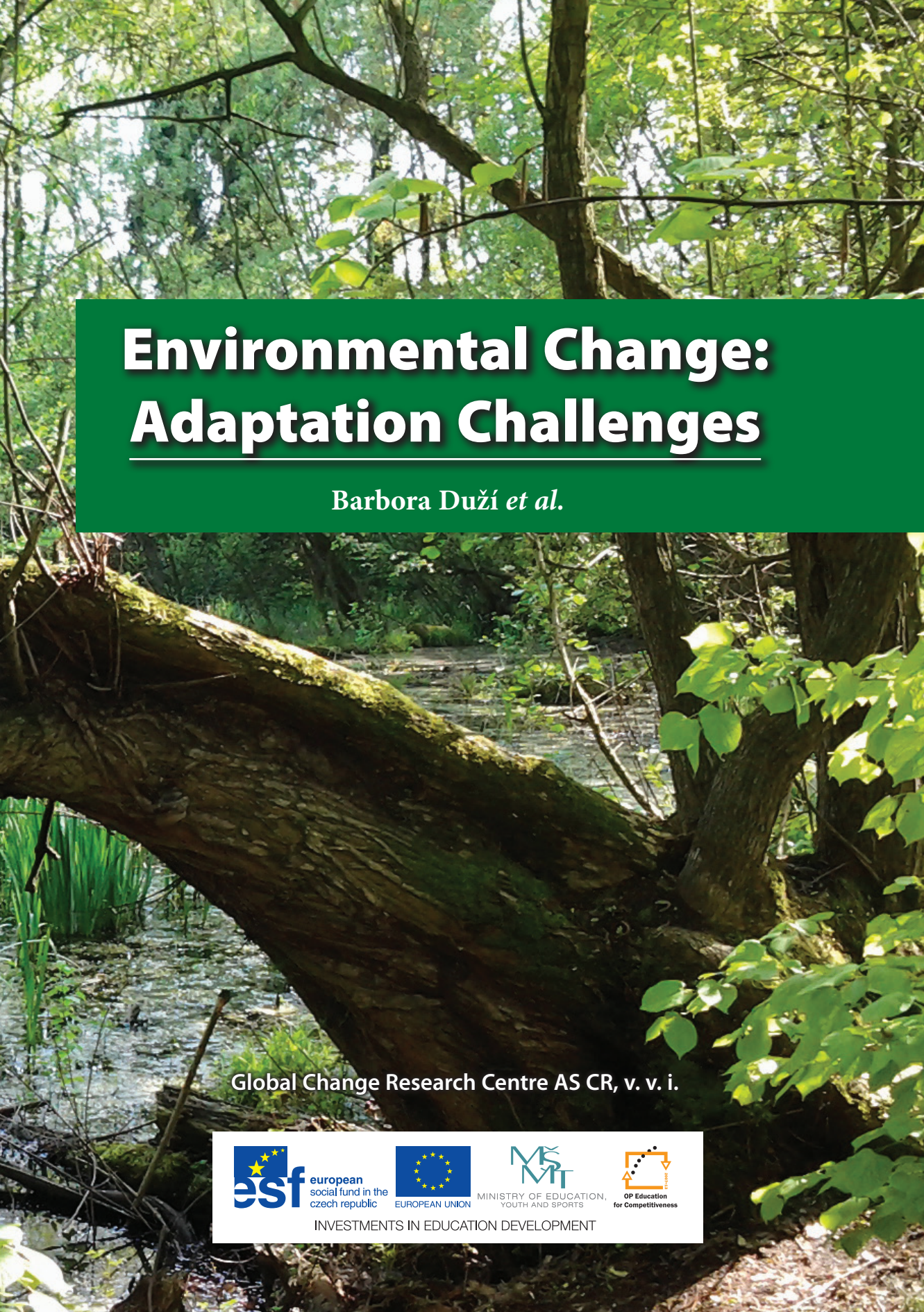

# Environmental Change: Adaptation Challenges

Barbora Duží *et al.*

Global Change Research Centre AS CR, v. v. i.

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# ENVIRONMENTAL CHANGE
## Adaptation Challenges

Global Change Research Centre,

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# 1. INTRODUCTION TO ENVIRONMENTAL CHANGE: ADAPTATION CHALLENGES

> *"Whatever the warming scenarios, and however successful mitigation efforts prove to be, the impact of climate change will increase in the coming decades because of the delayed impacts of past and current greenhouse gas emissions. We therefore have no choice but to take adaptation measures to deal with the unavoidable climate impacts and their economic, environmental and social costs."*
>
> (EU Strategy on adaptation to climate change, Brussels, 16. 4. 2013, p. 216)

This monograph summarizes theoretical and empirical evidence of environmental change impacts on the physical environment and human societies, with a focus on climate change. Global climate change is considered as one of the most serious environmental challenges facing our civilisation. Considerable anthropogenic contributions to climate change are generally accepted across scientific, policy, and practice communities. Human activities alter the climatic system mainly through greenhouse gas emissions, with lesser contributions from land use changes. Generally speaking, every economic sector and human activity influence the global climatic system in some way. Human society will need to adapt to these changes if we do not want to experience economic losses or further deterioration of environmental, and consequently livelihood, conditions.

Better understanding of ongoing trends in environmental and climate change affecting the physical environment and consequently the supply of ecosystems services that are essential for human well-being is needed. It is necessary to be aware that changes in ecosystem services could seriously affect the functioning of human systems. Schröter *et al*. (2005) worry about the decreasing trends of fundamental supply of ecosystem services, such as declining soil fertility and water availability, thereby causing increased environmental and social vulnerability in many regions. Many well respected scientific journals dealing with environmental change are published, as *Climatic Change*, *Regional Environmental Change*, and *International Journal of Climate Change Strategies and Management*. These journals bring diverse evidence from various regions throughout the world, not just about negative consequences of environmental change, but also about measures, strategies and policies being adopted to adjust and overcome these problems.

This monograph, *Environmental Change: Adaptation Challenges*, examines concepts of "environmental change" and "adaptation" within different discourses, frameworks, regions and regional case studies. We understand environmental change in a broad, general way, as the "interaction of environmental systems, including the atmosphere, the biosphere, the geosphere an the hydrosphere and human system, including economic, political, cultural and socio-technical systems. Human systems and environmental systems meets in two places: where human actions proximately cause environmental change and where environmental changes directly affect what human value" (Stern *et al.* 1992). Thus, climate change is one specific manifestation of environmental change, exemplified by rising temperatures in recent decades. Apart from temperature rise, climate change has been observed through sea level rise, changes in patterns of precipitation, and changes of intensity and frequency of weather extremes (EEA 2010).

Recently, we observe one important orientation in the scientific literature on "global" dimensions due to the character of these changes at the global level. Many attempts have been realised to measure and evaluate the level and magnitude of these changes on global environmental change. One of the most well-known activity is Millennium Ecosystem Assessment Report evaluating ecosystem services, their conditions, trends and scenarios, and response options on global and local scales (Millennium Ecosystem Assessment 2005).

Not accidentally, a special Report of the Intergovernmental Panel on Climate Change (IPCC) titled "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" (IPCC 2012) deals with the necessity of finding new ways of adjusting human society to one of the most visible manifestations of climate change: climate and weather-related extreme events. Even though adaptation is not a new term for use in the climate change framework, there are some points to be highlighted. The Report emphasises adaptation as a ***challenge*** and points out the need to take into account the ***uncertainty*** of risk management and future trends. The Report also

mentions that adaptation does not depend on climate extremes alone, but also on the level of ***vulnerability*** and ***exposure*** of society to climate extremes. Again, nothing is new, but the Report consolidates such material.

This monograph is based on several parts interconnected with these key concepts: environmental change, climate change, physical environment, society, communities, and different levels of adaptation. Several chapters cover the issue of human perception, evaluated as an essential part of these, but difficult to measure or quantify. We are aware of the limitations herein, but we hope to bring small pieces of the puzzle into the long and never-ending exploration of the better understanding of the issue with feasible and long-term solutions for human societies as well as the physical environment.

The structure of the monograph is following. Monograph opens with a contribution by Ilan Kelman and Stavros Mavrogenis introducing concepts of the theory, policy, and practice of adaptation to environmental change, with a focus on climate change. They define climate change adaptation, provide an overview of international negotiations and outcomes, and analyse several levels of adaptation, starting by distinguishing international, national and community-based adaptation. They also review the IPCC's approaches to adaptation being anticipatory, planned and autonomous adaptation.

The next contribution by Jan Vávra, Vera Peters, Eva Cudlínová, and Miloslav Lapka explores social perception of possible climate change impacts by the public in two different regions in the Czech Republic and in Germany. One of the most important contributions is introducing the social vulnerability index, indicated mainly by low education, low income, and high age in society. The authors researched the role of socio-demographic characteristics including mentioned social vulnerability in perception of climate change. The results show that water-related issues, like water scarcity, droughts, or floods are perceived as being the most severe climate change consequences. They also found some considerable differences in perception between the national samples.

Contribution by Barbora Duží, Dmytro Vikhrov, Robert Stojanov, and Ilan Kelman also discusses the Bečva region where they conducted a field survey among regional stakeholders and household residents, but focusing more on social dimensions of adaptation to floods. In the theoretical part, the authors explore societal adaptation to impacts of climate extremes and they further analyse various factors influencing adaptation, including perception. The authors examine adaptation in terms of coping as short-term adaptation and adaptation itself as an advanced, long-term way of adjusting to climate extremes. In the empirical part, the authors present several important findings, mainly low adaptation measures adopted by households, contrary to some advances on the regional level.

The monograph closes the contribution by David Juřička, Lucie Janošíková, Jindřich Kynický, Jitka Novotná and Martin Brtnický, who introduce environmental and social changes and their impacts on nomadic communities in a distant region of Mongolia. Compared to Europe, the region is quite different in terms of climatic conditions, ecosystems, and livelihood strategies of local communities. The chapter analyses the main environmental changes, especially aridification and social changes after the break up of communism and various responses of local societies. As one of the most visible trends is shifting nomads tracks and pastures, or finally giving up the nomadic lifestyle and increasing migration to large cities like the capital, Ulan Bator. The paper is designed mainly as an introductory review and calls for further empirical research.

*Barbora Duží*

*January 2014*

# 2. THEORY, POLICY, AND PRACTICE FOR CLIMATE CHANGE ADAPTATION

*Ilan Kelman and Stavros Mavrogenis*

**Abstract**
This chapter describes basic theory, policy processes, and practical approaches for climate change adaptation as one subset of wider environmental changes. Definitions and vocabulary comprise the theory section, focusing on the principal scientific (Intergovernmental Panel on Climate Change, the IPCC) and policy (United Nations Framework Convention on Climate Change, the UNFCCC) processes which have helped to popularise the terms used. The adaptation policy section covers international governance regimes for adaptation, namely the UNFCCC processes, accords, and critiques. Then, national governance regimes for adaptation follow, highlighting National Adaptation Programmes of Action (NAPAs) and other similar national policies for locations not eligible to produce a NAPA including the EU. Adaptation practice is discussed through community-based adaptation. The conclusions highlight the necessity of starting from a community perspective to ensure that adaptation policy and theory support the integration of climate change adaptation into a community's regular activities.

**Keywords**
Adaptation, climate change, community-based adaptation, IPCC, mitigation, NAPA, UNFCCC.

## 2.1. Adaptation Theory

Many environmental changes continually affect us all, from the local to global level. One of the most prominent changes today is concerned with changing the climate globally. The climate has always changed, through humanity's and the planet's history, including long-term trends, shifts in the state and baseline, variabilities, and cycles. Today, climate change is marked by human influence, through two main mechanisms. First, the human release of greenhouse gases (e.g. carbon dioxide and methane) which "trap" heat and warm the planet's average temperature. Second, anthropogenic changes to the Earth's surface which reduce the planet's ability to absorb greenhouse gases and to transform solar energy in other ways than to heat. The most prominent of these land use changes is deforestation.

Environmental changes can include all forms of change experienced on the planet (e.g. Ehrlich and Ehrlich 2013; MEA, 2005; Smith, 2004), such as to the biosphere through extinctions or biome shifts, to the lithosphere such as through tectonic processes, and to the atmosphere and hydrosphere. Within this wide variety of environmental changes, climate change specifically deals with climate, referring to "'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years" (IPCC, 2007, p.871).

This form of climate change has two principal definitions. The main scientific body responsible for assessing and synthesising climate change science is the Intergovernmental Panel on Climate Change (IPCC). The first IPCC assessment was published in 1990 with the latest one being gradually released during 2013-2014 (IPCC, 2013), providing some new findings compared to (IPCC, 2007a). The IPCC's (2007b, p. 871) definition of climate change is "any change in climate over time, whether due to natural variability or as a result of human activity". Meanwhile, the main United Nations treaty for addressing climate change is the United Nations Framework Convention on Climate Change (UNFCCC) which defines climate change to be "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC, 1992, Article 1, Paragraph 2). The difference is that the science examines all changes to the climate irrespective of origin while the UN policy process and measures consider climate change from only human origins. The reason for the narrow policy approach might be to focus on what policy can change, namely human actions. Other policy approaches are regional (e.g. EU), national, or local and often take wider definitions of climate change than the UNFCCC.

To deal with climate change and other forms of environmental change, various disciplines and vocabularies are used. The set which currently dominates most discussions comes strictly from climate change, both the IPCC and the UNFCCC, centring around the term 'adaptation' leading to the phrase climate change adaptation (CCA). The IPCC (2007b, p. 869) defines a complicated set of vocabulary:

> **Adaptation** - Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation:
> **Anticipatory adaptation** – Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.
> **Autonomous adaptation** – Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.
> **Planned adaptation** – Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

IPCC (2012) then further muddies the definitions by differentiating between coping and adapting. Relying on English dictionary definitions, IPCC (2012) suggests that coping means using available skills and resources to respond to risks with the aim of returning to a previous state of affairs, while adaptation is anticipative, proactive, and involves structural changes that consider longer time horizons. As such, coping strategies are the base on which adaptation strategies are built, thereby extending coping strategies into a longer-term perspective.

UNFCCC (1992) does not directly define 'adaptation', but UNFCCC's online glossary (http://unfccc.int/essential_background/glossary/items/3666.php) uses the same definition as IPCC (2007b). Several critiques can be examined of the IPCC's (2007b) definition, starting with the main one of 'adaptation'.

The explicit separation of 'natural or human systems' is can be misleading, because it should be a truism that natural and human systems are inherently connected. Consequently, any adjustments might occur with only human systems, only natural systems, or both simultaneously due to their connections. The keyword of 'adjustment' to start the definition comes from a long history, back to, for example, White's (1942/1945) foundational work investigating different ways in which people adjust to floods which can be beneficial, rather than viewing floods as an inevitable threat or problem. When the IPCC's work started, there was discussion around which term to use, ending up with the complicated choice of 'adaptation'. An alternative would have been using 'adjustment', especially considering that many languages, such as Norwegian, have verbs for only 'to adjust' so 'to adapt' is translated as 'to adjust' anyway. Additionally, the word "adaptation" has long been used in many other scientific fields, including evolution and anthropology. That leads to some difficulties in understanding, interpreting, and translating the word, its concept, and its definition across disciplines as well as across languages and cultures.

The three types of adaptation in IPCC's (2007b) definition are not truly differentiated. For example, 'anticipatory adaptation' and 'planned adaptation' overlap since 'a deliberate policy decision based on an awareness that conditions…are about to change' (planned adaptation) could be the same as 'proactive adaptation'. The narrowing of 'autonomous adaptation' to consider only 'ecological changes in natural systems and by market or welfare changes in human systems' eliminates the wide variety of other spontaneous adaptation measures, such as nature's responses to human conservation and preservation efforts related to climate change along with societal changes due to human rights, health concerns, or risk perceptions rather than market or welfare changes.

The complexity of the words used in the definition also make it difficult to apply operationally without extensive explanations and illustrations. Adaptation actions seem to be mitigating adverse consequences of climate change or using climate change as a livelihood opportunity. IPCC (2007b) and UNFCCC (1992), however, concur on a different definition of 'mitigation'. IPCC (2007b) calls mitigation 'An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks'. UNFCCC's online glossary (http://unfccc.int/essential_background/glossary/items/3666.php) puts that more straightforwardly as 'a human intervention to reduce the sources or enhance the sinks of greenhouse gases'.

In effect, the definition of "mitigation" means attempts to prevent or minimize the human influence on climate change, whereas "adaptation" aims to mitigate climate change's impacts, ostensibly irrespective of the origin of the changes to the climate, i.e. anthropogenic or natural. The terminological confusion is further exacerbated by Article 3.3 of UNFCCC (1992) which states "The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects", yet "mitigate its adverse effects" actually means "adaptation". From the beginning of the IPCC and UNFCCC processes, there were calls to bring mitigation and adaptation closer together rather than separating them, as was done. These calls soon entered the scientific literature (e.g. Kane *et al.*, 2000) with the need to link the two processes being shown for Vietnam (Dang *et al.*, 2003), the Sahel (Nyong *et al.*, 2007), and the insurance industry (Mills, 2007).

As an example of how harm can result by separating the processes, many forest protection schemes have been implemented as part of climate change mitigation, to increase the uptake of greenhouse gas emissions. Where people have thereby been cut off from their traditional forest livelihoods in order to 'protect' the forest, their ability to adapt to climate change is diminished due to fewer resources and fewer livelihood opportunities. Similarly, many structural sea walls have been built as part of CCA against projected sea-level rise, but structural sea walls are energy intensive in construction and maintenance, running counter to mitigation.

Policy approaches which avoid such problems could start from the community level to determine what people need and seek with regards to livelihoods in the context of their surrounding environment. Then, practices could be piloted with the support of the community to determine their effectiveness is encouraging the population to mitigate and adapt to climate change without causing or exacerbating other problems. An example comes from Boulder, Colorado and Toronto, Ontario where, over past decades, the floodplains of the rivers running through the cities have been turned into green ways with walking/cycling pathways, which has included purchasing and knocking down houses built in the floodplain. This approach is simultaneously climate change mitigation by encouraging a shift away from cars; CCA by moving properties out of the floodplain; and increased quality of life and well-being by providing green recreational and commuting areas through the heart of the cities. Other all-win solutions should be searched for and found, rather than separating and compartmentalising mitigation and adaptation.

Another example of how adaptation and mitigation can overlap, supporting each other, is increasing energy efficiency and moving towards local, small-scale, renewable energy sources (not necessarily large-scale wind or solar farms). That is climate change mitigation through reducing fossil fuel use. That is also CCA through localising energy supply systems which enhances a community's ability to deal with extreme weather events. Simultaneously, other development, health, and well-being goals are achieved by giving a community control over its energy, creating local livelihoods, yielding cleaner air, and avoiding a landscape cluttered by long-distance transmission lines and transformer stations.

Given that mitigation and CCA should not be separated and given the confusion which the terminology creates, are there alternatives? Given the need to translate climate change language into many languages, as well as translating it beyond technical experts, one alternative would have been to use straightforward terms, which means calling the processes exactly what they are: Instead of 'mitigation', 'prevention' could have been used and instead of 'adaptation', 'mitigating effects' or 'adjustment' could have been used. Additionally, in defining terms, aiming for straightforward and elegant definitions accounting for the discussion above would have made it much easier to communicate climate change concerns.

Irrespective of the terminology used, the theory behind adaptation is clear: adjustments are needed to deal with climate change, irrespective of the origin. Humanity and ecosystems have been doing that interconnectedly for millennia. Human-influenced climate change leading to major environmental changes makes these actions even more important now.

## 2.2. Adaptation Policy

### 2.2.1. International governance of adaptation: UNFCCC

Articles 2 and 3 of UNFCCC (1992) clearly state that is the obligation of the parties to the Convention to stabilize greenhouse gas emissions in order to "prevent dangerous anthropogenic interference with the climate system" (Article 2). Thus, the UNFCCC founds the pillars of climate change policy for mitigation, focusing on mitigation but nonetheless referring to adaptation four times throughout UNFCCC (1992; see also Bodansky 1993). In fact, Article 4 places specific obligations on the countries labelled as 'developed' to share the cost of adaptation measures in the countries labelled as 'developing'. Article 3.1 states that developed countries and emerging economies should undertake all the necessary measures to combat the adverse impacts of climate change while Article 3.2 describes how these measures should take under consideration the vulnerabilities of developing countries.

Article 4.1 is especially important for adaptation governance. It states that the member parties have to plan, implement, publish, and amend national plans for combating climate change including adaptation measures. Article 4.3 of UNFCCC (1992) refers to the financing of adaptation measures in which developed countries must provide "new and additional financial resources to meet the agreed full costs incurred by developing country Parties". The onus is particularly big for "the developing country Parties that are particularly vulnerable to the adverse effects of climate change" according to Article 4.4.

Much of this language is direct and clear. Climate change caused by human influences is identified as a significant problem, the cause is identified as mainly the more affluent countries, indications of action needed are provided, and commitments are made to give the less affluent countries support. Conversely, there is enough vagueness and lack of specificity to permit continued wrangling in implementing the Convention. That has been witnessed in the negotiation meetings for the UNFCCC which are the Conference of Parties (COPs) that have happened most years since 1995 (Table 2.1). Gupta (2010) further discusses that, irrespective of the successes of the Convention, some momentum within the UN was lost in terms of addressing climate change as an environmental issue. Instead, it became a development issue which could be addressed by technical measures. In fact, the UNFCCC (1992) has nine mentions of technology transfer from the more industrial countries to the less industrial countries but does not once mention 'behaviour' or a variation (which would be difficult to include in an international treaty), although some such changes are implied.

**Table 2.1** Summary of Milestones from UNFCCC COPs (this section) and the EU (section 2.2)

| Milestone | Year |
|---|---|
| UNFCCC's article 4 makes direct reference to adaptation. | 1992 |
| COP-1 the Berlin Mandate incorporates the three stages of climate change funding including adaptation measures. | 1995 |
| COP-3 resulted in the Kyoto Protocol. | 1997 |
| COP-7 the Marrakesh Accords established the NAPAs, the LDC Expert Group and the Least Developed Countries Fund and the Adaptation Fund. | 2001 |
| COP-12 established the Nairobi work programme on impacts, vulnerability and adaptation to climate change (NWP). | 2006 |
| The European Commission launches the Green Paper on Climate Change Adaptation. | 2007 |
| The European Commission published the White Paper "Adapting to climate change: Towards a European framework for action". | 2009 |
| COP-15 tried to reach a successor to the Kyoto Protocol. | 2009 |
| COP-16 established the Cancun Adaptation Framework. | 2010 |
| The European Commission adopted the "EU Strategy on adaptation to climate change". | 2013 |

Within these debates, several agreements emerged from the COP negotiations. The first was the Berlin Mandate (UNFCCC, 1995) which contributed to a restructured funding mechanism called the Global Environment Facility (GEF) while suggesting three stages for CCA: (i) planning, (ii) capacity building, and (iii) implementation. A concrete plan, however, did not emerge from the Berlin Mandate leaving limited influence on international adaptation governance.

To some extent, the linchpin of the UNFCCC COPs is the Kyoto Protocol (UNFCCC, 1997) which is an internationally binding treaty with quantitative targets for reducing six greenhouse gas emissions by 2012 for the countries labelled as developed. Specifically, Article 3 commits these countries "to reducing their overall emissions of such gases by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012". The Kyoto Protocol was signed in December 1997 but did not enter in force until February 2005 due to the reluctance of numerous countries to ratify it due to the specific targets. Even for those countries who have ratified it, many did not meet the targets to which they agreed. Others witnessed emissions reductions beyond their Kyoto targets due to the worldwide financial situation, rather than due to concerted efforts to meet their treaty obligations. With 2012 now past, subsequent COPs have been devoted to seeking an internationally binding treaty to succeed the Kyoto Protocol. Despite efforts, especially at COP-15 in Copenhagen in 2009, that goal has not yet been met.

Other agreements and mechanisms emerged for international adaptation governance through the UNFCCC. UNFCCC (2006) was adopted at COP-12 in Nairobi in 2006 as the 5-year Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change (NWP). The NWP aimed at assisting the developing countries, especially the UN-designated Least Developed Countries (LDCs) and the UN-designated Small Island Developing States (SIDS), to assess the impacts of climate change. The NWP also aimed to ensure the scientific basis of adaptation actions.

Although COP-13 in Bali in 2007 had no major breakthrough regarding adaptation, there were a few developments of note. The Adaptation Fund was seen as being a particularly important financial mechanism for CCA. The main difference from other mechanisms is that the Adaptation Fund Board is accountable to the meeting of the Parties to the Kyoto Protocol (termed CMP), maintaining some modicum of independence from donor countries and international financial institutions. That gives the recipient countries more confidence in its operations and fairness.

In fact, the Adaptation Fund Board comprises 16 members and 16 alternate members, with 70% of the members from developing countries, although it is currently chaired by Norway. The funds come from a 2% levy on Certified Emission Reduction credits which are earned by investors from implementing actions related to a specific UNFCCC mitigation mechanism set up by the Kyoto Protocol. This mechanism is called the Clean Development Mechanism and gives credits to the countries labelled as developed countries for supporting climate change mitigation projects in the countries labelled as developing countries. Another important advantage of the Adaptation Fund is the direct financing of projects in developing countries, reducing many bureaucratic obstacles and facilitating bottom-up CCA.

Additionally in Bali, a series of adaptation plans in Africa and the SIDS were implemented alongside a major attempt to coordinate CCA with disaster risk reduction approaches (Paragraphs 1(c)(ii) and 1(c)(iii) of UNFCCC (2007)), an effort which risk management and disaster risk reduction specialists had long been aiming for. However, the UNFCCC process and CCA more generally has still not adopted all the lessons and inputs feasible from wider work (Shaw *et al.*, 2010a, 2010b).

COP-16 in Cancun in 2010 is the final notable COP, as it established the Cancun Adaptation Framework (UNFCCC, 2010). COP-16 represented the first time in international adaptation governance that an Adaptation Committee was founded in order to coordinate the implementation of international adaptation. The agreement from COP-16 (UNFCCC, 2010) was also the first reference in COP outcomes to the need for incorporating traditional and local knowledge in implementing climate policies alongside the recognition that "displacement, migration and planned relocation" might result from climate change (Paragraph 14(f) of UNFCCC, 2010). Furthermore, in what has been a constant demand from SIDS, it introduced the first possibility for compensation in case of losses attributed to climate change, which continues the debate regarding the meaning of adaptation in terms of whether or not compensation for impacts counts as adaptation. Finally, COP-16 created the Green Climate Fund with the purpose "to make a significant and ambitious contribution to the global efforts towards attaining the goals set by the international community to combat climate change". Financial targets for the fund were ad hoc and unofficial, with the fund so far receiving very little support apart from start-up and operational costs.

### 2.2.2. National and multinational governance of adaptation

In 2001 at COP-7 in Marrakesh, alongside mitigation policies, an attempt took place to develop adaptation initiatives for the LDCs. Agreements prioritised the LDCs for technology transfer, adaptation funding and action, establishing climate policy centres, training in negotiation techniques for national representatives, and strengthening the capacity of meteorological stations for collecting and processing data. The "Marrakesh Accords" included the entry into force of the National Adaptation Programmes of Action (NAPAs), specifically for LDCs. The main feature, in theory, of NAPAs is that they offer the opportunity for LDCs to develop their own CCA priorities and to propose solutions based on their own needs and capabilities. NAPAs are not meant to complete new science, to model long-term scenarios, or to develop long-term policies. Instead, they are designed to summarise and build on existing strategies and knowledge. As such, the NAPAs are prominent for recognising adaptation action which is based in communities, in theory. In practice, many NAPAs were developed by external consultants with varying degrees of local, on-the-ground input.

The structure of a NAPA is simple, comprising two parts. The first part analyses the most vulnerable sectors to the effects of climate change. The second part highlights priorities for adaptation action. NAPAs are submitted to the UNFCCC's Secretariat in Bonn which publishes them and supports finding implementation funds. Post-Marrakesh COPs continued to support NAPAs, such as by highlighting gender empowerment, revising NAPAs, and mainstreaming NAPAs into development planning. As of August 2013, the UNFCCC Secretariat had received NAPAs from 49 of the 50 LDCs that received funding for preparing the document. As of April 2013, 97 NAPA-related projects had been approved for funding.

Funding NAPAs, though, has encountered obstacles (Mace, 2005). First, the obligation of Article 3.3 of UNFCCC (1992) which states "policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost". That is, any climate change related actions, even if taken at the local level, are meant to have global benefits, a major challenge for community-based adaptation. Second, the same clause implies rules of economic efficiency for any policies or measures, meaning that sometimes international funding mechanisms cannot fully finance the projects. A broader concern with NAPAs is that they usually reflect country-driven criteria, so that domestic political agendas might preclude the inclusion of sustainable development, gender empowerment, equality, and poverty reduction (e.g. Osman-Elasha and Downing, 2007). It is currently unclear how effective the NAPAs have been or could be.

Non-LDC countries are not mandated to have NAPAs. One of these is the Seychelles which is a SIDS and was the second country in the world to sign UNFCCC (1992). Just two months later, the country established a national commission for coordinating, developing, and implementing a national plan on climate change; for acting as an intermediary between the national plan and the government; and for preparing national communications to the UNFCCC. The country's national strategy for climate change has the main goal of minimising climate change impacts through coordinated and preventative action at all levels of society, deliberately connecting local, national, and international. The Seychelles' national adaptation strategy has already achieved institutional governance and community engagement through a series of open public consultations. Integrating top-down and bottom-up approaches has ensured progress on CCA despite the problems of funding, slow exchange of knowledge and technology, and continued marginalisation of the SIDS.

In Europe, the European Union has been tending to leave member countries to develop their own CCA approaches (see also Table 2.1). In 2007, the European Commission launched a consultation by publishing a Green Paper on CCA in Europe. The Green Paper is based on four pillars. The first, which is suggested as being the most important, concerns early action, namely adopting preventative measures for climate change mitigation (again, note the confusing vocabulary of mitigation being "preventative measures"). The second pillar concerns integrating adaptation into EU external actions. The third explores the potential for reducing uncertainty, based on investigating the knowledge base through integrated climate research. The fourth is about the involvement of civil society, business, and the public in developing coordinated and coherent policies and measures.

Based on the consultation, two years afterwards, the European Commission published the White Paper "Adapting to climate change: Towards a European framework for action" (Commission of the European Communities, 2009). Some of the main aspects are developing a knowledge basis for climate change impacts, integrating adaptation into EU policies, and identifying the most suitable funding mechanisms. The White Paper does not introduce any institutional developments, instead being more of a transitional policy paper. In April 2013, the

European Commission adopted the "EU Strategy on adaptation to climate change" as a package of a series of documents. This strategy aims at providing more specific steps for implementing EU adaption policies. Whereas the EU members have been developing their own national CCA strategies, the EU is now moving towards a more coherent regional approach including connections with other common policies such as the Common Agricultural Policy (CAP), the Cohesion Policy, and the Common Fisheries Policy (CFP) to better support multinational governance of adaptation.

## 2.3. Adaptation practice: Community-based adaptation

Reid *et al.* (2009, p. 13) define community-based adaptation (CBA) as "a community-led process, based on communities priorities, needs, knowledge and capacities which should empower people to plan for and cope with the impacts of climate change". Therefore, CBA focuses largely on supporting people to help themselves for CCA. Often, many sectors of a community can be excluded from a community-based process because power relations and elites always exist, frequently leading to any process being controlled by a sub-sector within a community. Additionally, it is important to ensure that CCA uses external support and knowledge, preferably where that is requested, but on equal terms with local support and knowledge to avoid domination of CCA by any group, internal or external to the community.

To achieve the combination of different knowledge forms, and to balance expertise that is internal and external to a community, Kelman *et al.* (2009) propose a four-step framework process that establishes long-term cooperative partnerships between communities and external collaborators at national, regional, and international levels in order to effect CCA. The steps involve establishing rapport with the community and recognising climate change problems to solve, identifying availability of and gaps in internal and external knowledge, seeking how to combine the knowledge forms to fill in the gaps, and identifying solutions to the problems which the community is willing to adopt and lead.

The main issue that CBA methodologies must address to be successful is integrating bottom-up and top-down activities and knowledge. A major gap in how CCA is applied in the context of CBA is described by Mercer (2010), amongst others, that much of CCA is already being conducted at the community level, so it is sometimes challenging to discern what is new or innovative about CCA processes. In particular, Mercer (2010) highlights how much could and should be learned from disaster-related activities in the context of development. Marshall *et al.* (2009) provide a synthesis of CBA toolkits demonstrating the similarity between CBA and many development processes.

Aiming to build on existing experience, rather than assuming that CCA is new or different from other development activities, international NGOs are conducting research and piloting of CBA tools (see Reid *et al.*, 2009). One example within CBA is the focus on recognising the inextricable links between human and natural systems (see also section 1) by implementing ecosystem-based adaptation (EBA) at the community level and beyond (e.g. Marshall *et al.*, 2009; Perez *et al.*, 2010; Renauld *et al.*, 2013). EBA combines CCA, ecosystem management, and livelihood development, exactly as ecosystem-based management and many development activities have been doing for decades.

Perez *et al.* (pp. 15-16) define EBA as "an approach that builds resilience and reduces the vulnerability of local communities to climate change…EBA integrates sustainable use of biodiversity and ecosystem services in a comprehensive adaptation strategy". Its main objectives are to support communities through maintaining ecosystem services and supporting livelihoods that might use, but never harm, ecosystems. EBA has led to several practical approaches, such as two IUCN tool kits, named CRISTAL (Community-based Risk Screening Tool – Adaptation & Livelihoods) and MESCAL (Mangrove Ecosystems for Climate Change Adaptation and Livelihoods). Meanwhile, the United Nations Environment Programme (UNEP) tested the RiVAMP (Risk and Vulnerability Assessment Methodology Development Project) methodology in a pilot project in Jamaica (UNEP, 2010). In their gap analysis for EBA in the Caribbean, Mercer *et al.* (2012) point out that "EBA activities are often not differentiated from non-EBA activities, instead recognizing adaptation as happening or being needed, with some aspects involving or related to ecosystems and other aspects not."

An ongoing programme that draws on and extends such lessons is Many Strong Voices (MSV; http://www.manystrongvoices.org and for publications see http://www.islandvulnerability.org/docs/islandsclimatechange.

pdf). The programme works with people from SIDS and the Arctic to address climate change. At their own request, MSV brings them together to exchange their indigenous knowledge about, and to devise approaches for dealing with, the climate change challenges facing their communities.

For instance, in the Seychelles, the government has introduced a mixture of measures and policies to develop an integrated CCA approach. Engineering coastline protection measures co-exist with EBA initiatives such as the Port Launay wetlands. The wetlands are jointly managed by the Constance Ephelia Resort, a five-star hotel that was opened adjacent to the wetlands in 2010, and the NGO Sustainability for Seychelles (S4S) under an arrangement with the Seychelles National Parks Authority and the Seychelles' Ministry of Environment, the official management authority for the site. Public consultations take place regularly with members of the adjacent Port Glaud community and they are organised by the NGO with the participation of the Ministry of Environment. This culture of vigorous stakeholder engagement is evident in every aspect of social life in the Seychelles, also supporting the country's National Climate Change Strategy (Seychelles Government, 2009).

Daly *et al.* (2010) combine knowledge forms for climate-related hazards and coastal management in Samoa. The process was funded externally but was led by the national government and based on local consultations in coastal villages. District meetings helped to integrate the highly localised perspectives for addressing district-wide topics that each village might not be able to connect with. The result was local coastal management plans integrated into a national coastal vulnerability reduction strategy. The consultation process was facilitated by external consultants, but was used as an opportunity to train national and local staff in participatory methods to ensure that one knowledge form does not overwhelm others.

That ethos applies to understanding local observations of weather and climate in order to adjust livelihoods to the changes being observed. Reindeer herders in northern Scandinavia have been proactive regarding CCA. In particular, they founded and run EALÁT which is "a Reindeer Herders Vulnerability Network Study and is a project that examines reindeer pastoralism in the light of climate change" (http://www.ealat.org). Their website provides reports, analyses, and interpretations regarding CCA for reindeer herders, mainly coming from reindeer herders including several who are pursuing Masters and PhD degrees. EALÁT then helps to implement the knowledge generated to effect CBA. One definitive lesson is that neither local nor scientific knowledge can necessarily provide the entire story alone.

The importance of these examples, and many more which exist around the world, is the active engagement and leadership by the communities. People, no matter how isolated or not isolated, are recognising that climate change is starting to affect them. Since little is happening at the international level to mitigate climate change, people are forced to adapt, often while engaging in mitigation actions themselves, especially those actions supporting CCA (see section 1). Additionally, numerous adaptation initiatives occur beyond the community level, at sub-national, national, regional, and international levels. Contemporary climate change is not making it easy for many people to continue their lives and livelihoods, but that does not mean giving up. MSV is a clear example of people taking control of their own situations and trying to improve them, despite climate change.

## 2.4. Conclusions

This chapter has reviewed theory, policy, and practice for adaptation to environmental change, with climate change being highlighted. The approach has been presented as linear: theory is developed which informs policy that in turn directs practice at the community level. Reality tends to be different. As shown by the CBA examples, people live with the environment and with environmental change on a day-to-day and decade-to-decade basis. It is the same for climate. Climate has always had variability, trends, and changes which have required people and communities to adapt in the context of their environment or to be harmed. Contemporary climate change influenced by human activities is, in many ways, having faster and more intense impacts than many humans have ever experienced, but that does not undermine the basic principle that life and livelihoods are about change and there should be little expectation that environmental conditions are constant or stable.

Development theory, policy, and practice accept such terms and they existed long before human-made climate change became concerning. In particular, there has long been recognition that aiming for livelihoods, development, and sustainability, keeping in mind the numerous definitions and interpretations of those concepts

entails community-based work. That does not necessarily mean complete community control over all decisions, instead suggesting a balance between internal/local and external/wider support, decisions, and implementation. Full and fair consultation and participation of all parties is the ethos of 'community-based', not necessarily the decisions and control.

As such, the starting point for development is the community, a tenet which should also apply to adaptation to environmental change. On-the-ground practice by the people affected, even where external support is essential, should be the baseline for adaptation. That baseline would provide the foundation for larger-scale practices on which policy could be built and then theory developed. Rather than so-called 'experts' defining the agenda, scope, and parameters for adapting to environmental change, if the key is to help people, then those people should be providing the basis for the agenda, scope, and parameters.

The basis for most people is their daily life and livelihoods, often with difficulty in immediately addressing decade- and century-scale changes, such as climate change. In order to succeed, any CCA activities must therefore occur within the people's regular life and be relevant for that. That will further help to overcome the large gap between the theory, the ideal policy, and the practice, especially in that many of the political structures around the world support natural resource overexploitation, social inequity, and injustice even while purporting to be interested in tackling climate change. In fact, as noted above, some climate change efforts even perpetuate the social and environmental destruction which the theory and policy try to avert. Overall, climate change is embedded within wider environmental changes. Consequently, dealing with long-term environmental changes needs to be integrated into dealing with shorter-term environmental changes. CCA sits within, not separately from, development-related concerns such as environmental hazards, water, food, energy, health, education, justice, and equity.

The IPCC, the starting point for CCA theory, has to a large extent sought to separate climate change into its own domain. Instead, the time has come to turn this around, by finishing rather than starting with a theory based on people's development needs regarding thriving amongst all forms of change.

# *3. SOCIAL PERCEPTION OF CLIMATE CHANGE CONSEQUENCES IN THE CZECH REPUBLIC AND GERMANY*

*Jan Vávra, Vera Peters, Miloslav Lapka and Eva Cudlínová*

**Abstract**
Climate change is probably the biggest present-day environmental problem and a great global challenge. The impact of climate change, direct or indirect, can affect whole societies as well as individuals. We wanted to explore the perception of possible climate change impacts in two Central European countries with different climate change awareness and public discourse. The study was carried out among the population of two regions in the Czech Republic and Germany. These regions are situated in the South Bohemia Region and the federal state of Brandenburg. In total, we asked more than 1000 respondents for their assessment of the impact of ten climate change consequences. We present the results on the perceived impact on different levels (global, country, personal), and the effect of socio-demographic characteristics using the concept of social vulnerability. The results show that water related issues, like water scarcity, droughts or floods are perceived as the most severe climate change consequences. There are considerable differences between the national samples, e.g. Czechs are more concerned about new diseases or species extinction, Germans about climate tax. Overall, Czech respondents show a higher risk perception, they are more concerned about most of the potential consequences than Germans. Regarding the different levels of impacts, respondents in both countries expect a higher impact on the global level than for their countries or themselves. The social vulnerability concept is a stronger predictor in the Czech Republic than in Germany; here the more vulnerable population expects higher impacts on the country and personal levels. Low education and low income are more important predictors than high age. We discuss possible causes of the results in the context of both countries.

**Keywords**
Climate change, Czech Republic, Germany, risk, social vulnerability, sociology, survey.

## 3.1 Introduction

Climate change is not only an object of interest of many natural scientists but of social sciences as well. The interest of social sciences in measuring public perception of environmental issues can be traced to the 1970s (e.g. Dunlap and Van Liere, 1978). Since the early 1990s climate change has become one of the most important topics in environmental sociology and related fields. Social research on climate change includes a variety of subtopics, like the public understanding and social representation of climate change (Kempton, 1991; Fischer *et al.*, 2012), knowledge of the topic (Bostrom *et al.*, 1994), comparison with other possible threats (Bord, Fischer and O'Connor, 1998), motivation for climate change mitigation (O'Connor *et al.*, 2002), factors influencing behavioural intention (O'Connor, Bord and Fisher, 1999) and personal responsibility for climate change and foreknowledge (Kellsted *et al.*, 2008). Recently, more attention has been paid to social denial of climate change (Norgaard, 2006), barriers to personal engagement (Lorenzoni *et al.*, 2007), perception of climate policies (Fischer *et al.*, 2011) and the changes of climate change discourse (e.g. Reusswig, 2010; Beck, 2010). Public awareness of climate change as a serious problem is also a topic in many opinion polls. By trend they report a decrease of public interest in climate change in the last few years in the EU (EC 2009, 2011) as well as the US, Canada, Australia or New Zealand (Ratter, Philipp and von Storch, 2012) after a peak of concern around 2007/2008.
In this study, we focus on the risk perception of climate change consequences among the population of two regions in the Czech Republic and Germany. Climate change risk perception is a significant predictor for the acceptance of behavioural intentions and governmental policies leading to climate change mitigation (O'Connor, Bord and Fisher, 1999; O'Connor *et al.*, 2002).
We present the countries' differences in their assessment of various impacts on different levels, and test the effect of socio-demographic characteristics using the concept of social vulnerability.

### 3.1.1 Perception of climate change in the Czech Republic and Germany

Earlier studies show that climate change perception and social factors influencing it is a very complex issue, diverging into a broad range of aspects and perspectives. In the context of our research it is especially relevant to distinguish between the general perception of climate change (salience of the issue, its time frame, causes of climate change, etc.) and the evaluation of specific climate change consequences. While the more general aspects of climate change perception have been surveyed quite extensively, much less research has been done on people's perceptions of specific effects of climate change.

Regarding the salience of the issue, the results of long term opinion polls in the Czech Republic suggest that the perceived importance of climate change has been decreasing, but results on the recent development are inconclusive. National surveys carried out in 2006 and 2007 showed that climate change was assessed as a very or fairly serious global problem by 84 % of the population, by 2011 this number had dropped to 64 % and by 2013 went down to 61 %. Even in the "peak years", other environmental problems were considered to be notably more urgent than climate change, i.e. the accumulation of waste and drinking water pollution or shortage (Tuček, 2013). However the Eurobarometer results from 2011 report a considerable recovery of public problem awareness between 2009 and 2011, suggesting a return to a rather high level of concern, even if not as high as before the financial crisis (EC, 2011a).

For Germany representative quantitative surveys like the Eurobarometer show a relative decline of climate change awareness: while 57 % in 2004 and in 2007 even 69 % of the German respondents named climate change as one of the five environmental problems they were most worried about, in 2011 this share of respondents shrunk considerably to 40 % (EC, 2005; EC, 2008; EC, 2011b). In the meantime other environmental problems have received more attention in public opinion, e.g. depletion of resources and manmade disasters like oil spills and industrial accidents (the survey was conducted soon after the nuclear accident in Fukushima). Still, the general concern about climate change is relatively high in Germany, with 67 % considering climate change very serious and another 23 % fairly serious problem in 2011 (EC, 2011a).

In comparison to the Czech Republic the priority that is given to climate change over other global problems appears to be higher in Germany. For example in the 2011 Eurobarometer 25 % of the German respondents chose climate change as the most important global problem facing the world, while in the Czech Republic only 16 % chose climate change (EC, 2011a). Also, some results suggest that on a personal level Germans feel more threatened by climate change: in a 2007/2008 Gallup poll 61 % of the German respondents indicated that climate change is a "very" or "somewhat serious" threat to them and their family, compared to 39 % of the Czech respondents. In 2010 still 59 % of the Germans felt personally threatened by climate change while the share of Czech respondents shrunk to 28 % (Pugliese and Ray, 2011).

The respondents of our study were also asked about the perceived importance of major threats for Europe (in 2010): here, the German respondents perceived climate change as a more serious global threat than the Czechs. But in both samples environmental pollution in general as well as economic downturn were described as bigger problems than climate change (Lapka and Vávra, 2011).

### 3.1.2 Perception of climate change consequences

Bord and O'Connor's study (1997) on the assessment of possible climate change consequences by US citizens showed that climate change was perceived as a threat to water quality and would lead to more droughts, an increase of air pollution (which is a rather incorrect consequence), species extinction and loss of forests and agricultural land, while an increased number of hurricanes or sea level rise was perceived as less likely.

In the Czech Republic a survey carried out within the local population with quota representation of different social groups has shown that a shortage of drinking water is the potential climate change consequence that all population groups are most concerned about (Lapka *et al.*, 2011), followed by floods and droughts and economic problems (higher costs for households and business, and climate tax). A survey among an international group of students confirmed the emphasis put on water resources, droughts and floods. It also indicated some international differences - students from the US and New Zealand put more weight on the economic effects, while Czech students paid more attention to the risk of sunbathing or species extinction (Lapka and Cudlínová, 2007) and Italian students stressed economic costs and new diseases (Lapka *et al.*, 2011).

A national survey of the German Environmental Agency in 2012 (Rückert *et al.*, 2013) asked about the impact of different climate change consequences and showed that Germans felt that in the future they would be most affected by heat waves (impacting their health) and were considerably less concerned about floods and droughts. The results, however, cannot be easily compared to the Czech ones, since the list of potential consequences was a lot less extended and people were explicitly asked about specific impacts on themselves (their health and lifestyle, their property, life threatening impacts). Overall, the respondents' concern about climate change impacts for themselves was low and the authors concluded that "the majority of the Germans do not yet see potential future consequences of climate change as a threat or disturbance for their own life" (Rückert *et al.*, 2013, p. 57).

Bord *et al.* (1998) also suggest that respondents in the US think of the possible impacts of climate change (like increased rate of diseases, food shortages or decreased standard of living) as more probable in "poorer nations" or "much of the world" and less probable for the respondents personally. Also in Leiserowitz's study (2006) US citizens appear to be much more concerned about the impact of climate change on the global level (50 % are concerned for "people all over the world") than for themselves and their family (12 %). Interestingly the concern was lowest for the US as a whole (only 9 %). Räthzel and Uzzell (2009) call this phenomenon "spatial optimism", i.e. the perceived effect of global environmental problems increases clearly by geographical distance (cp. also Uzzell, 2000). It is open for debate how to deal with this view, apparently common to the western or developed part of the world. Spence and Pidgeon (2010) argue that it is uncertain if "situating climate change in terms of an individual's present locality will render the issue more salient" (p. 657). This kind of framing could lead people to assess the overall problem as less salient since it is focusing on the (perceived) less dramatic, local consequences of climate change. This is connected to the fundamental question of whether people have to feel personally affected, or whether perceived social effects might be similarly important when it comes to their engagement with the issue of climate change (see also Bord *et al.*, 2000).

### 3.1.3 Socio-demographics and perception of climate change risk

Women usually assess environmental risks higher than men (e.g. Davidson and Freudenberg, 1996; Finucane *et al.*, 2000). Bord and O'Connor (1997) indicated that women see climate change as a more serious threat than men and think that various consequences of climate changes, including health, ecological and social impacts are more likely. These authors also show that younger people are slightly more concerned about health risks related to climate change. Education is often presented as a factor which increases environmental awareness (e.g. Dunlap *et al.*, 2000). However, in the study of Bord and O'Connor (1997) more educated people expressed lower risk perception connected to the impacts of climate change. This is supported by further research by the authors: higher climate change risk perception is correlated with being a female, of younger age and lower education (O'Connor *et al.*, 1999). Contrary to these results, Kellsted *et al.* (2008) studied the overall perception of negative impacts of climate change (including personal, family and social levels) and show that men expect higher impacts than women, but they find no effect of education, income or age. These diverging results could at least partially be attributed to the differences in the specific question design used in the surveys. Bord and O'Connor asked respondents to evaluate the likelihood and seriousness of particular consequences of climate change (health effects, sea level rise, droughts, etc.), while Kellsted *et al.* asked for agreement with general statements (e.g. "Global warming and climate change will have a noticeably negative impact on the environment in which my family and I live.").

A recent opinion poll in the Czech Republic shows that women and young people (under 29) are more likely to assess climate changes as a serious threat than men and senior citizens (over 60) (Tuček, 2013). Another more detailed Czech case study from 2006 (Lapka *et al.*, 2011) shows that while some of the concerns regarding possible impacts of climate change are widely shared in society, e.g. shortage of drinking water, others depend more on the specific social position. For example, farmers are personally more concerned about floods and droughts, whereas entrepreneurs and self-employed are more concerned about the climate tax or other economic costs. Overall, farmers expressed the highest degree of problem awareness, followed by entrepreneurs. There are no differences between university-educated or high school-educated respondents and pensioners. Low-skilled workers (usually with lower education) expressed the lowest rate of personal concern (Lapka *et al.*, 2011). These findings again stand in contrast to some of the above cited research and the traditional assumptions of the effect of socio-demographics. These discrepancies may be caused by different cultural characteristics of the Czech Republic and US, where most of the cited studies have been carried out.

### 3.1.4 Social vulnerability

We argue that the perception of climate change impacts is particularly interesting when looking at people who are more likely to be affected by natural, social or economic hazards. The same socio-economic characteristics that tend to increase social vulnerability have often been associated with lower awareness of climate change; this lower risk perception, in turn, could further amplify this group's vulnerability.

Psychological studies indicate that risk perception is a decisive factor influencing people's adaptation capacity such as precautionary actions (Grothmann and Reusswig, 2006; Werg *et al.*, 2013). Grothmann and Reusswig (2006) describe risk perception (also called "threat appraisal") as a major process in the "protection motivation theory" (p. 104) and as such it is an important factor to explain e.g. health behaviour and damage prevention measures (Grothmann and Patt, 2005; Howe, 2011). So, we argue that higher risk awareness, especially personal risk awareness, is connected to adaptation capacity, i.e. the ability to prepare for some of the impacts of climate change (McCarthy *et al.*, 2001). This argument definitely cannot be applied to all of the natural, social and economic hazards that are the focus of the study. Private households can to a certain degree adapt to flooding, drought or sea level rise, but cannot anticipate and prepare for consequences such as scenery change, species extinction, new diseases, migration or financial regulation.

In order to distinguish between less and more vulnerable social groups, we refer to the concept of social vulnerability and classify respondents according to a generic social vulnerability index (Yoon, 2012). "Social vulnerability" refers to social characteristics that make people more prone to natural hazards like flooding, heat waves and storms: e.g. elderly people being more affected by heat waves (Adger, 1999). Since in this study we cover a wide range of hazards connected to climate change, we want to come up with a generic vulnerability index that consists of characteristics that make people in general more sensitive to stresses; in our case not even only natural stresses, but also social and economic ones. Looking into social vulnerability literature (Grothmann and Reusswig, 2006; Fekete, 2009; Werg *et al.*, 2013) income, age and education of the respondents are the socio-demographic factors that have proved to be relevant in very different hazardous situations and were included in our study:

- Income and age represent important factors connected to social vulnerability; older and poor citizens are more vulnerable to natural hazards such as heat, flooding and storms.
- Education seems to be a less important factor, but combined with income education is useful to indicate socioeconomic capacity (see Fekete 2009).
- The effect of gender is ambiguous; it is most likely to play a role when it comes to heat waves; but even here gender sensitivity is not fully explored.
- Urbanity is not suited as a generic indicator from the micro perspective; in many papers it only represents one of the major vulnerability variables since absolute damage costs/fatalities are higher in urban areas. The rural population in the Czech Republic is often less affluent, thus more vulnerable, yet this is not true for Germany.
- People under 18 are generally more vulnerable to hazardous situations. [1]

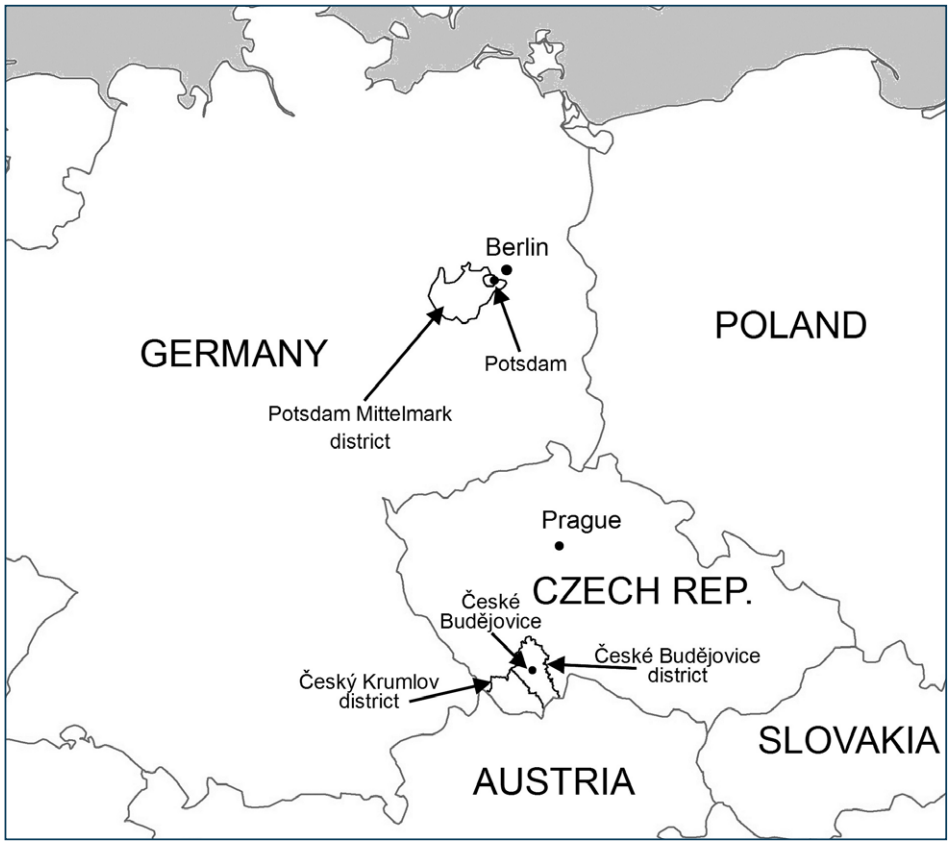
The perceptions of the older, poorer, and less educated segments of the population regarding climate change impacts are especially interesting, since some research indicates that they are less concerned about climate change (see the overview on socio-demographic effects above). On the other hand, previous results also suggest that these socioeconomic groups might place a high value on the more concrete hazards they are questioned about in our study: despite being less informed and by trend less aware of climate change, people with a lower socioeconomic status are very concerned about more concrete environmental problems, such as degradation and pollution of their local environment (Räthzel and Uzzell, 2009). Studies like Bord and O'Connor's (1997) indicate that this might also apply to climate change consequences: they focused on more specific effects of climate change and found a negative effect of education (more educated people being less concerned). So in this respect education and income might play a different role in our consequences-oriented study than in many other climate perception studies that focus on climate change as a general phenomenon.

[1] We did not survey people younger than 18 in our study and we have no information on the children's age living in the respondents' households.

## 3.2 Methods

The survey was conducted in spring 2010 as a part of the research project GILDED which focused on the energy consumption of European households. One region with an urban centre and rural surroundings was selected in each country. In Germany, the study site consists of the city of Potsdam (pop. 150 000), and the neighbouring district Potsdam-Mittelmark (pop. 205 000) which represents the rural area. The region is situated in the federal state Brandenburg surrounding the city of Berlin in Northeast Germany, a former part of East Germany. Czech study sites are the city of České Budějovice (pop. 95 000) and the rural areas of former administrative districts České Budějovice and Český Krumlov (pop. 145 000). These former districts are part of the South Bohemian Region, a relatively agricultural area with low population density. See map (Figure 3.1) and for detailed information about the areas see Vávra *et al.* (2010) and Reusswig *et al.* (2010).

**Figure 3.1.** Research areas: Potsdam district and České Budějovice and Český Krumlov districts




Source: ArcGis (own processing).

The questionnaires were personally distributed and collected ("drop and collect" approach) by the research staff and students in the Potsdam region and by a professional poll research company in South Bohemia. Altogether 1037 respondents participated in our survey, of which 537 were inhabitants of the Potsdam region and 500 inhabitants in South Bohemia. We combined cluster, random and quota sampling procedures aiming to achieve a representative sample. However the sampling is not representative regarding the share of urban versus rural households, since the objective of GILDED was to compare urban and rural subsamples. The samples for both case studies were relatively overeducated compared to the local population. We pay attention to this relative over-education when we interpret our results in the discussion. See Table 3.1 for information about the socio-demographic characteristics of the German and Czech samples. For the purpose of the statistical analysis, equivalent income was calculated from the disposable household income the respondents filled out in the

questionnaire by weighting it according to the consumption units (1 for first person, 0.5 for every other person)[2] and transforming it into quintiles.

We constructed an index of social vulnerability (SVI) inspired by previous indices successfully tested mainly in Germany (e.g. Fekete, 2009). The SVI was built as a dummy variable, i.e. a respondent belongs to the vulnerable group if he or she carries at least one of these characteristics: lower education, lowest income quintile or age over 65. It makes no difference if the respondents show one or more vulnerability traits. Our definition of vulnerability is rather broad, thus the number of the SVI group is quite high (see Tab. 3.1).

**Table 3.1.** Socio-demographic characteristics

| | Place of living (%) | | Gender (%) | | Mean age (SD) | Education (%) | | | SVI | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Urban | Rural | Male | Female | | Low | Middle | High | Non-vulnerable | Vulnerable |
| Czech Republic | 54 | 46 | 49 | 51 | 45 (15) | 32 | 51 | 17 | 55 | 45 |
| Germany | 50 | 50 | 54 | 46 | 50 (15) | 19 | 39 | 42 | 52 | 48 |

Note: CZE N = 500; GER N = 537. SD – standard deviation; low education – elementary school or lower secondary education (apprenticeship); middle e. – higher secondary education with graduation (maturita/Abitur) or non-university extension; high e. – any university degree.

Questions analysed in this chapter were part of the longer questionnaire focusing on energy consumption and opinions on climate change. Here we analyse the respondents' perception of the potential impact of 10 consequences of climate change. These 10 consist of: more droughts, more floods, appearance of new diseases, climate/energy tax, detraction of natural scenery, regulation of business and consumption, migration of people from endangered areas, accelerated species extinction, sea level rise and decreasing drinking water resources (water scarcity). These consequences were adapted from a 2006 survey of an international sample of students (Lapka and Cudlínová, 2007) and slightly modified.

The authors of the original questions based the item battery mostly on the IPCC projections of possible consequences of climate change. We asked for the impact of each consequence on three different levels (to myself, my country and the world); the importance of this distinction was explained in section 3.1.2. The question was phrased: "How much impact will each of the following potential consequences of climate change have at each of the three listed levels (you, your country, and the world)." Respondents had to rank the impact on a scale from 1 (no impact at all) to 5 (a major impact). They could also express the possibility that the suggested consequence is not likely to happen. For some analyses we work with the variable called "Average impact". This variable was calculated as the overall impact of each consequence (i. e. the arithmetic mean of the perceived impact on all three different levels). Table 3.2 shows the reliability (Cronbach's alpha) of the Average impact. Only the answers of the respondents who evaluated the impact for all levels were used for the calculation of this variable. However, respondents mostly indicated their opinion for all levels or did not fill in the information for any of the levels. The statistical analyses were carried out with IBM SPSS Statistics software.

[2] Since we have no information on the people's age living in the household, except for the respondents, we used a simplified version of the "OECD-modified-scale": first adult person = 1, other adult = 0.7, any person under 18 = 0.5.

## 3.3. Results

### 3.3.1 Overall description and comparison of the impacts

Table 3.2 shows that Czech respondents ranked water scarcity (decrease of drinking water resources) as the consequence with the highest overall impact, followed by floods, diseases, species extinction and droughts. Economic problems are perceived as less important as well as sea level rise. Czech respondents rarely express the opinion that one of the consequences is not likely to happen; on the other hand they quite often do not answer. Missing values occur especially with regards to the evaluation of the economic consequences and migration of the people. This could possibly bias the answers and increase the Czech mean values (if people with higher risk perception rather answered and those more critical did not take part).

In Germany, water scarcity, droughts and climate tax are perceived as consequences with a higher impact; other impacts received lower ranking. Interestingly, the number of people indicating that one of the consequences is "not likely to happen" is higher than in the Czech Republic, while the number of missing answers is lower.

**Table 3.2.** Overall average results

| | | More droughts | More floods | New diseases | Climate tax | Detraction of scenery | Regulation of business | Migration of people | Species extinction | Sea level rise | Water scarcity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Czech Republic | Ranking (Group) | 5 (2) | 2 (2) | 3 (2) | 9 (3) | 7 (3) | 8 (3) | 6 (3) | 4 (2) | 10 (4) | 1 (1) |
| | Average impact | 3.66 | 3.84 | 3.78 | 3.36 | 3.45 | 3.40 | 3.52 | 3.70 | 3.06 | 4.11 |
| | Average impact SD | 0.79 | 0.76 | 0.85 | 0.87 | 0.99 | 0.86 | 0.90 | 1.02 | 0.96 | 0.87 |
| | Not likely to happen (%) | 2 | 2 | 2.2 | 3.3 | 3.6 | 4 | 2 | 5 | 2.2 | 1.4 |
| | Missing answer (%) | 9.2 | 10.2 | 10.8 | 19.3 | 14 | 20.8 | 18 | 16.8 | 13.8 | 11.8 |
| | Cronbach's α (M+C+W) | 0.74 | 0.70 | 0.84 | 0.77 | 0.88 | 0.78 | 0.80 | 0.87 | 0.78 | 0.83 |
| Germany | Ranking (Group) | 2 (1) | 5 (2) | 8 (2) | 3 (1) | 4 (2) | 10 (2) | 7 (2) | 6 (2) | 9 (2) | 1 (1) |
| | Average impact | 3.58 | 3.31 | 3.22 | 3.51 | 3.33 | 3.19 | 3.23 | 3.26 | 3.19 | 3.63 |
| | Average impact SD | 0.73 | 0.75 | 0.95 | 0.94 | 0.85 | 0.82 | 0.89 | 0.91 | 0.86 | 0.97 |
| | Not likely to happen (%) | 3.9 | 3.5 | 12.3 | 8 | 4.8 | 8.6 | 6.7 | 6.0 | 4.1 | 5.2 |
| | Missing answer (%) | 6.0 | 7.7 | 5.6 | 6.2 | 5.6 | 5.0 | 6.0 | 6.1 | 4.8 | 4.7 |
| | Cronbach's α (M+C+W) | 0.73 | 0.69 | 0.87 | 0.83 | 0.80 | 0.83 | 0.77 | 0.81 | 0.75 | 0.83 |

Note: Ranking shows the overall position, however, the differences between the means of some consequences are statistically insignificant. The numbers in brackets (Group) show the group with insignificant differences of all means (within 95 % confidence interval), i.e. the Groups statistically differ one from each other. Average impact was calculated as mean of impacts on all 3 levels (myself, country, world), the scale was from 1 (no impact at all) to 5 (major impact). German N=537; Czech N=500.
There are four significantly different groups in South Bohemia and two in the Potsdam area.

### 3.3.2 Overall differences between the countries

As the results in Tab. 3.3 show, Czech respondents expect a higher impact for most of the consequences. Germans only rank the impact of sea level rise on the country level significantly higher, the impact of climate tax on the personal and country level, and the detraction of natural scenery on the global level. The biggest difference between both countries occurs in the assessment of the impacts on the personal and country level: Czechs apparently evaluate the impact of floods, water scarcity and diseases as more severe for themselves and their country, and species extinction as having a bigger impact on the national level. The least difference between respondents from both countries is shown in the assessment of the global level; their assessment on the global impact is similar in most cases.

**Table 3.3.** Differences in mean values of the expected impact between Czech Republic and Germany

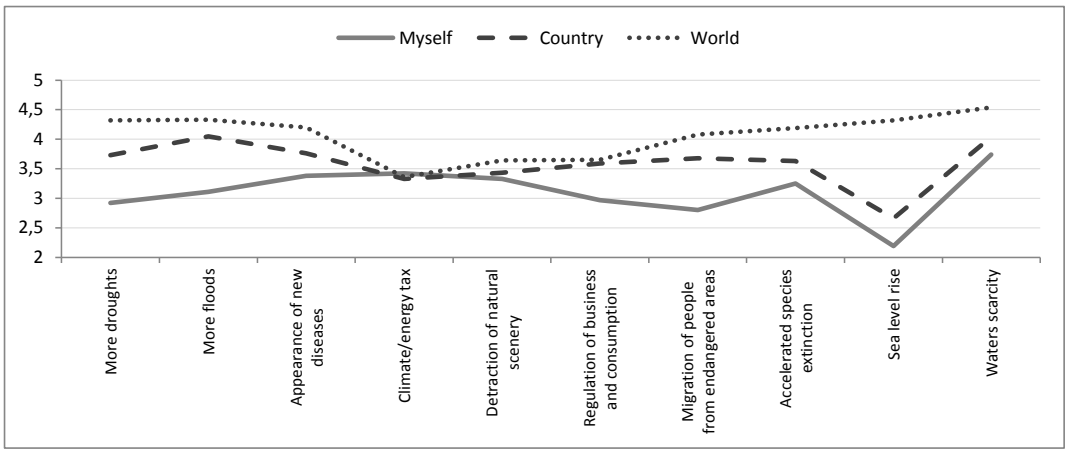
| | More droughts | More floods | New diseases | Climate tax | Detraction of scenery | Regulation of business | Migration of people | Species extinction | Sea level rise | Water scarcity |
|---|---|---|---|---|---|---|---|---|---|---|
| Average impact | 0.08 | 0.53** | 0.56** | -0.15* | 0.14* | 0.21** | 0.29** | 0.44** | -0.13* | 0.48** |
| Myself | -0.13 | 0.81** | 0.61** | -0.17* | 0.52** | 0.19* | 0.30** | 0.65** | -0.01 | 0.67** |
| Country | 0.31** | 0.66** | 0.68** | -0.25** | 0.24** | 0.38** | 0.23** | 0.47** | -0.49** | 0.68** |
| World | 0.03 | 0.03 | 0.38** | -0.02 | -0.38** | 0.06 | 0.35** | 0.17** | 0.08 | 0.11* |

Note: German N=441–501; Czech N=376–455. Independent samples T test with country as independent variable. Numbers are mean differences between Czech and German cases; Czech values are higher when the number is positive, German values are higher when it is negative. * $p < 0.05$, ** $p < 0.01$.

### 3.3.3 Impact on three different levels

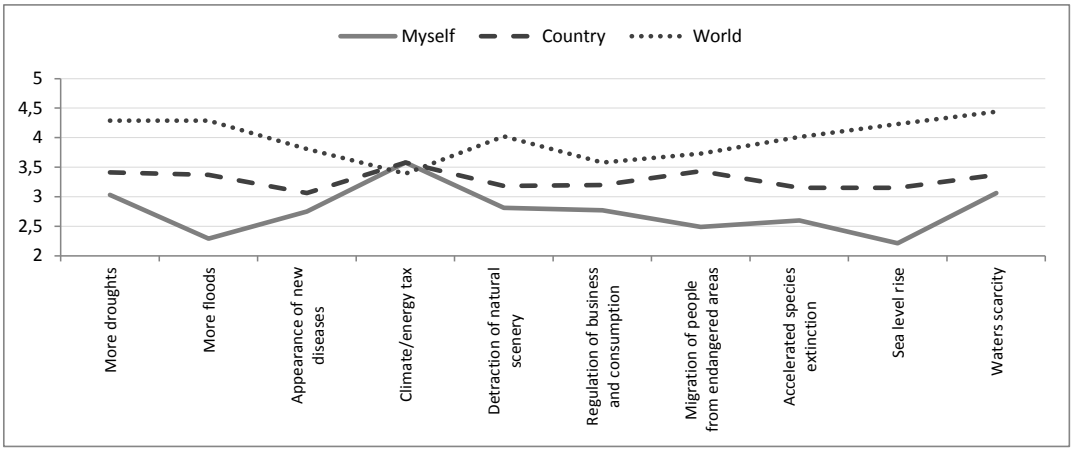
Regarding the respondents' different evaluation of climate change impacts on various levels, we can see a pattern whereby in almost all cases the impact is assessed as more severe on the higher level (world-country-myself) than the lower level. The difference in evaluation according to geographical distance is significant for most items. The exceptions are climate tax, detraction of natural scenery and business and consumption regulation in the Czech sample, and climate tax in the German one (see Fig. 3.2 and 3.3).

**Figure 3.2.** Czech Republic – all levels of impact




Note: Almost all of the differences between the levels (world-country, world-myself, country-myself) are statistically significant with $p< 0.01$, country-myself difference for the detraction of natural scenery is significant with $p< 0.05$. The world-country difference for regulation of business and consumption is not significant. Any differences for climate/energy tax are not significant. One sample T tests of the mean differences between the levels and 0. The original scale was from 1 (no impact at all) to 5 (major impact).

**Figure 3.3.** Germany – all levels of impact




Note: Almost all of the differences between the levels (world-country, world-myself, country-myself) are statistically significant with p< 0.01; the only exception is insignificant difference for climate/energy tax on the country-myself level. One sample T tests of the mean differences between the levels and 0. The original scale was from 1 (no impact at all) to 5 (major impact).

### 3.3.4 Effect of social vulnerability

The effect of social vulnerability varies according to the country and the level of impact (see Tab. 3.4). Vulnerable Czech respondents expect a higher impact on them personally for most of the consequences (except detraction of the scenery and regulation of business). On the country level this applies only for half of the consequences (e.g. more droughts or floods) and it does not apply at the global level.
In Germany social vulnerability is a much weaker predictor than expected: in a few cases the vulnerable population perceives a higher risk, mostly on the country level (e.g. water scarcity). Similarly to the Czech sample, the non-vulnerable population does not express a higher risk perception for any of the consequences. Nevertheless, in Germany the vulnerability status has no effect on the perceived risk for most of the climate change consequences (on different levels) while in the Czech Republic it has an effect on more than half of them.

**Table 3.4.** Differences in the mean values between vulnerable and non-vulnerable respondents

| | | More droughts | More floods | New diseases | Climate tax | Detraction of scenery | Regulation of business | Migration of people | Species extinction | Sea level rise | Water scarcity |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Czech Republic | Myself | 0.32** | 0.38** | 0.12 | 0.35** | -0.01 | -0.17 | 0.26* | 0.43** | 0.41** | 0.26* |
| | Country | 0.31** | 0.27** | 0.06 | 0.09 | 0.04 | -0.07 | 0.22* | 0.35** | 0.52** | 0.11 |
| | World | 0.08 | 0.09 | -0.02 | 0.16 | 0.06 | 0.04 | 0.09 | 0.18 | 0.12 | -0.05 |
| Germany | Myself | 0.12 | 0.21* | 0.10 | -0.03 | 0.12 | -0.05 | 0.06 | 0.05 | 0.11 | 0.18 |
| | Country | 0.06 | 0.07 | 0.19* | -0.01 | 0.12 | 0.12 | 0.09 | 0.21* | 0.02 | 0.24* |
| | World | -0.03 | 0.05 | 0.18 | 0.37** | 0.11 | 0.12 | 0.17 | 0.04 | -0.09 | -0.01 |

Note: Separate tests for Czech respondents (vulnerable N=164–196; non-vulnerable N=217–257) and German respondents (vulnerable N=214–236; non-vulnerable N=230–266). Independent samples T test with vulnerability as independent variable. Numbers are mean differences between the groups; vulnerable group values are higher when the number is positive, non-vulnerable group values are higher when the number is negative. * $p < 0.05$, ** $p < 0.01$.

### 3.3.5 Overall risk perceptions

Results presented in Tab. 3.2 and Fig. 3.2 and 3.3 suggest that the overall risk perception is higher in the Czech sample than in the German one. To check this, we calculated the general risk perception as an average of all 10 consequences of particular levels and compared them among the national samples. Czechs express more risks than Germans on the personal level (t=5.176; df=615.173; p=0.000), as well as on the country level (t=5.044; df=654; p=0.000) but not on the global level (t=0.988; df=645; p=0.324).[3]
We also tested the effect of social vulnerability on general risk perception (Tab. 3.5). The output confirms the results of table 3.4. The effect of social vulnerability is significant for the assessment of the impacts on the personal and country level in the Czech Republic (vulnerable respondents expressing higher risk perception), but not on the global level. In Germany, respondents' risk perception does not differ according to social vulnerability factors on any level.

**Table 3.5.** Effect of social vulnerability on overall risk perception

| | All impacts (myself) | All impacts (country) | All impacts (world) |
|---|---|---|---|
| Czech Republic | 0.26** | 0.17* | 0.04 |
| Germany | 0.11 | 0.13 | 0.11 |

Note: Separate tests for Czech (vulnerable N=118–123; non-vulnerable N=168–176) and German (vulnerable N=164–169; non-vulnerable N=194–197) respondents. Independent samples T test with vulnerability as independent variable. Numbers are mean differences between the groups; vulnerable group values are higher when the number is positive. * $p < 0.05$, ** $p < 0.01$.

### 3.3.6 Effect of socio-demographics

Finally, we want to analyse the effect of individual socio-demographic characteristics. We include the vulnerability traits (age, education and income) as well as nationality, gender and region (urban/rural) into the regression models. The population of both countries is analysed as one sample. Since the results show that the effect of socio-demographic characteristics differ in the Czech and German population, we focused on interaction effects in our analysis by dividing the demographic characteristics according to the nationality. The regression was calculated for two independent variables: the impact on the respondent's country and the gap between the impact on the global and country level (see Fig. 3.2 and 3.3). We chose to examine the country level and its difference when compared to the global effect, because the state level seems to be especially interesting to us. This is firstly, because at this level social and national differences in the evaluation of risk were apparent – unlike at the level of global risk perception and secondly because the national effects of climate change are arguably more meaningful than the effects for someone personally. Tables with the results of the regressions (3.6, 3.7) are presented in the Appendix. The overall explanatory power of the models is relatively low, but the results of the regression offer more detailed insights into the connection between risk perception of climate change consequences and social vulnerability. The most successful models explain about 13 % to 14 % of the variation related to the perceived impact of floods, drinking water scarcity and new diseases (cp. adjusted $R^2$). For the perceived impact on the country level (Tab. 3.5), nationality is clearly the best predictor. Socio-demographic effects are rather weak and explain very little of the variation, however, the effect is a little bit more pronounced in the Czech sample (as the results for the SVI already indicated). Especially low education repeatedly shows an influence in the Czech case: Czech respondents with low formal education perceive the impact of diseases, drought, sea level rise and species extinction to be significantly higher. In the German case low formal education is not connected to higher risk perception, but even shows a negative effect in the case of drinking water scarcity. On the other hand, low income has positive effects on risk perception in both cases. In contrast to that, elderly people do not show a higher risk perception, they by trend rather believe in a smaller impact. Interestingly, gender plays a more important role in Germany, where women are more pessimistic regarding the impact of climate taxes, detraction of scenery and especially water shortage on their country. In the Czech case study, women are only noticeably more concerned than men regarding the effects of potential drinking water shortage.

[3] Independent samples T test with respondents who assessed all 10 consequences on a particular level (CZE N=286–299; GER N=358–361).

The regressions clarify what factors of social vulnerability are most commonly connected to higher risk perception: low education and income in the Czech case, and low income in the German case. Except for senior groups, we can say that vulnerable income and educational groups seem to be more aware of some of the potential impacts of climate change in their country (more so in the Czech Republic) or have less confidence in their country's capacity to cope with the consequences.
Previous results (Fig. 3.2 and 3.3) suggest that the German respondents differentiate more in their evaluation of the global impacts of climate change compared to the impacts for their country (we call it "world-country impact gap") and seem to see Germany as rather detached from the problems on the global level. Regression results (Tab. 3.6) confirm this, especially in the case of more floods, detraction of natural scenery and water scarcity (accordingly the adjusted $R^2$ is relatively high: 14 to 17%). Gender, age and education have some effect; in both countries the lower income group believes in more similar effects on the global and national level (except the case of climate tax in Germany). Interestingly the German rural group of respondents shows the same tendency.

## 3.4. Discussion

The exceptional importance of drinking water scarcity, followed by the high ranking of floods and droughts in the Czech Republic, and droughts in Germany, is in accordance with the perceived severity of water related issues in many previous studies (e.g. Bord and O'Connor, 1997; Lapka and Cudlínová, 2007; Lapka *et al.*, 2011). Water issues really seem to be the most important and relatively easily imaginable potential consequences of climate change.[4] In one of the first studies on the perception of climate change, Kempton (1991) argued that people express more concern for the issues directly related to individual health and well-being. On the personal level, in both countries of our study, a decrease of drinking water and climate tax are perceived as most severe (accompanied by more droughts in Germany and new diseases in the Czech Republic). Kempton's more than twenty year old results from the US seem to be valid also for our populations.

Similarly to the previous US studies (e.g. Bord *et al.*, 1998; Leiserowitz, 2006), our results also suggest that the impact of climate change on the more abstract or global level (country, world) is almost always perceived as more serious. This could be caused by the fact, that the media are the main source of information about the rest of the world and they usually focus on the problems or catastrophes happening there, which could lead to our (often correct) perception that the consequences of climate change would be more severe (and more frequent) for the people in poorer nations.

Economic effects, particularly possible climate taxes, are one of the few consequences which received higher ranking in Germany than in the Czech Republic. We interpret this by the different states of the public discussion about energy and climate change in the two countries. In the more environmentally oriented governmental approach in Germany, climate tax seemed to be a more realistic option, while in the Czech Republic in 2010 this was quite improbable. However, the number of people who expressed the opinion that climate taxes "are not likely to happen" is higher in Germany than in the Czech Republic. On the other hand, many Czech respondents did not answer the item about climate taxes (highest percentage of missing values, together with business regulation). We think that many people find these consequences improbable, hard to link with climate change or to evaluate economic impacts alongside more fundamental ones.

The higher perceived risk of sea level rise among the German population is of course due to the presence of the sea in their country. Regarding the relative higher ranking of droughts in Germany we see a connection to the results of the national survey of the German Environmental Agency (Rückert *et al.*, 2013): as we mentioned in the introduction, this study indicated that people are most worried about heat waves. We did not include heat waves in our questionnaire, but we can hypothesize that people link droughts and heat waves in their minds, so our results then would be in line with the aforementioned research.
Czech respondents expressed lower attention to the possible economic consequences of climate change (or

[4] The explanation is not only theoretical, it is based on the Central European experience as well. Serious floods took place in South Bohemia in the last decade (2002, 2013) and a very hot dry summer too (in 2003 to mention at least the most severe one). In Potsdam and Potsdam-Mittelmark the summer of 2007 was marked by severe heat and droughts. The last, though not very damaging, flood occurred in 2011, but the region is less prone to floods in general, compared to South Bohemia.

rather the economic costs of its mitigation) than in a similar study in 2006 (Lapka *et al.*, 2011). This could be explained by the change in governmental policies and public discourse – in a 2006 climate tax or any other business regulations seemed more probable than in 2010, when the government focused mostly on the issues of austerity and restarting the growth.

In general Czech respondents express a higher perception of risk on the personal and country level (but not on the global level) than Germans. This suggests that climate change as a global threat is commonly understood in both nations. The generally worse expectations of the Czech respondents are supported by another study, where Czechs rank almost any of the offered global problems (climate change, economic downturn, terrorism, migration, etc.) higher than Germans (Lapka and Vávra, 2011). According to the European Quality of Life Survey, Czechs are also more pessimistic about the future and express less trust in other people as well as in their political institutions (especially in the parliament, legal system and government) than Germans (Eurofund, 2012). Additionally, research indicates that the political and institutional setting of society is more important for the Czechs' life satisfaction and that they face objectively worse governance (Böhnke, 2008). Summarizing this, we argue that the higher risk perception of the Czech respondents could be caused by high mistrust in state efficacy to manage the possible impacts of climate change consequences and, possibly, by a lower expectation in overall societal solidarity.

Another interesting point is that according to previous research (Pugliese and Ray, 2011) Germans feel more personally threatened by climate change than Czechs do. In our study, however, Czechs appear to be more worried about the effect of many particular climate change impacts on them personally and on their country. One could argue that when asked about climate change in general, Germans are able to link the broad phenomenon of climate change to potential consequences and thus feel more at risk. Czechs understand climate change as something rather abstract, distant (maybe also less salient) and do not feel affected by its consequences, unless these are explicitly listed. We found a similar pattern in the work of Bord and O'Connor (1997) and Kellsted *et al.* (2008).

As stated earlier, the link between risk perception and adaptation capacity that is founded in vulnerability studies can only be applied for some of the climate change consequences we examine in the chapter. At least for some of the consequences, though, the elderly and people with a lower socioeconomic status are probably more affected, e. g. floods, diseases, migration and also financial consequences. And indeed, in the Czech case, the more vulnerable group expect more severe effects for themselves and their country regarding many of the climate change consequences. That is different in the German case, where the more vulnerable group does not show a higher risk perception for themselves. However, the German respondents with lower income do tend to assume higher impacts for their country regarding the appearance of new diseases, sea level rise, water scarcity and business regulation.

We also argued that it is interesting to link perceived risk with social vulnerability, because generic social vulnerability encompasses social characteristics such as low socioeconomic status that are often prematurely – mainly in non-scientific contexts – connected to lower climate change awareness. Like previous research, especially the studies that deal with more specific phenomena connected to climate change, our results suggest that lower income and education groups by trend even have a higher risk perception.

Our study also confirms previous findings on the effect of the respondent's age: elderly people in Germany evaluate the impact of sea level rise and the regulation of business and consumption as less severe for their country then other German respondents; also in the Czech case elderly respondents appear to be less concerned about economic regulations.

However, the effect of socio-demographics has to be qualified by the overall low explanatory power of the socio-demographic factors in the regressions. The regressions show that the national differences in risk perception are considerably more substantial. Also, since the question design was quite complex, potential response sets have to be taken into account: in the Czech data lower education shows a comparatively strong positive effect on the perceived risk regarding sea level rise. Sea level rise is obviously not going to affect the Czech Republic (if we assume a more or less direct effect), so this might indicate that the responses of the lower educated people in the Czech Republic do not mirror an informed, higher perception of risk, but could be connected to a response set, i.e. a systematic pattern of choosing a certain type of category, in our case the higher end of the scale, because of social desirability or the complexity of the set up.

## 3.5. Conclusion

Our results confirm the importance of water related issues as consequences of climate change, which are of highest public concern in many countries. It seems useful to communicate the problem of climate change through the topics the public is most concerned about. However this does not automatically assure stronger public engagement in climate change mitigation and adaptation measures – the attitude-behaviour gap is a well-known problem.

The perception of severe climate change impacts on the global level is relatively similar in the Czech and German case study, while the Czech and German respondents differ most in their assessment of impacts on the country level. Czech respondents appear to be more concerned about most of the consequences and they also show bigger socioeconomic differences in risk perception. Nevertheless the effect of particular socio-demographics is not very strong (though significant) and quite complex. Overall concern for the impacts is higher in the Czech case study. We argue that this could be due to a different level of perceived social efficacy in the two countries.

This link between risk perception and perception of political, institutional and social settings, as well as the connection between risk perception and realisation of (or demand for) mitigation or adaptation measures on the personal or social levels in Central European countries are challenges for future research.

We would like to thank Zuzana Dvořáková-Líšková and Josef Maxa (University of South Bohemia) for the map preparation.

### Appendix

**Table 3. 6.** Multiple linear regression of impact on country level

Independent variable: impact on the respondent's country

| | More droughts | More floods | New diseases | Climate tax | Detraction of scenery | Regulation of business | Migration of people | Species extinction | Sea level rise | Water scarcity |
|---|---|---|---|---|---|---|---|---|---|---|
| Country (1 GER, 2 CZE) | 0.16* | 0.34*** | 0.37*** | | 0.18* | 0.21** | | 0.22** | -0.29*** | 0.25*** |
| Region (1 urban, 2 rural) | | | | | | | | | | |
| Rural CZE | | | | | | | | | | |
| Rural GER | | | | | | | | | | |
| Gender (1 male, 2 female) | | | | | | | | | | |
| Female CZE | | | | | | | | | | 0.14** |
| Female GER | | | | 0.09* | 0.10* | | | | | 0.15*** |
| Age (0 no,1 yes) | | | | | | | | | | |
| >65 years CZ | | | | | | -0.11** | | | | |
| >65 years GER | | | | | | -0.08* | | | -0.07* | |
| Education (0 no,1 yes) | | | | | | | | | | |
| Low edu CZE | 0.10* | | 0.08* | | | | | 0.12** | 0.17*** | |
| Low edu GER | | | | | | | | | | -0.14** |
| Income (0 no, 1 yes) | | | | | | | | | | |
| Low income CZE | | | | | | | 0.08* | 0.11** | 0.09* | |
| Low income GER | | | 0.09* | | | 0.09* | | | 0.09* | 0.08* |
| Adj $R^2$ | 0.04 | 0.14 | 0.13 | 0.02 | 0.02 | 0.07 | 0.02 | 0.07 | 0.07 | 0.14 |
| VIF <= | 4.16 | 4.15 | 4.25 | 4.13 | 4.18 | 4.17 | 4.19 | 4.15 | 4.12 | 4,19 |
| N | 835 | 837 | 791 | 777 | 816 | 778 | 804 | 785 | 819 | 824 |

Note: Multiple linear regression, cell entries are standardized coefficients (β). Enter method, only statistically significant β are presented. * p<0.05, ** p<0.01, *** p<0.001.

**Table 3.7.** Multiple linear regression of world-country impact gap

Independent variable: impact gap world-country

| | More droughts | More floods | New diseases | Climate tax | Detraction of scenery | Regulation of business | Migration of people | Species extinction | Sea level rise | Water scarcity |
|---|---|---|---|---|---|---|---|---|---|---|
| Country (1 GER, 2 CZE) | -0.22** | -0.46*** | -0.24** | | -0.57*** | -0.15* | | -0.20** | 0.23** | -0.37*** |
| Region (1 urban, 2 rural) | | | | | | | | | | |
| Rural CZE | | | | | | | | | | |
| Rural GER | -0.18*** | -0.12** | | | -0.12** | | | | | -0.09* |
| Gender (1 male, 2 female) | | | | | | | | | | -0.12** |
| Female CZE | | | 0.16*** | | | -0.10* | | | | |
| Female GER | | | | | | | | | | -0.12*** |
| Age (0 no,1 yes) | | | | | | | | | | |
| >65 years CZ | | | | | | 0.08* | | | | |
| >65 years GER | | | | 0.16*** | | | | -0.12** | | |
| Education (0 no,1 yes) | | | | | | | | | | |
| Low edu CZE | | | | | | | | | -0,14*** | |
| Low edu GER | | | | -0.15** | | | | | | 0.10* |
| Income (0 no, 1 yes) | | | | | | | | | | |
| Low income CZE | -0.08* | -0.10** | | | | | | | -0.08* | |
| Low income GER | | | | 0.08* | -0.09* | | | | -0.11** | -0.12** |
| Adj $R^2$ | 0.05 | 0.15 | 0.05 | 0.06 | 0.17 | 0.05 | 0.01 | 0.06 | 0.08 | 0.14 |
| VIF <= | 4.16 | 4.15 | 4.26 | 4.14 | 4.18 | 4.19 | 4.19 | 4.18 | 4.14 | 4.21 |
| N | 828 | 825 | 785 | 764 | 808 | 768 | 792 | 780 | 817 | 822 |

Note: Multiple linear regression, cell entries are standardized coefficients (β). Enter method, only statistically significant β are presented. * p<0.05, ** p<0.01, *** p<0.001

# *4. THE ROLE OF PERCEPTION IN ADAPTATION TO FLOODS: THE CASE STUDY OF BEČVA RIVER*

*Barbora Duží, Dmytro Vikhrov, Robert Stojanov and Ilan Kelman*

**Abstract**
This chapter investigates regional and household adaptation strategies in the region affected by diverse floods within the past 15 year period. The main research question focuses on the overall state of adaptation measures to floods in the rural area of the Bečva river basin, with respect to the the role of perception of flood risk. The target area is located along the upper and middle parts of the Bečva river basin in the eastern part of the Czech Republic. The main theoretical concepts draw from the concept of focusing events and perception of flood risk with relation to adaptation measures to flood risk protection.

In the empirical part, we use a mixed methodology and case study approach. Firstly, we conducted a qualitative research through in-depth interviews with relevant stakeholders (N=21), to serve as an initial lead-up to the issue and explore perception of individual stakeholders. Then we proceeded with quantitative research by conducting face-to-face questionnaires with household residents (N=304) in high, low and no risk areas in relation to flood occurrence, to find out if perception influences adaptation strategies. The qualitative research revealed in-depth local knowledge of the region and high awareness of weather fluctuations (flood and also drought risk) and its potential consequences. On the other hand, most of respondents were also aware of the limits of adaptation measures that have been taken up to now. Quantitative research detected that perception of flood risk significantly influences adaptation measures of the households, but the level of household adaptation measures is generally very low. Generally speaking, although regional bodies and households have taken some coping and adaptation measures to floods, complex ways of adjusting to climate extremes remain underdeveloped.

**Keywords**
Floods, perception, climate extremes, households, adaptation, coping, regional management, Bečva river basin, local knowledge.

## Introduction

In this chapter we focus on connection among the river flood experiences, adaptation and perception of the environmental/climate change. Even though river floods have been affecting human population for a long time, scientific evidence notify some weather changes only in the recent decades. For example Hansen, Sato and Ruedy (2012) point out that seasonal mean temperature anomalies within the last 30 years, compared with 30-year averages, have shifted toward higher temperatures. Moreover, according to more detailed statistical comparison, Coucou and Rahmstorf (2012) add that especially the last decade has experienced an exceptional number of unprecedented extreme weather event occurrences.

We simply apply the definition of extreme weather events according to the special IPCC report "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" - shortly called SREX (IPCC 2012). It defines *climate extremes* as "the occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable." For the purpose of the chapter we refer to both extreme weather events and extreme climate events as "climate extremes" (IPCC 2012, p. 5). Floods are not climate extremes itself, but represent an impact of these events. Flood usually results from heavy or longer-term rainfalls or snow melts and include floods from rivers, mountain torrents, and floods from the sea in coastal areas. Flood risk the combination of the probability of a flood event and of the potential adverse consequences (Directive, 2007).

With local trends, such as in the Central Europe, often not matching global trends (IPCC 2012), people's perceptions of the river flood risk and their adaptation responses to this perceived risk can be complex and are worthy of continued study. That is particularly the case of urban development, river engineering, and agriculture amongst other human activities can have more influence on river flood risk than climate change (e.g. Begum *et al.* 2007; Djordjevič *et al.* 2011; Mechler and Kundzewicz 2010; van Ree *et al.* 2011).
Complexity of flood risk phenomena, climate change and societal response is worth to study and analyse. IPCC Report (2012) point out that does not depend only on climate extreme itself, but the level of societal vulnerability and exposure to those risks. Directive 2007/60/EC on the assessment and management of flood risks also stress importance of flood as being natural phenomena which cannot be prevented. However, some human activities and climate change contribute to an increase of adverse impacts of flood events.

The Czech Republic has experienced numerous flood disasters throughout its history, the most recent at the national level being in 1997, then 2002, 2006, 2010, and 2013. While some studies on flood risk in the Czech Republic were performed (e.g. Dráb and Říha 2010; Rodda 2005), little work has been done regarding application of individual, household, and community actions for, and perceptions of, the flood risk. This chapter makes a contribution to filling in this gap in the literature by analysing evidence from household interviews regarding experiences with, perceptions of, and actions taken regarding the river flood risk.

The research aspires to connect environmental and social research and combine several research methods to acquire a complex view on social reality to enable a deeper understanding of what adaptation measures mean for various stakeholders and households in the region. The key research approach is the case study approach, and we also apply a mixed methodology of survey, combining qualitative and quantitative research methods. While the qualitative interviews serve as an entry-point to the issue and try to catch the respondents' thinking concerning the relation to rivers and preparedness for unexpected extreme events in general, the quantitative research focuses on a particular set of questions related to factors influencing adaptation measures on the household level. The overall research is enhanced by field observation, maps and regional documents analysis.

This chapter has five sections following this introduction. Section 1 and 2 places this study in the context of flood risk and adaptation to the climate change publications, focusing on flood risk perceptions alongside household and regional measures in the context of the climate change. The case study is described in Section 3 followed by Section 4 describing framework and methodology. The final sections, results and discussion followed by conclusions, indicate the key lessons and how to move forward from the new knowledge presented.

## 4.1. Social adaptation to climate extremes

The IPCC Special Report (2012) draws an attention to long term adaptation to climate extremes, to explore uncertainty management and look for the ways to reduce societal vulnerability and potential damages in exposure to climate risks. Climate change poses impacts in the forms of changing patterns and distribution of precipitation and changes of intensity of and frequency of weather extremes and thus call for more advanced ways of societal response to these threats.
According to Heffernan (2012), adaptation as a strategy to cope with climate change has not stayed, in contrast to mitigation strategies, at the centre of scientific focus so far. But recently, the reality of climate extremes in the form of extreme events like floods, droughts or heat waves (Lass *et al.* 2011) has forced researchers and policy-makers to explore ways to handle these extremes and adaptation to climate change has become more current and necessary than ever before.

Generally speaking, adaptation is seen as a common strategy of living organisms in adjusting themselves to changing environmental conditions including those related to climate. Climate change adaptation as a theoretical construct with practical measures is framed more specifically as "an adjustment in natural or human systems in response to actual or expected climate stimuli to their effects, which moderates harm or exploits beneficial opportunities" (McCarthy *et al.*, 2001, p. 982). Many regions face to large natural and societal damages due to a combination of increased economic and residential welfare in flood-prone areas and increased the societal vulnerability and incapability of handling climate extremes (Kreibich *et al.* 2005), climate change and its impacts. This trend imposed an urgent need to apply effective adaptation strategies, combining risk and disaster management together with a high level of anticipation use and treatment of uncertainty (Quevauviller 2011, Edgar *et al.* 2005).

Facing the occurrence of climate extremes, generally two main ways of adaptation are being applied in society. The IPCC report (2012) frames these strategies as coping and adaptation. While coping is about the use of available skills and resources to respond to actual risks and the aim to return things to a previous state of affairs, adaptation is rather anticipative, pro-active and about imposing some structural changes within the longer term horizon. Coping focuses on ensuring human safety and security, while adaptation extends human dimension by natural environment and their relationship. As such, coping strategies are the base on which adaptation strategies are built, thereby extending coping strategies into a longer-term perspective. Applying both strategies simultaneously means that each supports the other, simultaneously covering all time scales.

## 4.2. Which factors influence adaptation?

The authors of the Special IPCC Reports are not the only ones who call for cooperation with social scientists that explore relations between environment and society. Although some socio-economic studies on climate-related extremes have recently been conducted to calculate the potential damages and other consequences (Travis 2010; Pearce, Dessai and Barr 2012; Mills 2012 and many others), many uncertainties and tasks remain. Nevertheless, one of the main contributions of social sciences is exploring social theories and their application in particular case studies. Social sciences are beneficial in analysis of the societal adaptation state of mind of or factors limiting/enabling the application of adaptation measures on an individual as well as a regional or state level.

We should mention Adger *et al.* (2012a) exploring socio-political circumstances, particularly the concept of social contracts between state and individuals as a key factor influencing the adaptation to climate change/extremes. Authors focus on relationship between household expectations regarding role of state in assuring protection against floods and the level of individual responsibility. They argue for the need to make social contrasts explicit to promote longer-term adaptation.

Another important field of research is on the question of framing climate events from a negative point of view (for example Dessai 2003; Hansen 2012; Travis 2010) as risk/threat/danger/disaster or as a challenge. The challenge is meant narrowly as improving the risk system preparedness or the relevant coping strategies, as well as an opportunity to understand and manage risk and implement long term and effective adaptation strategies in all society sectors. Many authors also agree that one of the main challenges is to change "business as usual" and translate these draft changes into the "real world" (Kundzewicz 2004; Mechler and Kundzewicz 2010; IPCC 2012).

Perception of climate change belongs among another important factor, although difficult to quantify. Using mental models could help to find out how these models frame people's understanding of the environment which methods they use to solve various problems they face, and how these relate to practice. Otto-Banaszak *et al.* (2010) focused on the perception of experts engaging in the case of the climate change agenda. The results pointed out differences not only among sectors and stakeholders (science, policy makers, practitioners), but they also found regional differences. The results reveal that adaptation to climate change and its manifestations in climate extremes could not be framed as an implementation of a set of universal recipes or one size-fits-all strategy, but need to be sensitive to regional and historical specifics. Moreover, Adger *et al.* (2012b) point out that climate change perception and adaptation is strongly influenced by cultural factors. The cultural factors are strongly linked to local knowledge, historical memory, attachment, habits, and livelihood strategies and could present themselves as obstacles or be beneficial for the climate change adaptation.

When framing the issue, perception and some specific factors are one side of the problem, while practice and implementation are second. Kreibich (2012) explores this important link between *perception and practice*. She realised quantitative research dealing with the motivation of household residents to undertake some precautionary measures against floods and climate change perception. This research revealed that the majority of respondents agreed with the manifestation of climate change as extreme weather events. But despite this fact they found out that perception is weakly connected to motivation for taking any measures and also that socio-economic factors were revealed to be more important.

Grothmann and Reusswig (2006) also researched household protection against floods and framed through self-protective behaviour. They developed a model of precautionary adaptation based on an extended protection-motivation theory to explore how *socio-psychological factors* influence self-protective behaviour. The research

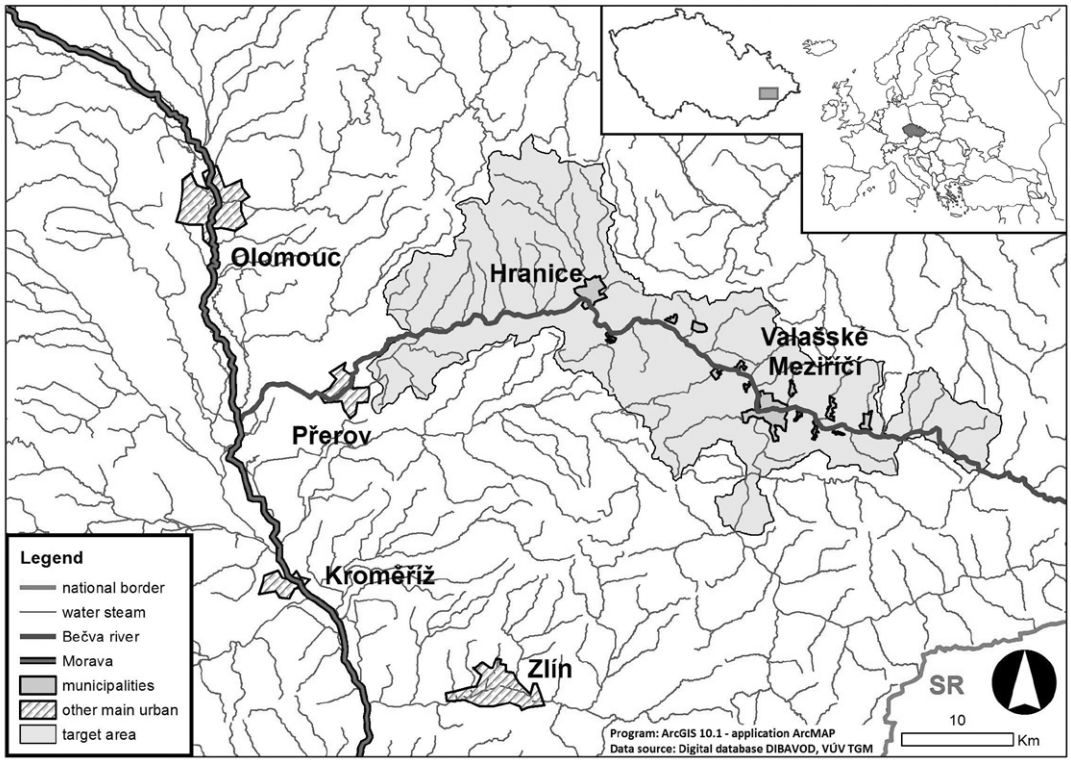
showed a strong correlation between experience of threats and protective measures; the strong correlation also indicated socio-economic characteristics like age, household income and ownership.
In our research we focus on factors like experience with climate extremes, local knowledge, relation to the river or local streams and social and economic surroundings. We assume that these factors have been underestimated in previous research and thus could bring some regional and cultural specifics into adaptation to climate extremes.

Moreover, direct experience, contrary to mediated theoretical evidence (Weber 2010), is appreciated as one of the key factors that could serve as a focusing event. Concept of focusing event of a sudden, unpredictable event that strongly influences human life and policy making was developed by Birkland (1997). He examine if some extreme events occurrence (natural or anthropogenic) could contribute to the process of catching the attention of stakeholders and speed up the process of decision- making to apply feasible solution or not. Birkland also put attention to the process of learning through experience and promoting new and complex ways of solutions (Birkland 1997; Kreibich *et al.* 2011).

## 4.3. The case study: Bečva river basin

The selected study region is located in the east part of the Czech Republic, on the middle part of the river Bečva which is an inflow of the Morava. This rural region remains economically disadvantaged, even for the Czech Republic and Central Europe (Morava basin Board s.e. 2009). Regional economic development mainly draws from tourism, food processing, agriculture and a chemical industry.

The elevation of target area ranges from 260 to 800 m a.s.l. The climate is characterised by a slightly warm, moist climate with average annual precipitation from 650 to 800 mm. This is a site in the central part of the Bečva river basin in the foothills of the Beskydy Mountains covering an area of about 184 square km. The area has a hilly character with a relatively ragged relief, sandstone and clay combination bedrock. The selected area involves about a 30 km long section of the river. Among the most important tributaries of the Bečva are the rivers Loučka in Valašské Meziříčí and the Juhyně near Choryně village.



In recent past, the area was affected repeatedly by floods. Typical summer floods, in terms of hydro-meteorological variables, occurred in 1997 and 2010 due to heavy rainfalls lasting several days. The 1997 flood (Q100 to Q800) was evaluated as the most serious flood in the 20$^{th}$ century. The particular monthly precipitation amounts in the study area exceeded 50% compared with the annual norm of the reference period of 1961-1990; in the highest parts of the Beskydy Mountains even around 80% (CHMI 1997). During the flood in July 1997, the highest flow rate the Bečva river reached in Teplice nad Bečvou (up to 950 $m^3 s^{-1}$) and at the same station in May 2010 the flow rate was about 246 $m^3 s^{-1}$. The average annual flow rate is just 12.68 $m^3 s^{-1}$ (CHMI, 2010). Moreover, some places in the monitored area were affected by floods more frequently – these usually involved minor floods of local character in 2006, 2007 and 2009.

Within the studied area, the lowest parts of the municipalities in the floodplain of the Bečva were affected. Quite significant damages were also caused by the high water level, which flooded cellars of homes farther from the river - depending on the nature of the terrain and other conditions. The situation in the spring of 2006 and 2009, during which there was an increase in water levels due to a combination of precipitation and water from snow melting in the river basin, was a somewhat different type of flood.

Apart from the exposure to floods from the Bečva, many settlements in the researched region have been repeatedly flooded from the nearby streams. These are smaller but very quick floods caused by very intense precipitations that occur in the smaller space. When a large part of such a rainfall falls into a collection area of smaller catchment, especially with the soil already saturated from previous rainfall, an outflow of water from the landscape and subsequent flooding rapidly occur. Flash-floods have traditionally been characterized by significant damage - they come very quickly and cannot be reliably predicted, and also occur in areas where human society does not have much experience with the flood risk caused by a major river (e.g. often along watercourses flowing directly through the centre of a village).

As the impacts of climate change and river floods in the Czech Republic have so far been researched only a little (e.g. Brázdil *et al.* 2011a, b; Dubrovský *et al.* 2005; Yiou *et al.* 2006), the work has principally been on larger river basins. For the smaller watercourses, researchers and authorities suffer from a lack of data (see Borga *et al*. 2011).

## 4.4. Methodology, data

In survey we use case study approach and mixed methodology used in social sciences to get more complex view on social reality to enable deeper understanding of what adaptation measures mean for various stakeholders and households in the region. Combining qualitative and quantitative approaches is successfully used by scientists conducting empirical research to cover human–environmental interactions (Lorenzoni and Langford 2006). In our research, qualitative interviews serve as an entry-point to the issue and try to catch the respondents' thinking concerning the relation to the river and the general state of preparedness for unexpected extreme events in general. Quantitative research focuses on a particular set of questions related to factors influencing adaptation measures at the household level.

In the target area we selected 12 villages located along the Rožnovská Bečva and the Bečva. The villages are rather small, with an average number of 2000 inhabitants, the smallest being Lhotka nad Bečvou (246) and the biggest Zubří – with over 5000 residents.

### 4.4.1. Introductory problem-oriented qualitative interviews

We interviewed 21 respondents from different sectors, trying to cover a wide scale of opinions of relevant stakeholders. Table 4.1. shows the proportion of respondent according to expertise.

**Table 4.1.** The scale of interviewed respondents

| Respondents | Number |
|---|---|
| **municipality authorities** | 4 |
| **non-governmental organizations** | 2 |
| **public policy** | 6 |
| **watercourse administrators** | 3 |
| **relevant local experts** | 2 |
| **researchers** | 4 |
| **TOTAL** | 21 |

We applied the intended selection in advance to cover the relevant respondents and to get an overall mosaic of opinions. Municipality authorities are regarded as key stakeholders having responsibility for the development of the municipality, influencing the direction of development and cooperating with others on the flood or drought agendas. Representatives from public policy take responsibility for a regional development or provide public services. We selected respondents from the crisis management, environmental policy and the Beskydy Protected Landscape Area, the meteorological service and members of the flood committee. Watercourse administrators, in this catchment the Morava River Board s. e. and for small streams the Forests of the Czech Republic s. e. provide management of the water courses (including small streams) and river basins, realize the set of measures influencing the face of the water stream and coordinate these actions with municipalities, the public, and so on. Researchers covering fields of landscape ecology, civic engineering or water management, provide a detached view on the issue. We also added two members of the non-governmental sector to enrich the discussion over the direction of the water stream and management of protected areas and so called local experts, one member of a regional museum and one chronicler. We are aware of the fact that all respondents (except researchers) who live in the area are considered to be local experts in some way.

Problem-oriented, semi-structured interviews were structured according to a cluster of questions containing general instructions that changed according to respondents' backgrounds. The main clusters were:

- Relation and knowledge of the river, including flood risk potential and experiences with river or flood
- Description and perception of the level of flood preparedness and of adaptation measures
- Perception of environmental change, including climate change

The main research theme focused on the overall state of adaptation measures to climate extremes on the Bečva river basin on a regional level. In this way we identified additional research topics: Is there any shift from coping strategies to longer term adaptation measures in the region? What is the local knowledge, experience and perception of the river? Which focusing events influence the state, development and direction of agenda setting in the region?

We have already described the main distinction in these approaches in general. In Table 4.2 we try to apply these approaches at the regional level and propose some examples for discussion. We assume that coping strategy focuses rather on "maintenance, reconstruction or improvement of existing infrastructure", and adaptation focuses on "innovations", "long term horizon" and looking for balance between natural environment and human settlements and infrastructure. Coping strategies help region to be better prepared and protected through a set of measures, starting with forecasting and ending with an anti-flood infrastructure, while adaptation strategies besides trying to cope also bring an additional level: long-term strategies and complex land-use change with the overall aim of achieving better societal adjustment to a changing environment.

**Table 4.2.** Distinctions between coping and adaptation to climate extremes on a regional level

| Strategy | Coping strategy | Adaptation strategy |
|---|---|---|
| **Time scale** | Short to middle term scale | Middle to long term scale |
| **Range** | Mainly human, also natural systems | Human and natural systems |
| **Type of Reaction** | Emergency preparedness: rather a set of emergency reactions/regulations in case of occurrence of extreme events. Reconstruction of damaged infrastructure. | Future preparedness: rather complex, future anticipation, pro-active actions based on developing more resilient systems to handle potential impacts. |
| **Type of agenda** | Closer to traditional Disaster and Risk Management, Crisis Management | It is an emerging issue, although the first attempts to involve long term measures have been registered in Strategic Plans, National Adaptation Strategy. |
| **Examples** | Short, middle term set of measures:<br>- flood risk management plans<br>- weather forecast system<br>- early warning systems in affected areas<br>- integrated rescue system (evacuation system, first aid, fire-fighter preparedness)<br>- regulation measures in case of drought incidence (drawing water from rivers, ban on setting fires)<br>- wide range of anti-flood measures on rivers with the aim of protecting residents and human settlements (walls, dams, stream regulation).* | Long term complex policy adaptation measures to floods, droughts:and other climate extremes and their impacts:<br>- integrated Water Management Plans (complex water management in case of flood risk and drought risk, to connect management of the key economic sectors, water and natural environment, including ecosystem services by sustainable way)<br>- complex changes and adjustments in land use planning (i. e. management of human settlements and infrastructure avoiding constructions in floodplain areas, giving the rivers more space to inundation, combination with retention reservoirs)<br>-changes in land use patterns (nature-friendly forestry, agriculture and water management to improve retention capacity of the landscape and reduce soil and water erosion)<br>-restoration of natural landscape functions (e.g. revitalisation of watercourses and floodplains including support of natural flood inundation and restoration of wetlands, natural mixed forests and floodplain forests) |
| **Aim** | To be prepared for potential and actual risk events and to cope effectively with risk in case of occurrence | To avoid or to moderate the impact of potential climate extremes in advance through large-scale adjustment of human and natural systems. |
| **Frame** | Response, Risk | Challenge, Pro-active approach |

* It is questionable whether technical anti-flood measures belong to coping strategy columns. They are designed to be long-term, but are aimed to protect humans rather then to give complex solution which takes into account natural environment with its ecosystem functions and services (functions that are directly beneficial to human)

Source: Authors' own arrangement based on Huntjens and Pahl-Wostl (2010), IPCC (2012) and National Adaptation Strategy to Climate Change of the Czech Republic (being prepared)

### 4.4.2. Quantitative survey, conducted through a questionnaire survey among local residents

We conducted a face-to-face survey through a questionnaire inquiry (N=304). We interviewed representatives of households with the aim of investigating the state of household adaptation especially to flood risk.

For major rivers, maps and data are publicly available from the Czech authority DIBAVOD (Digital Water Management Information) based on Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 (the Water Framework Directive) as incorporated into the Czech Water Act No. 254/2001. The main condition of the selection of respondents was permanent residence on the site and ownership of a family house in order to cover owners who are responsible for the treatment of the house. The main input criterion of spatial selection was division of the area into very low, low- and high-risk zones according to flood risk. Extent of inundation areas of the Bečva river was divided into 3 zones - zone of high risk (defined by the extent of the flooded area Q20), low risk zone (between the limit of the range Q20 to Q100) and very low risk zone (outside

the areas flooded by Q100s). All these zones were extended to floodplain areas of small watercourses during our field survey based on expert estimates, consultations with local experts, household experiences with floods and other available data.

Generally we can say that in the zone of high risk only households affected by repeatedly devastating floods in the past 15 years are located. The low risk zone includes households affected on rather a smaller scale, sometimes indirectly (e.g. due to increased water table). In very low risk zone, households close to the flood prone territory are located, with a potential flood risk in cases of extreme hydrological situations, but without any damage caused by floods to date. According to the risk criteria we selected approximately 30 households to cover three risk zones in each of the village, altogether we interviewed 304 respondents from 12 municipalities.

Based on previous studies (e.g. Begum *et al.* 2007; Botzen *et al.* 2013; Kreibich 2011; Travis 2010; Weber 2010) and local conditions in the case study site, our questionnaire covered the following data:

- Household characteristics, including household members' ages, education levels, incomes, and family structures.
- Flood experiences, including timing, frequency, level of impact, and damage.
- Coping and adaptation measures adopted (see Table 4.4) including economic aspects of households selecting measures.
- Flood risk preparedness, awareness, and perception, including forecasting and warning information sources, use of those sources, perception of local quality of life, and perception of flood risk reduction measures and systems.

We set up the indicators of household adaptation to floods, to apply the distinction of coping and adaptation strategies on a household level with understanding adaptation strategies as an extension of coping strategies. Table 4.3 introduces the idea that the strategies of coping households are to prepare simple, short-term or basic solutions mainly in interiors, whereas those with adaptation strategies prepare building adjustments in advance. The most visible is increased residential ground floor, and then protection of the house against water (drainage around the house or even plot). Other measures include some adjustment of the plot and terrain. We are aware of some limitation dealing with distinguishing these measures as coping or adaptation. We rather prefer to use interior and exterior measures. The aim of this introduction is to set up discussion about the potential of houses, to what extend may be protected meaningfully and effectively protected against flooding. Usually, the most feasible is combination of various kind of measures.

**Table 4.3.** Selected potential coping and adaptation household measures

| Field | Coping strategies | Adaptation strategies |
|---|---|---|
| **Building** | | - avoidance to build houses in flood-prone areas<br>- increased ground floor (at least 1 metre or above the level of Q100 level minimum), technical basement instead of residential ground floor |
| **Risk Insurance** | - basic insurance | -insurance against floods, landslides and other extreme weather relevant risks |
| **Measures to protect household and the plot** | Interior:<br>- movement of some equipment from cellar to higher floors<br>- change of floor material to more water stable on the ground floor<br>- mobile window and door barriers | Exterior:<br>- simple hydro-isolation of the walls ("cutting" the walls) or more complex water drainage system around the house<br>- complex water management of the plot<br>- anti-flood terrain adjustments (earth-work, ditch, small scale retention basin) |

Source: Kreibich *et al.* (2005), IPCC (2012) and own arrangements

The general research question of the quantitative survey was: what kind of adaptation measures have households undertaken in response to major climate extremes, such as floods? Which factors, including perception, do influence the adaptation?
As for hypotheses, we set up three key assumptions:
We expect that households experiencing more floods and more damage probably tend to apply more measures to protect their houses in future.
We expect that some socio-demographic and economic factors influence decision-making of household members and ask which of them are the most relevant.
Flood risk and preparedness perception do play important role in probability to adopt some measures and we test their relevance in case study research.

## 4.5. Results and discussion

### 4.5.1. Qualitative part of the research

The discussion with a wide spectrum of respondents showed several key findings:

*Knowledge of the river, historical knowledge and "big flood" as a focusing event: the river is stronger than people*

Most respondents are familiar with the river Bečva and its behaviour of a submontane stream, despite the partially regulations that were made in past. They evaluate it as a very dynamic, fluctuating and unpredictable river, moving large amounts of gravel and occupying a large area. Some of them even stated that after repeated experience with floods, they were able to predict the development of the behaviour of the river and its streams in the case of longer rains. Several respondents expressed this repeated experience in terms of "We have got used to living with floods" or "We have known for a long time that water flows here."

One interesting point was revealed when they mentioned historical knowledge. Most of the respondents pointed out that people tended to lose historical flood-knowledge due to a series of regulation works on the river and small streams in history (starting at the turn of the 19th and 20th century and continuing in the first half of the 20th century). Some mayors and local experts even indicated the paths of water streams before regulation (on historical maps). When they compared the present situation and history, they even assumed that some level of repetition of floods kept peoples' mind in a state of preparedness and could support their resilience, unlike long gaps in flood occurrence.

On the other hand, they also pointed out that people were still "incorrigible" and lost their memory several years after the last flooding. The main turning point concerning experience with the river was perceived to be the serious flood in 1997. Most respondents assessed that they did not anticipate this event, were not prepared, coordinated, informed, had low technical, human and other capacities. This event acted as a focusing event, as previously described by Birkland (1997) for change in the overall flood preparedness and adaptation. The memory of the 1997 flood is still alive despite the time lapse, especially among respondents such as watercourse administrators, public policy or municipality representatives. They evaluated this flood as something like a "threshold experience". Many of them remembered concrete stories and problems they had faced, and emphasized the role of the "human factor" and many "unexpected factors" influencing decision-making. Most of them perceived this flood as "a lesson" and were aware of the fact that despite a wide set of anti-flood measures, "people could not achieve total safety against big floods". They recognized that the river is stronger than people.

*Development of coping and adaptation strategies and current state of affairs: satisfaction with progress, but still much work has to be done*

Most respondents evaluated a radical improvement and development of flood preparedness, especially in the area of regional flood preparedness and coping strategies. This includes reparation of damages around the river and building up a wide range of new anti-flood measures, setting up digital flood risk plans[5], improvement of

[5] Flood risk plans are being developed and applied in different pace on regional level. Mostly they are being prepared on regional level such as micro-regions

human coordination, crisis management. forecasting and early warning systems, integrated rescue system etc. Mainly municipality representatives expressed "satisfaction", although they added that there was still some work which needed to be done. They also evaluated better coordination of voluntary fire fighters and other volunteers. Moreover, thanks to the influence of the public, NGOs and wider discussions concerning decision-making regarding the image of flood protection, a wider set of other flood measures have been enabled. In the past, mainly only technical measures were preferred (regulations, dams etc.), but recently a wide range of environment friendly measures has became planned.

In several cases, where the river came back to a more natural state after the floods and revitalized spontaneously, natural protection was suggested to be established[6]. Another important step was the support and realization of several landscape revitalization projects, restoration of wetlands, reforestation and giving rivers more space for natural flooding in general, develop retention basins[7]. But, mainly watercourse administrators and municipalities emphasized the need for "usefulness" and "effectiveness" of these measures. They also distinguished between built up areas (where they prefer technical measures) and non-urbanized areas (where more space would enable environmental friendly measures). But, especially scientists criticized the composition of the forests (as coniferous prevail over broad-leaved forests) and the state of agriculture (which is often done in the way that promotes accelerated surface runoff and water erosion).

*Regional development, barriers and challenges: changing perception of responsibility*

Several respondents (watercourse administrators, local experts and NGOs) pointed out the fact that thanks to river and stream regulations in the past, people moved closer to water and built houses in areas where it had not been possible to settle (and stay) before. In the past, rivers had occupied quite a wide area or unpredictably changed their stream. After their regulation, people expanded to these flood prone areas and were later surprised by the impacts and damage. Respondents who did not live in flood prone areas, rather than municipality authorities, expressed critical points regarding the household issue. Especially watercourse administrators pointed out that residents put responsibility on them to ensure their safety and anti-flood measures. One respondent formulated it in this way: residents think that, "we built the house here, we would like to live here, so you have to take care of us". They assume that people should avoid building houses in flood-prone areas or if they already live there, they should be aware of flood risk and take some adaptations or be responsible for their lives and move. The situation is complicated, one municipality authority pointing out its own weakness: "You cannot move them away; that is their decision".

Some respondents see a conflict of interest between regional development and the need for space for water. They point out that this region is typical with its narrow valleys and steep slopes that make development complicated. Another problem is seen with the establishment of floodplain areas, especially "active floodplain zone" ( usually is set up level Q20) within land use planning. Within active floodplain zones, any kind of building and development is not allowed; they should serve as a free zone for water. Some respondents indicate that progress of setting up active floodplain zones in land use plans is slow due to pressure for building houses and regional development by the river.

*Detecting wider and new attitudes towards coping or adaptation to climate extremes: half way between coping and adaptation*

Based on interviews with watercourse administrators stewards and public policy, we indicated some partial adjustments of land use planning and new attitudes towards permitting the process of the building of new houses. Before issuing building permits in flood prone areas, houses are recommended to be built with increased ground floor starting up the level Q100 (so called elevated house) with a "technical basement" bellow (similar to a cellar above the ground). This condition enables a new house with a technical ground floor to be built and to reduce potential damages from small and middle scale floods. But, these procedures are only a recommended not obligatory to apply. Another important land use instrument is setting up "active floodplain zones" (usually) within Q20 level where any kind of building is avoided. But, houses already located in active zones are not demolished.

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6 The river part near the municipality Chorynĕ

7 Revitalization of wetland near the municipality Chorynĕ, planned small scale retention basin above Chorynĕ

*Perception of climate extremes and future anticipation: surprising concern*

While researchers were rather cautious about expressing some clear opinions regarding climate change or extremes, local experts, NGOs and public policy representatives expressed a worry about the recent behaviour of the weather in several past years. They drew from personal experience of conducting horticulture, using underground water and observing the surrounding state of the landscape. They also had fresh experience with a drier spring and autumn in 2012 with at least two states of municipal regulations due to lack of precipitation and water. Surprisingly, they did not focus on either floods or droughts, but on both extremes: a combination of heavy rains and an unusual period of drought. For example, one local expert said: "Personally, I can see a deadly fluctuation of the weather. I cannot rely on the fact that I live in a mild climate". The problem of drought was mentioned by several respondents and they were also aware of some potential problems for the future: "Weather fluctuates from one extreme to another. We noticed a lower level of groundwater since the 2003 drought, but the level still has not recovered yet". Many respondents also expressed worry about the fact that climate extremes would cause worsening retention capacity of soil and consequently increase the probability of flooding.

*Critical points: uncertainty remains*

Respondents expressed some critical points. For example, one local expert criticizes: "We miss the creativity, individual responsibility, and the understanding of historical circumstances. The trouble is with landscape and water management, agriculture and forestry". Another respondent pointed out that some larger changes and revitalization projects were not realized due to "property rights conflicts" and pointed out to the common contradiction between collective and individual interest: "Everybody wants to protect their own affairs."
Several respondents indicated some mistrust in flood measures: "You can have the best flood plans and warning system available, but when the flood comes, you cannot do anything."
Respondents also pointed out to problems with repeated droughts, especially the experience with rotation of extremes. But in their point of view, but longer-term term adaptation, except any regulations measures in case of drought occurrence, has not been developed yet: "We can handle floods, but drought? It would bring much more serious impacts", or: "Floods are laughable, compare to droughts. Droughts will be worse."

### 4.5.2. Quantitative part of the research

### Descriptive statistics

One of the key elements in the questionnaire was to detect how much and to what extent households experienced flood events and what kind of adaptation strategies households undertook. According to risk spatial preconditions (division into 3 risk zones) of the research, 72.37% (224) households experienced floods (corresponding with high and low risk zones), while 27.63% (80) households had no experience with floods (corresponding with very low risk zone).

Around 75% (227) houses were located on flat land, 22% (67) on moderate slopes, while 3 % (10) on steep slopes. This indicates that most households are probably threatened by potential flooding, while a small percentage (3%) are threatened rather by landslides. 78% (236) houses have a cellar. Houses are made up of various building materials, 67% (203) houses are built from fired brick. Quite a high proportion of houses, 19% (57), are built of non-fired bricks or a combination of fired and non-fired bricks. The presence of non-fired brick makes houses more vulnerable to flooding. A quite interesting proportion of houses 6.6% (20) have a stone basement, which is an old, traditional coping measure against water flooding. Stone basement is usually elevated and better protected and enable to dry up water effectively. During our field work, we found another example of "house elevation" through constructing an artificial mound which elevated the terrain on which the house is built by more than 1 m. Although the house was effectively at ground level, it stands on its own artificial hill, elevating it from flood waters.

A significant characteristic of adaptation measures is the height of the living level - ground floor. Approximately half of the houses have residential ground floor level above terrain approximately 1 m above the ground – and 30% of the houses (91) have it even higher. But, when we compare the age of the house and the proportion of all houses, we see that the percentage of houses with increased ground floor has significantly decreased in the past twenty years. The proportion of new houses with increased ground floor has dropped from 45% to 10% in the last 20 years. It is surprisingly in contrast with higher flood occurrence in the past 15 years. Moreover, we did not

notice any significant differences among high-, low- and very low risk zones; the proportion of houses is similar. It indicates that owners of new houses, despite the flood risk, tend to follow "fashionable" or low cost choices of earthbound houses.

Czech legislation recommends, rather than demands, that building authorities elevate the ground floor for new houses in the Q100 zone. Current water legislation regulations included in the Czech Water Act No. 254/2001 request to incorporate active floodplain into land use plans and forbids building new houses in active floodplain zones. In practice, enforcement and monitoring of this issue are not strict — especially when political and development interests simply "delay" implementation in land use plans.

Table 4.4 indicates the frequency of floods: the highest proportion of households (60.5%) was affected in 1997, followed by a significant number households affected in 2009 (18.8%), and further in 2010 (21.7%) and in 2002 (12.2 %). Concerning repeated flooding, 36% (109) of the surveyed households had experienced one flood, 28% (86) had experienced two floods, and 8% (25) had experienced at least three floods (the remaining households had not experienced flooding). Besides this, some respondents also mentioned more years of flood experience, although with less serious impacts.

**Table 4.4.** The number of households affected by floods and estimated impacts (1997-2012)

| Year | Number of houses | Percentage % | At least cellar affected | Ground floor affected | Total financial losses (million CZK) |
|---|---|---|---|---|---|
| **1997** | 184 | 60.5 | 142 | 82 | 15.225 |
| **2000** | 2 | 0.7 | | | |
| **2002** | 37 | 12.2 | 27 | 12 | 1.7 |
| **2006** | 23 | 7.6 | 12 | 11 | 2.375 |
| **2007** | 1 | 0.3 | | | |
| **2008** | 1 | 0.3 | | | |
| **2009** | 57 | 18.8 | 35 | 14 | 2.275 |
| **2010** | 66 | 21.7 | 50 | 21 | 2.5 |
| **2012** | 2 | 0.7 | | | |

*Some information is difficult to evaluate (especially financial losses) due to long time period and people's memory

Crucial attention was devoted to the extent of coping and adaptation measures in general and in response to floods (Table 4.5 and 4.6). Table 4.6 shows a progress and ratio of particular interior measures (household coping), while Table 4.7 the same for exterior measures (household adaptation).

**Table 4.5.** Household coping (interior measures)

| Time scale | Moving things outside the cellar | Change of the floor material | Mobile windows and door barriers |
|---|---|---|---|
| **Before the 1997 flood** | 28 | 5 | 12 |
| **1997-2006** | 22 | 12 | 12 |
| **2007-2010** | 16 | 1 | 13 |
| **After the 2010 flood** | 12 | 6 | 14 |
| **Total** | **78** | **24** | **51** |

Table 4.5 shows some trend of progress: households tend to prefer simple and cheap solutions such as moving things upstairs or getting some mobile barriers, compared with a lower number of households that changed the floor material for a more water resistant one. Besides the mentioned measures, one respondent mentioned he bought a pump and a mobile boiler.

**Table 4.6.** Household adaptation (exterior measures)

| Time scale | Hydro-isolation of the house walls* | Hydro- isolation and drainage around the house** | Complex Water management of the plot*** | Complex anti-flood terrain and vegetation adjustments*** |
|---|---|---|---|---|
| **Before the 1997 flood** | 30 | 45 | 20 | 4 |
| **1997 - 2006** | 7 | 16 | 16 | 10 |
| **2006 - 2010** | 3 | 7 | 2 | - |
| **After the flood 2010** | 6 | 13 | 6 | 8 |
| **Total** | **46** | **81** | **44** | **22** |

* Hydro-isolation of the house walls is not generally considered to be a special measure against flood from rivers, it rather is a basic way to avoid the house getting damp from wet ground.
**Hydro-isolation combined with drainage is a higher level of house protection against soaking and small scale flooding from rainfalls. Drainage system around the house is more sophisticated, consisting of retention pipes and gravel around the house to prevent water and moisture and unable drying up around the walls. Anyway, hydro-isolation could partially help to protect a house from rainfall flooding and enable the house to dry up faster.
*** Last two options are difficult to distinguish, but they include some adjustments of plot and terrain around the house such as "home made" ditches, walls, drainage channels etc. Even though very useful, too much expensive is professional system of underground local water drainage designed to to rapidly increase of soil retention capacity near the house, is rarely used in the Czech Republic, our research showed no measure.

Table 4.6 indicates that households have already disposed of some flood measures before 1997. But we did not notice any rapid increase of adopting adaptation measures. After the big flood in 1997, the number of households taking some measures did not rise very fast. 95 measures were already applied before 1997, 181 measures applied in 2010. We see that the total number of measures has almost doubled, but over quite a long time scale.

Tables 4.5 and 4.6 show that households tend to prefer simple and cheap coping measures such as moving possessions upstairs or using mobile barriers, rather than changing their floor. In Table 6, the high application of hydro-isolation can be explained in that it is a standard and basic way of avoiding dampness in the house from wet ground instead of being a special flood risk reduction measure. Hydro-isolation combined with drainage are a higher level of house protection against wet soil soaking and flooding from rainfalls. Additionally, the amount of adaptation measures adopted was limited: 59% of households adopted one measure, 27% adopted two measures, 11% adopted three measures, and 4% adopted four measures.
Some respondents mentioned that they applied other measures, for example lifting a small bridge or using a small "floating bridge" a bridge over the water stream, applying special plaster on walls or leaving walls without plaster at all (some people found it useless due to frequent floods); one respondent even built a wall against flooding. Only one respondent confirmed moving away from the flood risk site to a more safe place thank to municipality donation.

When we compare adaptation measures and location in risk zones, we see quite positive trend that the more risky the area for a household is, the more adaptation measures would the household take. Adaptation measures in high risk zones vary between 40% and 55%, while adaptation measures in low risk areas are slightly smaller, oscillating between 25% and 30%. Together high and low risk areas cover an area of around 80% of all measures. There is some visible pattern of action based on experience and flood risk awareness. The higher is probability of flood where house is located, the more adaptation measures the household tends to apply. These results differ from Siegrist and Gutscher (2006) who found that, for Switzerland, flood risk perception or flood experience did not significantly supported application of flood damage prevention measures.. Contrary, research of Miceli et al (2008) conducted in Italy supported hypothesis concerning significant role of perception in supporting adaptation measures. They found that the higher the flood risk perception was, the higher the number of household applied some measures to reduce flood risk.

Quite interesting is comparison between household residents perception of its own and municipality preparedness against potential flooding, see Table 4.7. Marks show how is this protection perceived by household residents (we use evaluation as in educational system, 1 means the best, 5 means the worst). Households tend to evaluate

their preparedness a little better than the municipality does (see marks 1 and 2). As the best prepared perceive themselves 25.66% of households, but the same mark they assigned to only 9.87% of municipality. Generally, respondents do not perceive to be well prepared neither on household, nor in municipality level. Less then half of respondents assigned level of preparedness from mark 3-5 in case of household preparedness (46. 7% and more then half of municipality preparedness (58.23%).

**Table 4.7**. Difference in evaluation of the household and municipality preparedness

| Evaluation | Household | Municipality |
|---|---|---|
| **1** | 25.66% | 9.87% |
| **2** | 17.76% | 25.99% |
| **3** | 25.99% | 30.92% |
| **4** | 5.26% | 10.53% |
| **5** | 15.46% | 16.78% |
| **No response** | 9.87% | 5.92% |

## Probit regression dealing with factors influencing adaptation measures

To sum up, one of the key hypothesis were assumptions that experience, socio-demographic characteristics and flood risk perception could significant role in adaptation.
This section uses a probit model as a regression technique through the statistical software STATA to investigate of the link amongst various factors and the probability of household flood risk reduction measures being applied. The equation used is:

$$y_i = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \varepsilon_i$$

The variables are:
$y_i$ equals 1 if a household has undertaken any flood risk reduction measure and 0 otherwise.
$X_1$ is a vector measuring the level and intensity of the household's exposure to floods, such as the total number of the floods experienced and the total financial losses from the floods.
$X_2$ is a vector of dummy variables describing characteristics and the location of the house, such as having a cellar or an elevated ground floor.
$X_3$ is a vector describing household characteristics, such as gender distribution, education, income, occupation, and family status.
$X_4$ is a vector measuring individual perception of the household's flood risk and the flood risk reduction measures adopted by the local government.
$\varepsilon_i$ is a stochastic error term that is assumed to be distributed normally, $\varepsilon_i \sim N(0,\delta^2)$.

**Table 4.8.** Probit regression: factors influencing household adaptation measures (selected variables)

| | Exterior measures | | | | | | Interior measures | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | robust SE | | marginal effect | SE | | coefficient | robust SE | | marginal effect | SE | |
| floor2 | -0.606 | 0.211 | *** | -0.198 | 0.067 | *** | -0.008 | 0.258 | | -0.001 | 0.049 | |
| floor3 | -0.299 | 0.235 | | -0.098 | 0.076 | | 0.057 | 0.317 | | 0.011 | 0.060 | |
| Total floods | 0.116 | 0.132 | | 0.038 | 0.043 | | -0.177 | 0.164 | | -0.033 | 0.031 | |
| tot_loss | 0.020 | 0.079 | | 0.007 | 0.026 | | 0.186 | 0.097 | * | 0.035 | 0.018 | * |
| perc2 | 0.588 | 0.187 | *** | 0.193 | 0.059 | *** | 0.013 | 0.251 | | 0.002 | 0.047 | |
| perc3 | 0.726 | 0.304 | ** | 0.238 | 0.098 | ** | -0.090 | 0.368 | | -0.017 | 0.069 | |
| perc_mun2 | 0.407 | 0.306 | | 0.133 | 0.099 | | 1.185 | 0.480 | ** | 0.223 | 0.087 | *** |
| perc_mun3 | 0.432 | 0.241 | * | 0.141 | 0.078 | * | 0.558 | 0.270 | ** | 0.105 | 0.050 | ** |
| perc_mun4 | 0.394 | 0.265 | | 0.129 | 0.086 | | 0.865 | 0.326 | *** | 0.163 | 0.060 | *** |
| perc_mun5 | 0.340 | 0.335 | | 0.111 | 0.109 | | 0.246 | 0.379 | | 0.046 | 0.072 | |
| share | -0.004 | 0.002 | ** | -0.001 | 0.001 | ** | 0.010 | 0.004 | *** | 0.002 | 0.001 | *** |
| one_kid | -0.035 | 0.271 | | -0.011 | 0.089 | | 0.011 | 0.329 | | 0.002 | 0.062 | |
| two_kid | 0.302 | 0.244 | | 0.099 | 0.079 | | 0.738 | 0.380 | * | 0.139 | 0.071 | ** |
| three_kid | 1.398 | 0.705 | ** | 0.458 | 0.227 | ** | | | | | | |
| two_pers | 0.498 | 0.329 | | 0.163 | 0.106 | | 0.330 | 0.325 | | 0.062 | 0.061 | |
| three_pers | 0.304 | 0.357 | | 0.100 | 0.116 | | 0.337 | 0.360 | | 0.063 | 0.068 | |
| four_pers | 0.285 | 0.367 | | 0.093 | 0.119 | | 0.041 | 0.400 | | 0.008 | 0.075 | |
| avg_age | 0.005 | 0.007 | | 0.002 | 0.002 | | -0.002 | 0.008 | | 0.000 | 0.002 | |
| avg_gender | 0.759 | 0.456 | * | 0.249 | 0.147 | * | -0.772 | 0.502 | | -0.146 | 0.093 | |
| avg_educ | 0.003 | 0.078 | | 0.001 | 0.026 | | 0.109 | 0.115 | | 0.021 | 0.022 | |
| avg_income | 0.007 | 0.010 | | 0.002 | 0.003 | | 0.015 | 0.012 | | 0.003 | 0.002 | |
| _cons | -2.687 | 1.051 | | | | | -0.107 | 1.090 | | | | |
| Region FE | yes | | | | yes | | | | | | | |
| N obs | 304 | | | | 304 | | | | | | | |
| log-likelihood | -175.3 | | | | -102.3 | | | | | | | |

**Table 4.9**. Explanations of abbreviations:

| Variable | Definition |
|---|---|
| **floor2, floor3** | Dummy variables for whether a house contains an elevated ground floor of up to 1 m (floor 2) or higher than 1 m (floor 3). The base category is no elevation. |
| **total floods** | Total number of floods that a household has experienced, 1-3. |
| **one_flood, two_floods** | Dummy variables for one and two floods respectively. |
| **tot_loss** | Total financial loss from floods experienced, categorical variable, 1 (less) - 5 (more) losses. |
| **perc2, perc3** | Dummy variables for whether a household perceives that their house is located in zone of medium or high risk respectively. The base category is perception of being in a very low risk area. |
| **perc_mun2 to perc_mun5** | Set of dummy variables for individual perception of flood risk reduction measures done by the local government, - perc_mun2 compared to perc_mun5 means that less measures are and worse flood protection is perceived. The base category is perceiving the poorest measures. |
| **share** | A continuous variable for the share of total financial losses covered from the family budget. |
| **one_kid, two_kid, three_kid** | Dummy variables for the number of kids. The base category is no kids. |
| **two_pers, three_pers, four_pers** | Dummy variable for the number of people in the household. The base category is one person. |
| **avg_age, avg_gender, avg_educ, avg_income** | Variables measuring average age, gender distribution, education level, and household income. For gender distribution, the baseline is one woman and one man in the household and the base shifts depending on how many men and women are in the household. |

Regression analysis in Table 4.8 shows some interesting findings. Variables like family characteristics and perception showed to be more relevant. Amongst the household characteristics, the most significant correlations were found for gender, number of children, and number of people in a household. Having more children or more males in the household tended to lead to more flood risk reduction measures being adopted.

Owning an increased residential ground floor house decreased the adoption of other flood risk reduction measures by 20%. It is likely that households assumed that elevation would be sufficient for flood risk reduction, so further action is not needed. Then, we assumed factor of experience to be significant, but according to probit regression did not influence measures adopted. The small positive correlation between the total number of floods experienced and measures adopted was not statistically significant, which was the same case when checking total flood financial losses. Also for financial variables, regarding share, the more financial resources required for post-flood property rehabilitation or reconstruction, the fewer flood risk reduction measures that were adopted. Similar significant results, with very low positive probability (0,4%), have also showed with interior measures. This result is likely because people have a fixed budget for post-flood reconstruction, such as an insurance pay-out or loans. Basic reinstatement of a liveable house must be completed. Then, if flood risk reduction measures cost more or are assumed to cost more than the money available, the opportunity might not exist for spending on, or for investigating the costs of, further measures.

Perceptions corresponds with hypothesis, especially of the flood risk zone in which a household is located, influence flood risk reduction measures taken. Households perceiving that they are in low or high flood risk zones, saw the likelihood of taking an adaptation measure rise by 19% and 24% respectively. Perception plays quite important role in interior measures. In this case perception of municipality flood risk protection. The worse is perception of outer protection, the more significant is probability of adopting interior measures (even with different probability, but scaling from 48% to 27%).

Past literature presents varying results. For Germany, Grothmann and Reusswig (2006) showed a strong correlation between experience of flood threats and flood risk reduction measures undertaken. The strong correlation also indicated the influence of socio-economic characteristics such as age, household income, and house ownership. Conversely for Germany, Kreibich (2011) found that even though respondents revealed strong worries about climate change and flood risk, that was weakly connected to motivation to take measures. Instead, Kreibich (2011) found socio-economic factors being more important for adopting flood risk reduction measures.

## 4.6. Conclusion

Generally speaking, we found that the state of regional adaptation to climate extremes is on about "half way" from coping strategies to long term adaptation. Undoubtedly, respondents evaluated as a key threshold experience the big flood in 1997. After such an experience, society on a regional level (especially in the decision making sphere) is now better prepared to cope with potential or actual flood risks. However, long term adaptation is quite a new approach and is realized partly through several successful examples of landscape and river revitalizations. We contribute to the discussion about influence of focusing event/threshold experience to perception and decision making as a choice between an opportunity for change and restoration of the former status (Birkland 1997, Kreibich 2011). Society preparedness for climate change manifestations is just at the beginning. Although some respondents, especially local experts, were well aware of the problems and had quite marked repeated experiences with climate extremes, most of the expressed rather worry about future.

Qualitative part of research also revealed some level of human "humbleness" towards "power of natural forces, expressed mainly in perception of climate and weather related events and their impacts. Most of respondents perceived flood as "a lesson" and were aware of the fact that despite a wide set of anti-flood measures, "people could not achieve total safety against big floods". They recognized that the river being still stronger than people.

Field research and face to face survey enabled us to explore that households also had/have troubles with flash floods from the fluctuating level of small water streams. These small streams also tend to get dry during periods with less amount of precipitation. Contrary to regional level preparedness, we did not find any significant changes and progress in household preparedness for flood risk, even after the 1997 big flood. We noted slow progress in setting up coping and adaptation household measures, with the highest proportion in high risk and then in low risk areas. But on the other hand we discovered a decreased number of new houses with increased ground floor (currently around 10% of all houses), which is one of the most effective ways of adaptation.
Probit regression showed that besides some socio-demographic indicators such as number of children and men in household, perception manifested as a strong factor that influence the probability to take some adaptation measures of household. Conversely, elevating one's house was prominent in decreasing the likelihood of adopting other measures.

Another lesson learned is the need of improvement of communication amongst experts, municipalities, residents, and the private sector. Municipalities have data available on land use and flood risk zones, as well as the authority to change land use and urban development plans to try to reduce flood risk. If residents had more advices from experts (including from their insurance company) regarding coping and adaptation measures, then they might be willing to adopt them subject to financial constraints, saving themselves and their insurer the hassle of being flooded. Academics can assist by disseminating their knowledge to the public, municipalities, watercourse administrators, and insurance companies and by involving them in research (e.g. Otto-Banaszak *et al.* 2011). With floods being a common problem across Europe and around the world and with their characteristics changing rapidly due to the climate change, continued research and application will be needed for adapting to flood risk at the household level and at larger governance scales (see also Etkin *et al.* 2012; Haque *et al.* 2012).

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# *5. ENVIRONMENTAL AND SOCIAL CHANGES IN CENTRAL ASIA AND THEIR POSSIBLE IMPACTS ON THE TRADITIONAL LIFE OF MONGOLIAN NOMADS*

*David Juřička, Lucie Jánošíková , Martin Brtnický, Jitka Novotná and Jindřich Kynický*

**Abstract**
The region of central Asia is traditionally belongs to a large arid and semiarid area. Climatic condition in Mongolia shows a changing patterns in precipitation patterns, especially a decrease in the rain frequency, change in the character of rains from weaker and long-lasting to shorter and more intensive, and an increasing number of dust storms. These environmental changes implemented a shift in the growing season, loss of ground water and drying up of watercourses and consequently they negatively influenced socio-cultural patterns and habits of traditional communities. In this chapter we focus on environmental change and its impacts on the traditional life of Mongolian nomads. We presuppose an acceleration of the already ongoing rural-urban migration to capital city and other big cities in the future. The current expansion of slums considerably affects the pressure on the local environment and a decreasing quality of life. Climate change on the one hand and social changes on the other hand resulted in lowering the quality of life in rural areas and limiting the traditional nomadic way of life. The current situation shows not only frequent climatic extremes in the vicinity of the capital city Ulan Bator but also highlights the condition of the massive deforestation of the most valuable forest ecosystems of Central Asia due to the demand for new settlements.

**Key words**
Nomads, pastoralism, aridification, migration, climate change, environmental change, livelihood, adaptation.

## 5.1. Introduction

The chapter deals with the multiple social and environmental factors influencing the current Mongolian society. We used mostly literature review analysis methods, supplemented by the own field observations. Authors have been visiting Mongolia since year 2000 repeatedly every year. Research activities were conducted across Mongolia from north to south. At the north of the county, research was conducted mostly in Hentiy province and at the south in Omnogovi and Dungovi province. Authors did environmental research (climate and disaster monitoring, evaluation of soil, water and air pollution intensity; waste management and its evolution. Additionally, they observed livelihood of nomads, and realised informal personal interviews with several nomads (Kynický *et al.* 2010).

Climate change stands among the core factors that affect the structure and lifestyle of Mongolians, especially nomad herdsmen. Mongolia is unique due to its natural conditions and societal adaptation: 2/3 of Mongolia is covered by deserts and its inhabitants have developed specific patterns of livelihood and adaptation to this kind of climate based on nomadic pastoral farming (Sternberg 2008; Upton 2008).

Together with the socio-political changes after 1990 and the processes of modernisation and urbanization, Mongolia is one of the most vulnerable countries in the world (Zhang 2006).
Dynamics of change caught the attention of many social and environmental scientists. For example Adger *et al.* (2012) point out that human responses to environmental change have a strong cultural dimension and that culture plays a central role in adaptation to environmental and climate change. They understand culture practically, as closely tied to places where people live, then culture or community is rooted in place and uses local knowledge, tradition patterns and livelihood practices. They point out that local communities are affected by environmental change and that it threatens the livelihood patterns they are having up to now. They mention

several examples, of which the relevant one for the issue of this chapter is the phenomenon of drought. Increased areas affected by droughts have negative impacts on pastoralism as a cultural phenomenon.

The political and cultural transformation which Mongolia has passed through the last 100 years in the background of ongoing climate change may be an important decision-making factor between a traditional nomadic and so called modern urban way of life. Upton (2010) describes process of forced changes from the character of traditional pastoralism in the Soviet era the problem to the centrally planned economy in Mongolia during the 20th century. He also describes the transformation from centrally planned economy to market economy after the collapse of the Soviet Union during the ninetieths and how it influenced traditional herdsmen adaptation livelihood strategies. Adaptation trends as described Upton (2010) are about a change in species composition of herds and their abundance and changing of length and number of migration routes.

Marin (2010) states aridification as one of the biggest environmental problems of contemporary Mongolia in his publications. He draws from experiences and observations of local residents, which combines with modern measuring methods. He confirms the trend of the severe drying of environment with its direct impact on the indigenous nomads.

The chapter is structured into 4 parts: after introduction, part 2 describes the Mongolian society and its socio-demographic and ethnic composition. This chapter also highlights one of the extremes of Mongolia, the overall low population density and contrast of overpopulation of cities. Part 3 describes the climate in Mongolia in the context of Central Asia. It shows the progress and effects of climate change in Mongolia described within several specific cases by previously published studies and our own research. Part 4 describes complex of environmental, political and economical changes affect Mongolian society and also describes the more or less preferred adaptation strategies by indigenous nomads. The chapter ends with a conclusion, which summarizes the most important findings and warn about the urgent need to mitigate the current adverse trends.
This chapter describes to the main environmental, political and economical changes in Mongolia and its direct and indirect impact on the local population. Besides climate change, human impacts also affect the environmental conditions of many places and subsequently influence local communities, by overgrazing, overpopulation, deforestation and depletion of natural sources such as wood or water. This is a summary of the knowledge of up to now scientific evidence accompanied by our own field observations and GIS data.

## 5.2. Mongolia society. The main social, political and economical changes

In this part we introduce Mongolian society and describe how Mongolia went through main changes recently. The official name is the State of Mongolia. It is a landlocked country in Central Asia, located between South China and the north of the Russian Federation. The country covers an area of 1,566,500 km$^2$, but due to its only 2,921,287 inhabitants (Statistics department of Capital city 2013), Mongolia belongs among the states with the lowest population density in the world.

Mongolian population demographic structure is rather young, more than 66% of Mongolia's population consist of young generation under 30 years old. People older than 65 years constitute only 3.7 % of Mongolian society. Life expectancy is not very high, for men is 63 and for women 67 years. Nearly half of Mongolia's population lives in cities and currently, more than 1 278 000 people live in the capital city Ulan Bator. Overpopulation of this city, which was originally designed for 300,000 people, cause serious tensions (CIA, 2013).

Other Mongolian (Chalach, Dorvoits, Bajadas, Burjats, Arats) and non-Mongolian (Kazakhs) ethnic groups prefer nomadic lifestyle known as "pastoralism". Nomads are people whose lives depends on natural environment and their lives are based on production of organic sources and products. They breed animals as yaks, camels, cows, sheep, goats, deers or horses. They move through the Mongolia usually 2 or 4 times per years depending on ecosystem and changes of climate conditions. Pastoralism constitutes more than a third of Mongolians society and they make their living as herders, while living in yurts, traditional movable settlement(Grollová & Zikmundová, 2001; Marin, 2010).

During the last century Mongolia has experienced major political and economic changes that induced large impacts on pastoralism as the main traditional livelihood strategies of Mongols. The collectivization of agriculture and centrally planned economy started to be realised during twentieths and continued to ninetieths

of 20th century in Mongolia. Within this period, organized animal production was preferred; each herdsman breed some animal species and had approximately the same size of herd like other herdsmen and common areas were used to pasture. On the one side, herdsmen had to achieve planned production, but on the other side they received steady income from the sale of milk, meat and wool (Sternberg, 2008).
After 1989, with the fall of communism, very fast transformation from central planned economy to a market economy took place in Mongolia. This situation had a negative impact on herders, who lost their steady sales of their products and the income level on which they were to some extent dependent. The negative impact was also well studied in countryside as well as in small towns and villages where impossibility to sell organic products and animals (cattle) resulted in the overpopulation of animals which strongly destroy the natural ecosystems of grassland and even more also taiga forest newly used for pastoralism. The trends were similar all over Mongolia. After 1990, the country finally lost its subsidies from the Soviet Union after 1990. The herds were privatized after 1992 and sold to shepherds (Lkhagvadorj *et al.* 2013; Sternberg, 2008).

## 5.3. Environmental and climate change in Mongolia

### 5.3.1. General description of climatic and environmental conditions

First we start with description of climatic conditions of the Mongolia region. The territory of Central Asia is described by Petrov (1976) in Cowan (2007), Herzschuh (2006) and Stamp's (1967) as typical unfolded arid, semi-desert and desert character. Rudaya et. al (2008) highlight some climatic particularities of the area and delimited the Altai mountains as a climatic boundary between arid Mongolia and the Siberian boreal taiga permafrost. As Figure 5.1 shows, two-thirds of Mongolia is covered by Gobi deserts, which passes into the northern regions of China (Inner Mongolia province – southern border of Central Asia). A fluctuation of temperatures is significant for this area, with minimum annual temperatures on the mountainous north of Mongolia (Altai Mountain, Khangai and particularly Khentii) below -50°C, while temperatures in the Gobi Desert range from -40°C to 40°C. Especially in mountains parts of Mongolia occurs extremely cold and snowy winter - dzud, this period is critical for survival of animals, when animal can´t find grass under huge level of snow and may die of starvation. The region of Central Asia is poor on precipitation (particularly rainfall); the annual amount of precipitation for the northern part of Mongolia averages 400 mm, and the monthly average for the Gobi Desert does not exceed 50 mm (Marin, 2010). Precipitations are geographically distributed from dry south to the moisture richer areas of north Mongolia. Figure 5.1 shows location of Mongolia and vegetation cover through Ortofoto map of Mongolia.


Source: USGS world imaginary map

According to Finch (1996), ecosystems in Mongolia can be divided into six main units as high mountain ecosystems, taiga, mountain forest steppe, steppe and desert steppe ecosystems. First are high mountains ecosystems. These ecosystems covers only about 5% of Mongolia. They are composed primarily of Altai Mountains and still partly covered by glacier. Second unit consists of taiga ecosystems. It covers about five percent of Mongolia at the north part of the country. Predominant vegetation are spruce, larch and birch. Climate is extremely cold, especially in winter where can be about -50°C. Third is mountain forest steppe. It covers about 25% of Mongolia. This ecosystem creates a transition between low mountains and grasslands with numerous valleys. Another is steppe, covering about 20% of Mongolia. Predominate is grasslands which act as pasture for nomads. They are characterized by hot summer and cold winter. The last about one is desert steppe ecosystem, covering about 20% of Mongolia. Rocky desert with sporadic occurrence of shrubby vegetation. The last is desert ecosystem. This ecosystem is constituted by Gobi desert which is characterized by extremely climate. Table 5.1 briefly summarises the main ecosystems and their importance for livelihood of Mongolia inhabitants

**Table 5.1**. Main ecosystems in Mongolia and their importance for inhabitants.

| Ecosystem | General Characteristics | Approximate percentage, Location | Importance for inhabitants |
|---|---|---|---|
| High mountain | Covered by glaciers, extreme living conditions | 5%, northern parts of country | Low importance for livelihood, melting glaciers important source of fresh water |
| Taiga | Mostly mountain areas covered by mixed forest. | 5 %, northern parts of country near Russian border | Important source of wood, wild animals, forest grazing. Mining industry. |
| Mountain forest steppe | Transition between low mountains and grasslands, consisting of grasslands and sparse forest | 25%, middle position of county | Pastures, predominate nomadic life style. Mining industry. |
| Steppe | Extensive grasslands. | 20% middle and southern position of county | Pastures, predominate nomadic life style. Mining industry. |
| Desert steppe | Rocky desert with sporadic vegetation. | 20%, southern and south position of county | Sporadic pastures. Mining industry. |
| Desert | Rocky Gobi desert on south of the country | 25%, south part of county | Mining industry. |

Source: Finch (1996) and own research

### 5.3.2. Climate Change in Mongolia

As we mentioned in introduction, Mongolia is facing serious climate change, based on changes of precipitation patterns, space and seasonal distribution and decrease of overall amount of precipitation. According to Marin (2010), the South part of Mongolia, the land which is totally covered by the Gobi Desert, particularly faces decrease in precipitation, structural precipitation change, general lack of water, temperature increase and growing frequency of dust storms.

Natsagdorja *et al.* (2002) points out that during the years 1937 – 1999 the number of dust days in the mountain areas of Altai Khangai and Khentei increased by 5 per year and in the semi-arid and arid areas of the Gobi Desert by 20-37; and the most significant increase in dust days is being monitored in the areas of the Khongoryn Els sand dunes in the western part of Mongolia, which is the northernmost sand desert in the world.

The unfavourable trend of climate change in Mongolia is also observed by indigenous nomads. As Marin (2010) shows, the nomadic inhabitants of the Mongolian desert steppe in the environs of urbanized Saihanovoo, Mandalgovi, Gurvansaihan, Ondorshil and Mandakh observe rather fundamental changes in the character and frequency of precipitation in last two decades related to longer and more intensive droughts. So called "silk embroidered rains" (the rains with less intensity but longer duration) have nearly disappeared or have been significantly delayed, and are replaced by "hard rains" with torrential character, which causes an accelerated surface runoff with low infiltration into the soil. Herders are forced to migrate more often to places better

supplied with moisture and the growing season for grazing is shortened. This climatic trend, which is negatively perceived by herdsmen, has also been indicated by models and analysis of data series from measuring stations for decades. Measurements combined with herdsmen observations indicate a shift of the Asian monsoon to the east due to escalations of droughts and higher frequency of dust storms. It together contributes to the deepening of aridification of the landscape.

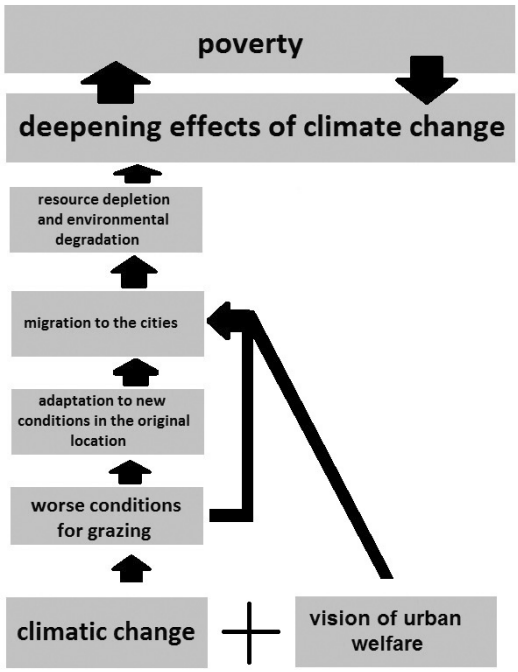
## 5.4. Societal responses to environmental and climate change in Mongolia

Various parts of the country suffer from climatic change in different ways. The nomadic population reacts to the new environmental condition and tries to adapt. Adaptation measures follow one another and start in the southern parts of the country, in the Gobi desert. The text below describes the complex of environmental and socio-economic influences on population and the main societal responses, generally speaking adaptation strategies. Individual cases are arranged geographically from dry south to the moisture richer areas of north Mongolia.
When we describe adaptation, we distinguish between coping and adapting according to (IPCC 2012). While coping means using available skills and resources to respond to risks with the aim of returning to a previous state of affairs, while adaptation is rather anticipative, proactive, and involves structural changes that consider longer time horizons.

### 5.4. 1. Situation in South Gobi: Overgrazing, Aridification and Overpopulation

The changing climate conditions in the south of Mongolia force nomads to change their current life style. Alterations are in place at several levels. We emphasize the strong link between climate change and the landscape environmental conditions for grazing, which can lead to destruction of the traditional way of life. Figure 5.2. shows simple scheme of adaptation strategies taken by herdsmen under the changing conditions. When some negative change of the environmental conditions (aridification of landscape) occurs, it will inevitably lead to a worsening of conditions for grazing. This is reflected in the social situation of nomads who have to choose some adaptation strategies. Short term ways of adaptation, as a result of degradation of natural conditions, is a change of pastures or shortening of the migration routes. As reported by Sternberg (2008), most of the nomads stated that the serious problem is lack of fresh and drinkable water. Consequently herders with the largest herd decide to reduce their migration length and number of stops at camp grounds during migration.

**Figure 5.2.** Impacts of climate change on nomads and adaptation responses




Source: author's own work

Shortening the migration routes and change of pastures is the first step before nomads definitely leave the current lifestyle and migrate to large urban centres in the Gobi and the north of the country. Overpopulated cities further contribute to the depletion of local natural sources (wood, water etc.) and deterioration of livelihood conditions of new incomers. Worsening of the current situation of herdsmen contributes to an increase of the number of cattle overall and also in their own herds. Herdsmen have to build up shelters for animals to overcome worse winter times, which are becoming more common. A large herd consumes more resources than a smaller number of animals. With worsening climatic conditions, it is increasingly difficult to keep the herd in good physical condition and reduce mortality, especially with newborns. As Lkhagvadorj (2012) described, the number of livestock in Mongolia, especially sheep and goats, has been growing with occasional fluctuations since 1960. The trend of growth of cattle herds was dictated mainly by the Soviet Union and the centrally planned economy of the former Mongolian Socialist Republic. Today's growth after the collapse of the Soviet Union and Mongolia's transition to a market economy is driven mainly by demand for cashmere, whose source is the cashmere goat. This reduces the overall number of seasonal migrations, herders with herds of over 200 head of cattle migrate more frequently than those with smaller herds (Sternberg, 2007).

A large herd has increased demands for water and pasture quality and quantity. There is an quicker depletion of pasture than there would be for a smaller number of cattle. As Sternberg says (2007), one of the main problems raised by the nomads during interviews was poor water quality. This is also related to the size of the herd. As Juřička *et. al.* (2010) stated a hundred heads of sheep produce in the form of faeces 5.38 kg of nitrogen, 2.86 kg of phosphorus and 7.25 kg of potassium per year. A large part of the excrement is concentrated around wells and nutrients seep through the soil into groundwater. Nutrients in water have a positive effect on the development of bacteria and algae growth, what leads to heavy organic pollution of water. The problem is more serious when we take into account that many wells are located in very permeable sandy soil dried-up riverbeds (wadis). The process of contamination thereby accelerates, because sand soils are more permeable than soils with high clay content.

To sum up, the main adaptation strategies of herdsmen consist of rather short-term coping strategies, such as changes of migration routes, pastures, amount and structure of herds, motivated both by economic and climatic conditions. However, they contribute to further deterioration of pastures through overgrazing and water sources contamination. The last step of adaptation is migration to the cities with additional adverse effects of overpopulation.

### 5.4.2. Situation in Northern Parts of Mongolia. Threat of Desertification and Permafrost Thawing

During the authors field research between 2000 and 2013, several major problems of Mongolian countryside environment were identified. Among the most impressive and the most discussed remains the total lost of cold environments due continuous aridification and desertification and cruel degradation of grassland in central Mongolia and forest ecosystem in northern Mongolia (Houška & Kynický, 2007; Samec *et al*., 2006; Kynický *et al*., 2009; Kynický *et al*., 2010).

This part of our study deals with situation in the Northern and Western parts of Mongolia which are more naturally supplied with moisture. It attracts herdsmen to move here from other part of Mongolia due to already mentioned deteriorated climatic and soil conditions. Resulting higher cattle concentrations cause excessive use of pastures and devastate forest grazing, which is a major environmental problem with potential serious problems to local people in the future. Cattle eat the young seedlings of trees and thus prevents forest to regenerate naturally. Over time, the age variety of vegetation is eliminated and becomes even-aged. Further due to the lower density of vegetation and the absence of herbaceous vegetation, the moisture conditions of the site are going to be worse and desertification slowly starts.

Due to climatic conditions, forested areas of northern Mongolia are habitats characteristic by occurrence of permafrost. The interaction of permafrost and intensive herding may be devastating for these highly environmentally sensitive ecosystems.

The cold localities connected to permafrost area in Mongolia have recently become (in the last decade) strongly prone to aridification and desertification (Houška & Kynický, 2007; Samec *et al.*, 2006; Kynický *et al.*, 2009). The unique existence and distribution of intra continental permafrost in semi-arid Mongolia is mainly dependent upon climatic, geographic, geologic, hydrological and surface cover conditions. The latitude is the second most important factor that influences the distribution of the mean annual air temperature (MAAT) and, thus, the

distribution and development of altitudinal permafrost. The permafrost is estimated at about 804×106 km$^2$, accounting for 51.4% of the total Mongolian land territory (Khubsgul, Orkhon-Selenge, Khentii, Khangai provinces).

One of the main negative factor causing deterioration of surface cover conditions is deforestation and over-grazing of forest and forest-steppe ecosystems. This leads to a greater warming of the surface and thus a more intensive and deeper thawing of permafrost which has serious consequences on the ecosystem. The degradation of permafrost, especially more intensive and deeper thawing of permafrost (see details in Juřička *et al.*, 2012) then initiates some other environmental risks, the most significant are the impacts on the hydrological balance of the territory and the health status of forest and non-forest vegetation. Lower evapotranspiration could further increase permafrost melting at the exposed sites and thus accelerate this degradation. For watercourses of the permafrost area are affected by degrading forest in response to degrading permafrost. It causing accelerate soil erosion, formation of shallow slope gravitational movements and debris flows that can decrease water quality, affect hydro-biological processes in streams, etc. The long-term reduction in discharge values can again bring further risks in relation to riparian vegetation or to periodical floodplain ecosystems during the snow melting season in spring. The destruction of plants population may occur due to drying up of the soil (Anisimov, 1996).

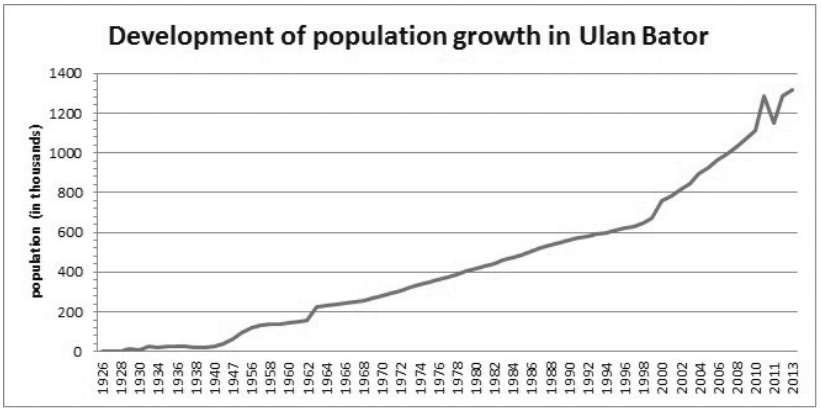
Thereby due to water being lost from the landscape and the loss of forest areas local residents are having problems. The quality of drinking water for animals is reduced. There is a gradually declining standard of living of the cattle producers.

**Figure 5.3.** Deforestation near Ulan Bator

Author: Kynický Jindřich

Besides climate change, human impacts also affect the environmental conditions of many places and subsequently influence local communities. The deterioration of the situation most often occurs as a result of mass migration to cities. There is an increase in the long-term concentration of herders in a small area and a growing need for firewood, especially in the rapidly expanding slums. The biggest problem is the migration to Ulan Bator, the capital of Mongolia. Ulan Bator was designed for 300 000 people but in the present day it is home to over 1 200 000 people (Statistics department of Capital city, 2013). Figure 5.4 shows increased trend of population growths in Ulan Bator City due to massive immigration. As figure shows, from 1926 to 1960 population grows continually, then experience faster pace from 1962 to 2000, but during last decade city experience rapid and uncontrolled population growth.

**Figure 5.4.** Population growth in Ulan Bator




Source: Statistics department of Capital city, 2013

Participants of expeditions to Mongolia interviewed local people during our research travels across Mongolia since year 2000. People describes us a scenario of the transition from pastoral to urban life. One of the triggering factors of migration was the policy of the Mongolian Government. The government put an effort to improve living conditions of nomads in the desert and provided them with solar panels and television. The apparent poverty has become real and in combination with the worsening climate it could stimulate the migration decision to the city, where, according to television, life is much easier. Allowing the nomads to realize their dreams of a better life in the city, they sell their cattle and all their possessions. The quality of life in cities is far below that of former herdsmen, labour is scarce and wages are low. The worst personal experiences in case of herdsmen falling into alcoholism and forcing their wives and children into criminal actions as prostitution, murdering for money or stealing of anything as the only income.

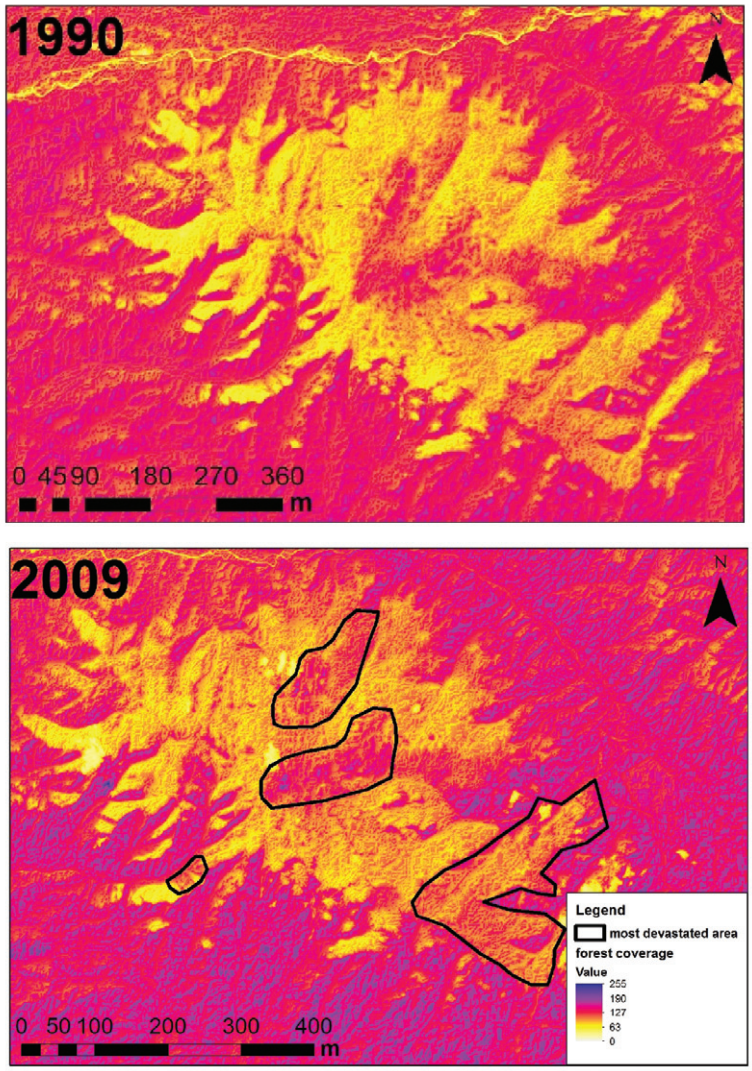
**Figure 5.5**. Slums in Ulan Bator with dry drainage basin trash contaminated

Source: David Juřička photo

The impact of migration of nomads on ecosystems is noticeable in Figure 5.6, which shows the change of damaging vegetation to the south of the main city. There is a strong pressure on resources, particularly forest as a source of firewood. Forests near Ulan-Bator are deforestation and also degradation of vegetation through the burning of low-quality brown coal. In 1990, the forest cover was not significantly fragmented. In 2009, there is evident fragmentation of vegetation across its whole surface. This is the direct result of deforestation and air pollution fallout originating from Ulan Bator.

Satellite imagery in the original colours was converted to false colour images. The tree vegetation and river system on the northern edge of the image has a distinctive yellow colour and contrasts with shades of pink and red, depicting land without vegetation cover. Shades of purple and blue show the rocky soil or soil completely dry. Various combinations of colours allow you to create the desired contrast and so we can better observe the landscape structure surveyed.

**Figure 5.6.** Comparison of area of the forests between 1990 and 2009




Source: Program: ArcGIS 10.2, data sources: USGS)

## 5.5. Conclusion

We found that complex set of environmental, social, political and economical changes, exacerbated by climate change has forced people to adjust and adopt some adaptation measures. They range from changes of pastures, migrations tracks with herd or finally migration to the cities. Overall described ways of adaptation measures were rather short-term, coping strategies, they did not contribute to problem solution, but rather caused further destructive impact on local ecosystems (i.e. deforestation, overgrazing, water resource contamination). This situation affects the north as well as the south of the country.

Areas in the Gobi desert, which are plagued by frequent sandstorms, reduce yields and cause a poor quality of water resources. Desert ecosystems became even drier and may become uninhabitable for humans in the long term horizon. On the north of the country are relatively humid ecosystems and due to migration, they are overexploited in all aspects. The mountainous ecosystems are susceptible to erosion, which is one of the factors of aridification. These areas are particularly affected by excessive grazing of pastures and the shift of the growing season of plants caused by climatic changes.

The aridification of Mongolia as a result of climate change strengthened by human interventions in the ecosystems is the main problem caused by current generation and possible limiting factor for the survival of future generations. Herdsmen adapt to these changes particularly by changing their migration route, shortening it and migrating less during the season. The final decision that herdsmen can make is migration to large urban centres, mostly to Ulan Bator, which is not designed for such a huge amount of new incomers and the city urgently needs to adapt its infrastructure. In the vicinity of urban settlements this leads to excessive exploitation of natural resources and pollution of the environment. This is mainly deforestation of adjacent forest ecosystems and air pollution by emissions from the combustion of low-quality brown coal. Excessive grazing and logging in the north of the country is unsustainable and results in the aridification of the environment.

One of the feasible solutions to current unfavourable social situation of Mongolia may be improvement of livelihood conditions in cities and support, promote and maintain a nomadic way of life by sustainable way. The state may offer Mongols subsidies for the purchase or the extension of existing herds of cattle farming in the various regions of the country and thus reduce the influx of new people into the cities and vice versa support the outflow of people from the cities, but with reflection of carrying capacities of local vulnerable ecosystems.

In this chapter, we draw attention to the unsatisfactory social and environmental situation in Mongolia. We aim to examine this topic more in detail and provide empirical research, while propose specific adaptation measures which can improve Mongolian livelihood conditions and contribute to improvement of the environment.

# *6. CONCLUSION*

The purpose of monograph Environmental Change: Adaptation Challenges was to bring together evidence of diverse aspects of environmental change, which is taking place across various regions around the world. On the other side, it also describes diverse spectrum of adaptation measures being applied. We asked if these measures are feasible, viable and solve problems in the long term or just overcome some immediate unfavourable conditions without some longer term perspective.

Researches observed one of the evident trend, depending on mutual influence of many environmental factors, but accompanied by social, cultural, political and demographic. Overall changes are exacerbated by climate change which reinforce some other negative trends and intensify wide spectrum of problems.

One of the main message of this monograph is to point out that adaptation, even as a simple response to negative trends, may be framed as a challenge, not as fight or combat. Monograph brings several approaches to framing of adaptation, starting with short-term responses to immediate threats, but indicates some trends to advanced, long-term adaptation as the more feasible solution. It also brings evidence that even though climate change is a global issue, practical adaptation strongly depends on regional and local environment and conditions, including local community adaptation capacities, cultural patterns and habits. If one dimension is being overlooked, the probability of successful solution decreases.

Among others, monograph also brings new concepts dealing with environmental, social issues and adaptation. Theory of adaptation was explored from several point of views and levels, with respect to planned and advanced adaptation and attention was oriented to ***community level***. Another important exploration was concept of ***social vulnerability*** in relation with perception of climate change. Further research dealing with limited capacities of social vulnerable groups and necessity to protect them against adverse impacts of environmental and social change is needed to be conducted. Empirical evidence of "living with floods" explored the role of ***perception,*** to what extent may influence adaptation. Despite being quite undervalued mainly by natural scientists, research conducted in Bečva river basin showed that perception of environmental risk played rather important role in decision-making process. Although environmental changes are manifesting on global level, contribution dealings with Bečva and further Mongolia brought evidence of impacts of these changes on regional and micro social reality, specifically on ***household*** and ***individual level***. Especially chapter dealing with Mongolia warns about negative consequences of radical changing environmental and social conditions with living patterns and livelihoods strategies.

Authors hope to contribute at least partially to theoretical and empirical evidence dealing with environmental change and adaptation. Finally, we wish readers to find some inspiration for everyday adaptation practice.

## Bibliography

Adger W. N. , Quinn, T. , Lorenzoni, I., Murphy, C., and Sweeney J. (2012a). Changing social contracts in climate-change adaptation. Nature Climate Change. 4p.

Adger W. N. , Berentt J., Brown, K., Marshall N and O Brien, K. (2012b). Cultural dimensions of climate change impacts and adaptation. Nature Climate Change, 6 p.

Adger, N. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. World Development 27(2): 249-269.

Beck, U. (2010). Climate for change, or how to create a green modernity? Theory, Culture & Society 27(2-3): 254-266.

Begum, S., Stive, M., and Hall, J. (eds) (2007). Flood Risk Management in Europe: Innovation in Policy and Practice. Springer, Dordrecht.

Birkland, T. A. (1997). After Disaster. Agenda Setting, Public Policy and Focusing Event. George Town University Press, Wahington D.C. 350pp.

Bodansky, D. (1993). The United Nations Framework Convention on Climate Change: a commentary. Yale Journal of International Law 18(2): 451-558.

Böhnke, P. (2008). Does society matter? Life satisfaction in the enlarged Europe. Social Indicators Research 87(2): 189-210.

Bord, R.J. and O'Connor, R.E. (1997). The gender gap in environmental attitudes: The case of perceived vulnerability to risk. Social Science Quarterly 78(4): 830-840.

Bord, R.J., Fisher, A. and O'Connor, R.E. (1998). Public perceptions of global warming: United States and international perspectives. Climate Research 11: 75-84.

Bord, R.J., O'Connor, R.E. and Fisher, A. (2000). In what sense does the public need to understand global climate change? Public Understanding of Science 9 (3): 205–218.

Bostrom, A., Morgan, M.G., Fischhoff, B. and Read, D. (1994). What do people know about global climate change? Risk Analysis 14(6): 959-970.

Brázdil, R., Máčka, R., Řeníčková, L., Soukalová, E., Dobrovolný, P., and Grygar, T. M. (2011b). Floods and floodplain changes of the River Morava, the Strážnické Pomoraví region (Czech Republic) over the past 130 years. Hydrol. Sci. J., 56 (7): 1166-1185.

Brázdil, R., Řezníčková, L., Valášek, M., Havlíček, Dobrovolný, P., Soukalová, E., Řehánek, T., Skokanová, H. *et al.* (2011a). Fluctuations of floods of the River Morava (Czech Republic) in the1691-2009 period: interactions of natural and anthropogenic factors). Hydrol. Sci. J., 56 (3):468-485.

CIA (2013). The World Factbook-Mongolia. Online. Available at http://ciaworldfactbook.us/asia/mongolia.html

Commission of the European Communities (2009). 1.4.2009, COM(2009) 147 final, White Paper, Adapting to climate change: Towards a European framework for action. Brussels: European Commission.

Coucou D. and Rahmstorf S. (2012). A decade of weather extremes. Nature Climate Change. 2: 6
Cowan P. J. (2007). Geographic usage of the terms Middle Asia and Central Asia. Journal of Arid Environments 69(2): 359–363

Czech Statistical Office (2012). Online. Available at http://www.cszu.cz

Daly, M., Poutasi, N., Nelson, F. and Kohlhase, J. (2010). Reducing the climate vulnerability of coastal communities in Samoa. Journal of International Development 22(2): 256-281.

Dang, H.H., Michaelowa, A. and Tuan, D.D. (2003). Synergy of adaptation and mitigation strategies in the context of sustainable development: the case of Vietnam. Climate Policy 3S1: S81-S96.

Davidson, D. J. and Freduenberg, W. R. (1996). Gender and environmental risk concerns. A review and analysis of available research. Environment and Behavior 28(3): 302-339.

Dessai, S., Adger, W.N., Hulme, M., Koehler, J., Turnpenny, J. and Warren, R. (2003). Defining and experiencing dangerous climate change. Tyndall Centre Working Paper No. 28: 12pp.

Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007on the Assessment and Management of Flood Risks

Djordjevič, S., Gourbesivlle, P., Mark, O. and Pasche, E. (2011). New policies to deal with climate change and other drivers impacting on resilience to flooding in urban areas: the CORFU approach. Environmental Science & Policy, 14:864-873.

Dráb, A. and Říha, J. (2010). An approach to the implementation of European Directive 2007/60/EC on flood risk management in the Czech Republic. Nat. Haz. Earth System Science, 10: 1977-1987.

Dubrovsky M., Nemesova, I., and Kalvova, J. (2005). Uncertainties in climate change scenarios forRepublic. Natural Hazard, 36 (1):207-220.

Dunlap, R.E., Van Liere, K.D., Mertig, A.G. and Jones, R.E. (2000). Measuring endorsement of the New Ecological Paradigm: A revised NEP scale. Journal of Social Issues 56(3): 425-442.

EEA (2010). The European Environment. State and Outlook 2010. Adapting to Climate Change.Luxembourg: Publications Office of the European Union. 52 pp. ISBN 978-92-9213-159-3

Ehrlich, P.R. and Ehrlich, A.H. (2013). Can a collapse of civilization be avoided? Proceedings of the Royal Society B, 280(1754): 20122501; doi:10.1098/rspb.2012.2501

Eurofund. (2012). Third European quality of life survey – Quality of life in Europe: Impacts of the crisis. Luxembourg: Publications Office of the European Union. Retrieved August 14, 2013 from http://www.eurofound.europa.eu/pubdocs/2012/64/en/1/EF1264EN.pdf.

European Comission. (2005). Attitudes of European citizens towards the environment – Special Eurobarometer 217 – EB62.1. Retrieved September 25, 2013 from http://ec.europa.eu/public_opinion/archives/ebs/ebs_217_en.pdf.

European Comission. (2008). Attitudes of European citizens towards the environment – Special Eurobarometer 295 – EB68.2. Summary. Retrieved September 25, 2013 from http://ec.europa.eu/public_opinion/archives/ebs/ebs_295_sum_en.pdf.

European Comission. (2009). Europeans' attitudes towards climate change – Special Eurobarometer 322 – EB72.1. Retrieved March 21, 2013 from http://ec.europa.eu/public_opinion/archives/ebs/ebs_322_en.pdf.

European Comission. (2011a). Climate change – Special Eurobarometer 372 – EB75.4. Retrieved September 5, 2013 from http://ec.europa.eu/public_opinion/archives/ebs/ebs_372_en.pdf.

European Comission. (2011b). Attitudes of European citizens towards the environment – Special Eurobarometer 365 – EB75.2. Retrieved September 25, 2013 from http://ec.europa.eu/public_opinion/archives/ebs/ebs_365_en.pdf.

Fekete, A. (2009). Validation of a social vulnerability index in context to river-floods in Germany. Natural Hazards and Earth System Sciences 9: 393-403.

Finucane, M.L., Slovic, P., Mertz, C.K., Flynn, J. and Satterfield, T.A. (2000). Gender, race, and perceived risk: The 'white male' effect. Healthy Risk & Society 2(2): 159-172.

Fischer, A., Peters, V., Neebe, M., Vávra, J., Kriel, A., Lapka, M. and Megyesi, B. (2012). Climate change? No, wise resource use is the issue: Social representations of energy, climate change and the future. Environmental Policy and Governance 22(3): 161-176.

Fischer, A., Peters, V., Vávra, J., Neebe, M. and Megyesi, B. (2011). Energy use, climate change and folk psychology: Does sustainability have a chance? Results from a qualitative study in five European countries. Global Environmental Change 21(3): 1025-1034.

Frei Ch., Davies, C. H., Gurtz, J. and Schar, Ch. (2000). Climate dynamics and extreme precipitation and flood events in Central Europe. Integrated Assessment 1: 281–299

Grollová D. and Zikmundová V. (2001). Mongolové: Pravnuci Čingischána [Mongians: Great-grandsons of Tchingischan] Praha: Triton, 232 p.

Grothmann, T. and Patt, A. (2005). Adaptive Capacity and Human Cognition: The Process of Individual Adaptation to Climate Change. Global Environmental Change 15 (3): 199-213.

Grothmann, T. and Reusswig, F. (2006). People at risk of flooding: Why some residents take precautionary action while others do not. Natural Hazards 38(1-2): 101-120.

Gupta, J. (2010). A history of international climate change policy, Wiley Interdisciplinary Reviews: Climate Change 1(5): 636-653.

Hansen J., Satoa M. and Ruedy R. (2012). Perception of Climate Change. PNAS. 9 pp.

Herzschuh U. (2006). Palaeo-moisture evolution in monsoonal Central Asia during the last 50,000 years. Quaternary Science Reviews 25(1–2): 163–178.

Houška, J. and Kynický J. (2004). Earth Remote Sensing and its Application of Desertification Monitoring in Mongolia In Samec, J. (eds) Scientific exploration of Mongolia. Brno: Mendel University, pp. 73-77.

Howe, P. D. (2011). Hurricane preparedness as anticipatory adaptation: A case study of community businesses. Global Environmental Change 21(2):711-720.

Huntjens P. and Pahl-Wostl C. (2010). Climate change adaptation in European river basins. Reg Environ Change. 10:263–284.

CHMI (1997). Vyhodnocení povodňové situace v červenci 1997 [Assessment of the flood situation in July 1997]. Czech Hydrometeorological Institute, Prague. Online. Available at: http://voda.chmi.cz/pov97/uvod.html. Accessed 26 June 2012

CHMI (2010). Vyhodnocení povodní v květnu a červnu 2010 – Hydrologické vyhodnocení průběhu povodní [Assessment of the floods in May and June 2010 - Hydrological evaluation of floods]. Czech Hydrometeorological Institute, Prague. 45 p.

IPCC (2007a). IPCC Working Group I Fourth Assessment Report. Geneva: IPCC (Intergovernmental Panel on Climate Change).

IPCC (2007b). IPCC Working Group II Fourth Assessment Report. Geneva: IPCC (Intergovernmental Panel on Climate Change).

IPCC (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. 590pp.

IPCC (2013). IPCC Working Group I Fifth Assessment Report. Geneva: IPCC (Intergovernmental Panel on Climate Change).

Juřička, D., Novotná, J., Cihlářová,H., Bartošová, R. and Mašek, J. (2010). Purity of Well Water in South Mongolia. In: Mongolia 2009 Proceedings. Brno: Mendel university, pp. 40-47. ISBN 978-80-7375-360-3.

Kane, S. and Shogren, J.F. (2000). Linking Adaptation and Mitigation in Climate Change Policy. Climatic Change 45: 75-102.

Kellsted, P.M., Zahran, S. and Vedlitz, A. (2008). Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. Risk Analysis 28(1): 113-126.

Kelman, I., Mercer, J. and West, J. (2009). Combining different knowledges: community-based climate change adaptation in small island developing states. Participatory Learning and Action Notes 60: 41-53.

Kempton, W. (1991). Public understanding of global warming. Society & Natural Resources 4: 331-345.

Kreibich H. (2012). Do perception of climate change influence precautionary measures? International Journal of Climate Change Strategies and Management. 2:189-199.

Kreibich H., Seifert,I., Thieken, A.H., Linquist, E., Wagner, K. and Bruno, M. (2011). Recent changes in flood preparedness of private households and businesses in Germany. Reg Environ Change 11:59–7.

Kreibich H., Thieken A.H., Petrow Th., Müller, M. and Merz, B. (2005). Flood loss reduction of private households due to building precautionary measures – lessons learned from the Elbe flood in August 2002. Natural Hazards and Earth System Sciences 5:117-126.

Kundzewicz Z.W. (2004). Floods and flood protection: business-as-usual? The Basis of Civilization – Water Science? Proceeding of the UNESCO/IAHS/IWHA symposium in Rome, December 2003. 201:209

Kynický, J. (2009). Permafrost and climatic change in Mongolia. In Pribulová, A. and Bičárová, S. (eds.) Sustainable development and bioclimate. 1. vyd. Stará Lesná: Geophysical Institute of he Slovak Academy of Sciences and Slovak Bioclimatological Society of the Slovak Academy of Sciences, pp. 34-35. ISBN 978-80-900450-1-9.

Kynický, J., Juřička, D. and Novotná, J. (2010). Earth Remote Sensing and its Application of Underground Water Monitoring in Mongolia In: Exploration Geophysics, Remote Sensing and Environment. 2010, 1: 77--86. ISSN 1803-1447.

Lapka, M. and Cudlínová, E. (2007). Problem of global warming and emerging patterns of global consciousness. International study. Journal of Landscape Ecology 0(0): 91-104.

Lapka, M. and Vávra, J. (2011). Regional perception of global challenges in five EU countries: Economic crisis, environment and technology. In M. Pech (ed.). Conference Proceedings INPROFORUM 2011 "Global Crisi-Regional Impacts" (CD-ROM), pp. 236-243. České Budějovice: Jihočeská univerzita.

Lapka, M., Cudlínová, E. and Marek, M.V. (2011). Vnímání globálních klimatických změn ve společnosti [Perception of climate change in society]. In M.V. Marek *et al.* Uhlík v ekosystémech České republiky v měnícím se klimatu [Carbon in ecosystem in the Czech Republic in changing climate], pp. 211-232. Praha: Academia.

Lass, W., Haas, A., Hinkel, J., Jaeger, C. (2011). Avoiding the Avoidable: Towards a European Heat Waves Risk Governance. Int. J. Disaster Risk Sci.1: 1–14.

Leiserowitz, A. (2006). Climate change risk perception and policy preferences: The role of affect, imagery, and values. Climatic Change 77: 45-72.

Lkhagvadorja, D., Hauckb, M., Dulamsurenb, Ch. and Tsogtbaatarc, J. (2013). Pastoral nomadism in the forest-steppe of the Mongolian Altai under a changing economy and a warming climate. Journal of Arid Environments 88: 82–89.

Lorenzoni, I. and Langfrod, I. H. (2006). Climate Change now now and in the Futurue: a Mixed Methodological Study of Public Perception in Norwich. Working papers ECM 01-05. pp 40.

Lorenzoni, I., Nicholson-Cole, S. and Whitmarsh, L. (2007). Barriers perceived to engaging with climate changes among the UK public and their policy implications. Global Environmental Change 17(3-4): 445-459.

Mace, M. J. (2005). Funding for Adaptation to Climate Change: UNFCCC and GEF Developments since COP-7, RECIEL 14(3): 225-246.

Marin, A. (2010). Riders under storms: Contributions of nomadic herders' observations to analysing climate change in Mongolia. Global Environmental Change. 20 (1):162–176

Marshall, N.A., Marshall, P.A., Tamelander, J., Obura, D., Malleret-King, D. and Cinner, J.E. (2009). A Framework for Social Adaptation to Climate Change; Sustaining Tropical Coastal Communities and Industries. Gland: IUCN.

McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. (2001). Climate Change 2001. Impacts, Adaptation, and Vulnerability: Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

MEA (2005). Millennium Ecosystem Assessment, Ecosystems and Human Well-Being. Washington, DC: Island Press.

Mechler R., Kundzewicz Z.W. (2010). Assessing adaptation to extreme weather event in Europe – Editorial. Mitig Adapt Strateg Glob Change. 15:611-620.

Mercer, J. (2010). Disaster risk Reduction or Climate change adaptation? Are we reinventing the wheel? Journal of International development 22(2): 247-264.

Mercer, J., Kelman, I., Alfthan, B. and Kurvits, T. (2012). Ecosystem-based Adaptation to Climate Change in Caribbean Small Island Developing States: Integrating Local and External Knowledge. Sustainability 4(8): 1908-1932.

Miceli, R., Sotgiu, I. and Settanni, M. (2008) Disaster preparedness and perception of flood risk: A study in an alpine valley in Italy. Journal of Environmental Psychology. 28:164-173

Millenium Ecosystem Assessment (2005). Ecosystems and Human well-being. Synthesis Report. Washington DC: Island Press. 137 pp. ISBN 1-59726-040-1

Mills, E. (2012). The Greening of Insurance. Science 338: 1424-1425.

Mills, E. (2007). Synergisms between climate change mitigation and adaptation: an insurance perspective. Mitigation and Adaptation Strategies for Global Change 12: 809-842.

Národní adaptační strategie České republiky na změnu klimatu [National Adaptation Strategy of the Czech Republic to Climate Change]. [unpublished, working version].

Natsagdorj, L., Jugdera, D. and Chungb Y.S. (2003). Analysis of dust storms observed in Mongolia during 1937–1999. Atmospheric Environment, 37(9–10): 401–1411

Newport, F. (2010). Americans' global warming concerns continue to drop. Gallup Politics, March 11, 2010. Retrieved March 23, 2013 from http://www.gallup.com/poll/126560/Americans-%20Global-Warming-Concerns-Continue-Dros.aspx#1.

Norgaard, K.M. (2006). 'We don't really want to know' – environmental justice and socially organized denial of global warming in Norway. Organization and Environment 19: 347-390.

Nyong, A., Adesina, F., Osman Elasha, B. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. Mitigation and Adaptation Strategies for Global Change 12: 787-797.
O'Connor, R.E., Bord, R.J. and Fisher, A. (1999). Risk perceptions, general environmental beliefs, and willingness to address climate change. Risk Analysis 19(3): 461-471.

O'Connor, R.E., Bord, R.J., Yarnal, B. and Wiefek, N. (2002). Who wants to reduce greenhouse gas emissions? Social Science Quarterly 83(1): 1-17.

Oleg, A., Anisimov, A., Frederick, E *and* Nelson, B. (1996). Permafrost distribution in the Northern Hemisphere under scenarios of climatic change, Global and Planetary Change 14: 59-72

Osman-Elasha, B. and Downing, T. (2007). Lessons Learned in Preparing National Adaptation Programmes of Action in Eastern and Southern Africa. Oxford: ECBI (European Capacity Building Initiative).

Otto-Banaszak, I., Matczak, P., Wesseler, J., Wechsung, F. (2010). Different perceptions of adaptation to climate change: a mental model approach applied to the evidence from expert interviews. Reg Environ Change (2011) 11:217–228.

Pearce, R., Dessai, S. and Barr, S. (2012). Re-Framing Environmental Social Science Research for Sustainable Water Management in a Changing Climate. Water Resources Management 1-21.

Perez, A., Fernadez, H. and Gatti, C. (eds). (2010). Building Resilience to Climate Change: Ecosystem-based Adaptation and Lessons from the Field. Gland: IUCN.

Petrov, M. P. (1976). Deserts of the World. New York: Wiley. ISBN 0706515137

Pokorný, D., Rolečková, E., Janková, J., Rauscher, J. (2013). Report on Water Management in the Czech Republic 2012. Prague: Ministry of Environment, Ministry of Agriculture. 132 pp.

Povodí Moravy, state enterprise (2009) Plán oblasti povodí Moravy 2010 – 2015 [Morava River Basin District Plan 2010-2015] [online]. Available at: http://www.pmo.cz/pop/2009/Morava/End/a-popis/a-1.html

Pugliese, A. and Ray, J. (2011). Awareness of climate change and threat vary by region. Gallup World, April 20, 2011. Retrieved September 25, 2011 from http://www.gallup.com/poll/147203/Fewer-Americans-Europeans-View-Global-Warming-Threat.aspx.

Quevauviller, P. (2011). Adapting to climate change: reducing water-related risks in Europe – EU policy and research considerations. Environmental Science and Policy, 14:722-729

Räthzel, N. and Uzzell, D. (2009). Changing relations in global environmental change. Global Environmental Change 19(3): 326-335.

Ratter, B. M. W., Philipp, K. H. I. and von Storch, H. (2012). Between hype and decline: Recent trends in public perception of climate change. Environmental Science & Policy 18: 3-8.

Reid, H., Alam, M., Berger, R., Cannon, T., Huq, S. and Milligan, A. (eds). (2009). Participatory learning and action: Community-based adaptation to climate change. London: International Institute for Environment and Development (IIED).

Renaud, F.G., Sudmeier-Rieux, K. and Estrella, M. (eds). (2013). The Role of Ecosystems in Disaster Risk Reduction. Tokyo: United Nations University Press.

Reusswig, F. (2010). The new climate change discourse: A challenge for environmental sociology. In M. Gross and H. Heinrichs (eds). Environmental sociology: European perspectives and interdisciplinary challenges, pp. 39-58. Springer.

Reusswig, F., Altenburg, C., Neebe, M., Schmidt, P. and Peters, V. (2010). Energy demand, governance and infrastructure in Potsdam and Potsdam-Mittelmark – The German case. In N. Gotts and I. Kovách (eds). Climate change and local governance: Alternative approaches to influencing household energy consumption. A comparative study of five European regions, pp. 110-184. Budapest: Hungarian Academy of Science.

Rodda, H.J. (2005). The Development and Application of a Flood Risk Model for the Czech the Czech Republic. Clim. Res., 29: 139-156.

Rückert, J., Bormann, I. and John, R. (2013). Umweltbewusstsein in Deutschland 2012. Ergebnisse einer repräsentativen Bevölkerungsumfrage. Berlin: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit. Retrieved September25, 2013 from http://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4396.pdf.

Rudaya, N., Dorofeyuk, N., Solovieva, N., Kalugin, I., Anreev, A., Daryin, A., Diekmann, B., Diekmann, B., Riedel, F., Tserendash, N. and Wagner, M. (2008). Holocene environments and climate in the Mongolian Altai reconstructed from the Hoton-Nur pollen and diatom records: a step towards Berger understanding climate dynamics in Central Asia. Quaternary Science Reviews, 28(5–6): 540–554

Samec, P., Kynický, J. and Kisza, L. (2006). Impacts of Aridization/Desertification to Ecotone Systems in Mongolia. In Samec, P., and Kynický, J. (eds). Summary of Mongolia Research 2000 - 2005 (II). Brno: Mendel university, pp. 72-83. ISBN 80-7157-920-3.

Seychelles Government (2009). Seychelles National Climate Change Strategy. Victoria: Government of the Seychelles.

Shaw, R., Pulhin, J.M. and Pereira, J.J. (eds). (2010a). Climate Change Adaptation and Disaster Risk Reduction: An Asian Perspective. Community, Environment and Disaster Risk Management. Bingley, Emerald Group Publishing Limited.

Shaw, R., Pulhin, J.M. and Pereira, J.J. (eds). (2010b). Climate Change Adaptation and Disaster Risk Reduction: Issues and Challenges. Community, Environment and Disaster Risk Management. Bingley: Emerald Group Publishing Limited.

Schröter, D., Crame, W., Leemans, R., Prentice, I.C., Araújo, B.M., Arnell, N.W., Bondeau, A., Bugmann, H., Carter, T. R., Gracia, C. A. (2005). Ecosystem supply and vulnerability to Global Change in Europe. Science, 310: 1333-1337

Smith, K. (2004). Environmental Hazards: Assessing Risk and Reducing Disaster, fourth edition. New York: Routledge.

Cowan, J. P. (2007). Geographic usage of the terms Middle Asia and Central Asia. Journal of Arid Environment. 69: 59–363

Spence, A. and Pidgeon, N. (2010). Framing and communicating climate change: The effects of distance and outcome frame manipulations. Global Environmental Change 20(4): 656-667.

Statistics department of Capital city (2013). Total population by sex at the beginning of the year, per thousand persons. [Online]. Available at> http://statis.ub.gov.mn/StatTable=11

Stern, P. C., Young, O. R. and Druckman, D. (1992). Global Environmental Change: Understanding the Human Dimensions. Washington: Committee on the Human Dimension of Global Change, Commission on the Behaviorual and Social Sciences and Education, National Research Council. 295 pp. ISBN 0-309-04494-4

Sternber,g T. (2008). Environmental challenges in Mongolia's dryland pastoral landscape. Journal of Arid Environment,s 72(7):1294–1304.

Travis, W. R. (2010). Going to extremes: propositions on the social response to severe climate change. Climatic Change, 98:1–19.

Tuček, M. (2013). Česká veřejnost o globálních problémech – květen 2013. Centrum pro výzkum veřejného mínění SoÚ AV ČR. [Czech public opinions about global issues. May 2013] Retrieved July 30, 2013 from http://cvvm.soc.cas.cz/media/com_form2content/documents/c1/a7041/f3/oe130627.pdf.

UNEP (2010). Risk and Vulnerability Assessment Methodology Development Project (RiVAMP): Linking Ecosystems to Risk and Vulnerability Reduction the Case of Jamaica. Geneva: UNEP (United Nations Environment Programme).

UNFCCC (1992). United Nations Framework Convention on Climate Change. New York: UN (United Nations).

UNFCCC (1995). Report of the Conference of the Parties on Its First Session, Held at Berlin From 28 March To 7 April 1995. Bonn: UNFCCC (United Nations Framework Convention on Climate Change).

UNFCCC (1997). Kyoto Protocol to the United Nations Framework Convention on Climate Change. Bonn: UNFCCC (United Nations Framework Convention on Climate Change).

UNFCCC (2006). Report of the Subsidiary Body for Scientific and Technological Advice on its twenty-fifth session, held at Nairobi from 6 to 14 November 2006. Bonn: UNFCCC (United Nations Framework Convention on Climate Change).

UNFCCC (2007). Revised draft decision -/CP.13. Ad Hoc Working Group on Long-term Cooperative Action under the Convention. Bonn: UNFCCC (United Nations Framework Convention on Climate Change).

UNFCCC (2010). Cancun Adaptation Framework. Bonn: UNFCCC (United Nations Framework Convention on Climate Change).

Uzzell, D. (2000). The psycho-spatial dimension to global environmental problems. Journal of Environmental Psychology 20(4): 307-318.

van Ree, C.C.D.F. *et al.* (2011). FloodProBE: technologies for improved safety of the built environment in relation to flood events. Environmental Science and Policy, 14:874-883.

Vávra, J., Lapka, M., Cudlínová, E. and Dvořáková-Líšková, Z. (2010). Energy governance in České Budějovice shire – The Czech case. In N. Gotts and I. Kovách (eds). Climate change and local governance: Alternative approaches to influencing household energy consumption. A comparative study of five European regions, pp. 76-109. Budapest: Hungarian Academy of Science. Retrieved March 20, 2013 from http://mek.oszk.hu/09300/09355/09355.pdf.

Weber, E. U. (2010). What shapes perceptions of climate change? Wires Climate Change, 1:332-342
Werg, J., Grothmann, T. and Schmidt, P. (2013). Assessing social capacity and vulnerability of private households to natural hazards – integrating psychological and governance factors. Naural Hazards and Earth System Sciences 13(6): 1613-1628.

White, G.F. (1942/1945). Human Adjustment to Floods: A Geographical Approach to the Flood Problem in the United States. Doctoral Dissertation, University of Chicago (1942) and republished as Research Paper No. 29 (1945), Chicago: Department of Geography, University of Chicago.
Yoon, D.K. (2012). Assessment of social vulnerability to natural disasters: A comparative study. Natural Hazards 63(2): 823-843.

Zelezny, L. C., Chua, P. and Aldrich, C. (2000). Elaborating on gender differences in environmentalism. Journal of Social Issues 56(3): 443-457.

Zhang, M. A., Borjigin, E. and Zhang, H. (2007). Mongolian nomadic culture and ecological culture: On the ecological reconstruction in the agro-pastoral mosaic zone in Northern China. Ecological Commits, 62: 19–26

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