OVERVIEW OF CHR PROJECTS FROM THE PAST

Dr. Wolfgang E. Grabs

HISTORY OF CHR

- Founded in 1970 within the framework of the International Hydrological Decade of UNESCO
- Co-operation on the basis of a memorandum of understanding ('Note Verbale') between the Ministries of Foreign Affairs of the member states
- Member states of the CHR are: Switzerland, Austria, Germany, France, Luxembourg and the Netherlands.
- Since 1975 co-operation in the framework of the International Hydrological Program (IHP) of UNESCO and the Hydrology and Water Resources Program (HWRP) of WMO

MISSION AND TASKS

- Extension of knowledge about the hydrology of the Rhine basin
- Contribution to solving cross-border hydrological problems
- CHR initiates and carries out hydrological studies for sustainable development of the Rhine basin and makes the results of these studies available to responsible authorities in the Rhine riparian states and to the EU. This way CHR tries to contribute to the development and evaluation of water management strategies.

CO-OPERATING INSTITUTES

- Switzerland
  - Federal Office for the Environment (FOEN), Berne
- Austria
  - Hydrological Bureau, Vienna
  - Hydrological Service of the federal state Vorarlberg, Bregenz
- Germany
  - Federal Institute of Hydrology (BfG), Koblenz
  - German National IHP/HWRP Committee, Koblenz
  - State Institute for Environment and Geology of the federal state Hessen, Wiesbaden
- France
  - IRSTEA, Paris
  - IFSTTAR, Nantes
- Luxembourg
  - National Water Management Service, Esch-sur-Alzette
- Netherlands
  - Rijkswaterstaat, Lelystad
  - Deltares, Delft

Development of the Knowledge Base

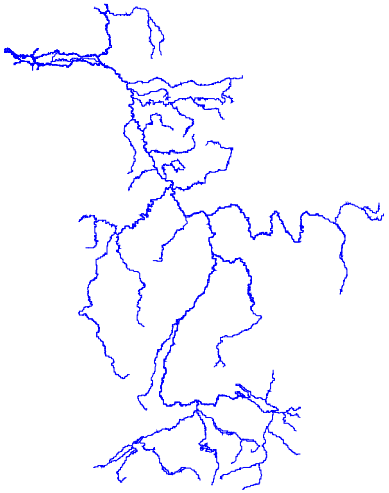
Over the past decades, CHR through its projects, workshops and scientific endeavors developed a huge knowledge base for use of all members and beyond.

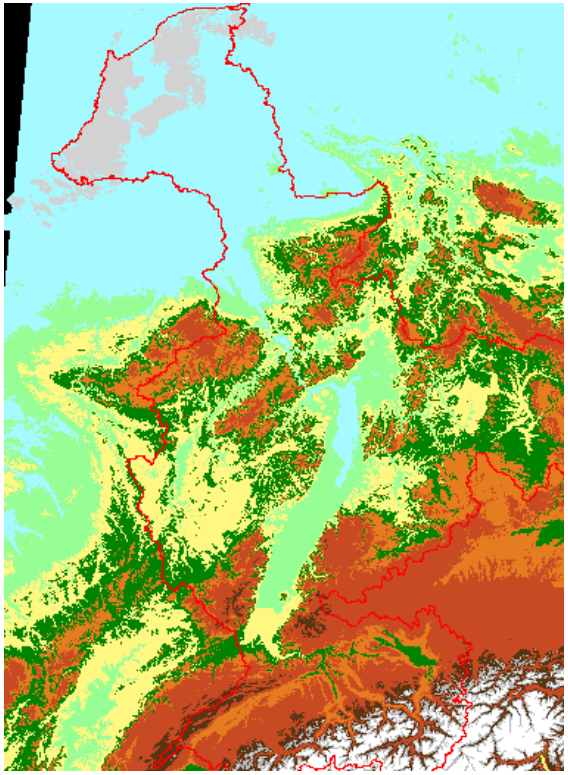
The planning and implementation of projects required the development of joint data bases a common GIS tool and the development of standard modeling tools amongst others.

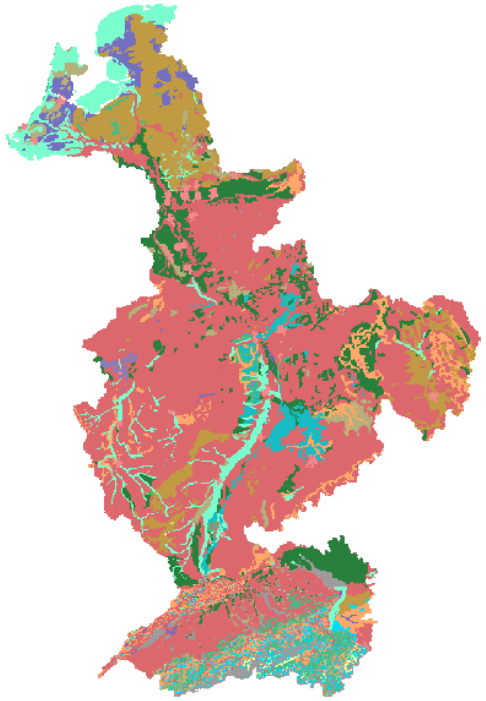
Development of tools :The results of the “Integrated Overview on the effects of socio-economic scenarios on the discharge of the Rhine river” triggered the wish to further develop models and to further develop a planning tool for the exploration of scenarios.

The tool can then be used to simulate the response of the Rhine Basin to changes in climate, economic developments, water management and more.

GEOGRAPHICAL INFORMATION SYSTEM (GIS)





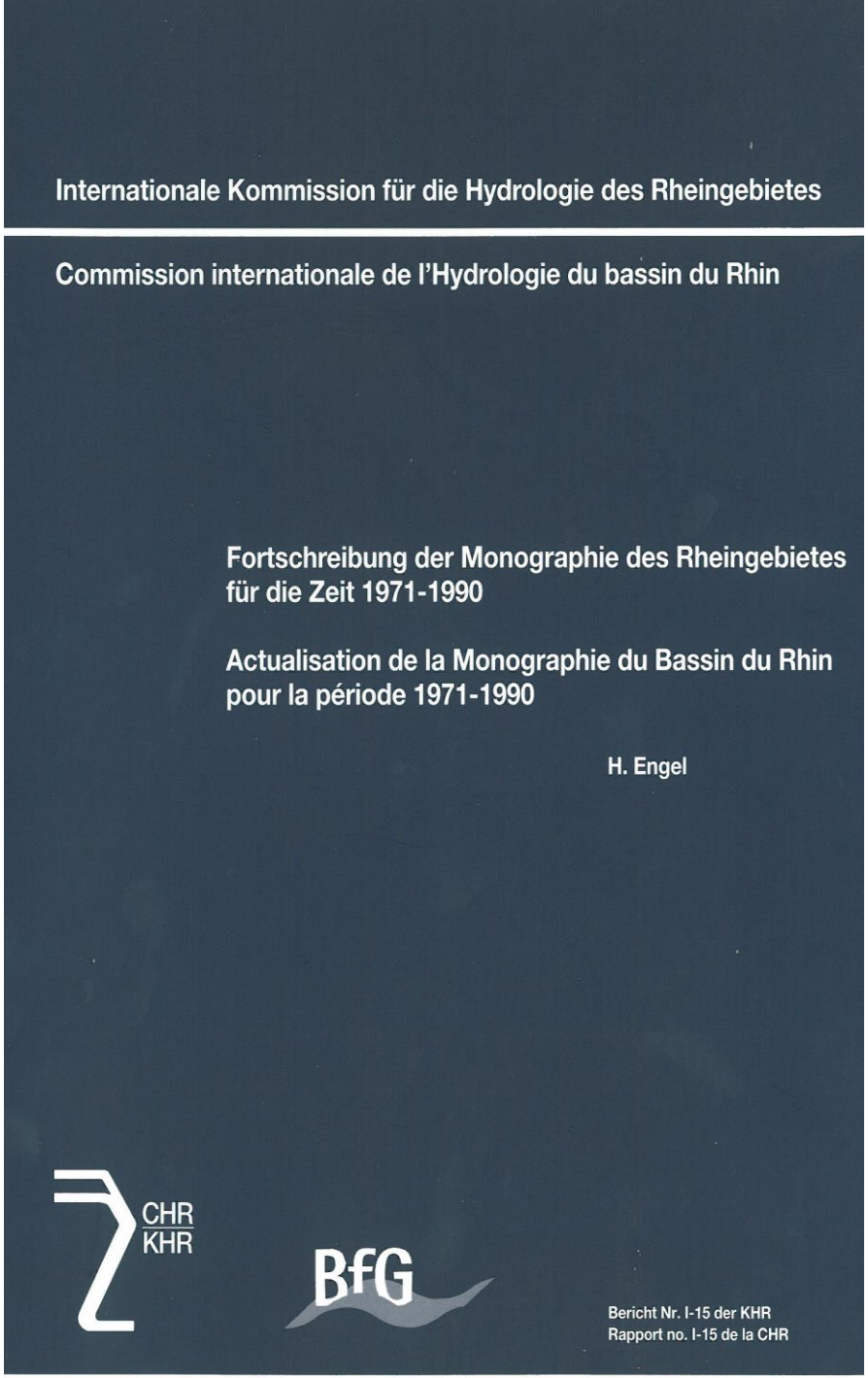


Station_ID	Date	Quality le	Coverage (	Rel humidi	Vapour pre	Air temper	Air pressu	Windspee	Air tempe	Air temper	Air temper	windspee	Precipitati	Precipitati	Sun shine	Snow heig	eor
282	19490101	5	8.0	62.00	4.8	3.8	-999	-999	.3	.2	6.0	-999	1	.0	-999	0	eor
282	19490102	5	8.0	86.00	6.4	2.7	-999	-999	1.1	1.7	5.9	-999	8	8.2	-999	0	eor
282	19490103	5	6.7	86.00	6.4	2.7	-999	-999	-.3	1.3	4.7	-999	0	.0	-999	0	eor
282	19490104	5	5.0	82.00	5.6	1.8	-999	-999	-2.3	-.7	5.3	-999	0	.0	-999	0	eor
282	19490105	5	8.0	85.00	6.4	2.6	-999	-999	-.3	1.7	4.0	-999	1	.0	-999	0	eor
282	19490106	5	8.0	95.00	6.4	1.2	-999	-999	.3	.6	2.5	-999	0	.0	-999	0	eor
282	19490107	5	8.0	91.00	5.1	-1.5	-999	-999	-1.3	-1.7	.6	-999	0	.0	-999	0	eor
282	19490108	5	8.0	94.00	5.2	-1.2	-999	-999	-2.1	-2.1	-.5	-999	8	.1	-999	0	eor
282	19490109	5	7.3	84.00	5.5	.6	-999	-999	-1.4	-1.0	2.1	-999	7	2.2	-999	1	eor
282	19490110	5	7.0	87.00	3.7	-4.5	-999	-999	-11.5	-10.5	1.0	-999	0	.0	-999	3	eor
282	19490111	5	8.0	88.00	4.3	-3.2	-999	-999	-7.5	-5.3	-2.4	-999	7	3.0	-999	2	eor
282	19490112	5	6.0	92.00	6.0	.8	-999	-999	-6.5	-3.6	2.2	-999	7	.5	-999	6	eor
282	19490113	5	7.3	83.00	5.2	.2	-999	-999	-4.9	-1.8	2.1	-999	0	.0	-999	6	eor
282	19490114	5	8.0	89.00	5.9	1.2	-999	-999	-2.4	-1.5	2.0	-999	8	1.9	-999	5	eor
282	19490115	5	7.3	87.00	6.4	2.0	-999	-999	.7	.2	4.0	-999	7	.6	-999	4	eor
282	19490116	5	8.0	90.00	6.5	3.1	-999	-999	-8.7	-2.1	6.6	-999	1	4.6	-999	2	eor
282	19490117	5	8.0	93.00	7.9	4.6	-999	-999	-.8	3.1	5.5	-999	1	1.5	-999	1	eor
282	19490118	5	7.7	85.00	8.1	6.1	-999	-999	3.6	4.8	7.2	-999	1	.8	-999	0	eor
282	19490119	5	8.0	84.00	8.9	7.9	-999	-999	4.2	5.3	8.8	-999	0	.0	-999	0	eor
282	19490120	5	8.0	82.00	7.9	6.5	-999	-999	6.1	5.8	8.8	-999	1	.4	-999	0	eor
282	19490121	5	7.3	82.00	6.5	3.5	-999	-999	2.6	1.6	6.7	-999	8	2.3	-999	0	eor
282	19490122	5	4.0	88.00	6.0	1.1	-999	-999	.7	-.6	4.6	-999	8	.6	-999	0	eor
282	19490123	5	8.0	94.00	4.8	-2.3	-999	-999	-3.3	-3.5	.0	-999	0	.0	-999	0	eor
282	19490124	5	5.0	91.00	4.7	-2.4	-999	-999	-3.6	-3.4	.5	-999	0	.0	-999	0	eor
282	19490125	5	3.3	90.00	5.1	-1.0	-999	-999	-5.2	-5.0	3.8	-999	0	.0	-999	0	eor
282	19490126	5	1.3	81.00	4.3	-1.8	-999	-999	-7.8	-6.9	5.3	-999	0	.0	-999	0	eor
282	19490127	5	2.0	82.00	4.1	-2.4	-999	-999	-8.5	-7.6	3.5	-999	0	.0	-999	0	eor
282	19490128	5	3.3	87.00	4.4	-2.2	-999	-999	-8.1	-6.2	1.5	-999	0	.0	-999	0	eor
282	19490129	5	2.7	87.00	4.8	-1.5	-999	-999	-5.9	-5.4	5.0	-999	0	.0	-999	0	eor
282	19490130	5	7.3	96.00	4.7	-2.6	-999	-999	-6.6	-5.9	-.3	-999	8	.0	-999	0	eor
282	19490131	5	8.0	83.00	5.7	1.8	-999	-999	-3.3	-2.3	3.5	-999	8	1.0	-999	0	eor
282	19490201	5	4.3	79.00	3.9	-3.6	-999	-999	-3.8	-5.2	.8	-999	7	.9	-999	0	eor
282	19490202	5	5.3	82.00	2.9	-7.6	-999	-999	-12.3	-10.8	-2.3	-999	1	.0	-999	0	eor
282	19490203	5	.7	83.00	3.2	-5.8	-999	-999	-13.8	-13.0	-1.1	-999	0	.0	-999	0	eor
282	19490204	5	.3	84.00	3.3	-6.2	-999	-999	-12.5	-11.8	2.0	-999	0	.0	-999	0	eor
282	19490205	5	5.3	87.00	3.6	-4.7	-999	-999	-13.3	-12.8	-1.2	-999	0	.0	-999	0	eor
282	19490206	5	2.7	85.00	4.7	-2.0	-999	-999	-11.3	-4.8	3.0	-999	0	.0	-999	0	eor
282	19490207	5	6.0	94.00	3.9	-5.0	-999	-999	-11.7	-10.2	-2.5	-999	0	.0	-999	0	eor
282	19490208	5	6.3	84.00	5.9	2.2	-999	-999	-6.9	-5.6	6.3	-999	1	.3	-999	0	eor
282	19490209	5	8.0	88.00	8.5	7.2	-999	-999	.5	2.2	11.0	-999	1	8.4	-999	0	eor
282	19490210	5	5.7	78.00	5.9	2.8	-999	-999	.3	1.4	11.1	-999	8	1.2	-999	0	eor
282	19490211	5	2.3	85.00	5.5	.6	-999	-999	-1.5	-1.0	4.9	-999	0	.0	-999	0	eor
282	19490212	5	5.7	76.00	4.5	-.1	-999	-999	-2.7	-3.4	3.0	-999	0	.0	-999	0	eor
282	19490213	5	1.0	75.00	4.4	-.5	-999	-999	-4.1	-3.1	4.2	-999	0	.0	-999	0	eor

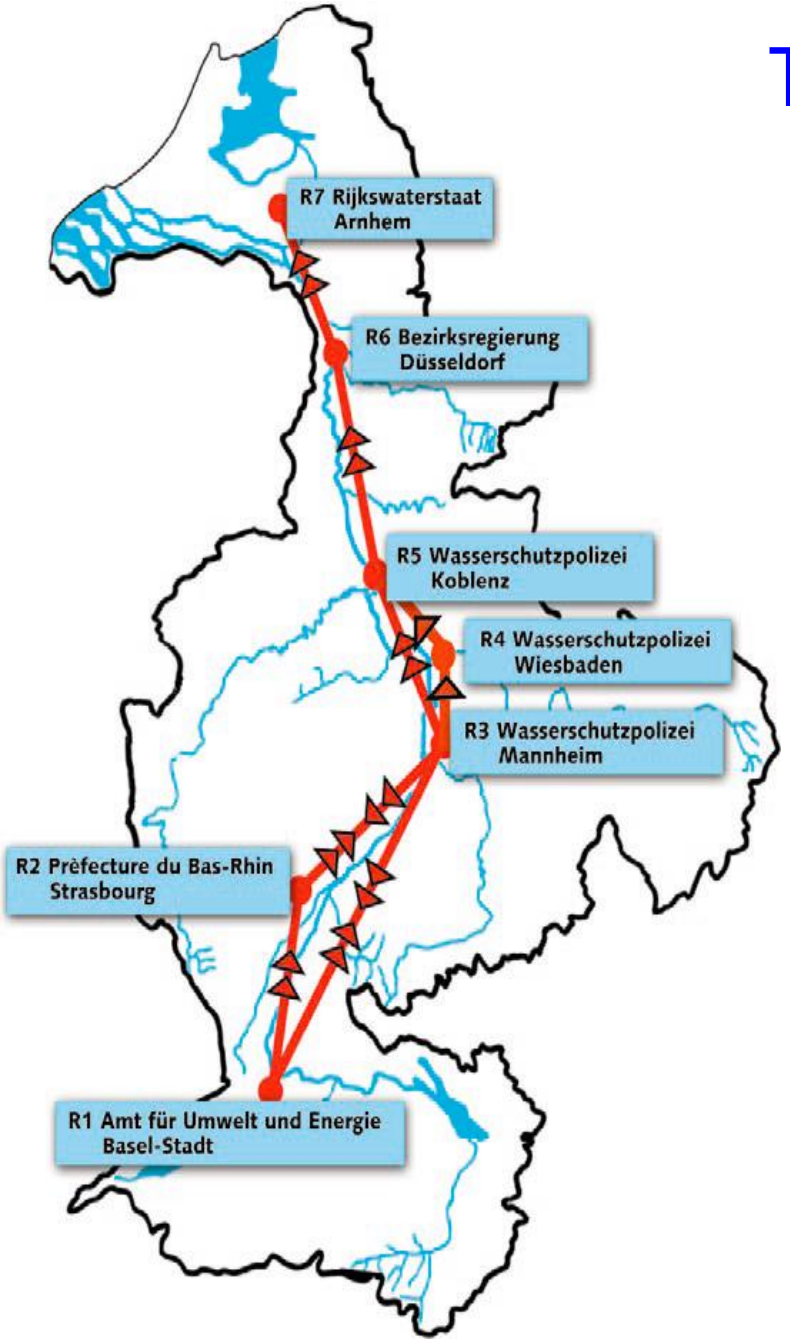
OVERVIEW OF PROJECTS

A true baseline project had been the Monograph of the Rhine Basin, published in 1978.

This project has been the first comprehensive compilation of data series, analyses and reports of the hydrology of the Rhine Basin and is considered as the first comprehensive study of this type in the basin.



The actualization of the Monograph of the Rhine Basin published in 1997, responded to the interest of CHR Members to have an insight into the dynamics of the hydrology of the Rhine Basin with regard to completed river works in that period and especially with regards to trends in runoff from selected gauging stations as well as observed trends in precipitation.



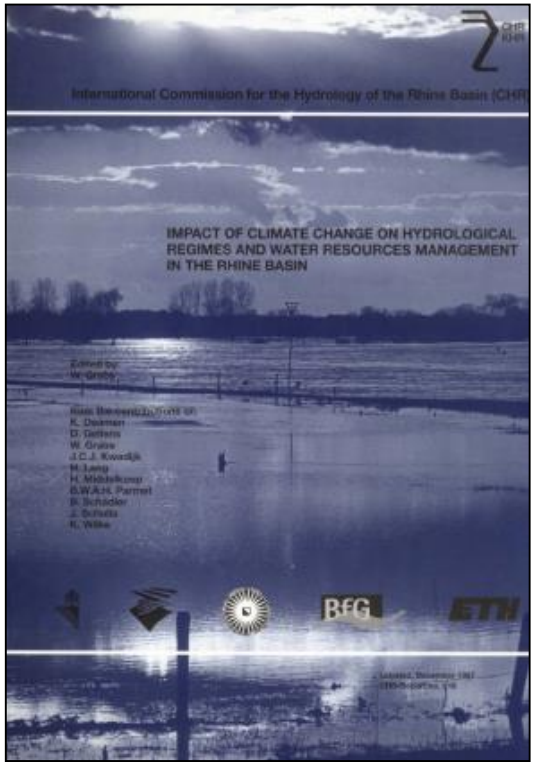
The Rhine Alarm Model

The ICPR and the CHR have jointly developed the Alarm model for the Rhine in about 1990, assigned by the 8th Rhine ministers' conference.

CHR is responsible for the management of the model and further technical development.

Climate Change Impact Studies on the Hydrology of the Rhine River

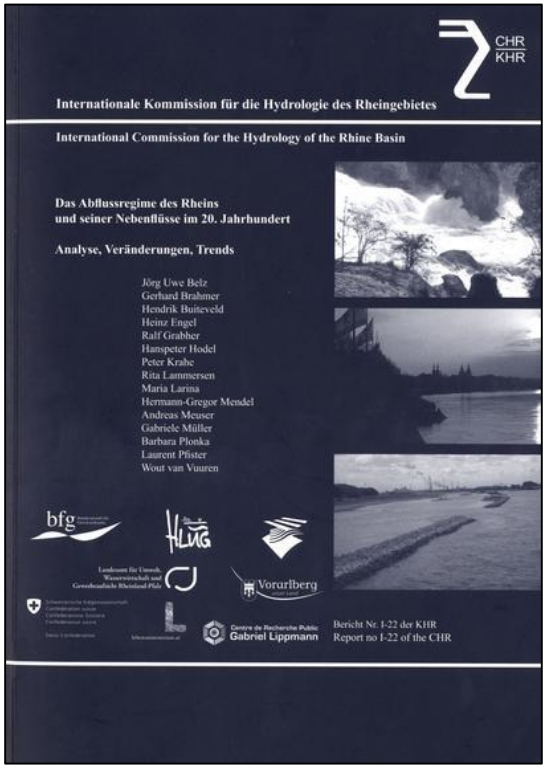
First CC impacts report



CHR report I-16
Grabs et al. (1996)

Impact of climate change on hydrological regimes and water resources management in the Rhine basin

Observed changes



CHR report I-22
Belz et al. (2007)

Das Abflussregime des Rheins und seiner Nebenflüsse im 20. Jahrhundert - Analyse, Veränderungen, Trends

Future changes /

CHR report I-23
Görgen et al. (2010)

Assessment of Climate Change Impacts on Discharge in the Rhine River Basin: Results of the RheinBlick2050 project

International Commission for the Hydrology of the Rhine Basin

CHR
KHR

RheinBlick2050

Assessment of regional climate change impacts on discharge in the Rhine River Basin – Overview

K. Görgen
Project Coordinator
CRP-GL / EVA / GEOSAT
Belvaux, Luxembourg
http://www.lippmann.lu

O. de Keizer

J. Beersma

H. Buiteveld
R. Lammersen

P. Krahe
M. Carambia
E. Nilson

C. Perrin

G. Brahmer

D. Volken

Motivation for the RheinBlick2050 Project

- **Regional climate change** does and will **modify hydrological processes** and the water balance and **discharge** in the Rhine River basin and its tributaries
- Decision makers need **suitable information** to develop adequate adaptation strategies

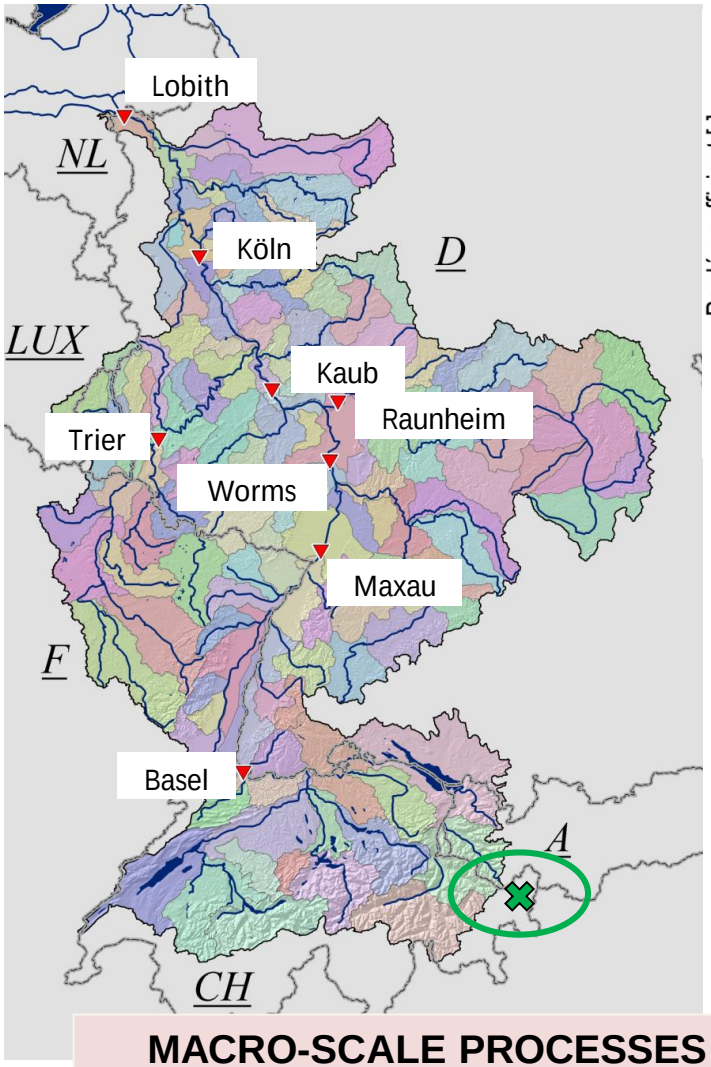
- The **CHR** has a coordinating role in hydrological research in the Rhine River catchments (joint research; exchange of data, methods, information; development of standardized procedures)
- Close linkage to and cooperation with the **ICPR / AG-H / EG Klima**; CHR specifically mentioned in ICPR′s tasks in Rhine ministers conference communiqué of 2007 under topic ″Climate change and its consequences″

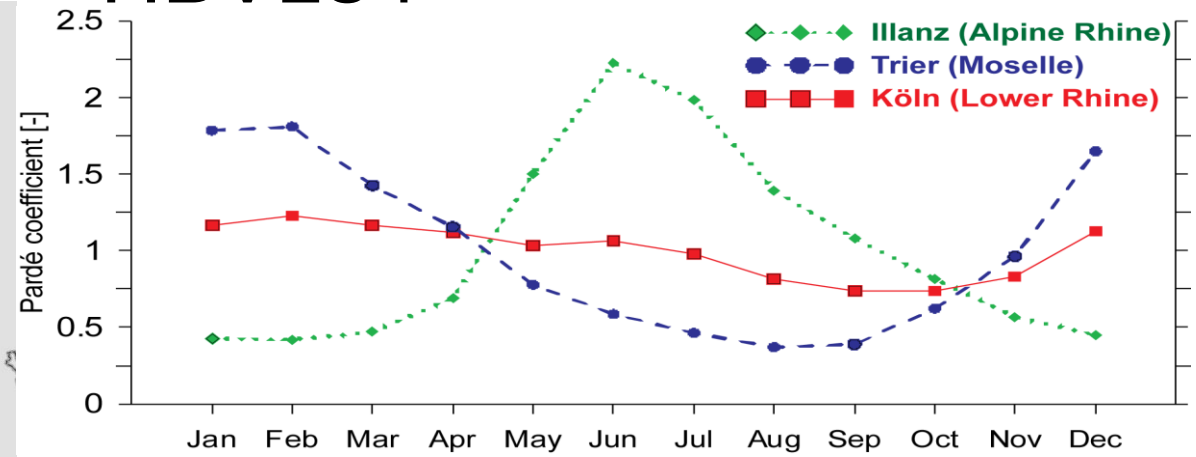
Project goals

- Overall objective: **Assessment of regional climate change impacts on discharge in the Rhine River basin** (“classical” hydrological impact study, no adaptation)
- Goals and results
  1. Development of a **common, consistent research framework** across participating countries (5) and institutions (8); “common” = agreement on suitability of data, methods, models; “consistent” = data and models available for the complete catchment
  2. Creation (acquisition, pre-processing, evaluation, bias-correction) of state-of-the-art **regional climate change projection ensemble** for analyses and as forcing data to hydrological models to generate **specific discharge projections***
  3. Compilation of partly heterogeneous** information into **applicable information (synchronized with stakeholders) and quantifiable statements** through **scenario bandwidths and tendencies** of future changes in meteorological and hydrological **key diagnostics** (mean, low and high flow statistics) for **time-spans up to 2050 and 2100**

Research framework

Study area and setup of hydrological model HBV134





- HBV hydrological model for discharge projections
- Version: HBV-96, implemented by BfG and RWS-WD to Rhine River catchment, daily time-step
- Semi-distributed, 134 model catchments (HBV134)
- Inputs: precipitation, air temperature, potential evapotranspiration
- Limitations (excerpt)
  - Linear description of base flow

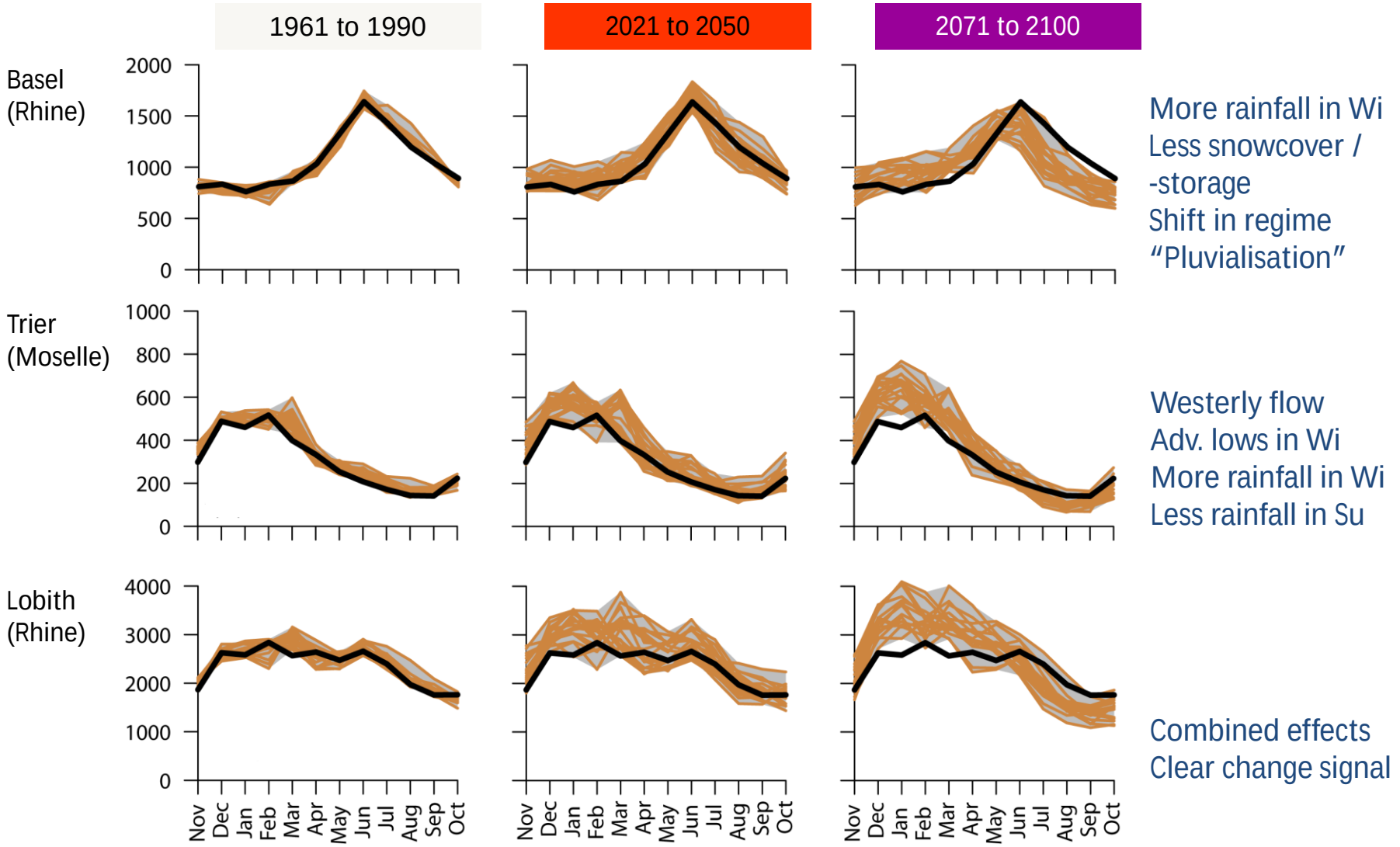
Flood routing, no hydraulic model, no overtopping of dikes

MACRO-SCALE PROCESSES → complimentary to small-scale projects

CC impacts – Mean flow changes

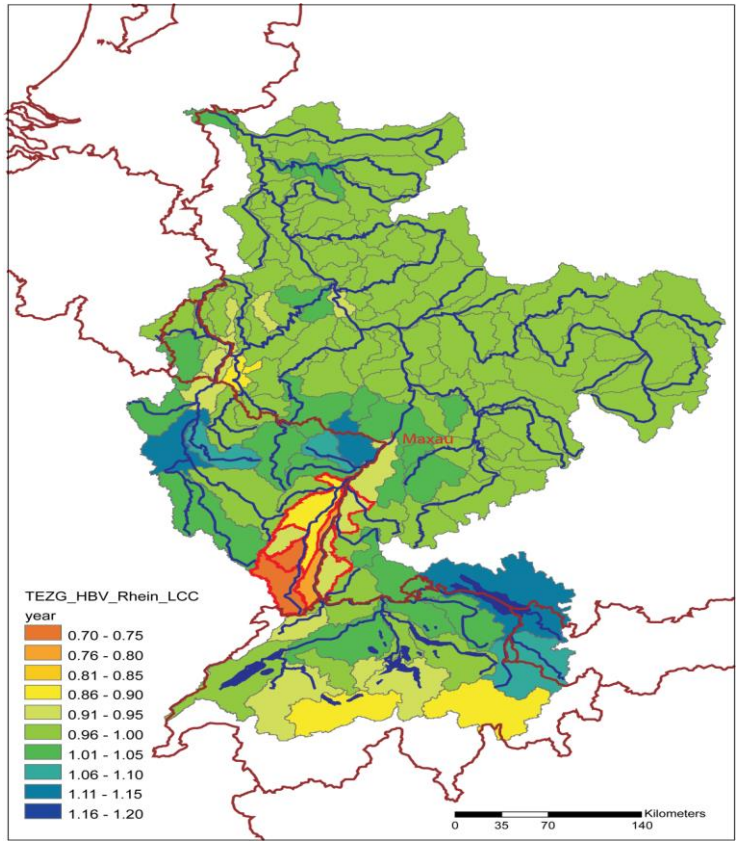
Modified discharge regimes throughout the basin

MQ [m³/s], 30-year long-term monthly mean discharge, annual cycles, Nov-Oct

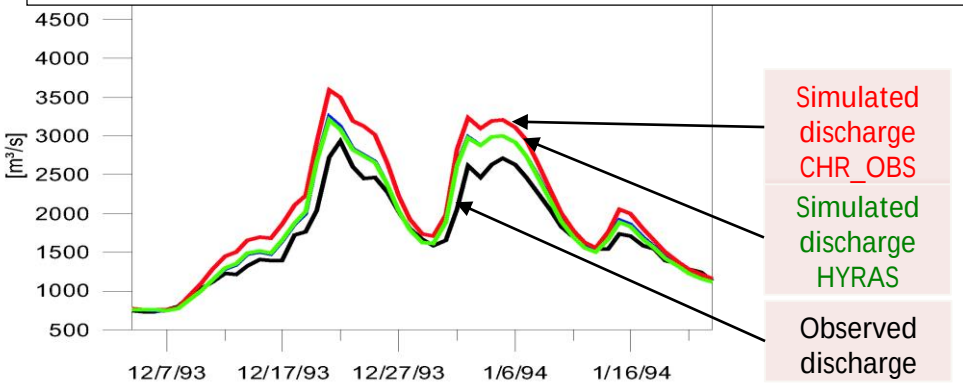


Lessons learned – Hydro-meteorological reference data makes a difference and has to be improved

Reference precipitation datasets intercomparison
HYRAS (KLIWAS) / CHR_OBS 30-yr long-term mean annual sums ratio (1961 to 90)



Effects of different hydrometeorological reference datasets on HBV134 discharge simulations, Q [m^3/s] daily, gauge MAXAU
Flood events 1993/94



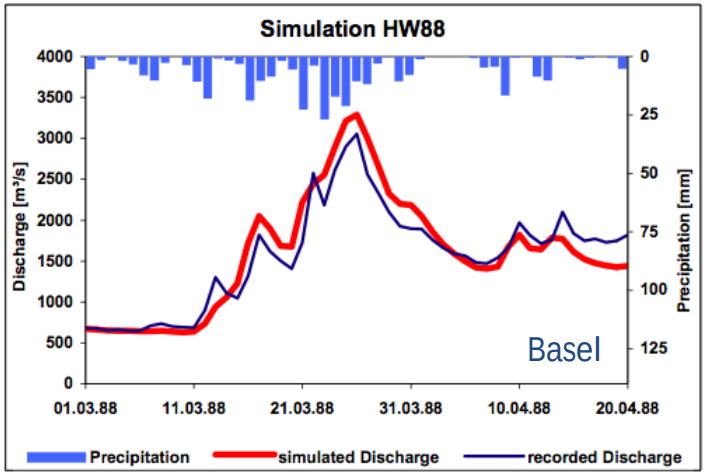
- **Hydrometeorological and discharge**
- **Needed for: bias correction, model calibration and development, statistical downscaling, validation experiments**
- **Deviation of different monitoring products from each other**
- **9 datasets listed in report**
- **New: HYRAS dataset**

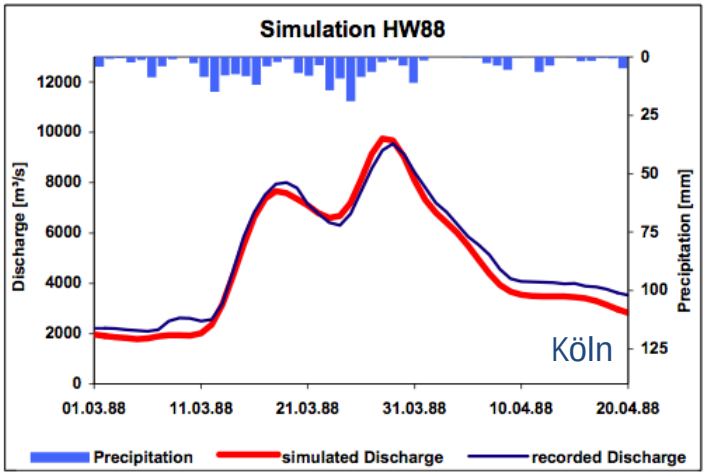
Lessons learned – Additional hydrological models and structures may be applied in future

HBV134 for discharge projections (HBV-96), [d], semi-distributed, TMP, A-PCP, G-RAD

Consistent results within framework of study → suitable and useable; all discharge diagnostics validated (not shown), **highest confidence in MQ**); **complete processing chain** yields **reliable results** (C20→GCM→RCM→BC→HM→diagnostic)**;** HM performance and uncertainty: **HBV134 most reliable**, errors < 5%, > 90% variance explained; atmospheric forcing dominant

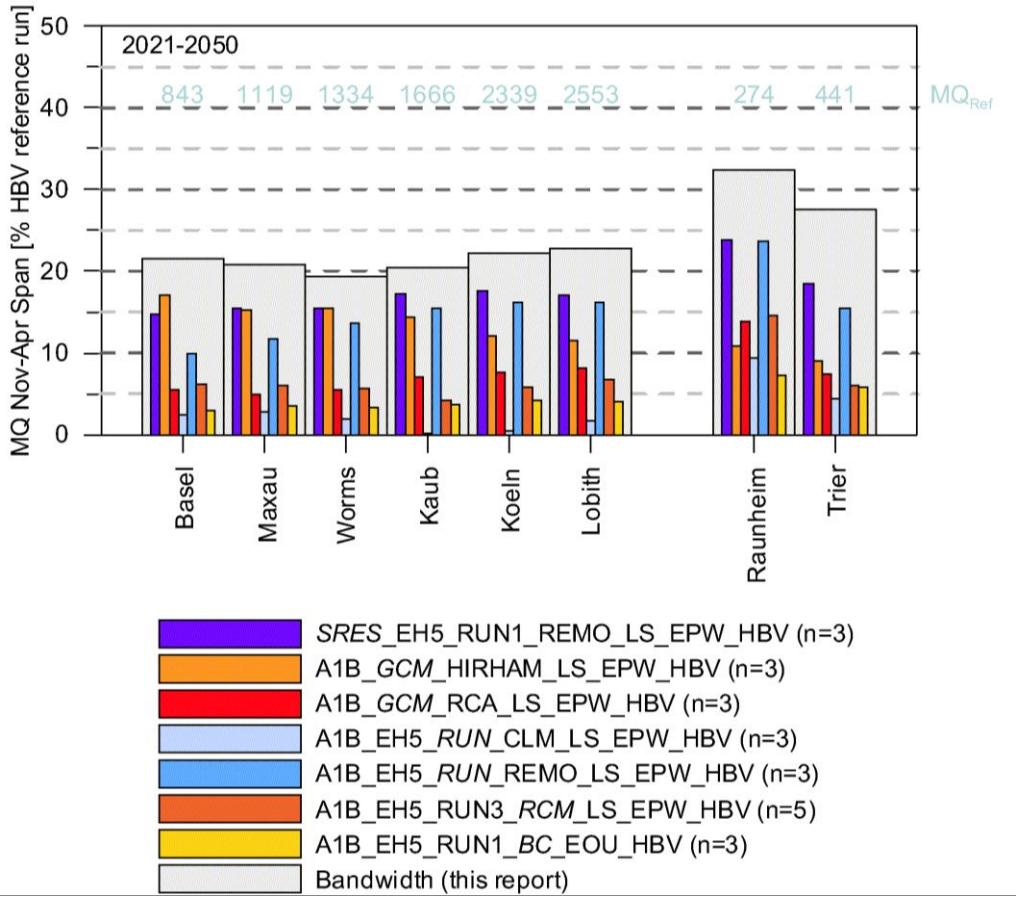
Adaptation perspective: water resource management systems, hydrodynamic modelling (flood routing, flood retention) have to be considered





Lessons learned – More certainty by knowing the uncertainty, assessment, attribution, understanding needed

- **Uncertainties** in future discharge behaviour under climate change are **inherent**, **"true" bandwidth is unknown → need for ensemble approaches (= best practice)**
- **Reduction of uncertainties**, understanding of contributions within the modelling chain but also **handling** of them **has to be improved**
- **Contribution to overall bandwidth differs with gauge, time-span, discharge diagnostic**
- **Atmospheric forcing more relevant than hydrological modelling**



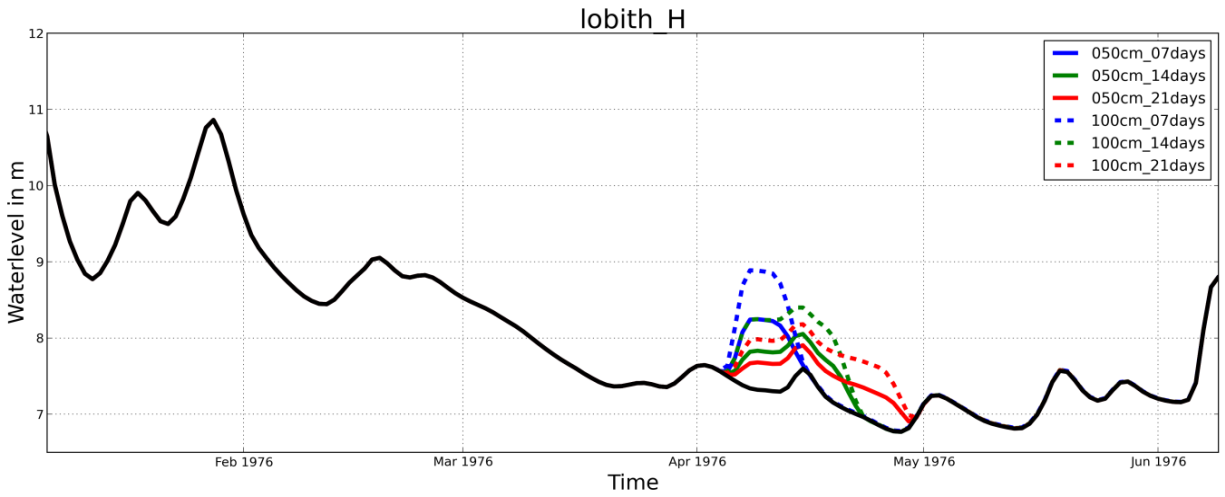
Conclusions
(Summary)

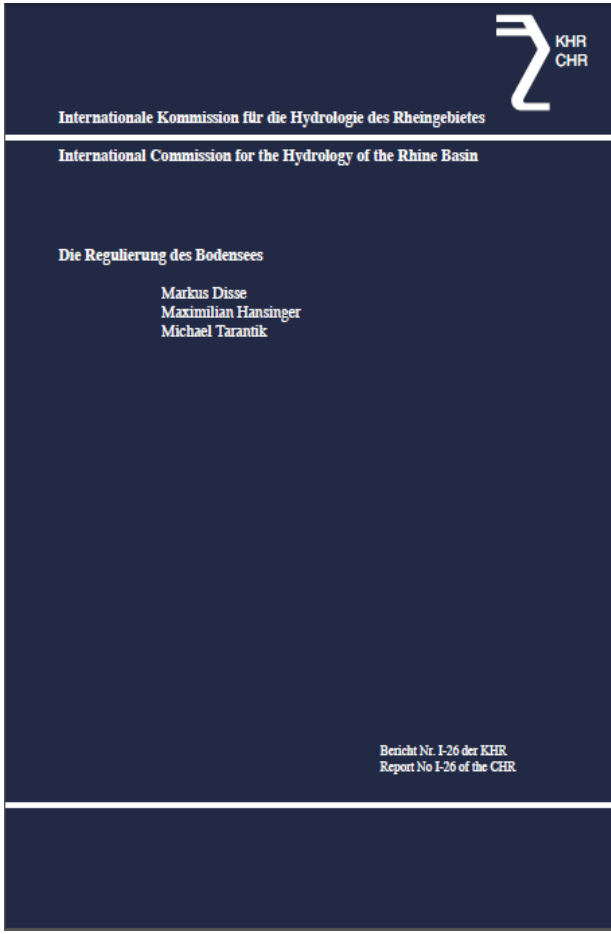
- **Project goals are reached**, (**one of the first successful efforts of this kind** in an international river basin with many horizontal and vertical linkages)
- **A concerted, international view of regional climate change impacts on** the discharge regime in the Rhine River basin is derived (at **macro-scale**!) → in line / complimentary with other projects
- **A common research framework /** institutional network is developed and ready for further studies
- **Changes in the regional climate system manifest themselves** in the hydrology of river systems in the Rhine River catchment; direction and magnitudes (bandwidths) are consistently determined
- Individual results (**mean, low, high* flow**) have **different** magnitudes of **uncertainties and reliabilities** assigned
- **Discharge analyses / scenario bandwidths and tendencies have been fed – into the political process at ICPR where eventually adaptation measures could be prepared among the riparian countries of the Rhine River**

LAKE CONSTANCE AS FLOOD AND DROUGHT RETENTION BASIN

A literature Study

Water level increase in cm	Surface in km2	Volume in 1E6 m3	Constant additional discharge if released in # days in m3/s		
			7 days	14 days	21 days
+ 50	500*	250	413	207	138
+ 100	500*	500	827	413	276





The results show that the implementation of regulatory measures are not feasible for diverging political interests and ecological impacts

The project is exemplary for the ability of CHR to act as a trusted broker between parties with differing interests

Tabelle 8-1 Synopse: Einschätzung des Realisierungspotenzials einer Bodenseeregulierung auf Basis der Literaturstudie.

Bereich	**Realisierungspotenzial**
Technische Machbarkeit (Wasserbau)	Realisierbar, aber die Erstellung des Reglement ist zeitintensiv und schwierig.
Hydrologische Auswirkungen	Zur Quantifizierung der hydrologischen Auswirkungen sind weiterführende Studien notwendig.
Ökologische Auswirkungen	Gravierende negative Auswirkungen auf die Ökologie. Kein Realisierungspotential
Ökonomische Auswirkungen	Zur Quantifizierung von Kosten-Nutzen und Abschätzung der Finanzierungsmöglichkeiten müssen aktuelle Beurteilungsgrundlagen erstellt werden.
Politische Machbarkeit	Unter heutigen politischen und gesetzlichen Rahmenbedingungen kaum realisierbar

COMPLETED PROJECTS after 1978

descriptive hydrological studies

- Quantitative precipitation analysis
- Quantitative discharge analysis
- Description of hydrological forecasting models
- Compilation of a geographical information system for the Rhine basin
- Probabilities of floods and droughts
- Survey of hydrological distribution functions
- Description of anthropogenic influences in the Rhine basin
- Effects of climate change on the discharge regime
- Effects of land use changes on the discharge regime
- Comparison of hydrological models for water balance simulation
- Several projects concerning the Rhine Alarm Model
- Description of existing flood warning systems
- Description of methods for the estimation of extreme discharges
- Development of methods for the analysis of effects of flood reduction measures
- From the source to the mouth – Compilation of a sediment balance from the source of the Rhine to the mouth in the North Sea
- Lake Constance as flood and drought retention basin – a literature study

Concluding Remarks (1)

- CHR is basically a science-based organization without political ambitions.

- Its member institutions however operate in a political environment.

- Projects have been selected based on a consensus of importance and priority by member organizations.

- In this regard, CHR has political relevance as the findings and results of projects found their way not only in scientific and operational decision-making but also to a significant degree in political decisions.

Concluding Remarks (2)

- A key to the wide acceptance of CHR in the scientific and political context has been that CHR hardly provided just only one solution to a problem but CHR thrived to offer scenarios and options for decision-making.

- One example highlights this approach: At a time when climate projections had a much larger degree of uncertainty than now, CHR provided its options under the banner *"Policy without regret and flexibility"*

THANK YOU FOR YOUR ATTENTION