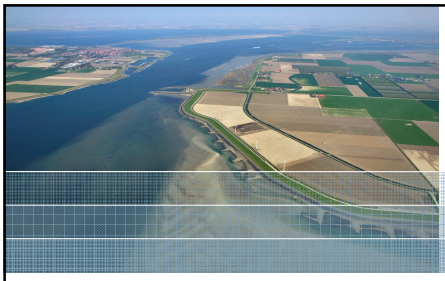

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Enabling Delta Life

Future Extreme Peak Flows in the Rhine basin

RheinBlick2050 project

1st of October 2010

Rhine basin
(upstream from Lobith)

Assumption often made:

Change in mean month discharge

EQUALS ?

Change in extreme river discharge

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Contents

- Methodology for high flow calculations
- Validation
- Projected changes
- Comparison with KNMI-06 based
- Conclusions

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Sub-selection of Rheinblick Ensemble

GCM	RCM
ARP	Aladin45
	HIRHAM5
EH5r1	REMO_10
EH5r3	RACMO
	REMO
HADCM3Q0	CLM
HADCM3Q3	HADRM3Q3
~~HADCM3Q16~~	~~HADRM3Q16~~

These climate projections represent large part of bandwidth contained in overall ensemble

Source: FP7 Ensembles project

Emission scenario: A1B

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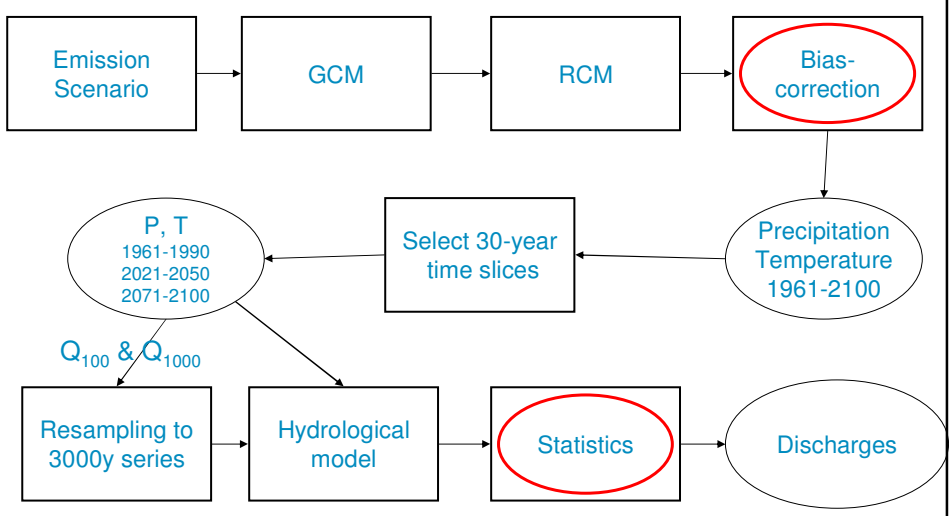
Modeling framework



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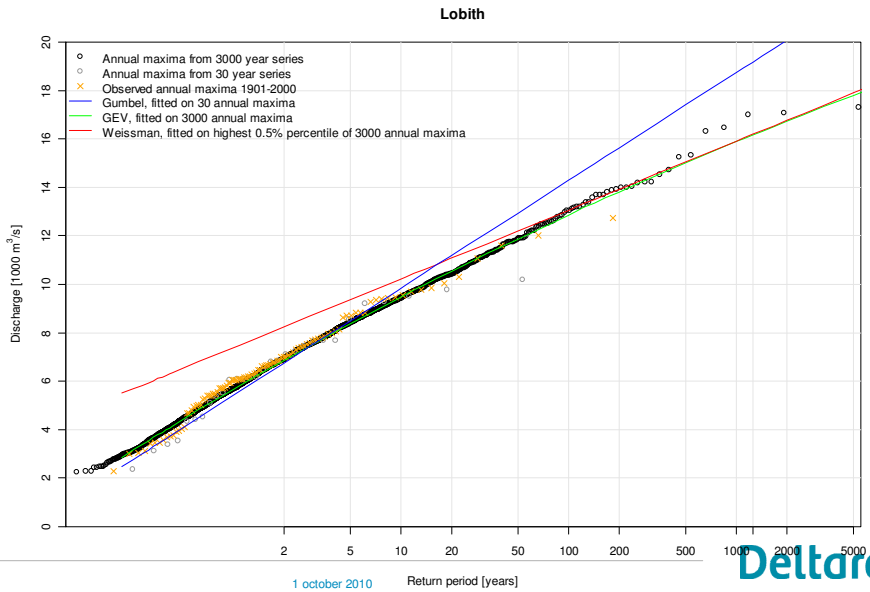
Time series extra- and interpolation



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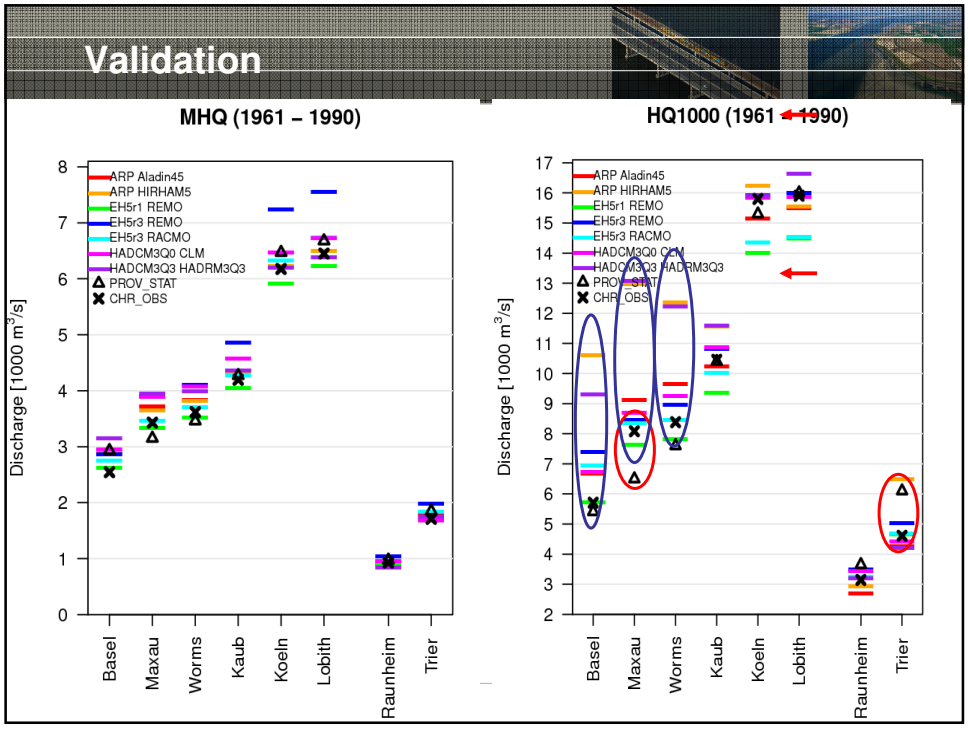
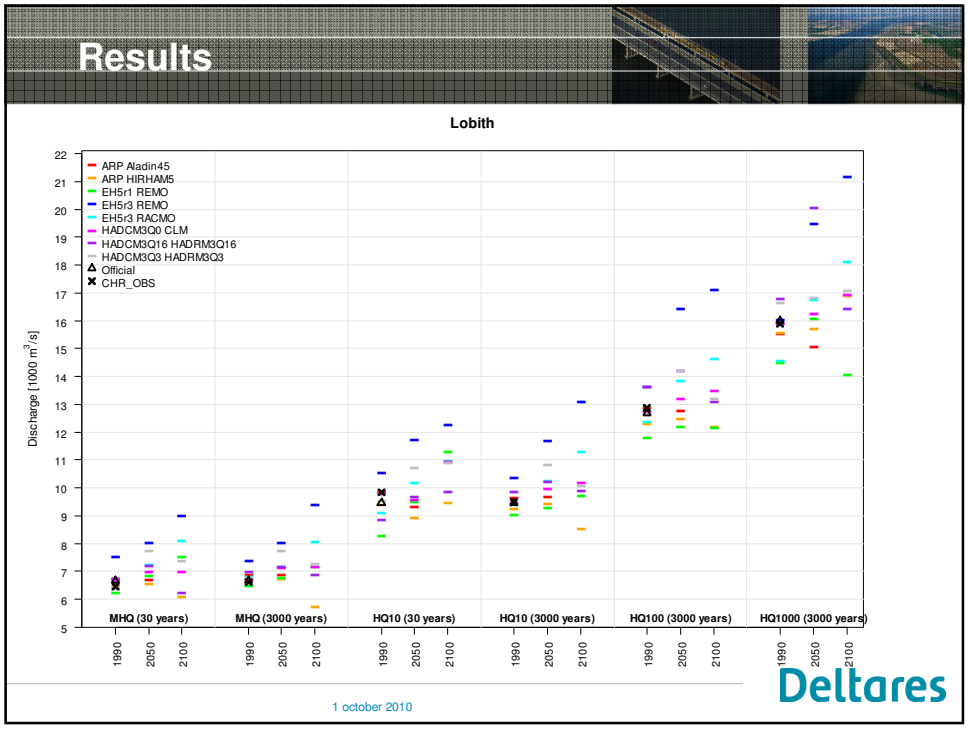

Validation
MHQ (1961 – 1990)
HQ1000 (1961 – 1990)
Discharge [1000 m³/s]
ARP Aladin45
ARP HIRHAM5
EH5r1 REMO
EH5r3 REMO
EH5r3 RACMO
HADCM3Q0 CLM
HADCM3Q3 HADRM3Q3
PROV_STAT
CHR_OBS
Basel
Maxau
Worms
Kaub
Koeln
Lobith
Raunheim
Trier


Results
Lobith
Discharge [1000 m³/s]
ARP Aladin45
ARP HIRHAM5
EH5r1 REMO
EH5r3 REMO
EH5r3 RACMO
HADCM3Q0 CLM
HADCM3Q16 HADRM3Q16
HADCM3Q3 HADRM3Q3
Official
CHR_OBS
MHQ (30 years)
MHQ (3000 years)
HQ10 (30 years)
HQ10 (3000 years)
HQ100 (3000 years)
HQ1000 (3000 years)
1990
2050
2100
1 october 2010
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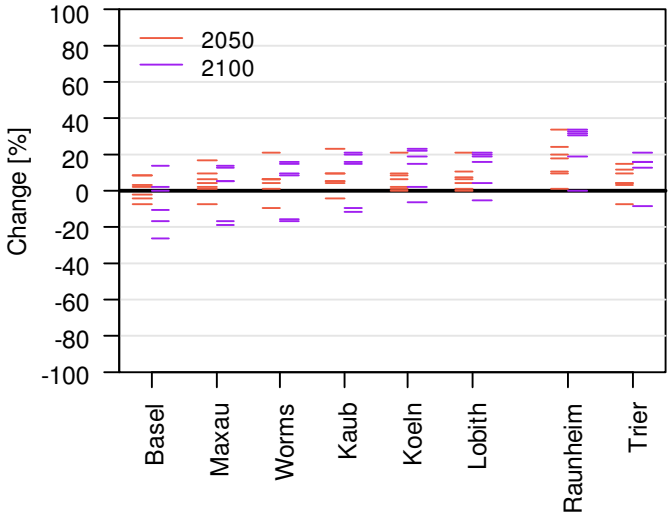
Mean maximum discharge



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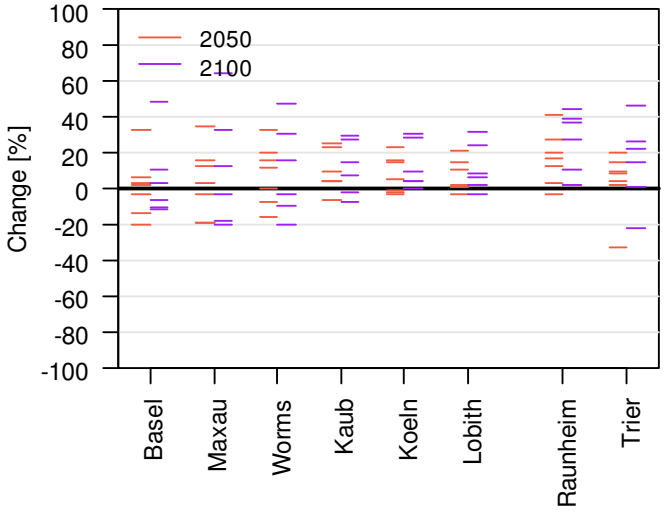
1000-year return flow



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Results

Lobith	2021 to 2050	2071 to 2100
MHQ	0 to +20 %	-5 to +20 %
HQ10	-5 to +15 %	0 to +35 %
HQ100	0 to +20 %	0 to +25 %
HQ1000	-5 to +20 %	-5 to +30 %

Kaub	2021 to 2050	2071 to 2100
MHQ	-5 to +25 %	-10 to +20 %
HQ10	-15 to +15 %	-5 to +40 %
HQ100	-5 to +20 %	-10 to +25 %
HQ1000	-5 to +25 %	-10 to +30 %

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Are these projections different from before?

At Lobith:

	2021-2050		2071-2100	
	Rheinblick	KNMI 06	Rheinblick	KNMI 06
$MQ_{jan-mar}$	+5 to +20	+5 to +15	+10 to +35%	+15 to +30%
MHQ	0 to +20 %	+5 to +15%	-5 to +20 %	+10 to +24%
HQ1000	-5 to +20 %	+5 to +20	-5 to +30 %	+5 to +40%

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Conclusions

- Overall, clear tendencies to increase are found for Raunheim (Main), Trier (Moselle), Köln and Lobith, in particular for the far future. For the near future the tendencies are generally smaller and noisier (except for Raunheim).
- No conclusions can be drawn for Basel, Maxau, and Worms since there is limited confidence in the extreme discharge projections as a result of the problem with the applied bias-correction in this part of the Rhine basin.
- The scenario bandwidths and thus the (relative) uncertainties become larger going from the near to the far future. In addition the uncertainties (bandwidths) increase going from MHQ to HQ1000
- The approach taken in Rheinblick results valuable for the calculation of extreme peak flows

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Recommendations (1)

As the current state of the art in climate modeling is far from producing unbiased climate projections, a clear need exists for further development of non-linear bias correction methods that are robust and generally applicable to any climate model simulation, any area of the river basin and any (hydrological) season of the year, and that are suitable for any target statistic of interest. Also research is needed on objective criteria to reject climate projections that do not produce realistic results.

Still some shortcomings exist with regard to the hydrological model of the Rhine River basin used in this study. In particular the upper part of the basin, upstream from Maxau, needs a better description of the hydrology. Maybe even more relevant is to analyze the validity of the hydrological models under unprecedented circumstances as a result of the changing climate (e.g. evaporation and routing approaches), and improve the model accordingly.

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Recommendations (2)

In the Rheinblick2050 project no hydrodynamic modeling has been performed. Although the routing module in HBV134 does also approximate the damping of flood waves, hydrodynamic modeling provides a much better physical basis. It is necessary however that this physical basis is also valid for the future (*read:* part of a possible water management scenario) and that the model descriptions are realistic enough to cope with the discharges that can occur under climate change. E.g. upstream overtopping of dikes can diminish the downstream peak flow considerably.

As uncertainties in the future behavior of a water system under climate change are inherent, besides an effort to reduce uncertainty it is also imperative to strengthen the scientific basis for dealing with uncertainties in climate change from an adaptation perspective. The use of critical thresholds for decision making processes is an example to be mentioned here.