RIVERTWIN EU-FP6 PROGRAMME

Modelling of diffuse pollutant loads using the Moneris model: The Neckar and the Oueme river basins.

AUTh FSA

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There are two main types of water pollution:
•Point source
•Nonpoint source

Point source pollution is pollution from a single, identifiable source such as a factory or wastewater treatment plant. Most people are familiar with this type of pollution.

Nonpoint source (NPS) pollution doesn't come from an easily identifiable point, such as a discharge pipe. Instead, it comes from everywhere else , from our yards, driveways, streets, parking lots, construction sites, agricultural fields, pastures, litter, spills, illegal dumping, improperly maintained septic tank systems, and any form of soil disturbance that can accelerate soil erosion.
Nonpoint source pollution is now the largest unregulated water quality problem. Each year the storm drains, creeks, ditches and riverbanks convey millions of pounds of pollutants of all types to the water bodies and to groundwater aquifers.

THE NECKAR RIVER BASIN (GERMANY)

Neckar is the third largest tributary of the Rhine river

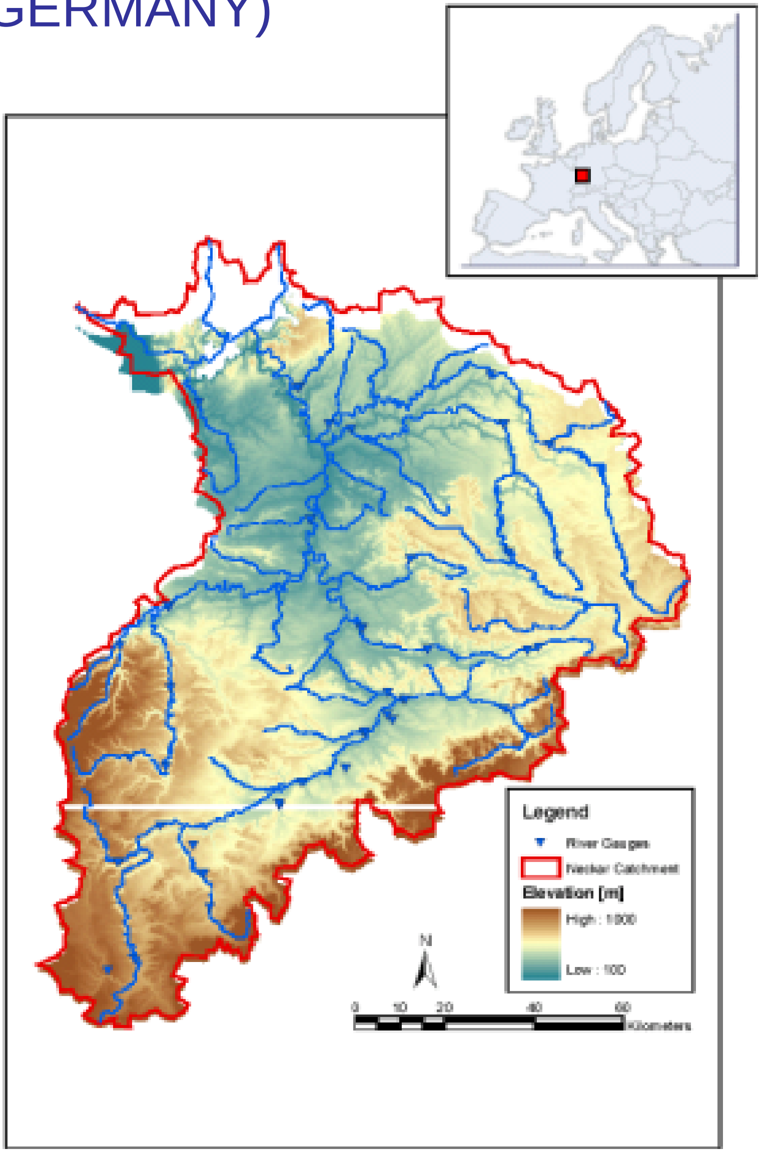
Basin area: 13.000 km^2 Population: 7.5 Mio

Climate: Semi humid and temperate
Inflow regime: Snow – Rainfall
Average annual precipitation: 950 mm
Average daily temperature: 8.7ºC

40% forest, 25% greenland
25% agricultural use,10% settlements

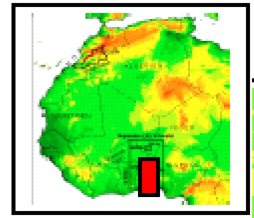
Water management problems:
- water quality (N,P losses)
- floods (origin from the upper part)
- hydromorphology
- water supply

Data availability: High



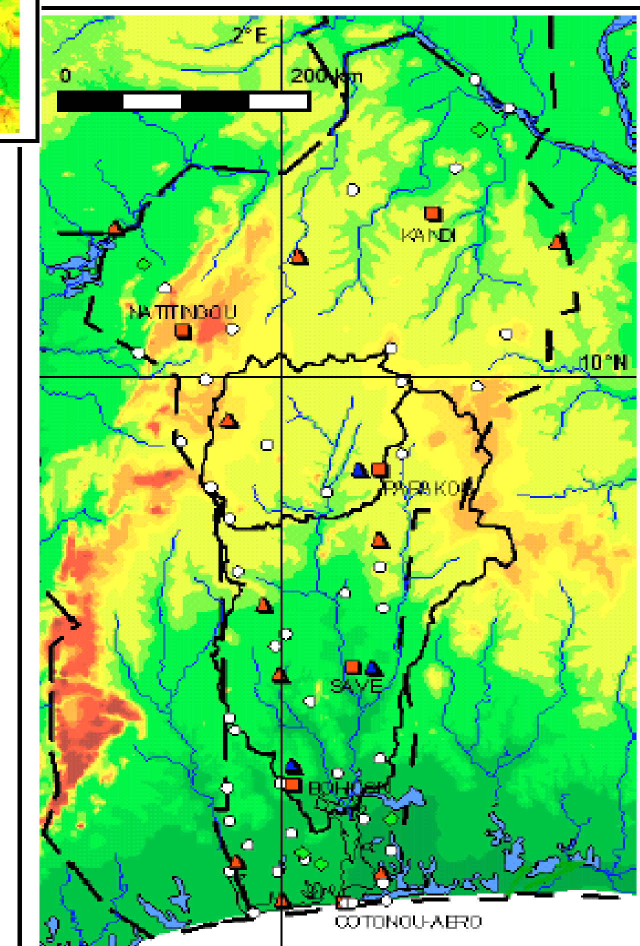
THE OUEME RIVER BASIN (BENIN - WEST AFRICA)

Area: 30.000 km^2 Population: 1-2 Mio



Climate: Tropical, subhumid
Inflow regime: Rainfall
Aver. annual precipitation over 1971-1990: 180 mm

In some regions the river basin is intensively cultivated. There are forest reserves where land use is prohibited.

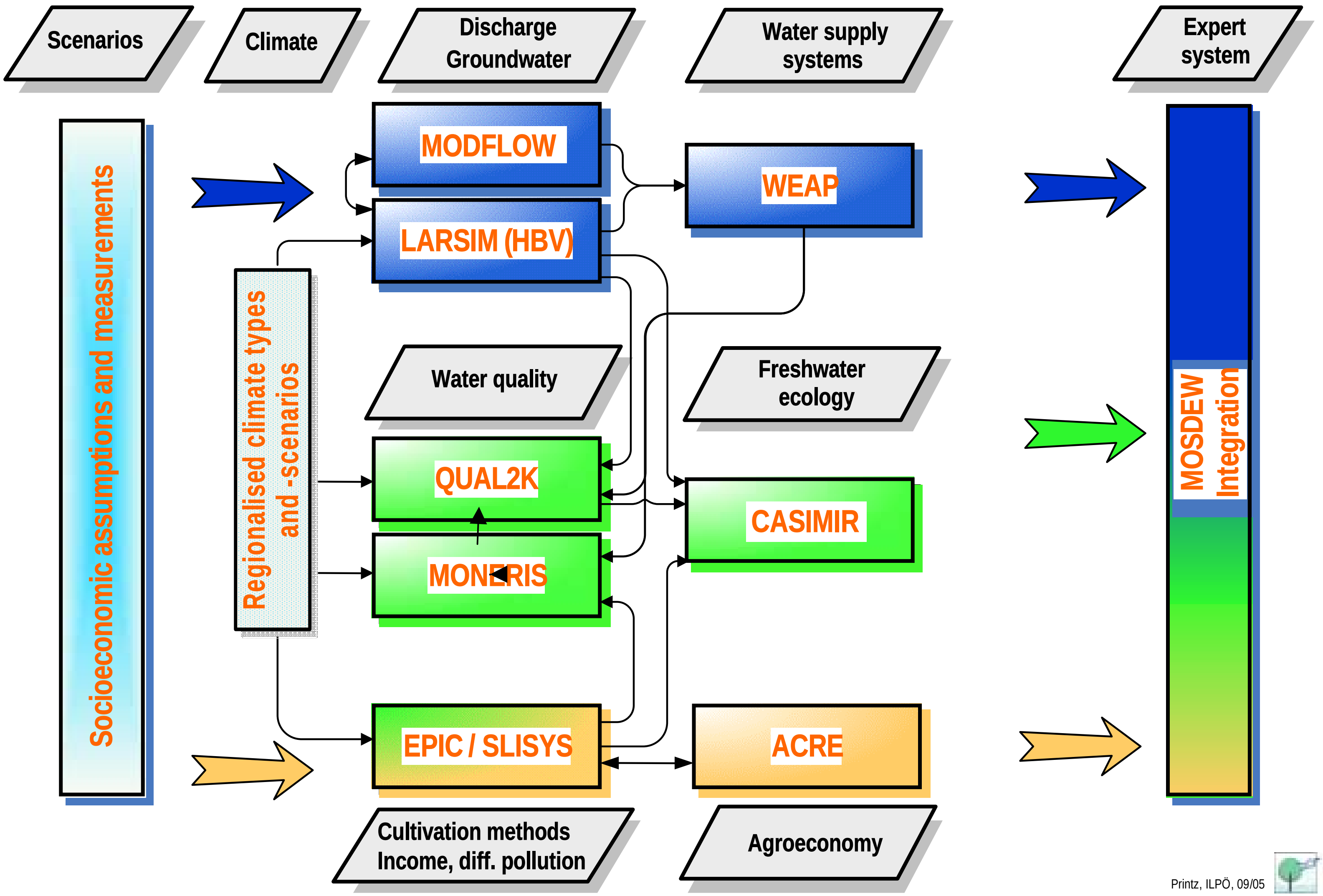


1970s: Prolonged drought in West Africa caused:
? deterioration in the economic/social development
? river discharges decreased by about 40-60% in recent decades, causing shortages in river water availability for domestic & agricultural purposes

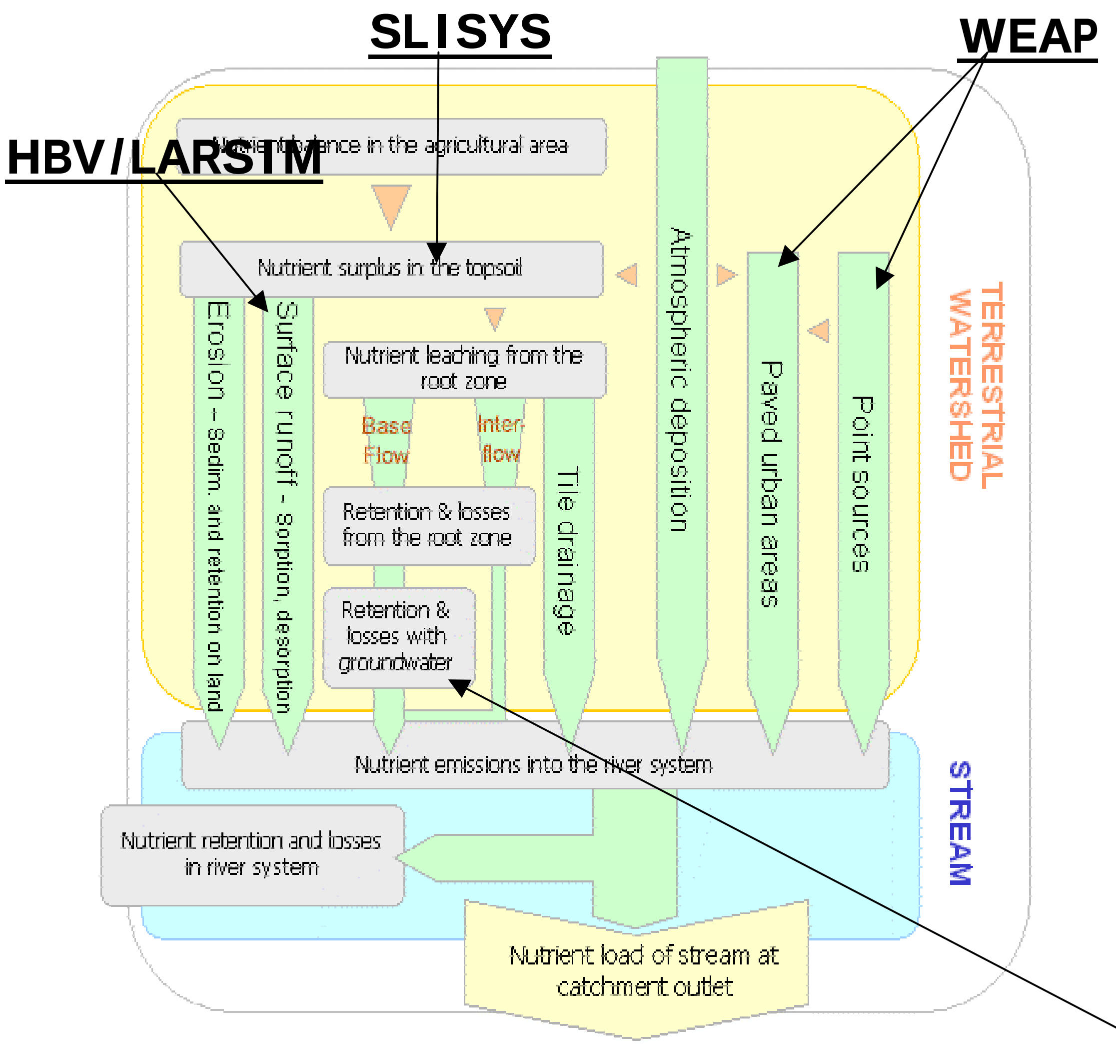
Water management problems:
- water quality (sanitation & chemical)
- flooding
- water supply in dry seasons (October to May)

Data availability: Low

INTEGRATED COUPLING SCHEME NECKAR RIVER BASIN



MONERIS (Behrendt et al. 2000)
(***MO***delling ***N***utrient ***E***mission in ***RI***ver ***S***ystems)



Point sources:
- direct discharges
- WWTP effluents

Diffuse pathways:
- atmospheric deposition
- erosion
- surface runoff
- groundwater
- tile drainage
- paved urban areas

Properties of MONERIS

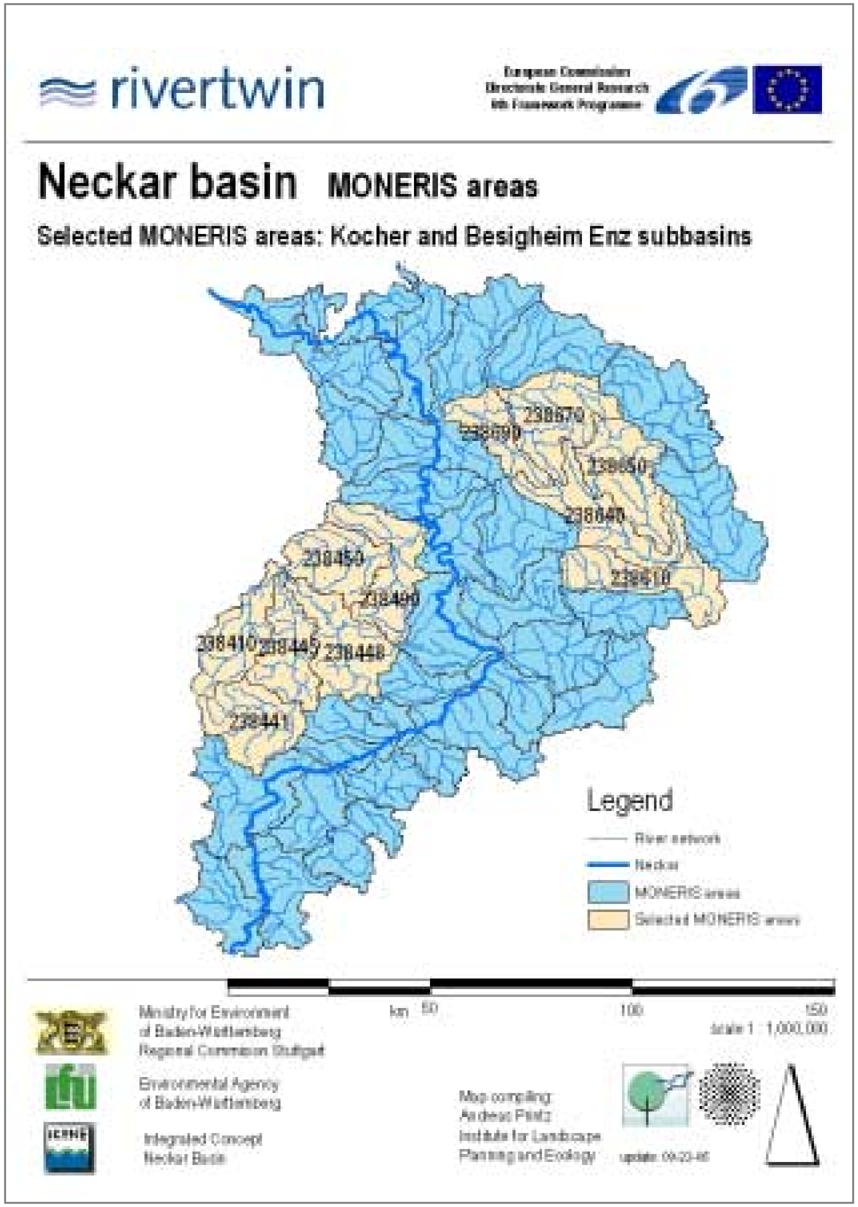
- Regional estimation of nutrient discharges
- Point sources and diffuse emissions
- River basins of medium and large spatial scales (> 500 km^2)
- Time step of 5 years
- GIS-supported, Excel software
- Use of independent data sets for validation
- Empirical correlations

Output of MONERIS

Estimation of annual nutrient load at the river outlet (emissions minus retention and loss within the river)

Required data for MONERIS

Required data for MONERIS	Available data for the Neckar basin	Available data for the Oueme basin
Mean slope	available	available
Tile drained ares	available	available
Landuse	available	available
Statistics of communes	available	available
Urban systems : Inhabitants connected to WWTP or sewer or septic tanks	available	not available
Hydrogeological types defined by soil, porosity, permeability, depth	available	not available
Mean soil loss, proportion of soil types	available	available
Nitrogen content in topsoil	available	not available
Precipitation	available	available
Evaporation	available	available
Nitrogen and phosphorus surplus	available	not available



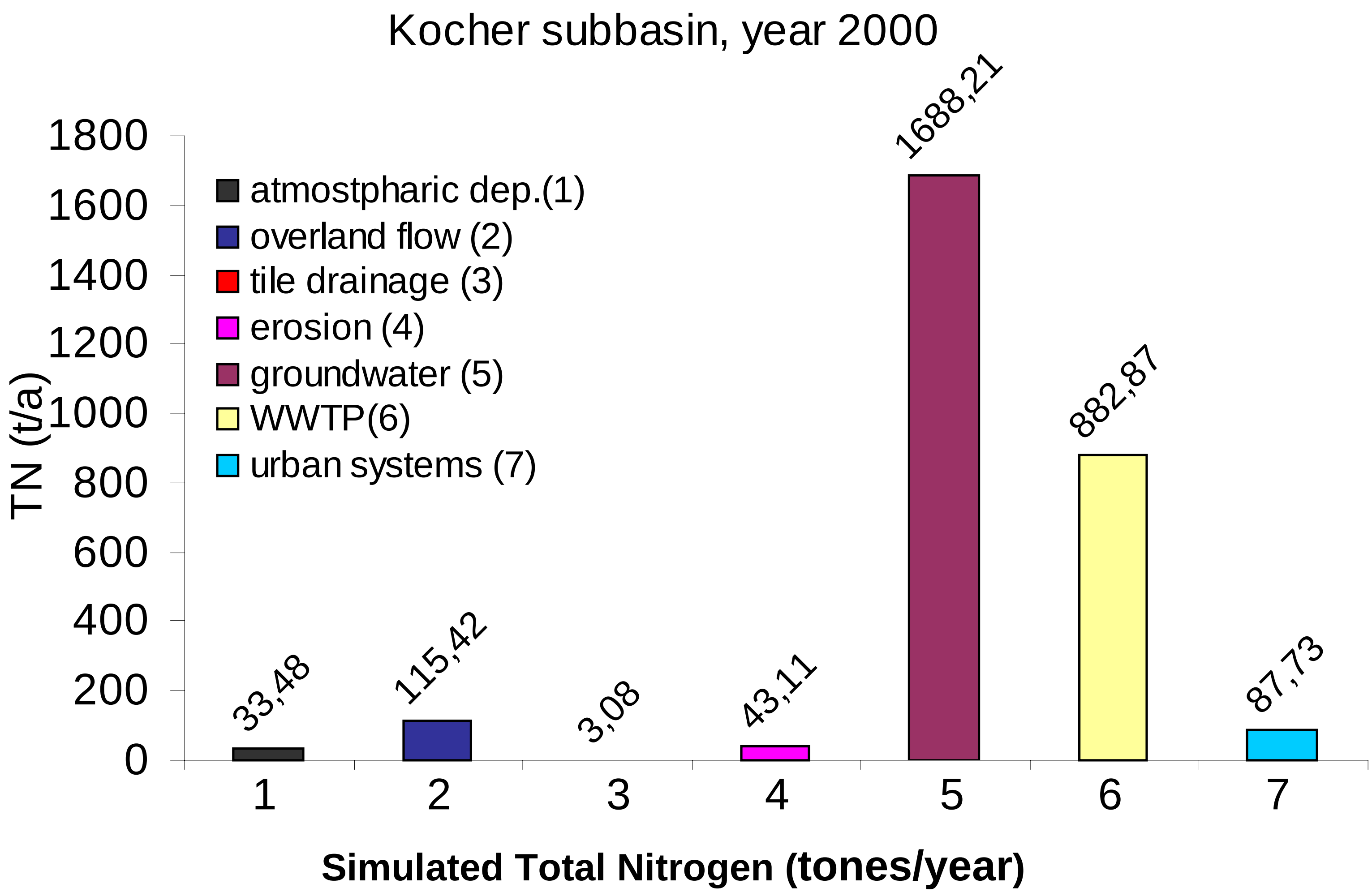
The Neckar catchement was divided in 42 subcatchements from 134 km^2 to 505 km^2.

The Kocher subbasin and the Enz subbasin were selected for the model calibration. First the model was applied for the reference year 2000. Some of the model outputs and comparison with available data are plotted in the graphs below.

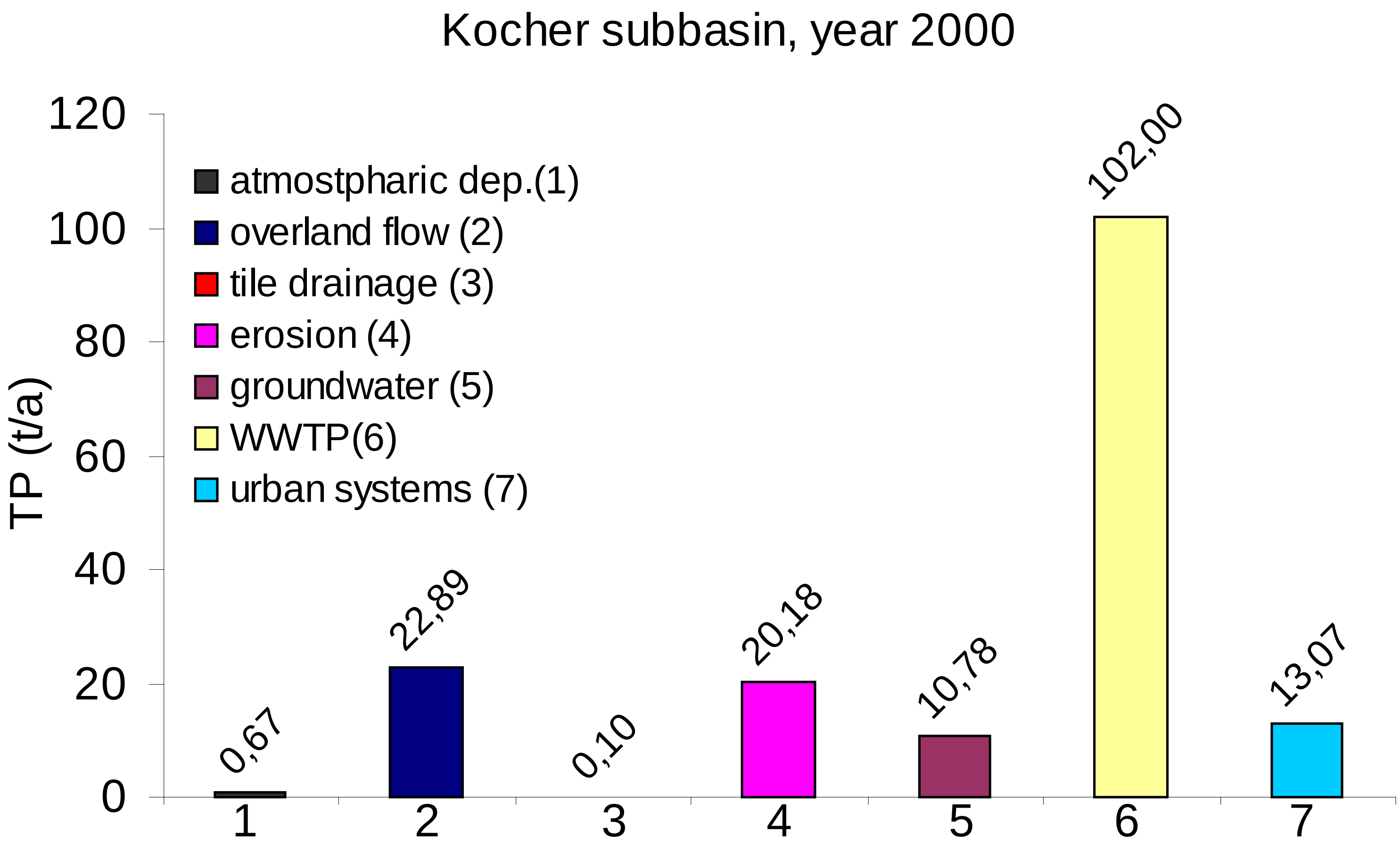
The water quality of the River Neckar was first modeled for the reference year 2000, secondly for the 5 climate types, and lastly for the ENKE dry, ENKE wet, Yang-Bardossy A2 and Yang-Bardossy B2 climate scenarios (Table).

Climate Scenarios	Simulation Years	Description
Type 1 (CT1)	2003	Hyper warm/hyper dry
Type 2 (CT2)	1988	Normal/normal
Type 3 (CT3)	1987	Hyper cold/hyper humid
Type 4 (CT4)	1997	Warm/dry
Type 5 (CT5)	1991	Warm/normal
Type 6 (Ref.Year)	2000	Reference Year
ENKE dry	2021-2050	
ENKE wet	2021-2050	
Yang-Bardossy A2 (YB A2)	2001-2030	
Yang-Bardossy B2 (YB B2)	2001-2030	

MONERIS output for the reference year 2000

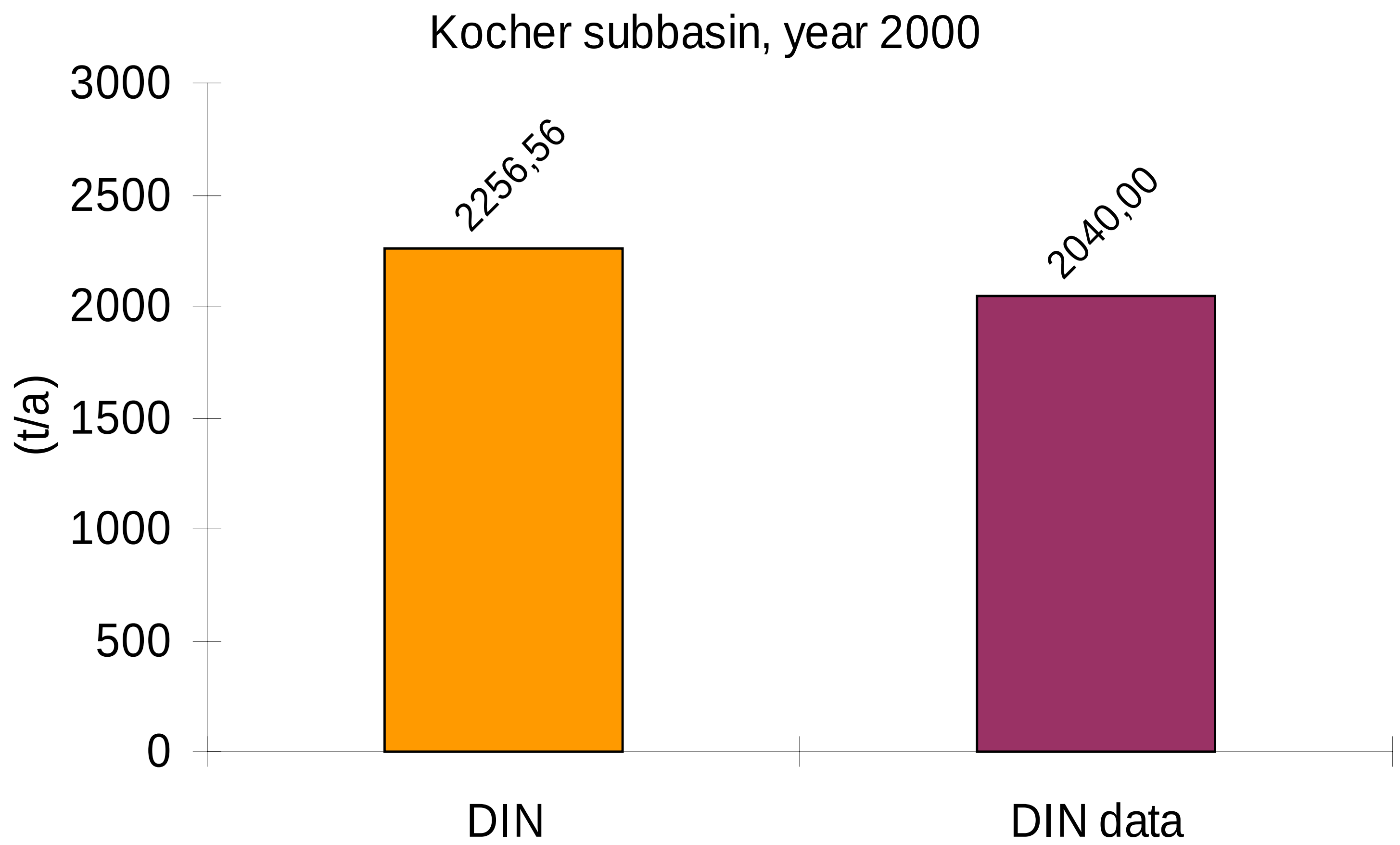


MONERIS output for the reference year 2000

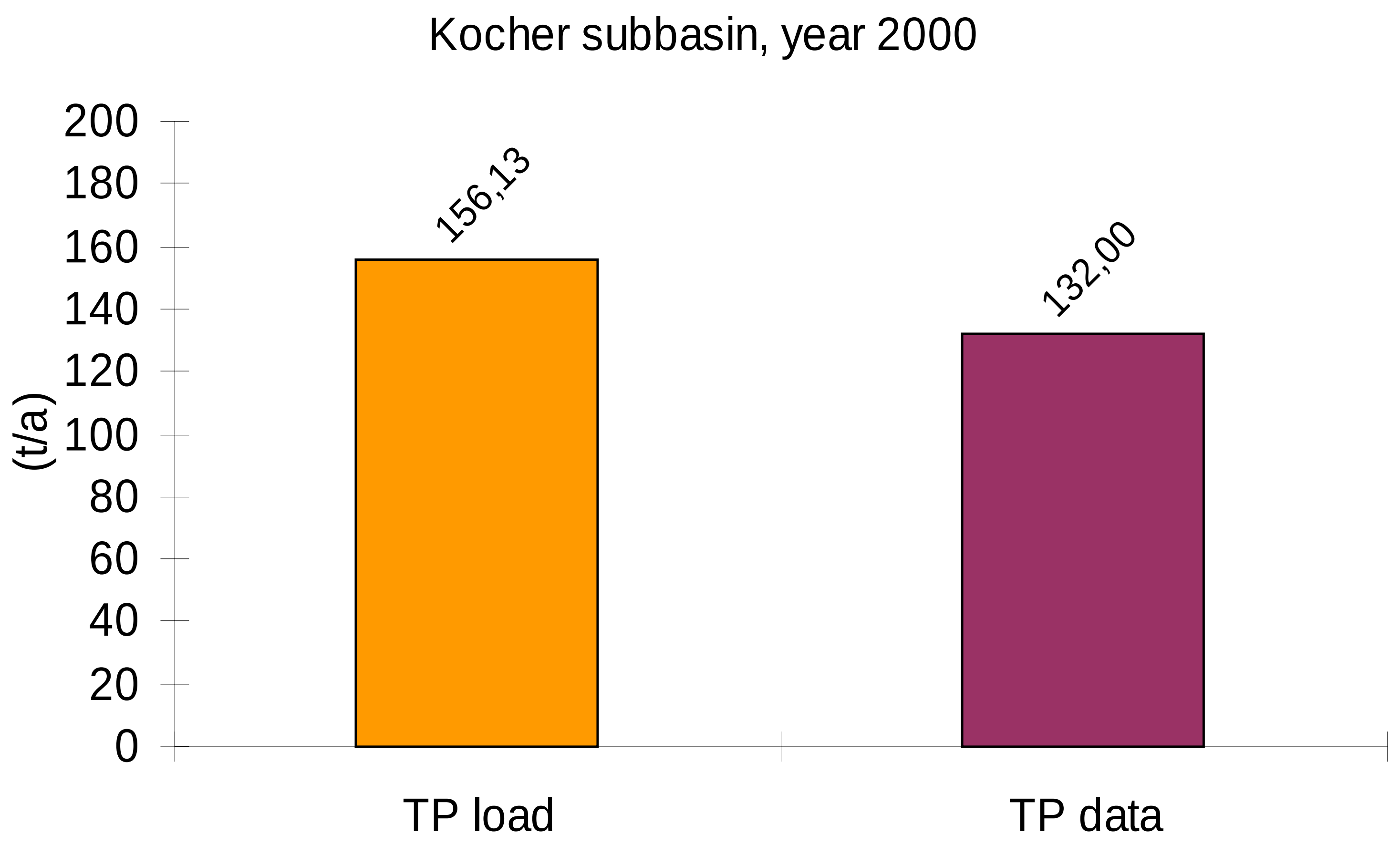


Simulated Total Phosphorus (tones/year)

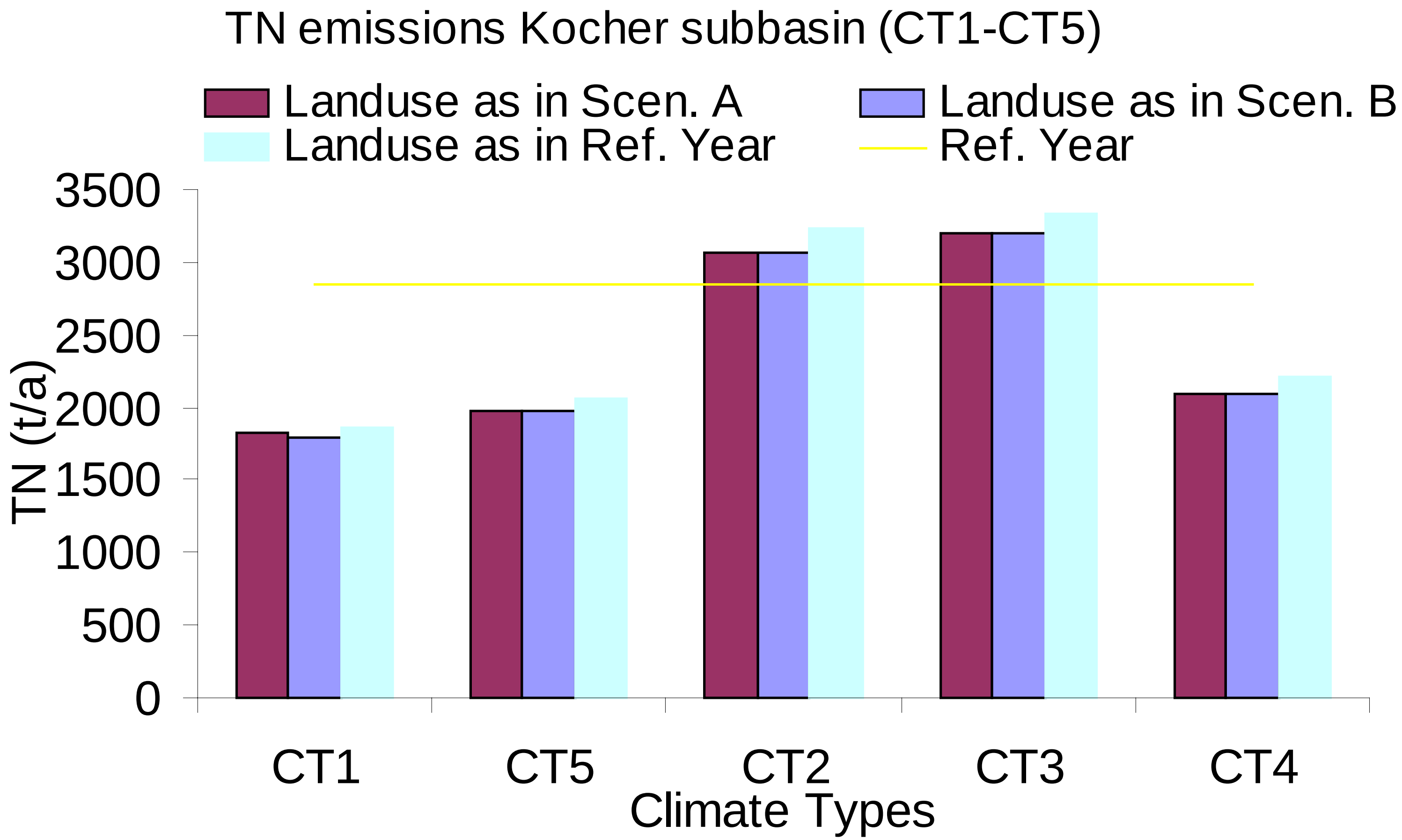
Comparing MONERIS output with measurement data for the Kocher sub-basin for 2000 (Total Nitrogen)



Comparing MONERIS output with measurement data for the Kocher sub-basin for 2000 (Total Phosphorus)



MONERIS model: Comparing TN, TP emissions for five climate types with different land use cover



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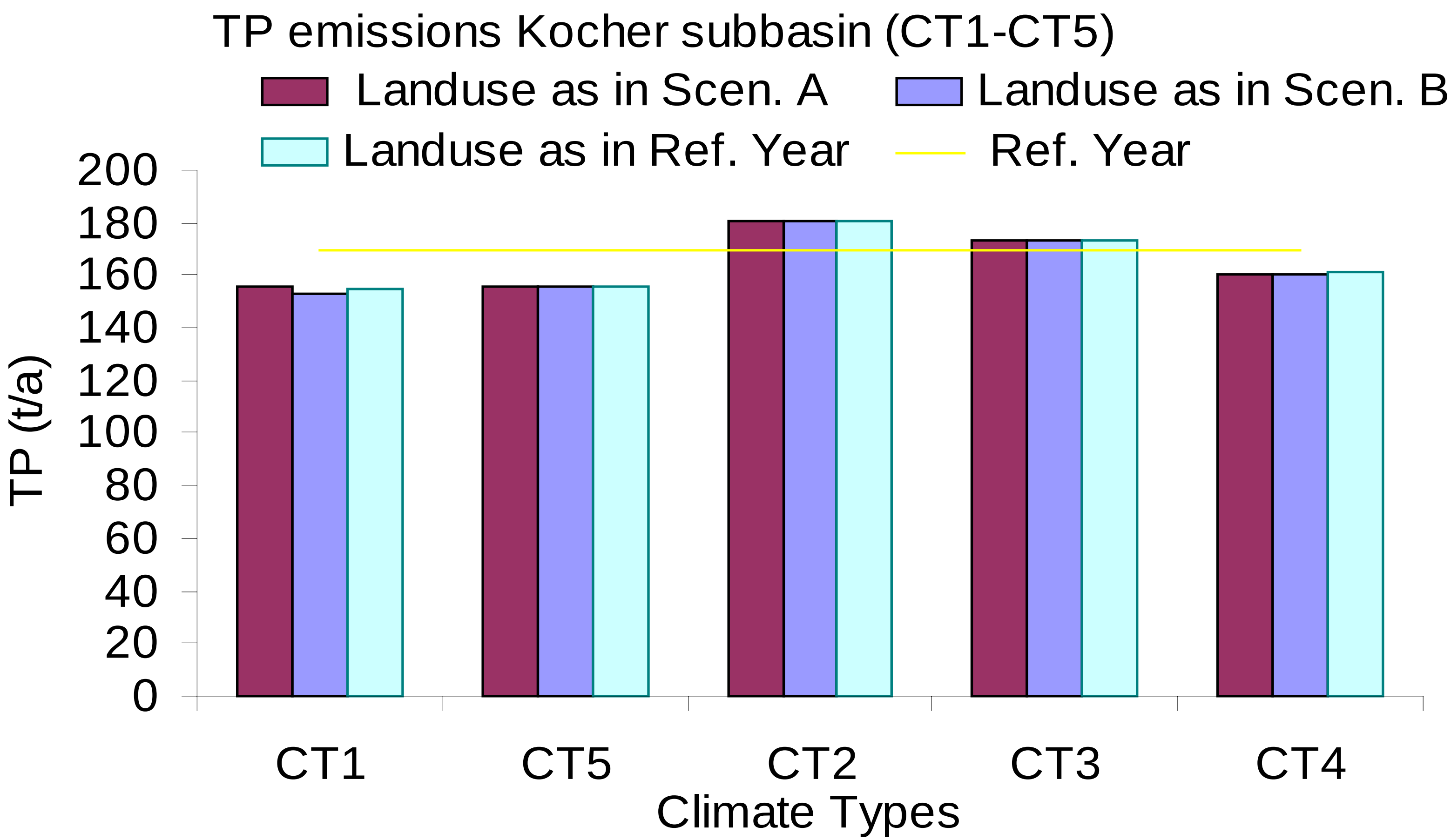
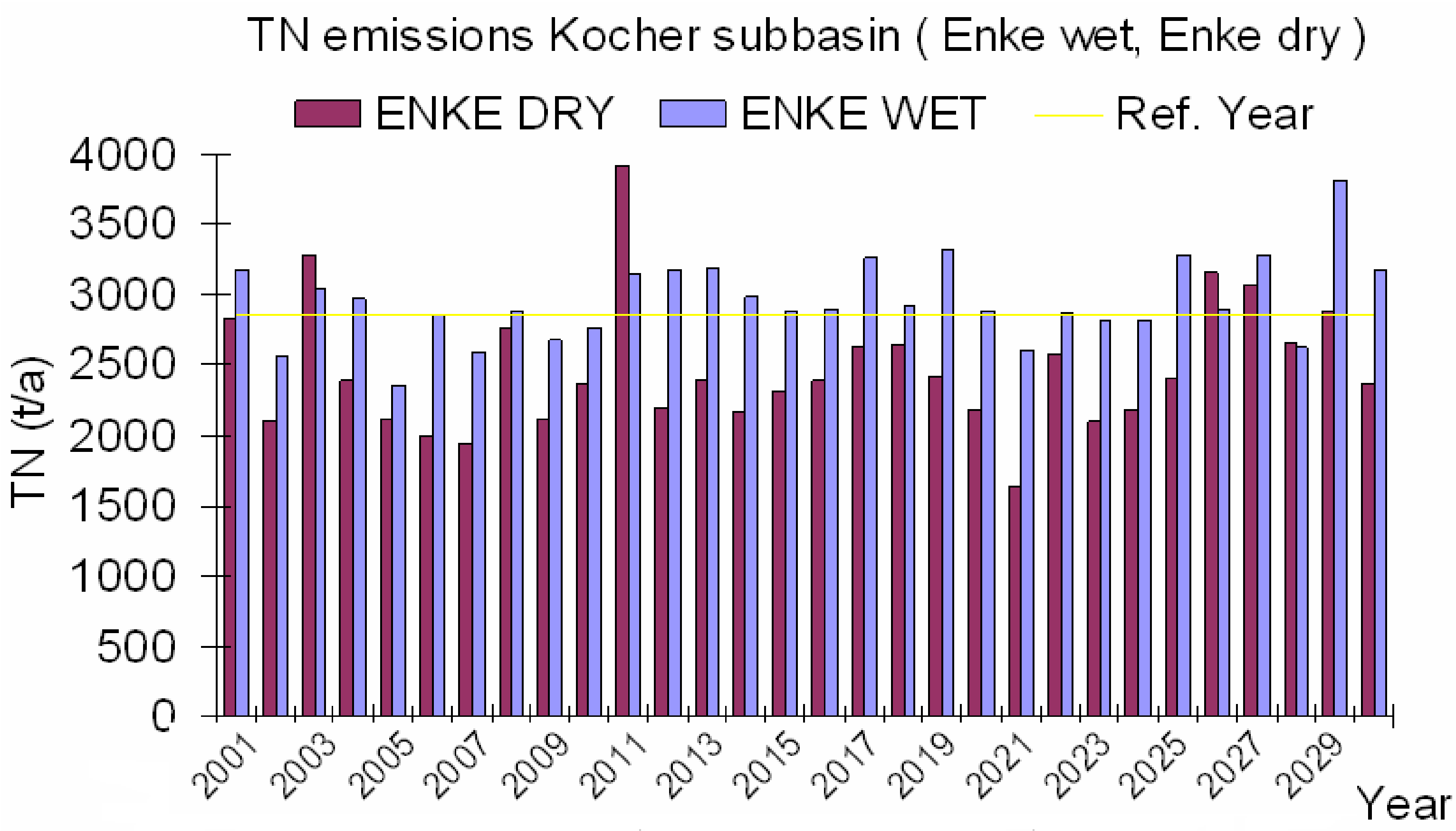
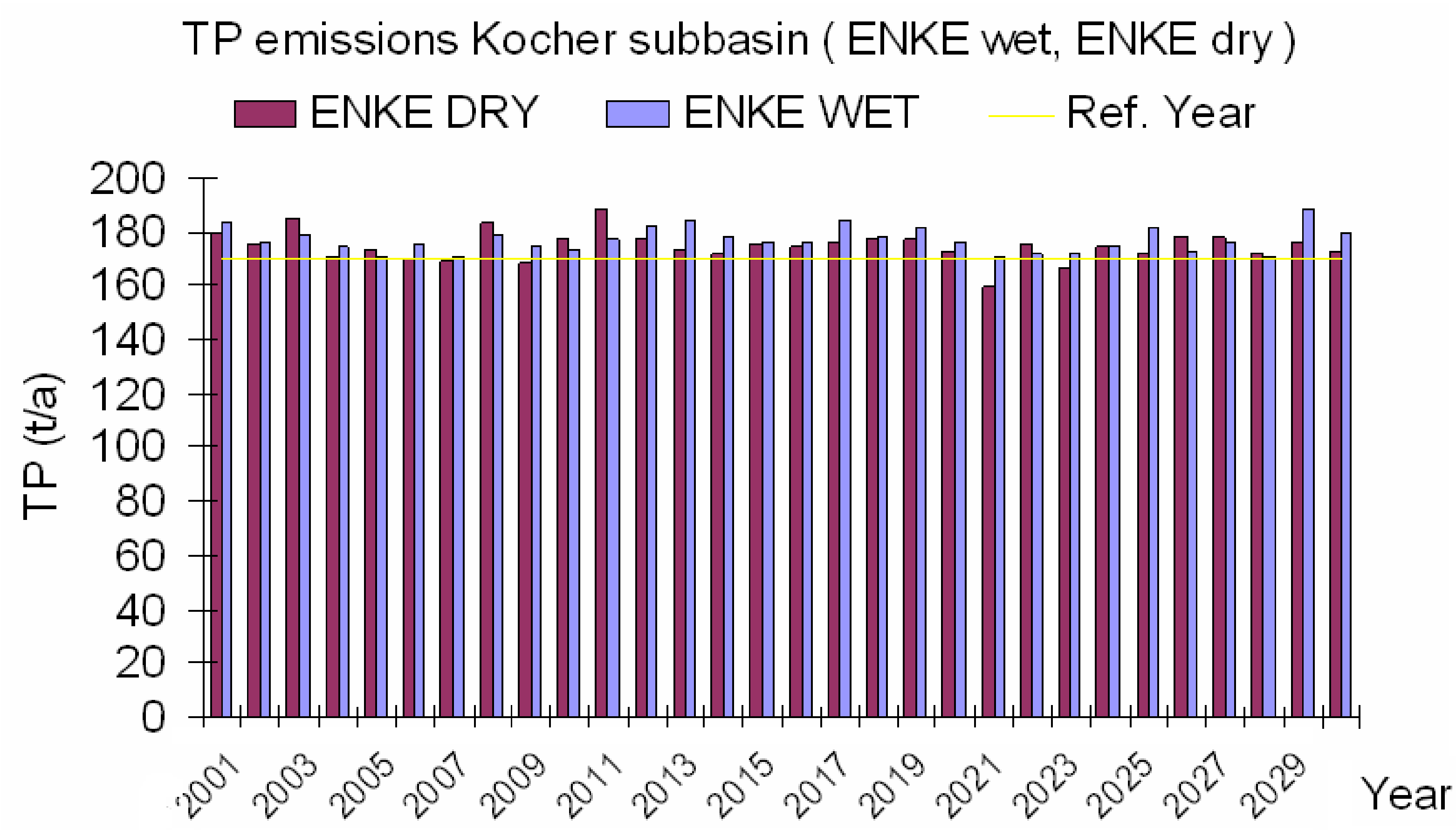


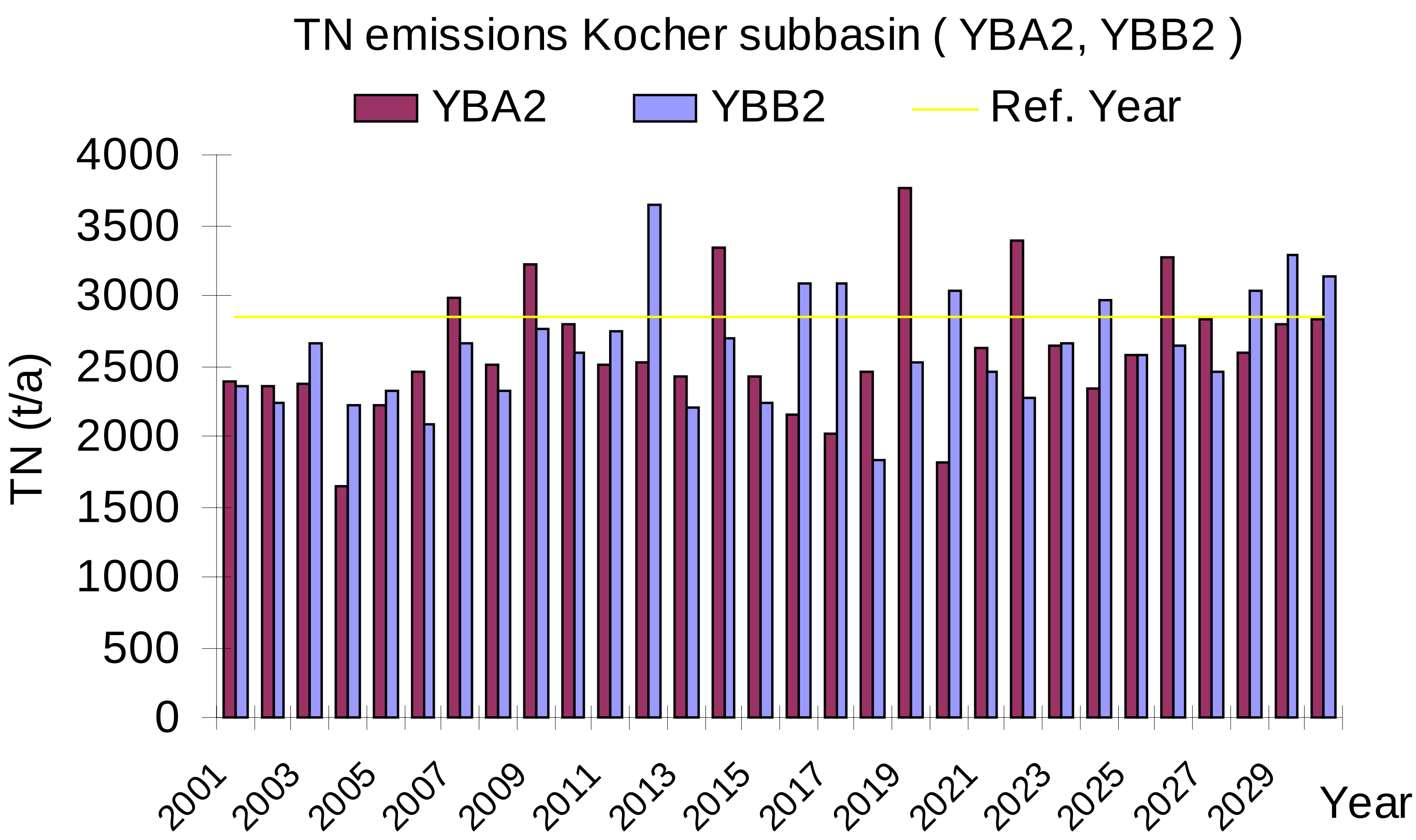
MONERIS model: Comparing TN emissions for the climate scenarios Enke wet, Enke dry, (socioeconomic status of the reference year)



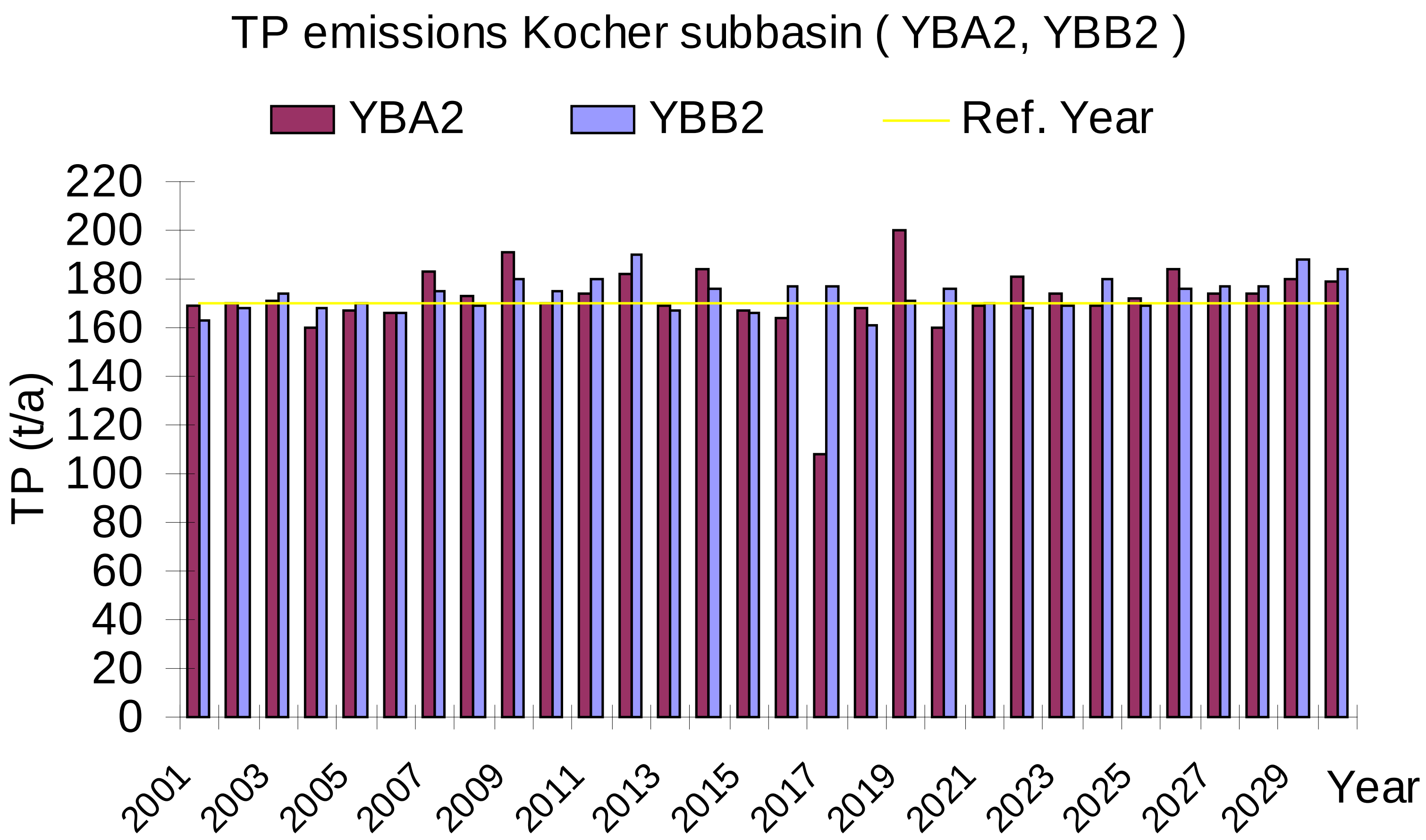
MONERIS model: Comparing TP emissions for the climate scenarios Enke wet, Enke dry, (socioeconomic status of the reference year)



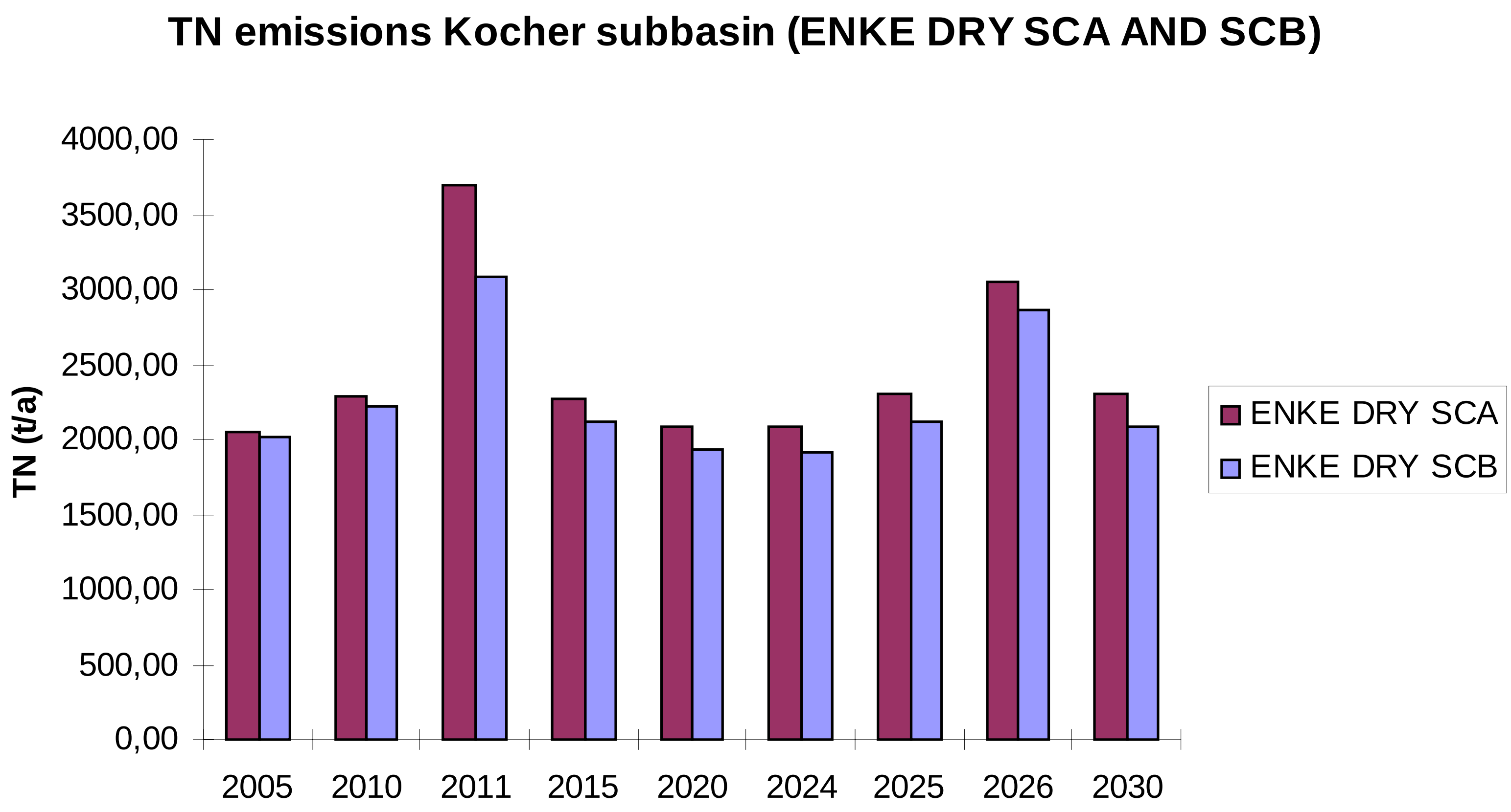
MONERIS model: Comparing TN emissions for the climate scenarios YBA2, YBB2 , (socioeconomic status of the reference year)



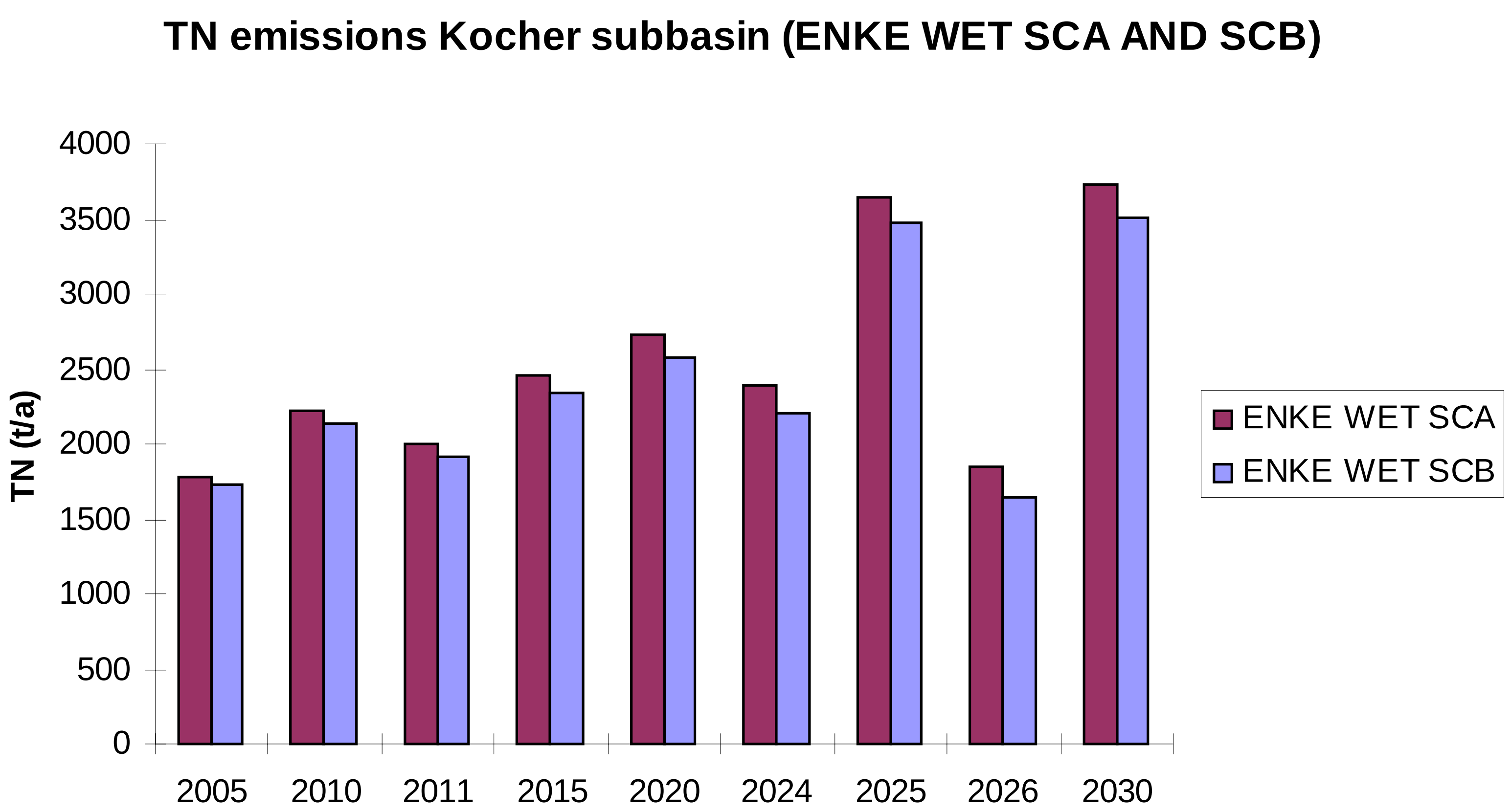
MONERIS model: Comparing TP emissions for the climate scenarios YBA2, YBB2 , (socioeconomic status of the reference year)



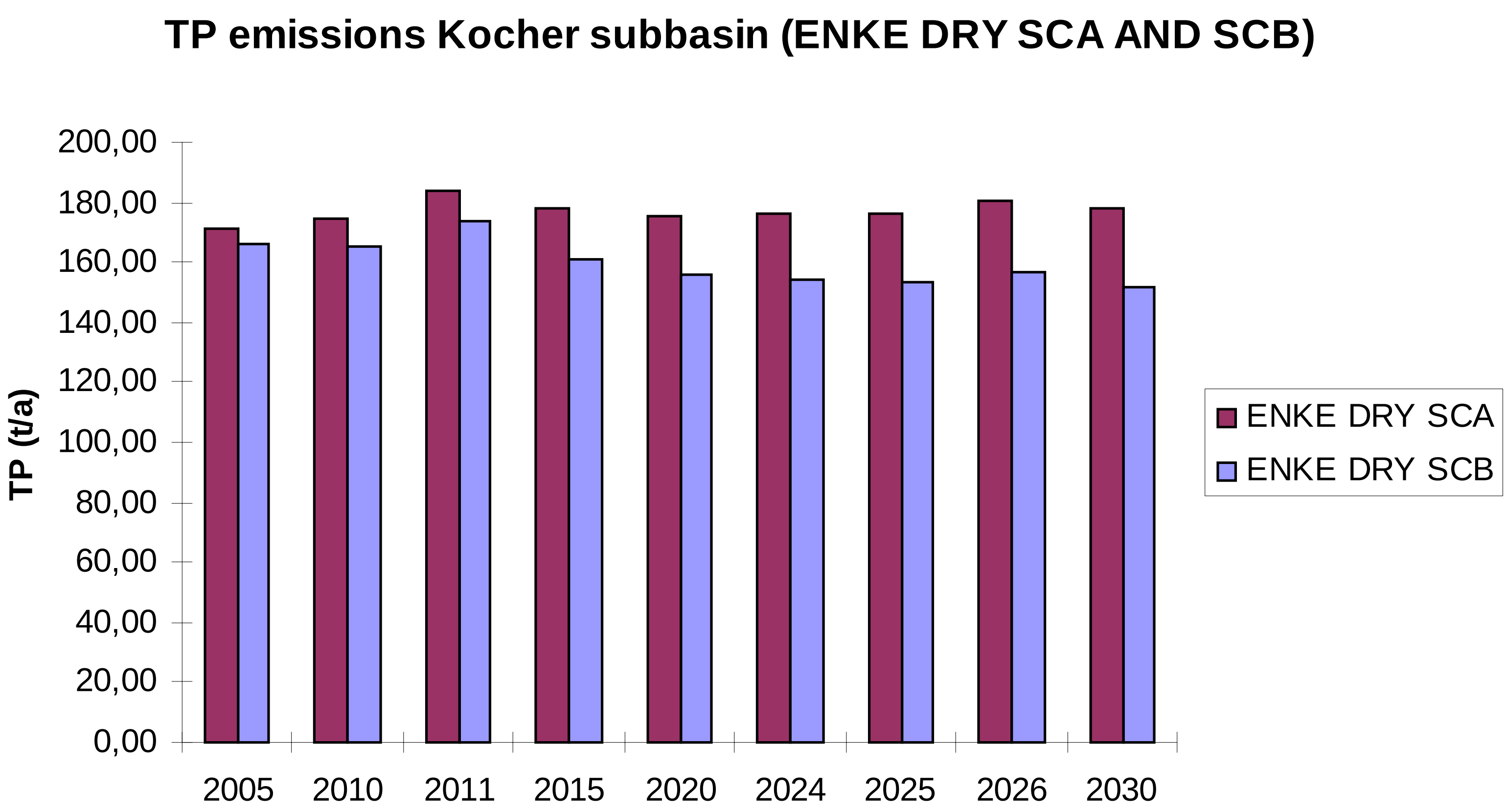
MONERIS model: Comparing TN emissions for the climate scenario ENKE DRY SCA with SCB



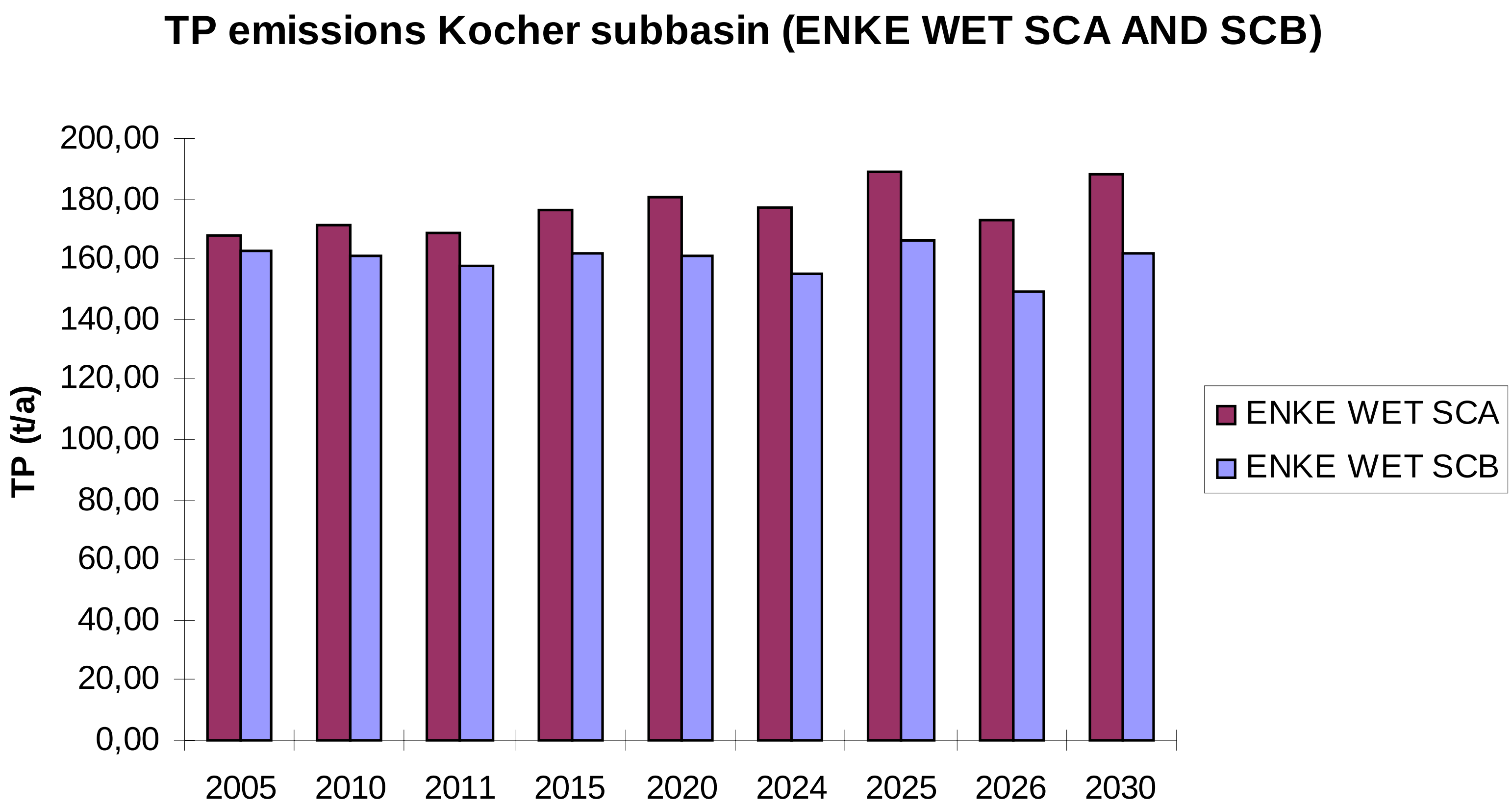
MONERIS model: Comparing TN emissions for the climate scenario ENKE WET SCA with SCB



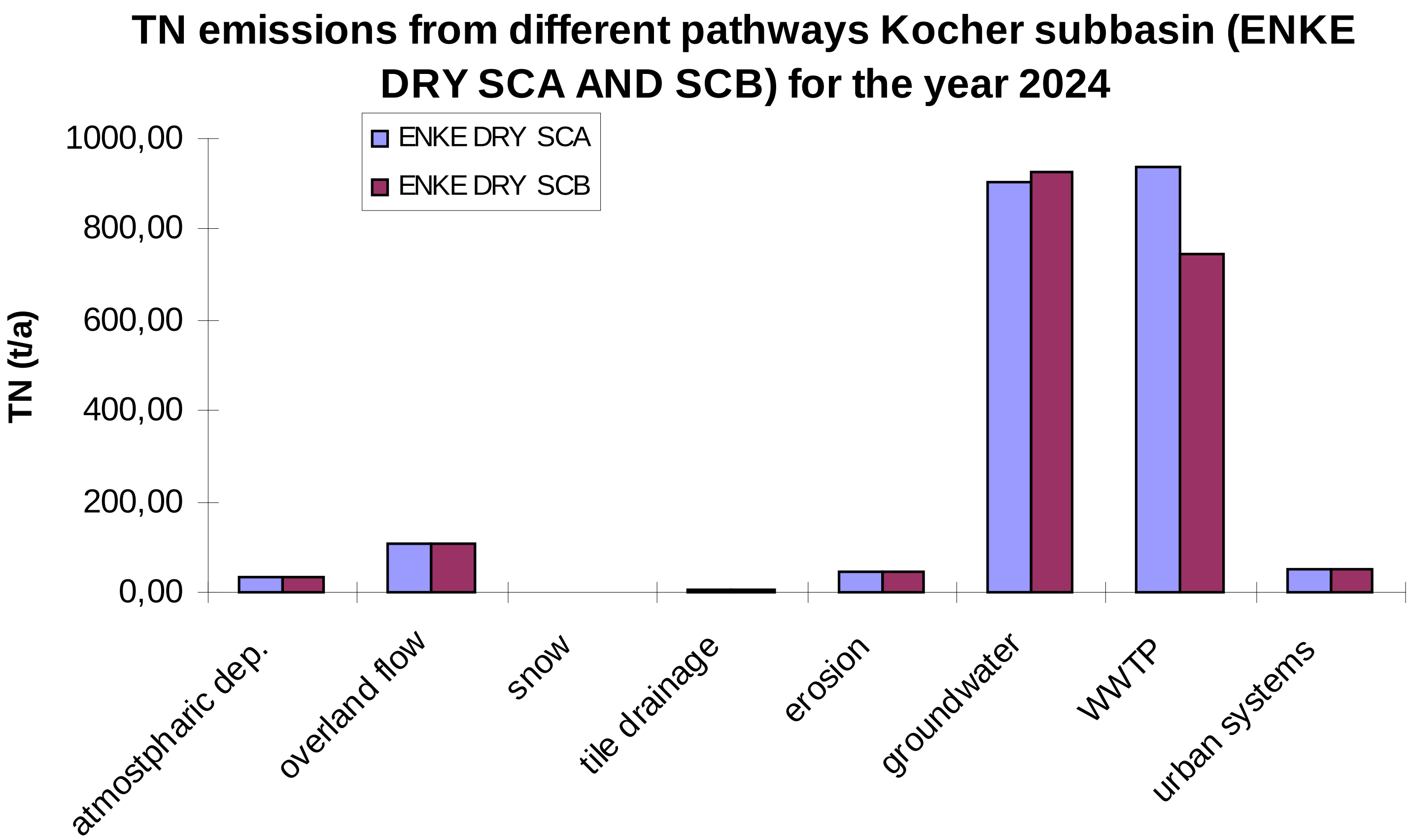
MONERIS model: Comparing TP emissions for the climate scenario ENKE DRY SCA with SCB



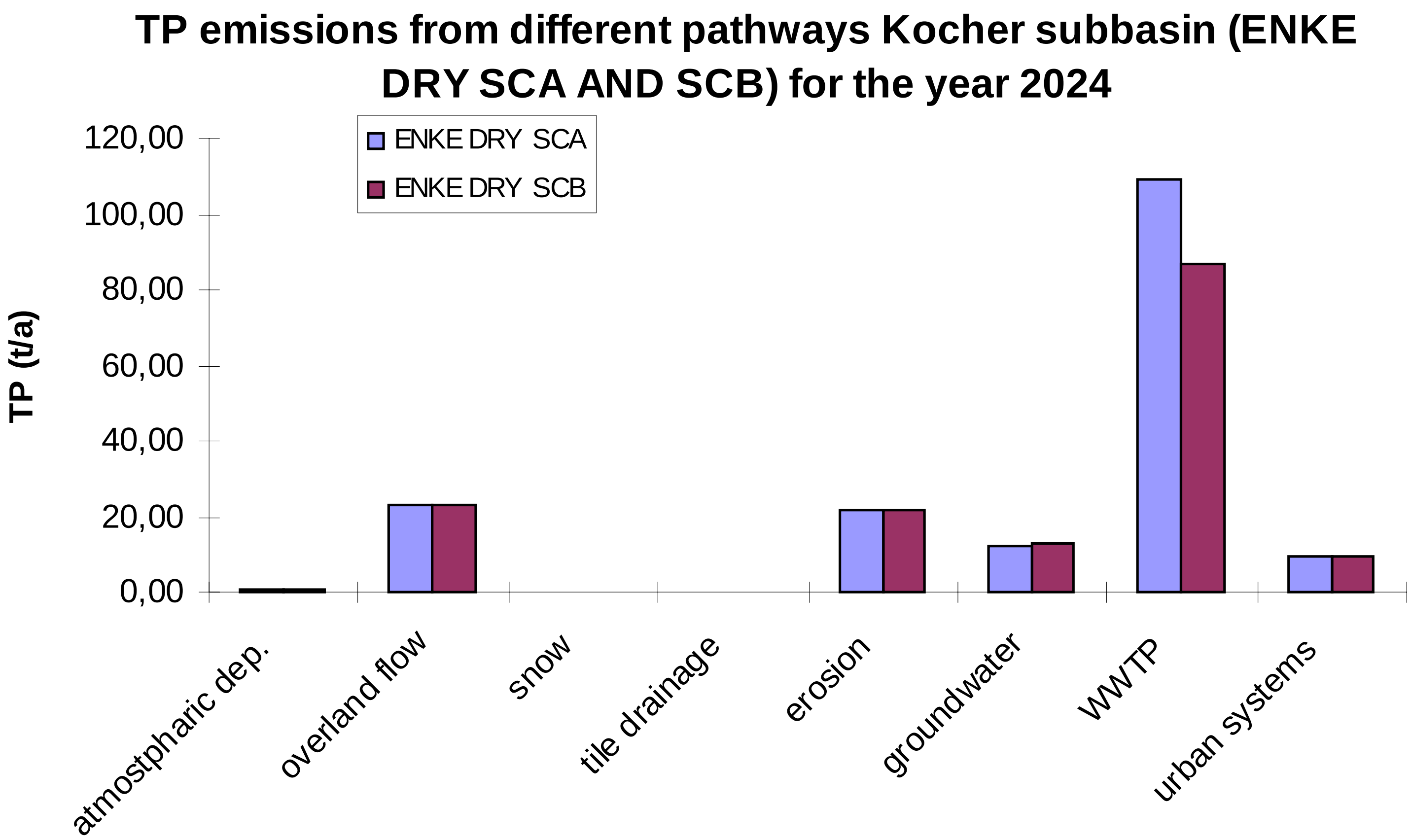
MONERIS model: Comparing TP emissions for the climate scenario ENKE WET SCA with SCB



MONERIS model: Comparing TN emissions from different pathways for the climate scenario ENKE DRY SCA with SCB



MONERIS model: Comparing TP emissions from different pathways for the climate scenario ENKE DRY SCA with SCB



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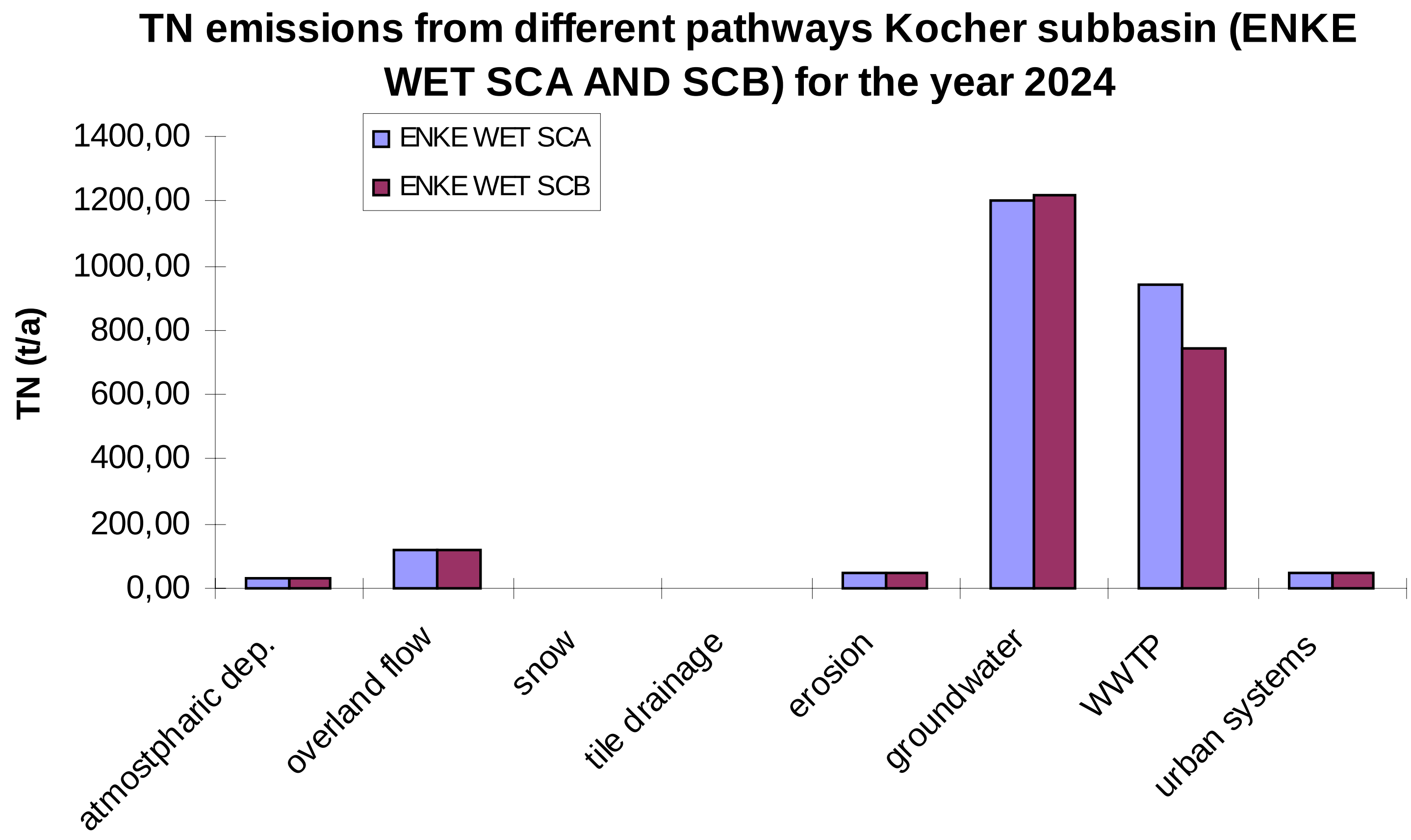

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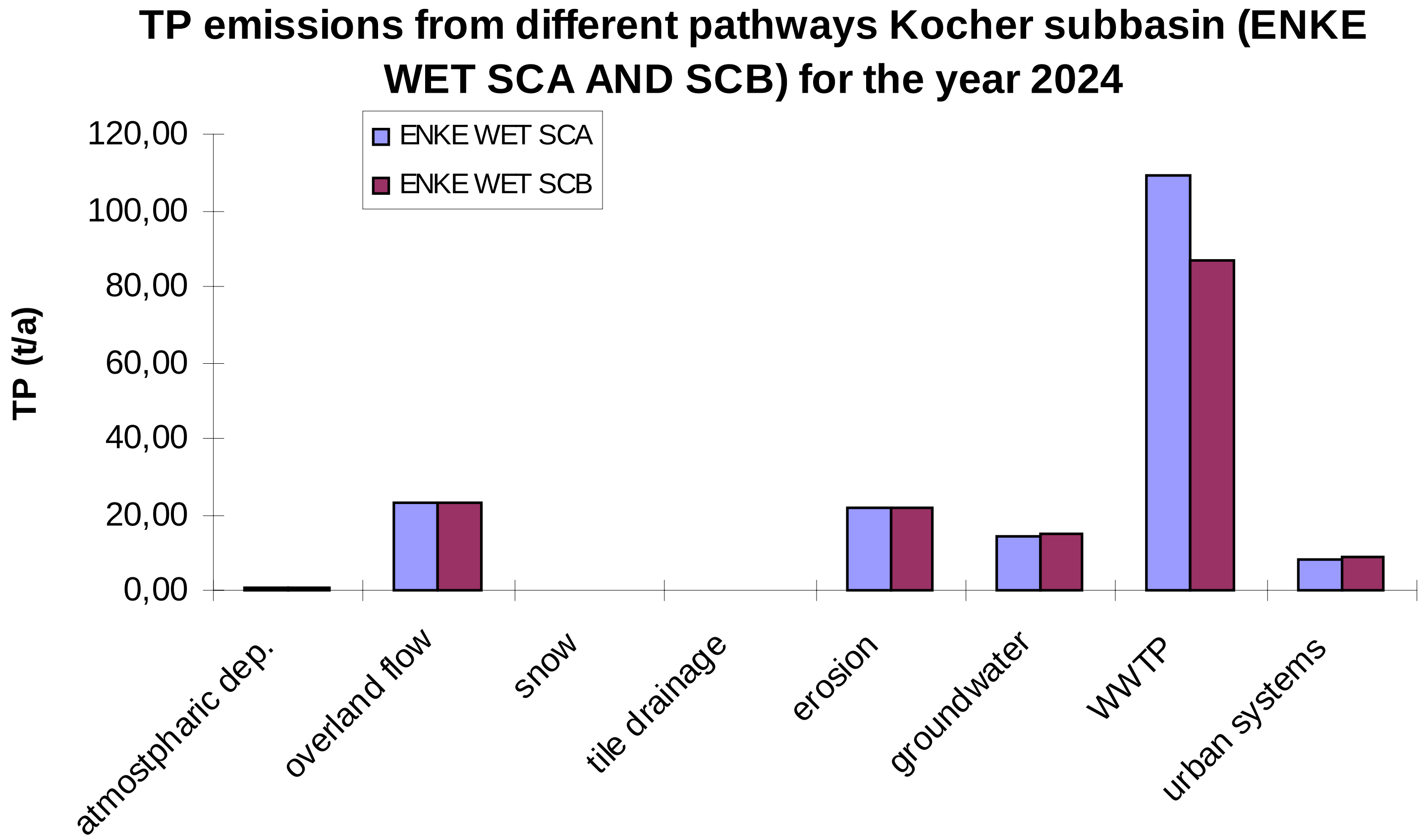
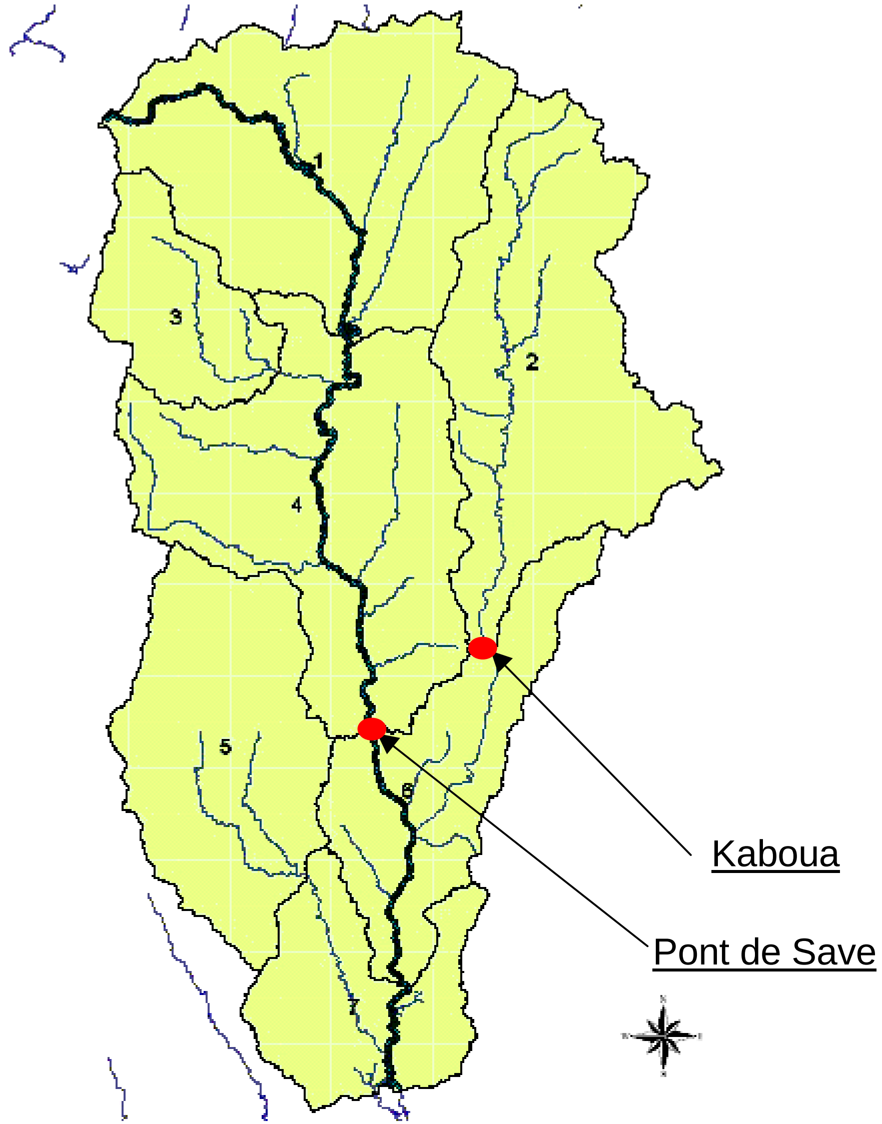




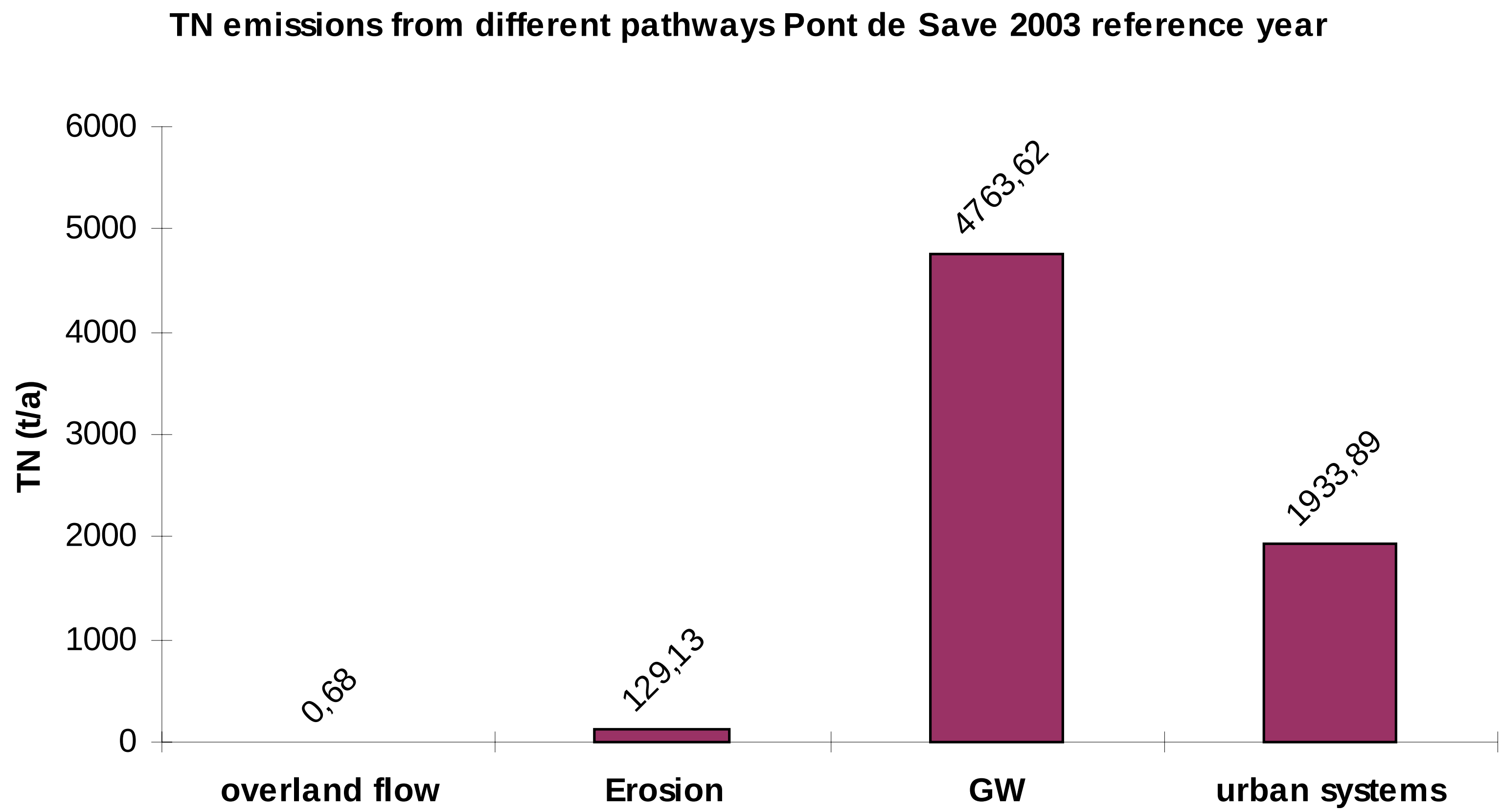
The Oueme catchement was divided in 7 subcatchements from 3060 km^2 to 10350 km^2.

Measurement data from the Pont de Save and Kaboua gauging stations were used for the model calibration. First the model was applied for the reference year 2003. Some of the model outputs and comparison with available data are plotted in the graphs below.

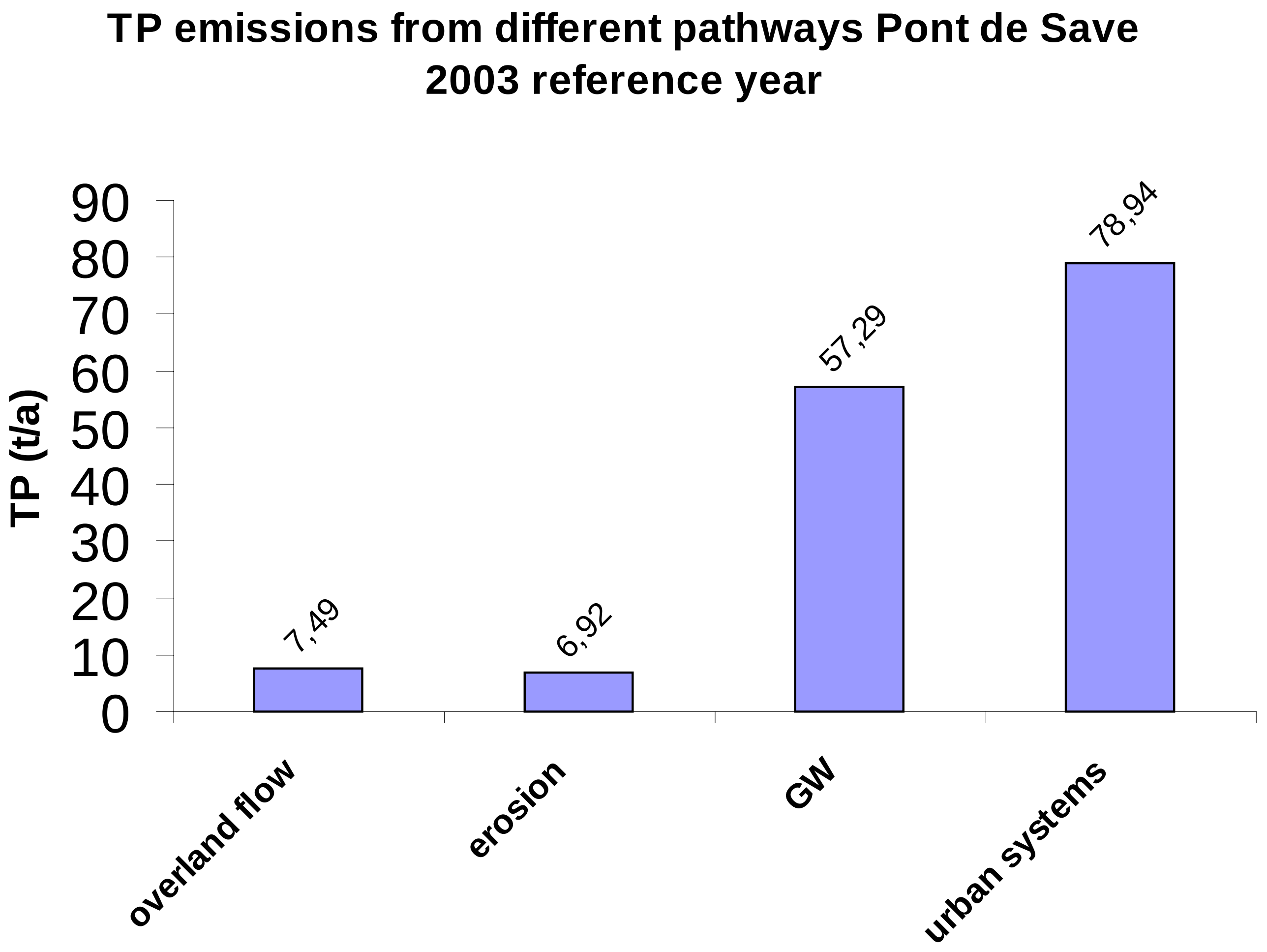
The water quality of the River Neckar was first modeled for the reference year 2000, secondly for the 5 climate types, and lastly for the ENKE dry, ENKE wet, Yang-Bardossy A2 and Yang-Bardossy B2 climate scenarios (Table).

Climate Scenarios	Simulation Years	Description
CT1	2003	Reference year
CT2	1999	wet
CT3	1983	DRY
YB(B2)	2004-2030	

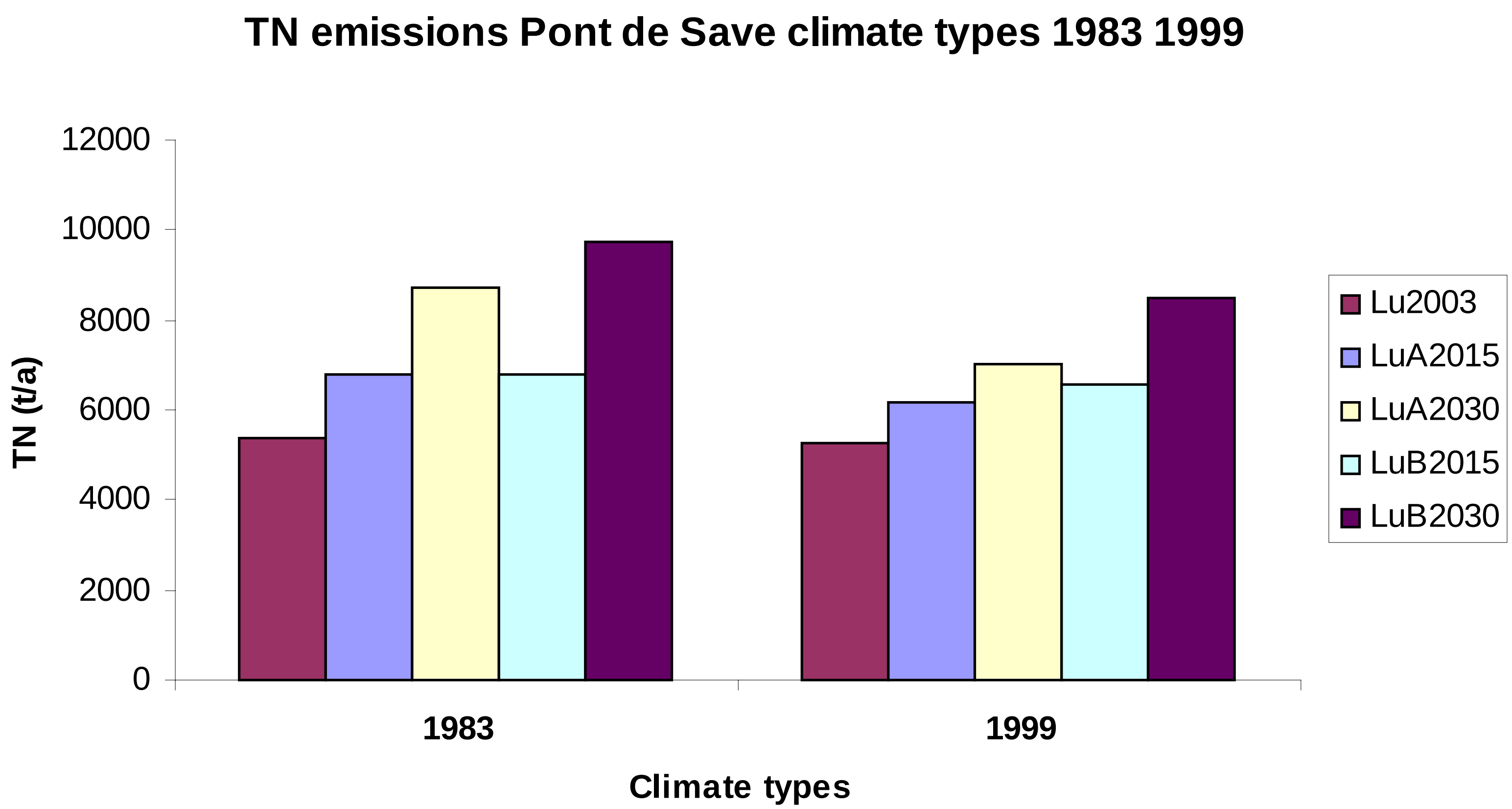
MONERIS output for the reference year 2003



MONERIS output for the reference year 2003



MONERIS model: Comparing TN emissions for two climate types with different land use cover



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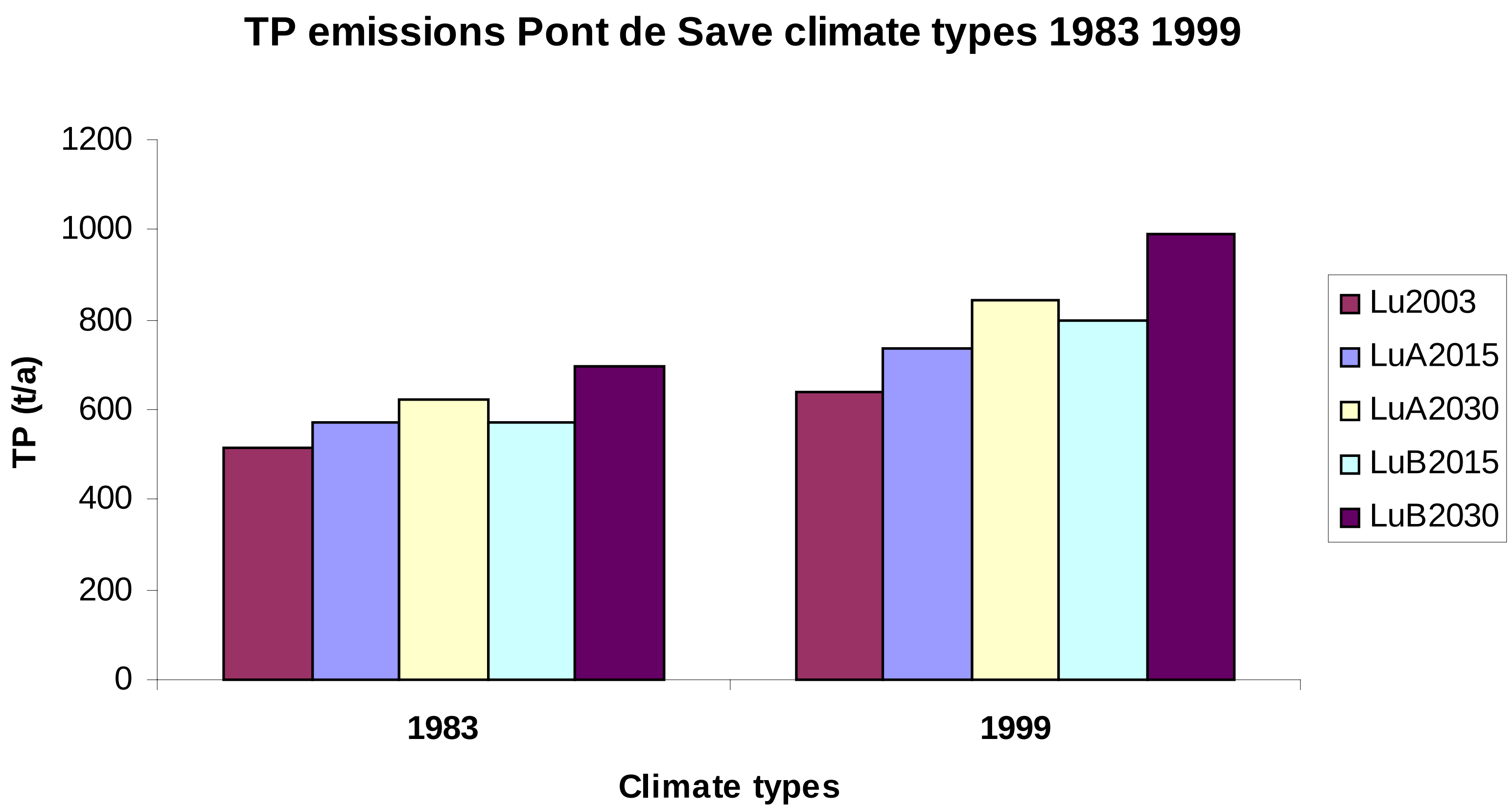
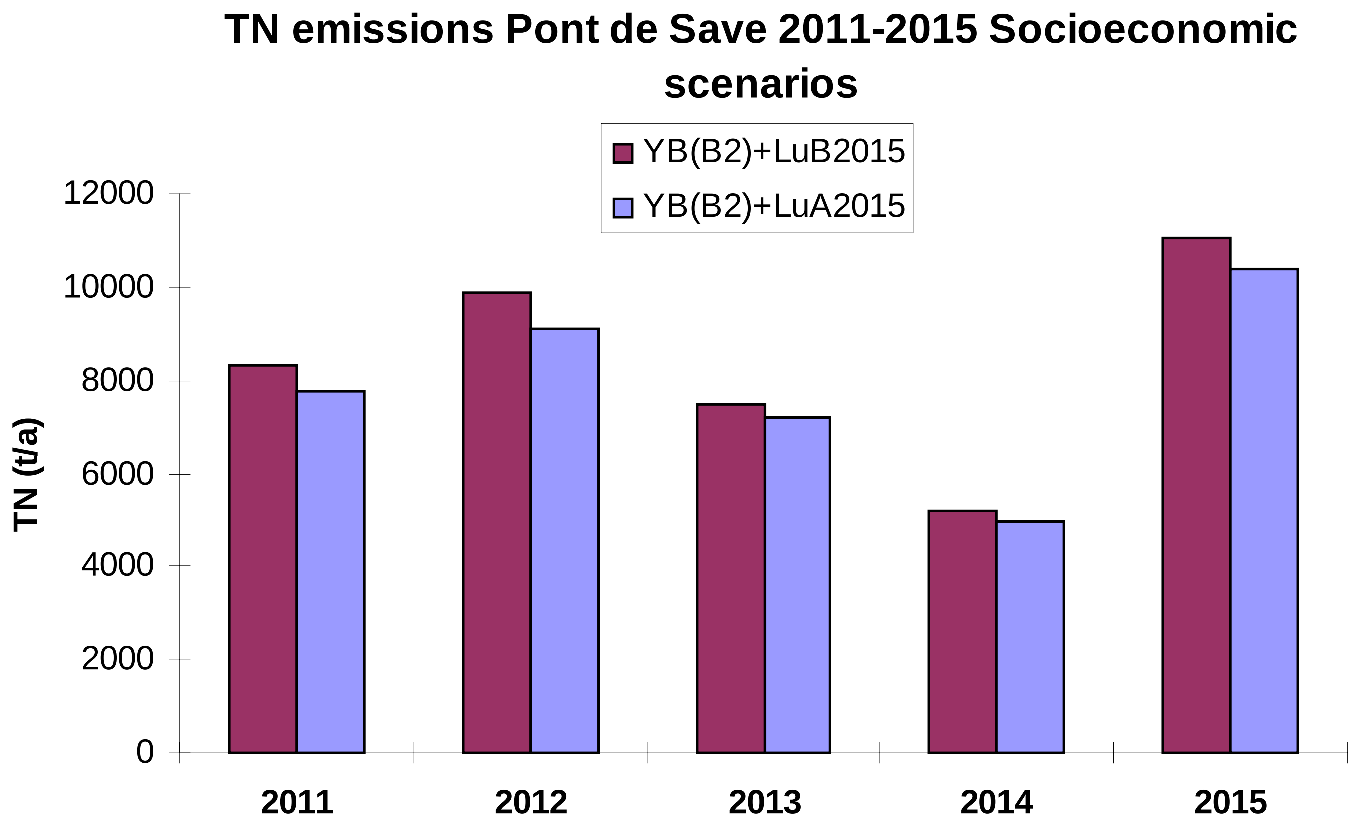


MONERIS model: Comparing TN emissions with different land use cover



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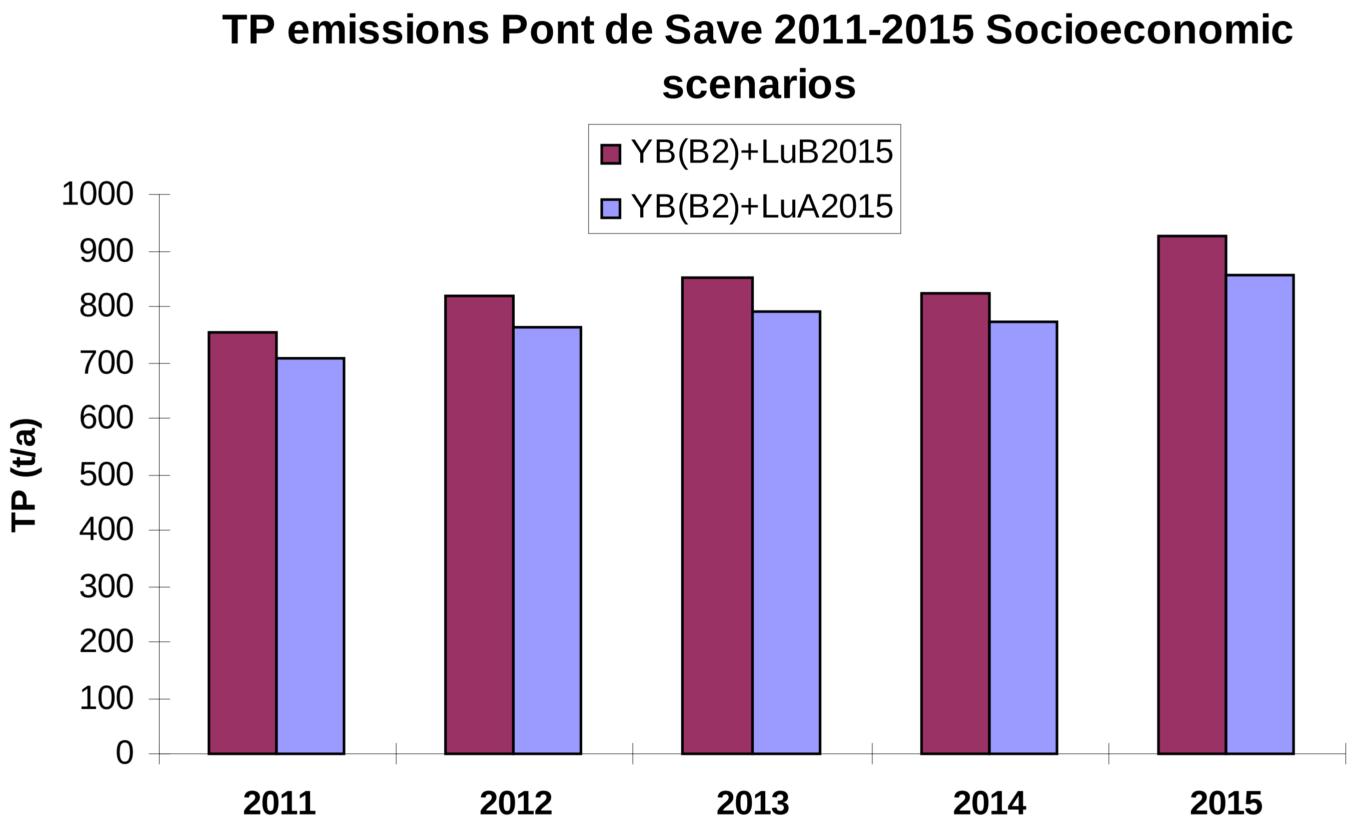

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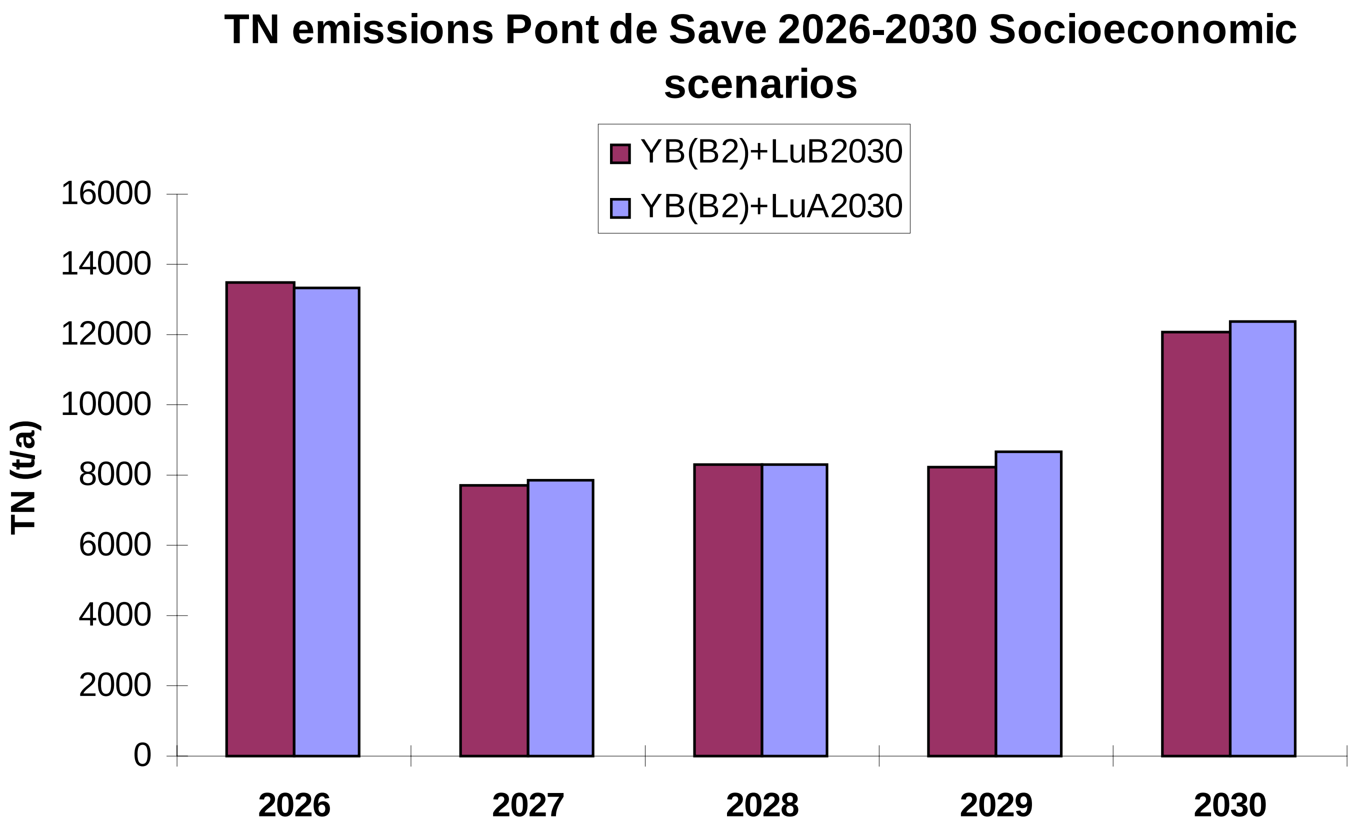

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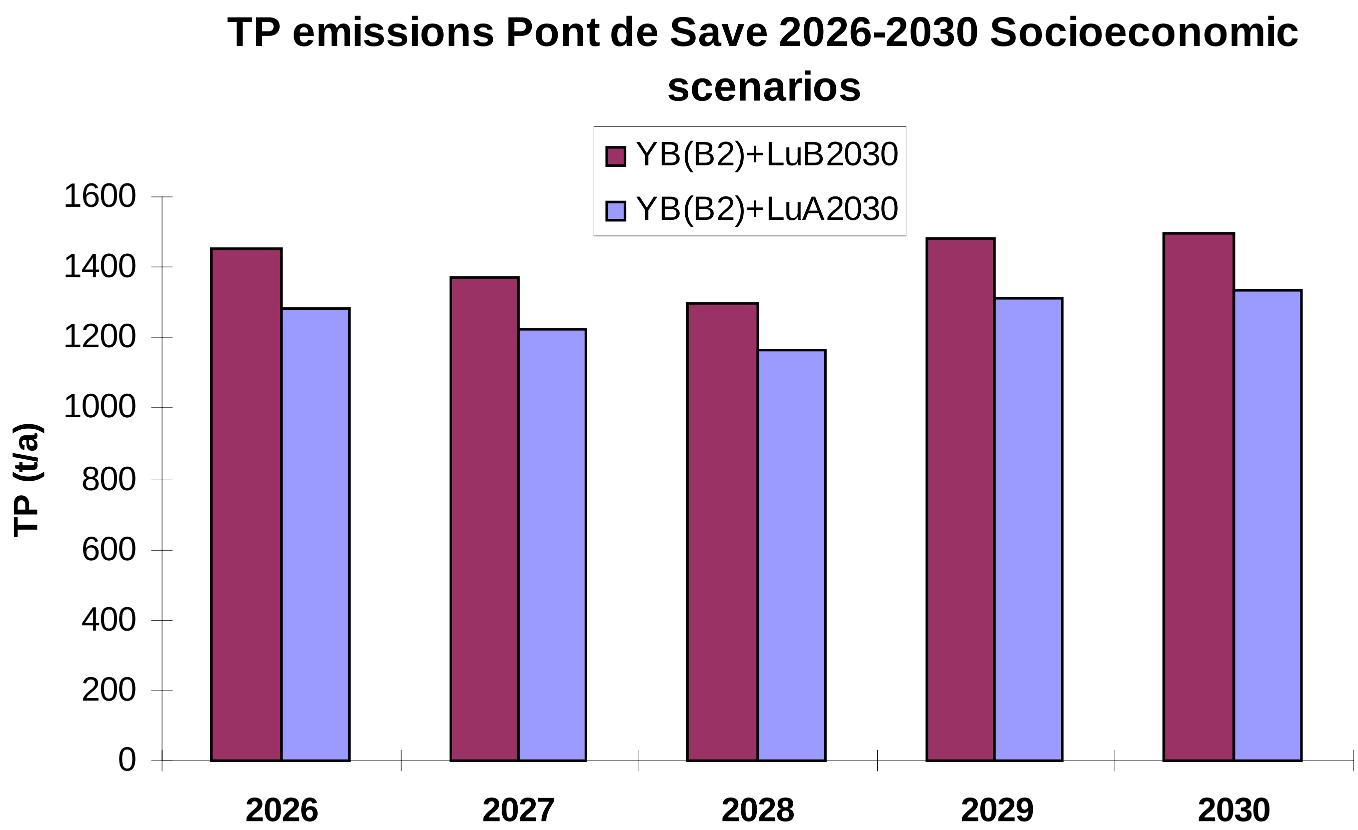

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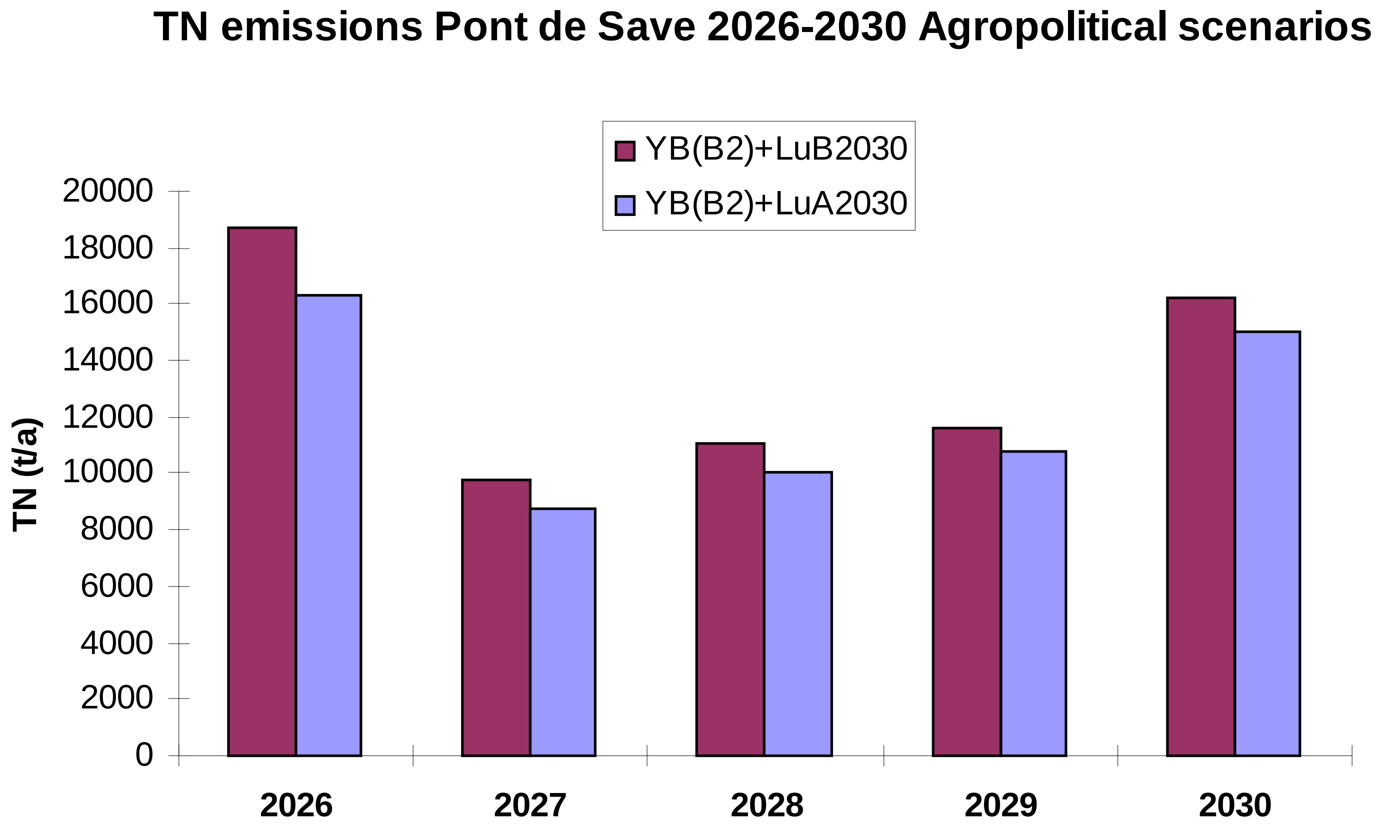

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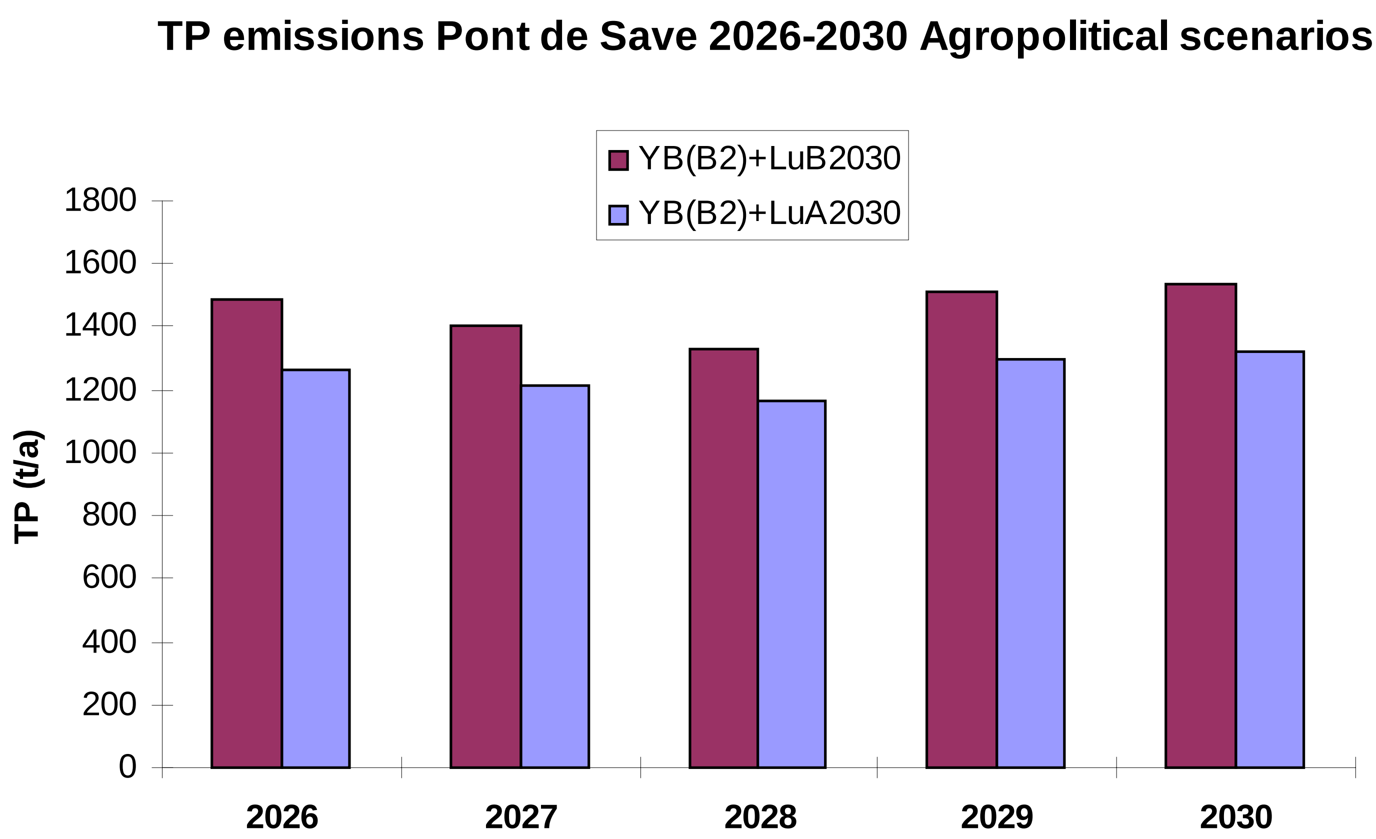

CONCLUSIONS : MONERIS SIMULATIONS

An increase of nutrient loads, especially nitrogen, is observed in years with high precipitation.

For the Neckar basin in socioeconomic scenario A, there is a small increase of nutrients compared with the socioeconomic scenario B. The main pathaway for the nitrogen is the groundwater and the WWTPs and for the phosphorous is the WWTPs.

For the Oueme basin between the scenarios A and B we almost have no change in nitrogen emissions and a small increase in phosphorus emissions in the scenario B. The main pathaways for the nitrogen and phosphorus are the groundwater and the urban areas.