Integrated Concepts and Adaptive Strategies for Addressing Social Vulnerability to Climate Change: the Case of the Mediterranean Region

Jürgen Scheffran
Institute for Geography, KlimaCampus, Hamburg University, Germany
Abstract for ICARUS Conference, February 11-13, 2010
Email juergen.scheffran@zmaw.de

Abstract: Climate change poses complex challenges to human security and social vulnerability that could exceed the governance capacities of countries and regions. Integrative concepts and institutional frameworks combine strategies from environmental policy, development policy and security policy to minimize risks and prevent violent conflicts. Approaches for adaptive governance seek to stabilize the climate-society interaction and strengthen adaptive capacities of individuals and their social environments. Participation of affected people and stakeholders with their interests and capabilities, knowledge and perceptions, responses and interactions are key for a creative transition towards a low-carbon society that integrates concepts of common security, sustainable peace and climate justice. Conceptual approaches will be specified and discussed for climate-related vulnerabilities and adaptation in the Mediterranean region, with a focus on the Nile river. It is expected that rising temperatures would exacerbate problems of desertification, water scarcity and food production, and spillover effects could/ expand the geographical extent of a crisis.

1 Integrated Assessment Framework of Climate-Society Interactions

Since human societies rest on certain environmental conditions, a changing climate that significantly alters these conditions will cause stress to social systems and have an impact on human life and society. Whether societies are able to cope with the impacts will depend on their responses to change and their abilities to adapt to or find creative solutions to associated problems. Finding human responses and societal strategies that avoid potential security risks and conflicts of climate change is a major challenge. To analyse these processes more systematically, an integrated assessment framework of climate-society interactions is needed, using concepts and methods rooted both in the social sciences and in complex systems analysis. To assess the implications for societal and political stability, it is crucial to not only understand the dynamics of systems, but also the perceptions and response patterns of human beings to climate-induced environmental change and how this shapes the social interactions in their respective societies (on climate change and security see further Scheffran 2008a, 2009, 2010; Scheffran/Link/Schilling 2009).

Figure 1 shows the causal linkages between climate stress, natural resources, human responses and societal consequences, building on related approaches such as the IPAT equation and the Kaya formula (Scheffran/Stoll-Kleemann 2003). Changes in climatic variables (such as temperature, precipitation, cloud and wind patterns) affect natural resources (e.g. soil, water, ecosystems, forests, biodiversity), through a sequence of complex interactions. Depending on vulnerability, adverse environmental changes will stress basic human needs and desires (such as the availability of water, food, energy, health and wealth). These adverse effects on human needs may impair the stability of societies that can appear in violent forms, such as riots, insurgencies, urban violence or war, which in return can aggravate social disruption. Feedback mechanisms allow societies to adapt to the changing situation and mitigate climate stress through strategies and institutions that apply technology, human and social capital for adjusting the economy, the energy system and human behaviour.

To determine the couplings along this causal chain, it is important to identify the sensitivities that measure how variables in one level modify variables in another level. For instance, desertification caused by climate change may undermine food security and force people to migrate or take violent actions. Many more of these linkages are feasible and future research may help to understand the most likely and most significant ones for crisis areas that are most affected by climate change (hot spots).

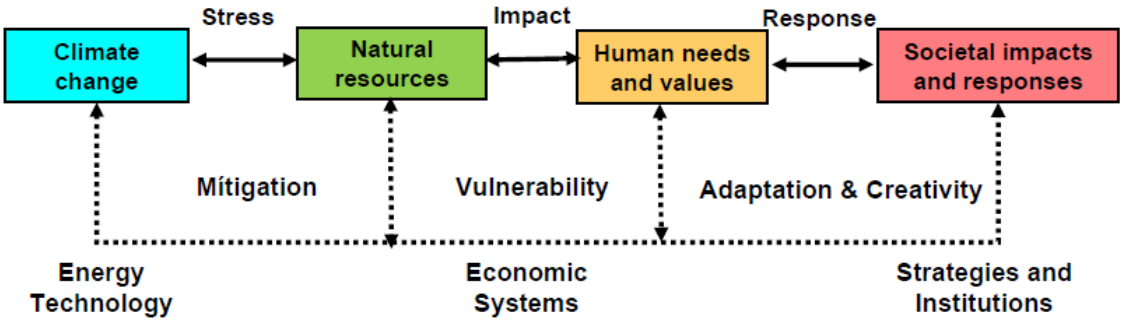

Figure 1: **Causal relationships between climate change, natural resources, human needs and societal impacts**

How significant the impacts of climate change on society are, depends on the linkages among the various system variables along the causal chain. They can be measured by the pair wise sensitivities between variables, i.e. how much the change of one variable induces a change in another variable. According to the IPCC (2007a) sensitivity in the context of climate change is the "degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise)." A prominent example is climate sensitivity, i.e. the temperature change induced by a doubling of CO_2 concentration in the atmosphere.

The possible causal chain from climate stress to societal instability can be constructed through a series of links between them where the couplings between variables are determined by the sensitivities. For instance, changes in the climate system affect the natural environment and resources through a sequence of complex interactions. Environmental changes will put stress on human needs and values (e.g. by reducing the availability of water, food, energy, health and wealth) and ultimately trigger societal impacts and instability events. The coupling between climate stress and societal instability captures both the direct linkages from climate change to societal stability and the indirect linkages through environmental and human impacts. Other linkages are also relevant here, such as the coupling between human needs and climate change, between societal and environmental change, or the reverse feedbacks. With this network of linkages it is possible to better understand the cascading spread of triggering events, e.g. an increase or a drop in precipitation, the loss of a species or a disastes, mass migrations, extreme weather events, social movements, and possibly develop an early warning system.

Many of the sensitivities are however unknown and depend on other variables. Due to non-linear effects, an increase in average mean temperature above a certain threshold (such as 2°C) may result in disproportionate impacts, such as a widespread reduction of agricultural output in regions of Africa, South Asia or Central and South America (Hare 2006; Schellnhuber/Cramer/Nakicenovic/Wigley/Yohe 2006). Food insecurity in one country may further increase competition of resources and force population to migrate into neighbour countries.

2 Social Vulnerability and Risks

The environmental effects of climate change events have multiple impacts on human needs and values. Systems that are essential for these needs include water, food and energy supplies, agriculture and land use, health, urban life and migration patterns, networks and infrastructures, economic activities and political processes. Environmental stress may directly threaten human health and life, such as floods, storms, droughts and heat waves, others gradually undermine the well-being over an extended period, such as food and water scarcity, diseases, weakened economic and degraded ecological systems. Life-threatening extreme weather events are expected to increase in frequency and strength. Storm and flood disasters could endanger large populations, e.g. in Southern Asia. The melting of glaciers could jeopardize water supply for people in extended areas, e.g. in the Andean and Himalaya regions. The impacts of climate change on human beings and societies depend on their vulnerability and responses. Some responses could help to adapt and minimize the risks, others may cause more problems. For instance, migration is a possible response not only to poverty and social deprivation, but also to environmental hardships. For existential threats the spectrum of responses may be restrained, making non-legal and violent acts more likely, but could also force people to work together to improve the chances for survival.

Vulnerability and adaptation

The impact of climate change on systems, persons or social groups depends on their vulnerability to loss (damage, harm, and hazard). According to the *Oxford English Dictionary* (Oxford 2009) a system is vulnerable (from Latin *vulnerare* 'to wound') if it is exposed to being attacked or harmed. This implies that events or acts may interfere with the normal operation of a system in a negative way. Blaikie, Cannon, Davis and Wisner (1994: 275) provide a human-centered definition of vulnerability as the "characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard." Thus, vulnerability depends on the person, the type of event and the actions taken against the hazard. Some persons may be more vulnerable to the same event than others, and some may not be vulnerable at all. An event causing vulnerability may be compensated by responses to protect against it or avoid it in the first place.

There is a range of different interpretations of vulnerability (Adger/Lorenzoni/O`Brien 2009, Brauch 2005, Ribot 2009), partly due to the diversity of the issues involved. One approach to present a formal framework (Ionescu et al. 2009: 3) defines "vulnerability *of* something *to* something" as a relative concept, depending on: (1) the entity that is vulnerable, (2) the stimulus to which it is vulnerable and (3) the preference criteria to evaluate the outcome of the interaction between the entity and the stimulus. Here the classification of vulnerability is a judgement referring to a possible future for a present entity, e.g. a potential event of causing harm. In terms of the preference criteria chosen, vulnerability has a negative connotation and classifies events into desirable and undesirable.

Within the context of climate change, the meaning of vulnerability has evolved over time (Füssel/Klein 2006). The core concept of vulnerability has been defined by the IPCC (2007) as the "degree, to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes." And further: "Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity." The operationalization of the IPCC vulnerability concept has proven difficult, partly because of the diversity of potential events associated with climate change, the variety of possible impacts and systems affected, all of which have different sensitivities and adaptive capacities.

The vulnerability concept is complicated because it involves the adaptive activities of the affected systems. For the IPCC (2007) adaptation is the "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". To adapt, a system must be able to respond to a climatic stimulus and take actions that either diminish harm or compensate for it by establishing positive values. The capability to take such actions is the adaptive capacity which is influenced by a number of factors (e.g. poverty, state support, economic opportunities, the effectiveness of decision-making, social cohesion). Each of those factors is affected by other variables, e.g. state support is a function of income and labour support, public education and health, law and (dis)order, credit and protective security (Barnett/Adger 2005: 4).

The overall assessment of vulnerability and adaptation depends on the balance between potential damage, costs and benefits. Implementation of adaptation measures comes at a cost which compares with the benefits they produce. Since complete invulnerability against all potential pathways for harm is impossible, the question is where to draw the line between what is tolerated and which further actions are taken which will ultimately depend on whether the additional efforts are worth the potential harm avoided. An insurance may compensate for a loss but this is difficult for existential loss. One approach to further operationalize the vulnerability concept is to develop indicators to measure the intensity of climate change, its harmful impact on various systems and the effectiveness of adaption measures to reduce the harm. In this approach vulnerability would be the ratio between net damage and the intensity of climate change which can be reduced by adaptation. An additional question is who will experience the damage and damage reduction and who will pay for it. A global assessment would not distinguish between the different actors but in reality the issue of equity matters.

The relationship between stimuli, losses and adaptive efforts will ultimately depend on the response functions of the respective systems. For a linear response function the adaptive response is proportionate to the stimulus (positive feedback) or inversely proportionate (negative feedback). In reality, responses can only occur within resource limits, given by a maximum and minimum response. Alternative response functions are dampened with increasing stimulus when approaching the upper limit, or they represent a logistic growth function, starting slowly until they reach a rapid transition point. A special case is a one-step response function where a switch towards the maximum response occurs at a particular stimulus.

Climate change will affect groups and sectors in society differently. A key variable is location, another one the group affected. Warming is greater at high latitudes than in the tropics, sea-level rise will have different impacts around the globe and some regions will experience more intense rainfall, others more dry periods. In some regions intense rainfall could lead to devastating floods, in others nobody may be harmed. Heat stress can be more fatal to elderly people than to young people. In South Asia tropical storms can kill tens of thousands of people, at the US Gulf coast they can lead to billions of dollars worth of damage. There are also significant differences in the degree to which regions, groups and sectors are able to prepare for or respond to the effects of climate change. Countries in Northern Europe have more advanced technological capabilities, financial resources and institutional systems to respond to sea-level rise proactively and protect their population than countries in Southern Asia or small island states in the South Pacific. For more frequent droughts, rich farmers will be better able to invest in irrigation technology than poor and less educated farmers.

Given the significant impact of climate variability on the natural environment, more affected are agricultural societies which rely more on natural resources and ecosystem services. Due to water scarcity and soil degradation, agricultural yields will further drop. The most serious climate risks and conflicts are expected in poor countries which are vulnerable to climate change, have less capital to invest in adaptation and thus cannot take the responses needed: A

progression of climate change will increase the vulnerability of weak and fragile states and further reduce their adaptive capacities. Climate change can thus reinforce obstacles to development and heighten poverty, thereby increasing the risk of conflicts in these societies.

But more wealthy countries are not immune either. While the impacts on some developed countries may be moderate or even positive at small temperature change (greater agricultural productivity, reduced winter heating bills, fewer winter deaths), they will become more damaging at higher temperatures as predicted towards the end of this century. Extreme weather events put the economic infrastructure at risk, including industrial sites and production facilities as well as networks for transportation and supply of goods. Depending on their type and intensity, climate impacts become a major obstacle to economic growth, regionally as well as globally.As impacts become more damaging, they may have severe consequences for developed economies, including population movements and disruption to global trade and financial markets.

Risks, threats and security

A risk analysis can be applied to situations with multiple uncertain results to determine the vulnerability to these events in terms of estimated losses and their probability (usually risk is the product of these two variables). To estimate the risks of climate change, information on the expected damage and probability of climate-induced events is needed. Furthermore, data on their timing and measures for risk reduction are useful. Each of the pathways from climate change to societal impacts is associated with a risk that is specific to the persons or systems affected. There is a sequence of probabilities along the causal chain: the probabilities for certain emission scenarios, atmospheric stabilization levels, global temperature change, climate change in each region, type of harm for each affected system, and finally the probability for each of the possible responses and societal instabilities. A practical approach is to focus on the essential pathways and develop aggregated risk indicators to measure how countries are potentially affected by climate-related stimuli, including the loss of lives, health, money or natural resources, ranging from moderate to catastrophic risk.

While risk assessments often deal with systemic contexts regarding technical or natural systems and claim a certain degree of objectivity, threat perceptions are often based on subjective attitudes towards an event or person and are usually interpreted as intentional acts that induce fear. During an armed conflict, threat assessments and perceptions are concerned with each other's military capabilities and combine the capability to threaten with the motivation to threaten. Various sources have extended the threat terminology to climate change, e.g. by the phrase "threat multiplier" (CNA 2007; European Commission 2008; IPI 2009). Since everyone is contributing to climate change and everyone is affected by it we would all pose threats to ourselves. However, the asymmetry between those who predominantly cause global warming and those who are largely affected by it, adds to the existing injustice between the rich and the poor.

The risks and threats of climate change are quite heterogeneous and influenced by a number of factors, including geographical location, the entity affected, and the social environment. Risk assessments also depend on human knowledge and perception, which in reality are bound to a window of attention, using limited information in terms of their temporal, spatial, social and other dimensions. Impacts and events outside of this window receive less attention. A spatial window pays more attention to near-distant events while far events are more 'out of view'. Similarly, temporal windows are restrained to the near past and future, and social

windows involve close relatives, friends and colleagues while people outside of the own social network have much weaker links.

In a negative sense, security is the ability to protect against danger, threat, and doubt. In a more positive sense, security means the preservation of core values. Combining both, security is a difference between chance and risk. A system facing threats can take measures to protect its core values and avoid harmful interference with its structure. To operationalize and specify security, it is important to determine the subject whose security is of concern, the values that are affected, the causes of risk, the vulnerability to harm and fear, as well as the capacity to protect against threats. In the emerging new world (dis)order after the Cold War, many actors and factors have been shaping the security discourse in a complex way (Scheffran 2008b). With the conflicting tendencies of globalization and fragmentation, social identities are torn between changing and sometimes contradicting roles and relationships.

Climate change could lead to both, fragmentation or further unification of humanity. Climate security builds on extended concepts, such as *common security* (common responses to common threats), e*cological security* (environmental problems as security risks) and *human security* (shielding and empowering people against acute threats). If the impacts of climate change provoke responses that affect the entire society, the consequences may also become an issue for national, international or global security, and contribute to securitization. Some climate impacts may cause governments and the military to take actions, e.g. for disaster management, in response to massive refugee flows, or in environmental conflicts.

3 Societal impacts and interactions

Environmental changes caused by global warming not only affect the life of human beings but may also have larger societal effects, either by undermining the infrastructures of society or by inducing destabilizing human responses and interactions of social systems. Vulnerable systems include water resources, agriculture, forestry, human health, settlements, energy and transportation systems, industry, and financial services. The associated socio-economic and political stress can undermine the functioning of communities, the effectiveness of institutions and the stability of societal structures. Societies which depend more on the environment, tend to be more vulnerable to climate stress. The stronger the impact and the larger the affected region the more challenging it becomes for societies to absorb the consequences. In the worst case, climate change could trigger a cycle of environmental degradation, economic decline, social unrest and political instability that could accumulate to become security threats and aggravate conflicts. For instance, due to water scarcity and soil degradation, agricultural yields could further drop and diminish food supply. Extreme weather events put the economic infrastructure at risk, including industrial sites and production facilities as well as networks for transportation and supply of goods. Each region of the world will be affected differently, and the societal implications depend on how human beings, populations and social systems respond.

Stability and instability

In a general sense, stability implies that “minor disturbances are not magnified into a major disturbance but are instead dampened to have only a small and disappearing impact” (Ter Borg 1987). Stability refers to a change in qualitatively different systemic conditions, like a transition from peace to war, from conflict to cooperation, or from environmental destruction to sustainability. Sensitivity is a key term in the stability concept. If a system is more sensitive

to changing conditions, it is more likely to become unstable if there is no correcting mechanism that maintains its stability. If climate change affects the stabilizing mechanisms of a social system, it can become potentially unstable. Depending on the given sensitivities, a climate-related event can induce a major destabilizing development in society or even trigger a cascading sequence of events leading to a collapse of society or a more stable situation. Depending on the type of systems, disturbances and responses, various stability concepts can be considered in the climate context.

- **Stability of the climate system, ecosystems and economic systems:** Article 2 of the UN *Framework Convention on Climate Change* (UNFCCC 1992) demands the stabilization of atmospheric greenhouse gas concentrations at levels that "prevent dangerous anthropogenic interference with the climate system." Conditions for environmental and economic stability determine tolerable windows for the allowable speed and magnitude of climate change (Petschel-Held et al. 1999). Ecosystems have adaptive capacities within a viability limit beyond which they break down (Aubin/Saint-Pierre 2007). Similarly, economic processes of production and consumption have an inherent resilience against disruption, as can be repeatedly observed in major crises and wars. Within these limits, an economic system is likely to be able to adapt to a long-term gradual climate change.
- **Stability against escalating threats:** In a multi-actor environment, a perceived loss of security for one actor may provoke reactions leading to a loss of security for other actors as well. Their responses may further result in insecurity for others. This "security dilemma" was prominent in the arms race of the Cold War but similar phenomena may be triggered by climate change if threat perceptions are increased in times of crisis. The concept of crisis stability reduces the motivation to use violence. The degradation of natural resources puts the survival of people at stake, provoking the use of violence to protect key resources against competitors. Instead, a peaceful approach would seek to strengthen mutually beneficial cooperation (win-win solutions), e.g. by resource sharing and joint risk management.
- **Human, societal and political stability:** Societies require rules, regulations, and institutions that maintain social order and ensure that cooperation is beneficial, effective, and predictable. Societal structures that loose credibility and support from the citizens become weak and unable to maintain order. Individuals who experience personal losses of life, income, property, job, health, family, or friends, which threaten their identity, may be more vulnerable to violate established rules, even more if there is only low risk of punishment. Thus, personal instability at a larger scale can induce political instability. Societies that are already on the edge of instability are especially at risk, in particular failing states that cannot guarantee the core functions of government, such as law and public order, welfare, participation and basic public services (e.g. infrastructure, health and education), or the monopoly on the use of force. Climate change may undercut the ability of governments to satisfy the needs of citizens and to provide opportunities for wealth and prosperity, and could augment other problems. The marginal impact of climate change could undermines the problem-solving capacity of societies in climate hot spots, contributing to their collapse.

Conflict and cooperation

Conflicts often emerge from incompatible actions, values, and priorities of actors who fail to reduce their differences and tensions to tolerable levels. The actions taken undercut each other's values and provoke responses generating further losses. A conflict escalates if actions by conflict parties aggravate the conflict tension and intensity, which corresponds to an inherently unstable interaction. Escalating conflicts consume a considerable amount of resources, forcing conflict parties to extreme actions and the use of violence, until the capability to act is exhausted or replenished by other sources. Conflict resolution can help to reduce the conflict tension and stabilize the interaction by mutual adjustment of actions until

an agreement is reached. Through cooperation actors adapt their goals and actions to each others benefits.

Whether conflict or cooperation prevails in social interaction depends on the responses of each actor that are determined by the decision rules and action priorities, and the potential for learning and adaptation (Scheffran/Hannon 2007). There are different types of responses that show how the efforts of one actor to achieve a certain value goal are related to the efforts of another actor. In a competitive relationship, effort is increased to compensate for the effort of other actors which is experienced as a loss, while in a cooperative situation both benefit from each other and the efforts may decrease accordingly for the same goal (Scheffran 2010). If agreement is not possible for admissible efforts, there is an unresolved conflict unless actors add more resources or change their own goals. Alternatively, one or both actors can change their behavior by switching to other action paths that make their actions more efficient and less threatening to the other actor. This increases the likelihood of reaching an agreement.

Whether climate change contributes to conflict is a difficult question. As the WBGU (2008) notes, climate change could also unite the international community to set the course for a dynamic and globally coordinated climate policy..Four conflict constellations are particularly relevant here: degradation of freshwater resources, decline in food production, increase in storm and flood disasters, and environmentally-induced migration.

Empirical evidence on the climate-conflict link still remains weak, Buhaug, Theisen and Gleditsch (2008) argue that a simple relationship between temperature change and the number of armed conflicts cannot be justified by data over the last two decades because the number of such conflicts has declined after the end of the Cold War, while temperature has increased. Recent studies have found relevant statistical correlations between a changing average global temperature and the frequency of war, e.g. during the Little Ice Age (Zhang et al. 2007). Burke et al. 2009 predict a significant climate-induced increase in the frequency of civil war in Africa until 2030.

Until more data are available, it is promising to look at regional case studies of environmental conflict which are important to explore the relationships in detail. The review of 73 empirically recorded “environmental conflicts” which occurred between 1980 and 2005 showed that these had a regional scope and did not yet present a serious threat to international security (Carius et al. 2007).

To study the link between climate change and conflict, agent-based approaches and social network analysis can be used, which depict the interaction between multiple actors (Flint et al. 2009). The actors are interconnected directly through communication processes to exchange information, or through the impacts of each other’s actions on the systems’ environment. Linkages between the actors determine how the value of one actor is affected by the efforts of all actors, which in turn depend on their own decision rules and action priorities. Negative couplings corresponds to a hostile or conflicting relationship, if they are positive the relationship is friendly or cooperative and thus beneficial to both. This framework allows the assessment of a wide spectrum of possible scenarios, based on assumptions of the various couplings for action alternatives and involving more than two actors to discuss collective action problems. Environmental change may increase violent conflict or spur cooperation to resolve common problems.

4 Integrated concepts and adaptive strategies

Avoiding climate security risks and mitigating conflicts induced by climate change requires an integrated set of strategies that address both the causes as well as the impacts of climate change along the causal climate-society interaction (see Figure 2).

Sustainable development of welfare and adaptive capacity

Since wealthy regions are less vulnerable and unstable, and have better adaptive capacities to manage the effects of climate changes, an important strategy to reduce security risks and stabilize societies is sustainable development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Report 1987: 43). Satisfying human needs and regenerating human capabilities makes societies more resistant to climate change and allows them to invest into low-carbon energy alternatives and the creation of institutions. Reducing poverty and establishing human rights would significantly improve the conditions for survival, strengthen human security, and build problem-solving capabilities. Less wealthy countries need development cooperation and supplemental international financial assistance, e.g. expansion of microfinance institutions.

Emission reduction and improved resource efficiency

Since greenhouse gas **(**GHG) emissions are the main cause of climate change, their deep reduction is essential to stabilize carbon concentration at levels that prevent dangerous climate risks and permit societal stability. This task requires more efficient and alternative uses of energy and other natural resources to create wealth with less resources. A number of instruments are available for this purpose, including taxes, transfer of capital and technology, and the Kyoto instruments (Clean Development Mechanism, Joint Implementation, tradable emission permits). Efficiency improvements can be achieved throughout the economic lifecycle, by innovative technology, economic instruments such as taxes and investment, behavioural changes and societal reorganization. In developing countries, multilateral funds (e.g. Global Environment Facility, Carbon Finance Unit) can make important contributions. Subsidies for fossil fuels need to be channelled into renewable energy sources. Carbon emissions from land use need to be reduced, adaptive capacity in rural areas strengthened.

Preserving natural resources

Consumption of natural resources should not exceed the natural carrying capacity for these resources. Limits are given by the finiteness of non-renewable resources, by the limited regenerating capacity of renewable resources, and by the limited ability of nature to absorb wastes. Sustainability requires that the underlying ecological processes are to be protected against disturbing changes of environmental conditions that could trigger tipping points and cascading breakdowns. To maintain the integrity and adaptive capacity of ecosystems, biodiversity needs to be preserved through building of nature preserves, sustainable land use, limitation of harvest rates, and preservation of endangered species. This would also protect terrestrial carbon stocks, especially tropical forests, against overexploitation and deforestation. Adaptation capacities of ecosystems against climate change need to be strengthened, recognizing their service for human societies. Within limits, ecosystems can be managed to adapt to and survive climate change.

Climate justice

Equity strategies seek to achieve a fair distribution between those who have the highest responsibility for climate change and those who are most affected, between north and south, rich and poor, current and future generations. A global framework of climate justice would balance responsibilities and impacts among countries, The challenge is to agree on collective emission targets that avoid dangerous climate change. As the largest emitters of greenhouse

gases the developed countries have a particular responsibility as well as the power to reach an agreement on reducing emissions to a non-dangerous level. A global diplomacy could help to contain climate-induced distributional conflicts, as well as the development of compensation mechanisms for the victims of climate change.

Managing risks, instabilities and conflicts

To implement the UNFCCC, the impacts of climate change need to be limited to non-dangerous levels. To specify 'danger standards' based in ethical norms would serve as guidelines for orientation to build legitimacy and acceptability of negotiation results. Concrete measures include disaster relief, protection of refugees, conflict management, among others. Robust societies need to develop and collaborate on mechanisms to handle conflict and capabilities to manage disasters, including emergency planning and establishment of clear decision-making structures and procedures. Global information systems for early warning could help with timely responses to extreme events and crises. Arms control, non-proliferation and disarmament would reduce the destructive potential of military forces (especially weapons of mass destruction) that could be used in conflicts. Regional security concepts would establish conflict resolution mechanisms and confidence-building measures. A high priority should be given to stabilizing fragile and weak states that are threatened by climate change. Emphasis should be given to crisis prevention which is less costly than crisis management and intervention which often come too late.

Participative approaches and stakeholder dialogues

Participation of citizens with their interests and capabilities, knowledge and perceptions, responses and interactions is a key for dealing with the challenges of climate change and managing associated security risks, instabilities and conflicts. Focus groups have proven successful in various contexts as a process of group discussion and evaluation of critical societal issues such as climate change. Multi-stakeholder sustainability planning is a social learning mechanism based on the vision of partnership between members of society and their environment, involving stakeholders in the formulation, monitoring and follow-up of sustainable development strategies. It contributes to the formation of social capital, democratization and stabilization of societies and can prepare the ground for cooperation, negotiation and conflict resolution (Scheffran/Stoll-Kleemann 2003)**.** Regional participatory assessment will include experts and stakeholders from the regions of concern into a discussion of key links and variables of the climate-society interaction.

Global governance, cooperation and sustainable peace

To master the global and long-term challenges and security risks of climate change, a well-designed global governance architecture would create and reinforce multilateral regimes that involve cooperation between states and non-government actors from the local to the global level. New concepts of adaptive governance influence the many decision points along the causal chain from climate change to societal instability to avoid cascading risks and prevent the breakup of natural and social systems. Global warming constitutes a common problem of humankind which needs to establish common solutions and cooperative approaches that combine sustainable environmental policy, development policy and preventive security policy into an integrated concept for sustainable peace. Cooperative approaches include the international transfer of investments and technologies to shift the composition and learning rates of the energy system towards emission reductions. To overcome diverging interests it is important to build coalitions and win-win solutions between industrialized and developing countries. Possible areas for cooperation are migration policy that strengthens the adaptive capacities of people living in poverty and the rights of environmental migrants, Another area is cooperation on transboundary water management,

Figure 2: Strategies for climate security within the integrated assessment framework.

5 The Mediterranean Region as a Climate Hot Spot

The Mediterranean region (Southern Europe, North Africa, and Middle East) will be severely affected by global warming, with a combination of factors that contribute to vulnerability:

- Rising temperatures are expected to exacerbate existing pressures on limited water resources because of altered rainfall patterns and losses of snow and glacial melt water. This adds to existing problems of desertification, water scarcity, and food production (Brauch et al. 2003; Giannakopoulos et al. 2005; IPCC 2007).
- Water scarcity has a negative impact on agricultural and forestry yields and limits the output of hydropower.
- Heat waves and forest fires compromise vegetation cover and add to existing environmental problems.
- Ecosystem change affects soil quality and moisture, the carbon cycle and local climate.
- Population pressure and water-intensive activities such as irrigation already impose a considerable stress on water supplies. This poses dangers to human health, ecosystems, and national economies of countries.

Within the Mediterranean region there are significant differences with regard to vulnerability and problem-solving capacity.

- Southern Europe is characterized by relatively high economic and social capabilities, which can be further backed up by support from the EU to mitigate the impact and strengthen long-term adaptation possible (Brauch 2006). Despite expected environmental changes, outbreaks of violence and conflict are less likely in the foreseeable future.
- In contrast, the environmental situation in North African is significantly worse. Climate change interacts with the region's other problems that involve high population growth, dependence on agriculture and weak governance. Countries are far more vulnerable, less able to adapt and more prone to conflict.

In Southern Europe, a temperature rise of 2 degrees Celsius could decrease summer water availability by 20 to 30 percent; a rise of 4 degrees Celsius by 40 to 50 percent (Stern Review 2006, part 2: 123). Increasing temperatures, forest fires and water stresses may lead to a general northward shift in summer tourism, agriculture, and ecosystems. Thus, climate change could endanger the tourism sector, the main employer in the region. The Canary Islands, the south of Italy and Spain, part of Greece and Turkey experience already an increasing competition for resources among different sectors, especially water and land. With increased warming, it may be increasingly difficult to sustain current living standards and provide development opportunities.

Lack of usable land and water resources adds to impoverishment and forces people to move from rural areas to cities. River deltas are at risk from sea-level rise and salinization. For 50cm sea-level rise salt water would penetrate 9 km into Nile aquifers, affecting agriculture and the whole economy (WBGU 2007). Desertification can affect the stability of the Mediterranean region and trigger large-scale migration, riots and violent clashes. European countries along the Mediterranean already face pressures from African immigrants. It is unlikely, however, that climate change alone would lead to conflict, rather it could interact with other forces, such as unemployment, economic recession and unstable political regimes to cause widespread dissatisfaction and, eventually, human insecurity and social instability. Whether and to which degree these development occur, not only depends on climate stress factors and the human and socio-economic vulnerability, but also on the adaptive capacities that contribute to problem-solving, Some of the key interactions between climate stress and environmental change, human, economic and societal impact, and the problem-solving and adaptive capacity in the region are summarized in Table 1..

Case study: Egypt and Water Conflicts in the Nile River Basin

Reduced water supply over an extended period also bears a conflict potential among the countries in the Nile basin (Mason 2004). In particular, Egypt depends on the Nile for 95% ofits drinking and industrial water and could feel threatened by countries upstream that over utilize the water from the river. This increases the chances for political crisis and violent clashes (Brauch 2006), but could also increase the need for agreements to regulate water distribution. Lack of usable land and water resources adds to impoverishment and forces people to move from rural areas to cities. At the same time, the agriculturally quite productive river delta is at risk from sea-level rise and salinization (WBGU 2007).

Egypt and especially the capital Cairo are highly vulnerable to various impacts of climate change. It is estimated that Egypt could experience a severe loss in agricultural productivity as a result of climate change induced water scarcity and land degradation. Wheat and maize production in Egypt could significantly drop by middle of the 21st century. Together with the continuing mounting demographic pressure (Egypt's population is estimated to double between 2005 and 2050), this may intensify competition over remaining arable land.

Table 1: Climate stress, impact and adaptive capacity in the Mediterranean (WBGU 2007)

Climate stress and environmental change	**Human, economic and societal impact**	**Problem-solving and adaptive capacity**
Warming and water scarcity Temperature rise 2.2–5.1 °C (mean 3.4 °C) likely by 2100 compared to 1980–1999 (IPCC 2007). Greatest warming and temperature fluctuations in summer; winter precipitation declined last 50 years. -By 2100 precipitation will likely fall 4–27% in southern Europe and by 20 % in North Africa. -Higher soil water evaporation exacerbates summer water shortages -Rivers water levels higher in winter and lower in summer, -Increasing water scarcity has negative impact on agricultural and forestry yields and on hydropower. Increased risk of fires will compromise vegetation cover (from forest to bush and patchy cover). **Ecosystem change affects soil quality and moisture, carbon cycle and local climate.** Water resources are already scarce and irrigation can result in salination. Soils in large areas of Spain and some regions of Italy and Greece are already salinated (MA, 2005a). If this trend continues it can lead to desertification, with land then being lost for agricultural use. Self-reinforcing consequences are lower air humidity and less precipitation **Soil situation of North Africa is already critical.** Already widespread soil salination at risk of increasing. Soils seriously eroded through overgrazing, deforestation, non-sustainable irrigation. Loss of pasture and arable land. Surface run-off in North Africa will fall significantly by 2050 Risk of desertification in all countries, partic, northern Sahara Climate change adds pressure to current non-sustainable land use.	**Economy in Southern Europe is vulnerable to climate change.** Resource-intensive agriculture, e.g. 7–8% of GDP in Greece. Tourism is water-intensive e.g. accounts for 9% of GDP in Spain. Hydropower is important in electricity generation. **Serious vulnerability to climate effects in North Africa.** Warming leads to growing aridity and reduced agricultural yields. Agricultural production in 2100 will decline by 0.4–1.3% of GDP, e.g. Soya production will fall almost 30% by 2050 in Egypt. Large population is directly employed in agriculture (e.g. 44% in Morocco, 28% in Egypt. Water competition between agriculture (15% of GDP), tourism (8% of GDP), and drinking water. **Demographic trends aggravate climate-induced impacts.** Population increase by 95 million in 2025, 31 million in coastal areas. Migration from Sahel region amplifies population pressure. North Africa is both destination and transit region for migrants. Urban agglomerations (e.g. Cairo), with high population pressure and non-sustainable agriculture. **Impact of sea-level rise on Nile Delta and other coastal areas:** For 50cm sea-level rise salt water penetrates 9km into Nile aquifers. Consequences for agriculture (salination) and the whole economy. Egypt depends on Nile for 95% of drinking and industrial water. **Impacts on security and conflict:** Overuse of water and soil has detrimental effect on food security. Migration has already led to violent conflicts. Climate change could drive water conflicts between states along Nile. History of virulent conflict and social unrest, fundamentalist religious movements.	Clear differences in adaptive capacity between southern Europe and North Africa. **Southern European (EU):** Consolidated democracies with functioning governance structures. Market economy structures, social security networks and supra-national equalization systems (e.g. European Structural Funds). Annual per capita income is US$19,000–29,000. State know-how and resources against drought or flooding. Extensive private insurance Possible European subsidies, e.g. European Disaster Relief Fund. **North Africa:** Poverty, high unemployment, wide social discrepancies and scanty state social security networks. Low Human Development Index, (except Libya). Weak states & autocratic regimes, under political phase transition. Annual per capita income: US$4,000–7,500. Some countries have deposits of fossil resources (e.g. Algeria). Regional integration unsuccessful, no strong institutionalized structures, besides Arab League. Lack of resources and institutions to facilitate protection & adaption. **Responses** Irrigation is problematic response to drought, fossil groundwater is not sustainable. Sustainable agriculture is needed. Euro-Mediterranean Partnership (Barcelona Process) has neglected regional issues of climate change. Nile Basin Initiative helps to resolve crises cooperatively. Increased climate stress could overtask conflict resolution mechanisms.

Furthermore, a 0.5m rise of the sea level of the Mediterranean Sea could displace between two and four million Egyptians (FoEME 2007). Most of them will seek refuge in Cairo's suburbs. Water scarcity and lower agricultural productivity in the Upper Nile area may also add to migration from the rural areas to Cairo and contribute to degradation of sanitary conditions and increasing social unrest as well. Changes in environmental conditions have an influence on water and land availability, which in turn affects economic production. Since human welfare and consequently societal stability depend on wealth, any deterioration of the economy has negative implications on society as well. Water availability and the conditions for agricultural production downstream depend on the water use further upstream. Also, there is a differentiation between the population of rural and urban areas along the Nile River, as economic activities differ substantially and the effects of climate change vary accordingly. Any large scale change in the structure of society, which may be caused by migration or population growth, triggers feedbacks that affect the economic output and subsequently the distribution of the remaining land and water resources (Scheffran/Link/Schilling 2009).

Conflicts between the various actors can arise on different levels. First of all, there is tension between geographic regions. Increased use of resources in the upstream region diminishes the conditions for successful agricultural production downstream. Also, tensions may build due to the distinctly different structure of the populations in the rural and urban regions. These may increase in intensity if migration between these regions or particularly large population growth leads to larger competition of the limited resources available. Such conflicts are by no means confined to tensions between regions but could also manifest themselves in internal conflicts within a particular part of society.

A strong cooperation between Europe and the North African countries on energy security and climate security could highly benefit the entire region, increase adaptive capacity, substantially contribute to emission reduction especially in the power sectors and create the preconditions for long term stability. A promising opportunity for strengthened North-South cooperation is the vision of linking Europe to North Africa with electric power lines.(DESERTEC (2008, 2007). Europe sees the possibility of producing a large quantity of electricity from renewable sources in North Africa to combat climate change, meet its emission reduction and renewable energy obligations, decrease energy dependency and, at the same time, engage with a neighbouring developing country region. North African countries see the opportunity of meeting the increasing local energy demand, to attract substantial foreign investments, generate export benefits and open the way to technology sharing, employment opportunities and economic desalination. Before such a project can be realized, a number of hurdles and criteria need to be addressed.

References

Adger, W. Neil; Lorenzoni, Irene; O'Brien, Karen (Eds.), 2009: *Adapting to Climate Change: Thresholds, Values, Governance* (Cambridge: Cambridge University Press).

Aubin, Jean-Pierre; Saint-Pierre, Patrick, 2007: "An introduction to viability theory and management of renewable resources", in: Kropp, Jürgen; Scheffran, Jürgen (Eds.): *Decision Making and Risk Management in Sustainability Science* (New York: Nova Science)**:** 43-80.

Barnett, J.; Adger, N., 2005: Security and Climate Change: Towards an Improved Understanding. Paper for the joint workshop of GECHS, CICERO and PRIO on "Human Security and Climate Change", Oslo, 20-21 June; at: <http://www.cicero.uio.no/hum-sec/papers/Barnett&Adger.pdf>.

Blaikie, Piers; Cannon, Terry; Davis, Ian; Wisner, Ben, 1994: *At Risk: Natural Hazards, People's Vulnerability, and Disasters* (London: Routledge).

Brauch, H.G.; El-Sayed Selim, M.; Liotta, P.H.; Chourou, B.; Rogers, P., 2003: Security and the Environment in the Mediterranean (Berlin: Springer).

Brauch, Hans Günter, 2005: Threats, Challenges, Vulnerabilities and Risks in Environmental Human Security (Bonn: UNU-EHS); at: <http://www.ehs.unu.edu/index.php?module=overview&cat=17&menu=36>.

Brauch, Hans Günter, 2006a: Regionalexpertise - Destabilisierungs- und Konfliktpotential prognostizierter Umweltveränderungen in der Region Südeuropa und Nordafrika bis 2020/2050. Expert Study for the German Advisory Council on Global Change; at: <http://www.wbgu.de/wbgu_jg2007_ex01.pdf>.

Buhaug, H.; Gleditsch, N.P.; Theisen, O.M., 2008: Implications of Climate Change for Armed Conflict". Paper commissioned by World Bank Group for'Social Dimensions of Climate Change' workshop, Washington, D.C., 5-6 March 2008, working paper; at: <http://siteresources.worldbank.org/INTRANETSOCIALDEVELOPMENT/Resources/SD-CCWorkingPaper_Conflict.pdf>.

Burke, M.B.; Miguel, E.; Satyanath, S.; Dykema, J.E.; Lobell, D.B. 2009: Warming increases the risk of civil war in Africa, PNAS Dec. 8, 106(49), 20670–20674

Carius, A.; Tanzler, D., Winterstein, J., 2006: *Weltkarte von Umweltkonflikten–Ansätze zur Typologisierung* (Berlin: WBGU); at: <www.wbgu.de/ wbgu_jg2007_ex02.pdf>.

CNA [The CNA Corporation] 2007: *National Security and the Threat of Climate Change* (Alexandria: VA: Center for Naval Analysis); at: <http://securityandclimate.cna.org/>.

DESERTEC 2008. Our vision of the Union for the Mediterranean: DESERTEC Concept. Deserts technology for energy, water and climate security. Hamburg: Whitepaper, Club of Rome.

European Commission, 2008: Climate Change and International Security - Paper from the High Representative and European Commission to European Council (Brussels); at: <http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/reports/99387.pdf>.

Flint, C.; Diehl, P.; Scheffran, J.; Vasquez, J.; Chi, S., 2009: Conceptualizing ConflictSpace: Towards a geography of relational power and embeddedness in the analysis of interstate conflict, *Annals of the Association of American Geographers*, 99,5: 827-835.

FoEME, 2007: Climate Change: A New Threat to Middle East Security; at: <http://www.foeme.org/index_images/dinamicas/publications/publ78_1.pdf >.

Giannakopoulos, C.; Bindi, M.; Moriondo, M.; LeSager, P.; Tin, T., 2005: Climate change impacts in the Mediterranean resulting from a 2°C global temperature rise. Study commissioned by WWF (Gland).

Hare, B., 2006: "Relationship Between Increases in Global Mean Temperature and Impacts on Ecosystems, Food Production, Water and Socio-Economic Systems", in: Schellnhuber, H.J.; Cramer, W.; Nakicenovic, N.; Wigley, T.; Yohe, G. (Eds.): Avoiding Dangerous Climate Change (Cambridge: Cambridge University Press)**:** 177-186.

Ionescu, Cezar; Klein, Richard J. T.; Hinkel, Jochen; Kavi Kumar, K. S.; Klein, Rupert, 2009: "Towards a Formal Framework of Vulnerability to Climate Change", in: *Environmental Modeling and Assessment*, 14,1: 1-16.

IPCC [Intergovernmental Panel on Climate Change], 2007: Climate Change 2007. Climate Change Impacts, Adaptation and Vulnerability, Working Group II, Summary for Policymakers (Geneva: Intergovernmental Panel on Climate Change).

IPI [International Peace Institute] 2009: Climate Change is a Threat Multiplier, Experts Say; at: <http://www.ipacademy.org/events/panel-discussions/details/93-climate-change-is-a-threat-multiplier-experts-say.html>.

Mason, Simon A., 2004: From conflict to cooperation in the Nile Basin. Interaction between water availability, water management in Egypt and Sudan, and international relations in the Eastern Nile Basin (Zurich: Swiss Federal Institute of Technologie ETH Zurich).

Medzini, A.; Wolf, A.T., 2004: "Towards a Middle East at Peace: Hidden Issues in Arab-Israeli Hydropolitics", in: *Water Resources Development*, 20,2: 193-204.

Oxford, 2009: Oxford English Dictionary; at: www.askoxford.com.

Petschel-Held, G.; Schellnhuber, Hans Joachim; Bruckner, Thomas; Toth, Ferenc L.; Hasselmann, Klaus, 1999: "The Tolerable Windows Approach: Theoretical and Methodological Foundations", in: *Climatic Change*, 41,3-4: 303-331.

Ribot, Jesse C., 2009. “Vulnerability does not just Fall from the Sky: Toward Multi-scale Pro-poor Climate Policy”, in: Mearns, Robin; Norton, Andrew (Eds.): *Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World* (Washington, DC: The World Bank, forthcoming).

Scheffran, J., 2008a: "Climate change and security", in: *Bulletin of the Atomic Scientists*, 64,2: 19-25.

Scheffran, J., 2008b: "The Complexity of Security", in: Scheffran, J. (Eds.): Security and Complexity, Special Issue of the Journal "Complexity", 14,1: 13-21.

Scheffran, J.; Hannon, B., 2007: "From complex conflicts to stable cooperation", in: *Complexity*, 13,2: 78-91.

Scheffran, J.; Stoll-Kleemann, S., 2003: "Participatory Governance in Environmental Conflict Resolution", in: Deb, K.; Srivastava, L. (Eds.): Transition Towards Sustainable Development in South Asia (New Delhi: The Energy and Resources Institute)**:** 307-327.

Scheffran, Jürgen, 2009: "The Gathering Storm - Is Climate Change a Security Threat?", in: *Security Index*, 87,2: 21-31.

Scheffran J, Link M, Schilling J, Theories and models of the climate-security link, Paper presented at the Conference "Climate Change, Social Stress and Violent Conflict", Hamburg, November 19-20, 2009**.**

Scheffran, Jürgen, 2010: "The Security Risks of Climate Change: Vulnerabilities, Threats, Conflicts and Strategies", in: Brauch, H. G.; Oswald-Spring, U.; Kameri-Mbote, P.; Mesjasz, C.; Grin, J.; Chourou, B.; Dunay, P.; Birkmann, J. (Eds.): Coping with Global Environmental Change, Disasters and Security (Berlin: Springer).

Schellnhuber, H.J.; Cramer, W.; Nakicenovic, N.; Wigley, T.; Yohe, G. (Eds.), 2006: Avoiding Dangerous Climate Change (Cambridge: Cambridge University Press).

Stern, N.; Peters, S.; Bakhshi, V.; Bowen, A.; Cameron, C.; Catovsky, S.; Crane, D.; Cruickshank, S.; Dietz, S.; Edmonson, N.; Garbett, S.-L.; Hamid, L.; Hoffman, G.; Ingram, D.; Jones, B.; Patmore, N.; Radcliffe, H.; Sathiyarajah, R.; Stock, M.; Taylor, C.; Vernon, T.; Wanjie, H.; Zenghelis, D., 2006: Stern Review: The Economics of Climate Change (London: HM Treasury).

Ter Borg, Marlies; Tulp, Marianne, 1987: Defence Technology Assessment - Improving defence decision making (Amsterdam: Nederlandse Organisatie voor Technologisch Aspectenonderzoek).

WBGU, 2008: World in Transition - Climate Change as a Security Risk (London: Earthscan); at: <http://www.wbgu.de/wbgu_jg2007_engl.html>.

Wolf, A., 1995: Hydropolitics along the Jordan River: The Impact of Scarce Water Resources on the Arab-Israeli Conflict (New York: United Nations University Press).

Zhang, D.D.; Brecke, P.; Lee, H.F.; He, Y; Zhang, J. 2007: Global climate change, war, and population decline in recent human history, in: *Proceedings of the National Academy of Science* (PNAS), 104,40 (4 December): 19214-19219.