Prepared for climate change in the Rhine basin?

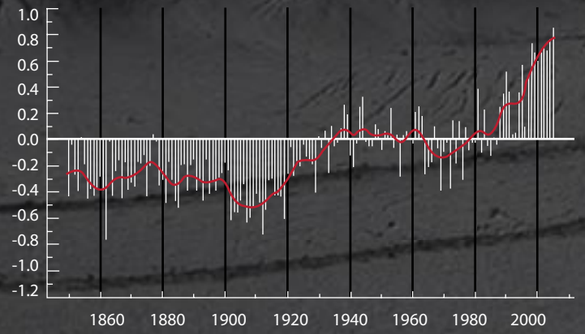
KHR
CHR

Starting position

According to the records of the WMO member countries the mean global air temperature for 2005 was 0.47-0.58°C higher than the average annual temperature of 14°C recorded in the time series of 1961-1990. With the exception of the years 1996 and 2000 the last ten years, 1996-2005, were globally the warmest years since systematic monitoring started in 1850. The European Environment Agency reports that Europe has not experienced such climate change for 5000 years. According to the latest information, global warming will continue in the future and as a result the hydrological cycle is expected to intensify.

Climate change cannot be stopped. But we can prepare ourselves for the consequences. Climate change leads not only to higher temperatures, but also to changes in precipitation both in summer and in winter. The International Commission for the Hydrology of the Rhine Basin (CHR) has in the past often concerned itself with the subject of climate change and its impact on water resources. The rising trend of principal climate variables such as temperature requires a new assessment of the consequences and risks for water resources management.

Northern Hemisphere Temperatures 2005



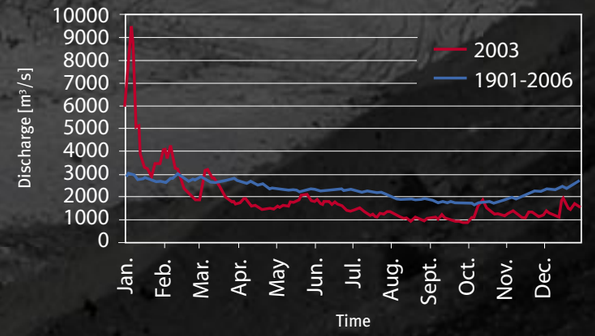
Annual anomalies of northern hemispheric average land-surface air temperature in °C relative to 1961 - 1990
Source: WMO, 2006

Piz Bernina with Morteratsch and Pers glacier
Graubünden, Switzerland. Summer 2004.
Source: Max Maisch
Geographical Institute of the University Zurich

Measures need to be taken ... to be on the safe side

The Rhine river basin will in future probably be affected more often by extreme discharge events. This requires additional measures to be taken in the fields of flood management and low flows. It will take much time and money to adjust the structural and non-structural measures and administrative approaches of a country to the changing environment. On the other hand, waiting for more certainty regarding the predicted changes could result in considerable economic damage and loss of life. Society benefits as a whole when water resources managers and planners take adaptive and precautionary measures in time. The CHR encourages the Rhine river basin countries to consider jointly the possible changes, consequences and risks, and to coordinate measures.

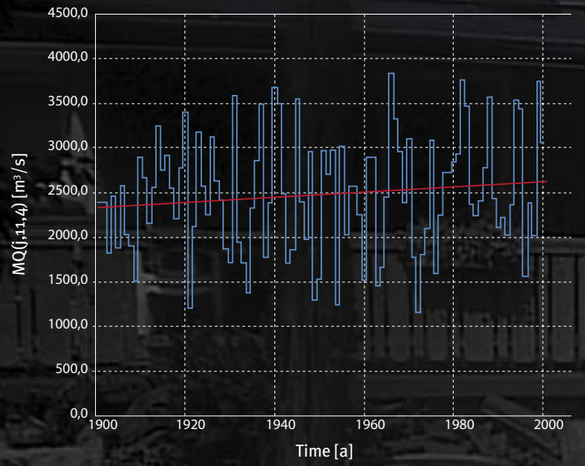
Gauge Lobith - Daily average of the discharge 2003



Gauge Lobith - Daily average of the discharge 2003 and averaged daily values of the discharge of the time series 1901-2006

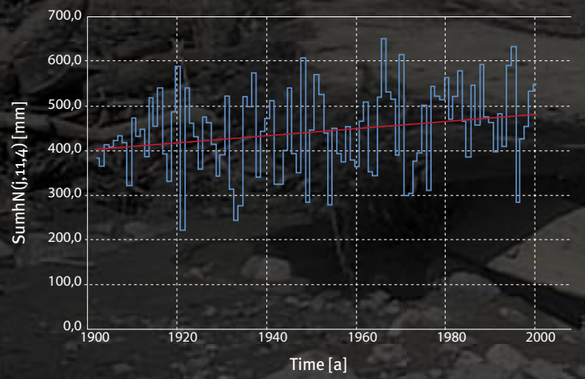
Gauge Lobith/Rhine, winter discharge

Trend calculation period 01-11-1900 – 30-04-2000



Gauge Lobith/Rhine, winter precipitation

Trend calculation period 01-11-1900 – 30-04-2000



Mean discharge of the River Rhine at the Dutch/German border as well as mean precipitation of the Rhine basin for hydrological winter half years of the last century, and linear trend lines. The mean winter discharge and the mean winter precipitation increased during the course of the century.

Mudflow damage in Sachseln, Switzerland
Source: Office for forest and spatial planning Obwalden, Switzerland

Climate change in the catchment area

There are two ways of gaining information about climate change in the catchment area:

- retrospectively, by analysing how climate has behaved in the past
- projectively, by forecasting how climate will change in the future.

Although many uncertainties remain, both methods provide valuable indications concerning the trend and extent of possible change.

Review of the past century

For more than 100 years reliable water level and discharge measurements have been taken in the catchment area of the Rhine. In the project “Changes in the discharge regime of the Rhine“, the CHR has analysed long time series of measurements. Results show that the Rhine discharge at the German-Dutch border is gradually increasing in winter, while in summer it is decreasing. Precipitation in the catchment is also changing in the same way. Because of the high natural variability of climate in the basin area, it cannot be finally established whether these changes are predominantly the result of anthropogenic climate change. However, the observed trends of key climate variables are in line with climate change predictions.

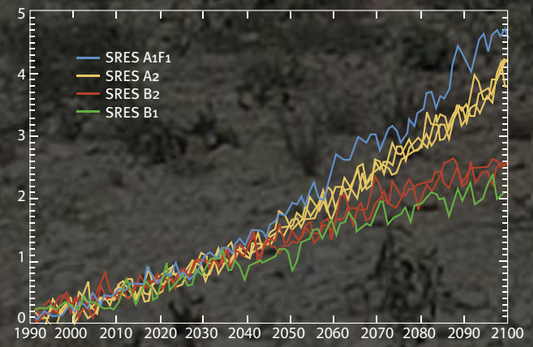
Forecast for the next few decades

Using state-of-the-art climate models, the Intergovernmental Panel on Climate Change (IPCC) has shown that air temperature will globally change depending on the emission of carbon dioxide. Various emission scenarios based on economic development and depending on the introduction of new energy sources and techniques were set up for the release of carbon dioxide. The scenario computations show that coupled with intensive economic development and increased carbon dioxide emission worldwide temperatures will rise by up to 5.8°C by the year 2100. However, even if the world manages to limit global warming to 2 °C, this will have far-reaching consequences for the

environment and society. Hence, the CHR is calling for countries not only to make efforts to reduce anthropogenic activities leading to climate change but also to plan and implement adaptive measures to minimise negative impacts of climate change.

The effects of worldwide climate change vary according to the region. Countries are therefore studying the IPCC global climate scenarios with regard to regional impact. One important finding is that the rise in temperature in the Alpine area is higher than in the estuary of the Rhine. Climate experts expect that the observed trend in rising temperature in the Rhine basin over the past 100 years will continue unabated. This will result in milder winters with more precipitation and higher river flows. The prospects for summer are less certain, but point to more frequent droughts and low flows of rivers in the Rhine basin.

Global rise in temperature (°C) based on four different IPCC climate scenarios



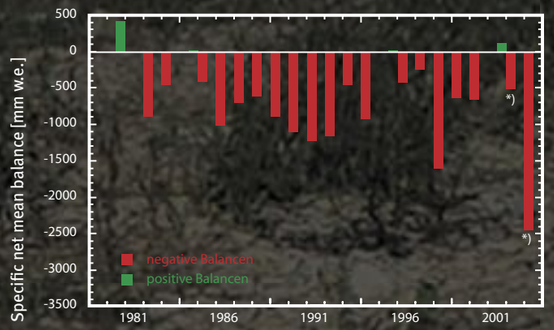
In climate scenarios for the 21st century the global rise in temperature will vary considerably depending on developments in world population, economy and technology.
Source: Hadley Center, technical note No. 44, November 2003

Drought in the River Thur
Source: Alluvial zones advice centre, Berne, Switzerland

Precautionary measures

The impact of wetter winters and drier summers can vary in the catchment area. In the Alps the risk of more frequent mudflows is increasing. The snow line is moving upwards, affecting winter tourism and hence the economic interests of the mountainous regions. The risk of river flooding is increasing. In summer navigation will be restricted more often by increased low flow frequency. This will cause high economic losses to inland navigation when river barges and passenger ships can travel only with reduced loads or must be kept in harbours. The dry period of 2003 clearly demonstrated these impacts that will become more frequent in a changing climate. In the Rhine estuary the sea may penetrate further inland, leading to groundwater and surface water salinisation. The warming of river water in summer significantly restricts its use as a coolant for power plants and affects the quality and biocenosis of the water bodies. The quantity of drinking water available may decrease. To mitigate these impacts, adequate precautionary and adaptive measures need to be undertaken foremost in the context of basin-oriented integrated water resources management and regional planning.

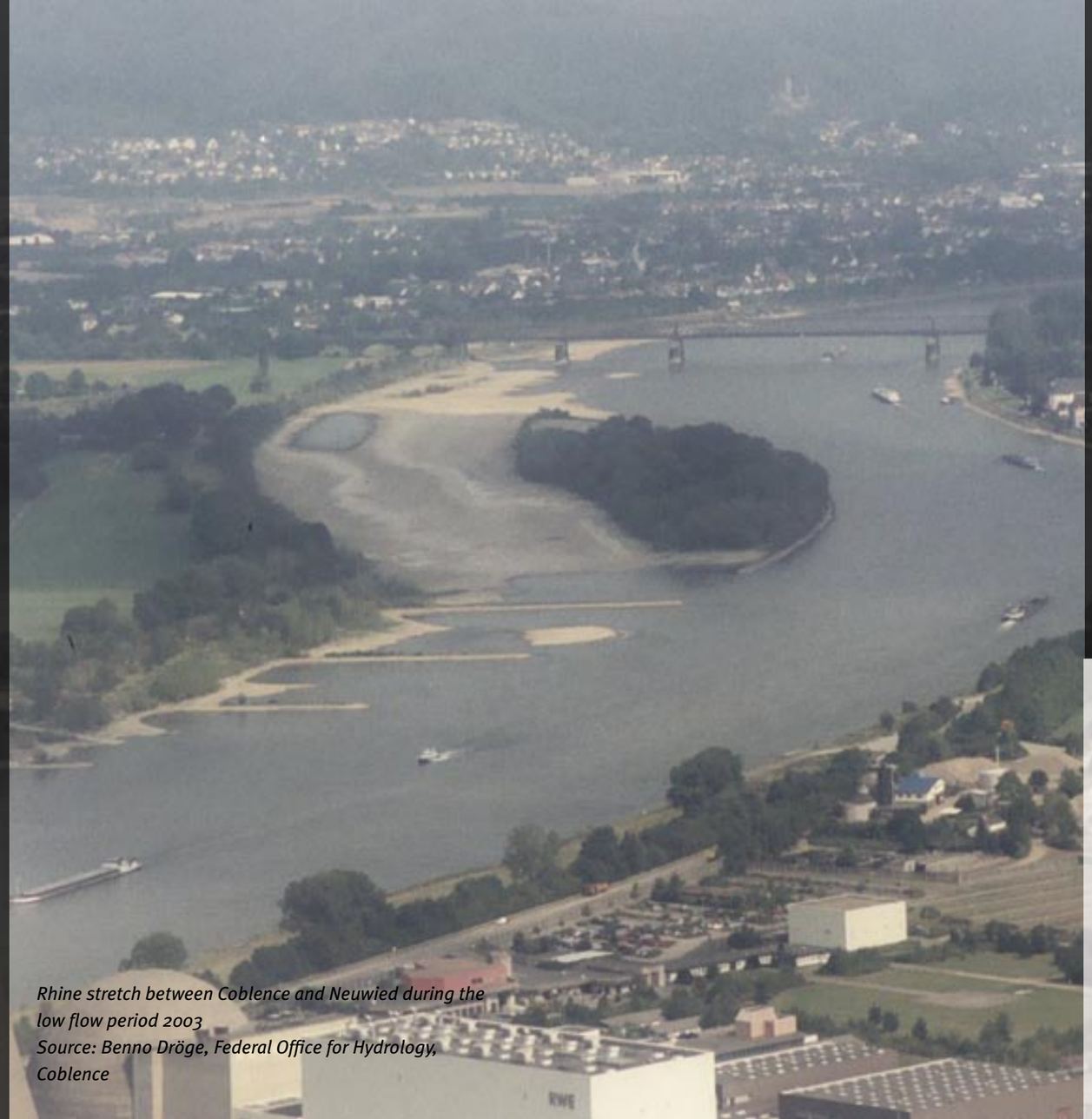
Glacier mass balance 1980-2003



The mass balance is calculated with the annual mass accumulation of nine alpine glaciers.
**) = 2002, 2003: incomplete sampling*
Source: Effects of the hot summer 2003 on water bodies. Publication series No. 369. Federal Office for Environment, Forest and Landscape, Berne

Examples of these measures are flood protection works such as the reinforcement of dykes, the establishment of polders and the development of detailed flood risk maps together with the resulting implementation of strict land use and building codes in flood prone areas. The implementation of such measures will take decades. Construction of the Delta Works in the Netherlands, for example, lasted nearly 50 years. The realisation of the planned flood retention basins in the upper Rhine valley is likely to take several more years, whereby it has to be remembered that these measures are being carried out to offset the intensification of flooding which has already occurred. Against the background of existing knowledge and experience, the CHR is of the opinion that now is the time to act so as to be prepared for the expected changes in discharge.
As climate projections and in particular possible regional effects are still associated with some uncertainty, it is difficult to find the preparedness to engage in costs-intensive investments. Recognising the observed positive trends of global warming and in view of the high probability that climate change will actually occur within the projected bands of uncertainty, the CHR promotes two generic options to address the framework of precautionary and adaptive measures: no-regret measures and a policy of flexible adaptation and response in politics and public administration.

• No-regret measures
In water resources management and regional planning various measures are conceivable that could be implemented effectively and with little financial investment. Measures to deal with water shortages in summer could be the well-directed seepage of rainwater in the catchment area, the more sparing use of water for drinking and domestic use, or regional drinking water transfers. The strict application of legal regulations for the use of flood plains would serve to protect against flooding. Contingency plans and disaster management limit the risk of victims and damage at times of flooding and drought.



Rhine stretch between Coblence and Neuwied during the low flow period 2003
Source: Benno Dröge, Federal Office for Hydrology, Coblence

• Flexibility in politics and administration
As the impacts of climate change are not clearly defined, it is important that administration and management agencies are able to adjust their strategies as new findings emerge. Regular assessments are essential. Also the implementation of measures should allow for flexibility.

Hence it should be possible to enlarge retention areas, strengthen flood protection works and at the same time reactivate old river plains to allow flooding. In parallel, measures should be implemented to prevent the siting, in those delineated areas, of infrastructure that may be damaged or pose a risk, such as industries that could emit pollutants in case of floods. In view of the expected changes in hydrometeorological extremes, design practices should be reviewed. Approaches such as those mentioned above contribute in de medium and long term to the reduction of costs compared to costs arising from merely responsive measures.

The dry, warm summer of 2003 caused the most varied problems in Switzerland. Glaciers reacted with record melting, the melting of permafrost caused increased incidence of rockfalls and the low levels of water led to conflicts of interest about its use. Switzerland is expecting more dry, warm summers in the future and has therefore initiated various precautionary measures. A website with information on how to restrict health hazards during heat waves has been set up. The meteorological services will issue timely heat wave warnings. The network of drinking water supplies will be improved. The risk of mudflows, rockfalls and landslides, which could occur due to melting permafrost, are to be recorded on maps.

Initial results of regional climate modelling show that considerable warming, up to +2°C, in the winter half of the year can occur. This means an increase of precipitation in winter. Therefore, some German states are proposing that climate change, i.e. higher runoffs, be taken into account as from now on in the planning of flood management measures. A climate-related allowance of, for example, 15% on the design discharges is suggested for the dimensioning of new dykes or retention measures. The reservation of space for future dyke fortification has also been considered. In future, an increase of the freeboard for local flood retention basins is to be considered already at the planning stage. Regarding the supply of drinking water during periods of drought, regional transfers will compensate for deficits. Also, measures to raise public awareness are indispensable. It is also necessary to provide risk-qualified messages to the planners and the public including information on the risks associated with living behind flood protection works.

The Netherlands are expecting the rivers Rhine and Meuse to discharge considerably more water in the coming 50 to 100 years. Studies have been carried out on the availability of additional space along these rivers for the diminution of extreme flood waves. A regional planning procedure has been established in order to be able to use these areas in future as flood plains. Definite measures in the Rhine basin are planned to the amount of ca 2 billion Euros.

Lowering of flood plains of the Nederrijn in the project "Room for the River"
Source: Rijkswaterstaat - RIZA

Joint course of action in the catchment area

Climate change affects the water balance and the runoff rates in the Rhine river basin. It is considered necessary that the countries in the catchment area develop a joint risk-related strategy to direct measures for the mitigation of the impact of climate changes in the right channels. This is only possible if scientists and decision-makers develop a joint agenda on the development of the climate and its impact on the water balance. It is also important to determine how the socio-economic boundary conditions change. The CHR argues for a joint database to provide information on the past, present and scenario-based future water balance in the catchment area of the Rhine.

Source: CHR /KHR

Editorial

This brochure has been compiled by the International Commission for the Hydrology of the Rhine Basin (CHR). The CHR's mission is to foster knowledge about the hydrology of the Rhine river basin and to contribute to the solution of transboundary hydrological problems. The information in this brochure is based on the CHR workshop "Climate changes and their effect on hydrology and water management in the Rhine basin". Further information on the aims and work of the CHR can be found on www.chr-khr.org. Should you have any queries, please contact:

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