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MEETING OF THE PARTIES TO THE PROTOCOL ON WATER AND HEALTH
TO THE CONVENTION ON THE PROTECTION AND USE OF TRANSBOUNDARY
WATERCOURSES AND INTERNATIONAL LAKES

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DRAFT GUIDANCE ON WATER AND CLIMATE ADAPTATION

This document has been prepared for the Workshop on Water and Climate Adaptation (Amsterdam, 1–2 July 2008).

It is an intermediary version of the draft guidance on water and climate adaptation being prepared under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes and its Protocol on Water and Health for possible adoption by the Meetings of the Parties to both instruments in 2009/2010.

The document has been jointly prepared by the Convention's Task Force on Water and Climate and the Protocol's Task Force on Extreme Weather Events.

The current draft is still incomplete. In particular, the final Guidance should include:

- An executive summary for policymakers;
- Examples in the Guidance text to make it more concrete;
- Case studies to be included in the annexes;
- Additional recommendations related to water supply and sanitation in extreme events (these policy recommendations should be read together with the technical and operational guidelines on water supply and sanitation in extreme weather events to be developed by the Protocol's Task Force on Extreme Weather Events);
- Specific recommendations related to the transboundary context;
- Financial aspects, in particular approaches to costing.

The final text will also aim at being of recommendatory nature; hence some editing will done to achieve the right tone and formulation of the text.

One of the main objectives of the Workshop on Water and Climate Adaptation is to comment and review the draft guidance and to collect good practices to illustrate its principles. Workshop participants are therefore invited to provide their comments to the existing text as well as suggestions for how its content and main message should be further developed.

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INTRODUCTION

1. As recognized by the Fourth Assessment Report of the Intergovernmental Panel on Climate Change in 2007, observational evidence from all continents and most oceans shows that many natural systems, among which the hydrological cycle and thus water availability and water quality as well as water services, are being affected by anthropogenic climate changes.

2. These changes have significant socio-economic impacts: in the period 2000–2006, worldwide the frequency of disaster from extreme events increased by 187 per cent compared to the previous decade, accounting for 33,000 deaths and 400 million people affected. In the same period, global economic damages for flooding events and heavy storms were estimated in about US$ 25 billion. [1]

3. Nearly all UNECE countries are anticipated to be negatively affected by the future impacts of climate change. Impacts will vary considerably from region to region and even from basin to basin. Negative impacts will include increased risk of inland flash floods, and more frequent coastal flooding, intensified erosion and extensive species losses. Mountainous areas will face glacier retreat and reduced snow cover which will affect winter tourism.

4. In Southern Europe, Caucasus and Central Asia, climate change is projected to lead to high temperatures and drought and to reduced water availability, hydropower potential, summer tourism and, in general, crop productivity. In Central and Eastern Europe, summer precipitation is projected to decrease, causing higher water stress. In Northern Europe, climate change is initially projected to bring mixed effects, including some benefits such as reduced demand for heating, increased crop yields and increased forest growth. However, as climate change continues, its negative impacts are likely to outweigh its benefits.

5. The first Assessment of transboundary rivers, lakes and groundwaters in the UNECE region has demonstrated that in many basins, climate change impacts can already be measured.

6. Climate change impacts on freshwater resources affects sustainable development and put at risk economic development, the reduction of poverty, child mortality, production and availability of food and the health of people and ecosystems.

7. Climate variability and associated changes in the available water resources and their quality are responsible for increased health risks. Direct effects include lesions and death from drowning or trauma in floods and premature deaths attributed to heat waves and cold waves. Indirect effects relevant to health risk are post-traumatic mental disorders and population displacement. Especially after flood events, populations are exposed to health hazards caused by contamination of water (e.g. pathogens, waste and toxic chemicals), lack of household hygiene, reduction of food safety, and increase in the number and geographical distribution of disease carrying vectors. These changes result in an increase of infectious diseases. In addition, due to increasing temperatures, new diseases are introduced in regions where they were previously absent, and diseases that had been controlled in the past, such as malaria in Central Asia, reappear.

[1] Emergency Events Database (EM_DAT) of the Centre for Research on the Epidemiology of Disasters (CRED), 2007.

8. Availability of a reliable supply of safe water and adequate sanitation is essential to safeguard human health. Disruption of these services, especially during extreme events, will result in an increase in water borne infectious diseases. It is therefore important to develop coping mechanism to deal with such disruption. The safety of the water supply and sanitation sector relies on close inter-sectoral cooperation during the prevention, management and recovery phases.

9. Adaptation to climate change is consequently indispensable. In addition, as recognized by various scientific panels, it is more cost-effective to start preparing for adaptation now than to wait until impacts of climate change are irreversible.

10. Climate change adaptation should not be done in competition with, but in addition to other water management measures. Climate proofing of existing water supply systems can for instance be done in combination with ensuring the basic human right to water to those that do not enjoy that right at present.

11. Countries with economies in transition and less developed countries are among the most vulnerable to the adverse effects of climate change; in addition, widespread poverty limits their adaptive capacity. The timely elaboration of national adaptation strategies and the integration of climate change aspects into development cooperation as well as into concerned national sectoral policies is therefore important.

12. Adaptation represents an important challenge for all countries and especially for countries with economies in transition, but few countries have developed adaptation strategies so far. Knowledge on adaptation in a transboundary context is especially lacking. For this reason, the Parties to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), at their fourth meeting (Bonn, Germany, 2006), decided to assist Governments in developing adaptation strategies at different government levels by elaborating a guidance on water and adaptation to climate change. Pursuant to this decision, the present Guidance was prepared by the Task Force on Water and Climate under the Water Convention, in close cooperation with the Task Force on Extreme Weather Events, under the Convention's Protocol on Water and Health.

.1 Aim

13. At the time when many countries are in the process of implementing integrated water resources management (IWRM), climate change adds to the complexity of its implementation. This Guidance aims to offer specific advice on the additional challenges caused by climate change. It does not address IWRM as a whole. It provides a step-by-step framework for assessing climate change impacts on water resources, identifying adaptation measures to climate change and developing adaptation strategies and measures that take into account the transboundary context.

14. It also addresses issues related to national health care dependent on water conditions and to specific sectors of national economies such as energy, agriculture, etc.

15. The Guidance aims at supporting decision makers from the local to the international level. It puts a special emphasis on the specificities and requirements of transboundary basins, with the objective of preventing, controlling and reducing transboundary impacts of national adaptation measures. The Guidance endeavours to promote sustainable water resources management and contributes to preventing and resolving challenges and possible conflicts related to the impact of climate change on water resources. It is intended to guide Parties to the Water Convention and Parties to the Protocol on Water and Health in the implementation of the provisions of the Convention and the Protocol within the context of climate change.

.2 Target Group

16. The key target groups of the Guidance are decision makers responsible for water management in general as well as relevant health-related issues such as the provision of safe drinking water and adequate sanitation, in particular in the transboundary context.

17. The document is also of interest for officials, managers and stakeholders (e.g. private sector, consumers) of other sectors with a direct relevance to water and health, such as the food sector (particularly aquaculture), the tourism sector, the agricultural sector managing irrigation and reuse of treated wastewater, industrial water users, inland water transport, production of electricity, fisheries, etc.

18. The Guidance is relevant for the entire UNECE region, with a focus on countries with economies in transition.

19. The Guidance was specifically prepared to assist Governments, joint bodies and other actors in the UNECE region. However, it could also be applied, as appropriate, in other regions.

.3 Scope

20. The Guidance is a general roadmap towards adaptation of water management to climate change but needs to be tailored to specific local situations. It provides a step-wise approach on how impacts of climate change can be assessed and how policy, strategic and operational responses can be developed.

21. It provides advice on how to assess impacts of climate change on water quantity and quality, how to perform risk assessment, including health risk assessment, to gauge vulnerability, and how to design and implement appropriate adaptation measures. The Guidance addresses not only extreme events but also daily water management under the influence of climate variability and future uncertainties of climate change.

22. The adaptation responses are considered in the context of IWRM on the basis of the catchment as required by the Water Convention and its Protocol on Water and Health. They include, inter alia, integrated management of surface and groundwater, integrated flood management, and drought mitigation and response, including improvement of the ecological status of waters.

23. The general application of IWRM is an important precondition for the development of realistic vulnerability assessments and the formulation of appropriate adaptation strategies.

24. The Guidance also addresses additional issues, such as spatial and planning aspects; prioritization; specific changes in measures required due to the climate change; the concept of risks and vulnerability (including their socio-economic dimension and the burden of disease due to climate changes), water quality, possible measures (e.g. regulatory and operational measures), capacity-building, financial instruments), awareness-raising and the involvement of the public, and transboundary aspects and the issue of solidarity between countries.

.4 Rationale of the Guidance

25. The Guidance provides a step-by-step framework for the development of an adaptation strategy (see figure 1). The steps in this guidance are:

1. Establishing the policy, legal and institutional framework (chapters I, II and III)
    - Assessing existing policies, laws and regulatory systems in relation to their effects on climate-induced vulnerabilities, including agriculture, forestry, disaster

management, water and all other relevant sectors, and revising and complementing them as needed;

- Defining the institutional processes through which adaptation measures are or will be implemented, including where decision-making authority lies at the national, local and intermediary levels and what the links are between these levels;

2. Understanding vulnerability (chapters IV, V and VI)
    - Ascertaining the information needed to assess vulnerability;
    - Gauging the future effects of climate change on the hydrological conditions of the catchment in terms of water demand and water availability, based on different climate scenarios and development scenarios;
    - Identify the main climate-induced vulnerabilities that affect communities in different places, with particular attention paid to water resources and the health related aspects (e.g. continuous supply of safe water and access to adequate sanitation);
    - Determining, through participatory processes, the needs, priorities and capabilities of different stakeholder groups in relation to adaptation to climate-induced vulnerabilities;
3. Developing and implementing an adaptation strategy (chapters VII and VIII)
    - Identifying potential adaptation measures to reduce vulnerability to climate variability by preventing negative effects and by enhancing the resilience to climate change, and by reducing the effects of extreme events through preventive, preparatory, response and recovery measures. Measures should include both structural and non-structural measures as well as the financial means and the institutional changes necessary to implement successful adaptation processes;
    - Based on participatory processes, prioritizing the potential reforms and investments taking into account the financial, institutional resources and other means and knowledge available to implement them;
    - Ensuring the step-wise implementation of the adaptation strategy, in accordance with determined priorities, including coping measures from the individual to the State level;
4. Evaluation (chapter IX)
    - Determining if the measures are implemented and if those measures that are implemented lead to reduction of the vulnerability; if not, adjusting the measures accordingly;
    - Assessing if the scenarios as applied materialize in practice and adjust the scenarios accordingly.

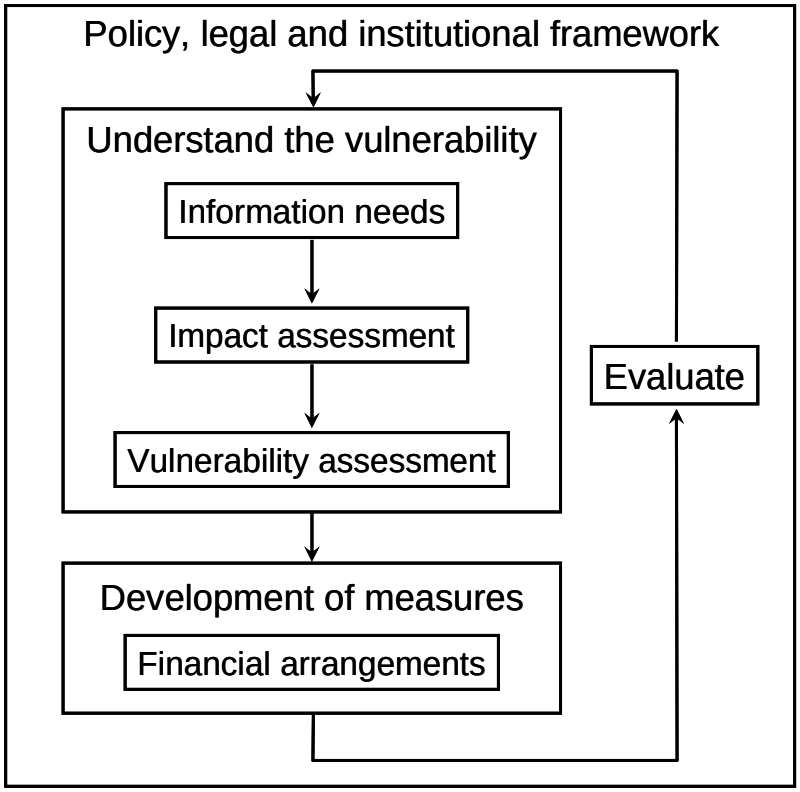

Figure 1: Development of an adaptation strategy

CHAPTER I GENERAL PRINCIPLES AND APPROACHES

26. In their actions to design and implement adaptation measures and policies, Parties should be guided by the following principles and approaches:

27. Climate change is a process characterized by a number of uncertainties and risks relative in particular to the magnitude, timing and nature of the changes. However, decision makers are not used to such uncertainty when dealing with other problems. To take into account this situation, various methods should be used. These include sensitivity analysis, risk analysis, simulation and scenario development.

28. As climate change raises threats of harm to human health and the environment, the precautionary principle should be applied and preventive actions should be taken even if some cause and effect relationships are not yet fully scientifically proven. According to the precautionary principle, uncertainty about the damage to be incurred should not serve as an argument to delay action. In the face of great uncertainty, a precautionary approach might even result in a more stringent emission-reductions target and/or adaptation response.

29. Climate-proofing of countries or vulnerable regions should become a political priority. Such programmes should aim to: (a) insulate human activities from the influence of weather and climate conditions, most likely extremes in precipitation (rain or snow), in drought and in temperature (both heat and cold waves); and (b) reduce the exposure of weather- and climate-sensitive activities to climate-related hazards. Differences in climatic conditions should be taken into account.

30. All new measures should take into account possible impacts of climate change and best available technology should be used as much as possible. Innovative sustainable approaches and technologies should also be taken into account.

31. The impacts of climate change are locally specific. However, the level of specificity of knowledge at the local level is limited and needs to be downscaled. Any policy or measure should be developed for and applied at the appropriate level (international, national, subnational and local) taking into consideration the river basin approach.

32. The health risk of climate change adaptation options should be assessed before adopting any strategy (e.g. the increased use of individual open-water reservoirs may create breeding grounds for vector-borne diseases).

33. Mitigation and adaptation strategies should be developed and implemented in an integrated manner aiming to minimize harm to humans and the environment and should take into consideration the adaptive capacity of a system.

34. The following overarching principles should apply to any adaptation policy framework:

- Adaptation to short-term climate variability and extreme events is a basis for reducing vulnerability to longer-term climate change;
- Adaptation policy and measures are assessed in a socio-economic development context;
- Following the principles of sustainable development adaptation policy and measures take social, economic and environmental concerns into consideration and ensure that the needs of the present generation are met without compromising the needs of future generations;
- Adaptation policies/ strategies are elaborated at different levels in society, including the local level;
- Effective transboundary cooperation is ensured at all relevant stages of decision-making, planning and implementation;
- In accordance with article 2 of the Water Convention, riparian Parties cooperate on the basis of equality and reciprocity, in particular through bilateral and multilateral agreements, to develop harmonized policies, programmes and strategies. These strategies cover the relevant catchments areas and parts thereof. They aim at the prevention, control and reduction of transboundary impacts as well as at the protection of the environment of transboundary waters or that are influenced by such waters, including the marine environment.

35. Strong interdepartmental (inter-ministerial) and intersectoral cooperation with the involvement of all relevant stakeholders should be a precondition for decision-making, planning and implementation.

36. Effective cooperation should successfully integrate both top-down and bottom-up approaches. [2]

37. IWRM should be applied to ensure the multi-layered integration of management in which existing approaches are distinct from one another and take into account the environmental, economic, political and socio-cultural conditions of the respective region. Some principal components of IWRM are:

[2] See also the United Nations Development Programme's Adaptation Policy Frameworks (APFs) for Climate Change. APFs focus on adaptation measures that are in line with a country's broader development goals, and highlight the "bottom-up" approach increasingly used by policymakers and scientists.

- *Managing water resources at the basin or watershed scale.* This includes integrating land, rivers, lakes, groundwaters and coastal water resources as well as their interaction with other ecosystems, in particular upstream and downstream dimensions. It is therefore, critical that any policy or measure is developed and implemented in accordance with the river basin approach;
- *Establishing improved and integrated policy, regulatory, and institutional frameworks*. Examples are implementation of the polluter-pays principle, water quality norms and standards, and market-based regulatory mechanisms;
- *Taking an intersectoral approach to decision-making*, where authority for managing water resources is employed responsibly and stakeholders have an impact on the process;
- *Optimizing supply.* This involves conducting assessments of surface and groundwater supplies, analysing water balances, adopting safe wastewater reuse and the use of rainwater, and evaluating the environmental impacts of distribution and use options;
- *Carrying out health risk assessment within IWRM*;
- *Managing demand.* This includes adopting cost recovery policies, utilizing water-efficient technologies and establishing decentralized water management authorities;
- *Planning and implementation of water management and of water services in coordinated way*;
- *Providing equitable access to water resources through participatory and transparent governance and management.* This may include support for effective water users' associations, involvement of marginalized groups and consideration of gender issues;
- *Sustainable groundwater use.* This can be achieved through: (a) developing and promoting a more accurate understanding of the socio-ecological value of groundwater as well as the nature and scale of the consequences of its unsustainable use; (b) developing and disseminating research knowledge on promising technologies and management approaches; and (c) exploring sustainable solutions and sharing them with the main strategic actors involved in national and regional groundwater systems. Surface and groundwater in one basin should be used in an integrated way.

38. No-regret and low-regret options should be considered as a priority. No-regret options are measures or activities that will prove worthwhile even if no (further) climate change occurs. For example, early-warning systems for floods and other extreme weather events will be beneficial even if the frequency of the events does not increase as expected. Low-regret options are low-cost options that can potentially bring large benefits under climate change and will have only low costs if climate change does not happen. One example is accounting for climate change at the design stage for new drainage systems, through making pipes wider.

39. The selection of scenarios and related methodologies and measures to deal with adaptation to climate change should take into consideration possible side-effects of their implementation.

40. Measures to cope with the effects of climate change have to be taken into account at different scales, both in space and in time. Regarding the spatial component, measures should account for local issues as well as regional and basin-wide issues. Regarding the time component, distinctions should be made between the strategic, tactical and operational levels.

41. The setting of time horizons should be considered when defining a strategy, policy, or measure, and also for monitoring the implementation of an adaptation strategy. Generally, strategies would be long-term in nature, and policies targeted at the medium to long term. Measures may have an implementation time of any length, but are expected to have sustained

results. Prioritization – mostly of measures, but in some cases also of (alternative) policies – should take the whole period into account.

42. Estimating costs of a measure is a prerequisite for ranking a measure and including it in the budget or in a wider adaptation programme. The four major methods used for prioritizing and selecting adaptation options are cost-benefit analysis, multicriteria analysis, cost-effectiveness analysis and expert judgement. The costs of non-action that could lead to a number of environmental and socio-economic effects (e.g. lost jobs, population displacement, and pollution) should also be considered.

CHAPTER II INTERNATIONAL COMMITMENTS

43. A number of international agreements include recommendations or even obligations for countries to develop strategies and measures for adaptation to climate change, in the water sector as well as in other areas. This Guidance builds upon these agreements. When developing their adaptation strategies, countries should take into account their obligations under such international agreements.

II.1 United Nations Framework Convention on Climate Change

44. The main obligations related to adaptation in the United Nations Framework Convention on Climate Change (UNFCCC) are contained its article 4, which requires Parties to develop, implement and regularly update national and when necessary also regional programmes of measures to facilitate adequate adaptation to climate change. Parties should cooperate in preparing for adaptation. They are requested to elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, as well as for the protection and rehabilitation of areas affected by floods or drought and desertification. Parties shall also take climate change considerations into account in their relevant social, economic and environmental policies and actions, and employ appropriate methods, for example impact assessments, to minimize adverse effects on the economy, public health and the quality of the environment due to projects or measures undertaken by them to mitigate or adapt to climate change. Thus, adaptation and mitigation obligations are linked and should reinforce each other. In addition, Parties are requested to assist developing countries in particular in their efforts to adapt to climate change impacts.

45. The Nairobi work programme on impacts, vulnerability and adaptation to climate change, launched in 2005, aims to help all countries improve their understanding of the impacts of climate change and to make informed decisions on practical adaptation actions and measures. It covers nine areas of work: (a) methods and tools; (b) data and observations; (c) climate modelling, scenarios and downscaling; (d) climate-related risks and extreme events; (e) socio-economic information; (f) adaptation planning and practices; (g) research; (h) technologies for adaptation; and (i) economic diversification.

II.2 WHO International Health Regulations

46. The International Health Regulations (IHR)[3] entered into force on 15 June 2007 as a new legal framework to better manage our collective defences to detect disease events and to respond to public health risks and emergencies. The IHR require State Parties to notify a potentially wide range of events to WHO on the basis of defined criteria indicating that the

[3] The complete text of the IHR (2005) can be downloaded from: http://www.who.int/csr/ihr/WHA58-en.pdf (accessed 9 May 2008).

event may constitute a public health emergency of international concern. Parties are further required to ensure that their national health surveillance and response capacities meet certain functional criteria and have a set time frame in which to meet these standards. The IHR therefore constitute an important additional defence framework for coping with the health impacts of climate change in general, and with changes in incidence and outbreaks of water-related diseases in particular.

II.3 Relevant UNECE Conventions and Protocols

II.3.1 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention)

47. Although the UNECE Water Convention does not explicitly mention climate, it represents one of the most essential legal frameworks in the UNECE region for cooperation on transboundary aspects of climate change and on development of adaptation strategies.. The Convention obliges Parties to prevent, control and reduce transboundary impacts including those related to adaptation to or mitigation of climate change. It also stipulates that water quality objectives shall be set and best available technology be used. Parties are required to follow the precautionary principle which implies in the case of climate change taking action even before adverse impacts are fully proven scientifically. The Convention also includes provisions for the exchange of information, common research and development and joint monitoring and assessment; encouraging riparian countries to cooperate in the development of adaptation strategies. In addition, Parties are obliged to establish early-warning systems and mutually assist each other.

II.3.2 Protocol on Water and Health

48. The Protocol on Water and Health to the Water Convention aims to protect human health and well-being through improving water management and through preventing, controlling and reducing water-related disease. The Protocol is the first legally binding instrument to ensure the sustainable management of water-resources and reduction of water-related disease. A number of its provisions are highly relevant to the adaptation to climate change, in particular:

- International cooperation to establish joint or coordinated systems for surveillance and early-warning systems, contingency plans and response capacities, as well as mutual assistance to respond to outbreaks and incidents of water-related disease, especially due to extreme weather events;
- International support for national action, provided by the Ad Hoc Project Facilitation Mechanism, which aims to help provide access to funding for activities to implement the Protocol.

49. In addition, the Protocol aims at providing access to safe drinking water and sanitation for everyone – a goal which could be complicated by climate change.

II.3.3 UNECE Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)

50. The Espoo Convention supports environmentally sound and sustainable development by providing information on the interrelationship between certain economic activities and their environmental consequences, in particular in a transboundary context.

51. The Convention is the one of the first multilateral treaties to specify the procedural rights and duties of Parties with regard to transboundary impacts of proposed activities and to

provide procedures in a transboundary context for the consideration of environmental impacts in decision-making. The Convention stipulates that an environmental impact assessment (EIA) procedure be undertaken for a proposed activity planned by one Party that is likely to have a significant transboundary impact in the territory of another Party.

52. The Convention describes an "impact" as any effect caused by a proposed activity on the environment including human health and safety, flora, fauna, soil, air, water, climate, landscape and historical monuments or other physical structures, or the interaction among these factors. It also includes effects on cultural heritage or socio-economic conditions resulting from alterations to those factors.

53. The Espoo Convention is an important framework for ensuring that the adaptation strategies developed in a country do not cause transboundary impacts in neighbouring countries.

II.3.4 The UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention)

54. By linking environmental rights and human rights, the Aarhus Convention provides the fundamental basis for developing and implementing national and transboundary environmental instruments, including those related to mitigation and adaptation to climate change. The Convention imposes on Parties and public authorities obligations and grants the public rights regarding access to information, public participation and access to justice. It establishes that sustainable development can be achieved only through the involvement of all stakeholders. It links government accountability and environmental protection and focuses on interactions between the public and public authorities in a democratic context.

55. The principles underlying the Aarhus Convention, which were also recognized by the UNFCCC at its thirteenth session, inter alia, encourage Parties to undertake activities to facilitate public access to data and information and to promote public participation in addressing climate change and its effects and in developing adequate responses.[4]

II.3.5 EU Legislation

56. The European Union (EU), having focused until 2005 mainly on climate change mitigation, has been progressively recognizing the need for adaptation. In June 2007, the Community published the Green Paper, "Adapting to climate change in Europe – options for EU action". This Green Paper examines the impacts of climate change effects in several European regions and attempts to define the possible adaptation actions which have a pan-European dimension, while recognizing that cooperation with and between Member States and regions will be essential. Stakeholders and the public have been consulted and the Commission plans to publish a White Paper with concrete actions for adaptation at the end of 2008.

57. Although there is currently no explicit obligation for adaptation to climate change in EU water-related legislation, the EU Water Framework Directive[5] in principle includes the requirements needed for addressing climate change impacts since it obliges Member States to assess environmental pressures on river basins, to set targets for improving the status of water bodies and to devise and implement management plans with concrete measures to achieve these targets. The need for greater integration of the qualitative and quantitative aspects of

[4] Decision 9/CP.13, paragraphs 14 and 15 (FCCC/CP/2007/6/Add.1), amended the New Delhi Work Programme on article 6 of the UNFCCC. The thirteenth session was held from 3 to 15 December 2007 in Bali, Indonesia.
[5] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000, establishing a framework for Community action in the field of water policy.

both surface and ground water, considering natural flow conditions within the hydrological cycle, is clearly laid down in this directive. Within transboundary river basins, requirements for environmental objectives as well as programmes of measures should be coordinated for the basin as a whole. Member States are also obliged to review management plans regularly to take into account recent data and information, such as those related to climate change.

58. The EU Flood Directive [6] states that measures to reduce flood risks should, as far as possible, be coordinated for the river basin as a whole, in particular for transboundary basins. Hence, even the identification of areas at significant potential flood risk belonging to an international river basin shall be coordinated between the Member States concerned from the beginning. Therefore, Member States shall ensure that exchange of relevant information and data take place between the competent authorities concerned. Accordingly, national legislation should be adjusted to the Flood Directive in an appropriate time period, be implemented, and be able to fulfil in particular the requirements at the national level as a basis for doing so at the transboundary level. Specific legislation is likely to be needed. Furthermore, in some Member States reform of the existing institutional framework will probably be unavoidable.

59. The European Commission is working on a Communication on water scarcity and droughts, which is closely linked to climate change and adaptation.

60. The *acquis communautaire* of the European Community has developed a strong body of legal instruments dealing with the surveillance and management of water-related disease. Some of the most important ones deal with:

- Early-warning and response systems for the prevention and control of communicable diseases;[7]
- Communicable diseases to be progressively covered by the Community network;[8]
- Laying down case definitions for reporting communicable diseases to the Community network;[9]
- Setting up a network for the epidemiological surveillance and control of communicable diseases in the Community.[10]

61. The activities of the European Centre for Disease Prevention and Control (ECDC) are based on Article 3 of the ECDC Founding Regulation (EC 851/2004). The Centre aims to enhance the capacity of the Community and the Member States to protect human health through the prevention and control of human diseases. Activities are designed to identify, assess and communicate current and emerging threats to human health from communicable diseases, including water-related and vector-borne diseases that are climate-sensitive.[11] ECDC also pursues core activities such as surveillance network, scientific advice, identification of emerging health threats ("epidemic intelligence"), training, health communications and technical assistance ("country support").

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[6] (2007/60/EC).
[7] Commission Decision 2000/57/EC of 22 December 1999; *Official Journal of the European Communities* L 21/30 dd 26.1.2000.
[8] Commission Decision 2000/96/EC of 22 December 1999; *Official Journal of the European Communities* L28/50 dd. 3.2.2000.
[9] Commission Decision 2002/253/EC of 19 March 2002; *Official Journal of the European Communities* L86/44 dd 3.4.2002.
[10] Decision 2119/98/EC of the European Parliament and of the Council of 24 September 1998; *Official Journal of the European Communities* L268/1 dd 3.10.1998.
[11] http://ecdc.europa.eu/index.html.

CHAPTER III POLICY, LEGISLATION AND INSTITUTIONAL FRAMEWORKS

62. This chapter aims to help decision makers to introduce and adopt policy, legislation and institutional frameworks that support adaptation to climate change at the national level as well as in a transboundary context. There are certain policies that will be directly or indirectly affected by the impacts of climate change and for which an appropriate response needs to be developed. The need for adaptation is not only a threat but also an opportunity for innovation and new technologies. This should be explored in close cooperation with the public and private sectors.

III.1 Policy and governance

63. Many policy tools such as land planning, environmental protection and monitoring, and health management are based on stable "old" climate and environmental scenarios which do not take into account variability and change. Sound and sustainable policies at the local, national and transboundary levels should therefore include adaptation to new current and long-term scenarios.

64. International rivers pose particular management challenges because of potentially competing national interests. Adaptation therefore requires a cross-boundary approach, based on river basins and bio-geographic regions. Effective and sustainable achievement of most of the adaptation measures requires inter-State coordination and cooperation at the level of transboundary river basins.

65. While measures will have to be taken or implemented at the national or local level, where operational capacities exist, it is essential that efforts be coordinated in an equitable, acceptable and cost-effective manner at the level of the transboundary basin.

66. Policy, legislation and institutional frameworks, both at the national and transboundary levels, should together support adaptation to climate change. This is needed at all national governmental level as well as at the transboundary level, with effective frameworks, clear responsibilities and roles for all players. The three frameworks are interwoven as policies and legislation together shape the institutions, institutions and legislation provide structures to enable policy development, and policies and institutions are the basis upon which the legislation builds.

67. Existing policy, legislation and institutional frameworks should be assessed vis-à-vis their capacity to support adaptation to climate change, and if needed should be reformed.

68. To enable cooperation between the different levels and across borders and to ensure broad-based decision-making on adaptation, the relationship between policy, legislation and institutional frameworks should be based on the principles of good governance:

- Making decisions at the appropriate level;
- Providing access to information;
- Enable participation by all stakeholders;
- Providing access to justice in environmental matters;
- Integrating environmental and health concerns into all decisions.

69. Multilevel governance is emerging on climate change adaptation involving all actors from individual citizens to local authorities to policymakers at the international level. The different levels interact and should support each other. This includes stimulation and development of interdepartmental and multi-stakeholder as well as transboundary cooperation, through, inter alia, the establishment of consultative mechanisms at both the

national and transboundary levels. Representation is particularly important to supporting good governance; key decisions should be made by representative authorities who are accountable to a broad public.

70. All sectors should be involved, be aware of the climate change challenge, and share a common understanding of the fact that adaptation to climate change is only possible through an integrated approach.

71. Spatial planning provides an integrated framework, linking vulnerability and risk assessment with adaptive capacities and adaptation responses. It is therefore the pre-eminent policy sector to facilitate the identification of policy options and cost-efficient strategies.

72. The Trialogue Model (box 1) describes the basic elements for good governance, namely government (involving all sectors having responsibility for the management of the water cycle and the preservation and promotion of human health), science and society, and is the basis upon which successful adaptation measures are taken.

73. Climate change adaptation should be integrated in development planning, programmes and budgeting, a process known as mainstreaming. Such a coordinated, integrated approach to adaptation is imperative to handle the scale and urgency of addressing climate change impacts. Governments should ensure that any national adaptation strategy is consistent with existing policy criteria, development objectives and management structures.

III.2 Legal aspects

74. As a first step, existing legislation, from the local to the transboundary levels, should be assessed vis-à-vis its capacity to support adaptation to climate change and, if needed, reformed. It must be recognized that some current legislation, for instance treaties drafted without taking climate change into consideration, may present barriers to future adaptation.

75. Moreover, new and newly adjusted laws and policies as well as transboundary agreements and strategies should take into consideration the results of new environmental and socio-economic scenarios that have arisen due to climate change.

III.3 Institutional aspects

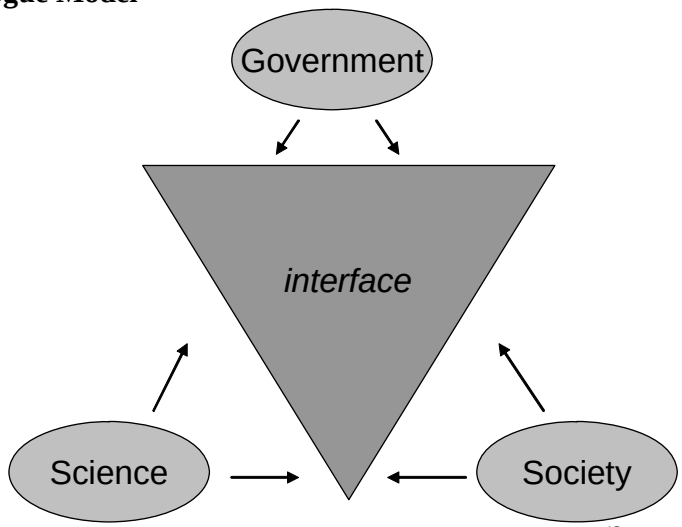
76. Regarding the development of adaptation strategies, all relevant authorities, including local authorities responsible for water management, should be involved. This is particularly important for federal States.

77. The institutional capacity of a community, region or country is crucial in implementing effective adaptation. Clear definition of the roles and responsibilities of each agency involved is an important first step in building adaptive capacity. Next, water management agencies and other related authorities should be willing to provide appropriate assistance to communities in support of adaptation implementation.

78. As there is a need to understand the implications of climate change for water resources, their sustainable management and societal goals, a dedicated research team, involving various disciplines, should be established at the national level for carrying out scientific activities on this topic. This team should aim to accomplish the scientific, practical and operational activities of saving, protection and increase of water resources. Similar arrangements should also be established at the transboundary level with the support of relevant institutions in the riparian countries.

79. Joint bodies, such as river basin commissions, should be responsible for the development of joint or coordinated adaptation strategies for transboundary basins and for following up their implementation and evaluating their effectiveness. The bodies should therefore have the capacity and means to ensure these tasks.

Box 1: The Trialogue Model



Schematic representation of the Trialogue Model[12].

The Trialogue Model assumes that the success of governance depends on the balance between the elements in the Model. Governance requires effective interfaces between each of the three processes, namely (a) society and science, (b) government and society, and (c) government and science. In essence, good governance promotes participatory management of ecosystems and, by deduction, prudent water resource management. This requires a good understanding of the institutional structures that enable a government to function effectively.

Specific issues identified within the Model include: (a) customary, traditional and scientific forms of knowledge; (b) decision-making structures and processes (or tools for decision-making); (c) organizational learning, and social, institutional; and (d) ecological adaptability. The quality of the interface determines the extent to which government can generate the incentives needed to develop society by allowing science to inform the decision-making process.

The Model recognizes the importance of making decisions that incorporate and weigh multiple factors and concerns and is therefore important for successful (transboundary) cooperation. To date, there is no predetermined process that clearly defines the roles of government, science, and society in transboundary water management. There is, however, a need for cooperation between Government and Society to find a viable solution that is agreeable to both parties. This solution should be sustained by scientific support.

III.4 Education, capacity-building and communication

80. Education and communication should be seen as prerequisites for achieving sustainable development and as essential tools for good governance, informed decision-making and the promotion of democracy. They strengthen the capacity of individuals, groups, communities,

[12] Turton, A. R. and others (eds.) (2007). *Governance as a Trialogue: Government-Society-Science in Transition.* Berlin, Springer-Verlag..

organizations and countries to make judgements and choices in favour of sustainable development.[13]

81. Education, communication and capacity-building are important to tackle the challenge of climate change. They should aim at increasing awareness and improving understanding of the mechanisms that drive climate change as well as the potential environmental and socio-economic impacts.

82. The lack of institutional capacity should not be a reason for not taking action. All countries need to take the initiative vis-à-vis building their own capacities to handle the challenges of climate change.

83. Reinforcing or creating capacity will provide a better understanding of vulnerability and needs, and will help identify adaptation measures and initiatives to reduce vulnerability and define sustainable development policies.

84. At the same time, the strengthening and/or creating of capacity at the national and regional levels will assist participating countries in international processes, make it easier to coordinate actions taken in response to climate change issues as well as integrating these issues into national and regional policies. Such a capacity-strengthening process will contribute to the negotiation of bilateral or multilateral support in the fields of disaster management, early-warning systems and climate change.

85. The issue of climate change should be addressed in formal and non-formal education as well as through communication, including awareness-raising. Governments should play a proactive role in promoting and facilitating education and communication, in partnership with stakeholders.

86. Capacity-building should be targeted at all the stakeholders that participate in the governance process, including members of joint bodies, to ensure that everyone has the same level of understanding.

87. Education, capacity-building and communication should be an integral part of any adaptation strategy and should take place at all phases of the adaptation chain. Existing institutional gaps should be identified through in-depth gap analysis that includes all steps of adaptation. A consistent programme to address such gaps should be developed as part of the national development strategy.

88. In addition, States should assist each other in capacity-building, in particular, States which are more advanced in terms of adaptation should assist the less advanced ones.

89. Education programmes and communication strategies should be designed and implemented to meet the need of target groups, taking into consideration such aspects as age, social roles and level of literacy. This apply as to the content so to the proposed framework for implementation. Persons at risk should be considered as a special target group. This can help to bring to people's attention that they should take adaptation and mitigation into account in their own life- decisions, e.g. whether to build in flood-prone areas and or to use climate-proof construction methods.

[13] See also the UNECE Strategy for Education for Sustainable Development (CEP/AC.13/2005/3/Rev.1).

CHAPTER IV INFORMATION AND MONITORING NEEDS FOR ADAPTATION STRATEGIES DESIGN AND IMPLEMENTATION

90. This chapter aims to clarify the additional requirements that climate change adds to information and monitoring needs for water policies, strategies, implementation and operation. This information is required mainly to support the modelling of scenarios to be able to assess vulnerability hot spots. Reference is made here to the UNECE Strategies on Monitoring and Assessment of Transboundary Rivers, Lakes and Groundwaters[14], which elaborate general approaches to information and monitoring needs.

IV.1 Definition of information needs

91. Information about climate change impacts is needed to help decide on both the urgency and the desirability of adaptive measures. As policymakers and managers working in health and water sectors should be able to understand and interpret the information, information needs should be identified by the policymakers and managers together with relevant experts.

92. Most frequently, water-resources information has been collected for a specific purpose, such as the design of a hydroelectricity scheme. The need for integrated water resources management that supports the understanding of interactions among different projects and users places a greater burden on the suppliers of information; the information needs to be relevant for and understandable to the various stakeholders in the different water-related sectors (e.g. navigation, hydropower, tourism). Thus a variety of information is needed simultaneously, and has to be presented in different forms for different users.

93. Assessment agencies should therefore understand the needs of all their users, and not just those with whom they have traditionally dealt. For this reason, all users should be involved in the process of defining the information needs. Even more demanding is the need to look ahead to the possible needs of future data users and to commence collecting the information before an actual demand occurs.

94. The process of specifying information needs should be based on an analysis of the water management issues related to climate change. Needs should be defined for:

- Uses (e.g. drinking water, irrigation, recreation) and functions (maintenance of aquatic life) of the water resources that put requirements on the quality and availability of water;
- Impacts on these uses and functions caused by climate change;
- Measures taken to address the impacts or improve the use or functioning of the water resources, including environmental aspects.

95. The information needs should be clearly determined for the different target groups (policymakers, sectors, operators), dividing the information into the relevant levels of time (strategic, tactical and operational), space (river basin, local and national levels), and purpose (early-warning, recovery, long-term planning).

96. Translation must be enabled between climate models and scenarios, and the hydrological models and scenarios must ensure that the information produced is relevant for water management. Close cooperation between the climate and the water communities is therefore imperative.

[14] Available at: http://www.unece.org/env/water/publications/pub74.htm.

Regional Climate Outlook Forums

Regional Climate Outlook Forums (RCOF) bring together climate scientists, policymakers and the general-user community to define information needs and develop warnings of potential climate impacts on various socio-economic sectors. The themes for RCOF are chosen depending on the dominant regional climate needs of the users.

Built into the RCOF process is a regional and national networking of climate service providers and user-sector representatives. Countries participating in RCOF recognize the potential of climate prediction and seasonal forecasting as a development tool to help populations and decision makers face the challenges posed by climatic variability and change. One important aspect of the forums is that of bringing together experts in various fields, local meteorologists and end-users of forecasts in an environment that encourages interaction and learning.

IV.2 Types of information

97. The most urgent need for information relates to the downscaling of climate models to the river basin and local levels. This requires long time series of hydrological data. Studies of trends provide improved understanding of the changes of the "natural" world relative to anthropogenic changes. This is achieved by comparing series of hydrological data from historical observation stations (usually established in areas influenced by human activity) with series of hydrological variables observed in pristine river basins (those river basins that are identified as characterized by minimal anthropogenic change).

98. Data needed for scenarios and subsequent vulnerability assessment at the national, subnational and basin levels include hydrological, meteorological and morphological data and data on water quality as well as the related statistics.

Examples of meteorological, hydrological, morphological data and data on water quality needed for scenarios and vulnerability assessment

Meteorological data:

- Precipitation, e.g., rainfall, snow, and fog-drip;
- Temperature;
- Evapotranspiration;

Hydrological data:

- River levels and flows, lake levels and reservoir storage, including steering rules;
- Sea level;
- Groundwater levels;
- Nationally generated water resources vis-à-vis transboundary water resources;

Morphological data:

- Sediment concentrations and loads in rivers;
- Area of glaciations;
- Coastal erosion;

Water quality data:

- Water quality (bacteriological, chemical, and physical) of surface water and groundwater;
- Coastal saline intrusion, especially in aquifers used for the production of drinking water;

Statistics related to these elements include:

- Mean annual, monthly, seasonal or daily values;
- Maximal, minimal, and selected percentiles;
- Measures of variability, such as the standard deviation;
- Continuous records in the form, for example, of a river-flow hydrograph.

99. Historical data should be used to identify trends, both gradual – i.e. able to recognize the change in climatic conditions – as well as extremes – i.e. identify the potential magnitude of climatic changes. For instance, lakes' levels are potentially useful for analysis of gradual climate impacts on surface waters, as they often reflect the effects of a changing ratio between evapotranspiration and precipitation. Similarly, predictions should include long-term trends for the development of adaptation strategies, seasonal variations to identify and develop tactical measures, and the magnitude of extreme events to identify and develop operational measures.

100. Climate change can lead to responses of groundwater systems that are difficult to predict. For example, while global scale predictions may suggest an increase in precipitation for a given region, if this precipitation occurs at a higher rate and over a shorter period of time, there may be less recharge to the groundwater system. Special attention should therefore be targeted to monitoring these systems.

101. In addition to the more conventional measurements, there is the need to measure other aspects of the freshwater environment and of the wider environment of which freshwater is a component. These include:

(a) The volumes of water needed for industrial, domestic and agricultural use, and for navigation. These are significant modifiers of the hydrological cycle;

(b) Attributes of rivers and required volumes of water related to in-stream uses, (e.g. freshwater fishery habitats or recreation);

(c) Basin characteristics that may be related to hydrology, e.g. vegetation patterns, soil moisture, topography, and aquifer characteristics;

(d) Environmental problems, e.g. eutrophication of lakes and damage to natural freshwater and estuarine ecosystems.

102. Water supply systems may need additional monitoring for microbiological or chemical contamination following floods or drought periods (pipes infiltration, increased chlorination/increased concentration of contaminants).

103. Environmental media monitoring in long-term and short-term critical conditions should be linked with systems of surveillance of water-related disease to ensure prevention of health risks. Development of ad hoc indicators will provide information and assessment of progress as well.

104. Information needs related to climate change adaptation not only pertain to climate prediction but include, inter alia, geographic information and socio-economic information (from e.g. national census data). This data must be available that enables development of adaptation measures at a scale ranging from local to river basin to national and transboundary levels.

105. National data collection and management systems are often inconsistent at the international and even at the national levels. Especially for the monitoring of health effects of extended drought events, appropriate indicators still need to be developed and adopted at the national level. The experience gained in the international Emergency Events Database (EM_DAT)[15] of the WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED) can be exported and networked in countries.

106. Information is also needed to evaluate the effectiveness of adaptation measures (see chapter IX).

IV.3 Sources of information

107. In terms of applying climate information to water resources management, a reliable monitoring system is of the utmost importance. Data reliability has many direct effects on the accuracy of numerical models, both climate prediction/projection and hydrological models. Therefore an integrated nationwide (or transboundary river basin-wide) observation system is necessary.

108. The scope and flexibility of monitoring systems should be such that they can gather the information important for the protection of human health in case of extreme events. Information should cover all possible exposure routes (e.g. direct ingestion, ingestion through

[15] Emergency Events Database (EM_DAT) of the Centre for Research on the Epidemiology of Disasters (CRED), 2007.

contaminated food, skin contact and droplet distribution) that may constitute a risk to human health. Monitoring systems should be also adapted to changing scenarios of diffuse and scattered point-sources in case of flooding events. They can provide information for contaminated sources including irrigated crops and seafood and, in case of extensive chemical contamination, for redefinition of water and land use. The information resulting from such information systems should be used to re-examine the land- and water-use planning and to define and implement changes that will protect human health to the greatest extent possible. For example, if serious contamination is found on land zoned for agricultural purposes, it may be necessary to rezone the land for exclusively industrial use.

109. The design and updating of data collection networks, especially the main stations, should be coordinated to ensure that stations for monitoring the different elements of the water cycle are sufficiently related, both in number and location, to achieve an integrated network. Such an approach enhances the information content of the data sets for both present and unforeseen future needs.

110. Hydrological or hydro-meteorological services or related agencies have been established in countries for the systematic water-resources data collection, archiving, and dissemination at the national level. Their primary role is to provide information to decision makers on the status and trends of water resources.

111. The existing sources of information are data sources maintained for example by relevant United Nations agencies, such as UN GEMS and FAO AQUASTAT. When focusing on transboundary rivers, often information is available from the river basin commissions where data sources are established.

112. Information technology implementation should provide open source exchange of information among sectors for preventive (early-warning), response, and long term planning purposes. Integration between in situ and satellite information (e.g. the Global Monitoring for Environment and Security (GMES), the Infrastructure for Spatial Information in the European Community (INSPIRE)) is also advisable.

113. For geographic information and socio-economic information, other sources need to be considered, such as…[to be completed]

IV.4 Joint information systems and exchange of information

114. To support effective cooperation in climate adaptation at the river basin level, the development of joint information systems (such as databases or GIS systems) is recommended. Such systems should be based on agreement on the relevant information to be shared and on which country will be responsible for producing what information. Existing systems should be adapted to include climate change issues.Where they exist, joint bodies should account for this.

115. If a joint information system is not feasible, exchange of data and information between different countries, bodies and sectors is needed. This includes exchange of information on adaptation plans and measures to enable riparian countries to harmonize their adaptation activities, including the exchange of data enabling improvement of climate prediction models.

116. Exchange of transboundary information is a main obligation of the Water Convention and is required by many international agreements. WMO member countries also provide, on a free and unrestricted basis, those hydrological data and products necessary for the provision

of services in support of the protection of life and property and for the well-being of all peoples.[16]

117. Data should also be made publicly available, except for cases where disclosure to the public might negatively affect confidentiality provided for under national law; international relations, national defence or public security; the course of justice; the confidentiality of commercial and industrial information (where such confidentiality is protected by law to protect a legitimate economic interest); intellectual property rights; etc. In such cases, data should be processed so that it cannot be used for purposes other than climate change adaptation.

IV.5 Design of adaptive monitoring systems

118. Because of the inherent uncertainties of predictions, adaptation to climate change is a process that requires continuous modification to account for improved insights. In addition, cooperation between water management and many different sectors is needed, as is the involvement of the public at large. Monitoring systems consequently must be developed in such a way that they support these characteristics.

119. The information as collected should be made available for other audiences than the policymakers and water managers (e.g. other sectors, the public). A significant problem in disseminating information to a wide audience is that translating the information produced by one community into a form that the other community can utilize is often difficult. To overcome this problem, dialogue is necessary between the relevant communities to about the needs and possibilities of the available information. The involvement of media and education sector is also needed.

120. The monitoring or information-producing systems supporting the inherent uncertainties should be adaptive, focusing not only on the state of different variables, but also on the links and feedbacks between them. In addition, the information producing system must support the complete process, from problem identification to evaluation of measures, including all the in-between steps.

CHAPTER V SCENARIOS AND MODELS FOR IMPACT ASSESSMENT AND WATER RESOURCES MANAGEMENT

V.1 Introduction

121. Adaptation of water management to climate change implies balancing water demands and resources in an uncertain and changing situation. Scenarios and models handle this uncertainty by providing information on possible futures; these in turn depend on policy choices. This chapter aims to describe how scenarios and models support water management in the light of climate change, by describing the steps involved in the process of developing scenarios and using models for prediction. These predictions build on available information and feed into the vulnerability assessments. Figure 2 provides an overview of how data, scenarios and models are used to develop an adaptation strategy to climate change.

122. Scenarios are alternative images of how the future might unfold and are an appropriate tool for analysing how driving forces may influence future emissions and for assessing

[16] WMO Congress General XIII adopted Resolution 25

associated uncertainties. **Climate scenarios** are developed to describe different possible futures, based on certain choices and assumptions about greenhouse gas emissions.

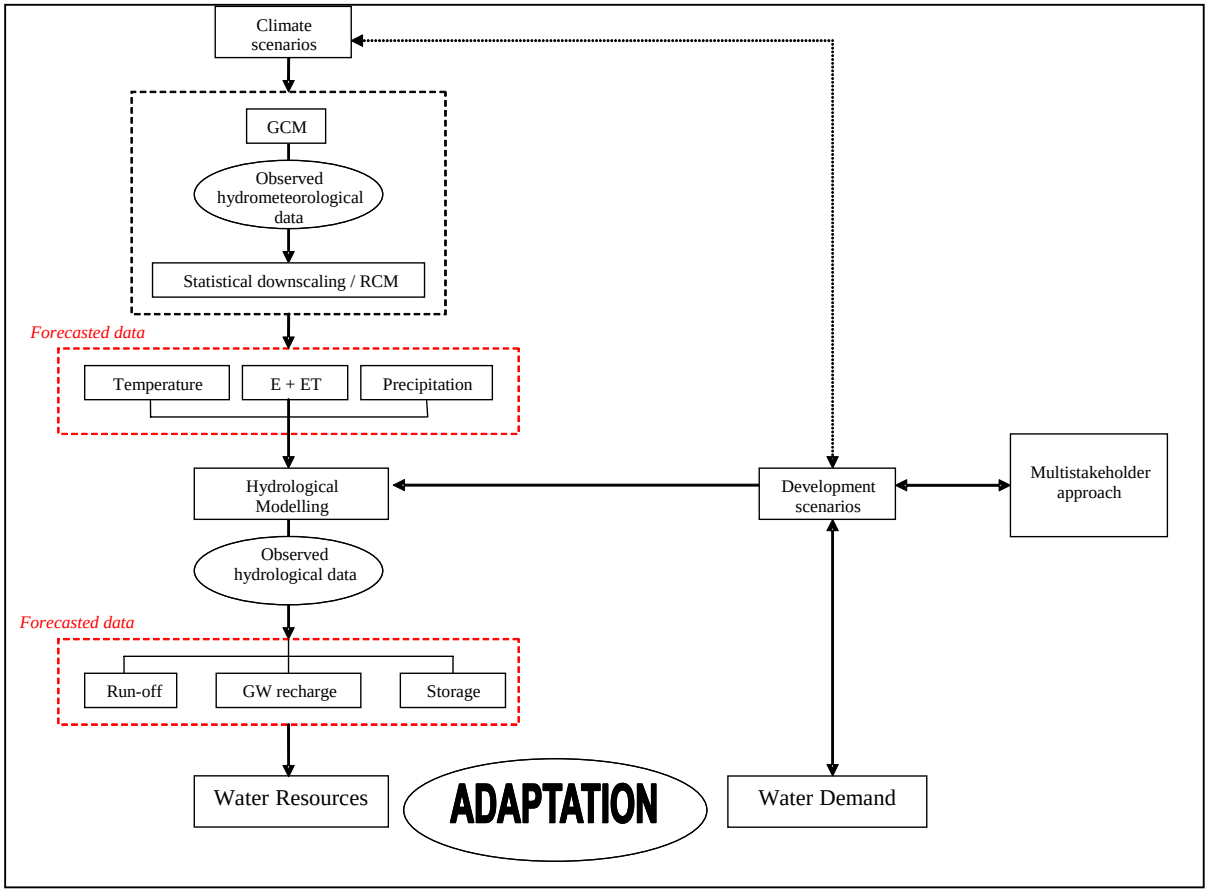


Figure 2: Scenarios, data, models and adaptation strategies

123. Based on the different climate scenarios, **climate models** can be run to provide information on possible future climate conditions in a certain region. Global climate models (GCMs) estimate the effect that emissions have on global climate. GCMs describe important physical elements and processes in the atmosphere and oceans and on the land surface that make up the climate system. Typically, a GCM has a resolution of a few hundred km. Regional climate models (RCMs) provide similar information, only at a smaller resolution. These are therefore more suitable for developing adaptation strategies at the river basin level.

124. To conceptualize and investigate the link between climate and water resources, it is necessary to combine GCMs and hydrological models. The main issue of coupling these models, as stated below, is that climate scenarios should be compatible with the catchment scale.

125. Demographic changes, economic and socio-economic developments influence the hydrological cycle and at the same time have impacts on water demands. Based on the current and future social and economic goals set out by countries, demographic and economic scenarios have to be developed that will be very different in various regions and have to be combined with different climate scenarios. The developed scenarios, together with the forecasted data from the climate models, are the basic input for hydrological models. These models calculate the hydrological responses to rainfall based on local characteristics such as

soil characteristics, the type and density of vegetation cover, and land-use characteristics. The models provide output on the future hydrological conditions in a river basin. The model output includes information on available water resources as well as water demands, thus providing background information for assessing the vulnerability in a basin.

126. The Intergovernmental Panel on Climate Change (IPCC) has developed four different narrative storylines (climate scenarios) to describe the relationships between emission driving forces and their evolution and to add context for the scenario quantification. Each storyline assumes a distinctly different direction for future developments, such that the four storylines differ in increasingly irreversible ways. The Special Report on Emissions Scenarios (SRES)[17] scenarios developed by IPCC assist in climate change analysis, including climate modelling and the assessment of impacts, adaptation and mitigation.

V.2 Global and regional climate models

V.2.1 Downscaling Global Climate Models

127. Models have proven to be extremely important tools for understanding and simulating climate. Models need to be calibrated, which means comparing output data (forecasted temperature, evaporation, evapotranspiration, and precipitation) with observed meteorological data. Model calibration is one of the most important steps as a basis for scenario development.

128. Global Climate Models (GCMs) are mathematical models, used to simulate both the present climate and the projected future climate changes. One disadvantage of GCMs is their quite coarse scale, since they have a data resolution typically of a 100–200 km grid size. This resolution does not permit an appropriate estimation of hydrological responses to climate change and consequently does not provide sufficient information to develop adaptation strategies on a river basin scale. Because of this difficulty of representing local basin-scale features and dynamics, there is a need to convert the GCM outputs into at least a reliable daily precipitation and temperature time series at the basin scale (downscaling).

129. This process of downscaling GCMs into daily meteorological variables appropriate for hydrologic impact studies can be done in two basic ways:

- Dynamically (simulating physical processes at sub-grid level), leading to RCMs; or
- Statistically (transforming coarse-scale climate projections to a smaller scale based on observed relationships between climate at the two spatial resolutions, and comparing forecasted data from the GCM with observed meteorological data).

130. The choice of the most appropriate downscaling technique partly depends on the variables, seasons and regions of interest.

131. **Dynamic downscaling** is done by nesting a fine-scale climate model in a coarse-scale model (figure 3). Dynamic downscaling is very intensive computationally and essentially impossible for multi-decade simulations with different global climate models and/or multiple greenhouse gas emission scenarios. This makes its application in impact studies limited.

[17] IPCC 2000. Emissions Scenarios – A Special Report of IPCC Working Group III.

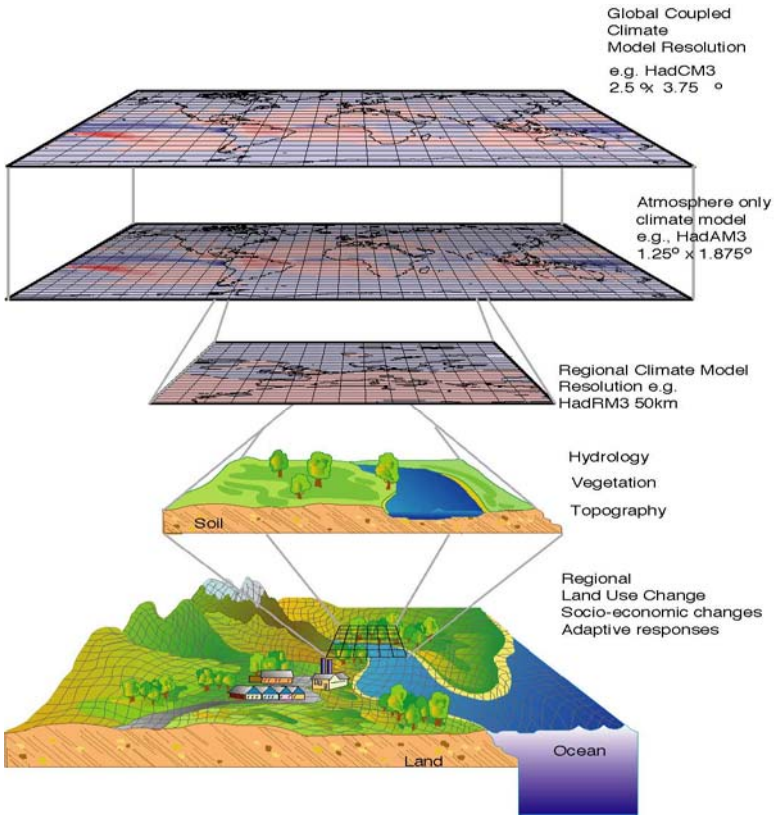


Figure 3: Dynamic downscaling

132. **Statistical downscaling** is typically used to predict one variable at one site. For studies of some climate impacts such as river basin hydrology, it is important to downscale simultaneous values of multiple variables (e.g. precipitation and temperature) over large, heterogeneous areas, while maintaining physically plausible spatial and temporal relationships. Few downscaling techniques have been developed to do this.

133. Statistical downscaling requires access to large data sets and considerable expertise to derive the statistical relationships, and is therefore difficult to apply. Statistical downscaling may be used whenever impacts models require small-scale data, provided that suitable observed data are available to derive the statistical relationships.

134. Both methods give comparable results in terms of their capability to reproduce the variability of present-day climatic or river flow conditions, on both daily and monthly time scales. Statistical and dynamical downscaling (whether with a nested RCM or a high-resolution global model) complement each other, and, where possible, both should be carried out in parallel.

V.3 Criteria for the development of scenarios

135. Based on the current and future social and economic goals set out by the countries different demographic and economic scenarios have to be developed. Scenarios will have to be developed through a multi-stakeholder approach , through initiatives such as the National Workshops on Climate Change Adaptation. In the process of scenario development, different driving forces determining the extent of future climate change and its impacts, should be considered, e.g. economic development and human impacts on ecosystems.

136. Many drivers need to be taken into account when developing scenarios. Some include demographic developments and land-use changes such as population growth which can result in increased water demand in quality and quantity, or urbanization and intensification of land use, which shortens the run-off travel time and may cause floods and flash floods. Economic development is another driver likely to put greater pressure on natural resources, particularly water and energy

137. Driving forces for the construction of scenarios should be chosen according to the local conditions and in consultation with relevant stakeholders, considering different controversial interests. To construct alternative scenarios, these driving forces should be given different weights and initial modelling conditions, for example a temperature increase of 2 degrees.

V.4 Criteria for the selection and application of models

138. Development of common scenarios and agreement on selected models to be used will help to develop and streamline a common understanding between countries on the effects of climate change. This in turn will support the development of joint adaptation strategies that will benefit of all concerned parties.

139. Models are roughly divided into statistical (black box) models and physical-based models (deterministic or conceptual models). The latter are generally considered to be more reliable, particularly in assessing the impacts of climate change. A range of conceptual models has been developed for operational hydrological forecasting. Conceptual models can only simulate run-off for the period for which input data are available. The forecasts from these models are based on predicted values of precipitation and temperature from climatic scenarios.

140. Unless the national institutions in charge of hydrological computations and forecasting develop a suitable model themselves, they are faced with the difficulty of choosing between the many models proposed for operational use. The selection of a particular model will depend on specific conditions and the objective of modelling, When selecting a model following factors and criteria need to be taken into account:

(a) The purposes of the model;

(b) The climatic and physiographic characteristics of the basin;

(c) The quality of the data available, both in time and space;

(d) The possible need for reducing model parameters from smaller catchments to larger catchments; and

(e) The ability of the model to be upgraded on the basis of current hydrometeorological conditions and climate scenarios;

(f) The particular models that have proven to be effective in the past.

141. Once the model is selected its calibration is necessary to ensure that the simulated data are in line with observed run-off data. If a model is capable to accurately calculate historical variables, it is more likely that the model forecast will be accurate.

142. Historical data collected during routine operations are useful to calibrate the model and improve its performance. Calibration and effective operation of a conceptual model require reliable, accurate, consistent, and sufficiently long data sets that include the necessary observations. Input data for operation of a model may come from observations and/or output from other models, such as the data coming from downscaled GCMs. By using observations rather than model output, uncertainties inherent in the modelling procedure, such as simplifying assumptions and concepts, are avoided.

143. Applied models should be evaluated and revised with regard to the previous approach and in accordance with new technologies, the real impact of the driving forces, and any other changes which influence the model structure itself.

CHAPTER VI VULNERABILITY ASSESSMENT FOR WATER RESOURCES MANAGEMENT AND WATER SERVICES

144. This chapter aims to help decision makers to assess the vulnerability of a basin. Vulnerability assessments (VAs) provide decision makers with information that guides choices related to where and when interventions should be made, and in what form. VAs are based on scenarios and model outcomes, and are the first steps to better understanding the potential impacts of climate change and move to more effective and adaptive management and finally, climate proofing.

VI.1 Vulnerability

145. Vulnerability is considered a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity. The vulnerability of a system to climate change consequently includes both an external dimension, represented by its exposure to climate variations, and an internal dimension; represented by its sensitivity to climate variations and its adaptive capacity. A highly vulnerable system is one that is very sensitive to modest changes in climate, where the sensitivity includes the potential for substantial harmful effects, and for which the ability to cope is limited.

146. People's vulnerability is not only physical but also social and psychological. The psychological effects of surviving traumatic climate events are not to be underestimated and can persist long after physical scars have healed. This is especially so for vulnerable groups with no or very weak social support systems, such as elderly people living in virtual social isolation.

147. The social vulnerability of peoples' livelihoods is determined by how weak or strong the livelihoods are (feel), how good their access is to a range of assets that provide the basis for their livelihood strategy, and how successful different institutions are in providing social protection. Socio-economic factors can make people and societies (feel) more or less vulnerable to climate change. By building up preparedness, resistance and resilience to climate change, vulnerability can be reduced, which in turn improves sustainable livelihoods.

148. Some current practices actually increase the vulnerability to a changing climate. For example, allowing further residential and commercial development on riverine flood plains subject to inundation substantially increases the likelihood of detrimental impacts and costs of climate change.

149. The functions or systems of different basins will respond differently to the same degree of climate change, depending largely on catchment physio-geographical and hydro-geological characteristics and the amount of lake or groundwater storage in the catchment.

150. Many river basins that are already stressed due to non-climatic drivers are likely to become more stressed because of their vulnerability to climate change. Of particular relevance is the vulnerability to climate change of costly water infrastructures (e.g., dykes and

pipelines), which have to serve for decades but were designed on the assumption of stationary climatic conditions.

151. Ecosystems are expected to adjust to some level of future climate change and, in some form or another, will continue to persist or evolve, as they have done repeatedly with paleo-climatic changes. A primary key issue, however, is whether ecosystem resilience will be sufficient to tolerate the very rapid future anthropogenic climate change. In any case, climate change will alter the supply of ecosystem services.

152. Environmental systems tend to respond to changes in a gradual way until they cross some threshold or the tipping point. Beyond this point, change becomes sudden rather than gradual causing irreversible environmental (extinction of species) and societal (disappearance of an island) dislocation. The change leads to a transition to a new state. The existing rate of change is therefore not an indicator for the severity of the potential change. The extent of warming needed to trigger these changes is not precisely known. Moreover, there is a strong possibility of such switches coming as a surprise to affected societies that had been prepared (at best) for the gradual growth of already-observed impacts.

153. Depending on the subsurface characteristics, the effects of climate change on groundwater resources can be either immediate or take a long time to materialize. These characteristics should therefore be assessed and accounted for when performing vulnerability assessments.

VI.2 Vulnerability assessments

VI.2.1 Defining vulnerability assessment

154. Vulnerability assessment (VA) delineates the places, human groups, and ecosystems that are at highest risk, the sources of their vulnerability, and how the risk can be diminished or eliminated. Therefore, identifying the regions and peoples at greatest risk and assessing the sources and causes of the vulnerability is critical for designing and targeting adaptation. This effort guides the prioritization of intervention and adaptation action and provides decision makers with information on where and when interventions are needed.

155. VAs should be predictive, conceptualizing what might happen to an identifiable population or ecosystem under conditions of particular risk and hazards. They should therefore be capable of seeking ways to protect and enhance peoples' livelihoods, assist vulnerable people in their own self-protection, and support institutions in their role of adaptation.

156. VAs should cover physical aspects such as land use and risk to infrastructures, including the health system infrastructure in areas that present a hydrological risk, but should also incorporate social vulnerability assessments. Such social aspects of vulnerability should take into account not only personal behaviour, but also explore existing differences in liability coverage (e.g. State disaster management funds, obligatory individual insurance coverage) and reserves for the immediate safeguarding of human life and the speedy recovery of critical infrastructure including health systems in the event of climatic catastrophes.

VI.2.2 Methodologies for vulnerability assessments

157. There is no "one size fits all" VA methodology. VAs should be tailor-made for the water resources management or water services of a particular basin. Typically, a VA includes the following steps:

- Scope and structure of the VA. This includes the objectives of the VA, the definition of the scenarios and models to be applied, and the stakeholders who will guide the use of the VA;
- Identification of vulnerable groups and areas of potential climate change damage. With the use of scenarios and models, the exposure of livelihoods and areas to climate changes are assessed;
- Assessment of the vulnerability of the selected system and vulnerable group. How resilient are the groups and areas to current and possible future stresses;
- Use of the VA outputs in the adaptation policy and in planning the adaptive strategies and measures.

158. The following criteria can be used to identify key vulnerabilities:

- Magnitude of impacts;
- Timing of impacts;
- Persistence and reversibility of impacts;
- Likelihood (estimates of uncertainty) of impacts and vulnerabilities, and confidence in those estimates;
- Potential for adaptation;
- Distributional aspects of impacts and vulnerabilities;
- Importance of the system(s) at risk.

159. The coping capacity of livelihoods and individuals can be assessed through various social, geographic and environmental parameters such as differences in health status, economic standing, and educational achievement. Combining such variables in development models allows making comparisons to determine the most critical regions or hot spots.

160. Determining which impacts of climate change are potentially of the utmost importance and which are the most dangerous is a dynamic process involving, inter alia, a combination of scientific knowledge with factual and normative elements.

CHAPTER VII MEASURES

161. Measures to cope with climate change are based on the VA. Measures aim to counteract negative effects of too much water, too little water, impairment of water quality and effects on health. Five different types of measurement form an adaptation chain: prevention, improving resilience, preparation, response, and recovery (figure 4). Measures for prevention and improving resilience are related both to the gradual effects of climate change and extreme climate events. Preparation, response, and recovery measures are relevant for extreme events. As categorization is considered within a continuum of adaptation measures, it is not always feasible to categorize certain measures as one specific type (see tables 1 and 2).

162. As will be discussed in more detail below (see section VII.2), climate change effects occur at different time horizons, while catastrophic events occur at comparatively short time horizons. Effects of climate changes playing out over longer time periods will become better understood as more information becomes available. Thus there will never be one definitive and final set of measures. Rather, measures will need to be developed to address theeffects that pose highest risk to human health first, and efforts will continuously need to be made to better understand ongoing climate change and to develop appropriate the adaptation measures to new risks as they become better understood.

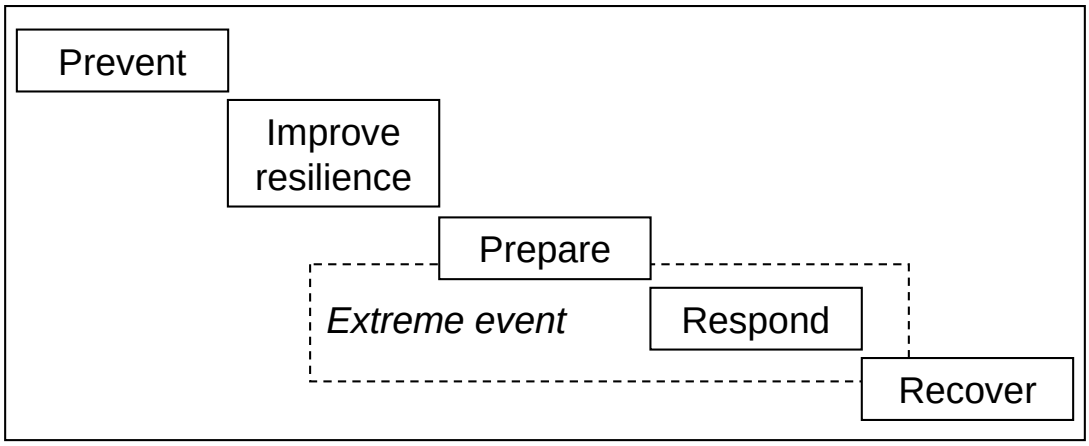


Figure 4: The adaptation chain

VII.1 Types of measures[18]

163. *Prevention measures* are measures taken to prevent the negative effects of climate change and climate variability on water resources management. Prevention measures are based on risks, hazards and vulnerability maps under different scenarios. To support them, forecasts are needed both on a seasonal and a long-term basis. Monitoring systems should be designed to capture early signals of climate change impact and differentiate them from signals of impacts from other pressures. Existing management practices need to be revised and amended, where appropriate, to adapt and respond to climate change impact.

164. Prevention measures can include, for instance, the prevention of urban development in flood-prone areas or development of water efficient methodologies in water-dependent sectors, but also measures such as afforestation to improve the retention of water or prevent landslides. Prevention measures target long-term developments and are therefore of a strategic nature.

165. Where the threat of climate change makes continuation of an economic activity impossible or extremely risky, consideration can be given to changing the use. For example, a farmer may choose to substitute a more drought-tolerant crop or switch to varieties with lower moisture. Similarly, crop land may be returned to pasture or forest, or other uses may be found such as recreation, wildlife refuges or national parks.

166. *Measures to improve the resilience* are measures that aim to reduce the negative effects of the climate change and climate variability on water resources management by improving adaptive capacity. Such measures are based on risks, hazards and vulnerability maps under different scenarios. To support resilience measures, forecasts are needed on a seasonal basis.

167. Measures to improve resilience target long term developments such as changing agriculture to crops that are less water-demanding or salt-resistant. Improving resilience can also be done at a tactical level, for instance by operating dams in such a way that sufficient water is retained in the wet season to balance for the water needs in the dry season.

168. *Preparation measures* are measures that aim to reduce the negative effects of extreme events on water resources management. Such measures are based on risk maps under different scenarios. To support preparation measures, short-term weather forecasts are needed as well as forecasts on a seasonal basis.

[18] Examples of measures are included in tables 1 and 2.

169. Preparation measures comprise the establishment of early-warning systems, emergency planning, and raising awareness as well as increasing storage, demand management and technological development. Preparation measures have a strategic and operational character. They are established to run over a long period, but are often only active at the operational level.

170. *Response or reactive measures* are measures that aim at alleviating the direct negative effects in the aftermath of extreme events. To support resilience measures, short term weather forecasts are needed.

171. Response measures include for instance establishment of safe drinking water and sanitation facilities in affected areas. Response measures target at the operational level.

172. *Recovery measures* aim at restoring the societal and natural system after an extreme event has taken place. To support recovery measures, forecasts are needed both on a seasonal and a long-term basis. Recovery measures include, for instance, activities for the reconstruction of infrastructure. Recovery measures operate at the tactical level.

VII.2 Measures at different time scales

173. Measures can be developed at different time scales depending on their characteristics. table 1 provides some examples of different types of decisions at the strategic, tactical and operational levels.

- *Strategic measures* are related to decisions to address long-term (decadal) climate changes and are based on long-term projections. They usually exceed the scope of water sector planning, because they affect the development model and the socio-economic background through institutional and legal changes.
- *Tactical measures* relate to decisions aiming at addressing medium-term (within one or two decades) climate trend forecasts, introducing the required corrections in the framework through hydrological planning measures such as risk management.
- *Operational measures* relate to decisions addressing identified problems under the current climate. They correspond to measures that can be adopted in the current institutional, legal and infrastructural frameworks, and usually refer to risk assessment, preparedness and vulnerability reduction.

Table 1: Types of decisions aiming at different time scales

Type of decision	**Future climate**		**Current climate**
	Long term (25–50 years)	**Medium term (5–25 years)**	**Short Tterm (0–5 years)**
	Climate scenarios	**Climate trend**	**Current climate**
Strategic	- Institutional framework - Legal framework - Development model - Land use planning - Socio-economic activity planning		

Type of decision	Future climate		Current climate
	Long term (25–50 years)	**Medium term (5–25 years)**	**Short Tterm (0–5 years)**
	Climate scenarios	**Climate trend**	**Current climate**
Tactical		- Capacity-building - Hydrological plans - Infrastructure planning - Drought and flood management plans - Infrastructure construction	
Operational			- Monitoring - Demand management - Operating rules for current infrastructure - Dam operations - Water allocations to agriculture - Flood and drought warning

VII.3 Development of measures

174. Climate risk should be considered as an integral element of decision-making. Adaptation options should not be developed separately from other dimensions of strategic planning and risk management. Reaching this point requires awareness-raising and development of science and of techniques for applying scientific knowledge in practical situations.

175. Decision-making criteria for selecting adaptation options will vary depending upon who is making the decision, the objectives of decision makers and stakeholders, which stakeholders are affected by the decision and what role they play in the decision-making process. Such aspects as uncertainty about decisions' outcomes, consequences of errors made in the decision-making process and irreversibility of consequences should be also considered. Another crucial factor is the ability of populations to adapt to climatic variability, which is heavily influenced by the degree to which people, finance, goods, services and information can move across local and national borders.

176. The participatory approach should be a basis for developing and implementing measures. Persons at risk should be involved in the adaptation process. This helps: (a) focus attention on the risks that are priorities; (b) learning from risk management practices currently in use at the local level; and (c) identifying opportunities and obstacles and applying evaluation criteria that are relevant and credible to at-risk groups. Use of local knowledge and expertise, garnering support and mobilizing local resources, increases the effectiveness of adaptation.

177. The development of measures should take into account the above statements, the described categorization approach and be in line with the required time scale. Depending on

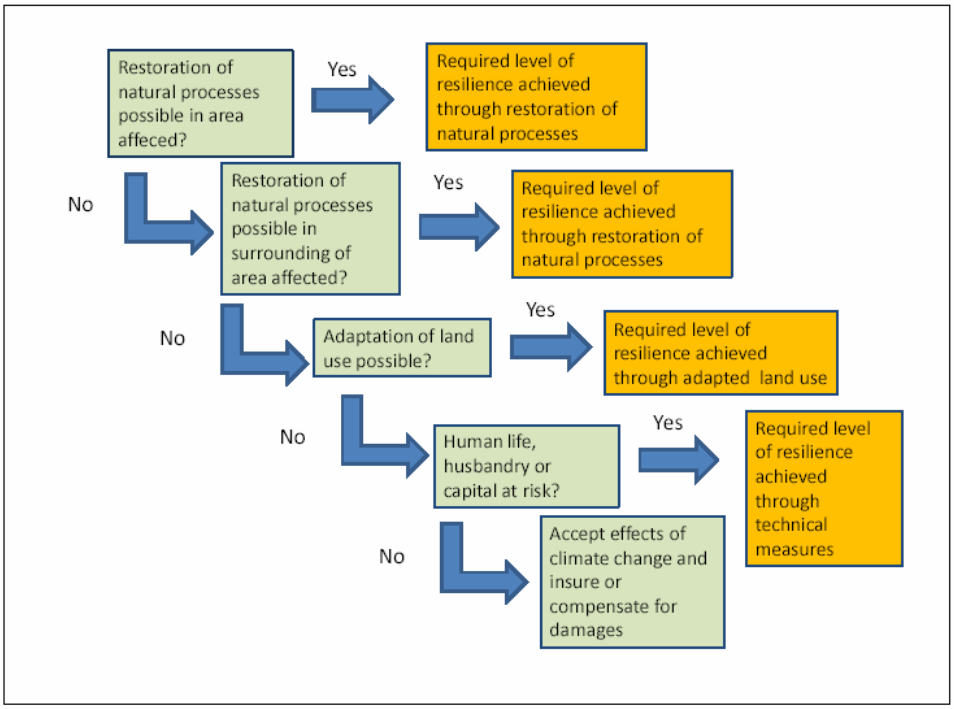
their purpose measures can be of different nature, e.g. legislative, financial, structural, non-structural or related to capacity-building.

178. The implementation and maintenance costs of adaptation measures and their technical feasibility should be compared to the costs of non-action.

VII.3.1 Enhancing resilience of ecosystems

179. Measures to enhance the resilience of the ecosystems and to secure the essential ecological services to human society should receive priority. These include: (a) protection of adequate and appropriate space; (b) limitation of all non-climate stresses; and (c) use of active adaptive management and strategy testing.

180. Conservation of keystone species, planning along climate gradients (e.g. mountain altitudes), promoting connectivity (e.g. protected areas and corridors), fragmentation avoidance and protection of climate refuge with especially resistant habitats should be covered under habitat protection.



Decision-making tree for building climate resilience of an affected area through restoration of natural processes (adapted from Stroming 2007)

VII.3.2 Development and maintenance of infrastructure

181. Conservation of water resources demands the rehabilitation and expansion of existing water-use systems, new construction (e.g. of dams, canals, dykes, aqueducts, etc.) and improvement of water consumption (through irrigation or by industry) and water supply. It is necessary to improve the technical condition of infrastructure, to carry out timely maintenance and repair waterworks and to equip them with modern water-saving devices.

182. Construction of new reservoirs will considerably improve conditions of run-off regulations and lessen the danger of severe floods. Planning procedures for the design of new infrastructure will need to undergo a philosophical change since the past hydrological characteristics may no longer apply.

VII.3.3 Reducing effects of extreme events

183. The prime objective of the United Nations programme International Strategy for Disaster Reduction (ISDR) is to build disaster resilient communities by promoting increased awareness of the importance of disaster reduction as an integral component of sustainable development, thus reducing human, social, economic and environmental losses due to natural hazards and related technological and environmental disasters. The many report and guidelines published under the Hyogo Framework for Action[19] aim to both build up the resilience of nations and communities to disasters and integrate disaster risk reduction with climate change strategies. Adaptation measures such as early-warning systems, risk assessment and sustainable natural resources use are considered in practice as disaster risk-reduction activities. Disaster reduction should be integrated in any adaptation strategy.

VII.3.4 Preventing and responding to negative health outcomes

184. Health systems[20] have the dual role of taking all necessary measures to ensure that water-related diseases linked to climate change are prevented as much as possible, but also ensuring that a system is in place to monitor the incidence of such diseases and detect outbreaks and that contingency plans are in place to deal with such outbreaks.

185. Countries should take a number of common actions to strengthen capacity of health systems and their preparedness to respond climate change challenge. These include[21]:

- Strengthening health security, maximizing synergy with existing instruments such as the IHR, preparing the health workforce to deal with climate-related events (e.g. offer appropriate mental care during climate events as well as adequate care for extended periods after climate events to the survivors), and ensuring that the logistic aspects of the health system infrastructure can withstand climate events (e.g. availability of stand by generators, capacity to ensure safe running water and adequate removal/disposal of sanitary and medical waste, etc.);
- Building the capacity of the workforce: health professionals should be prepared for new challenges of protecting health from the effects of climate change;
- Providing intelligence: ensuring that information systems and communication strategies serve the needs of the health care system in a multi-sectoral context. A robust information structure should be capable of: (a) providing reliable and timely information; (b) issuing warnings; (c) acting on early warnings received from other partners; (d) building trust and improve public perception, and (e) better overall management of climatic events.

[19] Hyogo Framework for Action 2005-2015: ISDR International Strategy for Disaster Reduction. Available at: www.unisdr.org/wcdr.
[20] Health systems comprise all organizations, institutions and resources devoted to improving, maintaining and restoring health.
[21] Menne, B. et al. (2008), "Protecting HEALTH in Europe from climate change", WHO-Europe.

Table 2: Overview of possible measures

	Flood prone situation	Drought prone situation	Impaired water quality	Health effects
PREVENTION **Measures** include…	• Restriction of urban development in flood risk zones • Measures aiming at maintaining dam safety, afforestation and other structural measures to avoid mudflows • Construction of dykes • Changes in operation of reservoirs and lakes • General land-use management *->Various legal/financial/economic instruments are available.*	• Reducing need for water • Water conservation measures/ effective water use (industrial and other sectors' practices and technologies) • Water saving (permit systems for water users) • Improved irrigation efficiency • Land-use management *->Various legal/financial/ economic instruments are available.*	• Prevention of and cleaning up of dump sites in flood risk zones • Improved waste water treatment • Regulation of wastewater discharge • Improved drinking water intake *->Various legal/financial/economic instruments are available.*	• Strengthen and use a capacity for long-term preparation and planning, especially to identify, address and remedy the underlying social and environmental determinants that increase vulnerability
IMPROVING RESILIENCE **Measures** include…	• Operation of reservoirs/lakes (surplus of water can be handled without causing damage) • Implementation of retention areas • Improved drainage possibilities • Structural measures (temporary dams, building resilient housing, modifying transport infrastructure) • Migration of people away from high-risk areas	• Enlarging the availability of water (e.g. increase of reservoir capacity) • Improving the landscape water balance • Introduction or strengthening of a sustainable groundwater management strategy • Joint operation of water supply and water management networks or building of new networks • Identification and evaluation of alternative strategic water	• Safety and effectiveness of waste water systems • Isolation of dump sites in flood risk zones • Temporary wastewater storage facilities	• Use existing systems and links to general and emergency response systems • Ensure effective communication services for use by health officials

	Flood prone situation	Drought prone situation	Impaired water quality	Health effects
IMPROVING RESILIENCE (cont'd)		resources (surface and groundwater) • Identification and evaluation of alternative technological solutions (desalinization; reuse of wastewater) • Increase of storage capacity (for surface and ground waters) both natural and artificial		
PREPARATION **Measures** include…	• Flood warning (incl. early warning) • Emergency planning (incl. evacuation) • Flash-flood risks, (measures taken as prevention, as the warning time is too short to react)	• prioritization of water use • restrictions for water abstraction for appointed uses • emergency planning • awareness-raising • risk communication to the public • training and exercise	• Restrictions to wastewater discharge and implementation of emergency water storage	• Strengthen the mechanism for early warning and action
RESPONSE **Measures** include…	• Emergency medical care • Safe drinking water distribution • Safe sanitation provision • Prioritization and type of distribution (bottled water, plastic bags, etc.)			
RECOVERY **Measures** include…	• Clean-up activities • Rehabilitation options such as reconstruction of infrastructure • Governance aspects such as legislation on, inter alia, insurance, a clear policy for rehabilitation, proper institutional settings, rehabilitation plans and capacities, and information collection and dissemination.			

Box 2: DEVELOPING ADAPTATION MEASURES IN THE DANUBE RIVER BASIN

The Danube is Europe's second largest river basin after the Volga. The river has a total length of 2,780 km, its basin covers a total area of 801.463 km^2, and includes territories of 19 countries. The Contracting Parties to the 1994 Danube River Protection Convention include 13 countries (Austria, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Moldova, Romania, Slovakia, Slovenia, Serbia and Ukraine) and the European Union. The following countries cooperate with the Convention under the EU Water Framework Directive: Albania, Italy, Switzerland, Poland, and The former Yugoslav Republic of Macedonia. The Convention's goals are to cooperate on fundamental water management issues and to take all appropriate legal, administrative and technical measures to maintain and improve the quality of the Danube River and its environment. Its Contracting Parties are also committed to making the necessary efforts to draw up a coordinated international river basin management plan for the Danube Basin.

On 3 December2007, a Conference on the Adaptation of Water Management to the Effects of Climate Change in the Danube region took place in Vienna. Its goal was to discuss the expected effects of climate change on the water cycle, such as enhanced droughts and floods, and how the related challenges can be met for the sake of nature and people. The work done by the Bavarian State Ministry for Environment, Health and Consumer Protection on climate change and water management in the German Danube Region[22] illustrates the different steps in developing an adaptation strategy:

1. *Assess the current situation:*
   (a) Analyse of hydrological and meteorological data concerning long-term climate change effects (air temperature, duration of snow cover, precipitation…);
   (b) Develop prognosis by means of regional climate and water resources models (progressive adaptation of global to regional climate models and regional water resources models);
   (c) Recording future changes in climate and water cycle.
2. *Develop adaptation strategies for water resources management:*
   (a) Vulnerability assessment of water systems and infrastructure;
   (b) General development strategies;
   (c) Sectoral adaptation strategies;
   (d) Prioritization of adaptation needs.
3. *Action on first priority: adaptation strategy concerning floods:*
   (a) Design of new flood protection measures under consideration of climate change, recognizing uncertainties in regional climate change models;
   (b) Redefine design flood criteria;
   (c) Allow for a regional adjustment in the definition of design floods as new results become available.
4. *Define follow-up activities:*
   (a) Refine scenarios of regional climate change and water cycle;

[22] Michael Becker, Bavarian State Ministry for Environment, Health and Consumer Protection "*Climate change and water management in the German Danube region"* – presentation to the International Conference on Adaptation of Water Management to Effects of Climate Change in the Danube River Basin, Vienna3 December 2007. Available at: http://www.icpdr.org/icpdr-pages/climate_change_conference.htm accessed 2 June 2008.

(b) Implement further studies on climate change and

(i) *Storm water management*
(ii) *Natural groundwater recharge*
(iii) *Low-flow conditions and droughts*
(iv) *Drinking water supply*
(v) *Water quality.*

CHAPTER VIII FINANCIAL MATTERS

186. Ensuring adequate financial means to implement the adaptation measures is an important precondition for success. To accurately assess the costs of implementing measures that are necessary and the revenues of these investments in terms of risk avoidance or reduction, it is essential to understand the long-term value of having adequate financial means in place. The cost of implementation should, in general, be borne by each country. Governments should therefore ensure that appropriate resources are available. Many of the proposed actions here can be incorporated into ongoing development work in the water sector, e.g. no-regret measures. Some actions can be more easily carried out as subregional or region-wide projects.

187. Governments should consider using budgets and economic incentives to finance adaptation measures. Efforts should be made to include these in relevant bilateral and multilateral programmes. Partnerships can be formed and should be encouraged to seek support, including in-kind contributions, from international funding agencies and the private sector. Financial assistance to certain parts of the region, in particular Eastern Europe, Caucasus and Central Asia and South-Eastern Europe, is crucial to help those countries to start the process.

VIII.1 Adaptation Fund of the United Nations Framework Convention on Climate Change

188. The objective of the UNFCCC Adaptation Fund[23] is to help finance adaptation to climate change in poor countries. Unlike other funds that are dependent on voluntary contributions, the Adaptation Fund is designed to draw resources from a 2 per cent levy on carbon credit sales through the Kyoto Protocol's Clean Development Mechanism.

CHAPTER IX EVALUATION OF ADAPTATION STRATEGIES

189. This chapter will introduce frameworks to evaluate adaptation strategies. Evaluation is a process for determining systematically and objectively the relevance, efficiency, effectiveness and impact of the adaptation strategies in the light of their objectives. Evaluating adaptation strategies is imperative to assessing the effectiveness of adaptation strategies and thereby identifying and measuring the ability to cope with short- to long-term threats. Evaluation should guide and support governmental decision-making and policymaking, as well as international aid and investment. It should support decisions prioritizing strategies and initiatives that reduce vulnerability.

[23] http://unfccc.int/cooperation_and_support/financial_mechanism/items/3659.php

IX.1 Objectives

190. As explained in the previous chapters, analyses of current and future vulnerabilities and risks as well as of existing policies are the basis for the developing good adaptation strategies. Evaluation and monitoring activities are essential for verifying the efficiency of the measures taken and facilitate adjustments.

191. Evaluation is carried out during implementation (ongoing evaluation), at the completion of a project (final evaluation), and some years after completion (post evaluation). Much of the evaluation activity can be based on self-assessment of the responsible operational staff, but external evaluation is also a common and beneficial practice.

192. Evaluating adaptation strategies includes evaluating the constituent elements of a given strategy; the policy, legal and institutional setting, vulnerability assessment; and the choice of measures. It also includes monitoring the adaptation progress.

193. Evaluation of an adaptation strategy starts off with assessing the progress achieved towards the objectives of the strategy. The next step is to determine if the policy as formulated is implemented and if it functions as intended. The legal framework as well as the institutional setting of the strategy should be assessed concerning their contribution to the strategy. Next to that, the financial arrangements should be evaluated.

194. Evaluating vulnerability assessment includes assessing if sufficient relevant information was available. Also the extent to which the scenario that was selected as the basis for the vulnerability assessment has enfolded in reality and if the output of the models reflects the actual situation transpiring. Finally, the relevance of the assumptions for the vulnerability assessment should be assessed.

195. Monitoring the progress in adaptation includes collecting information on all these elements as well as on the progress made vis-à-vis achieving objectives. Table 3 provides an overview of possible indicators that can be applied to assess the progress made. It distinguishes between the national adaptation strategy level and the level of concrete measures. The latter can also be linked to projects. On the measure or project level, distinction is made between the outcomes of the measures (in terms of effects on the reduction of vulnerability and increased adaptive capacity) and the output of the measures (in terms of the strategy chosen, the developed or implemented policy, and the concrete activities).

Table 3: Illustrative matrix mapping the strategy level goal, objective and indicators to measure level outcomes, outputs and indicators

<table>
<tr><th colspan="3">Strategy level</th><th colspan="4">Measure/project level</th></tr>
<tr><th>Goal</th><th>Objective</th><th>Strategy Indicators</th><th>Outcomes</th><th>Outcome Indicators</th><th>Outputs</th><th>Output Indicators</th></tr>
<tr><td rowspan="3">Climate proofing</td><td rowspan="3">Vulnerability reduction

Adaptive capacity enhanced</td><td rowspan="3">Coverage
Impact
Sustainability
Replicability</td><td rowspan="3">Outcome 1
Outcome 2

Outcome x</td><td rowspan="3">Coverage
Impact
Sustainability
Replicability</td><td>Strategies</td><td>…</td></tr>
<tr><td>Policies</td><td>…</td></tr>
<tr><td>Activities</td><td>…</td></tr>
</table>

196. The four types of outcome indicators shown measure the success of projects:

- *Coverage*: the extent to which projects reach vulnerable stakeholders (e.g. individuals, households, businesses, government agencies, policymakers) and the ecosystem;

- *Impact*: the extent to which projects reduce vulnerability and/or enhance adaptive capacity (e.g. through bringing about changes in adaptation processes: policymaking/planning, capacity-building/awareness-raising, information management).
- *Sustainability*: the ability of stakeholders to continue the adaptation processes beyond project lifetimes, thereby sustaining development benefits;
- *Replicability*: the extent to which projects generate and disseminate results and lessons of value in other, comparable contexts.

197. Sound evaluations can be carried out with simple, careful examinations of success, relative to what was expected. The following list provides examples of questions that can contribute to this evaluation:

(a) If, for instance, adaptation involved investing in a protection project in response to a climate hazard, then the evaluation should determine if losses have continued, grown or been abated;

(b) If the protection project simply tried to reduce sensitivity to extreme events, has it worked, and how?

(c) Have episodes of intolerable exposure become more or less frequent?

(d) Has the definition of "intolerable" in terms of physical effects changed?

(e) Has the investment expanded the coping range, reduced exposure to intolerable outcomes that exceed the range, or both?

(f) Have things stayed the same or grown worse because the adaptation was ineffective, or because unanticipated stresses have aggravated the situation?

(g) Is there a causal relationship?

198. The purpose of this exercise is to determine whether or not the objectives of an adaptation project have been satisfied. More complete evaluations of specific adaptations should identify the root causes of both successes and failures. A questionnaire specific to the particular adaptation can be constructed to understand the reasons why an adaptation succeeded or failed to meet its objectives.

IX.2 Learning by doing

199. Exploring the success or failure of the adaptation process depends on more than just the success or failure of implemented projects or strategies. More significantly, it depends upon the concept of learning by doing. This approach enables users to:

- Undertake midcourse corrections in implemented adaptations, so that they meet their objectives more efficiently;
- Improve their understanding of the determinants of adaptive capacity, so that capacity development activities can be more successful from the start.

200. To learn from mistakes and successes, it is important to combine these insights to:

- Compare actual experience with the initial characterization, and with the criteria;
- Construct a revised adaptation baseline that describes how the system would have performed in the absence of the implemented adaptation.

IX.2.1 Participatory evaluation

201. Participatory processes in support of adaptation can add value and enhance feasibility. Engaging as many stakeholders as possible can democratize the overall process of adapting to

climate change, including variability. It follows that participatory evaluation can be productive, but care must be taken to note the potential pitfalls. For example, stakeholder engagement can uncover obstacles such as a healthy degree of initial scepticism on the part of stakeholders about the information provided by government.

IX.2.2 Social, economic, political and ethical considerations

202. In evaluating adaptation strategies, it is necessary to (re)consider the social, economic, political and ethical implications of each adaptation measures. The impacts on all stakeholders need to be considered.

CHAPTER X ISSUES RELEVANT TO OTHER WATER-RELATED SECTORS

Issues relevant to other water-related sectors have been addressed, as appropriate in all other chapters; it will be decided at a later stage whether there is a need to include them in a separate chapter or leave them as an integral part of other chapters.

Annex

DEFINITIONS

For the purpose of this guidance, the following definitions should be considered:

Adaptability / Adaptive Capacity: in the context of both social and natural systems, adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences[24].

Adaptation strategy: The adaptation strategy for a country, a basin, or part thereof, refers to a general plan of action for addressing the impacts of climate change, including climate variability and extremes. It will include a mix of policies and measures with the overarching objective of reducing the country's vulnerability[25].

Climate model: A numerical representation of the climate system based on the physical, chemical and biological properties of its components and their interactions and feedback processes, accounting for all or some of the system's known properties[26].

Climate scenario: A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships and assumptions of radiative forcing, typically constructed for explicit use as input to climate change impact models.[27]

Coping capacity: The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster. In general, this involves managing resources, both in normal times as well as during crises or adverse conditions. The strengthening of coping capacities usually builds up the resilience to withstand the effects of natural and human-induced hazards.[28]

Downscaling: A method that derives local- to regional-scale (10 to 100 km) information from larger-scale models or data analyses.

Emission scenario: A plausible representation of the future development of emissions of substances that are potentially radiatively active (e.g., greenhouse gases, aerosols), based on a coherent and internally consistent set of assumptions about driving forces (e.g. demographic and socio-economic development, technological change) and their key relationships.[29]

Hydrologic model: A simplified, conceptual representations of a part of the hydrologic cycle, primarily used for hydrologic prediction and for understanding hydrologic processes. Hydrological models can be based on statistical approaches (black box systems) or based on process descriptions (known as deterministic hydrology models), in the effort to represent the physical processes observed in the real world.

Local: refers to all relevant levels of territorial unit below the level of the State.[30]

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[24] IPCC, 2007.
[25] UNDP, 2004: Adaptation Policy Frameworks for Climate Change. Developing Strategies, Policies and Measures. Annex A. Glossary of Terms.
[26] IPCC, 2008: Fourth Assessment Report, Working Group II, Appendix 1- Glossary.
[27] IPCC, 2008: Fourth Assessment Report, Working Group II, Appendix 1- Glossary.
[28] ISDR Terminology of disaster risk reduction, viewed June 2008, http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm.
[29] IPCC, 2008: Fourth Assessment Report, Working Group II, Appendix 1- Glossary.
[30] Protocol on Water and Health.

Mitigation: is an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and to enhance greenhouse gas sinks.[31]

Resilience: The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.[32]

Scenario: A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships.

Socio-economic scenarios: Scenarios concerning future conditions in terms of population, gross domestic product and other socio-economic factors relevant to understanding the implications of climate change.[33]

Vulnerability: Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes.[34]

[31] IPCC 2008: Fourth Assessment Report, Working Group II, Appendix 1- Glossary
[32] IPCC 2008: Fourth Assessment Report, Working Group II, Appendix 1- Glossary
[33] IPCC 2008: Fourth Assessment Report, Working Group II, Appendix 1- Glossary
[34] IPCC 2008: Fourth Assessment Report, Working Group II, Appendix 1- Glossary

MEETING OF THE PARTIES TO
THE CONVENTION ON THE PROTECTION
AND USE OF TRANSBOUNDARY
WATERCOURSES AND INTERNATIONAL LAKES

MEETING OF THE PARTIES TO THE PROTOCOL ON WATER AND HEALTH
TO THE CONVENTION ON THE PROTECTION AND USE OF TRANSBOUNDARY WATERCOURSES AND INTERNATIONAL LAKES

Workshop on water and adaptation to climate change
Amsterdam (the Netherlands), 1–2 July 2008

DRAFT QUESTIONNAIRE TO THE "GUIDANCE ON WATER AND CLIMATE ADAPTATION"

No	SETS	COMMENTS	A (1)	B (0,5)	C (0)
	I. INTERNATIONAL COMMITMENTS				
1.1	Ratification of UN Framework Convention on Climate Change		Yes, it was ratified	It is signed, but not ratified, yet	No
1.2	Ratification of Kyoto Protocol to the UN Framework Convention on Climate Change		Yes, it was ratified	It is signed, but not ratified, yet	No
1.3	Ratification of UNECEConvention on the Protection and Use of Transboundary Watercourses and International Lakes(Water Convention)		Yes, it was ratified	It is signed, but not ratified, yet	No
1.4	Ratification of the Protocol on Water and Health to the Water Convention.		Yes, it was ratified	It is asigned, but not ratified, yet	No
2.4	Is your country water legislation approximated to the EU Water Framework Directive?		Yes, almost fully approximated (more than 75%)	Partially approximated (less than 75%)	No
	II. POLICY, LEGISLATION AND INSTITUTIONAL FRAMEWORKS				
2.1	Is the implementation of the principles of		Yes	Under	No

	Integrated/Basin Water Resources Management required by the legislation of your country ?			Consideration	
2.2	Is the development of river basin/integrated management plans required by the legislation of your country? ?		Yes, fully developed	Under process of development	No
2.3	*Please only answer to this question, if you have answered A or B in the above question 2.2* Are climate change impacts, vulnerability assessment of water resources, water balance changes, and other climate change related issues reflected in your river basin/integrated management plans?		Yes, fully reflected	Partially reflected	No
2.5	Has your country any legislative act (law, under-law acts) related to "Water Management and/or Environment Protection Policy"?		Yes, it is adopted	It is in the process of development	No
III. PRINCIPLES AND APPROACHES					
3.1	Has your country established river basin management institutions/bodies?		Yes	In the study of establishment	No
3.2	Does your country apply the ecosystem approach to water ecosystems?		Yes	In the study of establishment	No
3.3	Does your country have an effective transboundary water cooperation?		Yes (existing agreements, working joint bodies, etc)	Cooperation agreements are available but not implemented	No
IV. INFORMATION AND MONITORING NEEDS FOR ADAPTATION STRATEGIES DESIGN AND IMPLEMENTATION					
4.1	Does your country have database/cadastre on water resources, water users, water systems?		Yes	In the study of development	No
4.2	Does your country have national database/cadastre on greenhouse gases?		Yes	In the study of development	No
4.3	Does you country carry out research and monitoring		Yes	Partially,	No

	and assessment of desertification processes and on droughts and floods?			research, monitoring and assessments are fragmented, neither regular nor continued	
4.4	Does your organization /authority have electronic/GIS maps of your country's landscape, on climate change and on water resources?		Yes	Partially / In the study of development	No
4.5	*Please only answer to this question, if you have answered A or B in the above question 4.4* Are water resources protective areas and areas of emergency (drought, floods, landslips, downpours etc.) included in these maps?		Yes	Partially	No
4.6	*Please only answer to this question, if you have answered A or B in the questions 4.1-4.4.* Do available data allow developing adaptation strategy?		Yes	Partially	No
4.7	Does your country have joint information system on transboundary basin(s)?		Yes	Partially / In the study of development	No
4.8	Does your country exchange information with other riparian countries located in transboundary river basin(s)?		Yes	Partially / In the study of development	No
4.9	Is the monitoring network periodically revised and enhanced? in your country?		Yes	In the study of improvement	No
V. SCENARIOS AND MODELS FOR IMPACT ASSESSMENT AND WATER RESOURCES MANAGEMENT					
5.1	Has your country elaborated regional climate scenario.models?		Yes	Partially / In the study of elaboration	No
5.2	Has your country elaborated hydrological model for		Yes	Partially / In	No

	assessment of climate change impact on the water resources (droughts, floods)?			the study of elaboration	
5.3	Has your country elaborated scenarios of socio-economical development on short/middle/long terms?		Yes	Partially / In the study of elaboration	No
VI. VULNERABILITY ASSESSMENT FOR WATER RESOURCES MANAGEMENT AND WATER SERVICES					
6.1	Are conflicts on water use between water users increasing or decreasing?		Decreasing	No changes	Increasing
6.2	Is the number of endangered species increasing or decreasing?		Decreasing	No changes	Increasing
6.3	Is the shortage of the planned water resources observed in the middle of year?		No	Yes, periodically (no more than one time per 5 year)	Yes, constantly
6.4	Has vulnerability assessment of ecosystems in relation to climate change been done in your country?		Yes	Partially	No
6.5	Does your country measure glaciation of the mountain areas?		Yes	Partially	No
6.6	*Please only answer to this question, if you have answered A or B in the above question 4.4*What is the status of glaciation cover of the mountain areas?		No changes		Decreasing
6.7	Are trends of water related diseases increasing or decreasing your country?		No	Decreasing	Increasing
VII. DEVELOPMENT OF MEASURES-					
7.1	Has your country created a green house gases monitoring system?		Yes	In the study of development	No
7.2	Does your country have a legislative act on strategic water stock? (Strategic water balance is a constant quantity of water which is necessary to prevent or to cope with cases of emergency, i.e. floods, droughts etc.)		Yes	In the study of development	No

7.3	Has your country developed effective systems of forecasting at the regional/national levels?		Yes	In the study of elaboration	No
7.4	Is the evaluation and methodology to reduce GHG Emissions in Energy Sector, Industrial Sector, Agriculture etc exist in your country		Yes	In the study of elaboration	No
VIII. FINANCIAL MATTERS					
8.1	Does the state budget of your country have an environmental fund which can be used to finance measures towards adaptation of water resources to climate change?,		Yes	In the study of development	No
8.2	Has your country pooled alternative sources of funding for adaptation of the water sectors to climate change (e.g. insurance, inatrenational assistance projects, etc.)		Yes	In the study of development	No
IX. EVALUATION OF ADAPTATION STRATEGIES					
9.1	Is the effectiveness of adaptation measures/strategies assessed?		Yes	Partially	No
9.2	*Please only answer to this question, if you have answered A or B in the above question 9.1* Does the assessment of the adaptation strategy include an assessment of the economic and social aspects, including the incidence of water-related disease?				
9.3	*Please only answer to this question, if you have answered A or B in the above question 9.1* Are positive changes of water availability and water quality observed?		Yes	Partially	No
9.43	*Please only answer to this question, if you have answered A or B in the above question 9.1* Is improvement of economic and social conditions in your country linked to appropriate water quality and water supply?		Yes	Partially	No