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The Lived Experience of Climate Change:

Water case study on the Nile and Rhine river basins

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The Lived Experience of Climate Change: Water case study on the Nile and Rhine river basins

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Before you start: aims, learning outcomes and how to study this module

The overall purpose of providing this case study is to familiarise you with one of the fundamentals of life – water – which is being affected by climate change. Water is of such importance, however, that it constitutes a complex subject in its own right, and this is how we present it here. A further important aim, therefore, is to provide a case study which is deliberately not written primarily from a climate change perspective (although it contains sections about the impact of climate change), but to which you can apply the insights you have gained through studying the modules from that perspective. This 'retro-fitting' of a climate change perspective to other, ongoing challenges such as water, is an important generic skill, and helps give you an appreciation of the broader picture. One thing we do not wish to do is present climate change as just another subject or 'discipline' within which you become locked. You should be prepared to conduct dialogues with those whose starting point is different but who also share many of your concerns.

Water and food are the two most important basic human needs. They are strongly affected by climatic variability and trends (IPCC, 2007) and the ensuing effects on water stress and food production. The lived experience of climate change consequently relates strongly to the impacts of changes in precipitation, temperature and evaporation on water systems and agriculture. Given that the impacts on agriculture are primordially related to water availability (in the soil or for irrigation), it becomes clear that the impacts of climate change on water are very important to our societies, and will become more so in the future.

Many experts warn that, in the future, water crises might become much more critical than energy crises or other societal problems. This is not only because of climate change but also population growth, economic growth and related increases in welfare and urbanisation. These changes are in general greatest in developing countries. Water (including its role in developing countries) therefore has been selected as a cross-cutting case study for the three Lived experiences of climate change modules.

Two river basins, the Nile in the global South (developing countries) and the Rhine in the global North (developed countries), are chosen for this case study. These cases will help you understand how people in different countries have adapted to changes in climate in the past and are currently adapting. At the end of the individual river case studies you will find general conclusions with some guidelines on how to study the water case.

Learning outcomes

After studying *The water case study* you should be able to:

- Describe the characteristics of the Nile and Rhine basins and their geographical locations.
- Communicate appropriate insights on water-related problems of the basin from environmental, socio-economic, meteorological, hydrological, institutional, and political points of view.
- Discuss climate and climate impacts in relation to the water sector
- Compare and contrast scientific results on climate change trends in recent years and future projections
- Analyse and discuss how populations in the past were able to adapt to changing climatic conditions in relation to water
- Analyse the general role of water management and technologies in adapting to climate change impacts and the role that dynamic water management strategies will play in the future

- Participate in a learning community of people with a wide range of professional or disciplinary backgrounds, different socio-cultural and physical environments who possess a variety of perspectives and methodological traditions.

Work load

In total the *water case study* will require about 25 hours of study time, if you work through it systematically as a separate module.

Introduction	1 hr
Nile case	11 hrs
Rhine case	11 hrs
Conclusion	2 hrs

Note that for active participation, we have included exercises within the case study, although there is no separate workbook. These exercises are part of the materials to be studied, and are included in the total workload for the case study.

The module workbooks, however, include specific activities which ask you to apply what you are learning to the water case study. The timings for these activities are part of the overall time for the module in which they appear. If you use the workbook activities to ‘lead’ you and you therefore read the water case study on a ‘need to know’ basis, the above study time does not apply as it is incorporated within these activities.

How to study this module

Unlike the teaching modules in this series, *The water case study* consists of a single ‘textbook’ comprising a central narrative about the subject, but within which exercises are embedded in order to foster your active participation (see above). We recommend that you do not neglect these exercises. Your sense of overall satisfaction with the case study is likely to be greater if you engage with them.

How in practice might you combine the *water case study* with your study of the three modules, bearing in mind that a major aim is for you to apply the principles and concepts within the modules to this case study? You should choose the method which best suits your own learning style, but one good way is to:

Read the narrative in the rest of this *water case study* and do the exercises along the way, so that you gain an overall insight into it.

Do the module workbook activities that relate directly to the case study. You may also find that your attempt at other module workbook activities can draw on it.

In other words you first read the case study as a resource in its own right in order to gain an insight into the ‘water’ perspective. Then you apply your study of the climate change modules to it, which is your primary perspective.

1 Introduction

Water is a unique natural resource important to meeting human needs and vital to the existence of life on earth. However, water resources are limited and unevenly distributed in time and space and our globe thus faces many challenges in relation to it. Primarily the demand on water resources is increasing rapidly as population and economic activity expand all over the world. Both the quality and quantity of water represent important challenges. Human activities such as deforestation, agriculture, urbanisation, pollutants in both surface and sub-surface water bodies and so on, all influence the timing and quantities of flows and are having a huge impact on the quality and quantity of freshwater (UNESCO, 2006). In addition, environmental issues, such as climate change and land use change, alter the quantity and quality of the resource. Furthermore, pressure on water resources is aggravated by higher demands for food security and socio-economic well-being by all of society as well as increased competition between different users and different uses to which water is put (UNESCO, 2006).

To obtain a fair, equitable and sustainable distribution of water in a specific basin, water management practices are imperative. These management practices should be able to synchronise the management of water quantity and quality, and life in the water environment. Thus it signifies the importance of implementing Integrated Water Resources Management (IWRM - see Box 1.1) strategies. Nevertheless, there are many influences on IWRM strategies and practices. Some examples are listed below:

- Access to reliable data concerning the quality, quantity and availability of water resources.
- Dynamic ecosystems and impacts of anthropogenic activities on these
- Water conflicts in international river basins concerning water sharing
- Socio-economic conditions of the countries/people who are using the water
- The existence of water resource institutions at basin level and their performance
- Uncertainty of the future in terms of climate change scenarios
- Opportunities for stakeholder participation in management decisions and policy formulation
- Risk and uncertainty

These and other factors can complicate water management practices and imply the need for an interdisciplinary and integrated approach. Climate change, as one of the current challenges facing the management of water resources, needs to be addressed using such an approach. Many aspects of climate have an impact on physical and biological systems. These aspects include temperature and precipitation, and their variability on all timescales, from days to the seasonal cycles to inter-annual variations (IPCC, 2007) and they will in turn have impacts on the environment, ecosystems, water resources and many aspects of human life.

One of the most important and immediate effects of climate change would be changes in local and regional water availability, since the climate system is interactive with the hydrological cycle (see Box 1.2) (Jiang et al., 2007). Such hydrological changes will affect nearly every aspect of human well-being, from agricultural productivity and energy use to flood control, municipal and industrial water supply, and fish and wildlife management (Xu, 1999).

Since the effects of climate change are certain to be felt in several sectors, it is important to formulate adaptation strategies either to live with the changes or to prevent potential damage. According to Smit and Pilifosova, (2001), adaptation is adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climatic change and variability. Adaptation strategies are likely to be river basin-specific according to the type and severity of the problem, and the capacity and sensitivity of the regions.

Even though climate change is real, its impacts are highly uncertain. The uncertainties in climate change emerge primarily from the fact that it is impossible to test the impact experimentally before the facts arise. Climate change projections are therefore based on different assumptions about temperature rise and so forth which then generate possible scenarios (see Module 1 Chapter 2 on climate models). The Intergovernmental Panel on Climate Change (IPCC) has identified a number of possible greenhouse gas emission projections that have led to different scenarios. All these scenarios have been designated as equally valid, with no assigned probabilities of occurrence. Secondly, different parameterization[1] schemes are used in the different climate models. Therefore, the projections we get from these various climate models will not be the same. As a result, our decisions will be challenged in terms of which projected impact we use as a basis for policy formulation. As all scenarios are equally valid, much uncertainty surrounds the results of climate change impact projection and also in the mitigation and adaptation measures that have to be taken.

Additional examples of causes of uncertainty in future climate projections include: possible changes in demography, social and economic status, the future mix of energy sources, the limited physical knowledge on climate and water system responses (climate and impact models) and future greenhouse gas emissions. Considering these and other sources of uncertainties, governments and other responsible institutes need to design/develop new types of management strategies that are flexible (adaptable) and which allow changes to be made (with minimal total cost) depending on the future evolution of our climate.

As mentioned above, the uncertainties in climate change projection are large. However, decision makers should not be deceived by lack of scientific certainty from taking appropriate measures. The question is how to deal with the risks, and how to adapt to uncertain future change. Do we want to take the risk, and adopt a wait-and-see policy? Or should we adopt the ‘precautionary principle’, meaning that, in cases of threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation?. The precautionary principle thus favours a ‘prevention is better than cure’ approach. What the preferred approach in water management will be depends on the views of experts and stakeholders on the future risks and uncertainties. One way to deal with this is to involve stakeholders, experts and decision makers in participatory approaches to identify appropriate management strategies.

The argument of this case study is that water resources management should follow a holistic approach to obtain a sustainable result. For this purpose we argue that inclusion of all stakeholders is important in making assessments. A stakeholder is somebody with a ‘stake’, i.e. an interest, in the water management issue at hand. Stakeholders in the context of water resources management can be defined as all individuals, groups, organisations and governmental agencies that use the particular water resource to meet their needs. For instance, when there is a decision to be made in a locality about the treatment of industrial waste water, different stakeholders – for example industries, municipalities, environmentalists – are involved, with different concerns and interests. In

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[1] Parameterization – in climate change models refers to the method of replacing processes that are too small-scale or complex to be physically represented in the model by a simplified process. See also Module 1 Chapter 2, while Module 3 Chapter 3 (Box 3.3) provides a generalized definition in terms of the ways in which parameterization is a process of constructing boundaries around complex phenomena through what we choose to consider and measure.

the context of climate change adaptation these stakeholders can provide useful information. Generally, the main role of stakeholders in the adaptation process is to share their views, knowledge and resources in order to find reliable solutions and to formulate relevant polices. Finally we argue that development plans or policies are likely to be sustainable if they have involved the capacity and knowledge of a range of stakeholders.

Box 1.1 Integrated Water Resources Management (IWRM)

According to Global Water Partnership (a network established by the World Bank and United Nations Development Programme in 1996), Integrated Water Resources Management (IWRM) is the coordinated development and management of water, land and related resources in order to maximise economic and social welfare without compromising the sustainability of ecosystems and the environment.

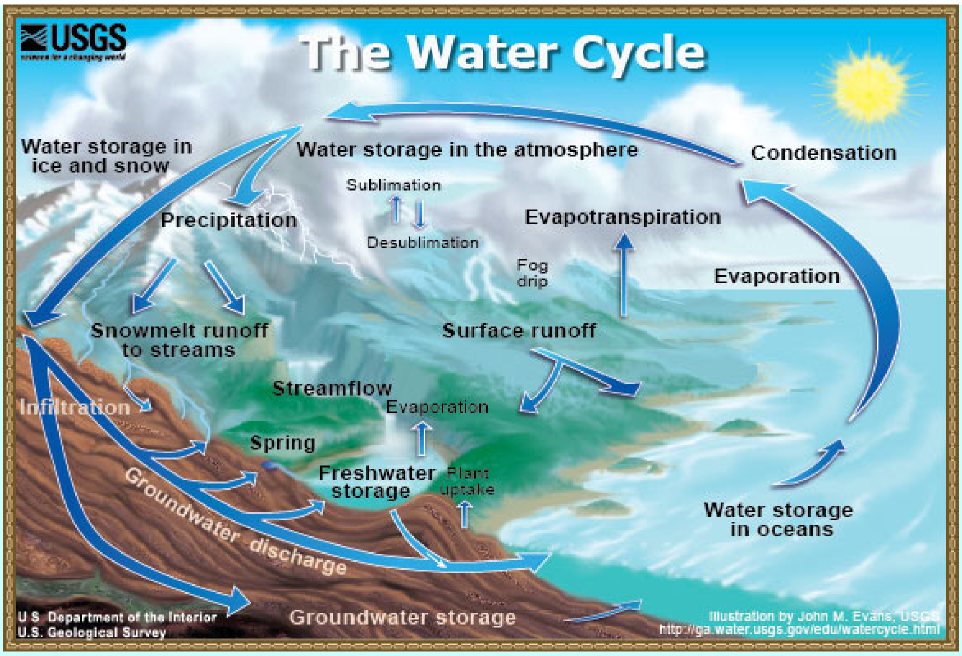
IWRM helps to protect the world's environment, foster economic growth and sustainable agricultural development, promote democratic participation in governance, and improve human health. Worldwide, water policy and management are beginning to reflect the fundamentally interconnected nature of hydrological resources, and IWRM is emerging as an accepted alternative to the sector-by-sector, top-down management style that has dominated in the past.

More information: http://www.gwp.org/The-Challenge/What-is-IWRM/

Box 1. 2 The Hydrological Cycle (The Water Cycle)

The hydrological cycle refers to the continuous movement of water on, in and above the earth in different states, that is from liquid to vapour to solid and back again. This process is driven by the energy from the sun. The hydrological cycle is therefore a continuous process that includes sub-processes where water can be stored in various forms. The figure below illustrates the different components and their interconnections. Some of the terms that appear in the Figure are:

- Evaporation – the transformation of water from a liquid into a gas, a process which humidifies the atmosphere.
- Evapotranspiration – a process that combines two separate processes whereby water is lost from the soil surface by evaporation and from plants by transpiration
- Condensation – the transformation of water from a gas into a liquid
- Precipitation – the transfer of water from the atmosphere to land surface or water bodies, which can be in different forms: rain, hail, snow, and sleet.
- Streamflow – the movement of water in a natural channel, such as in rivers
- Surface runoff – the amount of precipitation that flows over the soil surface and runs into the nearest stream channel
- Infiltration – the downward movement of water from the land surface into soil or porous rock
- Groundwater storage – water existing for long periods below the earth's surface



Source: http://ga.water.usgs.gov/edu/graphics/watercyclesummary.jpg