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Modelling human interventions in the Rhine basin using the hydrological model SIMGRO

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- Simgro model application to the Rhine basin

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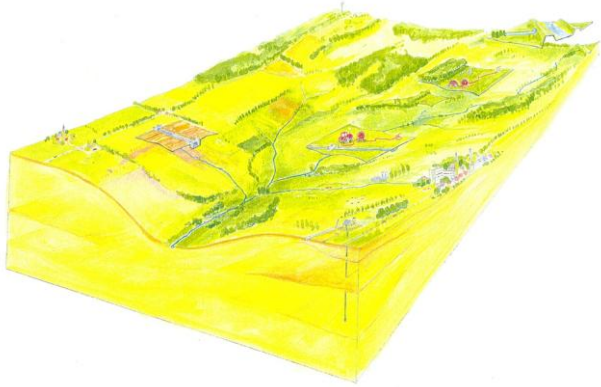
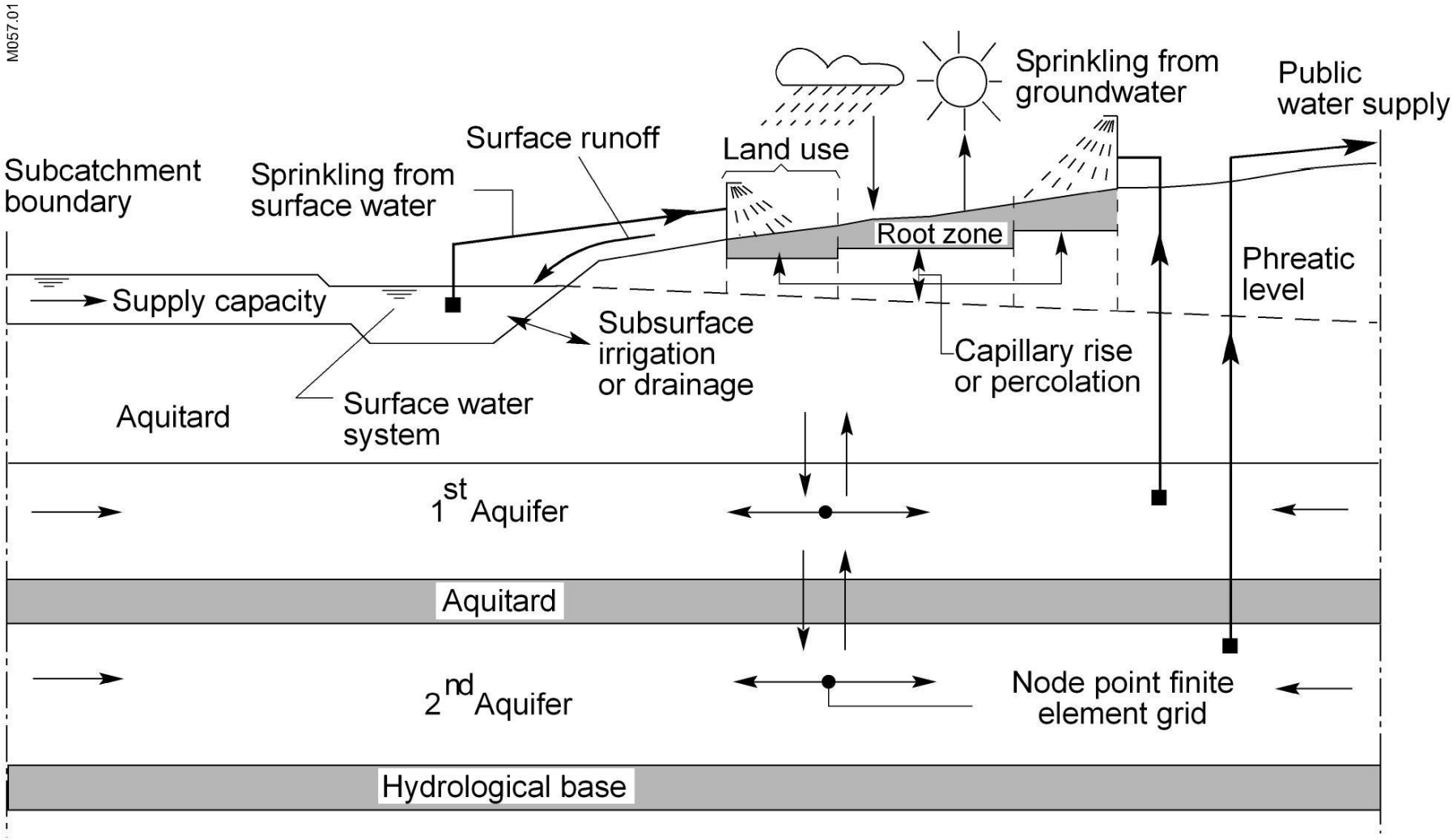


Objective of the study

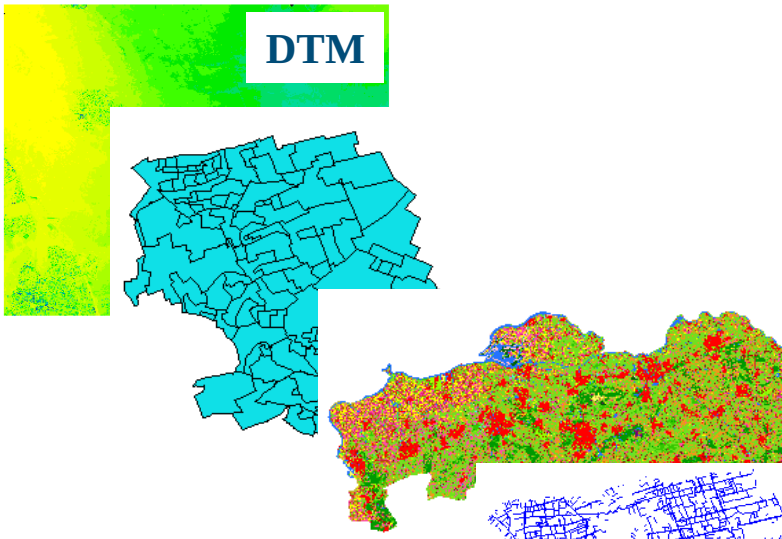
- How does a physical based hydrological model perform for a basin as the Rhine (snow module)
- Quantify the effect of land use and climate change on river flows
- What are the changes on droughts or low flows

Hydrological model SIMGRO



Aim of model SIMGRO

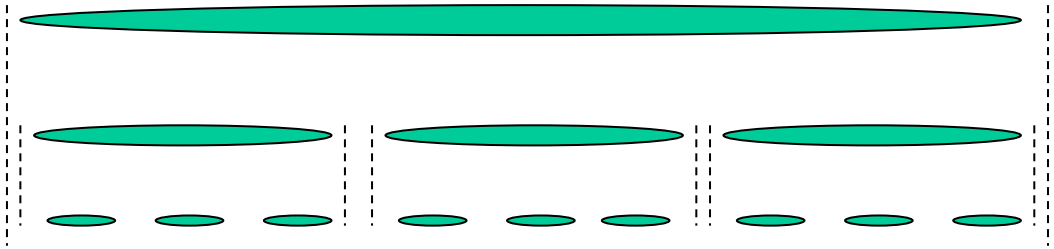
- Physical based model
- For practical problems and hydrological research



Model area

Subcatchments

Nodes



Modelling the Rhine basin

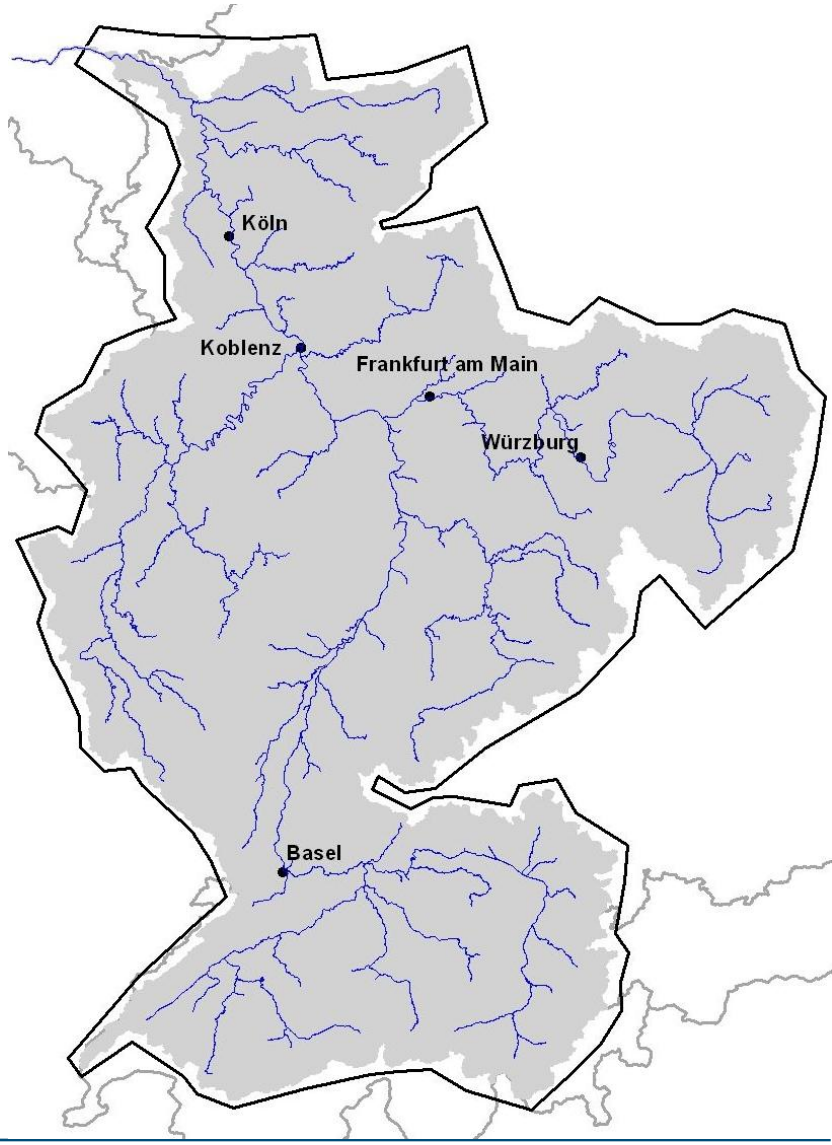
Basin area: 160 000 km^2

Mainly Switzerland, Germany, France,
Luxemburg, Belgium >> Netherlands

Finite element network:
5 x 5 km ; 8144 cells

Surface water:
Larger rivers > 400 km^2
630 sub catchments

Groundwater:
data Rhine Commission (CHR)
Land use: CORINE
Soil map FAO



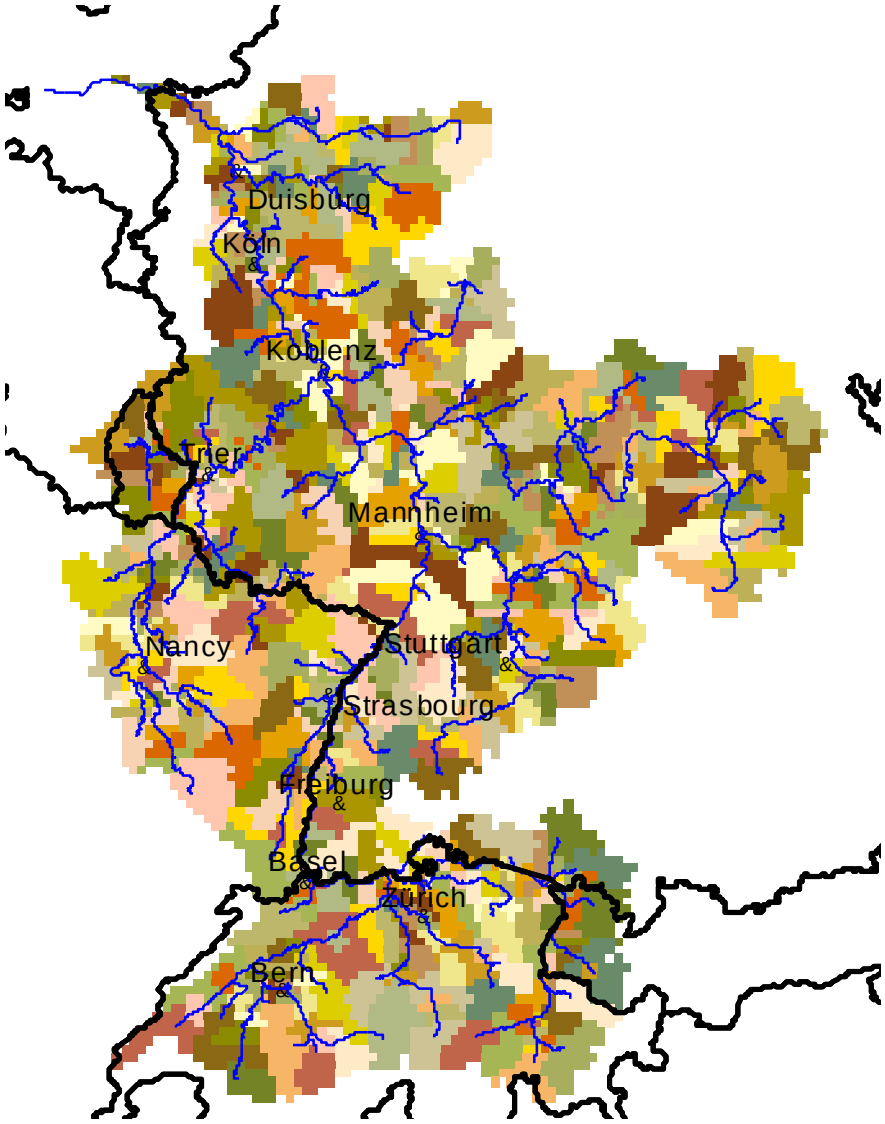
Surface water

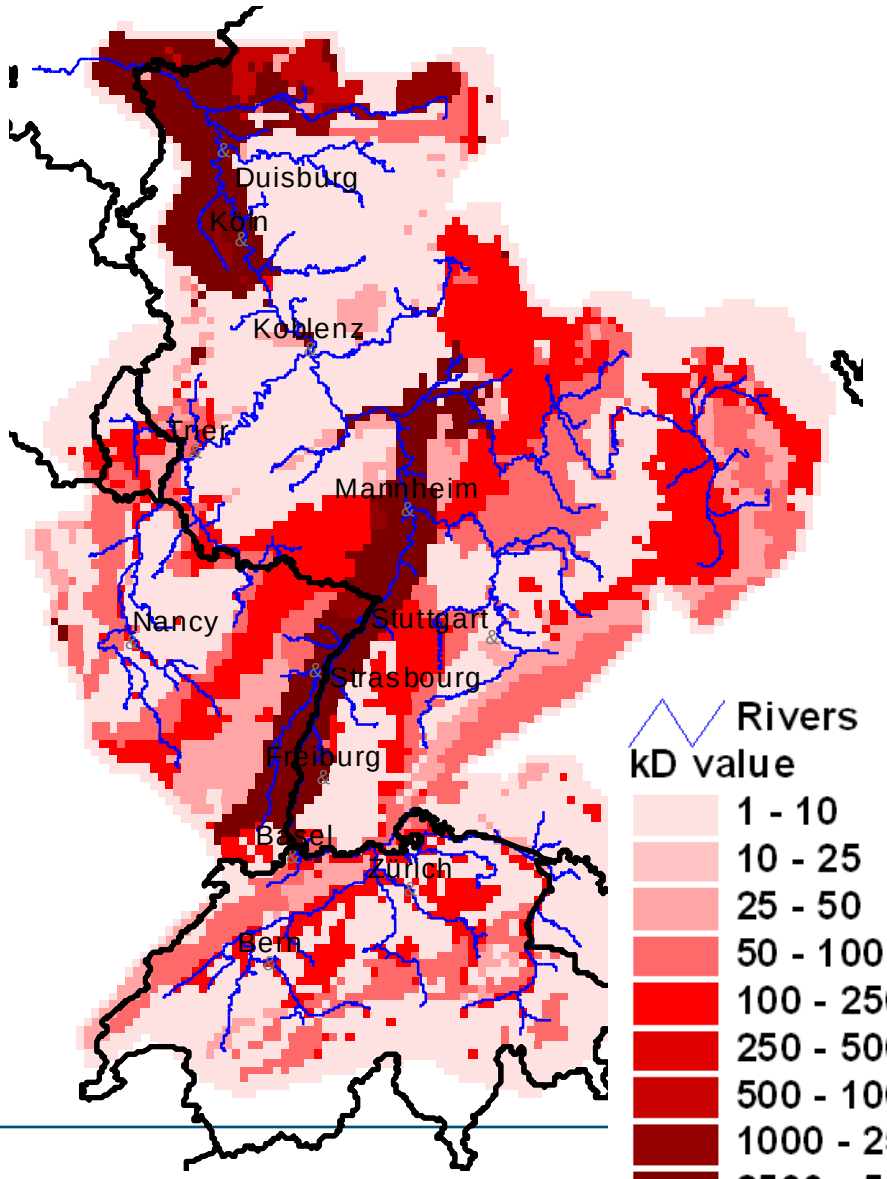
Drainage network is derived from DTM (Voigt e.a., 2007)

Important for interaction groundwater – surface water

SW: sub catchments

GW: transmissivity





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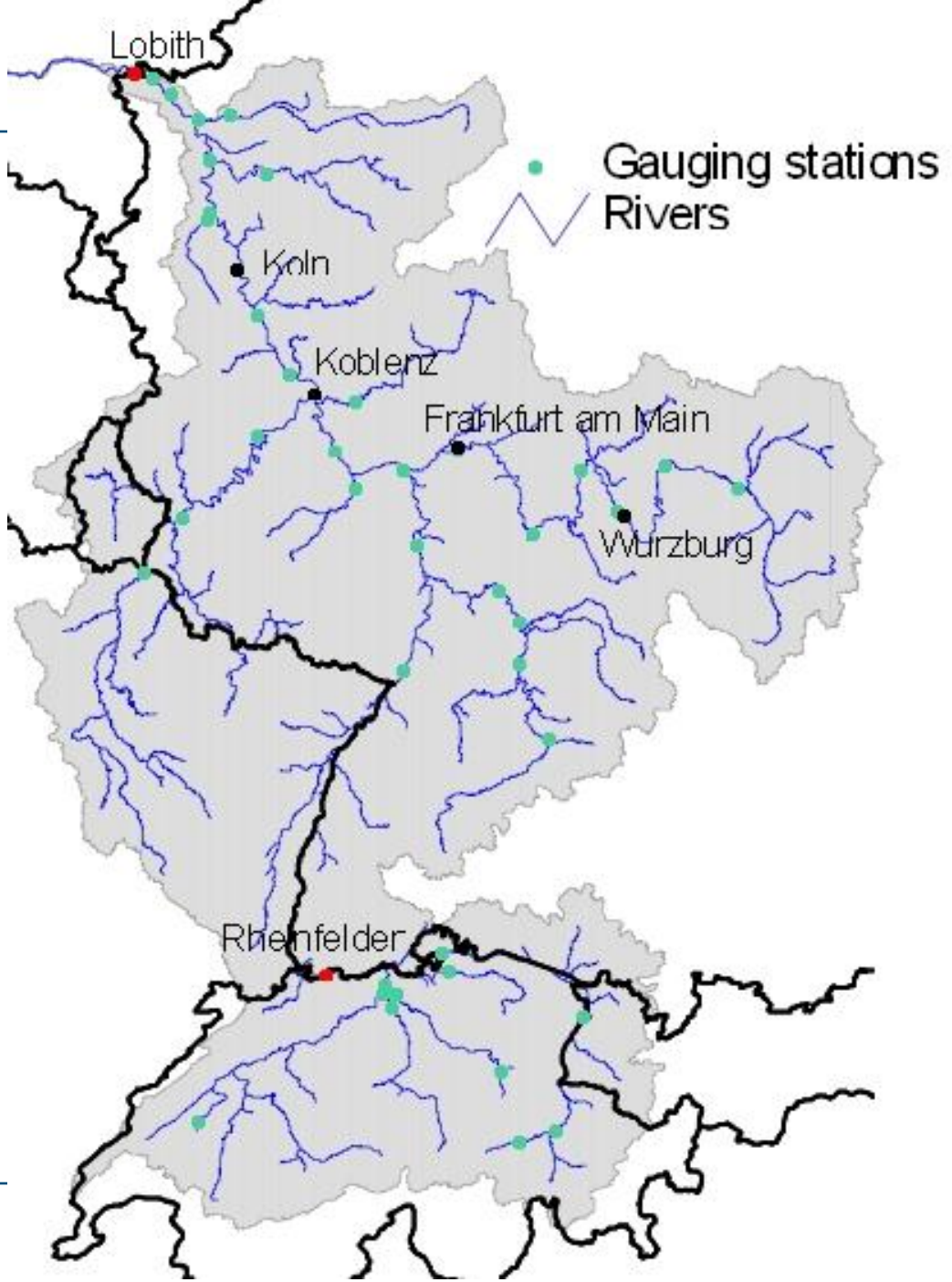
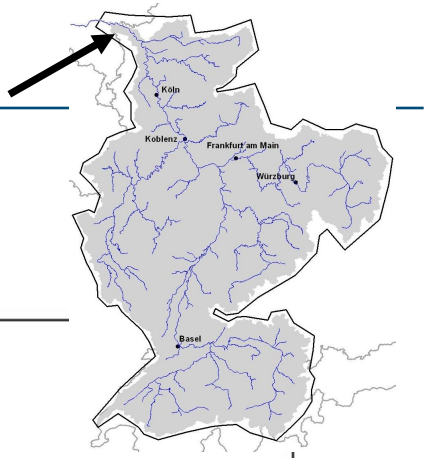
Gauging stations

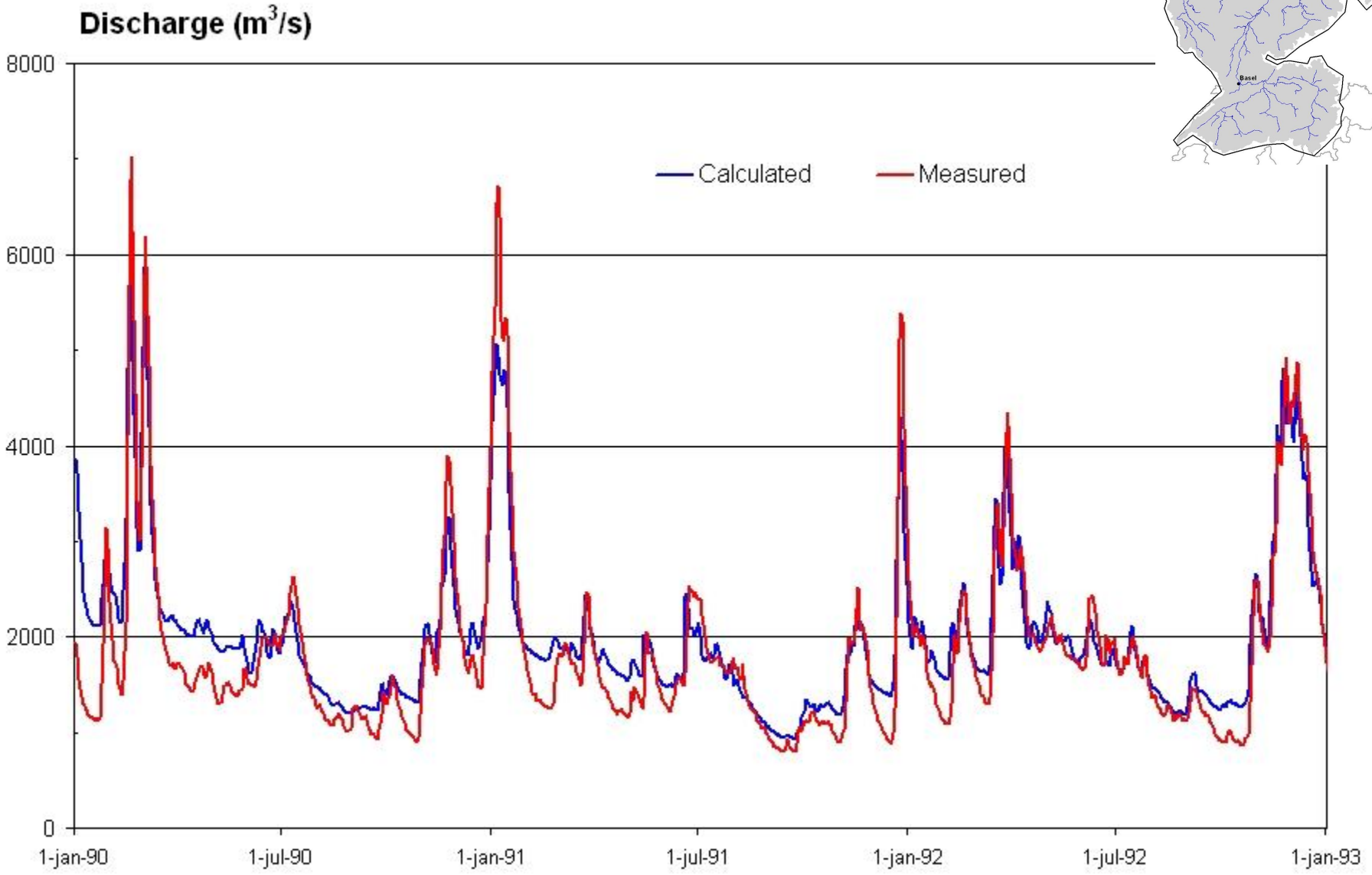
42 gauging stations used

Procedure to compare calculated-measured discharges in term of Nash-Sutcliffe model efficiency



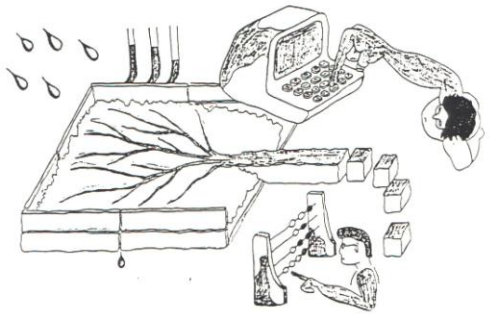
Lobith – compare measured and calculated





Nash-Sutcliffe modelling efficiency

Lobith	0.90	
Main	0.74	
Neckar	0.65	
Moselle	0.79	
Switzerland (5 stat)	0.30	
Downstr. Switzerl. (13 stat)		0.79



Scenarios

- Land use change (extreme)

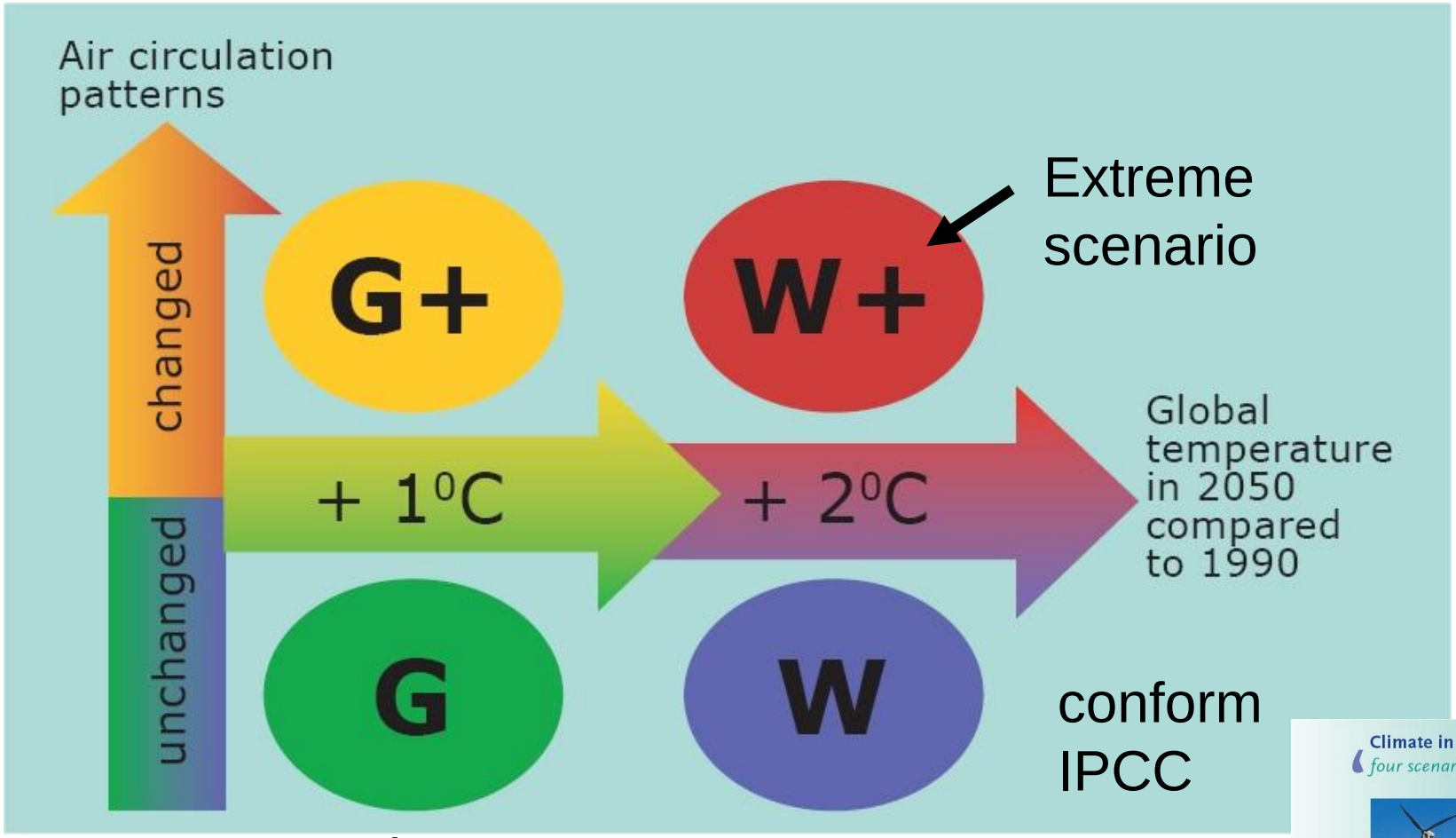
  all crops to grass ~ 33% area changed

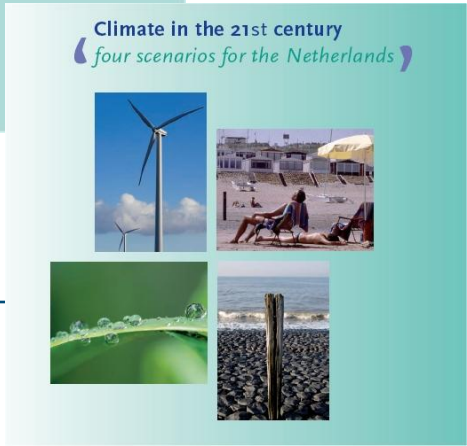
  all crops to forest ,,

- Climate change

  scenarios from Dutch Meteorological Institute (standardized)

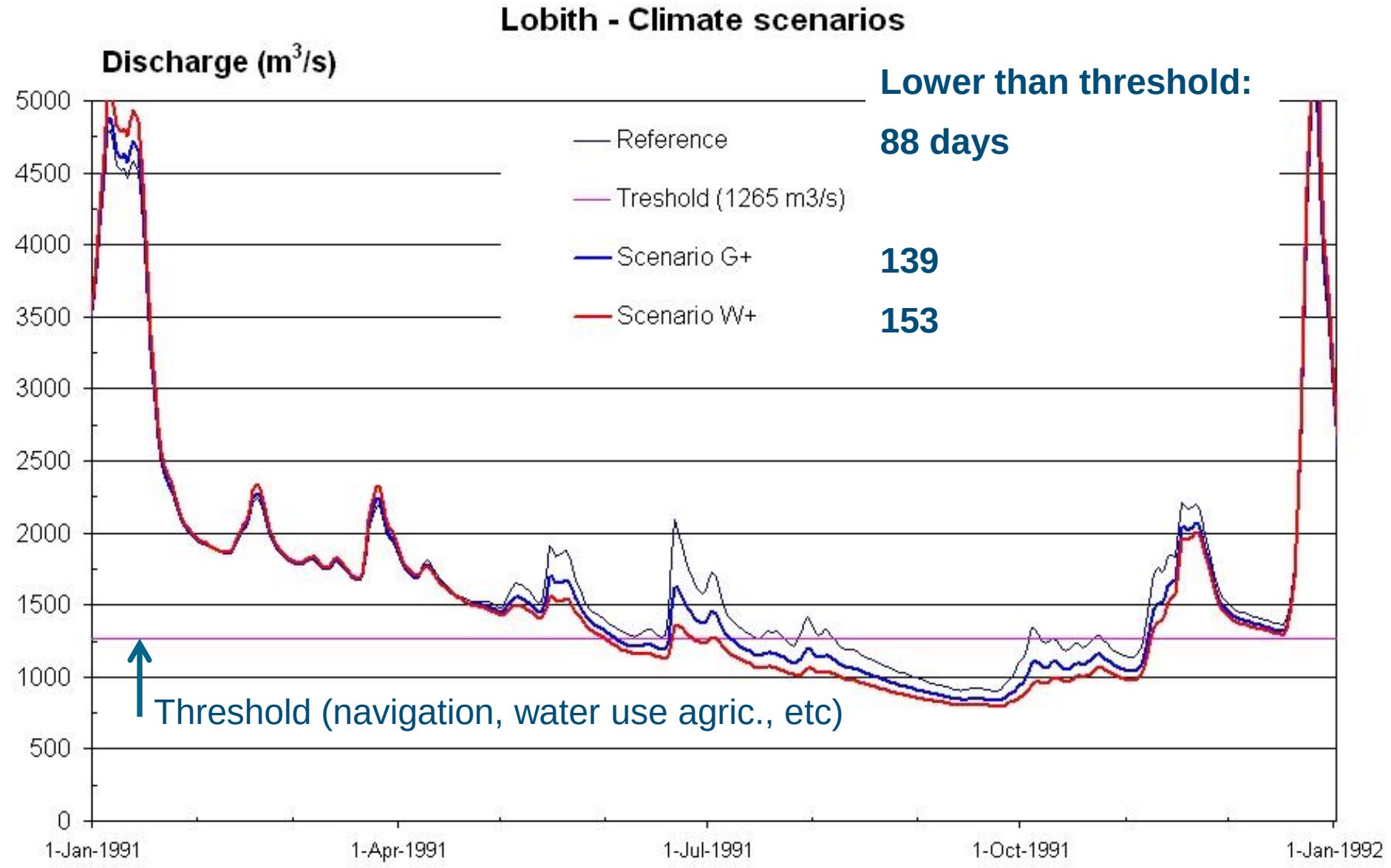
Climate scenarios for the Netherlands



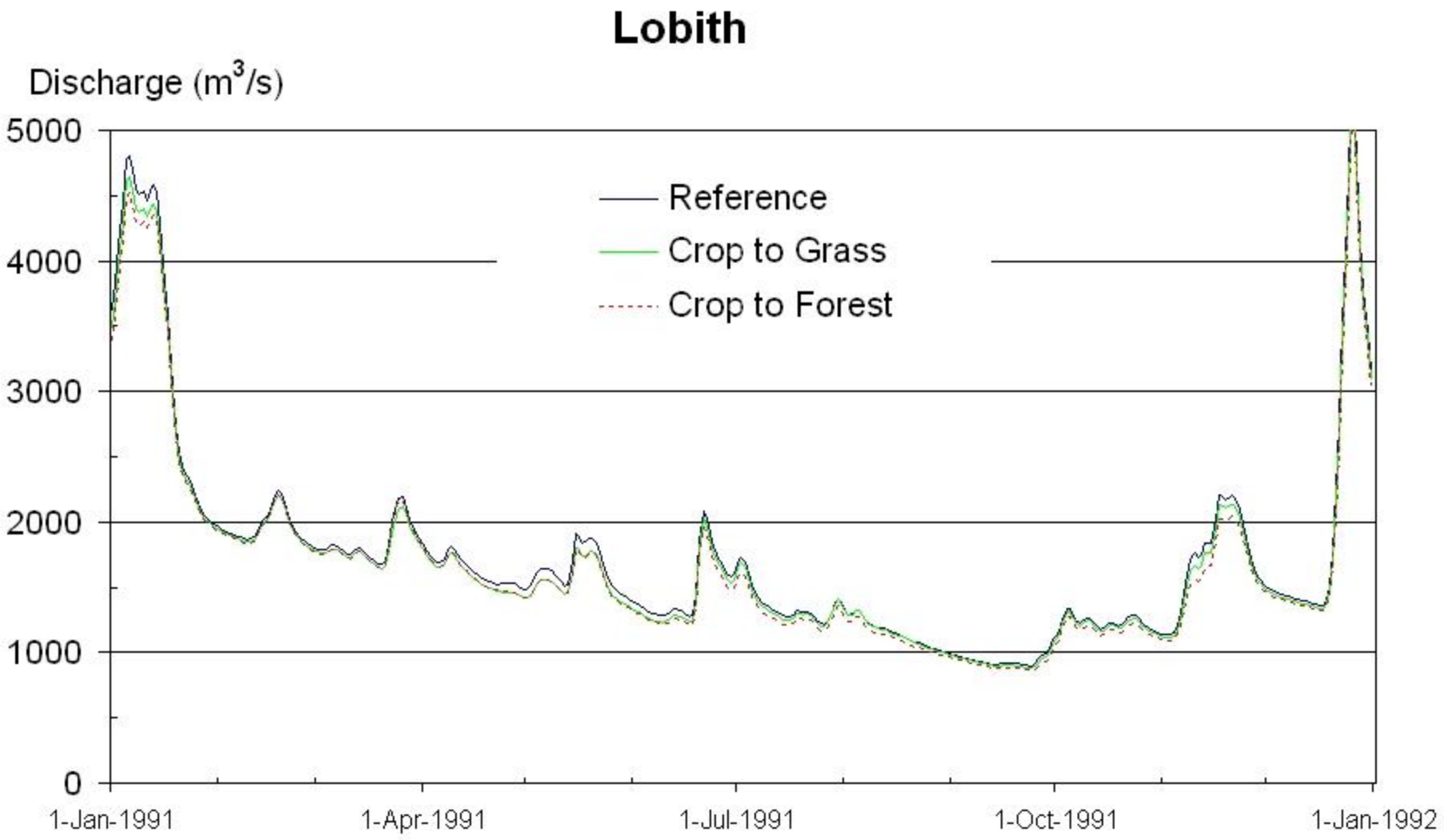


Climate scenarios: some details

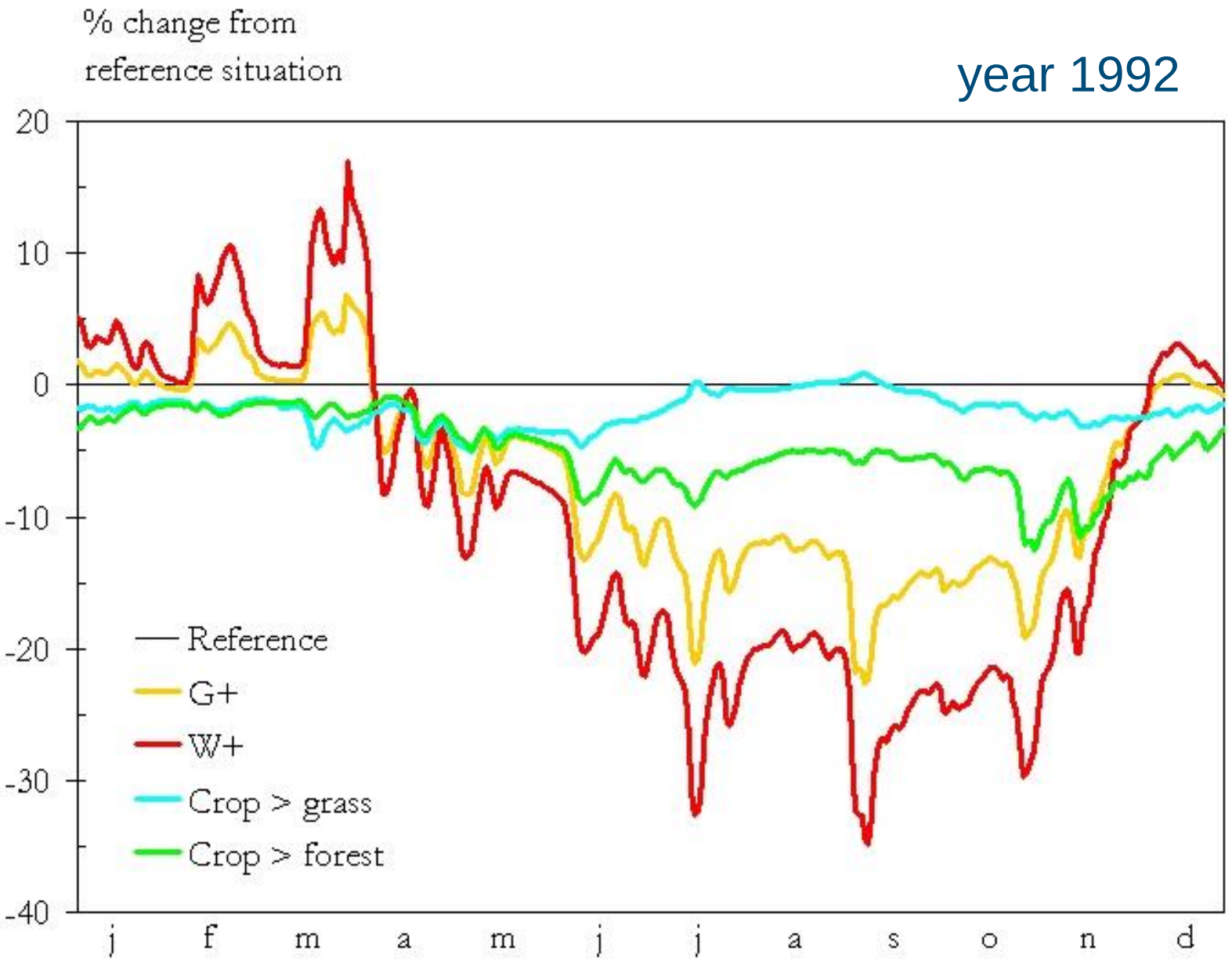
		G	G+	W	W+
Global temperature rise		+1°C	+1°C	+2°C	+2°C
Change in air circulation patterns		no	yes	no	yes
Winter [3]	average temperature	+0.9°C	+1.1°C	+1.8°C	+2.3°C
	average precipitation amount	+4%	+7%	+7%	+14%
Summer [3]	average temperature	+0.9°C	+1.4°C	+1.7°C	+2.8°C
	average precipitation amount	+3%	-10%	+6%	-19%
	potential evaporation	+3%	+8%	+7%	+15%


Lobith - Climate scenarios
Discharge (m3/s)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Reference
Treshold (1265 m3/s)
Scenario G+
Scenario W+
Lower than threshold:
88 days
139
153
Threshold (navigation, water use agric., etc)
1-Jan-1991
1-Apr-1991
1-Jul-1991
1-Oct-1991
1-Jan-1992

Scenario – land use



year 1992

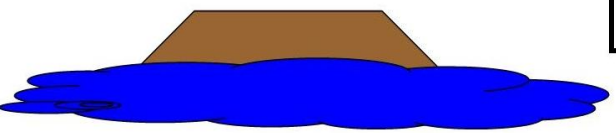

% change from
reference situation
20
10
0
-10
-20
-30
-40
j
f
m
a
m
j
j
a
s
o
n
d
Reference
G+
W+
Crop > grass
Crop > forest

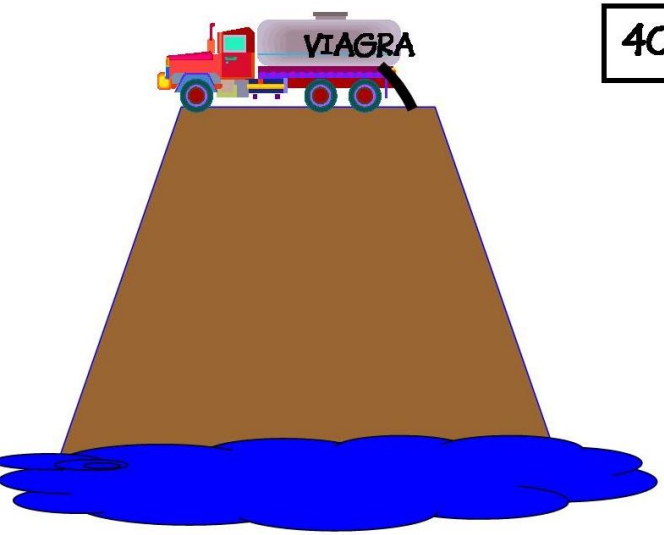
Strategy to follow

Is it acceptation or adaptation

Note the mark on high water levels (Moselle)

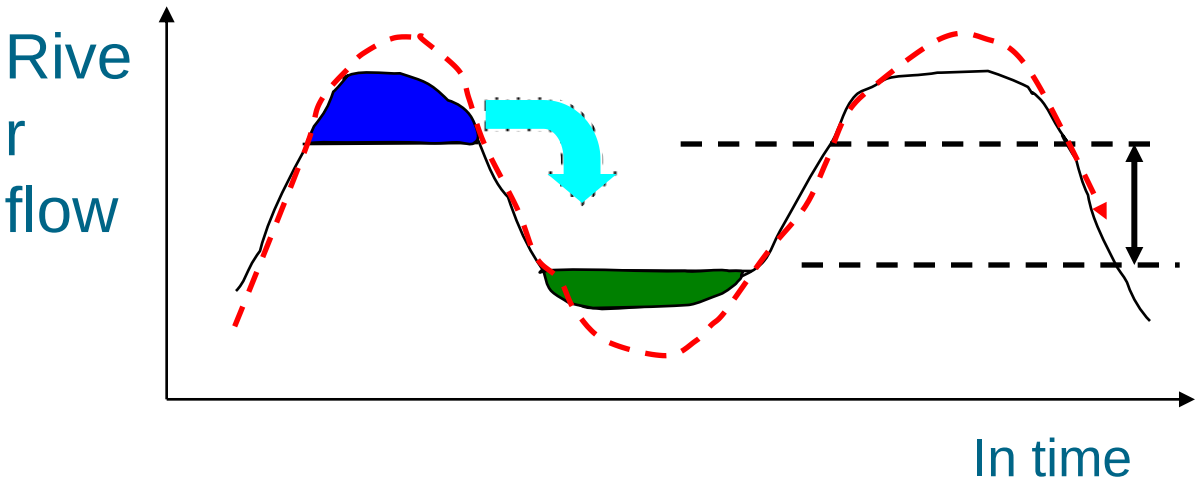
In the past: use of flood levees





There is an end in raising dikes

Strategy: analysis concept



Reduced range is also favourable in terms of WFD

- Reduce floods and droughts

- Further implications of climate change

- Make use of the groundwater system (retain water in the ground)

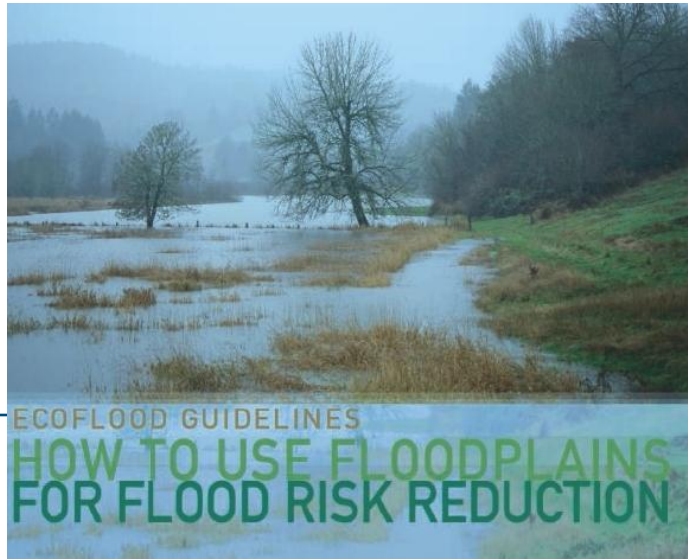
  Before the wet season have enough storage cap. available to cope with peak flows

  After the wet period save water for the dry period

- Natural flood defenses

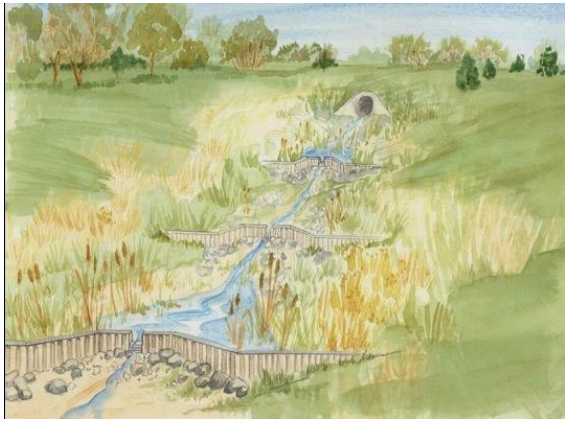
  The Ecoflood report gives guidelines

  on how to restore flood plains



Conclusions

- SIMGRO model: has the ability to model practical situations (scenarios like land use and climate change)
- Climate change has a much larger impact on discharges and droughts than extreme changes in land use
- Consider natural flood defence measures



Is this the challenge we are facing?

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Is this Acceptation or Adaptation ?

Thank you