REPORT ON

1st Rhine-Mekong Symposium
"Climate Change and its Influence on Water and Related Sectors"
8 - 9 May 2014, Koblenz, Germany

Contents

1 Background

The International Commission for the Hydrology of the Rhine basin (CHR), International Commission for protection of the Rhine (ICPR) and Climate Change and Adaptation Initiative (CCAI) of the Mekong River Commission (MRC) are currently conducting similar works in the area of climate change and adaptation. Sharing knowledge on approaches and methodologies suitable for large transboundary river catchments between the two river basins would provide benefits to enhance understanding and guide future actions.

Initial exchanges between the CHR and CCAI took place in Delft in the Netherlands on 30 November 2012 and with the ICPR in Luxembourg on 6 December 2012 in the framework of the CCAI roundtable discussions and study visit to Europe. In June 2013, the CCAI was approached by the Federal Institute of Hydrology, Germany expressing the interest and wish of the CHR and ICPR to organize a Rhine-Mekong Symposium together with MRC.

The symposium took place in Koblenz, Germany on 8 - 9 May 2014 on the premises of the Federal Institute for Hydrology (BfG). The symposium was attended by 64 delegates from the Lower Mekong countries as well as from the Rhine riparian countries. A list of participants and agenda can be found in Appendix 1 and 2, respectively.

2 Objective of the symposium

The broad aim of the symposium was to exchange and deepen the understanding on scientific and technical aspects related to climate change and its influence on the hydrological regime and related sectors of the two river basins.

The objective of the symposium was the initiation of a technical dialogue between MRC, CHR and ICPR on key questions and approaches regarding the assessment of climate change, its influence on the hydrological regime and consequent impacts on relevant sectors and people in the basin under a transboundary context. These results shall lead to the identification of possible options for further collaboration between MRC, CHR and ICPR.

3 Key points presented and discussed

The Symposium was organised in 8 parts (see also Agenda in Appendix 2), including common knowledge of both basins; the Rhine and country examples; the Mekong and country examples; common challenges and differences; formulation of transboundary climate change and adaptation strategy; and Rhine-Mekong cooperation.

In total, the 2-day symposium included 16 presentations from the Rhine, Mekong and riparian countries; 2 group discussions to identify common and different challenges and areas for cooperation; and a panel discussion. At the end of the Symposium, the 1st Rhine-Mekong Symposium Conclusion (see Appendix 3) was produced with recognition of the common challenges and differences and the potential for further cooperation. The 2nd Rhine-Mekong Symposium with the view of addressing the common challenges and differences is expected to convene in 2015.

The key points presented and discussed in the Symposium are summarised below. Details on each presentation / discussion are given in Appendix 4 and speaker profiles in Appendix 5.

1. Introduction of Rhine and Mekong Basins and Transboundary Cooperation

The presentations illustrated the differences in natural and socio-economic as well as political conditions between the two river basins. The similar level of economic development of all riparian states within the Rhine basin was identified as one significant advantage for the management of the river Rhine in contrast to the Mekong.

In the Mekong basin, the two upstream countries (i.e. China and Myanmar) are currently only dialogue partners to the Mekong River Commission, while in the Rhine basin the exchange and cooperation with the most relevant upstream country Switzerland is very comprehensive.

It was pointed out that transboundary cooperation is a long, ongoing process which requires constant efforts and which can perpetually be improved. Therefore, there are always further challenges to be solved. At the same time, this laborious and demanding effort is the only feasible and sustainable way to successful river basin management. In both basins, involvement of stakeholders in decision-making process is considered crucial and at the same time essential for sustainable water resources management.

2. Common knowledge on the Rhine and country examples

Major activities of CHR (RheinBlick2050), BfG (KLIWAS) and ICPR (Expert Group KLIMA) as well as of the Netherlands (sea level rise and floods) and Germany (drought and agriculture) were presented. An observation was made that socio-economic impacts of climate change are not yet a major focus in the Rhine basin. The water-energy-food nexus does not play a major role in studies conducted in the Rhine basin, while it is of relevance in the Mekong basin. The presented projects focused on specific sectors (e.g. KLIWAS on navigation) and did not take into account further water uses. Further coupled impact studies may be seen as a next step in research. As low water management is a relatively new topic, further research in this respect may also be initiated in future.

With respect to management of low water situations, the question was raised whether a basin-wide approach was needed (like the ICPR's Flood Action Programme), or it should rather be at regional/local scale. As the proportion of discharge stemming from upstream countries may be very large during low flow, the interdependencies among the countries are also large and transboundary cooperation is needed in this field.

3. Common knowledge on the Mekong and country examples

CCAI and FMMP were presented as current work of MRC on climate change in the basin as well as Cambodia (on flood), Lao PDR (agriculture), Thailand (drought) and Vietnam (sea level rise). The organization of transboundary cooperation was a main discussion topic. Coordinated transboundary emergency response in the LMB has not yet been established. However, along the Mekong mainstream there are hydromet stations, which measure the water volume for the region and can serve flood management work. Also, there are relevant bilateral agreements e.g. for sharing information on flood issues between Thailand and Cambodia.

Exchange and communication with upstream countries (China and Myanmar) exists on a regular basis. There are already mechanisms in place to cooperate, including with respect to reservoir management. Improvement of cooperation is of course still helpful.

4. Common and different challenges and issues (group discussion)

Topics of common challenges and issues discussed include saline intrusion, flooding and inundation, low flows and droughts, biodiversity, navigation, sedimentation and (delta) morphology, increased variation of climate, temperature increase, impacts of climate change, land subsidence, unequal distribution of water resources in time and space, groundwater management (protection, sustainability, quality and quantity), management in the future of water production and water quality because of rise of living standards.

For different challenges and issues, the topics discussed included natural factors, institutional framework and cooperation history, monitoring and data, financial support and mechanisms, development level and stage which influencing priority setting, low water, water quality, and approach to flood.

5. Climate change adaptation strategy

From the Mekong, Roadmap for the Mekong Adaptation Strategy and Action Plan was presented by CCAI; while ICPR presented the roadmap for adaptation strategy to climate change in the Rhine catchment. Although the adaptation strategies of the two basins are being developed with comparable approach, the starting points are different. Basin wide researches have been done quite substantial in the Rhine and has just started in the Mekong.

The strategic focus is also different. One field which has already been analyzed for the Rhine is water temperatures and assessment of possible changes in water temperature. These are of particular importance for power production as the river water is used for cooling purposes and for drinking water supply.

With respect to impact studies, the MRC has so far investigated impacts of climate change on wetlands as well as impact on irrigation and agriculture, but not on water temperatures yet. However, the water temperatures in the Mekong are of course already within a much higher range than in the Rhine and aquatic species might also be less sensitive to higher temperatures.

The adaptation strategy of the LMB is being developed to be linked to the Mekong Basin Development Strategy. In the Rhine basin, there are two umbrella conventions: The Rhine 2020 Action Programme and EU legislation (Water Framework Directive, Floods Directive, etc.).

The timeframe for the Rhine adaptation strategy is governed by the Water Framework Directive. Once every 6 years a river basin management plan has to be issued. The second plan which is due as a draft version in 2014 includes also the issue of climate change.

6. Areas for cooperation

Although the contexts in both basins differ, the overall acknowledgement was that cooperation can be fruitful and is desirable to gain new impulses for the way of working. It was recognised that mutual learning can be successful and helpful for the management of both basins.

The cooperation within the basins must be built on mutual trust and confidence. There are not always mechanisms to enforce international cooperation. Therefore, political commitment can to a large extent be decisive for successful cooperation. The same applies for cooperation among both river basins.

There are plans to institutionally restructure the MRC. This requires a comprehensive organizational reform process, which includes a commitment towards a smaller secretariat. Therefore, MRC may also be inspired and may benefit from knowledge exchange with respect to the institutional organization in the Rhine basin.

It is recognized that the best available information on climate change and its impacts is not perfect thus an exchange of experience may be useful, as one can learn from tested and developed approaches. Sharing of data and information is acknowledged as necessary yet challenging in both basins.

Relevant fields for cooperation between institutions from both basins should be made more concrete in the respective organizations and follow-up work has to be further aspired.

7. Feedbacks from participants and evaluation

Evaluation form was distributed at the end of the Symposium in order to collect feedbacks. The Symposium was very good at overall ranking, with average score given at 8.5 (out of 10). Most participants provided comments that further cooperation of the Rhine and Mekong should be continued. Selected symposium photos are presented in Appendix 6.

Appendix 1: List of participants

No.		Name	Position	Organisation	e-mail address
BMZ, Bonn, Germany					
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CHR					
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International organisations					
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25	Mr.	Manfred Spreafico	Professor (em.) / former CHR president	University of Berne / CHR	manfred.spreafico@hispeed.ch
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Appendix 2: Agenda

8 May 2014	
09.30 - 10.00	Arrival and registration of participants At Federal Institute of Hydrology (BfG) headquarters, Koblenz, Germany
10.00 – 10.45	**PART 1: Opening and introduction**
10.00 – 10.30	❑ **Welcome speeches** - Director General of BfG (5 min): **Michael Behrendt** - President of ICPR (5 min): **Gustaaf Borchardt** - Chief Executive Officer of MRC (5 min): **Hans Guttman** - Representative of BMZ (5 min): **Stefanie Ruff** - President of CHR (5 min): **Hans Moser**
10.30 – 10.45	❑ **Introduction to the symposium and expected outputs** - Overview of agenda and objectives (10 min): **Kai Gerlinger**, moderator - Short overview of participants (5 min): **Kai Gerlinger**
10.45 – 13.15	**PART 2: Common knowledge on both catchments**
10.45 – 11.45	❑ **Introduction to both catchments and transboundary cooperation** - **Rhine** (20 min +10 min Q&A): Introduction to the Rhine river basin (natural factors, cooperation), **Manfred Spreafico**, former president of CHR - **Mekong** (20 min +10 min Q&A): Introduction to the Mekong river basin (natural factors, cooperation), **Tien Truong Hong**, Director of Environment Division, MRC Secretariat
11.45 – 13.15	**LUNCH BREAK**
13.15 – 14.20	**PART 3: Common knowledge of the Rhine and country examples**
13.15 – 14.20	❑ **Overview of current work of CHR, BfG and ICPR on climate change in the basin** Research projects RheinBlick2050 (CHR) (**Eric Sprokkereef**), KLIWAS (BfG) (**Sebastian Kofalk**) and Expert Group KLIMA (ICPR) (**Adrian Schmid-Breton**) (20 min) ❑ **Examples of expected climate change impacts** (knowledge so far, challenges, need for cooperation) - Country example Rhine (15 min): Sea-level rise and floods, Netherlands, **Ralph Schielen** - Country example Rhine (15 min): Drought and agriculture, Germany, **Enno Nilson** - Q&A (15 min)
14.20 – 15.50	**PART 4: Common knowledge of the Mekong and country examples**

14.20 – 15.35	❑ **Overview of current work of MRC on climate change in the basin** - MRC's Climate Change and Adaptation Initiative (CCAI) **(Nguyen Huong Thuy Phan)** (10 min) - MRC's Flood Management and Mitigation Programme (FMMP) (**Nico Bakker**) (10 min) ❑ **Examples of expected climate change impacts** (knowledge so far, challenges, need for cooperation) - Country example Mekong (10 min): Flood, Cambodia, **H.E. Mr. Kol Vathana** - Country example Mekong (10 min): Agriculture, Lao PDR, **Vanxay Bouttanavong** - Country example Mekong (10 min): Drought, Thailand, **Chaiporn Siripornpibul** - Country example Mekong (10 min): Sea-level rise, Vietnam, **Nguyen Xuan Hien** - Q&A (15 min)		
15.35 – 15.50	**TEA BREAK** (exhibition of products/reports/posters)		
15.50 – 17.00	**PART 5: Common challenges and differences**		
15.50 – 16.20	❑ **Small group discussion: What are common challenges? What are differences?**		
16.20 – 16.45	❑ **Reporting back from groups**		
16.45 – 17.00	❑ **Wrap-up of day 1**		
9 May 2014			
09.00 – 09.15	**Recap of Day 1, Thanapon Piman**		
09.15 – 10.00	**PART 6: Formulation of transboundary climate change adaptation strategy**		
09.15 – 10.00	❑ **Mekong** (10 min + 5 min Q&A): Roadmap for the Mekong Adaptation Strategy and Action Plan (MASAP) (**Nguyen Huong Thuy Phan**) ❑ **Rhine** (10 min + 5 min Q&A): Roadmap for adaptation strategy to climate change in the Rhine catchment (**Ben van de Wetering**, Secretary of ICPR) ❑ Q&A (15 min)		
10.00 – 15.25	**PART 7: Rhine-Mekong cooperation**		
10.00 – 10.30	❑ **Comparative overview of climate change and ways to an adaptation strategy in the Rhine and Mekong basins** (20 min + 10 min Q&A) (**Kai Gerlinger**)		
10.30 – 10.40	❑ **Introduction to the group discussions** (**Kai Gerlinger**)		
10.40 – 10.55	**TEA BREAK** (exhibition of products/reports/posters)		
10.55 – 12.15	**Parallel group discussion: Areas for cooperation** – Ongoing work – Future plans – Areas for cooperation		
	❑ **Group 1:** Climate and hydrological changes and assessment including flood and drought **Facilitators: Wolfgang Grabs, Thanapon Piman**	❑ **Group 2:** Addressing climate change impacts and assessment in water related sectors **Facilitators: Johannes Cullmann, Tran Mai Kien**	❑ **Group 3:** Transboundary and policy issues in climate change adaptation **Facilitators: Hans Moser,** **Nico Bakker**
12.15 – 13:30	**LUNCH BREAK**		

13.30 – 14.30	❑ **Panel: Areas for cooperation for transboundary climate change adaptation** Report the group discussion results: **3 representatives from parallel group discussion and representatives from CHR, MRC, ICPR**
14.30 – 14.45	❑ **Q&A**
14.45 – 15.15	**TEA BREAK** (exhibition of products/reports/posters)
15.15 – 16.00	**PART 8: Closing**
15.15 – 16.00	❑ **1st Rhine-Mekong Symposium Conclusions (preliminary)** ❑ **Remarks by participants** ❑ **Closing of the 1st Rhine-Mekong Symposium** (representatives from CHR, MRC, BfG, ICPR, GIZ)

Appendix 3: Symposium Conclusion

Symposium Conclusions

1st Rhine-Mekong Symposium
"Climate Change and its Influence on Water and Related Sectors"
8-9 May 2014
Koblenz, Germany

Preamble

Representatives from the International Commission for the Hydrology of the Rhine basin (CHR), the International Commission for protection of the Rhine (ICPR), and the Mekong River Commission (MRC), government representatives, experts and scientists met on 8 – 9 May 2014 in Koblenz, Germany, at the 1st Rhine-Mekong Symposium under the theme *"Climate Change and its Influence on Water and Related Sectors"*. The meeting enabled the river basin organizations to share knowledge, understanding and challenges on the different and common issues as well as to discuss areas for potential cooperation.

The Symposium recognized that climate change has taken its toll on hydrological regimes, livelihoods and economies in both the Mekong River Basin and the Rhine Basin and acknowledged that mitigation of and adaptation to changing climate impacts are essential.

As the world's tenth longest river, the **Mekong supports an** exceptionally diverse and productive freshwater ecosystem that provides livelihoods and food to about 60 million people. The rapidly-growing Mekong River Basin has experienced development pressures such as changes in land use, intensive irrigation, hydropower development, development of flood control structures and other infrastructures. The region is experiencing less predictable climate conditions and more extreme weather. Rising temperatures and unpredictable rainfall are bringing drought to some areas and flooding to others. Sea level rise is increasing saltwater intrusion to farmland in the Mekong Delta

The **Rhine**, the third biggest European river accommodates approximately 60 million people and provides drinking water sources to 30 millions. For many centuries, the Rhine has played an important role in the social, political and economic development in Europe. Multiple uses, conflicting interests and environmental and flood problems in and along the river have highlighted the importance of an integrated approach. Climate change is taking its toll in the basin. For example, rising water temperatures have forced power plants to reduce their

production in recent years. Extreme changes in water flow, especially long periods with very low discharges, will also have economic and social impacts. These extreme events, together with a range of other anthropogenic impacts, will bring about far-reaching consequences on the environment and economy in the Rhine countries.

Participants of this 1st Rhine-Mekong Symposium concluded that the two basins share common challenges and differences which provide a basis for potential cooperation amongst their river basin organizations.

Common challenges and differences

1. The two river basins share many of the same challenges in addressing the impacts of climate change today and in the near future. Climate change in both basins can already be observed in the increase in temperatures, which have similar ranges (+0.08 to +0.18°C/decade). Whereas there are similar patterns in both basins for the observed sea level, recorded precipitation distributions remain more heterogeneous. However, there is a tendency in both basins of an increase of precipitation in the respective wet season. In spite of high uncertainty and a less precise model signal concerning future precipitation, an increase in heavy rain events is likely. Therefore the hazards are similar in both basins, but risks in Europe are mainly of an economic nature, while in South East Asia risks are of a more social nature (food security, health and livelihoods).
2. Climate change impacts on the basins' water resources, ecosystems and livelihoods are likely to be significant and a long-term issue. Similar approaches were chosen for both basins in order to provide the necessary basis for the development of a basin-wide adaptation strategy. In both basins, comparable studies assessing the climate and hydrological changes in the past and in the future have been conducted or are currently underway. Impact studies are investigating the response to common hazards in the same fields of interest. Sharing the existing study results and experiences will lead to mutual benefits and will create synergies and potential savings.
3. Transboundary aspects of adaptation to climate change should be seen as an integral part of a broader development policy, and not merely as an environmental issue.
4. Transboundary cooperation addressing changing climate impacts can enhance a broader set of benefits and opportunities than approaches by individual countries.
5. The roadmaps for formulating transboundary climate change adaptation strategies for the Mekong and the Rhine have adopted similar approaches. There are differences between the legal framework of the Rhine Commissions and the Mekong Agreement. Common challenges in both basins exist with regard to the uncertainty associated with future impacts from climate change as well as measuring the costs and benefits of adaptation. An adaptive management approach is therefore promoted in both basins.

The way forward

6. The participants recognize the common challenges and differences and the potential for further cooperation. The participants invite the river basin organizations to convene the second Rhine-Mekong Symposium with the view of addressing the common challenges and differences.

Koblenz, Germany, on 9 May 2014.

Appendix 4: Presentations and discussion

Part II: Common knowledge on both catchments- Introduction to both catchments and transboundary cooperation

II.1 Rhine Basin (presentation)

Introduction to the Rhine River Basin (Manfred Spreafico)

The Rhine has its sources in the Swiss Alps (Vorderrhein as main source from Lai da Toma, Hinterrhein from Paradise Glacier in Grison) and flows after 1'320 km into the North Sea at Hoek van Holland, Rotterdam. 9 countries (namely Switzerland, Liechtenstein, Austria, Germany, France, Luxembourg, Belgium, Netherlands and Italy) contribute water to the Rhine. The basin area is 185'000 km^2. The mean discharge is 2'200 m^3/s, maximum flow 13'000 m^3/s and minimum flow 800 m^3/s. Around 50 million people live in the basin area.

The main uses/users of the river Rhine are domestic and industrial water supply, navigation, hydropower production, fishery, agriculture, recreation/tourism and water drainage. Groundwater plays a dominant role especially in Switzerland, where more than 70% of the drinking water is groundwater. Groundwater protection plays therefore an important role. The Rhine is one of the most densely occupied waterways of the world. Navigation is since centuries an important user of the Rhine providing economic benefit but also cost for the maintenance of the navigation channels. The importance of hydropower production is different from one country to another. In Switzerland around 56% of electric power is generated by Hydropower, in Germany only 3%.

The environmentally sound management of the Rhine, as part of the Integrated Water Resources Management (IWRM), has since several decades very high priority, resulting in the R*hine Action Programme* implemented in the basin. A lot of efforts have been spent in developing of flood protection strategies in the riparian states resulting in the *Rhine Action Plan Floods*.

Since 20 years projects have been carried out for the determination of the impacts caused by global and climate change on the discharge in the river Rhine. Adaptation strategies have been developed.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_2_rhine_river_basin.pdf

II. 2 Mekong basin (presentation)

Mekong River Basin and Transboundary Cooperation (Tien Truong Hong)

The Mekong River Basin covers almost 800'000 km^2. The main stem of the river stretches some 4'800 km from the glaciers in the Chinese Himalayas, through Myanmar, Lao People's Democratic Republic (Lao PDR), Thailand and Cambodia, meeting the sea in the vast delta in southern Vietnam.

History of cooperation on development planning of the Mekong river began in 1957 with the establishment of the Committee for Coordination of Investigations of the Lower Mekong Basin by the governments of four lower Mekong countries: Cambodia, Lao PDR, Thailand and Vietnam. It aimed to promote, coordinate, supervise and control the planning and investigation of water resources development projects in the Lower Mekong basin. To meet the increasing needs of economic and social development of the countries in the basin, the governments of the four lower Mekong countries signed an Agreement on Cooperation for the Sustainable Development of the Mekong River Basin in 1995 (referred as 1995 Mekong Agreement) and established the Mekong River Commission (MRC). The 1995 Mekong Agreement serves as an important legal document setting basic principles and overall cooperation framework for the member states in the field of exploitation and protection of water resources and other related resources in the Mekong River Basin toward sustainable development, which contribute to the implementation of the socio-economic development strategies of the member countries.

The major achievements gained by the MRC and its member countries over 57 years of cooperation include strengthening dialogue on regional water resources development; facilitating a basin-wide, consultative planning process through an Integrated Water Resource Management approach; reducing the risks of regular flooding; increasing international trade opportunities through safer and more effective river transport and legal frameworks for cross-border navigation; defining a balance between the opportunities and risks of proposed hydropower projects; providing environmental decision support; and initiating a process to help the people of the basin adapt to the consequences of climate change.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_2_mekong_river_basin.pdf

II. 3 Key discussion

The presentations illustrated the differences in natural and socio-economic as well as political conditions between the two river basins.

The similar level of economic development of all riparian states within the Rhine basin was identified during the discussion as one significant advantage for the management of the river Rhine in contrast to the Mekong.

In the Mekong basin, the two upstream countries (i.e. China and Myanmar) are currently only dialogue partners to the Mekong River Commission, while in the Rhine basin the exchange and cooperation with the most relevant upstream country Switzerland is very comprehensive.

It was pointed out that transboundary cooperation is a long, ongoing process which requires constant efforts and which can perpetually be improved. Therefore, there are always further challenges to be solved. At the same time, this laborious and demanding way is the only feasible and sustainable way to successful river basin management.

In both basins, involvement of stakeholders in decision-making process is considered crucial and at the same time essential for sustainable water resources management.

It became also clear, that the usage and management of groundwater is very significant also on a large scale in the Rhine basin, while usage is confined to smaller scales in the Mekong. Furthermore, water demand is expected to further increase in the LMB countries, while demand is rather stagnating in the Rhine basin.

Part III: Common knowledge on the Rhine

III. 1 Overview of current work (presentations)

Introduction to the research project RheinBlick2050 (Eric Sprokkereef)

Climate change leads to modified hydro-meteorological regimes that influence the discharge behavior of rivers. This has variable impacts on managed (anthropogenic) and unmanaged (natural) systems, depending on their sensitivity and vulnerability (ecology, economy, infrastructure, transport, energy production, water management, etc.). Therefore, decision makers in these contexts need adequate information (i.e. "informed options") on potential future conditions to develop adaptation strategies in order to minimize adverse effects of climate change.

The RheinBlick2050 project has been a coordinated effort on the non-tidal catchment, initiated and coordinated by the International Commission for the Hydrology of the Rhine Basin closely collaborating with the International Commission for the Protection of the Rhine. Data, methods, models and expertise of different institutions and research activities of riparian states of the Rhine River have been jointly combined in this so-called "meta" project with a runtime from January 2008 to September 2010.

The main research question of the RheinBlick2050 project was: What are the impacts of future climate change on discharge of the Rhine River and its major tributaries?

The main findings from the RheinBlick2050 project:

- Up to 2050 moderate changes in average discharge
- Up to 2100 discharge projections in accordance with each other: decrease of average discharge in summer, increase in winter
- Large spread in the discharge projections
- Uncertainties can be quantified

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_3_11_rheinblick2050.pdf

KLIWAS: organizational aspects and current work of BfG on climate change (Sebastian Kofalk)

The expected climate change raised among the users of the waterways the question whether this transport mode will remain reliable in a long-term perspective. In this situation, politicians and

decisions makers in the German Federal Ministry of Transport (BMVI) and the Federal Waterways and Shipping Administration (WSV) needed reliable information to decide whether and when adaptation measures to climate change should to be taken. The research programme KLIWAS – "Impacts of climate change on navigation and waterways – options to adapt" studied these general issues, reflecting different climate change scenarios and their uncertainties. 30 projects were conducted, supplemented by numerous cooperation partners. They were guided by a Scientific Advisory Board that covered all fields of research – including economic analyses. The seven WSV directorates and operational offices were involved as main stakeholders, further governmental and non-governmental water management institutions.

KLIWAS organized integrated model chains including ecological and economical aspects. Two periods were under consideration: the nearer future (2021 to 2050) and the more-distant future (2071 to 2100). Projections for more than 40 indicators, representing the system of waterways and the management objectives were delivered. The portfolio of adaptation options comprises also engineering solutions.

Currently the project reports, a synthesis and publications are being finalizing. However, the results can be interpreted correctly only when the degree and the sources of the uncertainties they contain are known and communicated. High emphasis is put on explaining the dimension of climate signals and impacts and their relevance for acting. Finally the presenter would like to share experiences with methods and the results of KLIWAS research programme in the Global Framework of Climate Services (GFCS).

The BfG closes now the gap between operational forecasts and long-term projections by seasonal and decadal prognosis. Another task is to apply the most recent global climate model projections to update the regional downscalings. To develop consistent climate scenarios for all traffic modes is another task.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_3_12_kliwas.pdf

Knowledge about direct climate change effects on the water regime and water temperature of the Rhine (Adrian Schmid-Breton)

Recently, the ICPR has presented a report with an estimation of the effects of climate change on Rhine water temperature development in the near future (2021-2050) and the far future (2071-2100) (ICPR Report No. 213 – summary and Report No. 214 – full version). This multi-model estimation is based on the air temperature development and other parameters as defined in the scenario study for the discharge regime of the Rhine (ICPR Report No. 188, 2011). This report supplements the ICPR publication on the long-term Rhine water temperature development in the period 1978 -2011 (ICPR Report No. 209, 2013).

In these reports, the development of the water temperature over time as well as the effect of discharges of cooling water have been assessed. Important results include the finding that on average, between 1978 and 2011, water temperatures rise by about 1°C to 1.5°C.

One of the main indicators of the impact of climate change is the number of days on which the water temperature does exceed 25°C as this will have negative consequences for the aquatic life. Both studies show a substantial increase of the number of days.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_3_13_icpr_climate.pdf

III.2 Country examples (presentations)

Country example Rhine: Climate change impacts and mitigation - The Dutch Perspective (Ralph Schielen)

Water management is crucial for the Netherlands. To protect its citizens and its economy, an advanced system of levees, dams and dunes has been constructed over the past centuries, making the Dutch Delta the best protected delta in the world. Programmes like "Room for the River" and regular maintenance programmes ensure that the current standards are maintained. However, to keep up with climate change and increased economic value behind the levees, it is necessary to look again whether the height of the current standards is still sufficient for the long term (2050 and beyond). This is done in the Delta programme, a policy project to study new safety standards in combination with anticipated climate change (and hence, increased discharge and sea level rise) and the appropriate measures to get to those standards.

In this contribution, the new safety standards are based on an advanced cost-benefit analysis, taking into account climate and socio-economic scenarios for 2050. The new safety standards are also based on actual flooding probabilities of the levees (rather than exceeding probabilities of critical water levels). Furthermore, in this analysis it turned out that the current levees had a larger failure probability than anticipated, which means that additional measures to cope with this have to be carried out.

Hence, for the future (at first for the year 2050, but also extending this view to 2100) the problem to be solved is at least threefold: measures to ensure that the current safety standards are satisfied; measures that need to be taken to get to new (stricter) safety standards; and measures to solve the climate problem. It is eminent that the first part (‘overdue maintenance’) is the first step. Looking at 2050, it turns out that solving the safety standards requires more than solving the climate problem in terms of water level rise. How to solve this problem (by dike reinforcement, by additional spatial measures or by a mix) is the challenge of the delta programme. This challenge is taken up by the government, as well as the local stakeholders. This requires an intensive dialogue with local authorities such as waterboards, provinces, etc., which at the same time need to make sure that the set of measures has substantial support in the society.

In this contribution, the process of getting to a balanced choice of measures, solving the combined problem of new standards and climate change, will be explained. Also, some of the technical difficulties of computing the actual problem that needs to be solved in terms of increase flood water levels and reinforcing the dikes to comply with the new standards will be illustrated. This involves more than just making the levees higher as we can intervene in different failure mechanisms of the levee and hence adapt the actual flooding probability. Another possibility is for instance to make

them stronger, such that the flooding probability remains the same (but the nuisance behind the dikes might be larger). How the actual profile of the levee is going to be is again the outcome of an intensive communication with the local stakeholders and the government (in which also the available budget for the coming decades plays an important role).

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_3_2_climate_change_netherlands.pdf

Country example Rhine: Drought and agriculture – climate changes impacts in Germany (Enno Nilson)

As compared to other regions of the world, Central Europe is not known as a region extremely prone to drought and water scarcity issues. In the German part of the River Rhine Basin during normal years only a very small percentage of the available water is abstracted for irrigation. Nevertheless, past drought situations (e.g. in 2003) have led to a strong anomaly in net primary productivity in Europe. In Germany yields of several crop declined by about 15% although about 20% more money was spent for irrigation. Thus, also in Central Europe agriculture is vulnerable to drought situations and conflicts between agriculture and other sectors can occur.

With respect to possible future developments, the current IPCC report (IPCC AR5) states that regional to global-scale projections of soil moisture and (agricultural) drought remain relatively uncertain compared to other aspects of the water cycle.

Indeed for Central Europe, robust changes (similar direction of change over climate multi-model ensembles) in hydrological and agricultural droughts have been projected only for the distant future (increased droughts around 2071-2100), while there is no clear tendency in the next decades (until 2021-2050).

This presentation summarizes some of the issues in defining, monitoring and modelling droughts using examples from research projects in Germany and the Rhine River Basin. Possible general challenges which may also apply to the Mekong River basin are highlighted. Suggested topics which need cooperation between Rhine and Mekong commissions are:

- Coordinated selection of drought definitions and indicators
- Common procedures in generating projections (technical aspects such as data availability, model bias correction, evaporation models)
- Common procedures in generating drought scenarios (assumptions, uncertainty assessment, aspects covered, adaptation measures included)

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_3_3_climate_change_germany.pdf

III. 3 Key discussion

The main issue discussed was the fact that socio-economic impacts of climate change are not (yet) a major focus in the Rhine basin. The water-energy-food nexus does not play a major role in studies conducted in the Rhine basin, while it is of relevance in the Mekong basin. The presented projects focused on specific sectors (e.g. KLIWAS on navigation) and did not take into account further water uses. Further coupled impact studies may be seen as a next step in research. As low water management is a relatively new topic, further research in this respect may also be initiated in future.

With respect to management of low water situations, the question was raised whether a basin-wide approach was needed (like the ICPR's Flood Action Programme), or it should rather be at regional/local scale. As the proportion of discharge stemming from upstream countries may be very large during low flow, the interdependencies among the countries are also large and transboundary cooperation is needed in this field.

Part IV: Common knowledge on the Mekong

IV.1 Overview of current work (presentations)

MRC's Climate Change and Adaptation Initiative (Nguyen Huong Thuy Phan)

Recognising the needs of addressing transboundary impacts of climate change as well as the necessity for joint efforts on adapting to climate change, the MRC Council in 2007 requested the development of Climate Change and Adaptation Initiative (CCAI). In 2008, the framework of the CCAI was formulated for implementation in 17 years (2009-2025). Among the current 12 programmes of MRC, CCAI is established as a regional collaborative initiative with main purpose to support the Member Countries in adapting to the impacts and new challenges posed by climate change. The approach that CCAI apply includes IWRM principles as well as water-food-energy nexus. First, climate change itself needs to be investigated (what happened in the past and what will happen in the future). Impacts on hydrology, water balance, extremes (especially flood and drought), river morphology and sediment will be determined. Also, impact assessment on food security (agriculture and fishery), impacts on hydropower (yield and operation) and impacts on ecosystems will be conducted. Another approach that CCAI apply across the basin-wide assessments and local demonstration projects is the CCAI Adaptation Planning and Implementation Framework, consisting of scoping study, vulnerability assessment, identification of adaptation options and implementation. Moreover, since adaptation to climate change in the basin cannot be stand-alone, another key approach of CCAI is to mainstream adaptation into basin development. In this regard, the *Mekong Adaptation Strategy and Action Plan* will ensure that the Mekong Basin Development Strategy will be climate proof. Last but not least, stakeholder engagement and gender responsiveness are given importance for CCAI implementation both at regional and national levels.

For CCAI at the current phase (2011-2015), the ultimate goal is to develop the *Mekong Adaptation Strategy and Action Plan*. In order to do this, understanding on the status of climate change in the LMB is needed to be in place, which needs basin-wide assessments on impacts of climate change on food security, ecosystems, flood, drought and hydropower. Literature review of related issues in the Member Countries is required in order to provide current state of knowledge for the status report.

Database and monitoring system are being built to provide data and information for further analysis. Building capacity and understanding of the Member Countries is needed in order to facilitate decision making process. In short, this phase of CCAI will focus on 3 groups of work: (1) data, information, models and tools, (2) studies and assessments, and (3) adaptation plans and strategy.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_4_climate_change_and_adaptation_initiative.pdf

Flood Behavior and Climate Change Adaptation to future flooding in the Lower Mekong Basin (Nico Bakker)

The Mekong Flood consists of a single annual flood hydrograph generated by the SW Monsoon. Tropical typhoon incursions into the basin from the East Sea, across southeast Viet Nam and southern China generate individual peaks on the monsoonal hydrograph. The onset dates and duration of the dry season, transition seasons and flood season are remarkably consistent. While the strength of the SW Monsoon defines the overall character of the flood season, it is the typhoons and tropical storms that typically generate the extremes and most damaging events.

MRC's Flood Management and Mitigation Programme (FMMP) and the Climate Change and Adaptation Initiative (CCAI) are incorporating climate change into short and long term flood management while climate change adaptation is systemized in the Regional Flood Management and Mitigation Centreand the MRC Member Countries. An Initial Assessment (May 2012) recommended improvements to climate change data, hydrological and hydraulic modelling, together with training and capacity building activities. The suggested approach and methodology was discussed in Regional Technical Workshop (September 2012). FMMP, CCAI and the Information and Knowledge Management Programme (IKMP) joined hands to develop monthly change factors, based on existing climate modelling results for categories high, medium and low, to be used to generate primarily rainfall inputs required for the 10 sub-SWAT run-off models, and generate with the IQQM routing model the discharges, required as inputs for the hydrodynamic ISIS model. In 2013 additional country data was collected, time series and rating curves, topographic, hydrographic data updated, model versions tested, 12 years of hourly tidal data was processed to extract the tidal harmonics and storm surge values, while values for sea level rise were formulated.

The upgrading of the MRC Toolbox models under MRC's Decision Support Framework (DSF) is almost completed and flood simulation modelling for three time periods 2020s, 2050s and 2080s will be initiated in June/July 2014. At the same time the climate change adaptation piloting will be started-up soon in the Member Countries; results are expected by December 2014. For 2014 and 2015 implementation is scheduled for three demonstration projects (one in Thailand, one in Lao PDR and one transboundary project between Cambodia and Viet Nam), addressing impacts of climate change and sea level rise, upstream and floodplain developments to develop Strategic Directions for the management of future and residual flood risks. These initiatives will contribute to the basin-wide overview and understanding of flood risk in the Lower Mekong Basin.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_4_flood_behavior_and_cca.pdf

IV. 2 Country examples (presentations)

Country example Mekong: Climate Change and Water Resources Management in Cambodia (Kol Vathana)

Climate change is recognized as a national and global issue. Cambodia faces frequent floods and droughts resulting from climate change, which seriously damage and threaten human live, properties, crops and infrastructures. The poor are mostly vulnerable as they have weak adaptive awareness and capacity. The negative effects are mainly health impacts, food insecurity, economic and development impacts and the like, which are identified and recognized to accelerate the people's poverty and to severely obstruct the socio-economic development.

The government line agencies including civil society have paid attention and engaged in the climate change response after Cambodia ratified the UNFCCC in 1995 and Kyoto Protocol in 2002, by e.g. the preparedness and implementation of National Adaptation Programme of Action to Climate Change (NAPA), 1st and 2nd National Communication, relevant Clean Development Mechanism (CDM), climate change adaptation and mitigation projects, Cambodia Climate Change Alliance (CCCA), Pilot Programme for Climate Resilience (PPCR), boosting and implementing carbon credit programme, etc.

Many reports address gaps of awareness, technical capacity and capability to respond to climate change and other natural disasters, as well as participations from NGOs and civil society. There is a high demand for better understanding and assessing the potential impacts from climate change and variability and in particular the options for adaptation to these severe impacts, while mitigation options will be applied afterward.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_4_1_cambodia.pdf

Country example Mekong: Status of climate change adaptation in agriculture sector for Lao PDR (Vanxay Bouttanavong)

Lao PDR is heavily dependent on its agricultural sector. Agriculture and forestry together account for 30.4% of the gross domestic product. The major expected impacts of climate change on agricultural sector are floods, droughts, pests and plant diseases. In Lao PDR, the Department of Disaster Management and Climate Change at the Ministry of Natural Resources and Environment is the institutional focal point for climate change mitigation and adaptation. Several achievements in climate change policy have already been made. These include establishment of the technical working group on climate change which involves eight different ministries, formulation of the National Climate Change Strategy, Climate Change Action Plan 2013-2020 and National Adaptation Programme of Action (NAPA) with several follow ups. The concrete adaptation measures in agriculture and forestry may, however, locally differ, depending for example on geographical features and local farming system. A number of adaptation measures are being tested at different sites aiming, among others, at more efficient water management and soil fertility improvements.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_4_2_lao_pdr.pdf

Country example Mekong: FED Triangle, a new hope of Water Resources Management in the Northeastern Region, Thailand (Chaiporn Siripornpibul)

Northeastern Region of Thailand covers an area of approximately 169'000 sq.km. or 1/3 of the country area and the population is about 21.6 million people or 1/3 of the country. The irrigation area is only 1.2 million hectares and the rain-fed area is about 11.2 million hectares. The gross regional product is about 10.5% of gross national product. This figure illustrates that the region is the poorest area of the country. Most of the people are farmers, their living conditions heavily depend on variation of seasonal rainfall. The major problems in this area are flood, drought and also saline soil and salt water. Even though this region has moderate rainfall of about 1'348 mm/year, the capacity of existing reservoirs and storages are very low, causing flood and drought problem every year. Groundwater resources are developed mainly for domestic use but not much for agriculture compared to its potential in many areas. Another problem is the existence of salt water that occurs as groundwater flow systems dissolve rock salt underneath and flow upward to the surface in the discharge areas and, thus, causes both saline soil and salt water. The variation of both quantity and quality of water resources play a great role and control the socio-economic condition of the region. The proposed new management named by the presenter as "FED Triangle: Linkages and Management of Water Resources" links the possible activities amongst 3 major problems: Flood (F), Environment or Ecology (E) and Drought (D). It may raise new hope of appropriate management of water resources. It will help rural people to access and use water in dry season especially under the concept of the "Conjunctive Water Use". Surface water is used in wet season and groundwater in dry season when the surface water sources dry out. Crop types have also carefully been selected to be harvested in dry season that are suitable for dry period and also effective water uses are applied, especially a micro irrigation technique. According to technical review, there are many high potential areas in the Northeastern region to be developed and to use groundwater following this concept.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_4_3_thailand.pdf

Country Example Vietnam: Challenges of integrated water resources planning & management in the Mekong delta (Nguyen Xuan Hien)

Fast development from upstream and sea level rise as an impact from climate change will certainly intensify existing Integrated Water Resources Management issues in the Mekong Delta. Increased water abstraction due to increasing demand, construction of dams, and sea level rise together will have direct impacts on the Mekong and its Delta, resulting in increased flooding, salinity intrusion and therefore decreasing water quality. Saline intrusion threatens freshwater projects and freshwater storage, neutralizes existing dyke systems and drainage systems, as well as affects the duration and damages of flooding periods.

This presentation examines and assesses the several combined impacts of the said issues. The presentation also suggests adaptation initiatives, emphasizing the importance of a "good combination

between structural measures and non-structural measures" in encountering the impacts of upstream development and climate change, with minimized investment cost. Combined adaptation measures include making use of and improving existing structures while maintaining the diverse ecosystem of the Mekong Delta, establishing new dykes and resettlement areas, in addition to protecting and developing coastal mangroves forests, adapting crops to be suitable with the impacts, and finally, focusing on climate change in working agenda and studies, creating strategic plans based on the forecasted impacts, and constructing and improving legal system on water resources management.

In conclusion, the presentation presents the need to continue studies to give a clearer overall picture of changes in the Mekong River and impacts on populations around the river basin, in order to find measures to cope with these impacts and ensure water demand can be met. Finally, the complexity of the issue requires closed cooperation among riparian countries as well as international assistance.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_4_4_vietnam.pdf

IV.3 Key discussion

The organization of transboundary cooperation evolved as a main discussion topic. Coordinated transboundary emergency response in the LMB has not yet been established. A dialogue on this topic was initiated in earlier years but attention has shifted to other fields. However, along the Mekong mainstream there are hydromet stations, which measure the water volume for the region and can serve flood management work. Also, there are relevant bilateral agreements e.g. for sharing information on flood issues between Thailand and Cambodia.

Exchange and communication with upstream countries (China and Myanmar) exists on a regular basis. There are already mechanisms in place to cooperate, including with respect to reservoir management. Improvement of cooperation is of course still helpful.

Furthermore, the Tonle Sap system was once more emphasized as a very complex natural buffer system - also in terms of flood protection. Any artificial intervention poses risks to the ecosystems as well as to the livelihood of the population, which can be hardly assessed beforehand and interventions (e.g. to abstract water from the Tonle Sap Lake during dry season for drought management) should thus be avoided.

Part V: Comparison between Rhine and Mekong Basins

V.1 Common and different challenges and issues (group discussion)

The objective of this group discussion was to identify commonalities and differences of the Rhine and Mekong basin in order to provide basis for further identification of areas for cooperation.

In groups of approximately 10 members, participants were to identify the five most relevant common challenges and issues and the five most relevant different challenges and issues they had collected during the introductory presentations on both river basins.

The results of all groups are categorized and summarized below. Certain issues have been raised by several groups, stressing the importance of the respective points.

Common challenges and issues

Topics:

- Saline intrusion, flooding and inundation, low flows and droughts, biodiversity, navigation, sedimentation & (delta) morphology, increased variation of climate, temperature increase, impacts of climate change, land subsidence, unequal distribution of water resources in time and space, groundwater management (protection, sustainability, quality and quantity), management in the future of water production and water quality because of rise of living standards

- Overall same topics, but differences in hydrological regime

Research:

- Scientific basis on floods, droughts, etc. jointly agreed, need for good data and measurements, need for finances is based on scientific results/studies, challenge of transformation of knowledge from scientific information to policy

- Many open questions: How to assess drought? How to assess sea level rise & salt intrusion? Improvement of downscaling techniques? How to deal with uncertainties? Differentiation between socio-economic and climate change impacts?

Transboundary cooperation:

- Both have river basin organizations (RBOs) and procedures/rules for transboundary water management and a function of committees and platform for discussions, information and knowledge sharing is common practice, harmonization of procedures/data/standards, best practice in transboundary cooperation, transboundary flood forecasting incl. early warning, collaboration and mutual help in emergency, water management depends on public support, national adaptation strategies/instruments developed - still a need for transboundary adaptation framework/strategy, decisions on the use of the water (which section (industry, irrigation, etc.) may use the water in dry periods)

- Challenge of how to bring member countries together and to improve cooperation

Different challenges and issues

Natural factors:

- River morphology, seasonality (also for uses), ecosystems, discharge, monsoon environment, tropical climate vs. moderate climate, fish species

Institutional framework and cooperation history:

- Different political systems of member states, having a regional legal framework, Comprehensive membership of riparian states, Mekong is border river over long stretch, Rhine flows through countries
- Rhine: Two commissions - scientific and political, all riparian countries part of governance structure, experience of cooperation since 1950, EU as overall policy umbrella, close cooperation with upstream country (Switzerland)
- Mekong: One commission for both, not all riparian countries part of governance structure, development of cooperation with China and Myanmar, different standards (e.g. for navigation)

Monitoring and data:

- Rhine: Dense hydromet network, high level of using scientific monitoring systems standards
- Mekong: Sparse hydromet network, data sharing between countries still a challenge

Financial support and mechanisms:

- Financial and funding capabilities are different (adaptive capacity)

Development level and stage - influence on priority setting:

- Rhine: Development in the past/almost completed, various infrastructure and protection measures along the river, management and protection topics are a high concern, climate change adaptation being implemented in Rhine basin
- Mekong: Very dynamic development now, land use change is a problem, low flexibility for farming (Mekong Delta), climate change adaptation pilot implementation

Low water:

- Rhine: Challenge for navigation
- Mekong: Negative effects on navigation in Mekong Delta may not be an issue because of sea level rise

Water quality/protection for different uses:

- Rhine: Industrial use/cooling, navigation, natural heritage (UNESCO) as good example, use of groundwater on large scale
- Mekong: Agriculture, fishery, no groundwater system or only small scale

Approach to flood:

- Rhine: Living against floods, protection measures (dyke, restraint) in place and maintained, public only aware during high water
- Mekong: Living with floods, exploration of options for protection measures, floods are needed for agriculture/fisheries

Part VI: Climate change adaptation strategy

VI.1 Mekong adaptation strategy (presentation)

Roadmap to formulate the Mekong adaptation strategy (MASAP) (Nguyen Huong Thuy Phan)

The *Mekong Adaptation Strategy and Action Plan* (MASAP) is an important output required for the MRC CCAI in the period of 2011-2015. The MASAP will set out strategic adaptation priorities and actions for transboundary climate change adaptation of the MRC. Those strategic actions will be addressed in the MRC 2016-2020 Strategic Plan. The MASAP will be reviewed and updated every 5 years, following the 5-year planning cycle of MRC.

At the national level, each MRC Member Country has developed its own national adaptation plan in order to address the impacts of climate change and vulnerability. CCAI will therefore conduct a policy review exercise to identify entry point for transboundary adaptation actions as well as to make sure that the basin-wide adaptation strategy will not cause conflict but instead add value to the national level. At regional level, ASEAN Adaptation Strategy (2012) is in place and focuses on sharing information and developing a work programme to address loss and damage, mitigation, issues on finance and investment, transfer of technology, and capacity building. MRC is mentioned as a regional organisation to be cooperated on climate change adaptation. According to a CCAI's preliminary review, at international level in Asia Mekong is the only river basin which aims to have adaptation strategy. In the North and South Americas, none have adaptation strategy. In Africa, the Nile is the only one with adaptation strategy while 4 river basins in Europe have or are developing their adaptation strategy.

At MRC, Basin Development Strategy (BDS) and MRC Strategic Plan (SP) are key tools for adaptation to climate change. MASAP will guide the way to integrate climate change adaptation into the BDS and the MRC SP. Therefore, the roadmaps for updating the BDS 2016-2020 and formulating the MASAP 2016-2020 must be linked. In formulation of the MASAP, considerations will be put on information on impact and vulnerability assessment; climate change scenarios for the next 30, 60, 100 years; in agreement with and having synergies to national climate change adaptation strategies; and allowing for continuous updating of the adaptation plan. The process of MASAP formulation is following the CCAI Adaptation Planning and Implementation Framework. Stakeholder engagement, capacity building and decentralisation of core functions are considered in the whole process. Mechanisms on the formulation include active involvement of all MRC Programmes, especially the Basin Development Programme (BDP); CCAI Regional Technical Working Group (RTWG); national consultations; MRC Informal Donor Meeting and Donor Consultative Group; MRC Joint Committee; and MRC Council. For the timeframe, there are 4 stages, i.e. preparation (which is where we are at present), formulation, finalisation and approval, which is aimed in December 2015.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_6_roadmap_mekong.pdf

V.2 Rhine adaptation strategy (presentation)

Towards an Adaptation Strategy in the Rhine Catchment (Ben van de Wetering)

Changes in climate values do have an impact on hydrological processes and the water regime. Therefore, the Conference of Rhine Ministers requested the ICPR in 2007 to carry out a "Study of Scenarios for the Discharge Regime of the Rhine" and subsequently in 2013 to develop an adaptation strategy.

Following a review of available literature in 2009 (ICPR Report No. 174), a study on direct effects of climate change on the water regime was published in July 2011 (ICPR Report No. 188). The results (in form of discharge scenarios for 2050 and 2100 resulting from climate scenarios) have been evaluated within the different ICPR working groups with a view to assessing potential effects on the ecology (ICPR Report No. 204), water quality of the Rhine as well as on the risks of floods and low water.

Following this, the possible impact on different uses (e.g. during floods and during low flow combined with high temperature) is being assessed as well as possible measures to reduce these impacts. This assessment will be the basis for a preliminary adaptation strategy for the Rhine and its catchment which should be finalized by the end of 2014.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_6_roadmap_rhine.pdf

VI. 3 Key discussion

Although the adaptation strategies of the two basins are being developed with comparable approach, the starting points are different. Basin wide researches have been done quite substantial in the Rhine and has just started in the Mekong.

The strategic focus is also different. One field which has already been analyzed for the Rhine is water temperatures and assessment of possible changes in water temperature. These are of particular importance for power production as the river water is used for cooling purposes and for drinking water supply.

With respect to impact studies, the MRC has so far investigated impacts of climate change on wetlands as well as impact on irrigation and agriculture, but not on water temperatures yet. However, the water temperatures in the Mekong are of course already within a much higher range than in the Rhine and aquatic species might also be less sensitive to higher temperatures.

The adaptation strategy of the LMB is being developed to be linked to the Mekong Basin Development Strategy. In the Rhine basin, there are two umbrella conventions: The Rhine 2020 Action Programme and EU legislation (Water Framework Directive, Floods Directive, etc.).

The timeframe for the Rhine adaptation strategy is governed by the Water Framework Directive. Once every 6 years a river basin management plan has to be issued. The second plan which is due as a draft version in 2014 includes also the issue of climate change.

It was furthermore contributed with respect to the uncertainty of climate change impacts that it is difficult to derive from assessment conclusions recommendations for policy makers. There are in principal three types of responses. (1) Do nothing and wait until impacts become apparent, which is not reasonable as it may require later very large investments within a very short time period. (2) Prepare for the worst case scenario, which may not be an economic solution. (3) Follow a no-regret and flexible adaptation strategy, which allows action despite uncertainty.

Part VII: Comparative overview of Rhine and Mekong (presentation)

Comparative overview of climate change and ways to an adaptation strategy in the Rhine and Mekong basins (Kai Gerlinger)

To face the challenges posed by climate change by means of an effective adaptation strategy, a knowledge basis on the nature of climate change and related risks is needed. In order to avoid superfluous investments, transboundary cooperation of nations within one single catchment is desirable.

The first step in a comprehensive approach to adapt to climate change is thus the identification of the current transboundary knowledge on past and future climate change. Such review documents exist (Rhine basin) or are currently being prepared (Mekong basin) in both considered basins.

The temperature record analyses collected within this context within the Mekong and Rhine basins show already the influence of climate change in the past. Ranges of detected temperature increase are of the same order of magnitude in both basins. Reviewed changes in precipitation records are very unequivocal and no clear trends can be identified.

Projections of future climate change are usually obtained by a model chain consisting of an emission scenario, a general circulation model, possibly a downscaling procedure and eventually different impact models. A broad variety of such climate projections exists already for both basins.

The most recent, comprehensive climate projections which exist for the entire globe and allow thus a direct comparison of results for both basins, are the projections presented in IPCC's Fifth Assessment Report (AR5).

The median of these projections points towards slightly stronger future temperature increases in Central Europe than in South-East Asia. Precipitation projections are very heterogeneous for both regions, with a larger inter-model range covered in South-East Asia. The median of all projections indicates slight precipitation increases for both regions in the respective wet season.

Possible hazards deduced from climate change are on the very large spatial scale considered in the AR5 also to some extent comparable. The resulting risks are, however, of a more substantial nature in the LMB.

IPCC AR5 delivers coherent results for mean trends deduced from global circulation models. For effective regional and local adaptation, these results are too general. However, if a downscaling towards a higher spatial resolution is undertaken, the uncertainty and complexity of the results increases. Also, mean changes in climate parameters - such as described above for both regions - are interesting, but at the same time, information on extreme events is relevant for the development of an adaptation strategy. Projections of extreme events feature yet also higher uncertainty and complexity. In order to increase adaptive capacity in different sectors, information on changing climate does not suffice. There is additionally a need for a model chain including impact models to assess consequences of climate change. This extended model chain implies also growing uncertainties and complexities.

Although the Rhine and Mekong basins feature many different characteristics, the way towards an adaptation strategy is similar. In both basins, several steps on the way from the analysis of climate and hydrological change via the assessment of its impacts towards policy issues of adaptation have already been undertaken. One example are the literature reviews mentioned above which build a foundation for further steps. Other steps are currently initiated and ongoing. It should be kept in mind, that the approach towards adaptation is not a straight linear procedure. Instead, different steps have to be tackled by appropriate measures at the same time.

The understanding that the approach to adaptation may be similar in both catchments offers possibilities for knowledge exchange and cooperation. Eventually, the fact that climate change assessment is always associated with considerable uncertainties should not prevent decision making.

The presentation can be found online:

http://www.chr-khr.org/sites/default/files/chreventdocuments/part_7_comparative_climate_change_overview_0.pdf

Key discussion

It was clarified that the impact model and impact assessment usually go together. However, impact assessment must not necessarily be based on a modelling approach. One example is the Social Impact Monitoring and Vulnerability Assessment (SIMVA) study conducted by MRC based on surveys.

Part VIII: Areas for cooperation

Areas of joined cooperation (group and panel discussion)

This group discussion was intended to identify possible areas of cooperation between the Rhine organizations and the Mekong River Commission on the way towards respective climate change adaptation strategies.

The knowledge basis for the group discussion was formed by the previous presentation and the approach towards an adaptation strategy identified therein. The different working steps of the approach were grouped under three different topics and separate groups were tasked with identifying potential areas of cooperation for each of these three topics (see also FigureFigure 1).

- Group 1: Climate and hydrological changes and assessment including flood and drought
- Group 2: Addressing climate change impacts and assessment in water related sectors
- Group 3: Transboundary and policy issues in climate change adaptation

Three common guiding questions for all groups identified:

- What has been done so far?
- What is currently happening?
- Which starting points/ideas exist for cooperation?

The results elaborated by all working groups were presented and discussed in a panel discussion. The outputs are summarized below.

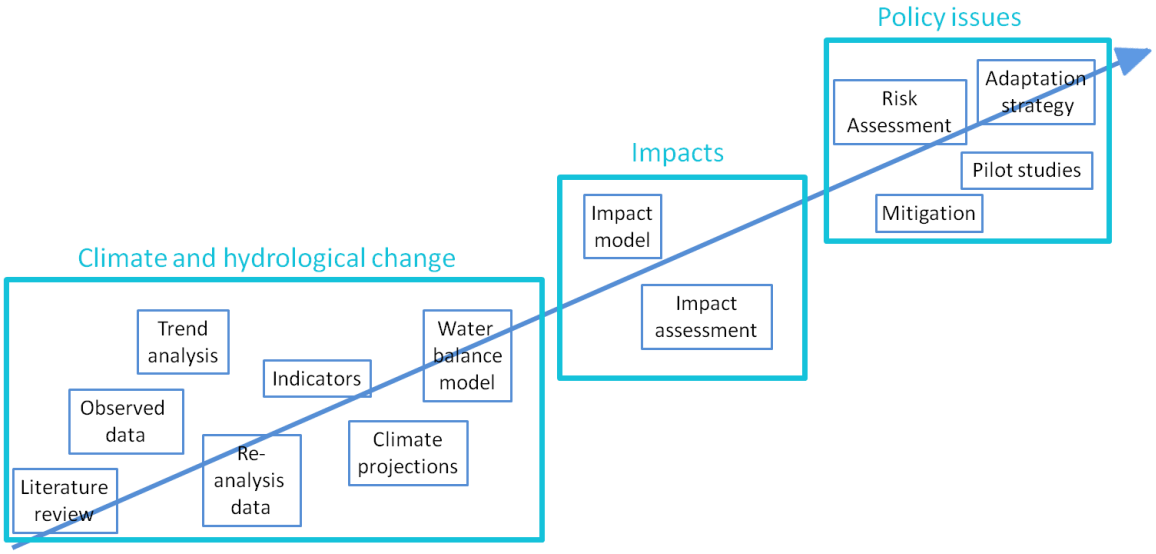

Figure 1. Group division based on the working steps of an approach towards an adaptation strategy

Group 1: Climate and hydrological changes and assessment including flood and drought

Facilitators: Wolfgang Grabs and Thanapon Piman

The group discussion included the topics of historical hydro-meteorological data (including trend analysis and reanalysis data), climate change indicators, climate projections and hydrological modeling.

Generally, the current status of work on these topics in both basins was first shortly reported, which was followed by a comparison of further relevant concerns and necessary working steps. With respect to each field, there were some key challenges identified, which have to be tackled in both river basins and provide thus a basis for potential cooperation, although the natural, socio-economic and political preconditions may differ substantially.

The following issues have been agreed upon by members of Group 1:

Data issues

- Data quality management: Storage and access to data, Preparedness of member countries to share information
- Concern: diminishing information collected from private operators of dams and reservoirs

Indicators:

- How to measure climate change and characterize adaptation impacts
- Development of robust indicators
- Define threshold levels

Climate projections:

- Comparable approaches to dynamical downscaling
- Foster cooperation with centers of excellence in riparian countries
- Comparable approach to the selection of models
- Strengthen decadal observation driven projections

Water balance model

- Use of hydrological ensembles
- Cooperation on modeling
- Strengthen information on consumptive water use for water resources management
- Develop a dynamic approach to water resources assessment

Group 2: Addressing climate change impacts and assessment in water related sectors

Facilitators: Johannes Cullmann and Tran Mai Kien

The facilitators proposed the group to discuss potential impacts of climate change by sectors and pay attention to priority sectors for each river basin, with view to reveal common issues rather than differences as in the previous group discussion. The discussion was also facilitated with orientation towards possibility for adaptation actions and some comparison between the two basins to extract the lessons learned.

Priority sectors proposed and agreed by participants are: agriculture and fisheries which linked to food security (most important for the Mekong but less for the Rhine), navigation (most important for the Rhine and having high potential in different parts of the Mekong), environment including water quality and biodiversity. Most serious and common risks are extreme events leading to flood and

droughts, sea level rise (for the deltas and estuarine/coastal zones of both river basins) and environmental degradation.

The participants from the Mekong basin started discussing the impact of climate change on fisheries (both captive fisheries and aquaculture) since climate change impacts may cause fish population and number of fish species to decrease. They also added that an increase in temperature can adversely affect the habitat, breeding zone and food for fish which in turn can lead to changes in migration pattern or shift to new habitat. At the same time, the participants from Rhine River stated that fish was not an issue for the Rhine.

The group also discussed about the climate change impact on food security and emphasized that this issue is very broad and interconnected with many sectors. They mentioned that climate change can cause outbreak of diseases affecting crop and fish. Another impact of climate change is a change in water flow and sea level rise which leads to salinity intrusion and land degradation and erosion in the Mekong Delta. This will have most serious negative impacts on agriculture production. One of the solutions was to build dike and salinity preventive sluice systems to prevent the intrusion while at small scale (e.g. in Mekong Delta), natural coastal protection by mangrove forest can be effective to some extent.

Navigation was another topic that the group brought into the discussion. The Mekong group recognized that overall in the Mekong climate change is not a big question for this issue since there is enough water for navigation in both dry and wet seasons in most of the navigable zones. On the other hand, the Rhine group emphasized that climate change related extreme water level and flow (very high or very low) may cause strong impact on the navigation. During dry and low water level period, shipping may be difficult due to narrow waterways, while during flood time the transportation remains difficult as the ships can be damaged, hit the bridges or debris. This leads to rising prices for shipment during recent decades in Europe.

Appendix 5: Speaker's profiles

PART 2: Common knowledge on both catchments		
Introduction to both catchments and transboundary cooperation - Rhine		
	**MANFRED SPREAFICO** Former president of CHR	Manfred Spreafico studied at the Department of Civil Engineering of the Federal Technical University at Zurich. In the past, he was Head of the Swiss National Hydrological Survey and now a professor at the Institute of Geography, University of Berne as well as former President of the International Commission for the Hydrology of the Rhine Basin. Furthermore, he worked as chairman, secretary and member of committees as well as of working groups in the fields of hydrology and IWRM in national and international organizations and institutions. He has also experience as lecturer, trainer, project manager and project member in more than 60 countries. He still works as a consultant for Integrated Water Resources Management, specialized in hydrometeorology, flood and sediment management.
Introduction to both catchments and transboundary cooperation - Mekong		
	**TIEN TRUONG HONG** Director of the Environment Division, MRC Secretariat	Tien Truong Hong holds a degree in irrigation and drainage engineering from the Moscow Water Resources University, a master degree in water resources development from the Asian Institute of Technology and a doctoral degree in civil engineering and environment from the Nagoya University, Japan, where he conducted postdoctoral studies in the field of soil and groundwater contamination and remediation. In the past he worked at the Viet Nam National Institute for Agricultural Planning and Projection, at the Regional Flood Management and Mitigation Programme of the MRC Secretariat, and as Deputy Director General at the Viet Nam National Mekong Committee. Currently he is the Director of the Environment Division of the MRC Secretariat.

PART 3: Common knowledge of the Rhine and country examples		
Overview of current work of CHR, BfG and ICPR on climate change in the basin		
	**ERIC SPROKKEREEF** CHR	Eric Spokereef is a civil engineer. He started working at Rijkswaterstaat as technical assistant within the secretariat of the International Commission for the Hydrology of the Rhine basin (CHR) and has more than 25 years experience in operational river flood and drought forecasting for the Netherlands, first as member of the forecasting group and since 2000 as head of the Dutch river forecasting centre. Since 2002, he works as Secretary of the CHR. He was active in several international cooperation projects like the European Flood Foresting System, the WMO RA VI Sub group on Flood Forecasting and Warning, the EU working group Exchange Circle on Flood Forecasting and the European Flood Awareness System (EFAS). Furthermore, he is project leader for the cooperation between the Netherlands and China on Flood Management and Protection.

		**SEBASTIAN KOFALK** Federal Institute of Hydrology, Germany	Sebastian Kofalk holds a PhD in agricultural sciences. He works at the German Federal Institute of Hydrology since 1999 where he was, amongst others, head of the project group Elbe-Ecology. Currently, he is responsible for the management of the project KLIWAS. This project analyzes the potential consequences of climate change for navigation on inland and coastal waterways and formulates appropriate strategies for adaptation.
		**ADRIAN SCHMID-BRETON** ICPR	Adrian Schmid-Breton is a geographer with a specialization in natural risk management. He works since 2010 as a scientific assistant within the Secretariat of the International Commission for the Protection of the Rhine supporting and coordinating the international working group "Floods" and its expert groups dealing with transboundary flood risk management and climate change adaptation. He is particularly interested in integrated management, socio-economical, environmental and risk aspects of international rivers.
		**RALPH SCHIELEN** Rijkswaterstaat	Ralph Schielen got his PhD in applied mathematics. He works since 2000 for Rijkswaterstaat as expert on river hydraulics and morphology. Between 2000 and 2005 he was involved in policy-studies along the river Meuse in the Netherlands. After that, he participated in the Room for the River project. Now he works for the Deltaprogram|Rivers which aims at maintaining the Netherlands as a safe and reliable country to live in and to work in for the long term (up to 2100), taking into account the effects of climate change. He also holds a position for one day a week as associate professor at Twente University, department of Civil Engineering and Management.
		**ENNO NILSON** Federal Institute of Hydrology, Germany	Enno Nilson holds a degree in Geography, Geology, Soil Science and Forestry from the University of Bonn and a doctoral level in Physical Geography. Since 2007, he is a researcher at the German Federal Institute of Hydrology. Within the department Waterbalance, Forecasting and Predictions (BfG-M2) he is responsible for research and consultancy in the fields of water-related aspects of climate change. He coordinated the research activities on inland hydrology within the German research programme KLIWAS between 2007 and 2013.

PART 4: Common knowledge of the Mekong and country examples

Overview of current work of MRC on climate change in the basin			
		**NGUYEN HOUNG THUY PHAN** MRC's Climate Change and Adaptation Initiative (CCAI)	Phan Nguyen holds a position as Programme Coordinator at MRCS in charge of the Climate Change and Adaptation Initiative, a regional cooperation initiative of the MRC to assist the Member Countries in policies and actions concerning climate change adaptation issues of the Lower Mekong Basin. By training she has a Doctor of Engineering in Water Resource Development. She is a hydraulic engineer and a hydrodynamic and morphological modeller with more than 20 years of combined experiences in hydropower development projects, coastal engineering projects, and climate change risk assessment projects.

		**NICO BAKKER** MRC's Flood Management and Mitigation Programme (FMMP)	Nico Bakker is the International Technical Advisor of MRC's Flood Management and Mitigation Programme. He is a civil engineer and worked for 27 years for the Netherlands' Ministry of Transport, Public Work and Water Management. In parallel, he served as "water management specialist" for the Netherlands' Ministry of Foreign Affairs for international assignments during 18 years. He has joined the MRC since 2005.
		**H.E. Mr. KOL VATHANA** Deputy Secretary General and National Coordinator for MRC Climate Change and Adaptation Initiative Programme (CCAI), Cambodia National Mekong Committee (CNMC), Cambodia	H.E. Mr. Kol Vathana holds a degree in forest science of the Royal University of Agriculture, Cambodia, and a degree in Soil Science of the University of Gent, Belgium. He worked for the Department of Forestry and Wildlife, Cambodia, as well as for the Department of Nature Conservation and Protection of the Cambodian Ministry of Environment. For the past 11 years he has been working for Mekong cooperation in the Cambodia National Mekong Committee (CNMC), where he is now a Deputy Secretary General and National Coordinator for the MRC Climate Change and Adaptation Initiative.
		**VANXAY BOUTTANAVONG** Deputy Director of the Climate Change Adaptation Division, Department of Disaster Management and Climate Change, Lao PDR	Mr. Vanxay Bouttanavong holds a degree in agriculture and a degree in business administration. He is Deputy Director of the Climate Change Adaptation Division in the Department of Disaster Management and Climate Change of the Ministry of Natural Resource and Environment of Lao PDR. For the past 5 years he has been working on various climate change issues.
		**CHAIPORN SIRIPORNPIBUL** Deputy Director General, Department of Water Resources, Ministry of Natural Resources and Environment, Thailand	Mr. Chaiporn Siripornpibul holds a degree in Geology from Chiang Mai University and a degree of Public Administration from Sripathum University, Thailand. From 2002 to 2010 he was Director of the Bureau of Groundwater Conservation and restoration in the Department of Groundwater Resources of Thailand. Since 2010, he has been a Deputy Director General of the Department of Water Resources of the Ministry of Natural Resources and Environment of Thailand.
		**NGUYEN XUAN HIEN** Director of Southern Institute for Water Resources Planning (SIWRP), Vietnam	Mr. Nguyen Xuan Hien is a senior hydraulic modeller in the Southern Institute for Water Resources Planning in Vietnam. He has extensive experience in working with hydraulic models.. He has applied the VRSAP model for simulations of hydraulics and of salinity intrusion in many water resources projects in the Mekong Delta. In addition to his modelling experience, Mr. Hien also has many years of experience in water resources planning and management.

PART 6: Formulation of transboundary climate change adaptation strategy

Mekong			
		**NGUYEN HOUNG THUY PHAN** MRC's Climate Change and Adaptation Initiative (CCAI)	Phan Nguyen holds a position as Programme Coordinator at MRCS in charge of the Climate Change and Adaptation Initiative, a regional cooperation initiative of the MRC to assist the Member Countries in policies and actions concerning climate change adaptation issues of the Lower Mekong Basin. By training she has a Doctor of Engineering in Water Resource Development. She is a hydraulic engineer and a hydrodynamic and morphological modeller with more than 20 years of combined experiences in hydropower development projects, coastal engineering projects, and climate change risk assessment projects.

Rhine			
		**BEN VAN DE WETERING** Secretary of ICPR	Ben van de Wetering graduated as chemical engineer at the Technical University Enschede in the Netherlands in 1975. He started his career at the National Institute for Public Water Supply. This was followed by a position at the National Institute for Inland Water Management and Waste Water Treatment. At this institute, he started his international career in 1984 as national delegate in several international fora. In 1995, he was appointed as Executive Secretary of the OSPAR Commission on the Protection of the Marine Environment of the North East Atlantic. In the period 2001-2005, he was one of the lead authors at the European Commission for developing the European Marine Strategy Directive. In 2007, he was appointed as Secretary General of the International Commission for the Protection of the Rhine.

PART 7: Rhine-Mekong cooperation

		**KAI GERLINGER** HYDRON GmbH	Kai Gerlinger holds a PhD in engineering. From 1997 until 2007, he was employed as head of the hydrology department at Dr.-Ing. Karl Ludwig Consulting Engineers Hydraulics and Hydrology Engineering. His work included the development, programming and application of hydrological models in national and international contexts. Since 2008, he works as director of HYDRON GmbH Hydrological and Environmental Consulting and Engineering. In 2013, he has been working as a consultant to support MRC with respect to technical aspects of flood management and climate change modeling. Furthermore, he conducted on behalf of MRC and ICPR, respectively, literature reviews to distil currently available knowledge on the impacts of climate change on the water environment of the Rhine and Lower Mekong Basins.

Appendix 6: Selected symposium photos