Effects of input data resolution on SWAT simulations – a case study at the Ems river Basin (Northwest Germany)

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BACKGROUND AND MOTIVATION

- Research Programme River Basin Management
  Funding - German Ministry of Education and Research
  Goal - Strategies for Implementation of the EU WFD

- Main Goal
  good ecological situation of all waterbodies at the territorry of the EU - surface and groundwater

- FLUMAGIS
  Development of DSS tool for river basin management
  Visualisation of Management Measures and their effects to water bodies http://www.flumagis.de

- Integration of simulation models in a DSS tool (visualisation)
  participation of all stakeholders
  calculation time
  scale specific data requirements

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VISUALISATION

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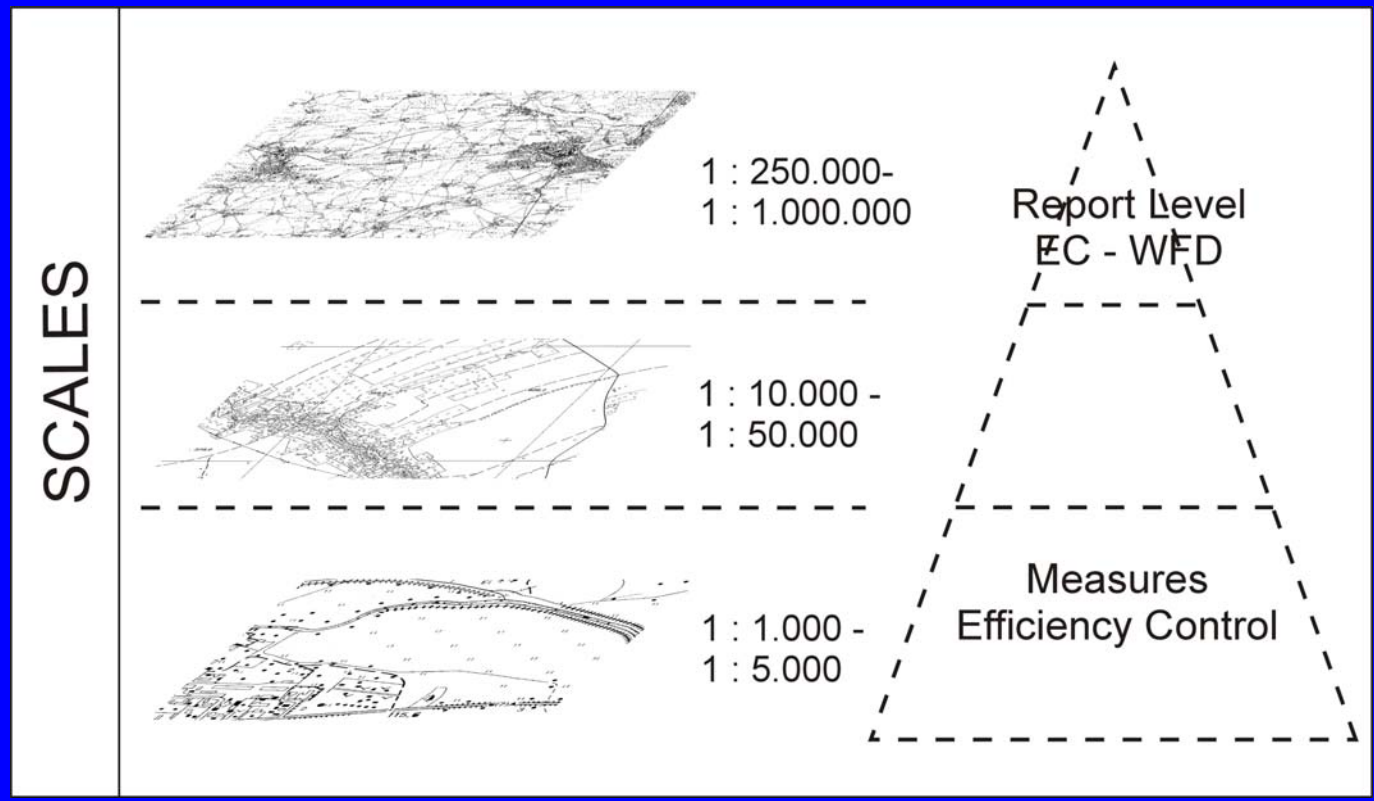
OUR CONTRIBUTIONS

- Derivation of indicators to assess hydrological situation
- Development of a scale system and methods for scale transfer
- Water and Nutrient Balance
  description and assessment of current situation
- Developing future land use scenarios
  Landscape planning programs, EU Funding, Nature Conservation plans.....
- Predicting effects of land use change to hydrological situation and water quality

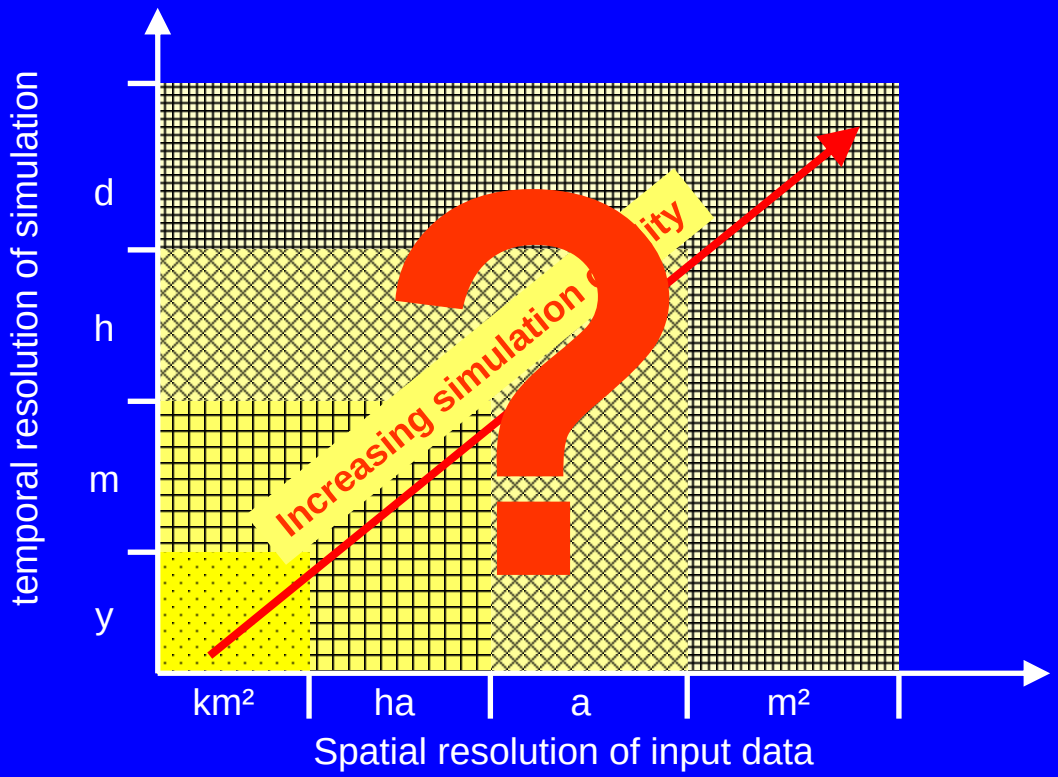
SCALE DEFINITION

- EU WFD - „Report Scale“ 1 : 500.000
- River Basin Management – Planning Measures an Efficiency control ?
- Scale definitions in Geography, Hydrology, Landscape Ecology, Biology, Regional Planning – different ideas!



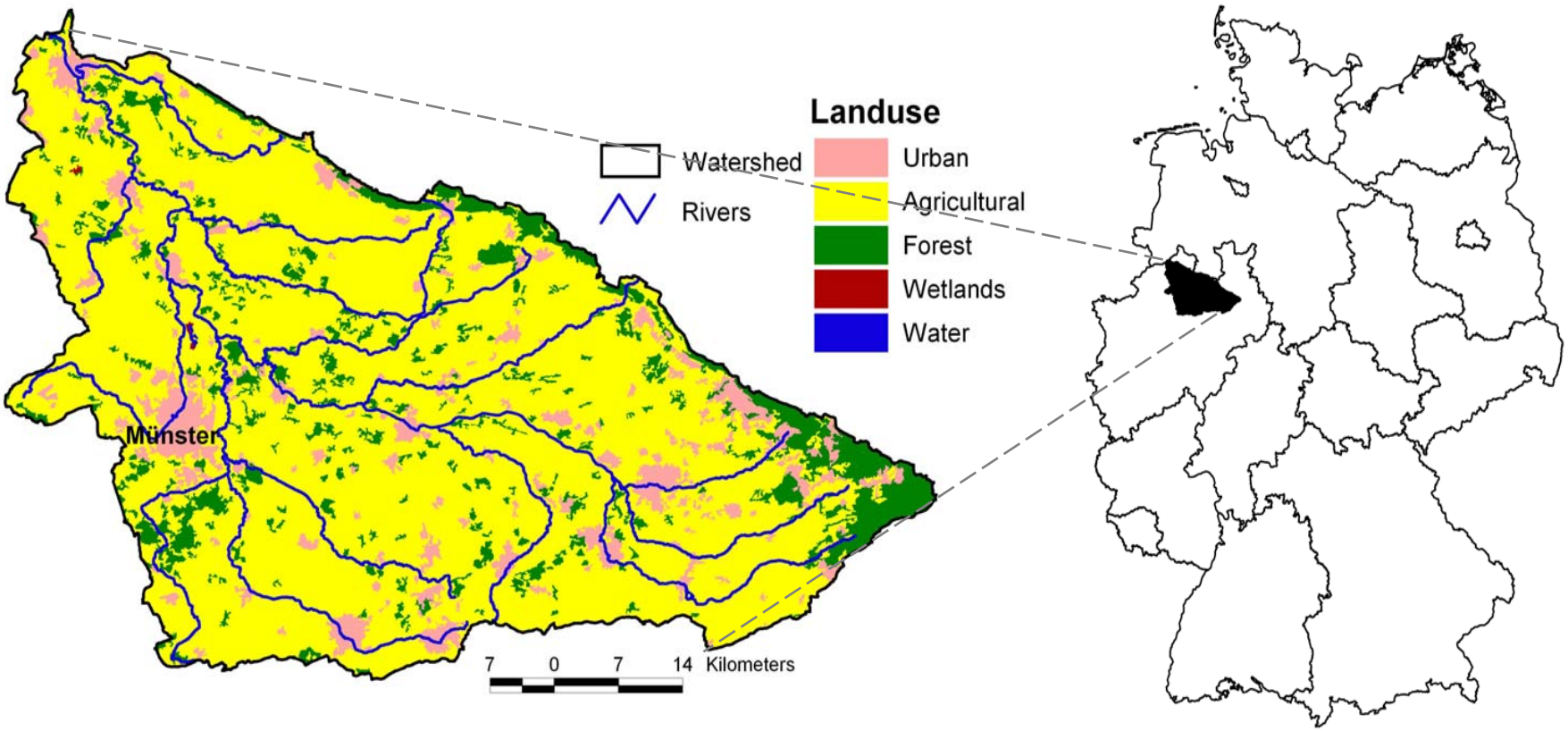
QUESTIONS

- What are the scale equivalent/appropriate input data sets?
- Leads higher input data resolution to better simulation results?
- Which spatial resolution is suitable for derivation of different hydrological indicators? (seasonal, monthly averages; peaks, yields….)
- Can be figured out a critical catchment size for SWAT modelling?



UPPER EMS RIVER BASIN

Area: 3740 km² **Elevation:** 27m – 350m asl



- Poor sandy soils, high ground water influence
- Rainfall 600mm SW
  1200mm E

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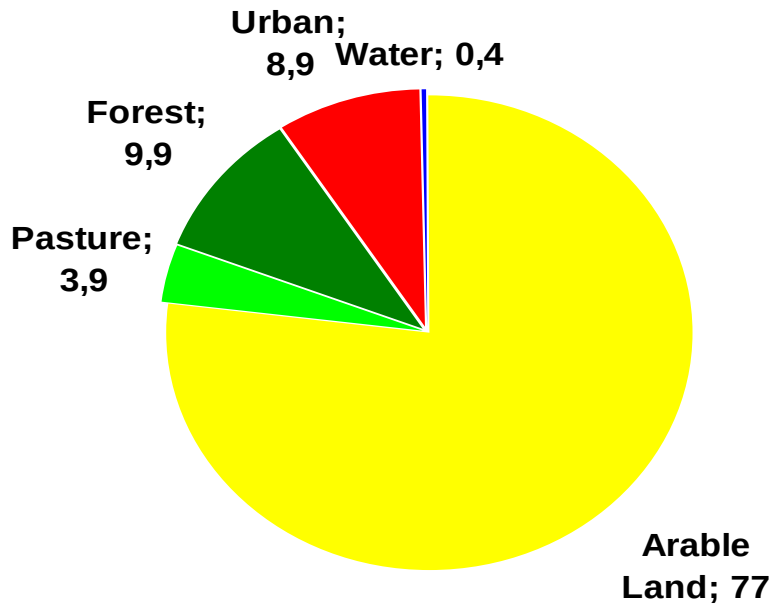
Land use characteristics



Land use distribution

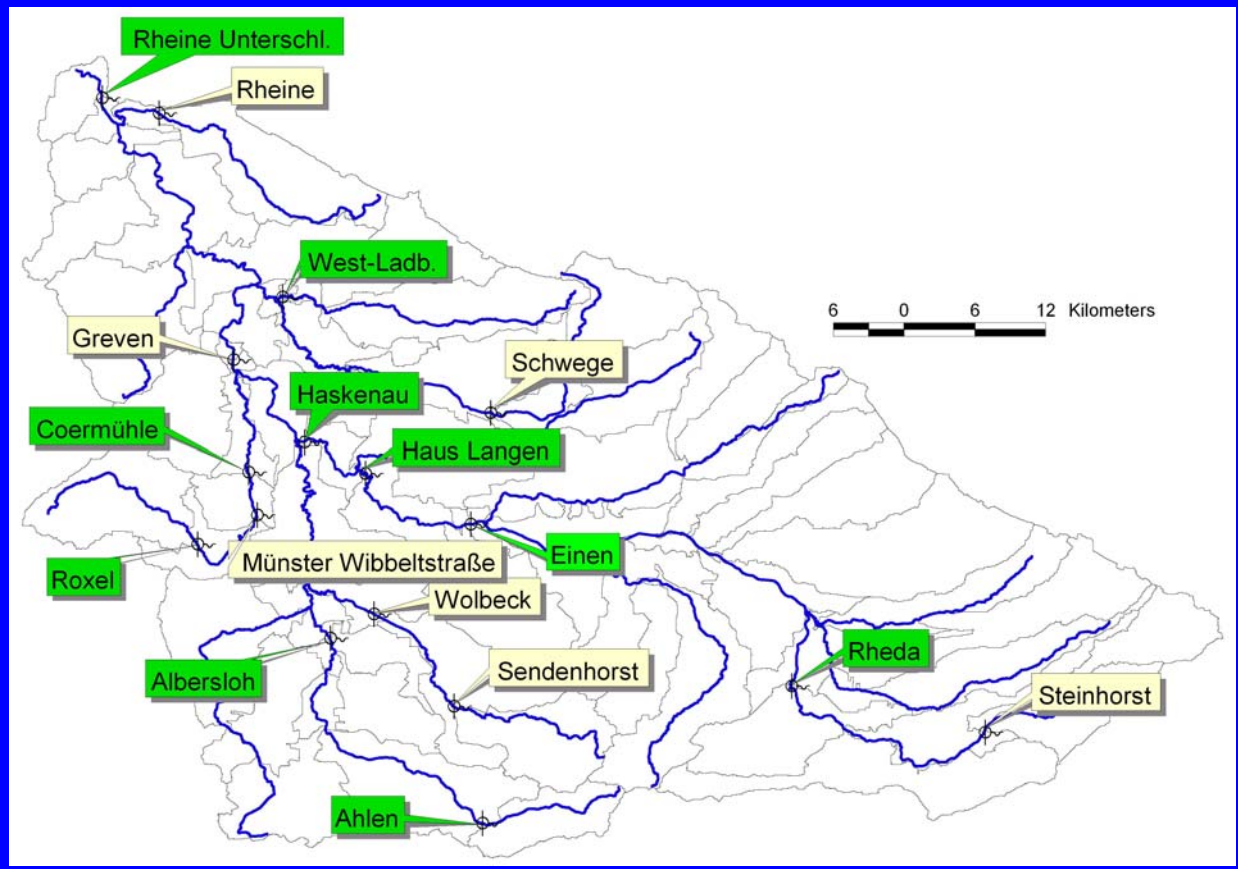
- Tillage - food production
- Stock farming
- Milk and meat production
- Highest live stock numbers
- High amount of liquid manure





HYDROLOGICAL AND WATER QUALITY MONITORING

- 17 Gauges 10 Usable for Calibration
- 600 sampling points only two with 2 - weeks random sampling mostly not connected with gauges



- Main problem: N – input 14 mg/l TIN
- Target for „good ecological quality“ 3 mg/l TIN

DATA BASE AND METHODS

- Official available data collected by the governmental departments and the national surveys, but…
- Comfortable situation - two data sets with different spatial resolution for the same area
  (DEM, SOIL, LAND USE)

- Using SWAT with the AVS2000 extension
  watershed delineation and HRU distribution with the same settings

- Parametrisation of land use and plant parameters with regional information

- Simulations at different temporal resolution

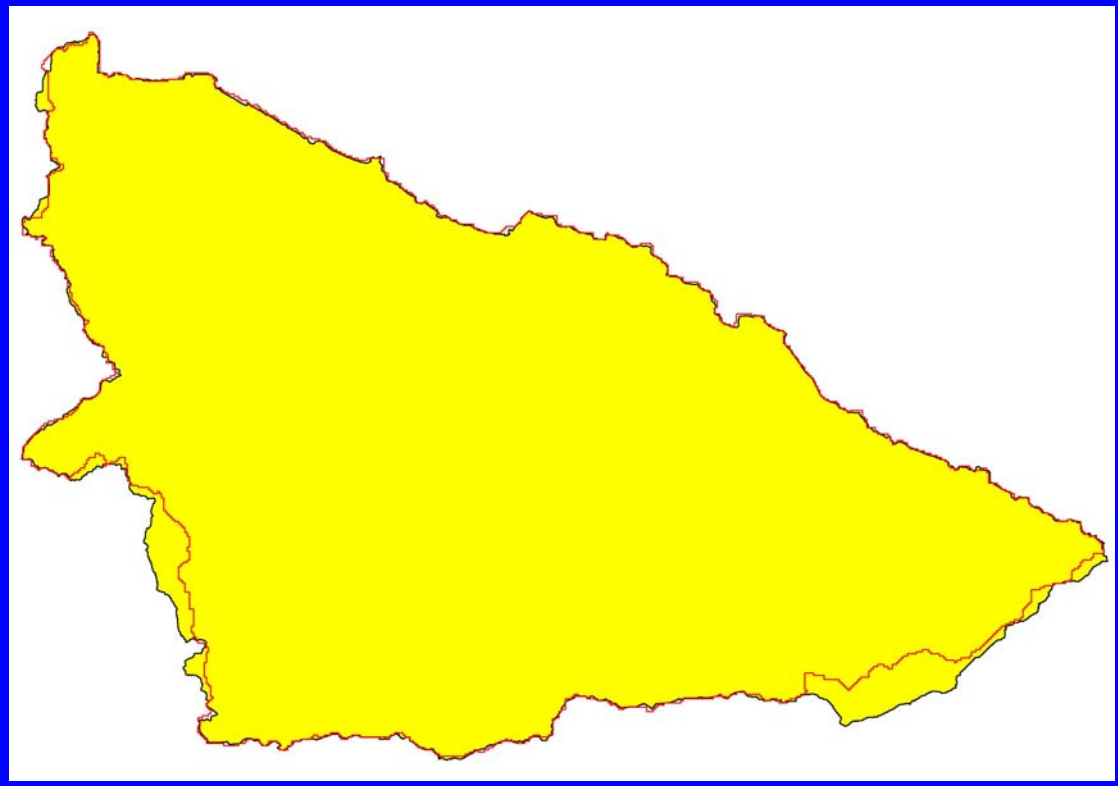
- Comparing efficiency

DATA BASE AND METHODS

Data set	Low resolution	High resolution
DEM	200m grid	50m grid
Soil	BÜK1000 – 1:1,000,000 21 soil types, (Federal Institute for Geoscience and Mineral Ressources)	BK50 1:50,000 854 soil types (Geological Survey of NRW and LS)
Land use	Corine Land Cover – aggregated 5 land use types	Topographic Information system 24 land use types (ATKIS-DLM)
Climate	regional stations of German weather survey 5 fully equiped 21 precipitation stations	regional stations of German weather survey 5 fully equiped 21 precipitation stations

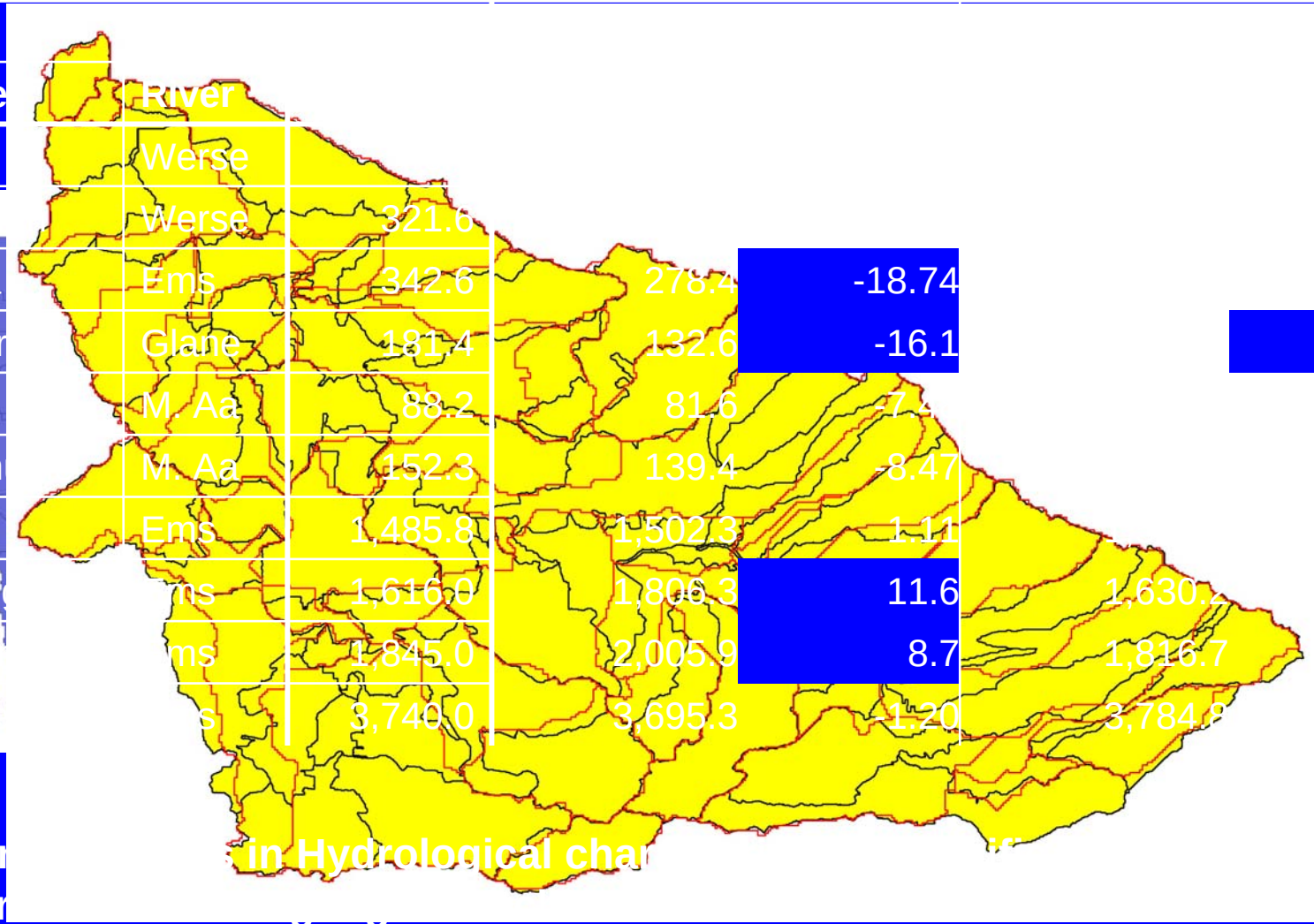
- **Agricultural management practice, crop rotations**
- **Waste water input 256 (urban and industrial)**

WATERSHED DELINEATION



	Low resolution	High resolution	Difference
Catchment size in km²	3695	3785	90
Number of subbasins	62	76	10

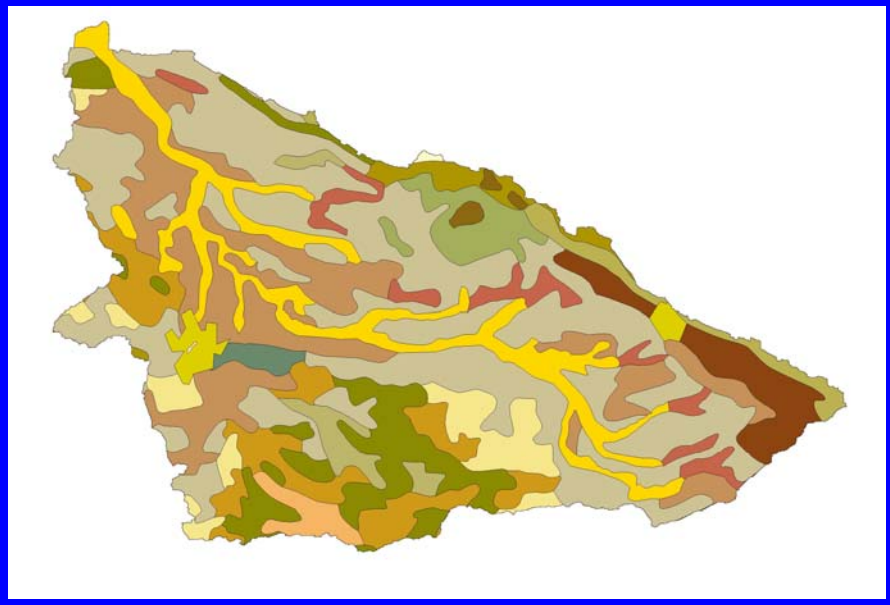
GAUGED SUBCATCHMENTS

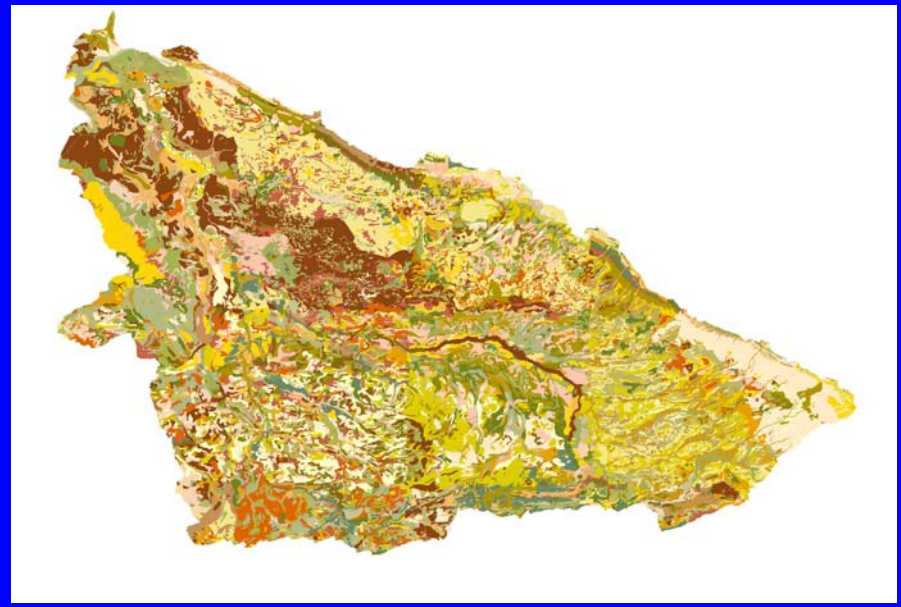


Gauge	River						in %
Ahlen	Werse						1.29
	Werse	321.6					
Rheda	Ems	342.6	278.4	-18.74			
Ladber	Glane	181.4	132.6	-16.1			-5.7
oxel	M. Aa	88.2	81.6	-7.4			
berm	M. Aa	152.3	139.4	-8.47			
	Ems	1,485.8	1,502.3	1.11			
	ms	1,616.0	1,806.3	11.6	1,630.2		0.89
	ms	1,845.0	2,005.9	8.7	1,816.7		
	s	3,740.0	3,695.3	-1.20	3,784.9		

- U in Hydrological char
- Pr

HRU GENERATION





	Low resolution	High resolution	Difference
Soil types	21	854	833
Land use classes	5	24	
Number of HRU's	387	1950	1563

- Soil parametrization
- Management practices, crop rotation

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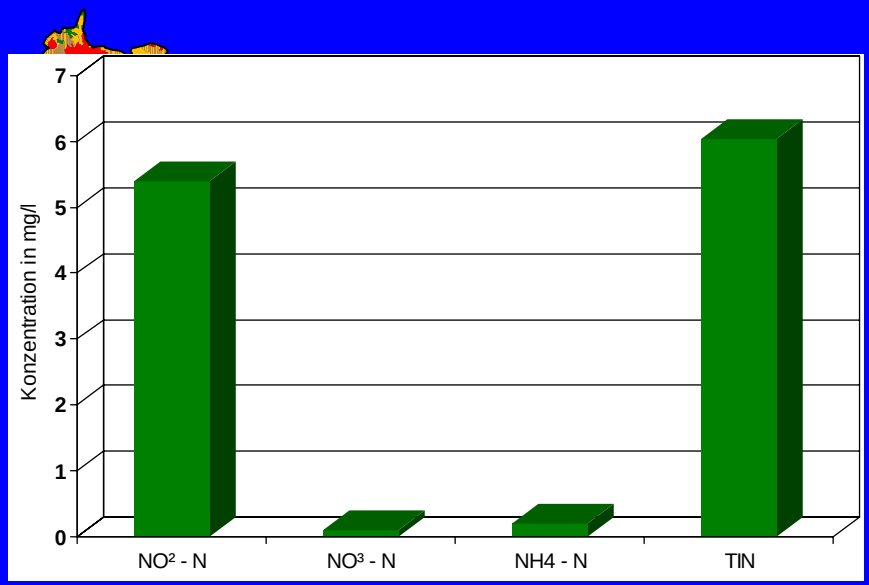
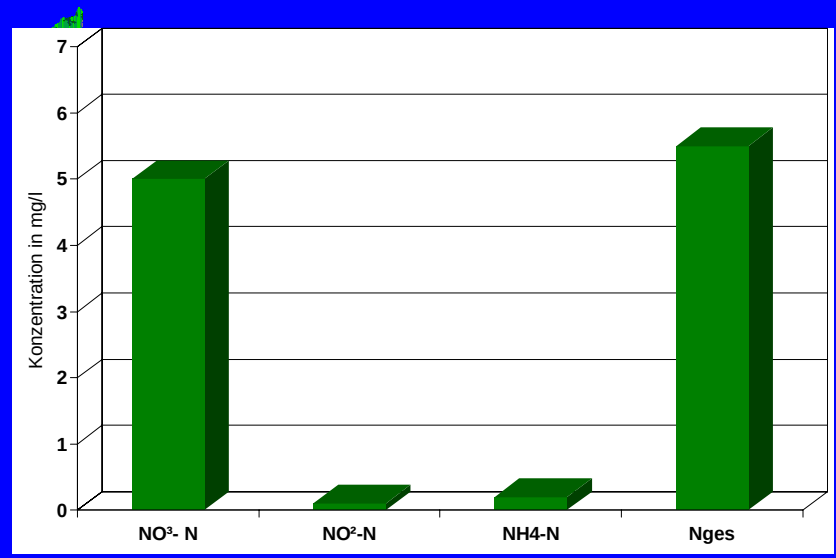
SIMULATION RESULTS

GAUGE RHEINE

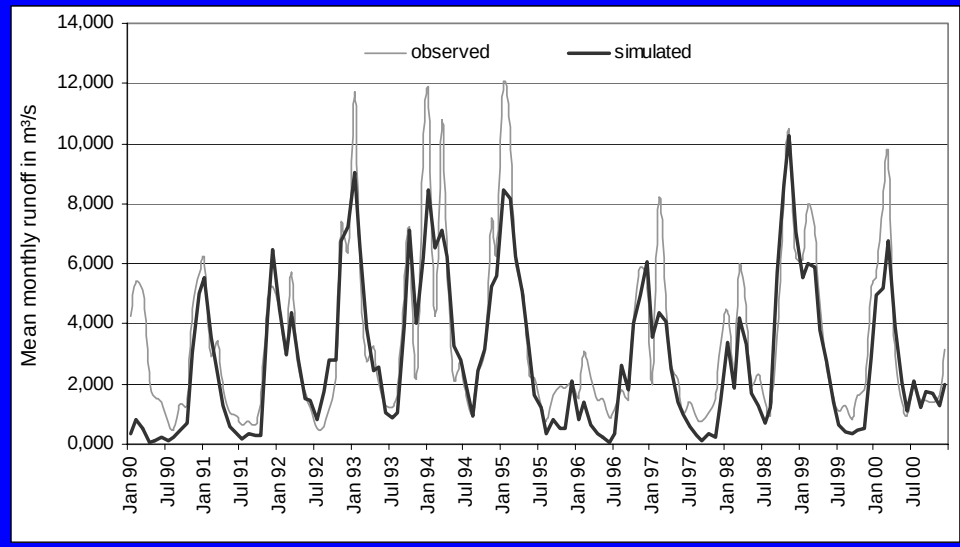
Land use change at hydromorphic soils
from arable land to extensive pasture



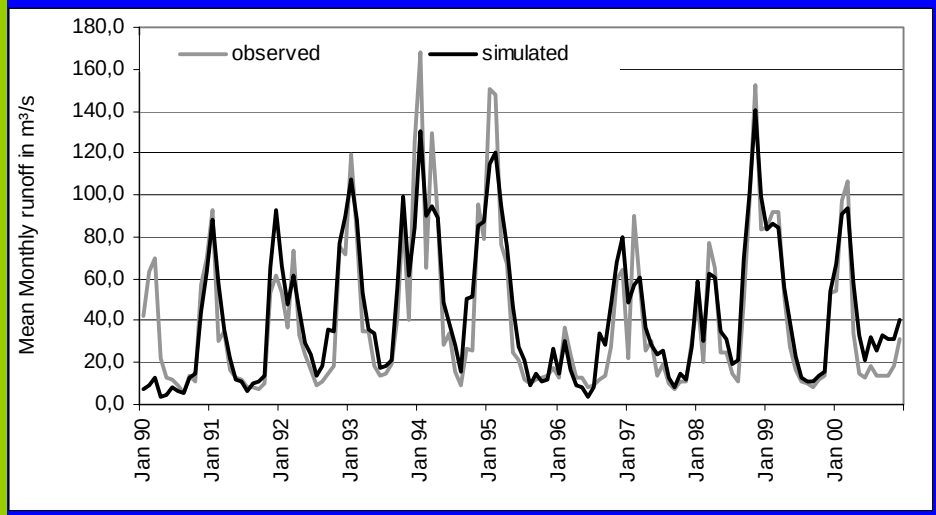


Monthly Hydrographs

- Good description of monthly dynamic



Average discharge at Gauge Rheda (342 km²) based on monthly calculations



Average discharge at Gauge Rheine (3740km²) based on monthly calculations

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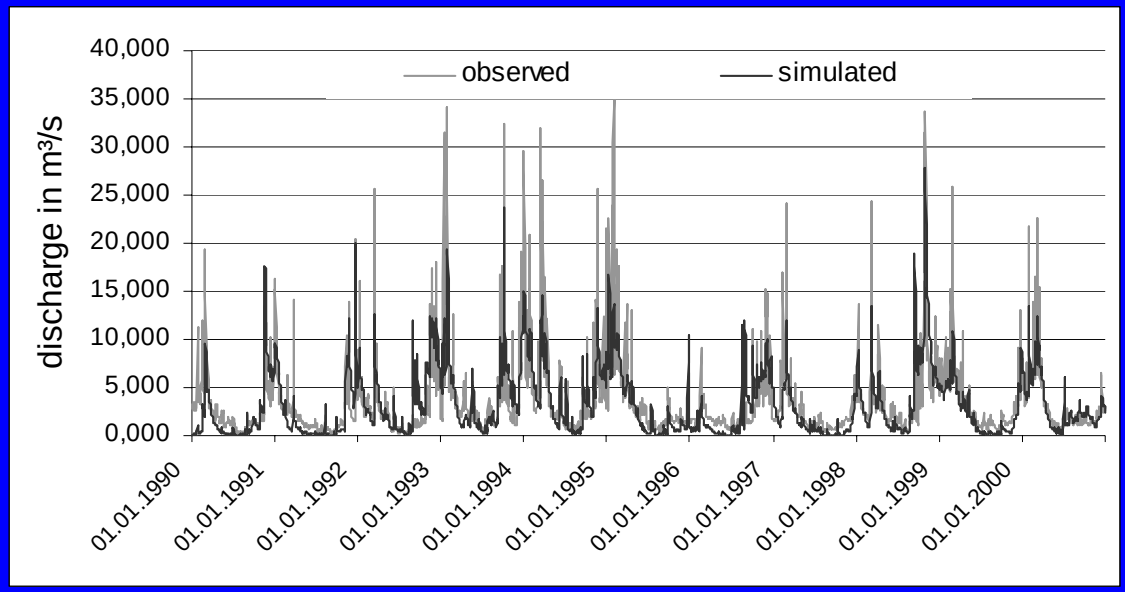
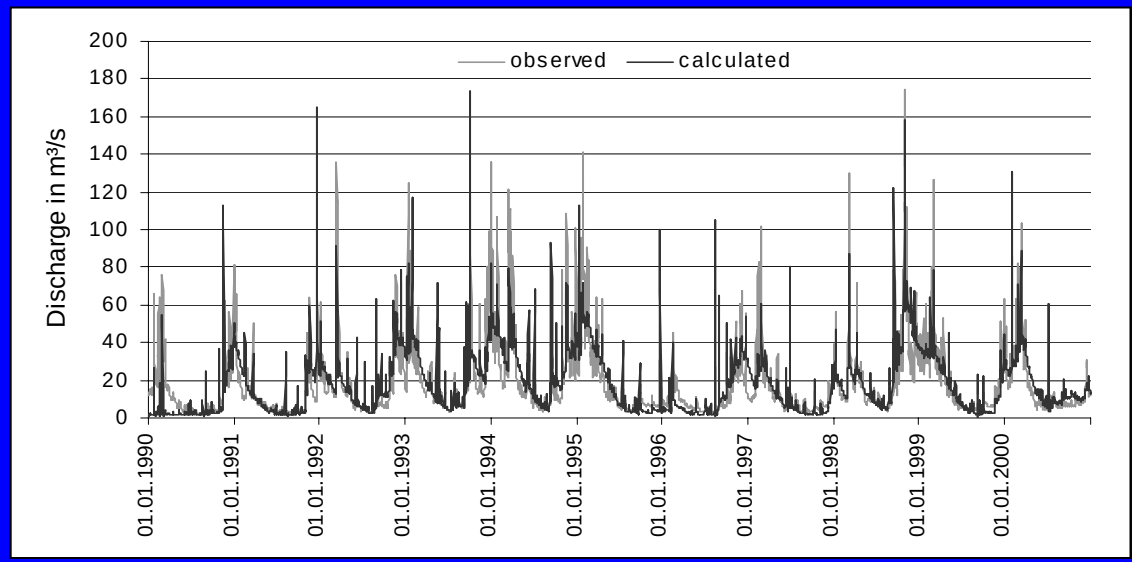
DYNAMIC AT DAYLY SIMULATION



Gauge Rheda (342 km²)

Gauge Haskenau (1616 km²)



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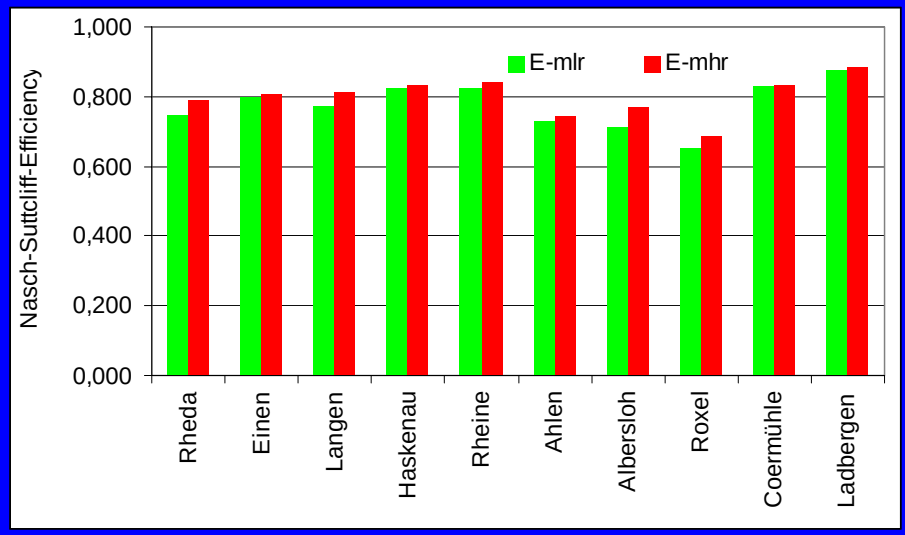
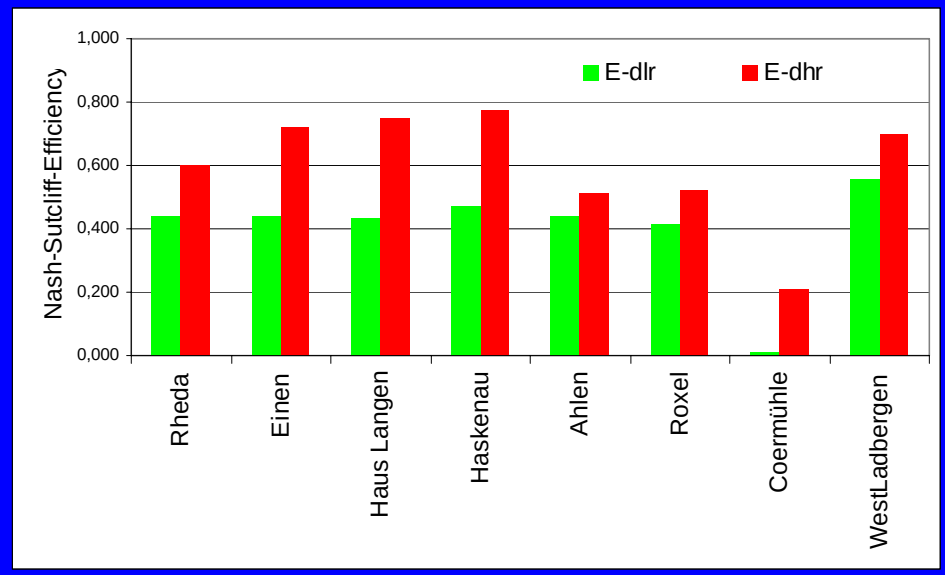
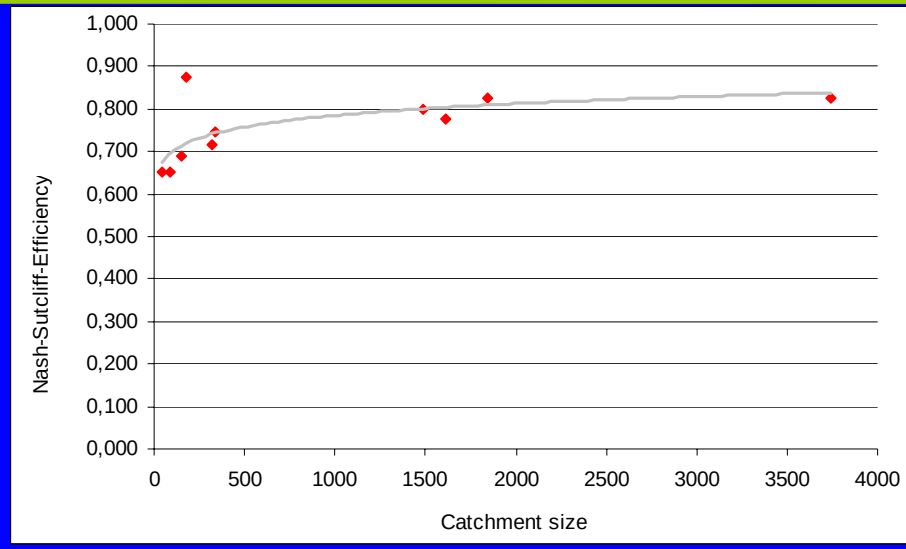


Comparison of model efficiencies at main gauges based on monthly simulations

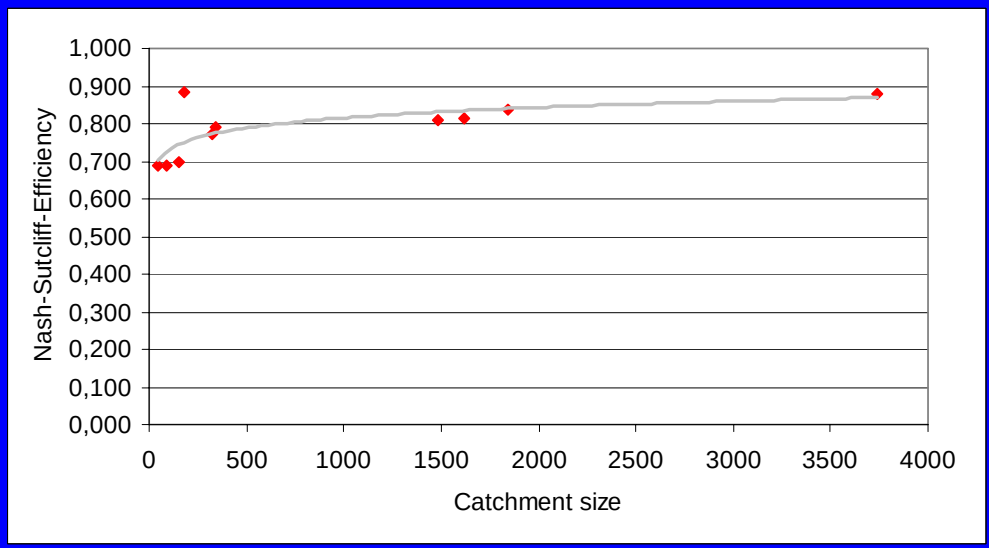


Comparison of model efficiencies at main gauges based on dayly simulations

- Relation between catchment size and simulation quality



catchment size - model efficiency – relation with low resoluted data set based on monthly calculations



Catchment size – model efficiency – relation with high resoluted data set based on monthly calculations

CONCLUSIONS

- Effects of input data resolution to simulation quality depends depends on time steps – dayly, monthly, yearly
- Use of data sets and parametrisation efforts should focus on the questions to be answered
- Decreasing of model efficiency with catchment size, but.....
  it could vary on physical conditions of the catchments
  unknown management operations
  .
  .
- Including more gauged catchments with other physical conditions and of different size

GAUGED SUBCATCHMENTS