spread of vectors and pathogens.

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Vattenfall's Experience with the CCS Technology

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Keywords

Climate change – Emissions – CO_2 – CCS – Coal – Oxyfuel technology

Abstract

Vattenfall Europe is an integrated energy company operating along the complete energy industry value chain and a significant part of the Vattenfall Group which is under Swedish state ownership. With climate change having emerged as one of the major challenges of the 21st century, Vattenfall has focused on the strategic goal of making its electricity and heat production climate-neutral by 2050. Thus the sustained reduction in CO_2 emissions is an integral part of our business mission.
Vattenfall's climate strategy consists of a broad portfolio of projects and technologies, among which carbon capture and storage – CCS – has assumed a very special position. For while renewable energies are set to become increasingly important and nuclear energy will have a future if and when society and the markets permit this, fossil fuels and especially coal will continue to be a significant mainstay in the worldwide supply of energy.
In Germany, lignite plays a special role thanks to its abundant availability as an unsubsidised domestic source of energy. In order to reduce the CO_2 emissions caused by the generation of electricity from lignite, Vattenfall is focusing its research and development work on optimising its power plants by continuous increasing their efficiency levels.
For more than a decade now, Vattenfall has conducted research into completely new high-tech approaches to reducing CO_2 emissions from the burning of fossil fuels. And over the course of this work, it has become a pioneer in the CCS technology field. In September 2008, Vattenfall commenced operations at the world's first ever pilot unit utilising this breakthrough technology at its Schwarze Pumpe premises in the Lusatia region. Investments here of more than €70 million have permitted this step from the lab into practice, paving the way to a future where the conversion of lignite into electricity is almost completely climate-neutral.
The test phase at Vattenfall's 30 MWth oxyfuel CCS pilot unit in Schwarze Pumpe started in September 2008. It has already provided essential knowledge about the entire oxyfuel process chain. The oxyfuel pilot unit will remain in operation as a research and development test facility until 2013, and the next years will be marked by intensive research into the oxyfuel concept. Doing so, a range of technical solutions will be tested. The results will supply the experience and know-how required for the successful scale-up to a demonstration plant.
During the 2009 testing phase, approximately 1,400 tons of CO_2 were liquefied in the oxyfuel pilot unit and more than 5,000 operating hours were completed, providing an average availability rate of 40 %. A large number of tests and different measurements were carried out during this time. One of these is to examine and analyse the quality of the CO_2 as a product. The results show that the CO_2 can have a high level of purity thanks to the extensive scrubbing in the pilot CO_2 purification unit. The capture rate achievable is greater than 90 %, or in other words more than 90 % of the liquefied CO_2 can be separated out of the flue gas. A most important result from the test phase is that the principle of the oxyfuel process could now be verified on a scale relevant for industry.
The next step to achieving full commercial availability of the technology is already at hand: Vattenfall is planning to construct a CCS demonstration plant with a gross capacity of approximately 470 megawatts at its Jänschwalde premises. The aim is to commence operations here in 2015. For this purpose investments of up to €1.5 billion are required. By 2020 Vattenfall Europe intends to reach full commercial viability for this technology. Parallel to this in the context of the new CO_2 "transport and storage" business field, the first storage infrastructures will be established. In this way a significant contribution to achieving both our own company's and Europe's ambitious climate targets will be made. Furthermore the economic future of domestic lignite in Germany and the long-term security of supply with a reliable domestic primary energy source will be guaranteed.
The CCS demonstration power plant planned for Jänschwalde is to receive up to €180 million in funding from the European Commission. The money is coming from the EEPR (European Energy Programme for Recovery), the EU's energy related economic programme that was adopted in June 2009.

Adaptive Governance within Europe – the Need for Integrated Adaptation Strategies

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Keywords

Adaptation – Social vulnerability – Climate policy integration – Uncertainty – Multi-level-governance

Abstract

Adaptation to climate change, however, raises fundamental challenges concerning the development of integrated climate change adaptation strategies involving multiple societal sector and level of decision-making. Climate change adaptation must not only address a few economic activities or societal sectors, but most sectors and development patterns of modern societies: from architecture, infrastructure and urban development up to spatial planning, water management, agriculture and forestry, among others. Moreover, whereas climate mitigation focuses on the reduction of green house gas emissions, climate change adaptation cannot be measured by a single indicator. Instead, reducing vulnerabilities and improving adaption capacities are mentioned as long term goals of adaptation measures. Sometimes these goals are supplemented by using the term resilience as a concept for guiding adaptation measures, but all of these terms represent very broad and unspecific societal goals. They carry different meanings for different sectors of society and neither their success nor failure is easily to measure. Moreover, the aim of adapting to climate change has to be included in the goals, strategies and measures of nearly every single sector of modern societies to adequately address the challenges expected to result from climate change. Thus, the need for integrated strategies (not completely novel to environmental policy) becomes even more urgent than in other fields of environmental decision-making. In the presentation, four overarching challenges and how to respond to them will be elaborated in more detail:

- First, integrated strategies have to avoid conflicts between climate change mitigation and adaptation measures.
- Secondly, to reduce societal vulnerabilities and to improve adaptation capacities integrated response strategies need to address the adaptation requirements of important industrial sectors as much as the distribution of costs and gains.
- Third, appropriate approaches need to address the specific regional vulnerabilities, taking into account high uncertainties concerning the predictability of climate change impacts and different temporal scales of decision making (from short time legislative periods up to long time planning of forests and landscapes).
- Fourth, climate policy has to interlink several levels of decision making, because regional and local decision making on climate change impacts and specific regional vulnerabilities are as much important as the institutional framework and financial support from the European or national level.

The issue of adaptation to climate change thus presents far-reaching challenges in terms of shaping societal development and, more specifically, societal relationships with nature as a whole. Particular emphasis is required concerning the ways in which particular regions and social groups will be affected by regional climate fluctuations, and what kind of social vulnerabilities and adaptive capacities exist in those particular locations. To adequately comprehend the issues, a dialectical understanding of the relationship between nature and society is required, one capable of taking into account the mutual dependencies and interactions between various biophysical and societal processes as well as the possibilities for reshaping these interactions. Moreover, the specific spatial (scalar) dimensions of the mutual interdependencies in different regions and the interplay between global and national climate policies and local or regional adaptation strategies must be analysed carefully. The presentation builds upon several research projects conducted to analyse the challenges of climate policies at several levels, including a comparative project on climate policy integration in different European countries (Mickwitz et al. 2009), on synergies or conflicts of national adaptation measures (focusing on the German adaptation strategy DAS) and on regional adaptation strategies (in the contexts of the project KLIMZUG-Nordhessen, funded by the BMBF). The presentation will analyse some challenges in more detail, including the question how to deal with cross-sectoral and cross-level interdependencies and how to address uncertainties in decision making. Moreover, it introduces some strategies how to improve decision making, including approaches to evaluate the efficiency of policy performance to improve climate policy integration and to stimulate synergies between adaptation measures and other policy aims.

POSTERS

AMERICA

AFRICA

ASIA

GENERAL ASPECTS

AUSTRALIA/POLAR REGION

EUROPA

AMERICA

Subjective Well Being and the Impact from Climate Change

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Keywords

Subjective well being – Climate change

Abstract

We analyze the relationship between subjective well-being as a non-income welfare measure and climate variables such as temperature, precipitation rates or cloud covered days. Therewith, we estimate the effects from events related to climate change on subjective well-being and point out possible welfare losses and gains due to climate change.

Even though that there is a growing number of research done on well-being in terms of income measures and climate change, there is only little research done on the effect of climate change and non-income measures such as subjective well-being. Further those studies lack some comparison. Except Rehdanz and Maddison (2005) all studies turn to national analyses when analyzing the influence of climate on subjective well-being. So far there are very few studies on middle- and none on low-income countries done, but at the same time extreme weather events may especially affect people in poorer countries. Therefore, we test this relationship for low and middle-income countries in Latin America and put the results in comparison to earlier studies.

We apply survey data from the World Value Survey and Latinobarometro which cover the years 1985–2008. In a panel study we estimate subjective well-being in Latin America and control for gender, age, marital status and income. Further we introduce climate variables such as the deviation from the mean temperature and precipitation rates as to analyze how the rising variance in climate affects subjective well being.

Agricultural Soil Erosion and Global Carbon Cycle: Controversy over?

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Keywords

Climate Change – Soil erosion – Carbon cycle

Abstract

Carbon release, uptake and lateral movement within terrestrial ecosystems represents a major source of uncertainty in global Carbon cycle models. Recent research on the contribution of soil erosion on agricultural land to atmospheric CO_2 emphasizes either the contribution of soil organic matter (SOM) mineralization during transport as source for atmospheric CO_2, or the deep burial of SOM-rich sediment in agricultural landscapes as a sink. The contribution of either process is subject to a controversial debate. In this study, we present results of laboratory experiments and field sampling which highlight the need for an integrated research of geomorphic and ecologic processes within the global Carbon cycle at appropriate temporal and spatial scales. We argue that only an eco-geomorphologic perspective on organic Carbon movement through landscapes can reconcile the two positions debated above and improve our understanding of the interaction between terrestrial ecosystems and the atmosphere.

Global Circulation Changes Since the Late Pleistocene and their Impact on Man & Environment in Southern Peru (14°S)

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Keywords

Peru – Southern Westerlies – Nazca – Geoarchaeology – Loess – Holocene – El Niño

Abstract

Today, the assessment of potential impacts of global warming is one major task of environmental sciences. Based on current knowledge about atmospheric and oceanic circulation, global circulation models (GCM's) are used to predict future conditions. But as the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4 2007) and others note, more data are required to improve the GCM's for reliable regional forecasts. On this, palaeoclimatic research provides important information to GCM's and finally to stakeholders to assess the regional effects of global warming – both on temperature and precipitation.

In the dry coastal strip of South America, where water is the most prominent controlling factor of life, deserts retreated and expanded several times due to precipitation oscillations since the Late Pleistocene. These oscillations were induced by large-scale circulation changes, which controlled the airflow in the upper troposphere over South America (Vuille 1999) and as a result the intensity of moisture transport from the Amazon basin to the Andean cordillera. This transport mechanism oscillated on annual timescales (i.e. El Niño and La Niña) as well as decadal/centennial timescales and triggered yields of irrigation agriculture along the river oases as well as long-term shifts of vegetation belts.

During the Late Pleistocene and Holocene, the southern Peruvian coastal desert was a region of shifting desert margins, as studies of landforms, molluscs and sediments revealed (Mächtle et al. 2010). During the Late Pleistocene, advances of tropical glaciers give evidence of more humid periods in the adjacent Andes, since these are anti-phased with colder global temperatures. During the Holocene, for millennia the southern Peruvian coastal strip was grassland, as loess deposits as well as molluscs archived. Afterwards, precolumbian cultures as the "Nasca" flourished synchronous to sufficient water resources. Due to declining water availability, the spirituality of Nasca changed. They built ground drawings for religious purpose, known as the "Nasca lines" (Lambers 2006).

The chronology of environmental changes in southern Peru supports the hypothesis of global interactions between oceans and atmosphere, both during the Late Pleistocene and the Holocene. Our records show a continuous warming after the Antarctic Cold Reversal, which supports the idea of the "bipolar seesaw". The terrestrial geoarchives document the regional impact of distinct changes, which are also archived in the ice core proxy data from Antarctica as well as in marine proxies from the southern mid-latitudes. Thus we want to hypothesize a direct link between changes in the Atlantic thermohaline circulation, the position of the southern Westerlies and the precipitation in (semi-)arid tropical southern Peru. This connection may explain the inconsistence of the mid-Holocene drought reported around Lake Titicaca and northern Chile, in contrast to the grassland ecosystem around Nasca, a few hundred kilometres to the west. Our findings show that the proxy data from Lake Titicaca or Quelccaya ice cap are not universal for the central Andes, as they previously were interpreted. The atmospheric circulation and its regional impact are more complex.

Global warming will change both atmospheric and oceanic circulation and therefore the extent and the spatial distribution of future precipitation over South America, as those did during past millennia. The impact on ecosystems, mining and farming as well as the water collection and disposal of (mega)cities will be strong. GCM-based large scale scenarios are not accurate enough to predict the consequences of global change on regional scales. The environmental history of southern coastal Peru does not agree with both the occurrence of more El Niño-like conditions and a southward shift of the southern Westerlies, which is predicted by most GCM's (IPCC 2007). Thus, the findings of the past may picture Peru's regional future and improve the circulation models.

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Climate Change and Expansion of Ectoparasites: The History of the Winter Tick *Dermacentor Albipictus* Distribution in the Canadian North

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Keywords

Northwest Territories – Winter tick – Barrenground caribou – Climate change – Arctic – Parasite invasion

Abstract

Since the early XXth century, winter tick (WT) Dermacentor albipictus infestation from mild to severe has been documented further north in the Northwest Territories (NWT) in both moose Alces alces and boreal woodland caribou Rangifer tarandus caribou, but apparently does not occur in barren-ground caribou Rangifer tarandus groenlandicus. The observations of "ghost moose" (heavily infested individuals with damaged fur) increased in the last 10–15 years, there is a growing concern that with climate changes resulting in warming temperatures and increasing precipitation, the WT will expand its range and invade barren-ground caribou populations. The caribou is a key species in the circum-arctic ecosystem and it is also extremely relevant for the aboriginal communities as they heavily rely on caribou populations for their subsistence, and their culture is centered on caribou hunting. We collected the historical and current data available on WT occurrence in the NWT, and tested a simple climatic driven model of WT distribution formulated in the late 60s based on the number of degree days above a temperature threshold (5.6 C), that is considered to be a critical condition for the WT to survive. The model has been first applied to describe the past evolution of the distribution in NWT on a 20 year based time lap (1967, 1987, 2007), and then to project the WT distribution over the next 20 years (2030) under different climate change scenarios. The results have been compared with actual data, confirming the expansion trend, although discrepancies have been detected. To increase the model power, a predictive and testable WT distribution model will be formulated for the NWT, including other environmental factors that have been shown to shape WT range on top of the temperature conditions: humidity, vegetation/land cover, elevation and aspect. We will incorporate these layers in a predictive model of current distribution pattern of the WT population. The model will then be tested using field data on WT distribution in the NWT, and then to preliminarily project the future WT expansion range under different climate change scenarios.

The projected expansion estimates has been overlapped with current and projected caribou distribution patterns and phenology. A preliminary analysis of the projected overlapping distributions and the projected phenology of both host and parasite, allowed us to make a preliminary estimate the potential effects of climate change on the risk of WT infestation of barren-ground caribou in the NWT. Although further research is needed to quantitatively assess the alterations of the WT life-cycle induced by climate change, and the expected variations in the caribou ecology, our study represents the first attempt to estimate the potential consequences of WT invasion on the barrenground caribou under different climate change scenarios.

Low Level Jet Structure in South America Using a Regional Climate Model

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Keywords

Low level jet – South America – Regional climate model

Abstract

From previous studies, the mesoscale convective systems (MCSs) in the South America La Plata Basin has the second highest frequency of occurrence in the tropical region after Africa. These systems are responsible for a large proportion of rainfall in tropical and warmer mid-latitudes and often produce severe convective weather events such as strong winds, hail tornadoes, lightning and flooding. The occurrence of MCSs is associated with the low level jet (LLJ) east of Andes which develop from the Amazons and propagates downstream towards the La Plata Basin. A considerable amount of moisture is being transported from the Amazons towards the La Plata which favor the organization of convection into MCSs and in turn, could strengthen or weaken the LLJ maximum in the Bolivian region. The aim of this work is to study the mechanism of the South American LLJ (SALLJ) and how it influences its associated MCSs.

The horizontal and vertical structure of SALLJ and its relationship to convection is investigated using a regional climate model. The model simulations with a horizontal resolution of about 50 km covering the whole South American continent are analyzed. The boundary condition is from the ERA-INTERIM reanalysis data with the period covering from 1989 to 2008. The model results on winds are then compared to reanalysis data, observations and a global model.

Results show the representation of the horizontal structure of SALLJ in a regional climate model. During summer, where the LLJ and the MCS are prominent, the regional model represented the vertical structure of the meridional winds. These maximum winds are weak in the global model. Further analysis will be done for the detection of MCSs systems and the feedback mechanism between the MCSs and the SALLJ in the future.

Typical Patterns of Climate Vulnerability and Food Security: Insights from the Dryland Smallholder Systems in the Peruvian Altiplano

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Keywords

Climate vulnerability – Pattern approach – Food security – Drylands – Altiplano – Peru

Abstract

Complex interlinkages between the marginal dryland resources and human development in the Peruvian Altiplano challenge the analysis of smallholders´ climate vulnerability and related decision-making. The present study thus proposes a pattern approach to evaluate the smallholders´ climate vulnerability with respect to food security based on similarities of household attributes. We first specify the most important vulnerability-generating mechanisms. According to these mechanisms, we focus our analysis on the most important dimensions of vulnerability: land and livestock resources, agricultural management, education, traditional knowledge and purchasing power. They are specified by six indicators at household level. A cluster analysis reveals similarities among the livelihood systems resulting in a set of five typical vulnerability patterns. This approach firstly provides information that is to some extent aggregated and hence reduces the complexity of the real world. The resulting vulnerability patterns further allow us to differentiate the social group of smallholders recognising that the livelihood systems show clearly distinct characteristics, including their ability to absorb climate shocks. The differential household attributes are thereby related to differential vulnerability outcomes in agricultural production and food purchase that are used to verify the vulnerability patterns. By ranking the vulnerability patterns according to the severity of vulnerability, we propose thematic and spatial entry points for vulnerability reduction. Given the similarities among the households, the results are of practical use beyond individual cases. As such they may well assist decision-making at above local level. Reference is made to pilot communities in the Puno region of the Peruvian Altiplano.

AFRICA

Factors Influencing the Decision to Adapt to Climate Change, the Cases of Two Wards in Rural Tanzania

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Keywords

Agriculture – Micro-level practices – Small-scale farmers – Adoption – Household survey – Vulnerable groups – Livelihood strategies – Adaptation – Climate change – Tanzania

Abstract

Tanzania is likely to suffer significant socio-economic and physical impacts from climate change (Chambwera & MacGregor 2009, Mwandosya et al. 1998). The central-eastern region of Tanzania hosts several **hot spots** where Global Circulation Models predict **20–50 % failing seasons** by 2020 (Thornton et al. 2006). People in the region already practice **autonomous adaptation** to climate variability, but this will be probably not enough to cope with the impacts of future climate change (Paavola 2004). Policy driven **planned adaptation** is necessary. Assessing effective adaptation practices, identifying **obstacles for implementation** of these practices and suggesting options to overcome them are prerequisites for planned adaptation (Füssel 2007, Künkel 2009).

The objective of this contribution is to assess factors influencing the **decision** of rural households in two Tanzanian administrative wards to **adapt to climate change**. One ward is disadvantaged in terms of food production and the other ward has a higher agricultural potential due to its biophysical characteristics. The assessment departs from identifying the **socio-economic characteristics** of the household in terms of land use, access to productive assets, education, training and income. Furthermore households' **perception** of climate variability and change as well as current practices to adapt to weather related shocks are analyzed. The underlying hypothesis is that the **adoption** of **micro-level measures** for adaptation to climate change depends on current climate variability; future climate change; non-climate, context-related factors (e.g. market pressure, demographic change etc.); the perception of climate risks; household characteristics (e.g. access to credit, farming experience, the mix of crops and livestock etc.); the character of the available adaptation practices; the spatial position of the household (i.e. the agro-ecological zone).

The hypothesis is tested using quantitative data of **300 households** in two wards of Tanzania. The **household data** is complemented by findings from focus group discussions with farmers in the two wards following the methodology of **Rapid Rural Appraisal**. All data was collected between May and October 2009. The focus group discussions are analyzed by means of a qualitative content analysis (Böhm 2003). The household data is analyzed using descriptive statistics and statistic regression techniques.

The **results** show that households' vulnerability to climate variability and change is a function of demographic aspects, household assets, livelihood strategies and other factors. Effective adaptation policies need to take into account the **heterogeneity** of different household types.

Climate Change in an Unrecognized Country. Impacts, Vulnerabilities, Adaptation Opportunities and Institutional Representation in Somaliland

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Keywords

Climate change – UNFCCC – Non party country – Internal adaptation strategy – Vulnerability – Pastoralism – Local knowledge – Consecutive droughts – Traditional institutions – Enclosures

Abstract

Somaliland is not internationally recognized as a nation and therefore not represented in the UNFCCC either as a party or as an observer state. This is one of the reasons why the country is not involved into any international efforts of mitigation or adaptation to climate change, despite its attachment to a very comprehensive environmental and socio-economic monitoring programme of FAOSWALIM and FNSAU.

While the ecological impacts and vulnerabilities to climate change in Somaliland might be similar to other countries under comparable natural conditions, such as an overall disruption of the regenerative capacities of the human-environmental system due to detrimental weather changes which result especially in consecutive droughts, there are specific features which are unique to the socio-economic and political system, which has been historically been shaped by pastoralism and has been affected by wars and political conflicts until recently.

Due to the loss of a productive grazing base, herd sizes declined to a level below the necessary size that still can support the subsistence of most families and ensures their mobility. While this historically used be common in pastoral societies from time to time, this status seems to become permanent now. Women are usually the most affected group, since they are frequently left alone with only few remaining numbers of livestock to take care for the children, while the husband has either died or left to town to find work.

As a consequence climate change has triggered more sedentary lifestyles, either by uncontrolled out-migration to towns of pastoralists who totally lost their livestock, decline of mobility due to herd size reduction or switching to opportunistic agriculture. This leads to the emergence of new types of livelihoods and land management systems, but on a much lower level of living quality and productivity than before, if no supporting measures are taken. In this trend of overall change, also pastoral institutions like Xeer (customary law) and Xiddigiye (local knowledge experts) have lost their significance, so that the original high capacities of traditional institutions to adapt flexibly to erratic natural conditions have been eroded or completely lost, while modern institutions which are linked to the present climate change debate are not yet put in place. Uncontrolled land grabbing has become rather the rule than the exception, usually leading to the exclusion of less powerful pastoralist groups from productive grazing resources by the powerful, exacerbating social and environmental injustice. Consequently conflicts about land resources have increased in the last decade to an alarming extent.

Current coping strategies in the way they are practised, such as selling out the remaining resource base for charcoal, are in no respect capable of mitigating or adapting to the conditions of climate change in the long run, and – while mostly practiced by men – moreover undermine the usually more sustainable economy of women, such as selling milk, which is dependent on a productive – or at least available – vegetation base.

The country needs therefore to develop an internal national adaptation and mitigation strategy, which includes mainstreaming climate change policies and capacity building on climate change issues on all levels. Since the country is not linked to the UNFCCC, it needs to develop an international advocacy strategy, by linking civil society and governmental organizations through international donors to the political and financial instruments of the UNFCCC. It has furthermore to be ensure that these international organizations mainstream climate change policies into their own programmes they are implementing in the country, taking rights-based approaches and developing appropriate financing strategies for all measures to mitigate and adapt to climate change.

Impacts of Climate Change in Rwanda

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Keywords

Climate change – Rwanda – Equatorial Africa – Tropical Africa – Climate zones – Global warming – Rising temperature – Decreasing precipitation

Abstract

Rwanda, a tropical mountainous country amidst the African continent, one of the smallest states of Africa, shows a distinctive relief. This is being generated by the Central African foothills of the East African rift, which separates the savannah of the African highlands from the lowland rain forests of the Congo basin. At first glance a statement about the climatic relations of the country from the climatological view can be made quickly. Because of the earth's graticule between 1° to 3° S and 29° to 31° E it is out of question that Rwanda belongs to the tropical, equatorial zone; regardless of the interpretation of the climatic situation after the effective or genetic climate classification.

The project ReCCiR (**Re**cent **C**limate **C**hange **i**n **R**wanda) maintained by the University of Kaiserslautern has sat one's sights on analyzing the climatic conditions within the tropical mountainous country. Evidences should be given about how the global climatic change already affects this state today. Climate modelling offer the opportunity to establish forecasts how the Rwandese climate might change during the next decades. Not least the obvious altitude differences in Rwanda, from ≈ 900 m to 4,507 m a. s. l., reveal that significantly different climatic regions should be considered. Based on data of long climatic time series from 1930 to 2008, Rwanda offered actually four zones:

- East-Rwandan, dry and hot lowland zone,
- Temperate zone of the central highland,
- Mountain climate,
- Kivu-sea climate.

Regarding the last 15 years the impacts of climate change are obvious and the classification of four climatic zones must be enlarged:

- East-Rwandan, dry and hot lowland zone,
- Temperate zone of the central highland,
- North-Rwandan dry mountain region,
- South-Rwandan humid mountain region
- Kivu-sea climate,
- Urban climate region of Kigali.

Nevertheless, it already appears that a clear and visible shift of the single zones has taken place during the last decade. Thus, the dry and hot savannah zone moves into westerly direction, while the temperate zone and the mountain climate can be found in continuously rising altitude, with a decreasing amount of precipitation, since the temperature is increasing and against the advices of the Intergovernmental Panel on Climate Change the tropical heavy precipitation events are decreasing and the amount of precipitation is presumable declining all over Rwanda.

Participation of Women in Community Based Disaster Preparedness (CBDP) Programme in West Africa

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Keywords

Women's role in CBDP – Nontraditional skills – Participation of women

Abstract

A qualitative study by Dr Captain Francis Lysongo Ekosso and Ms Rosemary Olive Mbone Enie looks at the degree and nature of women's role in the process of Community Based Disaster Preparedness (CBDP) Programme in West Africa. This is done with the understanding that women's role cannot be analyzed in isolation from the understanding of how men maintain status quo in their roles in the process. The study brings out findings that underline the transformation women have experience within themselves by participating in the CBDP Programme. This transformation happens through those components of the programme which bring them into public spaces, give their opportunities and context to question the stereotypical roles allocated in the CBDP Programme. The examples are women learning nontraditional skills such as rescuing, managing relief camps and doing damage assessments.

The study brings to bear the fact that though women's burdens are increased and have to juggle with household chores and other household and community responsibilities such as attending meeting and trainings the benefits of involving women outweighs the sense of pressure due to multi tasking in the public and private domains. Due to the traditional setting of West African communities it is very evident that men still have more spaces than women. When women are questioned they bring forth analytical situations that critically tend to contest the prevailing gender based biases in order to claim strategic roles in the process.

The study highlights the fact participation of women is important as they can effectively undertake such tasks such as rescue, camp management etc to ensure that they are not only victims but active participants during trainings and at actual disaster situations enabling them to be able save themselves and their children. It is evident that in many disasters women and children die the most and effective training and capacity building for women in preparedness for disaster must be compulsory for every disaster prone area in West Africa.

The Becoming of the Irrigation Sector under the Climate Change Context: Study Case of the Southern Tunisia Oases

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Keywords

Tunisia – Climate change – Oases – Groundwater – Irrigation – Efficiency

Abstract

Located in the Northern Africa, Tunisia is delimited by the Mediterranean Sea in the north and the large desert in the south. The mean annual precipitation is estimated to 207 mm whereas the annual evapotranspiration ranges between 1200 mm in the north to 1800 mm in the southern country.

Similarly to the Maghreb countries region, Tunisia is strongly concerned by the climate change impacts. In 2005, within the framework of the Tunisian-German cooperation, an assessment analysis managed by the GTZ, aimed to identify the impacts of climate change in Tunisia with a focus on agriculture and water resources development vulnerability. This two years process provided the country with comprehensive references and national forecasts that have led to develop the national adaptation strategy to climate change. Particularly in the arid southern Tunisia where the agriculture still plays the key role in the development, the main incomes provide substantially from the oases production.

These ecosystems became an intensive irrigated perimeters permanently submitted to desertification risks. They had been also identified as strongly vulnerable to the future climate change impacts. Their tributary to the underground water resources which are sustaining a chronic depletion is compromising their sustainability for the coming decades.

Under an acute water shortage context, these perimeters are called to experience more than more difficulties in managing less reliable underground water resources. The main issue that determines the survival of the irrigated agriculture in such conditions will definitely pass through the promotion of optimal water management solutions. This paper attempts to underline the preparedness of the irrigation sector in such specific context to the climate change impacts. The study case of the southern Tunisia oases is selected to demonstrate the crucial need of such measures to meet the coming challenges of the climate change impacts on the irrigation water reliability.

Our approach illustrates also the feasibility of the oases irrigation practices conversion into more efficient alternatives. Such measure aims to provide the water policy adequate options and facilitate effective decision making to enhance the local capacity and preparedness to cope with the climate change issues.

Climate Change and Sustainability of Eucalyptus Plantations in the Kouilou Basin (Congo-Brazzaville)

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Keywords

Climate change – Sustainability – Plantation – Eucalyptus – Savannah – Soil-water balance – Evapotranspiration

Abstract

Since 1950 approximately, the savannah of the Congolese littoral has gradually been planted with Eucalyptus in dense populations exploited on rotations of seven years. To appreciate the sustainability of these plantations of Eucalyptus in the climate change context (the rainfall reduction), it is necessary to make a comparative study of energy, carbon, mineral and water balances of two ecosystems, i.e. the original savannah ecosystem, and the man-made ecosystem the Eucalyptus plantations that have succeeded it. The aim of this work is to study the water balance of the two ecosystems and more particularly their actual evapotranspiration (transpiration and evaporation).

In a six years-old Eucalyptus plantation (Eucalyptus PF1 and Eucalyptus 12ABL*saligna), mean height is 24.2 m, mean stem diameter at soil level is 0.17 m, stand density is 502 trees ha^{-1}, total basal area is 11.0 m^2 ha^{-1}, leaf area index is 3.2, total wood production is 118.5 m^3 ha^{-1}). In a savannah with Loudetia arundinacea, gross precipitations (Pi), throughfall (rain gauges) and soil water content (neutron probe) were measured weekly during the rainy season from November 1996 to April 1997, from November 1997 to April 1998, from November 1998 to April 1999 and during the dry season, from June to September 1997 and from June to September 1998. Actual evapotranspiration (E_a), net interception and transpiration were derived by the water balance equation method.

Moreover, transpiration was measured using the radial flow meter. The soil water profiles (soil water content and potential plotted to soil depth) were established, indicating of preferential water uptake zones and rooting depths of Eucalyptus plantation (5 m depth) and savannah species (3 m depth).

Throughfall, net interception during the rainy seasons (1996–97, 1997–98 and 1998–99) were 867 mm and 112 mm (89 and 11 % of Pi) for the Eucalyptus plantation and 878 mm and 101 mm (90 % and 10 % of Pi) for the savannah, respectively. The mean seasonal daily actual transpiration of the plantation and savannah was 3.6 and 2.6 mm day^{-1} during the rainy season (November to April) and 1.4 and 0.9 mm day^{-1} during the dry season (June to September); the mean seasonal daily actual evapotranspiration of the plantation and the savannah was 4.2 and 3.2 mm day^{-1} (rainy season) and 1.4 and 0.9 mm day^{-1} (dry season); the total seasonal actual evapotranspiration was 767 mm and 579 mm (rainy season) and 183 mm and 121 mm (dry season), with total annual respectively 1127 mm for a plantation (95 % of Pi) and 821 mm for a savannah (69 % of % of Pi). During the year transpiration/potential evapotranspiration ratio (T/E_p) is related to the soil-water depletion: The T/E_p ratio of 0.79 was not reduced from field capacity (R_{FC} = 618 mm) until 65 % of R_{FC} (402 mm), and then it decreased quickly to near zero (0–0.2) at wilting point or 53 % of R_{FC} (R_{FC} = 309 mm). The drainage out of rooting depths of savannah during the rainy season of 1997–1998 and 1998–99, was of 827 mm, a total over 3 years (0, 390 and 438 mm); while the drainage out of rooting depths of Eucalyptus plantation was of 470 mm (0, 207 and 263 mm), a difference in drainage between two ecosystems of 357 mm a total over these three years (0, 183 and 174 mm).

The Eucalyptus plantation is man-made ecosystem which takes up and transpires every day throughout the year and uses all available water. The succession of several rain-deficient years will reduce the wood production of the plantation but, knowing that between 1949 and 1998 four successive rain-deficient years have only occurred once while the length of rotation is seven years; this dry episode does not compromise the survival of the plantation, although it reduces its wood production. The savannah has a cycle of vegetation such that at the end of the dry season (September) the water remaining in the rooting depths of savannah (15 % of R_{AW}) (R_{AW} = 181 mm), is sufficient for three successive rain-deficient years to have no impact on its production.

Interest Using the Bowen-Ratio Method to Study the Actual Evapotranspiration of the Savannah in the Climate Change Context (the Kouilou Basin, Congo-Brazzaville)

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Keywords

Climate change – Canopy resistance – Bowen-ratio – Monteith equation – Evapotranspiration

Abstract

The aim of this work is to study the actual evapotranspiration and surface resistance of the savannah using the Bowen-ratio method for two contrasted periods, dry and rainy season in the climate change context.

The reliability of this method has been assessed by comparison with the Monteith equation and the soil-water balance method in a 90 % Loudetia arundinacea dominated savannah (Pointe Noire, Congo).

Our results relate to the period from 18 September to 11 October 1998 (24 days): (a) from 18 to 29 September ("dry season"), the soil-water content was less than 70 % of the soil-water content at field capacity (63–70 % of R_{FC}; large soil-water stress; T/E_P from 0.2 to 0.4); (b) from 30 September to 11 October ("rainy season") soil-water content close to 90–92 % of R_{FC}; no soil-water stress; T/E_P from 0.73 to 0.77).

The mean daily surface resistance resulting from the Bowen-ratio method was 317 s m^{-1}, 355 s m^{-1} during the "dry season" and 279 s m^{-1} during the "rainy season". The total actual evapotranspiration (E_a) resulting from the Bowen-ratio method, Penman-Monteith equation and soil-water balance method were, respectively of 58.6–57.8 and 56.2 mm, with the mean daily E_a of 2.4–2.4 and 2.3 mm day^{-1} (2.4–1.5 and 2.2 mm day^{-1} in "dry season" and of 2.5–3.4 and 2.5 mm day^{-1} in "rainy season").

The Bowen-ratio method was used for the assessment of the actual evapotranspiration from the temperature and specific humidity differences, net radiation and the soil heat flux measurement: its advantages are a rapidity of installation, a temporal resolution of measurement in less than one hour and a good integration of the heterogeneousness of the savannah's latent flux of vaporization.

This method is adapted to eco-physiological studies in tropical conditions with reduced teams.

Late Quaternary Climate and Landscape Changes in Southern Africa Based on Integrative Analyses of Geoarchives

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Keywords

Southern Africa – Paleoclimate – Holocene – LGM – Rapid temperature changes – Geoarchives – Geomorphodynamic

Abstract

Although it is clear that large, rapid temperature changes have occurred during the last glacial-interglacial cycle and the Holocene in Southern Africa, we have only limited, and often imprecise, knowledge of how the major moisture-bearing atmospheric circulation systems have reacted to these changes. Using slope deposits, soils and sediments as palaeoclimatic geoarchives, we will overcome these constraints. The role of many geoarchives in the reconstruction of the Quaternary climate in Southern Africa remains controversial, since the palaeoclimate data are based on evidence from marine cores, lake sediments, speleothems and spring sinter, fluvial sediments, aeolian sands and dust, colluvium, and coastal sediments. To elucidate climate controls on Quaternary landscape evolution and to use the data for palaeoclimatic reconstructions, slope deposits, soils and fluvial as well as aeolian sediments in Southern Namibia and Northern South Africa have been investigated.

The project will employ state-of-the-art geoscience methodology to interpret the record of precipitation changes of the Late Quaternary, including the shifting of the summer and winter rain belts, the chronology of catastrophic floods, the wind intensity and direction, and the role climatic factors may have played for prehistoric cultures. High resolution Late Quaternary records are provided by analysing the interstratification of slope deposits and soils with fluvial, lacustrine and aeolian sediment sequences. Earlier research and the first results of two field trips have shown that aeolian and fluvial processes were active at the same time in the southwestern Kalahari during the LGM, documented by sequences of alternate bedding of aeolian, colluvial and fluvial sediments. The interfingering of slope deposits with fluvial flood sediments (slackwater deposits) in Namib Desert valleys document extreme precipitation events in the upper highland catchments and rains at the same time in the desert itself. There is also evidence of a wetter climate during the Little Ice Age which interrupted the long-term climatic trend to more arid conditions.

All in all, for the Holocene, a distinctive stability of the Southern African landscape with only a few indications of erosion or sedimentation can be concluded.

Large Floods in the Sinai Mts., Egypt, during Late Oxygen Isotope Stage 3

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Keywords

Large floods – Sinai Mts. – OIS 3 – Wadi sediments – Alluvial fans – Erosion

Abstract

Wadis emerging from the Central Sinai Mountains and extending westwards to the Gulf of Suez are characterized by huge late Pleistocene (< 40 ka) sediment fillings constituting heights of more than 40 m, which have been subsequently eroded down to their Quaternary base since the last glacial maximum LGM. Such prominent sedimentation and erosion processes are the consequent results of fundamental changes in morphodynamic regimes distinctively caused by climatic variations. The studied sediment fillings are neither described or interpreted regarding their genesis nor dated within the context of corresponding literature. They are associated with extensive alluvial fans which have developed at the intersection of the wadi edges along the Sinai Mountains and the adjacent El Qaa plain leading towards the Gulf of Suez with heights reaching up to 500 m a.s.l. at the edge of the mountain rim. GPS based terrain analysis clearly shows that the processes of sedimentation have consistently ceased within the reaches of the alluvial fans and have never proceeded beyond the margins of the 20–40 km wide plain towards the Gulf of Suez. Each basic fan body exhibits a strong hypsometric association with the highest sediment body in its corresponding wadi. The fan slope is impressive with the fan itself being just a few kilometres long and wide. The great number of wadi-plain intersections along the edge of the Sinai Mountains results in the convergence of fans emerging from adjacent valleys. According to numerous OSL dates, the maximum age of the sediment fillings can be assumed to be 40 ka (isotope stage 3). Latest datings from the top of the sediment bodies deliver ages of approximately 25 ka, which confirms the hypothesis of pre-LGM formation.
The presented findings provide a very detailed and revised reconstruction of sedimentation processes and climate prevailing throughout the Sinai peninsula. As the age of erosion can be considered of equal interest, associated alluvial fans represent essential geoarchives to be investigated in future.

ASIA

Climate Change and Land Use Change in Bangladesh. Learning about an Amphibic Country under Increasing Pressure

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Keywords

Land use change – Deforestation – Shrimp Farming – Vulnerability – Bangladesh

Abstract

Within the last decades the ecological conditions in the southern parts of Bangladesh have altered dramatically due to land use change. Dense mangrove forests which once protected the coast have been replaced by widespread aquacultures. Apart from the loss of this natural coastal defence system the sedimentation pattern is also expected to undergo significant changes. Economic interests, population pressure and forest degradation increase the vulnerability of the coastal zone. The impact of climate change, particularly a rising sea level and intensifying tropical cyclones in the Bay of Bengal region, further increases the risk of natural disasters.

The scientific background – The people of Bangladesh and their environment will be particularly affected by the impact of climate change. As most parts of the country lie just above sea-level, marine transgression is one of the main threats for the living environments and a carefully growing economy. Vast areas of this deltaic environment can be described as amphibic or semiamphibic and in the case of storm or monsoon induced floodings, more than 2/3 of the country are submerged. The hydrological situation is characterized by three major river systems running through the country and tidal- marine influence from the south. Both hydrological systems interact and underlie intense variations which are partly influenced by human activities. A precarious economic situation and an increase in the country´s population forces people to further intensify their agricultural activities. Furthermore an increasing number of people settle in highly vulnerable environments or move into one of the larger cities. Nearly all ecosystems of Bangladesh will face serious changes due to the impact of global warming. Rising temperatures will lead to changes in precipitation patterns, river discharge, storm activities and coastal environments. More rain during the monsoon and less rain in dry seasons are predicted for the future. This sharpening climatic contrast between the seasons will have an impact on agriculture and could even lead to droughts in the northwest. In addition more intense and more frequent tropical storms are predicted for the Bay of Bengal. Bangladesh's rural community relies on a degree of 'normal' flooding to bring in moisture and fresh sediment. Drastic man made changes like the various effects of global warming and the degradation of natural ecosystems for economic reasons lead to a situation which is almost unpredictable. Storm events, riverbank erosion, inundation and flooding will occur much faster then decades ago. Since the end of the Pleistocene era rivers have deposited a large amount of sediment from the Himalayas constituting about 80 per cent of todays landmass. Even the Holocene sea-level rise of about 120 meters had been compensated by sedimentation processes, the delta complex has developed over the last 10 000 years under mainly transgressional conditions. Extended mangrove forests along the coast compensated impacts from land and sea. The impact of storm surges on the Hinterland and the river systems were reduced, whereas the roots acted as vast sediment catchment areas. Within the last 30 years most of the protecting mangrove fringe has been cut to give room for the construction of large shrimp farms. Apart from the loss of habitats for fauna and flora sediment material is lost by increasing abrasion and bank erosion. Flood events develop much faster and the wind speed of tropical storms is not reduced by friction.

The educational context – The example of shrimp farming in Bangladesh is an ideal topic to enable the students to learn about a very complex, interactive system of various causes and effects. In the context of globalization and climate change coherences of economy and ecology can be illustrated. It is of fundamental psychological and motivational importance that learners as consumers of shrimps become a part of the story they have to learn. That is why dealing with problems at the other end of the world is of highly personal relevance, the topic is not at all abstract or removed from their individual experiences. Furthermore, learning about land use and climate change in Bangladesh is ideal to illustrate the multiperspective approach of Geography as the only subject bridging social and natural sciences. The key question to be answered in this Mystery like teaching approach is: *Year by year people in the western world consume many tons of delicious king prawns. Why does our hunger for prawns lead to more and more disastrous floodings in Bangladesh?*

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The Effect of Forest Vegetation on Storm Surge and Flood Attenuation: A Feasibility Study

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Keywords

Storm surge – Coastal forest – Wave attenuation – Sea-level rise – Coastal flood – Stabilizing coastal sediments

Abstract

This study assesses the degree of resilience of coastal forests to storm surge and their role in coastal protection and the future of mangroves in the face of climate change. Many scientists have urged the correlation between extreme weather events (such as cyclone, storm surge, etc) and global environmental change. But the quantitative research on these topics is still lacking. To fill up this gap, a defence concept, named "Divide-and-Rule Defence Strategy" against extreme coastal floods has been proposed by Oumeraci (2006) which also allows prioritizing the research needs. In the case of densely populated areas and highly vulnerable coastal zones – the defence strategy will be more helpful to prevent loss of life and further impacts of climate change. Moreover, observations from the 2004 tsunami showed that coastal forest vegetation practices can intensify the negative environmental impacts of a tsunami or storm. It can be considered as comprising two components, with the first being the well-known wave attenuation and the second, protecting coastal areas from storm damage by stabilizing coastal sediments. That is, the coastal forest vegetation acts on the wave system and cause both the wave energy to dissipate and the sediment to stabilize.

On the basis of "Divide-and-Rule Defence Strategy", the hydraulic performance of mangrove forest of different widths B and different water depths h is systematically tested in the Twin Wave Flumes (TWF) of Leichtweiß-Institute, Technical University Braunschweig, Germany (2 m and 1 m wide, 90 m long, and 1.20 m deep) for both regular and irregular wave trains. The result highlights that the transmission coefficient decreases with increasing forest width which is strongly related to the energy dissipation coefficient as the contribution of the forest itself to wave reflection is almost negligible.

On the other hand, we have analyzed the sediment accretion data by mangrove forest (Alongi 2008) against sea-level rise. It is observed that the sediment accretion rates in forest vegetations are keeping pace with the mean sea-level rise which may demonstrate considerable resilience against climate change.

The above information should be taken into account when assessing the flood attenuation performance of existing forests and when 'designing' new coastal forests where storm surges are more likely to occur. Especially, Bangladesh is one of the coastal marginal countries of the Bay of Bengal in Asia subcontinent where the storm surges are very common phenomena with dramatic consequences.

Threats to Megacities through Climate Change-Related Infectious Diseases (ID) with Focus on South Asia: Review and Theoretical Framework

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Keywords

Climate change – Infectious diseases – Diarrhoea – Malaria – Dengue – Megacities – Indian Sub-continent

Abstract

Changing climate and growing megacities have drawn considerable public health attentions worldwide. Both climate change and megacity development can affect all ecosystems and hence influence the occurrence of both water-borne and vector-borne diseases by expanding the suitable conditions e.g. for vector breeding and multiplication and maturation of infectious agents. Diarrhoea/cholera, dengue, and malaria are sensitive to climate factors such as precipitation, flooding and temperature. Whereas megacities are more vulnerable to the impact of climate change than other settings, limited information is available regarding these diseases in megacities. Considering this background, the review focuses on the diseases in five megacities of the Indian sub-continent namely Dhaka, Mumbai, Delhi, Kolkata, and Karachi and then proposes possible multi-level interventions. Evidence shows that all megacities are similar in many aspects (e.g. population density, infrastructure, and poverty) and have experienced recent dengue outbreaks. Dengue has re-emerged after 1990 in all megacities with an increasing trend. This disease is found to be highly seasonal with a higher number of outbreaks during the monsoon period. Burden of diarrhoea/cholera varies remarkably among the megacities. For instance, diarrhoea/ cholera is found to be more common in Dhaka and Kolkata than in other megacities. Information about malaria is scarce particularly in Dhaka and Karachi. None of the reviewed studies explicitly assessed the long-term association of the diseases (except cholera/diarrhoea in Dhaka) with any particular climate factors by using time series data. In spite of some limitations, overall information regarding climate change and infectious diseases (i.e. increasing occurrence of dengue outbreaks in urban areas) suggests that megacities will be more affected by these diseases in the future particularly in the absence of adequate interventions. We propose a framework for multi-level interventions (namely micro-, meso- and macro-level) that may be useful to control the climate change related outbreak of infectious diseases especially dengue and diarrhoea/cholera in the megacities of the Indian sub-continent and in other developing regions of the world.

South Asia Summer Monsoon Climate: Recent Past and Future

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Keywords

South Asian Monsoon – Regional climate modelling – Indian Climate – Regional climate scenarios

Abstract

Climatological features associated with South Asian summer monsoon is examined on intrannual time scale by Max Planck institute for meteorology (MPI) regional climate model REMO with a focus over India. Three simulations were performed, one forced by ERA15 for the period 1979–1993 and for the other two simulations boundary condition were obtained form ECHAM5/MPIOM IPCCAR4 runs for the period 1970–1999 and 2070–2099. The simulated climatological features of the summer monsoon compared well with reanalysis data and observations. The complex topographical precipitation pattern, and the mean annual cycle of precipitation and 2m-temperature are well simulated by the model both over model domain and over the India. Over model domain (India) schematic cold bias is noticed during the winter up to 10 °C (20 °C) and mean JJAS monsoon precipitation is 10 % less simulated by the model over India, when compared to observed. Future simulations shows that mean monsoon precipitation is likely to be increased by 13 % with a wide spread warming reaching up to 5 °C.

The Role of Central and High Asia in Northern Hemisphere Short-Term Climate Variability – A Palaeoclimate Perspective

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Keywords

Central Asia – Aeolian dust – Short-term climate variability – Glacial-interglacial – Loess – Palaeoclimate

Abstract

Past and present climate dynamics, i.e. large-scale ocean circulation and coupled synoptic atmospheric circulation patterns, associated with the Eurasian continent are well studied and receive ongoing scientific interest. However, the impact of interhemispheric-scale climate variability on the entire Eurasian landmass, as well as the self-generated effects of the continent on the global climate system, is still a matter of considerable debate. While western Atlantic polar and tropical air masses penetrate into the continent and are modified and transformed as they cross Eurasia, the interior regions of Eurasia strongly influence Earth's climate system. Significant cooling and heating of Central and High Asia (Tibetan Plateau) drive interactions between atmosphere and ocean processes and regulate teleconnection patterns of the Northern Hemisphere.

This paper utilizes high resolution particle size analyses from the Central Asian loess sequence at Remisowka, Kazakhstan, to reconstruct the dynamics of past synoptic atmospheric circulation patterns and aeolian dust transport within interior Eurasia since the onset of the last interglacial period. The observed dynamics in aeolian dust transport (particle size record) closely mirror $\delta^{18}O$ and fine dust variations seen in Greenland ice cores, suggesting a correlation with short-term climate oscillations (Dansgaard-Oeschger – DO events) recorded therein. An Asian origin of fine aeolian dust preserved in Greenland ice cores has been discussed previously (e.g., Mayewski et al. 1994, Science 263), and recent papers reveal a close link between Central and East Asian aeolian dust dynamics and DO events recorded in Greenland ice cores. The onsets of individual DO events were slightly preceded by decreasing Greenland dust deposition (e.g., Steffensen et al. 2008, Science 321).

In this context, our data represent the first Central Asian aeolian dust record in which DO events are recorded, providing a means to verify hypothesized links between short-term climate variability recorded in Greenland and associated climate dynamics at Asian dust source areas. Ultimately, the data extend existing theories, suggesting that the Central and High Asian mountains are a crucial element within the sensitive glacier-desert-dust response system in interior Eurasia and may be considered a pacemaker of suborbital global climate changes and an initiator of abrupt climate oscillations in the Northern Hemisphere.

Meteo-Ocean Forecasting System – First Phase

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Keywords

Weather forecasting – Wave forecasting – WAM – HRM – Surface wind field – Operational forecasting – MPI

Abstract

There may be many individual models, which are used in met-offices for forecasting weather and wave condition. Any model runs with its own method with pre and post processing programs without any integrated management, which leads to more complicate installation and maintenance. The idea of this research is to develop a fully integrated meteo-ocean forecasting system to fulfill needs of forecasters. The package should provide a flexible platform to be able to take advantage of different meteorological and wave models. The designed system consists of meteorological model, wave model, circulation model, backbone network, manipulation engine, Linux cluster, post-processing package, products website and verification software. Eech part, works consistant with other parts and comunicates with them trough shell scripts and utility programs. Everything from recieving boundry conditins to publish in web server is automated.

Every year, several storms hit ports, coastal infrastructures, and coastal cities along the shoreline of Caspian Sea and causes damages and economical losses to human and nature. Therefore, in this study, an operational real time wind and wave prediction system for Caspian Sea region has been developed as the first phase of the Iranian Meteo-Ocean System. As an accurate wind field plays an important role in wave prediction, we took advantage of a high resolution numerical weather prediction model HRM, which is developed by German Weather Service (DWD). The model receives boundary conditions sent by DWD four times a day and runs at 11 km grid size. This system uses WAM4.5 wave model which is parallelized with MPI as part of this study. Whole system was set up at Iranian Meteorological Organization Linux cluster. The output of both models is accessible to every client, from forecasters to engineers, by using a well developed and efficient website. Users can easily view the latest forecast or archive of products for different wind or wave parameters in the form of maps, time series, spectra and, etc. An on-line verification system is also developed in order to evaluate performance of models. Comparison of the model results for a number of events with Synoptic stations and buoys measurements proves reliability of the system as tools for different national and local user groups. The developed components of the system would prepare a basis for decision makers to manage threats because of sea and define better strategies to construct necessary infrastructures and avoid future lost in this regard.

Highly Resolved Climate Change Simulations for the Jordan River Region

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Keywords

Climate change – GCM – RCM – MM5 – RegCM – Jordan River

Abstract

The Jordan River basin is located within the climate zone of the Eastern Mediterranean (EM). The region is considered to be among the most vulnerable to global climate change effects. Projections of future climate conditions, particularly of future spatial and temporal distribution of temperature, precipitation and other climate parameters, are a central prerequisite for the delineation of adaptation and mitigation strategies. Climate change projections produced in usually coarse resolution global climate change simulation experiments in accordance with different emission scenarios are available. Due to the role of small-scale physical processes in controlling the climate in the EM region, results of the climate change simulation experiments with global climate models have to be downscaled to higher spatial resolutions to account for regional and local climate patterns.

Under the GLOWA Jordan River project, transient runs of the regional climate models MM5 and RegCM3 from 1961 to 2060 are performed to simulate the regional climate change over the Jordan River area. The main focus of the effort is set on the delineation of uncertainty ranges and the statistical analysis of extreme events as well as on provision of highly resolved meteorology data from the RCM runs as input data for subsequent impact analysis. The spatial resolutions of the RCM simulations are 18 km and 25 km, respectively. The regional climate change simulations are driven from the lateral boundaries by the data from global experiments with HadCM3 and ECHAM5 general circulation models (GCM). The use of the ensemble of two different RCMs in the experiments driven with data from two GCM experiments allows for consideration of model uncertainty of the model estimates.

The poster illustrates the modeling approach and presents the results of comparison of the simulated regional climate with the observational-based reference data for the years 1961–1990 as well as the simulated changes during 2031–2060.

GENERAL ASPECTS

"One Size Fits All?"Can the IPCC Serve as Blueprint for Scientific Advice on Adaptation to Climate Change?

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Keywords

Science policy interface – Integrated assessment – IPCC – Impacts – Adaptation

Abstract

The Intergovernmental Panel on Climate Change (IPCC) became a blueprint for the science-policy interface at the global level. Different initiatives to set up a powerful international scientific body for providing scientific advice for biodiversity governance (such as the Millennium Ecosystem Assessment or the IMoSEB) were launched with the goal to become an "IPCC for Biodiversity."
In this paper I ask what lessons can be learnt from the IPCC experience for setting up scientific advice on adaptation to climate change.
Based on insights of science and technology research I argue that the debates have too often been narrowed over the last couple of years, sometimes because of an obsession with the IPCC model. It remains contested, for example, whether adaptation policies require more accurate and specific predictions from climate models.
The paper is based on a review of the social science research on the IPCC in particular and global environmental assessments in general. It also draws on an analysis of current stakeholder consultations funded by the German Federal Ministry for the Environment (BMU) and the German Environmental Agency (UBA) that will feed into the formulation of the National Strategy on Adaptation.
Based on lessons learnt from these political initiatives we point out why the IPCC approach to provide a united, authoritative scientific voice to inform decision makers does not fit to address the particular challenges of adaptation. There are considerable concerns whether these efforts will succeed at all and whether the specific needs of adaptation can be addressed properly. By going beyond this model we try to opening up the debates towards alternatives that are both politically more feasible and at the same time more appropriate to the needs specific of adaptation policies at different levels of decision making.
We discuss what the plurality and diversity of information needs, knowledge and framings can have for consequences for governance. We demonstrate what alternatives exist and what the trade offs between different options are in terms of saliency, credibility, and political legitimacy.

Climate Observations under Global Coordination and National Contributions

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Keywords

Earth Observation – Global Earth Observing System of Systems – GEOSS – Group on Earth Observations – D-GEO – Global Climate Observations

Abstract

Mitigating the negative effects of anthropogenic climate change requires an understanding of the climate system at global and regional scales. The corresponding models must be driven and validated using comprehensive observations of all components of the global climate system. The Group on Earth Observations (GEO) is committed to build a Global Earth Observing System of coordinated Earth observation systems (GEOSS). GEOSS will strengthen the societal benefit from Earth observations in general, including observations of the climate system. The Global Climate Observing System (GCOS), sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the United Nations Environment Programme (UNEP), and the International Council for Science (ICSU) leads the implementation of GEOSS in the domain of climate observations.

GCOS and GEOSS are built from contribution of their sponsors, including contributing international organizations and national member states. Germany strongly supports the implementation of coordinated systems of Earth observations in GCOS and GEOSS. These systems are essential for knowledge based decision making in the context of climate change. No single country is able to provide observations of all relevant parameters with the necessary global distributions. To better structure its contributions and participation in GEOSS, the German government has created a standing working group, D-GEO. Its members are federal agencies and research institutions with substantial involvement in Earth Observation activities.

This paper will highlight the national contributions to global climate observations in the framework of the relevant European and global initiatives.

Climate Change Adaption Technologies: A Four Step Methodological Framework

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Keywords

Climate Change adaption – Adaptation technologies – Regionalisation – Renewable energy planning

Abstract

Despite mitigation efforts to reduce greenhouse gas emissions, it is clear that Global Climate Change will not be stopped from unfolding throughout the 21st century. Adaptation will be needed to avert the most threatening impacts of Climate Change. To make adaptation work, there is a pressing need for a concerted effort of all parts of society to act. For a successful implementation of newly developed adaptation technologies and strategies, communication, education, awareness building and knowledge transfer are vital. Based on a comprehensive literature review four areas of research were identified and analysed which shall lead to a four-step approach:

A) **SPECIFICATION**: Climate Change adaption research needs to 'translate' expected regionally specific effects of Global Climate Change. It needs to analyse the resulting trends, constraints, opportunities and innovation potential in key resource areas. Second, it needs to develop sustainable and commercially viable solutions in the technological and socio-economic realm in regard to present and future challenges. In practice, this is NOT another climate change modelling approach. Rather, IPCC scenarios are applied to the physio-geographical and the socio-economic realms of a certain area. Regional climate models and socio-economic scenarios are analysed and applied to specific physical and societal contexts.

B) **GOALS**: Sustainability goals need to be defined, implemented and evaluated. This may be broken down to different key areas or topics such as LAND, WATER, ENERGY or SOCIETY with the aim to i) addressing the climate change impacts, ii) evaluating the risks and opportunities and iii) developing appropriate adaptation technologies and strategies in the identified key areas.

C) **INSTRUMENTS** are needed for i) data collection, analysis and evaluation; ii) technical counter measures where appropriate; as well as iii) developing innovative approaches for participation, communication and knowledge transfer of research findings and innovations.

D) **KNOWLEDGE TRANSFER** needs to disseminate scientific findings and to communicate adaptation strategies developed to all parts of society in an understandable, yet scientific sound way.

Based on a critical meta-study of scientific publications and reports in regard to ongoing and planned climate change adaption strategies and plans, we demonstrate that the development of adaptation technologies needs to take place in anticipation, before impacts will occur. Although planning for an uncertain future entails a delayed return on investments, these risks need to be taken if current quality of life and economic prosperity should be maintained. Several studies are highlighted and complemented with the results of own studies in Renewable Energy planning.

Based on this literature survey it was found that no comprehensive climate change adaption methodology exists and we elaborate the status quo of worldwide research and in particular estimated timeframes for the four-step approach outlined above. We conduce to this methodological development with providing a clear conceptual ladder from i) gaining the understanding of the precise nature of regional and local expressions of climate change impacts to ii) developing and assessing adaptation strategies to iii) development counter measures and to iv) dissemination, requires considerable effort and time.

Bridging the Information Gap between Developed and Developing Nations – How Online Climate Conferences Contribute to the Global Exchange of Climate Information

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Keywords

Climate change – Information gap – Online conference – Knowledge sharing – Capacity-building – Adaptation

Abstract

There is a perceived need to foster knowledge sharing about climate change (CC) among researchers, authorities, business, schools and universities as well as the general public especially for the developing part of the world which often lack financial means and access to latest climate know-how. Yet, although much is written and spoken about Climate change at scientific circles, little information filters through to the other levels. Therefore, providing accessible information is a key especially in terms of engaging young people such as students, i.e. future professionals, in the search for local solutions for a problem which has global dimensions.

Communicating climate change is not an easy task, as there are barriers to raising awareness of the complex concept, such as misconceptions, limited access to know-how, lack of resources etc. Also, a person's attitude towards climate change – influenced by one's knowledge, personal background, former experience level, perception, values and the context it's placed in – does matter. A strategic approach to effective communications should therefore comprise not only raising personal accountability and activating all sectors of society, but also the recording and disseminating of good practices. By addressing long-term perspectives as well as short-term implications, climate change gets less detached from day-to-day life (Leal Filho 2007:195–196).

An example for an innovative approach is the 3rd worldwide online climate conference CLIMATE 2010 (www.climate2010.net) since much can be gained by using scientific information to foster the sharing of knowledge on Climate change. The online conference is organized from 1–7 November 2010. Designed as climate-friendly event, it will present peer-reviewed papers on the particular theme of "Climate Change and sustainable Water Management", will bridge the climate debate among different communities and allow for international networking by means of many interactive elements.

New approaches like CLIMATE 2010, utilizing internet technology to meet the challenge of addressing a complex theme like climate change in a holistic way, can prove to be a valuable complement to raising global awareness about climate change in an efficient and inclusive manner. The e-conference does not claim to supersede conventional climate conferences, where you need to be physically present, and internet technology bears some restrictions in itself. However, events like CLIMATE 2010 are characterized by the unique and democratic features of the internet: knowledge is just a mouse click away, distance is irrelevant and limited resources do not matter as access to the climate knowledge pool is free.

The Role of the Carbonic Anhydrase Enzyme in the Biocalcification Processes of Corals and their Resilience to Global Climate Change

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Keywords

Calcifying marine organisms – Coral reefs – Carbonic anhydrase (CA) enzyme – Interconversion of CO_2 – Stable mineral carbonates

Abstract

The present world is facing a great problem due to climate change, presumably caused by the increased input of anthropogenically produced CO_2; therefore, it is essential to conduct research to find ways to contribute to solving this problematic issue. The response of calcifying marine organisms, especially from coral reefs – arguably among the most biologically diverse and ecologically important ecosystems on the planet – could have a potential mitigating role in buffering atmospheric CO_2. Here we report that the organic substances that participate in calcification in coral skeletons contain a carbonic anhydrase (CA) enzyme, which is a biological catalyst responsible for the interconversion of CO_2 and bicarbonate. Also, it appears that the internal physiological condition of the body of corals has precisely evolved to respond to external environmental conditions. We find that the CA acts as "keys" to control those internal conditions to enable a response to external environmental change. We also find that this enzyme works as a catalyst to accelerate the rate of CO_2 hydration for subsequent fixation into stable mineral carbonates. Therefore, the CA enzyme is considered to be key biomolecule to understand calcification mechanisms and the response of coral calcification to global climate change. Detailed characterization of this enzyme was carried out and subjected to bioinformatic analysis involving identification of similarities to other animals' proteins. The information gained from this study contributes to our understanding of calcification mechanisms of corals along with their response to climate change.

AUSTRALIA/POLAR REGION

The Arctic Environment as a Common-Pool Resource: Structure of a Comprehensive Regional Arctic Regime to Ensure Sustainability

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Keywords

Arctic Regime – Common-Pool Resource – Biodiversity – Index of Biodiversity Integrity – Appropriation – Law of the Sea – UNCLOS – Sustainability

Abstract

Current international conventions regulating terrestrial and aquatic polar environments did not anticipate the demilitarization of the Arctic and the impact climate change would have on industrialization and commercialization of the area. This increase in Arctic activity threatens to increase the rate of biodiversity loss already occurring due to ecosystem changes. This paper defines the Arctic Environment as a common-pool resource and examines the possibility of using an aggregate of environmental indicators coupled with an index of biodiversity integrity as the basis for a resource unit to measure and control provision and appropriation. It then examines the current system of Arctic Environmental governance, both 'hard' and 'soft' law regimes and conflicts. From the shortcomings of the current system, three proposals commonly found in academic literature – Oran Young's Strengthened Patchwork System; an Arctic Treaty based on the Antarctic Treaty System; and a Comprehensive Regional Arctic Regime – are examined using Elinor Ostrom's "Design Principles illustrated by long-enduring CPR institutions" as a basis for examining sustainability of proposed regimes. It concludes with policy recommendations for creating a comprehensive Regional Arctic Regime which does not incorporate the existing Arctic Council as its foundation and provides possible political scenarios which might enable such a regime to be created while creating binding regulation.

Glacier and Ground Ice as Archives of Late Holocene Climate and Environmental Change in the Russian Arctic

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Keywords

Permafrost areas – Ice wedges – Isotope records – Warming and cooling events – Arctic warming

Abstract

Ice cores are well known as one of the best climate and environmental archives and provide substantial information for the understanding of climate changes. In non-glaciated Arctic permafrost areas, ice wedges are a wide-spread type of ground ice. They are formed by the periodic repetition of frost cracking and subsequent crack filling mostly by melt water of winter snow. Therefore, ice wedges can be studied by means of stable water isotopes analogously to glacier ice. Their stable isotope composition is indicative for past winter climate conditions.

We present Late Holocene stable water isotope ($\delta^{18}O$ and *d* excess) records of glacier and ground ice from the Russian Arctic. The ice core analysed was drilled at Akademii Nauk (AN) ice cap on Severnaya Zemlya (80.5° N, 94.8° E) in 1999–2001, whereas ice wedges exposed at the coast of the Dmitrii Laptev Strait (72.7° N, 143.5° E) were studied in 2007 in the framework of the "International Polar Year" Project 15 "Past Permafrost".

Both stable isotope records differ in the temporal resolution but provide valuable paleoclimatic information. AN $\delta^{18}O$ data can be used as high resolution temperature proxy for the Western Eurasian Arctic revealing significant changes on different timescales. A long-term decreasing $\delta^{18}O$ trend does not solely reflect climate cooling but also reflects the growth of AN ice cap. Several rapid decadal-scale warming and cooling events from the 15th to the 20th centuries are probably caused by the internal dynamics of the Arctic climate system.

Ice wedge $\delta^{18}O$ data exhibit a distinct Late Holocene winter warming trend in North-Eastern Arctic Siberia, characterised by a marked variability and several briefer maxima and minima.

Both glacier and ground ice stable isotope records show clear evidence that the last century was the warmest in the Late Holocene, reflecting the ongoing Arctic warming. This was accompanied by distinct changes in the moisture sources (visible in *d* excess), probably related to changes in the atmospheric circulation patterns and/or sea ice dynamics.

EUROPA

Analysis of the Effects of Water Management Options for Large, Agricultural Used Wetlands under Climate Change

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Keywords

Water management – Weighable groundwater lysimeter – Hydrological modelling – Water balance of wetlands

Abstract

In future, water management of large, agricultural used wetlands must be designed in a more flexible way in order to face increasing extreme weather situations and heterogeneous requirements of stakeholders. Within the framework of the BMBF-funded cooperative research project INKA BB water management options under climate change should be developed. Therefore, principal aims of the project are the analysis of the effects of selected water management options on evapotranspiration, water withdrawal, water discharge and water storage in the area and the development of fundamentals for flexible water management systems in the future.

Water management options in agricultural used wetlands can be the modification of storage levels (e.g. increased winter storage levels and their later lowering in spring) as well as an optimized control of water management plants depending on the actual meteorological and hydrological situation. The evaluation of the effects of adjustment options will be investigated by modern weighable groundwater lysimeters, which are located in an area typical for the Spreewald wetland. The test plant is located in the Oberspreewald, north-west of the scattered settlement Burg in the "Stauabsenkung Nord" (polder north). The results will be used for the parameterization, calibration and verification of a water-balance model for sites with groundwater levels near surface. Based on this, a scenario analysis with actual climate scenarios will be accomplished and the effects of adjustment options will be evaluated.

In the beginning of the project it will be tested, if the lysimeter-technique is suitable to simulate different water management options and to quantify their effects on water balance parameter. For this purpose preliminary tests like the recording of a storage characteristic curve are conducted. Their results should demonstrate that the required water balance parameters can be measured precise and with high temporal resolution.

The poster will show the results of the preliminary tests and the test design. Furthermore a description of the project and its integration in the framework INKA BB will be given.

Urban Sites in Climate Change

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Keywords

Heat load – Urban heat island – Urban climate model – MUKLIMO_3 – Regional climate projections – Downscaling – Cuboid method – Temperature threshold exceedance – Urban planning – Frankfurt

Abstract

For the 21st century a significant rise of near surface air temperature is expected from IPCC global climate model simulations. The additional heat load associated with this warming will especiallly affect cities since it adds to the well-known urban heat island effect. With already more than half of the world's population living in cities and continuing urbanization highly expected, managing urban heat load will become even more important in future.

To support urban planners in their effort to maintain or improve the quality of living in their city, detailed information on future urban climate on the residential scale is required. To pursue this question the 'Umweltamt der Stadt Frankfurt am Main' and the 'Deutscher Wetterdienst' (DWD, German Meteorological Service) built a cooperation. This contribution presents estimates of the impact of climate change on the heat load in Frankfurt am Main, Germany, using the urban scale climate model MUKLIMO_3 and climate projections from different regional climate models for the region of Frankfurt.

Ten different building structures were considered to realistically represent the spatial variability of the urban environment. The evaluation procedure combines the urban climate model simulations and the regional climate projections to calculate several heat load indices based on the exceedance of a temperature threshold.

An evaluation of MUKLIMO_3 results is carried out for the time period 1971–2000. The range of potential future heat load in Frankfurt is statistically analyzed using an ensemble of four different regional climate projections. Future work will examine the options of urban planning to mitigate the enhanced heat load expected from climate change.

Climate Change and Pollen in Germany and Europe

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Keywords

Climate change – Pollen – Germany – Europe

Abstract

Recent research has shown that there are many effects of climate change on aeroallergens (pollen) and thus pollen-induced diseases (allergic rhinitis and asthma bronchiale) in humans.
Increased atmospheric carbon dioxide concentration acts as a fertilizer for plant growth including pollen producing plants like trees and grasses. The fertilizing effects of carbon dioxide, as well as increased temperatures from climate change, increase pollen production in a regional level and influence the allergen content of pollen grains, too. In addition, higher temperatures are changing the timing and duration of the pollen season.
As regional climates change, plants can move into new areas and new allergenic pollen types might appear. An example is the increasing occurrence of common ragweed (Ambrosia species) in South-France, Austria, Hungary and Germany with locally high concentrations of pollen, inducing sensitization (allergen-specific IgE antibody) in children and adults and triggering rhinoconjunctivitis and severe asthma. It was documented (using nasal provocation tests) in German patients that the small amount of only 10 ambrosia pollen are able to induce severe acute reactions on the nasal mucosa.
Changes in atmospheric circulation with increasing episodes of long range transport of allergenic pollen can blow pollen- and spore-containing dust to new areas, thus introducing people to allergens to which they have not been exposed previously. An example is the transport of birch pollen from Siberia to Island, documented by pictures from EUMETSAT. The population in the region of Dresden (East Germany) is exposed to ambrosia pollen from Hungary.
Climate change also influences the concentrations of airborne pollutants, which alone, and in conjunction with aeroallergens, can exacerbate asthma or other respiratory illnesses.
The pollen season might become earlier (e.g. in trees) and longer thereby extending the period in which patients suffer from allergy symptoms. This extension of the pollen season could be due to a prolonged flowering period of certain species, e.g. grasses.
Most changes in the start and end of pollen season, and the allergenic content show regional patterns and are not ubiquitous in all Europe, reflecting possibly regional climate changes.

Future Lake Ice Covers of the Berlin-Brandenburg Area

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Keywords

Climate warming – Lake ice cover – Ice break-up – Freeze-up – Lake model FLake

Abstract

Global mean air temperature increased since the preindustrial age by 0.8 °C and will rise further from 1.8 to 4.0 °C by the end of this century. Considering that the increase on a regional scale is much larger and lakes are very sensitive ecosystems we should be able to pre-estimate effects of climate warming on lake ecosystems. Rising air temperatures increase lakes temperatures and reduce the amount of winter lake ice in the northern hemisphere. Changes in lake ice cover occurrence, duration and thickness due to warming have drastic effects on lakes, e.g. changing light levels, mixing regime, oxygen and nutrient availability, also changes in species timing, abundance and diversity in all trophic levels. One step in pre-estimating warming effects on lake ecosystems is to investigate lake ice coverage. Therefore, accurate predictions of lake ice phenology and thickness are essential.

To analyse past and future ice covers of the Berlin-Brandenburg lakes we used the one-dimensional physical lake model 'Flake'. The model simulates ice cover thickness in daily resolution using time series of meteorological parameters like solar radiation, air temperature, air humidity, wind speed and cloudiness and lake specific parameters like lake location, mean depth and turbidity as input data. Ice phenology data are derived from simulated daily ice thickness data.

FLake was calibrated and validated for two Berlin-Brandenburg lakes (Müggelsee and Lake Stechlin) differing in mean lake depth and turbidity in the period 1961–2007. The model predicts its ice phenology until 2100 based on measured meteorology data (1947–2007) from the Potsdam station and simulated meteorology data (1961–2100) derived from three regional climate model scenarios (GLOWA, RCAO, WettReg). Simulated ice data were used to investigate changes and variability in ice cover timing, intensity and duration of a representative set of lakes in the Berlin-Brandenburg area. These lakes cover the range of mean depth and trophical state of lakes in the region.

As expected, lake ice data showed that deeper and clearer lakes had more ice-free winters, later ice cover freezing and earlier ice cover thawing dates, resulting in shorter ice-covered periods and fewer ice-covered days than shallow and turbid lakes. For the past and the future we found trends of later ice start and earlier ice end, shorter ice cover duration and an increase in ice-free winters. Interestingly, FLake ice simulations revealed ice cover trends with climate warming that depend on lake depth, lake turbidity and mixing regime. Thus, lake ice coverage reduction of deep, clear and dimictic lakes is stronger than of shallow, turbid and polymictic lakes. Deep and dimictic lakes show stronger responses in lake ice to climate than shallow and polymictic lakes, which are more related to local weather conditions than to climate. Deep Berlin-Brandenburg lakes were predicted to remain ice free for the near future (ca. since 2060) according to FLake and its future input meteorology based on three regional climate models.

FLake is a good tool for forecasting lake ice phenology for lakes with different morphologies and trophic states. Modelling of lake ice is important for climate impact studies in order to predict the effects on lake ecosystems under different climate scenarios, e.g., for lake management. Thus, predictions of climate warming effects on lake ecosystems can be assessed with the help of: (i) regional climate models, (ii) physical lake models capable of predicting ice cover (like FLake) and (iii) lake ecosystem models.

Climate Change Effects on the EU-Wide Network of Nature Protection Areas Natura 2000 – A Conceptual Framework of Adaptation Possibilities

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Keywords

Natura 2000 – Adaptation strategies – Protected areas – Habitats – Management options – Future challenges

Abstract

Climate change is discussed globally and impacts on species, communities and ecosystems are widely expected. Research concerning this topic increased within the last years, including field experiments, observations and notably modelling approaches. Research on impacts on protected areas in Europe and the world is scarce up to now, although they are containing the most valuable and threatened species and habitats. However, we have to decide now how we can react on climate change and an increase of extreme weather events, to avoid or at least constrain the loss of species and ecosystems protected by nature reserves.
Natura 2000 is an EU-wide network of nature protection areas. It was established under the European Habitats Directive in 1992. The aim of the network is to assure the long-term survival of threatened species and habitats with community importance. It consists of Special Areas of Conservation (SAC) designated under the Habitats Directive and Special Protection Areas (SPA) designated under the Birds Directive. In the case of species, the so-called umbrella species have been chosen as representatives for several rare species. The selected habitats are rare and endangered habitats with a unique biodiversity.
Protected areas will be subject to extensive changes during the next decades. Therefore, a review of existing conservation techniques on their suitability for future challenges and a development of adaptation strategies on inevitable consequences of climate change are necessary and should consider national and international aspects.
Here, we present a conceptual framework of adaptation requirements and adaptation possibilities in Germany and Europe. We summarize local adaptation strategies as well as management recommendations and answer questions on where, when and how to adapt.

TERENO – A New Network of Terrestrial Observatories for Global Change Research

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Keywords

Global Change – Terrestrial Observatories – Long-term data – Subsurface environment – Biosphere – Lower atmosphere – Hydrology

Abstract

Climate change and land use changes are the most important factors of Global Change which have to be managed by the society. Changes in terrestrial systems take place at different spatial and temporal scales. In order to address the challenges of Global Change, interdisciplinary research in terrestrial environmental science is of great importance. Therefore, long-term operated Global Change Observatories for scientific monitoring, analyzing and predicting state variables and fluxes within the different environmental compartments are of special importance. Terrestrial systems are extremely complex. Despite its complexity, the terrestrial component in most process-based climate and biosphere models is typically represented in a very conceptual and often rudimentary way. Remedying this deficiency is therefore one of the most important challenges in environmental and terrestrial research. Thus long-term operated Terrestrial Observatories are an important step towards a new quality in Global Change research.

The infrastructure activity TERENO (Terrestrial Environmental Observatories), a research initiative of the Helmholtz Association, establishes a network of Terrestrial Observatories in different sensitive and representative regions in cooperation with universities and national and international organisations. The observed terrestrial system consists of the subsurface environment, the land surface including the biosphere, the lower atmosphere and the anthroposphere. Hydrological units are used as the basic scaling units in a hierarchy of evolving scales and structures ranging from the local scale to the regional scale for multi-disciplinary process studies. Four Terrestrial Observatories in Germany are currently established: the Lower Rhine Valley/Eifel Observatory, the Harz/Central German Lowland Observatory, the Bavarian Alps/pre-Alps Observatory (consisting of the Ammer catchment, the long-term research stations Hoeglwald and Scheyern and the Northeastern Lowland Observatory. Here, we will present the basic concept of TERENO.

Abrupt Climate Change: A Challenge for Climate Research

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Keywords

Geo-archives – Climate reconstruction – Dating – Rapid change – Annual laminations – Lake sediments – High resolution

Abstract

A sudden and rapid climate change is a major threat for mankind since the time to adapt to new climatic and environmental conditions might be very short. Despite the definition of regional 'tipping points' in the climate system, we are far from being prepared to the possible appearance of a really rapid change, because our still very limited knowledge about the dynamics of such shifts and their consequences for the human habitat. Major uncertainties are on (1) the velocity of rapid changes, (2) their ultimate triggering mechanisms and possible thresholds, (3) potential impacts on flora, fauna and land surface processes (e.g. erosion), and, (4) changes in frequency and amplitudes of weather extremes like floods and droughts. Another important issue is to identify prognostic symptoms preceding such shifts in order to eventually become able to establish an early warning system.

The main reason for this lack of knowledge is the absence of a major rapid climate shift in historical times that could have been observed in detail. Therefore, understanding abrupt climate shifts has to rely on the evaluation of longer time series from natural archives. Only in the last decade, enabled through the development of new methods for reconstructing past climate changes at very high resolution, we realised that in geological time scales abrupt climate shifts were more common than assumed and that they can even happen in less than a decade. A new challenge for climate research now is to bridge geological and human time concepts through integrating geological archives that enable tracing changes at human time scales. Ideal records are found in deep lakes where the conservation of annual layering provides seasonal evidence of changing environments directly within the human habitat. Counting of these layers enables a precise year-by-year measure of the timing of these changes. This paper presents new data from lake records covering different time intervals in the past and thus different climatic boundary conditions. For the first time, it was possible to measure the velocity of rapid climate shifts in the human habitat and discuss abrupt re-organisation of atmospheric circulation patterns as possible triggering mechanisms based on these data (Brauer et al. 2008).

Hence, reconstruction of past climate changes from high-resolution lake archives will significantly contribute to creating sophisticated knowledge about the nature of rapid climate changes including their triggering mechanisms, velocity, impacts, and probably even predictability.

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Return Frequency Assessment of Harmful Extreme Temperatures until 2100 in Champagne Vineyards

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Keywords

Gev and Gumbel distributions – Extreme daily temperatures – Champagne vineyard – Climate change – ARPEGE-Climate model

Abstract

Recent studies have shown that, since 1900, mean annual temperature in France has increased by an average of 0.9 °C (Moisselin et al. 2002). In the context of climate change, ecosystems as wine growing are touched by temperatures increase: phenology is perturbed and harvests are earlier since thirty years. Vineyard is sensitive to temperatures, particularly thermal extremes: it regulates vegetative cycle. Extreme are considered as a significant aspect of vineyard climate: changes in magnitude and frequency of climate extreme could have environmental and economical consequences on wine growing in future. A great interest is consecrated to simulated extremes evaluation by regional circulation models as ARPEGE-Climate model with projected anthropogenic forcing. ARPEGE-Climate model, with its variable-grid is used to investigate potential future changes (2001 to 2100) in climate extremes around Champagne vineyard.

This study permits to estimate values for 1- to 15-days return periods in using daily temperatures during sensitive moments for the vegetable: during minimum daily temperatures of budbreak in April and maximum daily temperatures in Summer. Indeed, in April extreme minimal temperatures can freeze buds, maximal temperatures in summer can grill bunches and cause damages for future harvest. Several steps are developed successively.

- The longest series of daily temperatures in Champagne vineyard (Reims-Courcy synoptic station) are used to determinate which is the more adapted law of extremes: Gumbel distribution or Generalized Extreme Value (GEV) distribution, which are adapted to meteorological and hydrological sciences. Using a theoretical distribution to fit a sample of extremes is more appropriate to describe extreme events. Extremes events are expressed in terms of returns values, estimated from a Generalized Extreme Value distribution fitted daily extremes during significant periods for vineyards. The probability weighted moments method is used to estimate the parameters (location, scale and shape parameters) and quantiles of GEV distribution (Lubes & Masson 1991). The GEV distribution combines the three possible asymptotic extreme values distributions (Jenkinson 1955).
- Return frequency of extremes temperatures are studied on the control period (1950–2000) with the comparison between Reims-Courcy (reference station) and four grid points of ARPEGE-Climate model, which are included in Champagne vineyard. The ARPEGE-Climate variable resolution grid demonstrates its usefulness in regional climate impacts studies: its resolution is of about 50 km on France.
- Changes in extremes of daily minimum temperatures in April and daily maximum temperatures in summer are discussed under the IPCC-A2, B1 and A1B emission scenarios thanks to these four grid points.

The model simulates relatively well extremes of the contemporary climate during the period of control. On average over Champagne vineyard, cold extremes decrease in April and warm extremes increase in summer.

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Conception of Climate-Vulnerable Areas of Germany in the Past 1000 Years

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Keywords

Vulnerability – Conceptual Framework – Vulnerable Areas – Historical Climatology – Germany

Abstract

Based on the reconstruction of climate development in Germany for the last 1,000 years, a meso-scalic methodical concept is introduced to estimate human vulnerability for longer periods of time and their changing spatial impact. This concept integrates vulnerability and resilience aspects as shown in Figure 1. The occurrence of climatic stressors such as rising sea levels, droughts, temperatures extremes and floods has changed in the past 1,000 years and had distinct changing spatial impacts. Both benefiting and disadvantaged regions could be determined. For historic times, we assume that food security and therefore the maintenance of health as well as a specific economic protectionism constituted the core of human strategies of action.

The connection to be drawn to modernity is that the historic response and adaptation strategies aimed at food security and survival, i.e. health maintenance. This aspect is expressed in modern approaches of industrialised countries by parameters such as heat stress, strain from sultriness, drought, and flood hazards. The focus on health aspects in livelihood concepts provides an interesting opportunity to interrelate and evaluate historical conjunctions with modern assessments.

The long term analysis of adaptation and mitigation to changing climate for livelihood security reveals the spatial dimension on a regional scale. The introduced concept enables to understand and predict expected spatial effects of modern climate change.

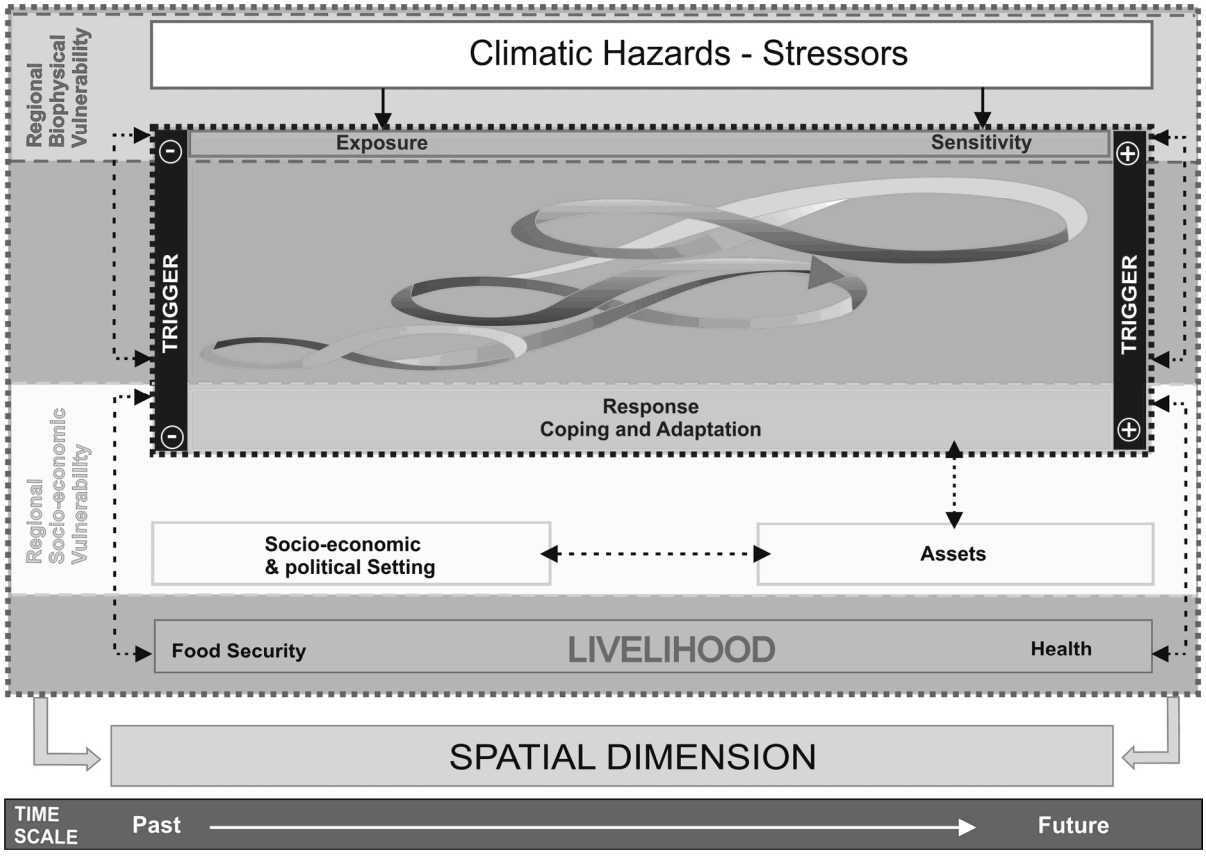

Fig. 1: Schematic illustration of the conceptual framework. Climatic stressors are linked to regional biophysical and socio-economic vulnerability via livelihood strategies. The dynamic of this linkage is considered with respect to changing spatial patterns in a long and medium-term perspective.

"Climatic Impacts on Ecosystems and Climatic Adaptation Strategies" (FORKAST)

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Keywords

Global change – Ecosystems – Grasslands – Forests – Extreme events – Experiments – Monitoring – Modelling – Adaptation strategies

Abstract

Ecosystem research regarding climate adaptation

Consequences from global changes are increasingly manifesting themselves in terms of the regional sphere. To date ecological repercussions in all their dimensions are still not completely visible. Hence there exists a sense of uncertainty regarding upcoming impacts of global and climate changes. Therewith new understanding and strategies are necessary to counter challenges we are facing in ecological systems research. Long-lived ecosystems, such as forests, grasslands and lakes can be expected to be considerably impacted by future trends and changes. These ecological systems cover a large proportion of Bavaria and carry considerable economic as well as socio-ecological significance. In the light of current climate and weather changes, the probability is steadily increasing that seldomseen and extreme climatological events will occur more often and with rising intensity. Moreover, novel forms of extreme conditions can be expected. Possible negative developments must therefore be immediately addressed with sufficient adaptive measures. Moreover, eventual positive developments should be recognised and developmental opportunities in the offing should be utilised early on.

The research cooperation FORKAST integrates climate researchers of 19 chairs and faculties from the universities of Bayreuth, Erlangen-Nuremberg, Regensburg, the Technical University of Munich and Würzburg. Central issues of interest are: How do extreme climatic conditions (e.g. drought and torrential rains) affect the characteristics of ecological systems, communities and functions? How are ecological processes, such as the production of biomass or the interaction between animals and plants, affected? How resilient are our ecological systems, like grasslands or lakes? Research results in this matter are essential prerequisites in order to evaluate how ecological services (e.g. stability of mountain slopes, agricultural and silvicultural production) will be affected.

To facilitate the realisation of these subject-overlapping and inter-structural demands, FORKAST has inter-linked research competencies of Bavarian universities with technical authorities. Up-to-date developments in methodology are continuously implemented and combined within the research cooperation. In this manner, the various qualities of monitoring, manipulative experiments and modelling (i.e. simulations) can be optimally networked. The fundamental research results within the cooperation could offer opportunities for implementation in commerce and society in, for example agriculture and silviculture, natural hazards, nature conservation, planning of spaces and water management.

Empiric Analysis of Climate Change Driven Crop Yield Changes in Germany Taking Natural Site Conditions into Account

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Keywords

Crop yield changes – Crop yield variability – Empiric crop yield models – Climate change – Agricultural economic modelling – Agricultural economic impacts

Abstract

Future changes of regional production conditions due to climate change are of great interest for farmers, agribusiness and the policy decision makers. A central issue is the uncertainty about the impact of climate change on crop yields that strongly depend on natural site conditions. This in turn determines potential adjustments in agriculture in order to alleviate climate change effects or benefit from climate change. This paper analyses empirically the relationship between climate variability and agricultural crop yields taking the natural site conditions throughout Germany into account and derive explanatory models for climate driven crop yield variations. In a second step the explanatory models are applied, to assess the impact of future climate change on crop yields. Annual crop yield data from 1995 to 2006 of a sample of about 12.000 anonymous farms that can be attributed to the municipal level (NUTS IV) are used in the analysis. A set of variables on the natural conditions of arable land such as soil quality, field moisture capacity, and climate is spatially prepared for the municipality level using GIS. Climate indicators that are relevant for the crop yield variability are derived from parameters such as precipitation, precipitation free days, phases of severe water deficit in the soil and temperature according to crop specific phenological growth phases. These indicators along with variables on natural conditions are used in regression analyses to explain the crop yield variability for homogenous sites that result from a cluster analysis with respect to natural conditions.

In first analyses empirical models are estimated for winter wheat yields. These models are able to represent the regionally different impacts of the drought in 2003 on winter wheat yields. The models are then used to simulate the effects of a moderate climate change scenario provided by the climate model STAR 2 on the winter wheat yield for the time horizon until 2060. According to the results the average sectoral yield declines by 3 % in the period from 2021/40 to 2041/60 in Germany while the yield variability increased. However, the climate impact displayed substantial regional differences with more pronounced impacts in eastern German region than in western German regions. The results of the empiric analysis provide a basis to assess the impacts of further climate change scenarios on crop yields and for an economic analysis with an agricultural economic model such as RAUMIS.

Integrative Assessment of Multicriteria Flood Vulnerability in Urban Systems: Exploring Risk and Coping Capacity with Respect to Climate Change

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Keywords

Flood vulnerability – Risk – Coping capacity – Multicriteria approach – Climate change

Abstract

The face of climate change is diverse, and its consequences need to be assessed to allow the implementation of adequate adaption measures. Water balancing is a field in which major impacts of climate change are expected. While southern Europe will need to cope with more severe droughts, northern Europe will most likely be confronted with an increased flood risk and more frequent flooding. Adaption will be necessary in a short- and long term to advance the capacity to cope with adverse flood hazard impacts. The assessment of flood vulnerability and its modification due to climate change is a cornerstone in that process of adaption.

We present an approach of modeling multicriteria flood vulnerability seeking to integrate the ecological, economic and social dimension of risk and coping capacity. We present a starting point view of vulnerability, excluding individual adaption measures at first. We extent this model towards an end point view by successively evaluating coping capacities and coping strategies for each respective dimension. The presented multicriteria approach allows the involvement of stakeholders at various stages and aims at incorporating local knowledge, which currently is a widely under-used resource. The variation of vulnerability is reviewed in regard to climate change, i.e. due to the alteration of hazard probabilities on one hand, and changes in adaptive capacity on the other.

The methodology is applied to an urban case study, the city of Leipzig, Germany. Our results show that it is possible to map multicriteria risk as well as coping capacities and relate them to each other to yield a likely magnitude of the overall flood vulnerability. Furthermore, causal relationships between risk, coping capacity and adaption are investigated as well as their relative importance under current or altered climate conditions.

Vulnerability of Biodiversity Conservation to Climate Change: The Example of Protected Areas

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Keywords

Biodiversity conservation – Conservation strategy – Climate change vulnerability – Complex systems – Protected area management – Systemic management – Adaptive management

Abstract

Biodiversity conservation can be described as the complex endeavour of strategically deploying resources in order to abate threats to conservation targets such as populations, species, ecosystems or ecological processes and enhance their viability. For more than a century, the management of protected areas has been among the most effective conservation measures mitigating anthropogenic loss of biodiversity at least locally. Mounting evidence shows that climate change is becoming an overarching threat impacting biodiversity on top of the harmful mix of 'conventional' conservation problems.

Vulnerability of protected areas, which represent complex systems where humans (conservationists, stakeholders from land use etc.) interact with the surrounding ecosystems, is the result of the interrelated vulnerabilities of a variety of system components. Here, vulnerability is considered a function of exposure change, sensitivity and adaptive capacity. Actually, this vulnerability goes far beyond the biological or ecological vulnerability of the conservation targets. Conservation managers themselves can unwittingly enhance the vulnerability of protected areas, e.g., by inadequate spatial design, lack of priority setting and static or otherwise non-adaptive goal setting, institutional fragmentation or insufficient consideration of existing scientific knowledge.

A new index illustrates the manifold facets of protected area vulnerability against climate change and allows a semiquantitative assessment. It consists of more than 30 weighted criteria. These criteria cover directly climate change-related, management-related and conservation target-related stresses to successful conservation management. The respective indicators are scored on a scale from 0 to 2 (2 representing maximum vulnerability) evaluating, as far as available, management plans and spatial information. According to their scores, protected areas are finally assorted into three classes of low, medium and high vulnerability. The index was applied to a set of 121 protected areas representative for the German protected area system in terms of management categories as well as spatial and ecoregional settings.

Most protected areas prove considerably vulnerable: no protected area is thought to be of low vulnerability, and three quarters (74 %) turn out as highly vulnerable. Among the protected areas of medium vulnerability large protected areas (national parks and biosphere reserves) predominate over areas pertaining to the EU's highly fragmented Natura 2000 system. Those areas expected to be most affected by future climate change do not have a management plan at all (yet).

Among the stresses that contribute most to overall vulnerability are direct climate change impacts, edge effects related to small size and high level of fragmentation at several scales, and lack of an adaptive management that allows to continuously react to impacts. Ideally, adaptive management would also proactively prepare the protected area for future stresses.

Changes in management strategies could significantly lower the protected areas' sensitivity or enhance their adaptive capacity. For this purpose, static approaches and inadequate goals would have to be abandoned, spatial management scopes would have to become far more ambitious, and a more systemic and adaptive management would be required.

CORDEX: A *CO*ordinated *R*egional Climate *D*ownscaling *EX*periment

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Keywords

Regional climate change projection – Dynamical downscaling experiment – Regional climate model – Regional analyses – Climate impact assessment and adaptation

Abstract

The World Climate Research Programme (WCRP) sponsors a coordinated effort by the international Regional Downscaling community to downscale the CMIP5 scenarios, in order to provide a coordinated set of high-resolution, regional climate projections for all populated land regions of the world. This effort, referred to as CORDEX (Coordinated Regional Downscaling Experiment), involves until now more than 20 RCM groups around the world. Boundary conditions for the CORDEX RCMs are a mandatory output from the CMIP5 core integrations. CMIP5 and CORDEX are envisaged to provide the majority of new climate simulations to support the IPCC AR5 process.
The main goals of CORDEX can be summarized as follows (text partly from the CORDEX homepage, http://wcrp.ipsl.jussieu.fr/RCD_Projects/CORDEX/CORDEX.html):

- Provide a quality-controlled data set of downscaled information for the recent historical past and 21st century projections, covering the majority of populated land regions on the globe. The information will sample uncertainties in Regional Climate Change associated with (i) varying Global Climate Model (GCM) simulations; (ii) varying greenhouse gas (GHG) concentration scenarios; (iii) natural climate variability; and (iv) different downscaling methods.
- Define a common set of Regional Climate Model (RCM) domains for dynamical downscaling and define a standard set of variables, frequency and format for output and archival at a number of CORDEX data centres.
- Coordinate a range of RCM simulations for the defined domains, forced by analyses of observations (currently ERA-Interim) to provide a benchmark framework for model evaluation and assessment. This exercise should include also statistical downscaling (SD) methods.
- Encourage and coordinate the development of Regional Analysis and Evaluation Teams to; (i) Evaluate the ensemble of RCD simulations, (ii) Develop a suitable set of regionally-specific metrics for RCD evaluation, (iii) Collect suitable observational data to evaluate high-resolution RCD simulations and (iv) Design experiments to investigate the added-value of RCDs and target future priorities in RCD research.
- Provide support and information to climate impact assessment and adaptation groups interested in utilizing CORDEX RCD material in their research.

While the base resolution for CORDEX is 50 km, eight European groups have agreed to generate scenarios on the pan-European CORDEX domain at ~10 km resolution partly supported by national funding agencies. This set of experiments will endeavor to sample the range of uncertainties. The first Euro-CORDEX runs will likely start in late 2010 or early 2011, initially using GCM boundary conditions from the ECHAM6, EC-Earth, NorESM and Hadley Centre GCM integrations.

Paleoclimatic Implications Recorded in a Late Pleistocene Dated Stalagmite, Vernjikica Cave, Serbia

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Keywords

Speleothem – Stable isotope analysis – Paleoclimate – Marine isotope stage (MIS) 5 – Balkan – SE Europe

Abstract

Mid-latitude speleothems often contain detailed, high-resolution records of local and regional interglacial climate changes. Several speleothem records of Holocene (MIS 1) and Eemian (MIS 5e) climate evolution have been investigated, but there is very little work being done in the Balkan region, despite the fact that the area is very rich in limestone caves with speleothems. The presented study is considered a prelude to a broad study on paleoclimatic and paleoenvironmental change in the Balkan area, utilizing speleothem records from Serbia, Montenegro and Bosnia-Herzegovina to help understand how climate has evolved during past interglacial periods and help predict the regional prospects for future climate in SE Europe.

The stalagmite of interest, collected in Vernjikica Cave, Serbia (Carpatho-Balkans), is a fine-laminated calcite stalagmite about 50 cm tall, extending conically from the base to the top, presenting at least two visible growth discontinuities. Four preliminary uranium-series ages (234U/230Th) constrain the general period of growth to the MIS 5d to MIS 5b. Currently, no high-resolution information on chronologic aspects is available. The established paleoclimatic proxy record comprises more than 900 stable oxygen and carbon isotope analyses at a sampling resolution of 0.5 mm, including 14 lateral sampling sequences (Hendy tests).

From bottom to top, $\delta^{18}O$ values decrease from averagely -8.5 ‰ (PDB) to about -9.4 ‰. The $\delta^{13}C$ record is characterized by a gradual shift from lower values (-8.8 ‰) towards higher values (-6.0 ‰). While the $\delta^{18}O$ and $\delta^{13}C$ record exhibit differing long-term trends, simultaneous high frequency shifts occur that coincide with pronounced accumulations of denser and darker laminae. Stable isotope results of individual growth layers (Hendy tests) show in eight out of eleven a considerable correlation between $\delta^{13}C$ and $\delta^{18}O$, suggesting that kinetic effects might be important. However, considering the great possibility of sampling-induced biases and that stable isotope variations along the growth axis do not show any co-variances, it is suggested that the magnitude of any potential non-equilibrium fractionation between the drip water and the calcite is not superimposing on the general, climatically driven trend.

Results suggest that the continuous stable oxygen isotope profile obtained from the axial zone of the stalagmite largely reflects the unaltered isotopic composition of the cave drip water. The observed shifts in the isotope records display long-term changing climate conditions from temperate warm and humid conditions to relatively colder and dry conditions. High-amplitude oscillations superimposed on this trend are interpreted as short warm and dry intervals during which calcite precipitation is primarily effected by non-equilibrium conditions. In light of modern synoptical scale climate in the region, it is suggested that the proxy record primarily reflects a shift in precipitation regimes, triggered by the long-term seasonal displacement and duration of the subtropical high-pressure ridge.

Climate Change Impacts on Lake Characteristics – A Pan-European Simulation Approach

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Keywords

Lake characteristics – Hydrodynamics – Turbulence model – Water temperature – Ice cover – Plankton succession – Biodiversity – Harmful algal blooms – Anoxia

Abstract

Lake stratification is to a large extend determined by regional climatic conditions. Changes in climate patterns – most prominently increasing air temperature – will lead to a shift in lake characteristics thus changing the physical basis for live in the aquatic system. Using numerical simulations with a k-epsilon turbulence model we simulate the seasonal hydrodynamics of lakes in Europe. To account for hydrodynamic differences due to lake morphometry and trophic state, we use several model lakes differing in depth (range [5, 100] m) and absorption coefficients (range [0.1, 3] 1/m), respectively. The model lakes are forced by meteorological data – air temperature, relative humidity, cloud cover, irradiance, and wind speed – given as gridded fields over Europe for current climate condition as well as for future climate scenarios. This results in several tens of thousands simulations of lake temperatures and turbulent diffusivities, from which we extract key events and characteristics relevant for biological processes such as the onset of stratification, duration of the spring bloom and timing of the clear-water phase, or ice cover duration. These characteristics provide predictions for a pan-European comparative ecology of plankton succession across the latitudinal, longitudinal and altitudinal gradients. Climate scenarios then show in which direction European lakes might shift, e.g., a dramatic decrease in ice cover duration in lakes of northern Europe, or a prolongation of stratification periods of up to 6 weeks increasing the threats of anoxia (e.g. fish kill) as well as of cyanobacteria blooms (release of toxins).

The Course of the Mean Daily Values and Changes of Air Temperature and Pressure in the Years 1920–2008 in Poznań (Poland)

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Keywords

Air temperature – Air pressure – Long term changes – Diurnal changes – Poznań (Poland)

Abstract

The climate changes belong to the most important challenges for the mankind last time. They can manifest on many different areas of our life. To see the problem from the bioclimatological point of view we can indicate two important factors which have an impact on the human life and self feeling. These are the air temperature and air pressure and their diurnal changes. The aim of the study was to investigate the course of daily values of both elements and their daily variability in Poznań (Poland) for the period 1920–2000 (the course of the air temperature). The air pressure was investigated in the period 1951–2000.

For each year of the period 1920–2008 the frequency of days with the mean temperature under 10 °C, between 20,1–25 °C, and over 25,1 °C were investigated. Furthermore the frequency of daily temperature changes between 4,1–6 °C and over 6 °C were analyzed. For the air pressure the frequency of days with the diurnal changes higher than 8 hPa during the research period 1951–2000 was investigated.

The obtained results indicate that the climate in Poznań during at least 50 years has become les friendly for the human being. The high temperature and strong diurnal air pressure changes are more often. The problem becomes more and more important because the number of people suffering on problem with health caused by weather conditions in Europe and Poland is growing.

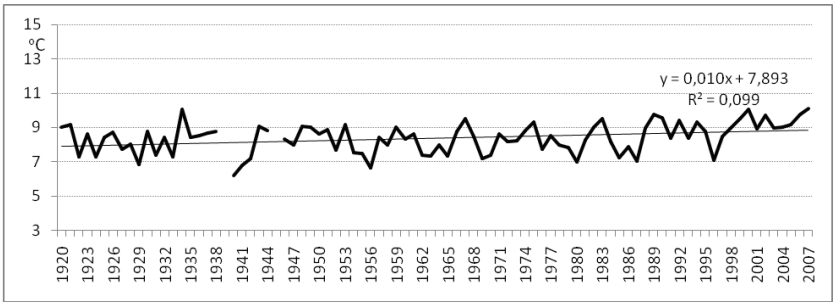

Fig. 1: The cours of mean temperature of the year in Poznań (Poland). Data from 1920–2008

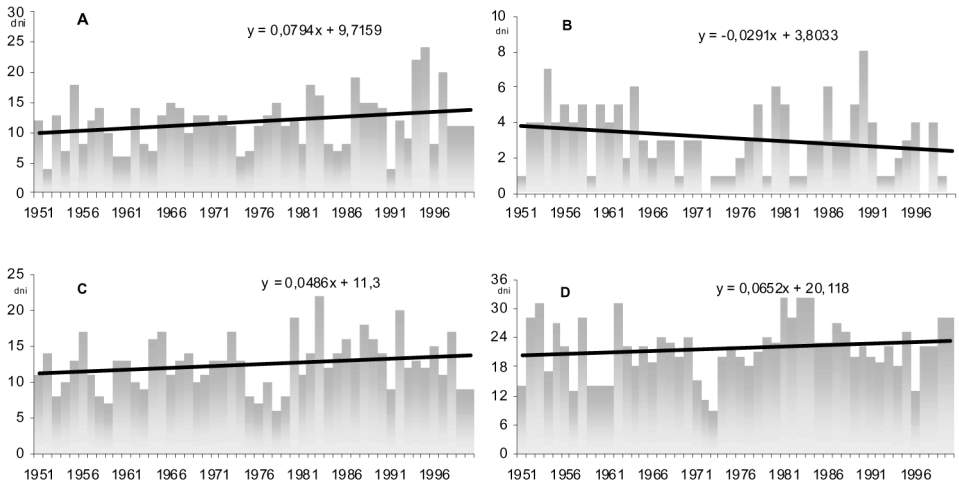

Fig. 2: The number of days with air pressure changes higher then 8 hPa for a day in Poznań (Poland). A – Spring, B – Summer, C – Autumn, D – Winter. Data from 1951–2000

From Carbon Sinks to Carbon Sources – Insect Mass Outbreaks and the Increased Risk of Carbon Loss in Forest Ecosystems

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Key words

Climate change – Mass outbreaks – Phytophagous insects – Biomass production – Forest ecosystems

Abstract

The eastern parts of Germany as well as large parts of Poland are dominated by a subcontinental/ continental climate with annual precipitation rates ranging from 430 to 640 mm. For these areas summer temperatures are predicted to increase between 1.5 to 2 °C accompanied by a decline of summer precipitation of 10 % to 20 % over the next 50 years (e.g. Gerstengarbe et al. 2003). Forests in these areas are dominated by Scots Pine *Pinus sylvestris* (Brandenburg 83 %, Great Poland 86 % of total of forested area), which is attributed to be one of the most adaptive species in areas with low precipitation, soil water and nutrient availability. Scots Pine also shows high increment rates even under adverse environmental conditions, especially in the above mentioned regions, and thus presents itself as the backbone of the forestry industry. Consequently, vast areas of eastern parts of Germany and large parts of Poland were afforested with Scots Pine and are presently pure, even aged class managed stands. However, such homogenous stands are characterised by low biodiversity and enhanced susceptibility for pest attacks. Pure stands reveal unfavourable conditions for pest antagonists and provide ample food for insect pests. The fourth assessment report of the IPCC (2007) predicts that forest perturbations such as mass outbreaks of insects will increase dramatically due to climate change such as changes in precipitation and temperature. Thus, limitations of water availability will not only affect the metabolism of plants by lowering the photosynthetic activity and thus biomass and ecosystem production (NPP, NEP), but will also increase the susceptibility of trees for diseases and insects attacks.

As yet few investigations studied the consequences of forest disturbances and their importance for biogeochemical processes in forest ecosystems. We found out that phytophagous insect mediated organic matter input under mass outbreak conditions enhance the soil decomposition activity thereby resulting in an elevated production of CO_2 and N_2O (le Mellec et al. in prep.). As a consequence, insect mass outbreaks might turn forests from carbon sinks into carbon sources due to a limited C storage in woody material and an enhanced soil induced respiration. Seeing from this point of view forest stands with an enhanced vulnerability to mass outbreaks might reveal with an increasing global warming potential (GWP).

In order to alleviate the consequences of outbreaks in forest stands and the associated monetary detriments it is indispensable to take preventive measures such as transformation of existing species-poor forest stands into site-adapted, resilient management units. In a collaborative research project, we are analysing these consequences of insect mass outbreaks in pine forests to develop tools for a sustainable forest management.

Impacts of Climate Change on Feed Value of Chosen Plants as Well as Feed Intake, Performance and Physiological Parameters of Dairy Cows and Beef Cattle

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Keywords

Climate change – CO_2-concentration – Temperature – Feed value – Ruminal degradability – Nutrient digestibility – Ruminant nutrition

Abstract

Introduction

Potential changes of climatic factors such as increasing atmospheric CO_2-concentration, rising ambient temperature and alternating precipitation patterns exhibit the capability to impact future composition and feed value of important forage plants utilized in ruminant nutrition. Effects on nutrient digestibility, feed consumption, water intake and physiology of dairy cows and beef cattle are conceivable.

Project

The research network KLIFF[1] comprises several fields investigating impacts of climate change on Agriculture and Environment focussing local implications for Lower Saxony, Germany. The aim of the subproject 2.4 is to examine potential effects on ruminant nutrition. An increasing atmospheric CO_2-concentration alters plant growth and the composition of plants [1] used preferentially for dairy cow and beef cattle feeding. Ambient temperature affects feed and water consumption as well as physiological parameters of dairy cows, whereas uncertainty exists whether it directly influences the nutrient digestibility in ruminants or only mediates an effect via alternating feed intake. Future regional drought is projected to impact growth and chemical composition of important forage plants.

Methods

FACE (Free Air Carbondioxide Enrichment) technology will be employed to assess the effects of elevated CO_2 up to an atmospheric concentration of 550 ppm and water stress on growth and composition of maize. Ruminal degradability, nutrient digestibility and implications on physiological parameters of that notional future feedstuff will be determined using rumen fistulated dairy cows and castrated male sheep. Composition and ruminal degradability of various legumes whose relevance is expected to increase as a result of climate change will be investigated. The impacts of ambient temperature and relative humidity on feed and water intake as well as animal performance will be quantified in a long-term study. The data will be used to deduce equations for estimation of the mentioned parameters.

References

[1] Weigel, H. J., Manderscheid, R. (2005): CO_2 enrichment effects on forage and grain nitrogen content of pasture and cereal plants. Journal of Crop Improvement 13 (1–2), 73–89

1. KLIFF = Forschungsverbund Klimafolgenforschung – Szenarien für die Klimaanpassung, Teilprojekt 2.4, www.kliff-niedersachsen.de

Adaptation of Governmental Nature Conservation Management to Climate Change in Brandenburg (NE-Germany)

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Keywords

Adaptation to climate change – Nature conservation – Adaptation of protected area management – Vulnerability analysis – Water management – Loss of biodiversity – Natural resource management – Brandenburg – Germany

Abstract

The Brandenburg region is situated in eastern Germany and is thus expected to suffer considerable impacts by climate change. The increase of summer temperature by 3.5 °C within the past 100 years exceeds the average increase in Germany significantly. Most recently, a distinct summer-to-winter shift of the overall low amounts of precipitation during the course of the year has been recorded. Several climate change scenarios agree in that these already observable trends will continue progressing in the region. The research project **Adaptation of governmental nature conservation management to climate change in Brandenburg** is one of 24 integrated units in the joint research project **Innovation Network for Climate Change Adaptation Brandenburg Berlin – INKA BB**. This collaborative effort is shared by 20 research institutes, around 20 NGOs and more than 30 commercial enterprises. The project focuses mainly on adaptation of water management, land use practices and network development in the region of Brandenburg and Berlin.

In the field of nature conservation there is a clear need for action to adapt targets and goals as well as general approaches and methods in order to effectively face the challenges of environmental changes. Based on detailed vulnerability assessments of protected areas and their conservation targets (species, habitats, ecosystems and their services), a strategic and proactive management will consider the spatial design of protected areas in the landscape (matrix), tries to improve the connectivity between them and promote more integrative and cyclical approaches (see Figure 1).

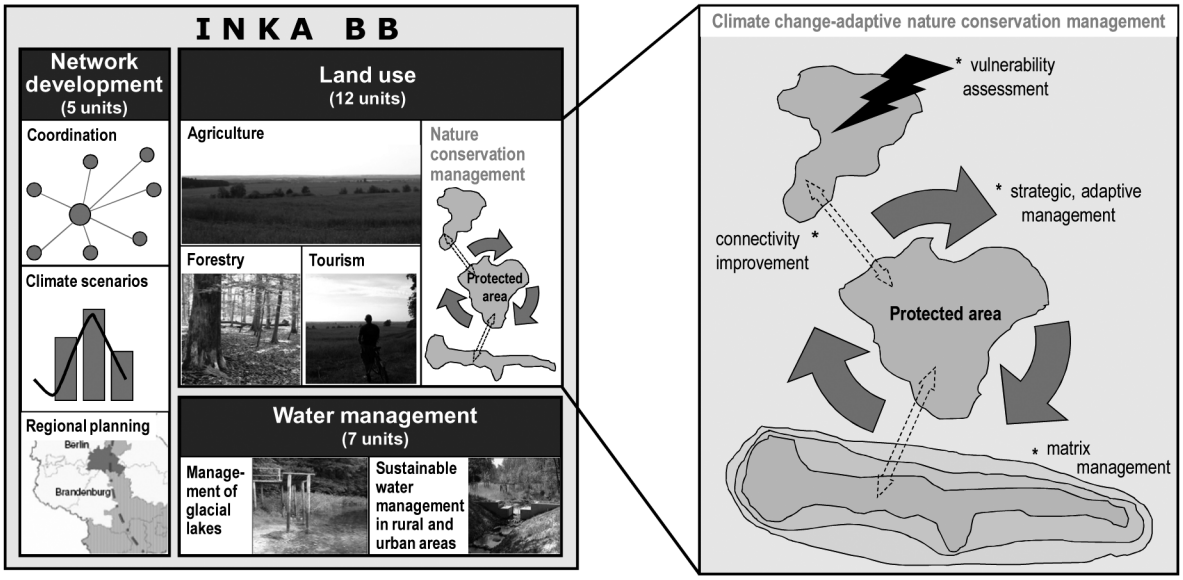

Fig. 1: left: three fields of action of "INKA BB"; right: important aspects of climate change-adaptive nature conservation management

Effects of climate change are to be minimized particularly by increasing the resilience of species, habitats and ecosystems. Prioritization of ecosystems, which function as carbon sinks (especially peatlands and forests), contributes to the mitigation of climate change and at the same time helps to enhance hydroclimatic resilience at a landscape scale.

The project will be realized in close cooperation with partners from the public conservation sector and lasts from 2009 until 2010, optionally until 2014. Among the concrete products there will be practical management guidelines for practitioners and decision makers.

German Experience in Establishing a National Adaptation Framework

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Keywords

National adaptation strategy – Adaptation measures – Implementation – Governance – Actor-networks

Abstract

The German Federal Government resolved in its 2005 Climate Protection Programme to initiate the necessary steps for development and implementation of a comprehensive national concept on adaptation to climate change in Germany. Allocating responsibilities in the shaping of federal policy and carrying out adaptation measures require close cooperation between the federal government and federal states. For this reason the Conference of the German Federal and State Environment Ministers decided in spring 2007 to support the federal government in its efforts to identify and implement a German adaptation strategy.

The road to this decision as well as the current and future process to identify this national adaptation strategy can be considered as a governance process. A lot of actors on different levels and from different sectors participate in this process, among them the German Environment Protection Agency represented by its Competence Centre on Climate Impacts and Adaptation (KomPass). Based on its scientific analyses KomPass gives technical and conceptual advice to the German Federal Environment Ministry in the work on the German adaptation strategy and acts as a central office for coordination and implementation of the strategy.

Information given in this abstract has not emerged from an analytical scientific study but should rather be considered as a report on climate adaptation practice in Germany from the Agency's prospect. This contribution attempts to reflect and to assess our daily work as a part of a governance process with a view on recent developments in Germany.

Governance approaches include quite a few aspects: several theoretical orientations, the multi-level problem regarding to political decisions, governance can deal with specific themes as environmental governance, and particularly the relationship between formal and informal networks. We want to make and discuss a case that informal occupation in actor-networks supports and speeds up formal processes.

For five years KomPass has operated an informal network with representatives from environment offices and agencies of the federal states for the purpose of, firstly, join together sectoral and regional results on climate change, impacts and adaptation projects as well as R&D activities, secondly, learning about requirements and concerns of its partners and taking them into account in the centre's work on the German adaptation strategy.

As a result the network partners had developed a general – informal – agreement among the need, objectives, means, necessary framework and procedures which could support regional as well as national adaptation processes by a time the national process has been launched. In contrast to environment offices and agencies the task of establishing a national adaptation strategy emerged as a rather "new" task for the most of other ministerial administrations on the federal as well as the state level. Up to now there were no comprehensive discussions about the content of the strategy outside the Ministries in charge of key vulnerable sectors. On the one hand the process has been clear and straightforward during the first phases (e.g. gathering knowledge base). On the other hand it decelerates current process phases (identifying key questions and agreeing action), especially at the national level. As the German adaptation strategy should help make adaptation management an integral part of all fields of policy and action the challenging work for the current and further phases (e.g. implementing) will be to combine the ongoing formal processes with informal meetings, workshops and expert discussions, preferably focussed on intersectoral or crosscutting issues of relevance.

Natural Climate Variability During the Last Two Millennia in the West Eifel Volcanic Field, Germany: Quantitative Reconstruction of Climate Dynamics Based on High Resolution Stable Isotope Time Series

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Keywords

Stable isotope time series – Natural climate variability – Peat deposit – Climate archive – West Eifel Volcanic Field

Abstract

Environmental and climatic conditions particularly determine the development of ecosystems, including the development of human livelihood. Following the Intergovernmental Panel on Climate Change, there is strong evidence that most of the warming observed over the last 50 years is attributable to human activities. The most important questions in this context are: To what extent do human activities contribute to climate change observable at global and regional scales and what part of climate dynamics is due to natural processes? What was the natural decadal to centennial climate variability during the late Holocene? While decadal climate variability can be estimated with some confidence from existing instrumental observations, estimation of the structure of centennial variability is strongly limited due to the shortness of the instrumental record. Little Ice Age, Medieval Warm Period, and the Migration Period are examples for centennial natural climate variability. Detailed knowledge about strengths and magnitude of longer time scale natural climate variability is a prerequisite to estimate present-day human impact on climate. Only if the temporal and spatial patterns of natural climate variability are known in detail, the climate change detection and attribution problem can be fully addressed (International Ad Hoc Detection and Attribution Group 2005, and references therein). Peat deposits are terrestrial archives of environmental changes and climate dynamics over time. They are widely distributed and cover a large part of the earth's land surface often within human habitat and, thus, form an excellent basis for evaluating ecosystem and climate dynamics by multiple geochemical and biological methods. We present results from an ongoing study at "Dürres Maar", Germany (Moschen et al. 2009). High resolution records of the stable carbon and oxygen isotope composition of Cellulose chemically extracted from distinct Sphagnum plant components are presented. Time series of stable isotopes reflect transitions between wet and dry bog surface conditions. Over centennial timescale, air temperature during the growing season has been assumed to be the most important driver for bog surface wetness (e.g. Barber & Langdon 2007, Charman et al. 2009) enabling to attempt a temperature reconstruction of the growing season at Dürres Maar. In summary our results give evidence of a direct response of the peat bog plant community to natural environmental and climate dynamics during the last 2000 years.

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Estimating Changes in Extreme Climate in Europe: Selected Methodical Aspects

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Keywords

Temperature – Precipitation – Climate extreme – Europe – Time series analysis – Risk analysis – Bootstrap resampling – Monte Carlo experiment – Hypothesis test – Lower Saxony – KLIFF project

Abstract

Estimating the future risk of extremes in the climate system (temperature, precipitation) has a high socioeconomic relevance: heatwaves and floods may lead to thousands of fatalities and billions of EUR economic damages. Estimating the climate risk is also a scientific challenge, owing to the scarcity of documented events (extremes are rare) and the nonstationarity of the problem (with climate changes also risk changes may come). Here we study methodical aspects of statistical estimation of risk changes and analyse past observations from, and future climate model projections for, the European continent. First, statistical tests help the analyst to reject or accept the null hypothesis of time-constant rate of occurrence of an extreme (probability per time unit). We compare the test after Mann and Kendall with the test after Cox and Lewis by means of Monte Carlo simulations and show that the latter has a clearly higher power (detectability). Second, we outline the advantages of nonparametric risk estimation with kernel functions and bootstrap resampling, which permit construction of confidence bands for the estimated occurrence rate. Third, we explore methods of climate model bias correction based on data pairs of observations and model output. The correction is shown to depend not only on the variables analysed, but also possibly on the extremal data type (peaks-over threshold, block extreme, percentile). We present an analysis of changes in extreme precipitation in the Lower Saxony region for the interval from mid-19th century to the end of the 21st century (KLIFF project).

Coastal Protection of Lowlands: Are Alternative Strategies a Match to Effects of Climate Change?

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Keywords

Climate change – Sea-level rise – Storms – Storm surges – Waves – Wave overtopping – Flooding – Coastal protection strategies

Abstract

The expected changes in global climate and the consequently resulting acceleration of sea-level rise require a thorough reevaluation of coastal protection strategies in many parts of the world. This requirement yields also for the lowlands at the southern North Sea coast in Europe which are protected by a line of dykes since about 1,000 years. The anticipation of an accelerated sea-level rise due to changing climate has raised the question if this strategy of keeping the line will still be appropriate or if alternatives should be taken seriously into consideration. This yields the more since furthermore a number of secondary effects will lead to stronger loads on coastal protection structures: increasing intensity of storms and consequently higher set-ups of storm surges create as well larger water depths in front of coastal structures as the delayed adaption of tidal flat levels to an accelerating sea-level rise. Since wave heights and periods on flats are strongly depth-controlled any increase of local water depth is accompanied by corresponding higher wave loads on coastal structures.

Though line protection has been practised and improved for more than 1,000 years strategic alternatives are well known from the past: retreat, accommodation and moving the protection line seaward. Recently other alternative strategies like set-back of the protection line or combined protection by separate structures have also been discussed (Fig. 1). The knowledge of inevitable occurrence of climate change and accompanying effects endangering the present coastal protection system has triggered a discussion on strategic alternatives which until now has been limited on qualitative judgements in respect of most important expected effects: physical processes and costs. In order to close that gap as a first step physical effects to be expected due to presently known climate change scenarios are evaluated on a regional scale also delivering a sound basis for afterward cost-benefit evaluations: A research project on future storm surge levels and wave attack in the Ems-Dollard estuary due to expected climate change scenarios and alternative strategies for the mainland coast has been designed and approved. It has already started in 2009 and is funded in the framework of the KLIFF programme by the Lower Saxon Ministry for Science and Culture. Its major aim is to evaluate both the effect of climate change on existing coastal protection structures and the loads on alternative structures and landscape due to alternative strategies. Basing on the available scenarios on climate change downscaling to wind fields above the North Sea will take place providing wind fields in a first step. Using these boundary conditions enables modelling of storm surges and accompanying waves in a model chain up to the coastline and into anticipated flooded areas. The model results provide realistic data about the loads on landscape and protection structures. Also part of the project is a socio-economic study enabling the regional stakeholders to participate and support the project with their experience.

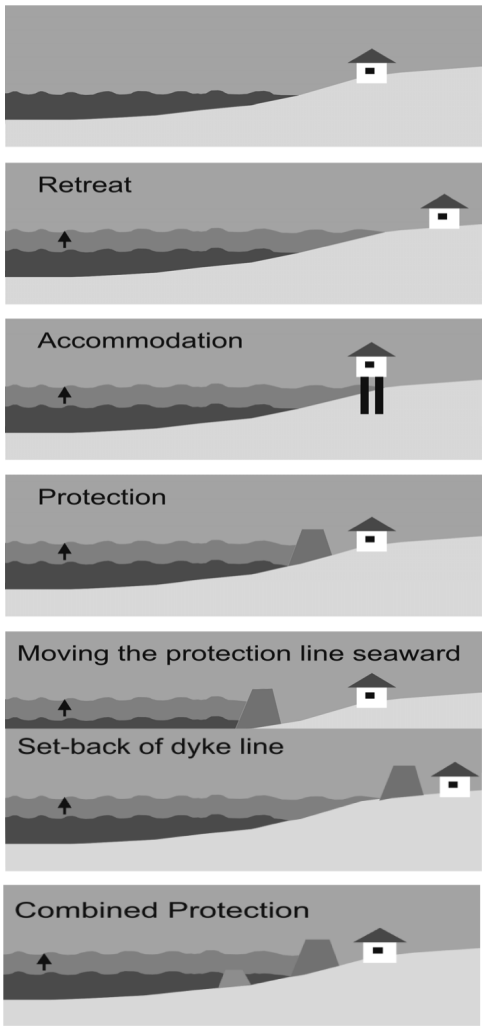

Fig. 1: Basic strategic alternatives in response to sea-level rise (based on IPCC 1990)

The Range of Regional Climate Change Projections in Central Europe: How to Deal with the Spread of Climate Model Results?

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Keywords

Regional climate modeling – Climate change projections – Spread of cilimate simulations – Robustness – Central Europe – KLIMZUG NORD – Metropolitan Region of Hamburg

Abstract

The regional climate change projections for central Europe in the 21st century show a large spread of simulated temperature and precipitation changes due to natural variability and modelling uncertainties. The questions are how to extract robust climate change signals and how to transfer the range of possible temperature and precipitation changes to climate change impact studies and adaptation strategies?
Within the BMBF funded research priority "KLIMZUG – Managing Climate Change in the Regions of the Future", innovative strategies for adaptation to climate change are developed. The funding activity particularly stresses the regional aspect since the global problem climate change must be tackled by measures at regional and local level. The focus of the joint project "KLIMZUG-NORD – Strategic Approaches to Climate Change Adaptation in the Hamburg Metropolitan Region" is to establish an interdisciplinary network between the research, administrative and economic sectors in this region.
The data on regional climate change is provided by the Max-Planck-Institute for Meteorology as input for climate change impact assessments. The cross-sectional task "climate change" is to prepare consistent regional climate data, to transfer the spread of information and to advise on its reasonable use. The project benefits from the results of the ENSEMBLES EU project, in which an extensive set of regional climate models (RCMs) was employed with a coordinated experimental design for Europe to explore model biases by systematic evaluations. The results imply the need to use different climate change simulations of several regional climate models. For impact studies, higher horizontal resolutions are required. With the regional climate model REMO, three global climate change scenarios were downscaled to 50 km with three ensemble members each, and in a second step, some members were further downscaled to 10 km for central Europe. The analysis indicates a strong natural climate variability, which further increases the range of climate change simulation results. This all recommends the application of 1. several RCMs to consider the uncertainty of downscaling methods, 2. different ensemble members of a certain climate change scenario to consider natural climate variability, 3. different global climate change scenarios to consider the influence of greenhouse gas emissions. This resulting spread of climate change information needs to be transported into impact assessments in order to develop flexible adaptation strategies.

The Role of Urban Green Spaces for Cities under Climate Change

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Keywords

Urban heat island – Urban adaptation – Urban resilience – Green spaces – Green space systems – Ecosystem services – Bioclimatic conditions – Urban climate modeling

Abstract

Urban areas suffer from special climate conditions: the urban heat island is characterised by dryness, heat and less wind compared to the rural surrounding. It is expected that these conditions will be strengthened by the impacts of climate change. This will influence the quality of life in urban areas. Heat waves and heat depending health problems are one of the big challenges in creating resilient cities.

Urban green spaces have positive microclimatic effects as an element of the ecosystem services provided. So they do have potentials to regulate the urban climate and to offer cooler places in the dense and hot city. Therefore urban green spaces should be part of adaptation strategies, which underline their relevance and importance in urban strategies dealing with the climate change.

Against the background of a research project funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety dealing with urban green space systems in climate change, current scientific findings will be presented based on urban vegetation analysis and climate modelling results according the different interrelations of green space development and urban development in climate change.

In the poster research findings will be presented regarding the (future) relevance of urban green spaces and systems in urban adaptation strategies. This is derived from quantitative evidence and information according climatic effects of urban green spaces gained from structural analysis of urban green and results of climatic modeling according determining factors of the climatic effects and relevant parameters regulating microclimate. Based on urban biotope mapping and identified urban vegetation structure types, relations between structural parameters as green volume, vegetation height and size of urban green spaces and climatic regulatory effects are presented. The potentials of different types and structures of urban green spaces and urban vegetation to influence micro- and bioclimatic conditions in urban areas affected by the urban heat island and the impacts of climate change will be described. Summarising consequences for urban planning and development will be discussed.

The contribution addresses researchers as well as urban planning authorities dealing with the potentials, challenges and approaches of urban green space development in cities under climate change.

"City 2020+" – Assessing Risks, Challenges and Opportunities for the City of Aachen Resulting from Demographic and Climate Change

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Keywords

Climate Change – Demographic change – Urban development – Urban planning – Human health – Heat stress – Air quality – Social networks – Building structures – Governance

Abstract

The City2020+ Project is part of the interdisciplinary Project House HumTec (Human Sciences and Technology) at RWTH Aachen University funded by the Excellence Initiative of the German federal and state governments through the Deutsche Forschungsgemeinschaft (German Research Foundation, DFG). This research initiative CITY 2020+ assesses the risks and opportunities for residents in urban built environments under projected demographic and climate change for the year 2020 and beyond, using the City of Aachen as a case study. We investigate how the urban environment, political structure and residents can best be adapted, with attention to the interactions among structural, political, and sociological configurations and with their consequences on human health. Europe has an aging infrastructure and an aging population. Demographers project that in the EU-25-States by 2050, 30 % of the population will be over age 65. An aging workforce and population combined with higher energy prices, environmental concern, and technological changes are likely to transform living and working arrangements. Also by 2050, average temperatures are projected to rise by 1 to 2 K, and summers in Central Europe might exhibit prolonged dry periods. Combined, Europe can expect enhanced thermal stress and higher levels of particulate matter. The confluence of demographic change, an aging infrastructure, and global warming will overburden European cities and their aging populations. Our research:

1. identifies the ways micro-climates in the city, health outcomes, and the urban environment are related,
2. assesses the risks especially older individuals face living and working in these conditions, and
3. proposes new strategies based on cooperation from the fields of medicine, natural science, demography, sociology, history, civil engineering, and architecture for adapting the city for future needs. Organized into 3 clusters, CITY 2020+ develops scenarios, options and tools for planning and developing sustainable future city structures.

First results from measurement campaigns and surveys together with commendations for adapting Aachen's urban environment for the demands of the future climate and aging population will be presented in this contribution. This includes a risk assessment for the influence of climate and air-quality factors on human health and well-being.

The Impact of Low Water Periods on Mass-Cargo-Affine Industries along the River Rhine and Possible Adaptation Options

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Keywords

Low water periods – Rhine – Adaptation – Mass-cargo – Industries – KLIWAS – Climate change – Vulnerability

Abstract

The interdisciplinary project KLIWAS, funded by the german federal ministry of transport, building and urban development, analyzes inter alia the impact of climate change on the river Rhine, inland navigation and mass-cargo-affine industries along its shores, which use inland navigation as an efficient and cheap way of transport.
One focus of this part of the project is to analyse the impact of low water periods on these industries. These impacts are well known by most intra-company specialists which organize the inland navigation transport as well as by the ship-operaters. As inland navigation depends on sufficient water levels, during low water periods the transport via inland navigation is shortened. This leads to logistical bottlenecks for mass-cargo-affine industries as their transport demand is not reduced at the same time. So during low water events some companies (e.g. some companies of the chemical industry) have to reduce or even stop their production. Due to climate change, more or more intense low water periods might occur. But contrary to for example the possible impact of climate change on public water supply, the impact on inland navigation is very rarely topic of climate impact research.
First, a brief overview on the status-quo impacts of low water levels on mass-cargo-affine industries along the river Rhine and the factors of influence will be given. Important for the magnitude of the impact of low water are for example the amount of needed goods, the prefered ship size and the storage capacity of the company concerned. Some companies very much rely on "just-in-time"-transport (e.g. car industry), which is why they only have a storage capacity of one to four days. If they also have a large share of transport via inland navigation and/or prefer large ships for this transport, they are very quickly affected by low water levels. By identifying the factors of influence, adaptation measures can be developed. The poster will show some already applied short-term adaptation options as well as other well discussed adaptation options. For these, the most important pro's and con's will be shown.
One regularly used adaptation option is, for example, to shift cargo from ship to train- or truck-transport. But as the free capacities of train-transport are very limited, especially for train transport along the river Rhine, only small amounts of goods may be transferred. This is also true for truck-transport on this route. Additionally, truck-transport is not practicable for most mass-cargo transport compared transport via inland vessel. Therefore only small amounts of time-critical or supply goods are transferred to road-transport, mostly containerised freight or, in very urgend situations, even hard coal. Another important factor is, that these transport modes leed to higher transport costs, which also limits their applyability, especially for low priced goods.
Other often discussed adaptation options as deepening the river or enlarge the storage-capacities might lead to conflicts with environmental protection or urban development. Here, an overall view of all factors may leed to applyable adaptation options. For example, if the storage capacity of companies should be enlared, one way of doing this is to establish interim storage facilities in harbours. But as harbours are often situated near town center, they are in confict with urban development, because the needed space otherwise might be used for expensive office buildings near town center. This example shows, that, if the whole picture is regared, adaptation options often have to be compromizes.

Growing Season Changes in Boreal North Eastern Finland

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Keywords

Growing season changes – Boreal forest – Frost risk – Late frost events – North-eastern Finland

Abstract

The recent increase in global air temperatures is well-documented by means of proxy and meteorological data. The former development and future prediction is explained by sustainable models like CGCM2, CSM_1.4, ECHAM4/OPYC3, GFDL-R30_c, HadCM3. These models expect a more intensive warming in high latitudes (arctic, subarctic, and boreal regions) in comparison to the world average. The amount of global warming in European boreal areas is expected to reach 3.5 - 5 K by the end of the 21st century and to an even greater extent during the winter period (4 - 7 K).

However, a more detailed analysis of the thermal conditions is necessary than the use of mean annual temperatures to allow assessments for bio- and geoecological consequences caused by global warming. Especially forest operations are affected by seasonal thermal impacts.

An analysis of the changes in the period of the growing season of six synoptic stations (Kuusamo, Pudasjärvi, Rovaniemi, Salla, Sodankylä, Suomussalmi) in north-east Finland (boreal region) is presented for the period from 1973 to 2009 (37 years).

In Kuusamo the growth period increased by 17 days on average during the mentioned period. All other analysed stations are also affected by an increasing growing season, achieving values of between 4 and 14 days. Thereby an enhancement of the trend in northern and eastern locations can be observed.

Furthermore, the annual beginning of the growing season, defined as the first five continuous days with a mean air temperature ≥ 5 °C, shifted to an earlier time. In Sodankylä the start of the growth period now occurs ten days earlier on average, compared to the beginning of observational time period. At all the other spots the shift is between 5 and 8 days.

The autumn end of the growing season changed to later dates at the most, but not all stations at the survey area. In Kuusamo the growth period shifted about 11 days towards the end of the year, while the northern stations Rovaniemi, Salla and Sodankylä showed a delay between 3 and 6 days. No changes occurred in the southern locations Pudasjärvi and Suomussalmi.

An early start of the growth period is linked to a higher risk of late frost incidents. During the presented period 1973–2009 a rise of late frost events in spring has been observed at all mentioned stations. However, no regional distribution of the increase is evident. The northern municipalities Sodankylä (+2.6 days) and Rovaniemi (+3.0 days) as well as Suomussalmi (+5.7 days) in the south were affected by the changes at most. At the other stations a rise between 0.1 and 1.7 days occurred.

Frost events causing potential damage to trees defined by a day minimum of ≤ -3 °C ascended by 0.2 to 3.0 days. Like before, the most northern and southern stations in the survey area were particularly affected.

Autumn frost events decreased at all mentioned stations in a range of 0.9 to 9.2 days with the exception of Kuusamo (+0.2 days).

Autumn occurrences of a daily minimum ≤ -3 °C decreased at all stations between 2.0 and 7.1 days. The largest decrease has been observed at the southern stations Pudasjärvi and Suomussalmi.

In summary, climate change in Finland is connected with an extension of the growing season. This extension is primarily a result of an earlier start of the growth period in spring. In this context an increasing frost risk for the forest vegetation is to be expected because of a rising number of late frost events at the beginning of the growing season or during the bud burst phase.

Experimental Study – Adaptation of Plant Glacial Relicts to a Changing Climate

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Keywords

Relict populations – Wetland – Common-garden experiment – Latitudinal gradient – Sphagnum

Abstract

The ombrotrophic mires of Northern and Central Germany are inhabited by several putatively relict plant populations, which grow closely to the southern margin of their species´ ranges (except of a re-occurrence of these species at higher altitudes of the Alps). During the pleistocenic glaciations, these cryophilous species were possibly widespread in Central Europe, with rangeshifts to higher latitudes and altitudes during intermittent periods of global warming. After the last glacial maximum (LGM), these shifts were compounded by the destruction of mire habitats by human activities, especially at the southern range margins in Central Europe. The few remaining bogs there persist as isolated habitat fragments. Today, their plant communities are exposed to harsher climatic and hydrological conditions compared to those at the centre of their species´ ranges in the boreal zones. Future climate changes appear to be a serious threat for their further existence.

The presented study focuses on the bog plant-communities of Northern and Central Germany. According to the "Rear-edge-hypothesis" (Hampe & Petit 2002) these populations experienced a comparatively long selection for tolerances of heat and drought stress, which could have resulted in several local adaptations. Therefore, the role of these habitats for the past and future evolution of the bog plant community could be crucial. They could have been the source of several colonizing events after the LGM and are a possible shelter for well adapted populations to future climate changes.

Different populations of several plant species from ombrotrophic bogs along a gradient from Northern Sweden to Central Germany are being tested in a common garden experiment for adaptations to an increasingly wartmer climate and its associated environmental changes (higher decomposition and nutrient availability). The experiment will be accompanied by molecular analyses to verify the experimental data and to reconstruct intraspecific relationships in the present bog plant-communities as well as possible colonization routes of its members after the LGM.

The expected data will allow predictions on prospective responses of bog plant-communities to climate change. It will make a case for the conservation of the few mires left in Central Europe and for other populations that occur at the margin of their species´ ranges especially if the southern populations perform better in a drier and warmer climate compared to their northern conspecifics.

Innovation Network for Climate Change Adaptation Brandenburg Berlin (INKA BB) – Development of Strategies for Land, Water and Health Management

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Keywords

Action research – Climate change adaptation – Health management – Land use – Network – Strategies – Water management

Abstract

The common goal of the Innovation Network for Climate Change Adaptation Brandenburg Berlin (INKA BB) is to ensure the sustainable use of land and water resources in the north eastern region of Germany under changing climatic conditions and empower actors in business, administration, public agencies and civil society to react on the emerging climate change with strategic flexibility. The Brandenburg region is among the most vulnerable regions in Germany to the impacts of climate change due to relatively low annual precipitation and the dominance of sandy soils with low water capacity that is combined with a high share of surface water bodies. The Berlin metropolitan area might be especially affected by more intense and prolonged heat waves, likely to cause health issues. Additionally, heavy rainfall events, with the consequence of short-term deterioration of water quality, strongly affect the wastewater management of urban areas. In general, the already predicted climate trends of rainfall decline in summer and increase in extreme weather conditions presumably lead to more climatically critical situations and developments.

It is the overall goal of the network to enable and ensure the close cooperation of science and practice partners, who through their participation in INKA BB increase their capacities to adapt to climate change.

This includes

- pro-active handling of climate change related risks and opportunities in land, water and health management,
- development and implementation of innovations and adaptation strategies with cooperation between science and practice, and
- institutionalisation of and political support for proven adaptation strategies.

The network partners are 12 research institutes in Berlin and Brandenburg, roughly 15 associations in the fields of land and water management and more than 30 private enterprises as well as a number of administrative bodies from both Brandenburg and Berlin.

The network itself is conceived as a large self-organising body of corporative actors and regional agencies. The network management designs and promotes the ongoing internal process of learning and change management. Hereby, the network partners are methodologically supported by a module that focuses on the coordinated development of adaptation strategies and strengthens the integration of practice partners. The design of the network's strategy development is based on an action research approach, applying group-based analysis and decision making instruments and methods for content and process management. Content management is based on strategic organisational development principles with iterative stages such as a) situation analysis looking at strengths and weaknesses, b) common perspective by the development of objectives and an overall mission and c) testing and evaluation of innovations as a master plan. Process management is based on observation, evaluation and intervention, where steps of reflection and self-evaluation together with external feedback are combined and orientated at the network-internal need for learning.

Thus, action research has two functions in the overall project: It ensures the common strategic approach on all network levels and at the same time it warrants service functions for the network partners with the practical support of common procedures as well as continuous reflection and feedback.

How Do Business Organizations Adapt to Climate Change? – A Conceptual Framework

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Keywords

Climate change – Adaptation – Private sector – Business organizations – Strategic management – Survey – Innovation – Metropolitan region Bremen-Oldenburg

Abstract

The project "nordwest 2050" (http://www.nordwest2050.de/), that is funded by the German Federal Ministry of Education and Research, is going to undertake a survey to analyze how business organizations in the metropolitan Region Bremen-Oldenburg cope with risks and opportunities caused by climate change. The survey is based upon a conceptual framework we want to present and to discuss at the Conference. Our aim is to broaden the view on adaptation in the private sector. The IPCC (2007) revealed that in industrialized countries several branches of economy are vulnerable to climate change and for some economic branches climate change implies opportunities. But the IPCC does not respond to the micro level and the fact that business organizations hold a diverse exposure, a diverse adapting capacity and a diverse innovation potential. Based upon our assumption, that both exposure and adaptive capacity are endogenous variables that can be modified by decision maker, we discuss six main conditions for reducing the vulnerability of business organizations and how to make use of their innovative potential:

1. *Agenda setting:* In contrast to mitigation the emerging necessity of adapting to climate change is not yet considered by the vast majority of business organizations. Whether adaptation becomes a strategic issue depends on the sectoral and regional business agenda and on proactive actors like government agencies, research or pioneering companies that set agenda.
2. *Providing strategic information:* Providing sector specific information (scenarios, indicators, data etc.) about potential hazards and opportunities caused by climate change seems crucial.
3. *Sector and company specific cognitive frames:* Managers have to deal with a diversity of strategic issues and challenges. Whether climate change becomes a strategic core issue depends on the cognitive frames of the dominant actors ("dominant logic") in a company or sector.
4. *Processing within the company:* Adaptation to climate change is always a decision under uncertainty and restricted resources. At this stage manager benchmark the relevance of adaptation through e.g. backcasting, delegation.
5. *Implementing adaptation strategies:* once climate change is evaluated as a crucial strategic issue, adaptation strategies and tools need to be developed. Here we discuss different management approaches, cooperation strategies with external partners and the role of climate change intermediaries.

Evaluation and adjustment: Here we focus on the question, to what extent "self-assessment" of business organizations is possible and appropriate and to what extent regulation and external support and monitoring e.g. by government agencies, industry associations etc. is necessary.

The Effect of Climate Extremes on Food Production Stability and Agricultural Adaptation in Europe – An Index Based Land Use/Cover Simulation Approach –

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Keywords

Food security – Climate change – Extreme event – Vulnerability – Adaptation – Europe – Simulation

Abstract

Several land use models were used to simulate the impact of global change on food security. Most of these studies emphasized on food production, without considering the other dimensions of food security (stability, access and utilization). At the same time, studies regularly encompassed climate change patterns with slow rates of change (mean values), but extreme events were rarely considered. Nonetheless, climate extremes strongly affect food security and particularly food stability.

Thus, studies focusing on food security should put a greater emphasis on questions of food stability and the impacts of climate extremes to better guide agricultural adaptations. The motivation of this study was to methodically improve a land use/cover model in order to support food security simulations under climate change conditions. The following research questions were outlined:

- Are local yield vulnerability indices (YVI), deduced from crop models, suitable to include climate extreme patterns in food security simulations?
- How would the consideration of such indices influence the results of land use/cover simulations?
- What adaptation potential (of land use allocation) would they outline to propose more stable food production systems?

The core model of our study is LandSHIFT, a dynamic land use/cover model. We use an adjusted version of CORINE1990 as base map and simulate land use/cover changes with socio-economic drivers from FAO statistics. We conduct two simulation runs with annual time steps until year 2000, one including the YVI and the other without the inclusion of YVI. The resulting land use/cover maps are then compared regarding the differences caused by the inclusion of YVI. We generate and apply the YVI to compute the adaptation potential of land use allocation against climate extremes for European food systems in general and the Mediterranean food systems in particular. Afterwards, we calculate the potential annual crop production in regard to three different climate environments from both maps. To do so, we simulate annual historic yield date for the periods 1961–1970 and 1991–2000 as well as future yield data for the period 2051–2060 with the LPJmL model from PIK. For the later period, we use climate predictions from the IPSL-CM4 model with IPCC A2 storyline assumptions. Thus, the crop yield data differ as it bases upon different climate assumptions (climate normal, recent climate and future climate). We obtain the regional YVI during a geo-statistical analysis of the yield data for each crop type (inter annual standard deviation).

We aggregate the yield data and also the YVI to average decade values for the early simulations to generate the two land use/cover maps from 1990 to 2000. In that way, the food system adapts steadily to the socio-economic drivers. We set the computed maps (1990–2000) constant and implement the original annual yield data from the three decade periods. Thus, the effect of point events (such as experienced between 1961 and 1970 or between 1991 and 2000 as well as simulated for the period 2051 and 2060) can be assessed on the production capacity for adapted systems, where the indices were applied and for not adapted systems, where no indices were applied.

The annual balance, in metric tons produced, between the adapted and not adapted food systems (of the same decade) outlines the potential that vulnerability based indices could have, to suggest more stable food production systems. Additionally, a comparison between the decades underlines the increasing need to spatially adapt food systems to increasing frequencies, intensities and spatial expansions of extreme climate events.

The IPSL-CM4 model with IPCC A2 storyline assumptions computes extreme condition for the European continent (high temperature and low precipitation) and, consequently, provides high YVI values. A comparison to simulations based on moderate GCM predictions is planned. In addition, sustainable irrigation potentials will be considered in later research stages, when the LandSHIFT model is coupled with the WaterGap3 model. Agricultural adaptation potentials (allocation and irrigation) will then be highlighted comprehensively in order to reduce climate vulnerabilities and, in turn, strengthen the stability of food production systems particularly in Mediterranean region.

Starting Adaptation of German Road Network to Climate Change

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Keywords

Road infrastructure – Adaptation – Climate change – Vulnerability – Regionalized climate data – Risk-identification – REMO – Weather extremes – BISSTRA – Brigde – Soil – Aquaplaning

Abstract

Mitigation strategies for the limitation of climate-relevant exhaust gases will buffer the implications of climate change only to a limited extend. Hence, there is an apparent need for action concerning the development and application of adaptation measures. Higher temperatures, changes in the amount of precipitation and longer periods of heat are expected to occur at the end of this century. Long-lasting infrastructure should, in a reaction to this, be adapted.

Climate change will not affect the whole world in the same manner. Climatologists have developed programs to regionalize global climate models. From the resulting maps it becomes visible that the regional diversities in climate change allow for adaptation measures which are specific to the regional circumstances.

The available prognoses on climate change, the knowledge on road-, bridge-, and tunnel construction, traffic structure and flow, together with the already known damages caused by weather events, allow for an estimation of the possible effects of climate change on road infrastructure.

In particular the soil is heavily affected by extreme precipitation . It influences the stability of foundations due to saturation with water of the terrain or the shrinkage of the former caused by a continuing drought.

Extreme weather events can impair the stability, usability, durability und traffic safety of bridge and tunnel structures and their components and features. Undercutting of the roadway, overload of the drainage facilities, aquaplaning as a result of water films on the roadway, etc. are to be expected in the area of traffic engineering due to changing climatic conditions.

It can be anticipated that increasing air temperatures can cause increasing rutting tendency of asphalt roads, rising in the number of "Blow up's" of concrete pavements, overstressing of the end slabs at crossovers (concrete/asphalt), etc.

In a first step our Federal Highway Research Institute (BASt) verifies the possible effects of climate change on road networks. The effects of Climate Change are quantified through detailed studies. With these results vulnerabilities can be identified and effective adaptation measures can be analyzed. This object-specific evaluation provides results for each single object which is exposed to the effects of Climate Change. The solution to the question where the German road network is most at risk can be obtained by overlaying regionalized climate data with the identified vulnerabilities.

By using this combination of object and network related approach critical sections of the road network (including bridges and other engineering structures) can be identified and measures to ensure the necessary high availability can be applied.

Economic Assessment and Financing of Adaptation Measures to the Effects of Climate Change in the Field of Wastewater Management

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Keywords

Economic assessment – Financing – Adaptation measures to the effects of climate change – Fee systems – Cost analysis – Decision support system

Abstract

Impacts of climate change will cause urban water management to develop adaptation measures to climate change, involving different parties and interests. Since measures generally entail costs, an integrative urban drainage system and water resource management is desirable, however, considering economic aspects to sustainably reduce costs, or, at least keep costs in a tolerable range.

This applies particularly because of long-term planning, which e. g. comprises the urban water management infrastructure. The long operation life of wastewater plants and sewer systems leads to long-term depreciation periods, making short-term adaptations hardly possible. The variable costs caused play a minor part in water management; a changed operation pattern is difficult to demonstrate.

Besides various planning areas involved in integrative urban drainage and water resource management, the question of 'who is affected?' or risk prevention for residents/users must be considered.

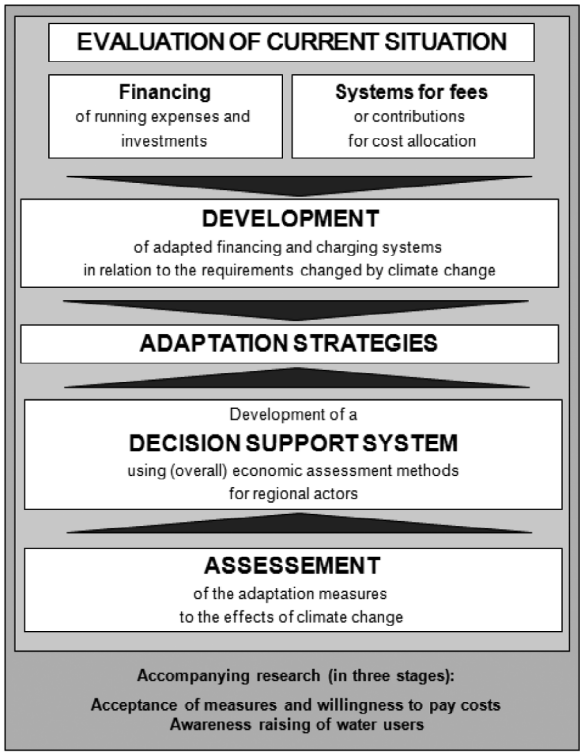

Fig. 1: Overview on work program[1]

The overview (see left) shows a part of the *DynAKlim* project work fields (*DynAKlim*, Dynamic Adaptation of Regional Planning and Development Processes to the Effects of Climate Change) for financing water management services.

Assessing measures is only possible with regard to the defined objectives, which comprise e. g. cost effectiveness, cost efficiency or a cost-benefit analysis. Prior to assessing, it is furthermore necessary to make a decision regarding the assessment and investigation periods. To be able to assess the requirement for implementing adaptation measures, the required costs for implementing measures to the effects of climate change (investment costs, operating costs) must be opposed to the expected risk of damage considering economic aspects. The risk of damage results from the possible potential for damage and the probability whether damages are likely to occur or not. The damages resulting e. g. from a flood after a heavy rain event also affect, besides infrastructure facilities and water resources, individuals, urban structures, businesses etc.

If an (overall) economic assessment leads to adaptation measures, financing must be clarified.

Basically, there are different financing possibilities. The *DynAKlim* project then verifies the guarantee of economically and socially acceptable cost distribution according to the polluter-pays principle of the required investments resulting from adaptation measures. Fees and contributions represent only one financing option. Additionally, it would be also possible to use funds or other taxes. Besides implementing adaptation measures, insurances may play a considerable role.

1. For this purpose, small changes were made to the overview. Original overview created in the course of *DynAKlim* project in cooperation with **FiW**, a research institute for water and waste management; **RUFIS**, a research institute for innovation and structural policies; **IWW**, a water center.

Efficiency Analysis of Water Retention Measures for Climate Change Adaption – Watershed Study Greifenhainer Fließ, Brandenburg, Northeast Germany

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Keywords

Small catchments – Low flow mitigation – Water balance monitoring – Hydrological modelling – Water management

Abstract

Climate models reveal a redistribution of precipitation from summer to winter months and higher monthly mean temperatures for the whole year for Germany. In northeast Brandenburg, Germany, a region which will particularly be affected by climate change, climate induced lowering of groundwater levels have been observed during the last decades. Already, rivers and wetlands within small watersheds (< 500 km²) are affected as a consequence of a declining water supply. An intensification of this situation is expected as climate models project increasing evapotranspiration. In numerous small watersheds these changes of the water balance are also expected to significantly raise water distribution conflicts between the stakeholders involved.
Imbedded into the Innovation Network of Climate Change Adaptation in the Region of Brandenburg Berlin (INKA BB) project, founded by the Federal Ministry of Education and Research, methods and tools for a sustainable water resources management in small watersheds are analysed. Therefore still not yet managed ponds of different size, a lake and a restored river segment were instrumented for the monitoring of the management effects in the research watershed Greifenhainer Fließ, an affluent to the river Spree. Measurements include water level, groundwater level and meteorological parameters in order to characterise the water balance of each reservoir. Furthermore, measured parameters are used to calibrate and validate models of the different reservoirs. These models are embedded into a model (e.g. BlueM or WaSim-ETH) of the whole research watershed to investigate the effects of the reservoirs on water retention and low water stabilisation during summer months. The consideration of reservoirs of different sizes located in one watershed should help improving the generalisation and thus leading to methods examining the retention capacity of similar reservoirs inside and outside of the research watershed. Different approaches of water management are discussed on the basis of first monitoring and modelling results.

Climate Adaptive Regional Planning in the Uckermark-Barnim and Lausitz-Spreewald Regions, Brandenburg, Germany

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Keywords

Spatial planning – Regional planning – Brandenburg – Climate-adaptive regional plan – Regional effects of climate change – Aridity – Innovation Network for Climate Change Adaptation in the Brandenburg-Berlin Region (INKA BB)

Abstract

"Climate-adaptive regional planning in the Uckermark-Barnim and Lausitz-Spreewald regions" is a sub-project of the research-network "Innovation network for climate change adaptation in the region Brandenburg-Berlin (INKA BB)". It is located at the University of Applied Sciences Eberswalde. The project started in June 2009 and will last until April 2014.

INKA BB deals with the challenge of adapting to the consequences and risks of climate change in two regions in the Land Brandenburg and also partly in Berlin. The main topics are water management and land use, especially under the focus of increasing aridity in summer and extreme rainfalls in winter.

The main goal of the sub-project is to create a comprehensive spatial strategy dealing with the effects of climate change. It shall on one hand be able to implement climate adaptation into spatial planning; on the other hand it will include and harmonize newly developed sector-specific adaptation strategies. This strategy shall in the long run lead into a multifunctional, climate-adaptive land use. The aim is to implement this strategy into the daily work of the regional stakeholders after the year 2014. Therefore working together closely with the main stakeholders of our research-regions is an important part of the project.

The workflow until June 2014 will consist of the following main steps:

- Analysis of the vulnerability and resilience of the two regions in reference to the expected regional consequences of climate change
- Modelling scenarios that show the consequences of climate change for the development of space and land use
- Analysis of concflicts and possible synergies between sectoral adaptation strategies in the project-regions
- Developing a general principle for regional planning for the project regions
- Creating new instruments and an exemplary guideline for the content, display and structure of Climate Adaptive Regional Plans as well as a transferable methodology for the development of Climate Adaptive Regional Plans
- Designing a conceptual climate-adaptive regional plan for each of the two project regions as spatial overall-strategies for land use under the new terms / conditions of climate change
- Regular cooperation, transfer of knowledge and exchange with regional stakeholders in the form of workshops, working-groups, presentation and discussion of intermediate data etc.

The project-partners are the Lausitz-Spreewald Regional Planning Authority and the Uckermark-Barnim Regional Planning Authority.

Plant Protection in Horticulture under a Changing Climate: Prospective Impacts on Pest Species and Natural Enemies

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Keywords

Heavy rains – Dry spells – Plant production – Lower Saxony vegetable crops – Plant protection – Adaptation strategies

Abstract

The climate will continue to change within the next years as it did in the last century. Important changes are related to greenhouse gases and are followed by increasing temperatures (warmer winters and nights) and changing precipitations (heavy rains and dry spells). Besides several direct and indirect large scale impacts on ecosystems it is likely that plant production is affected. The upcoming challenges under warmer climates are to adapt the production systems as well as the plant protection strategies.

In Lower Saxony vegetable crops are nowadays an important income source for many growers. Among these crops, the economically most important are asparagus with an area under cultivation of 4018 hectare, followed by lettuce (3755 ha) and cabbage (3301 ha). From the plant protection perspective cabbage is most demanding, since more then 13 varieties are grown and 30 different pest species are associated with this crop. Additionally cabbage crops are gaining greater economic importance in Lower Saxony evidenced by an increased area under cultivation in the last years and this is bound to increase in the near future.

The impact of climate change on plant protection is manifold. Besides changes in the relevance of current pest and natural enemy species it is likely that new species arrive. Additionally it has been predicted that in a warmer climate there will be more pest outbreaks and that crop associated pest species will change. For example recent observations indicate that the cabbage whitefly (*Aleyrodes proletella*), the cabbage aphid (*Brevicoryne brassicae*) and some butterflies (e.g. *Mamestra brassicae*) might become much more important pests in the future. Since the efficiency of pesticides is already limited due to pest resistance and consumer demands, conventional and biological plant protection strategies have to be adapted and developed further. Although natural enemies are in general affected in the same way as pest species by a changing climate it is likely that their importance in targeted plant protection strategies will grow in the future. It is the aim of the KLIFF-Network (KLImaFolgenForschung in Niedersachsen) to study the influence of climate change on agriculture, forestry and water management and develop adaptation strategies. In particular we will focus in our sub-project on the reaction of some of the coming pest species in horticultural crops and interactions with natural enemies under changing temperatures and precipitation.

Impacts of Climate Change on Insect Pests; A Case Study of Effects of High Temperature Pulses and Drought Stress on *Plutella xylostella*

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Keywords

Climate change – Extreme temperatures – Drought stress – *Plutella xylostella*

Abstract

Climatic changes have a great impact on plant-pest interactions. These changes include among others the rise in global temperatures, rise in carbon dioxide concentration and a rise in drought-stress due to increased evapotranspiration brought about by a rise in temperatures. More specifically, there will be notably seasonal extremes in weather changes in different regions. It is therefore expected that these seasonal changes brought about by a dynamic climate will consequently affect range distribution, development and behavior of various insect pests and their effects on the agro-ecosystems.

We investigated effects of seasonal extremes in high temperature pulses coupled with drought stress on the lepidopteron pest species i.e., *Plutella xylostella* on Brussels sprouts plants. Half of the plants were drought stressed while the rest were normally watered. This was done in four climate chambers maintained at 24, 28, 32 and 36 °C respectively.

Contrary to other studies done in constant temperatures, which have recorded hardly any egg hatch at high constant temperatures, we found that at the above extremes in temperatures, more than 50 % hatchability was experienced. Likewise, at extreme temperatures, there was significantly faster development from egg to pupation. Additionally, there was a trend for faster larval development on intermittently drought stressed plants as compared to regularly watered plants. With high temperatures and drought stress there was further an accumulation of L3 and L4 larval instars at the apex part of the plants. This is critical for the quality of the crop.

These results give a starting point on the outlook to investigate further the impact of extreme temperatures and drought stress under field conditions. Should these results be reproducible under field conditions, they will open new fields of study of the effects of climate change even on other insect herbivores pests and their respective natural enemies.

Adapting Europe's Forest to Climate Change – The Role and Perspective of Adaptive Management

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Keywords

Climatic warming – Heat – Drought – Storms – Pathogen attacks – Adaptive forestry – Management concept – Active adaptation – Passive adaptation – Experimental trial system

Abstract

Climatic warming may lead to increased or decreased future forest productivity. However, more frequent heat waves, droughts and storms and accompanying pathogen attacks are also expected for Europe and are considered to be increasingly important abiotic and biotic stress factors for forests. Europe's forestry sector is vulnerable to climate change due to the long rotation period of most of the forests. Adaptive forestry can help forest ecosystems to adapt to future conditions in order to achieve management goals, maintain desired forest ecosystem services and reduce the risks of forest degradation. With a focus on Europe's temperate and boreal zones, this paper presents the following management strategies: (1) conservation of forest structures, (2) active adaptation, and (3) passive adaptation (Bolte et al. 2009a). The feasibility and criteria for application of the different strategies are discussed. Forest adaptation may entail the establishment of ''neonative'' forests, including the use and intermixing of native and non-native tree species as well as non-local tree provenances that may adapt better to future climate conditions. An integrative adaptive management concept is proposed that combines (1) species suitability tests and modelling activities at the international scale, (2) priority mapping of adaptation strategies at the national to regional scale, and (3) implementation at the local scale. To achieve this, an international experimental trial system is required to test suitable adaptive measures throughout Europe and worldwide (Fig. 1, Bolte et al. 2009b).

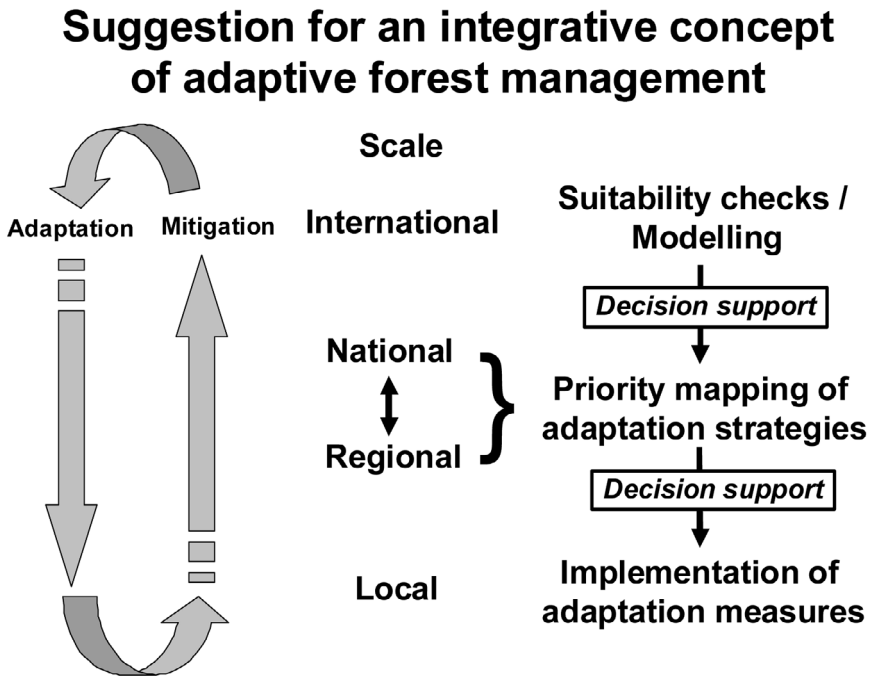

Fig. 1: Integrative concept of adaptive forest management (Bolte et al. 2009b)

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