# INTEGRATION OF SWAT AND QUAL2K FOR WATER QUALITY MODELING IN A DATA SCARCE BASIN: A CASE STUDY OF CAU RIVER BASIN OF VIETNAM

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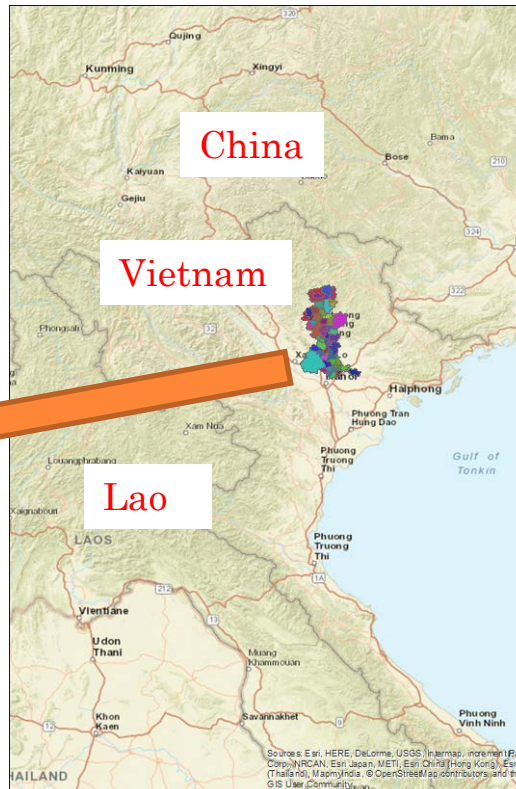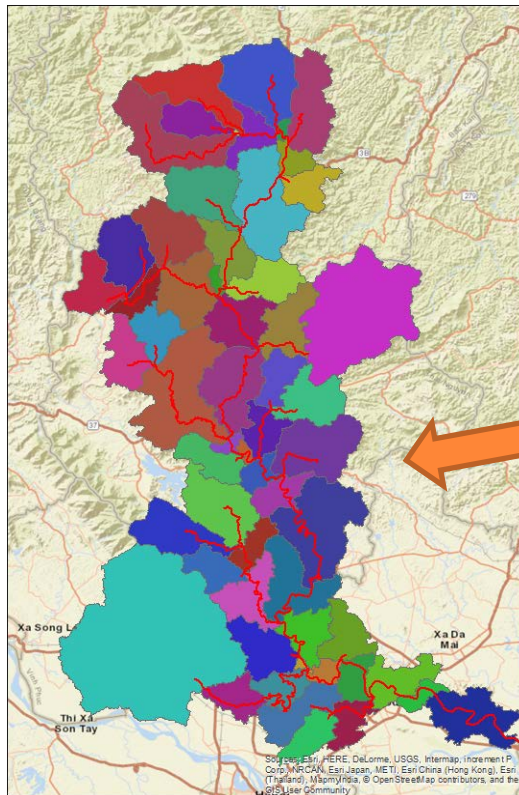
Vietnam Academy of Science and Technology (VAST)

# OUTLINE

- STUDY AREA

- WATERSHED DATA PROBLEM

- WQ MODEL CONSTRUCTION (SWAT & QUAL2K)

- RESULTS

- RECOMENDATIONS

## Cau river watershed



The Cau River is in North-East part of Vietnam. Cau River mainstream is 288 km long. The river network in the Cau River basin is relatively dense with tributaries evenly distributed along the mainstream. The catchment's area is 6030km$^2$
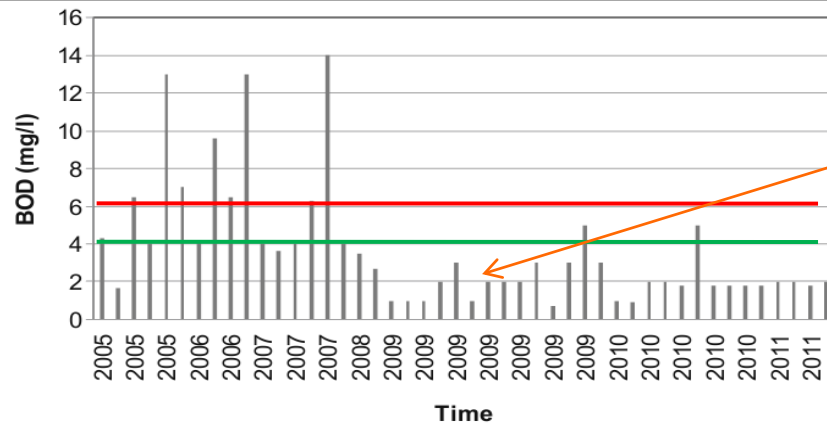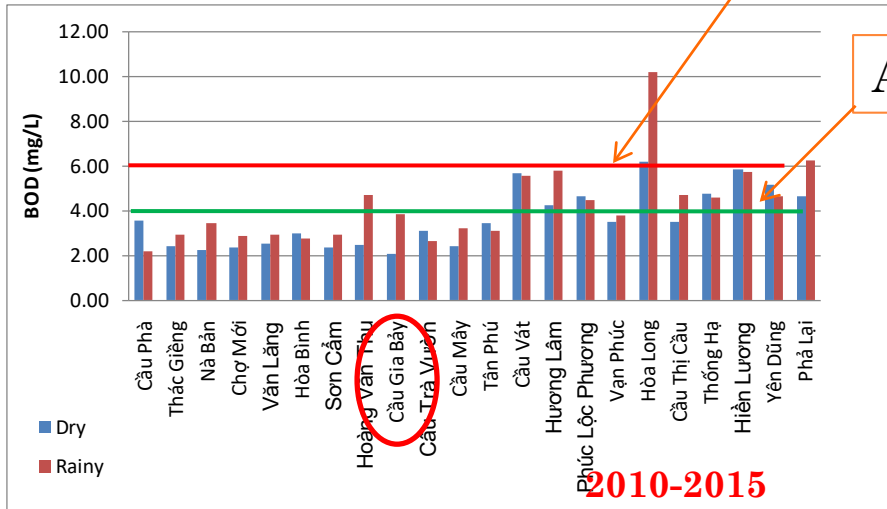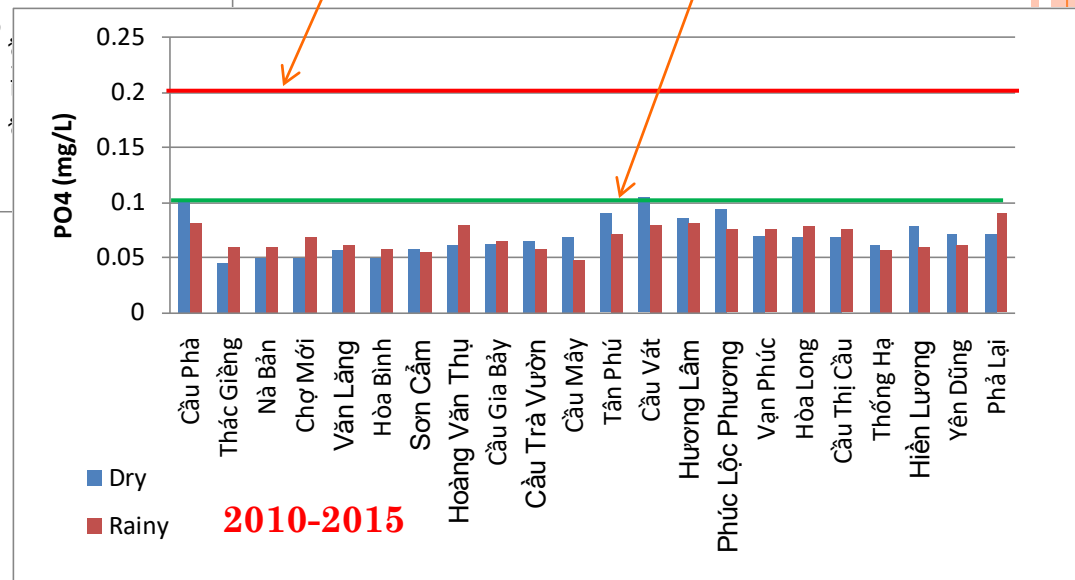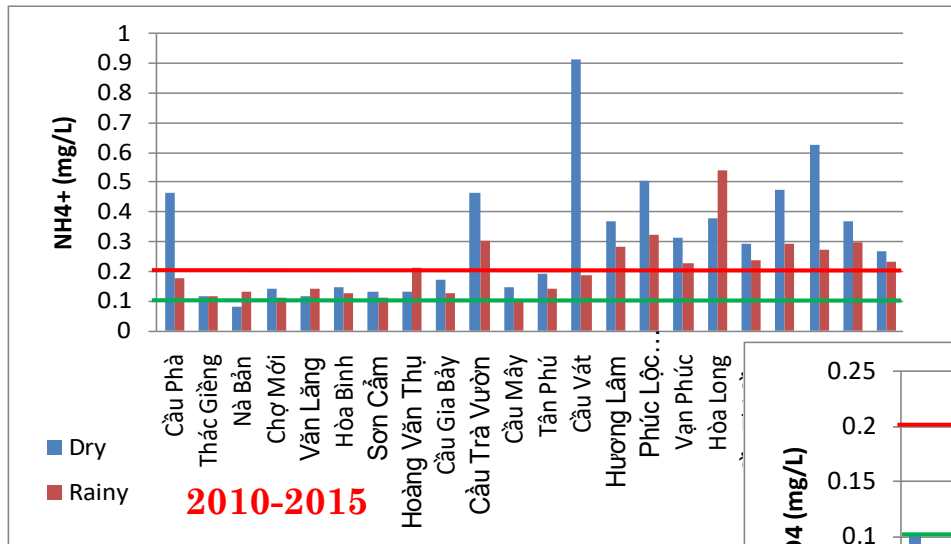
# STUDY AREA

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- Water quality problem

VN standard A2

A1



2010-2015

# STUDY AREA

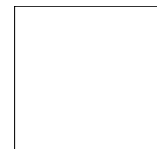- Water quality problem



VN standard A2

A1

2010-2015

# WATERSHED DATA

- Hydro-meteorology stations

+ 01 Discharge station, 05
  water level stations

+ 06 Meteo stations

+ 42 Rain stations

# WATERSHED DATA

- Pollution source information

  + Point sources: about 500, spatial locations about 200 (Industry, Hospital, Trade, …)

  + Non-point sources: domestic, livestock, agriculture, forest,...) calculated based Provincial Statistical Books for districts
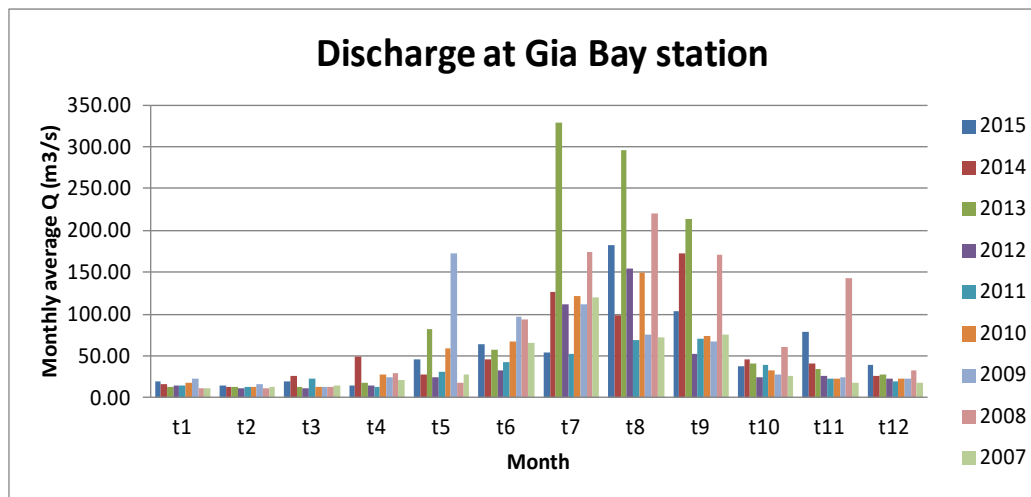
# WATERSHED DATA

- Pollution load of sub-watershed (based on monitoring data and rapid estimation method)
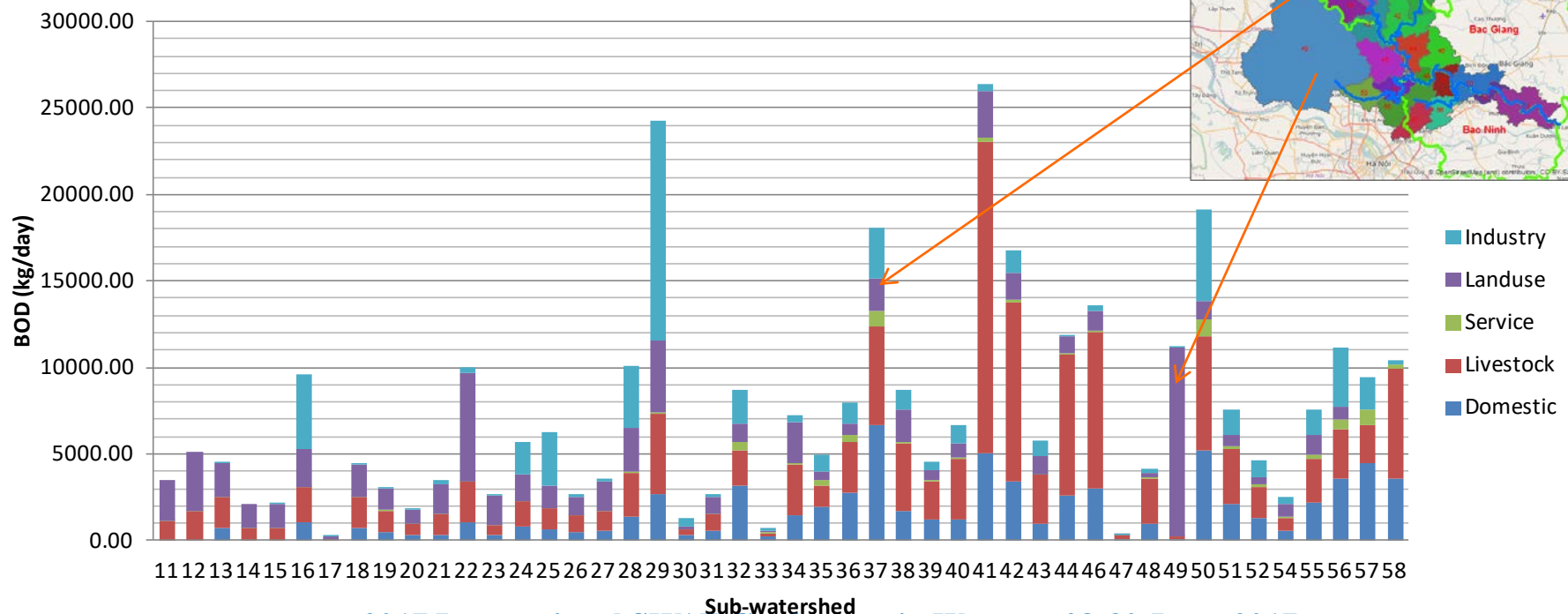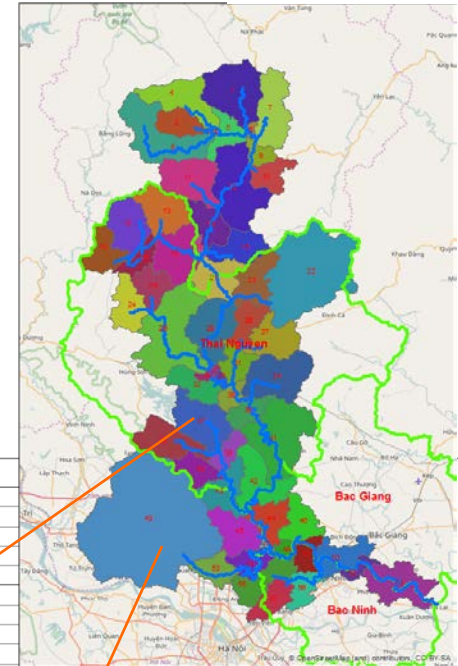
# WATERSHED DATA

- River Water quality

  Regular monitoring data from 2010:
  42 stations, 5 times/year (BOD5,
  COD, EC, NO3, NH4, T, pH,
  PO4, TKN, T-P, TSS) in March,
  May, July, Sept, Nov)



Discharge at Gia Bay station

# WATERSHED DATA

- Data gaps:

  + River discharge: only one station, not measured during WQ monitoring campaign

  + Poor spatial data for pollution sources (houses, livestock, manufacture factories, service establishments, …)

  + Poor GIS data for landuse, soil type …
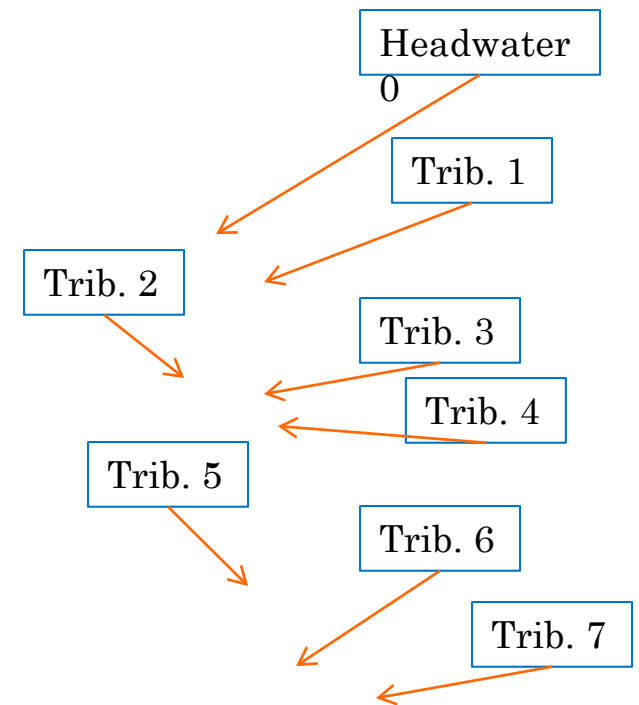
# WQ MODEL CONSTRUCTION

- Purpose: Construction of WQ for Cau river watershed for TDML implementation of BOD, N and P

- SWAT: Poor (modest) spatial data

- QUAL2K: Missing discharge data in mainstream and tributaries

- Proposed solution: Using calibrated SWAT for hydrology (with observed data at Gia Bay station) for river (headwater) discharge inputs for QUAL2K; using WQ monitoring data (at mainstream and tributaries) for boundary conditions of QUAL2K.
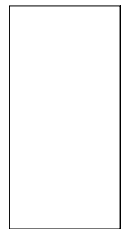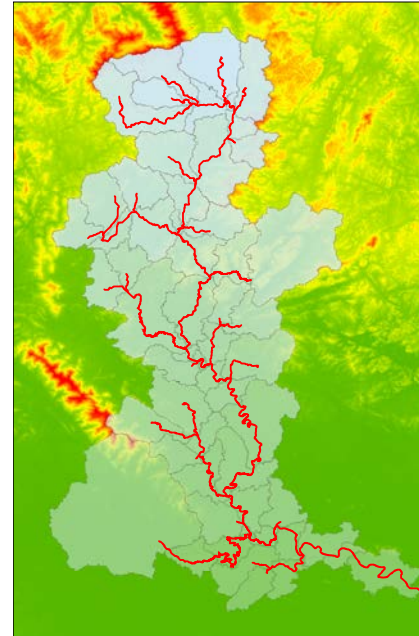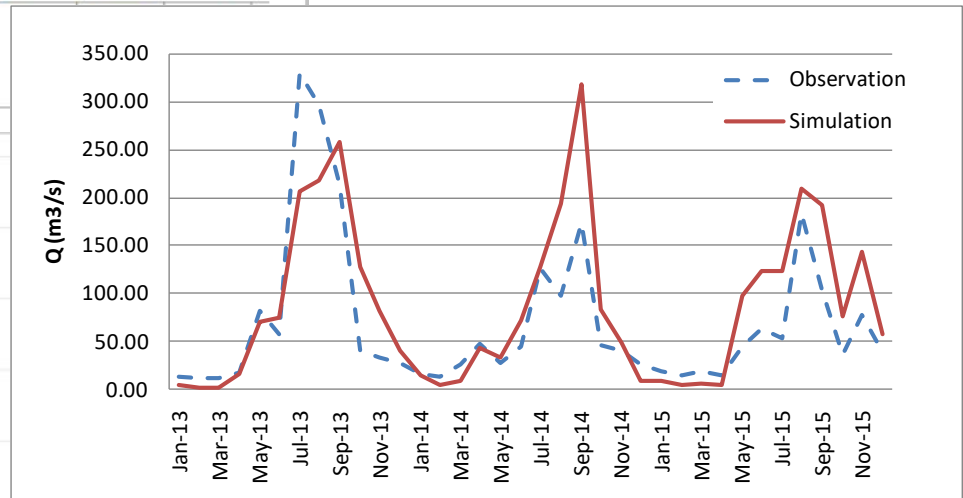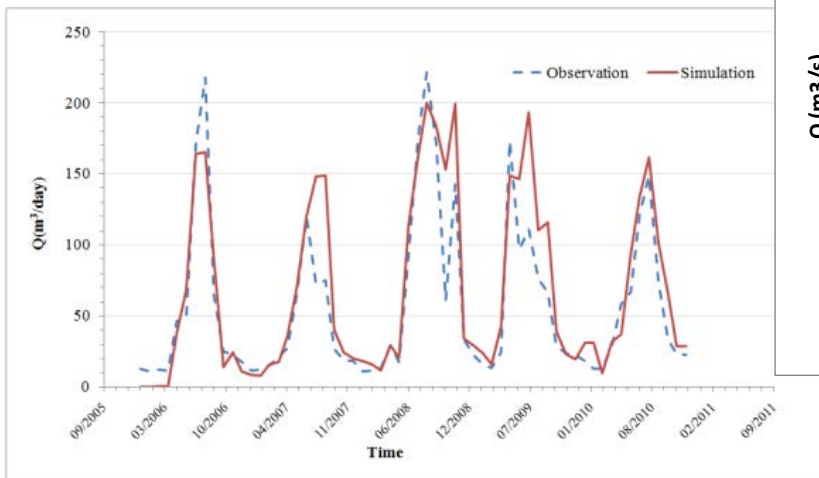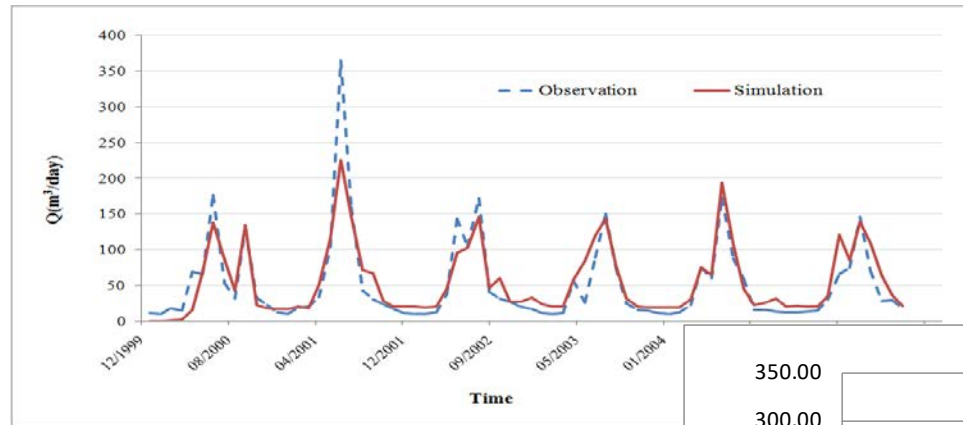
# WQ MODEL CONSTRUCTION

- Target area: 3 provinces (Thai Nguyen, Bac Ninh, Bac Giang), mainstream of Cau river (yelow area)

- SWAT: constructed for whole watershed to provide river discharges, lateral flows,…

- QUAL2K: river network consist of mainstream and 7 tributaries

Headwater 0

Trib. 1

Trib. 2

Trib. 3

Trib. 4

Trib. 5

Trib. 6

Trib. 7

# WQ MODEL CONSTRUCTION

- SWAT model

  - DEM 1-arc (USGS)

  - Landuse: 2007 (by IET)

  - Soil type (FAO)

  - 5 Meteo stations

  - 42 Rain stations

  - Calibration period 2000-2005
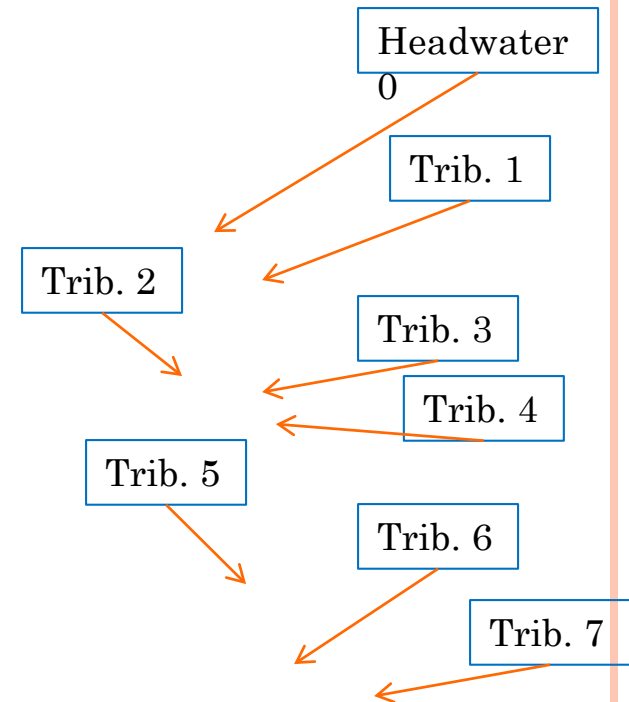
  - Validation period 2006-2014
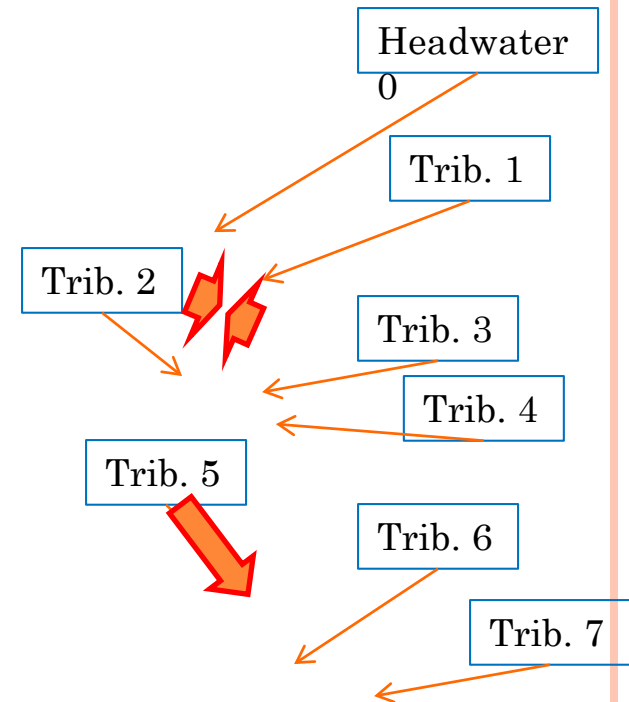
# WQ MODEL CONSTRUCTION

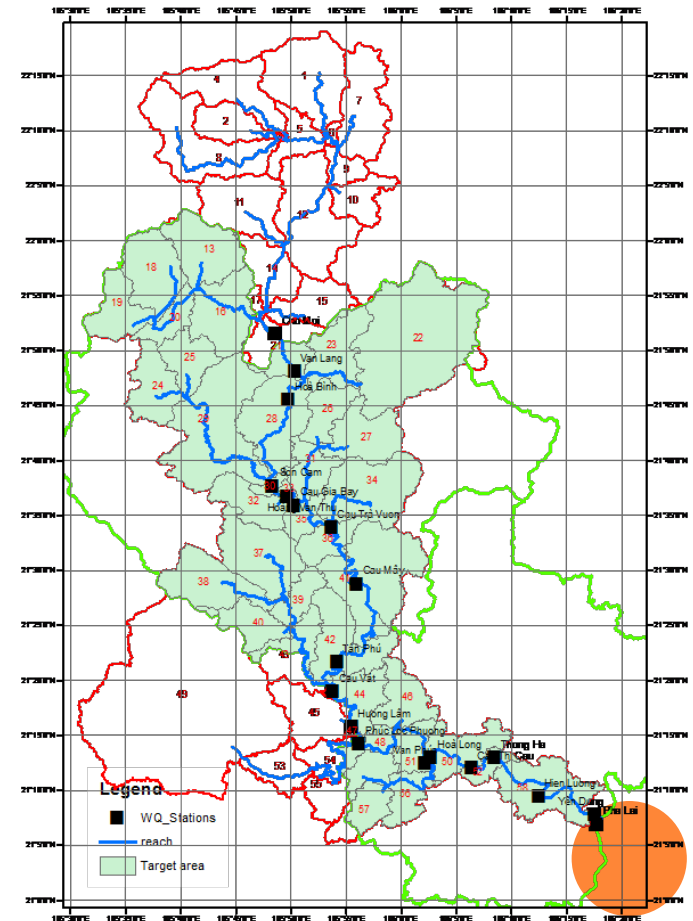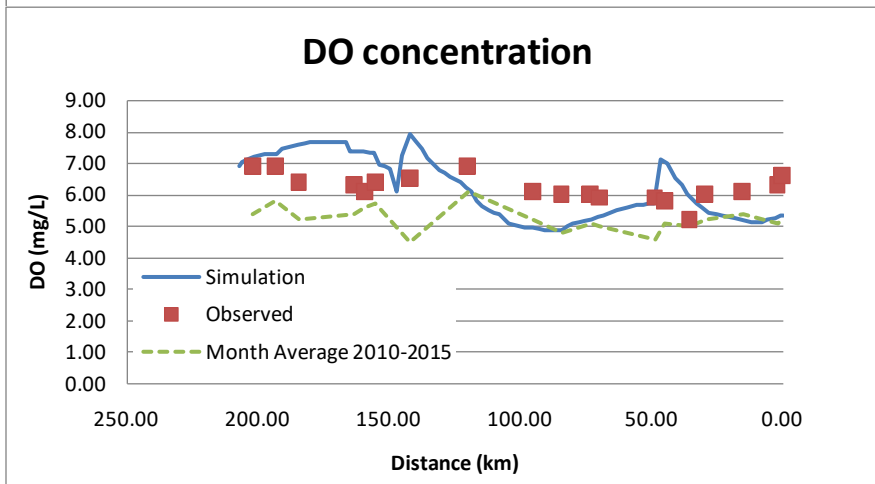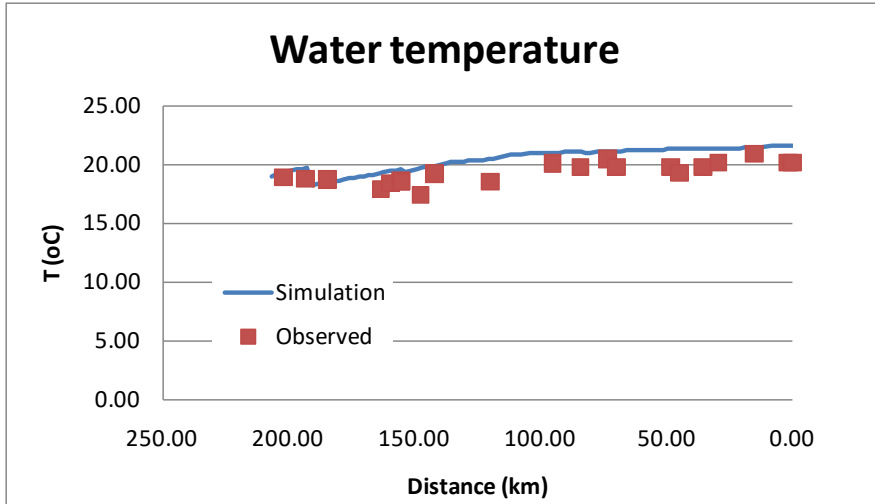SWAT hydrological results

○ QUAL2K model

Simulation period:

- 11/03/2014 to 19/03/2014 (dry season)

- 03/11/2014 to 09/11/2014 (end of rainy season)

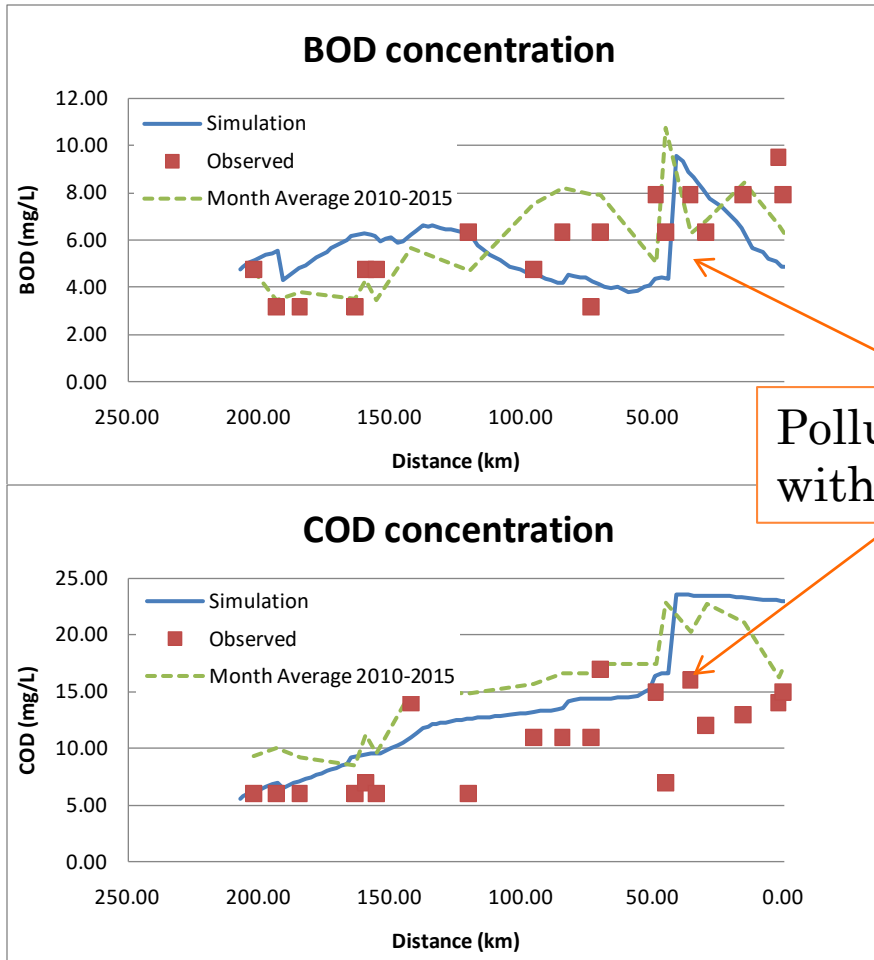 - Input data: daily average (discharge, concentration, …) of the period.

Headwater 0

Trib. 1

Trib. 2

Trib. 3

Trib. 4

Trib. 5

Trib. 6

Trib. 7

- QUAL2K model
- Special treatments:

- Non-point pollution load of sub-watershed bordering to the mainstream discharge uniformly to the river

- Pollution load of others sub-watershed discharges to the outlet of river tributaries

- *Reaching ratio coefficient* varies 0.1 -0.5 depending on watershed

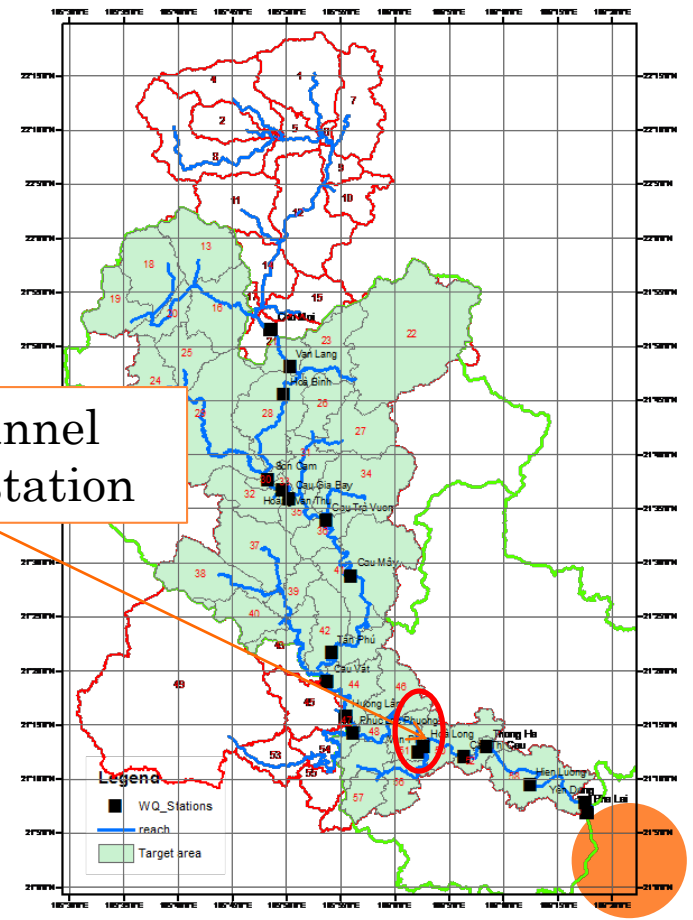(Discharge load=reaching ratio coeff. x generated load)
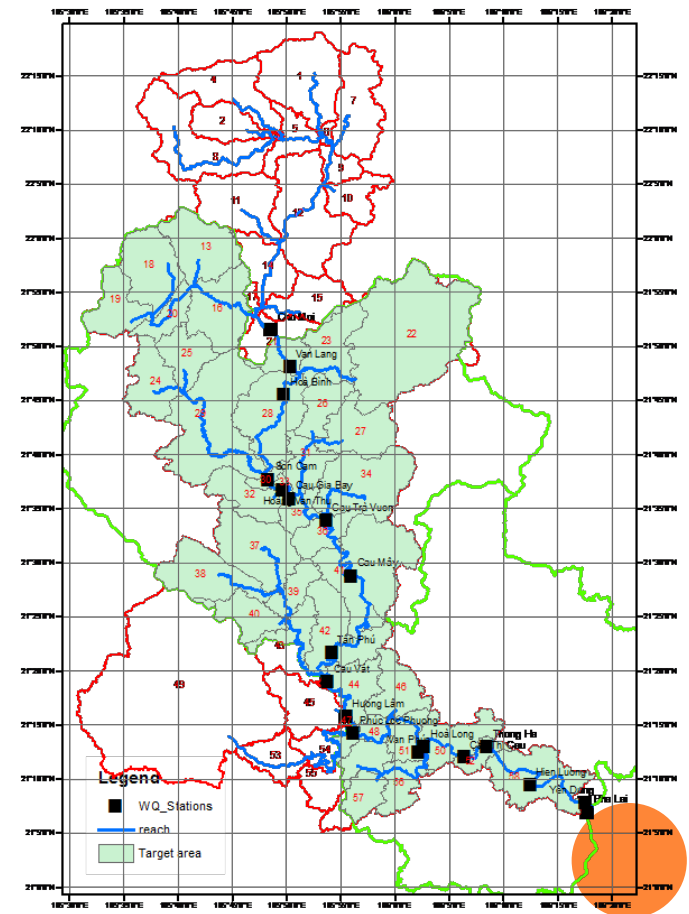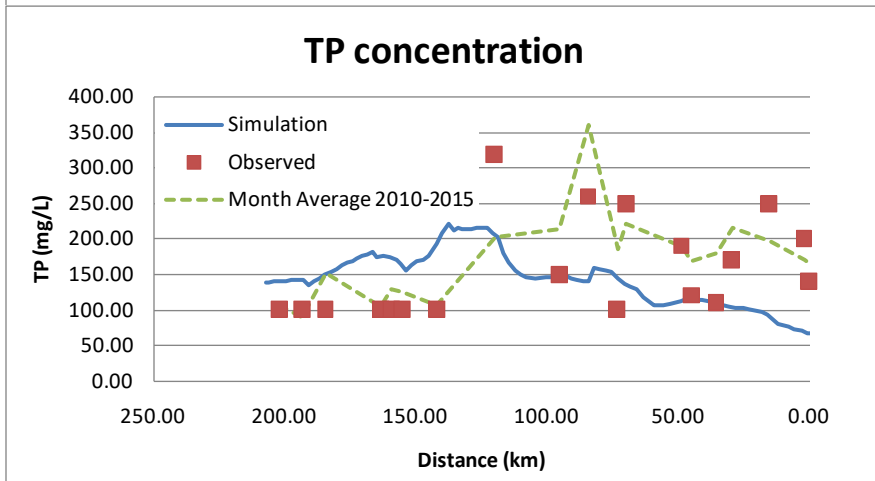
Headwater 0

Trib. 1

Trib. 2

Trib. 3
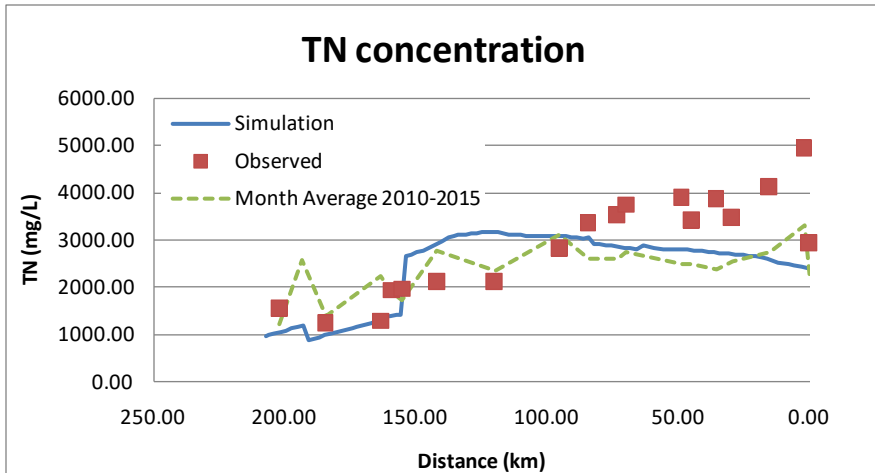
Trib. 4

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Trib. 7

# RESULTS

Dry season: 11/03/2014 to 19/03/2014
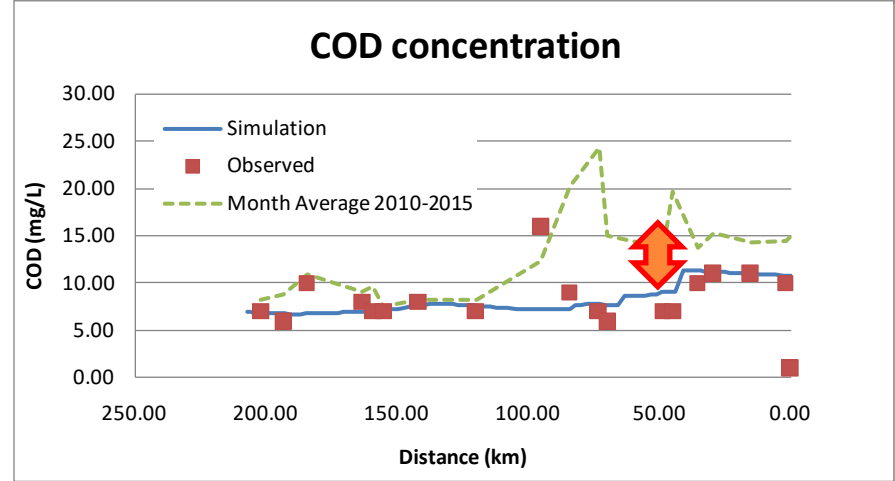
# RESULTS
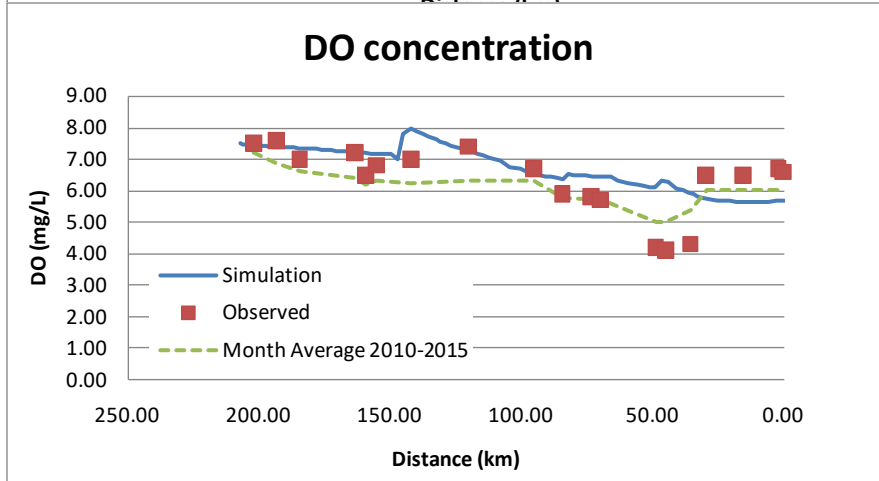
- Dry season: 11/03/2014 to 19/03/2014



Polluted channel with pump station

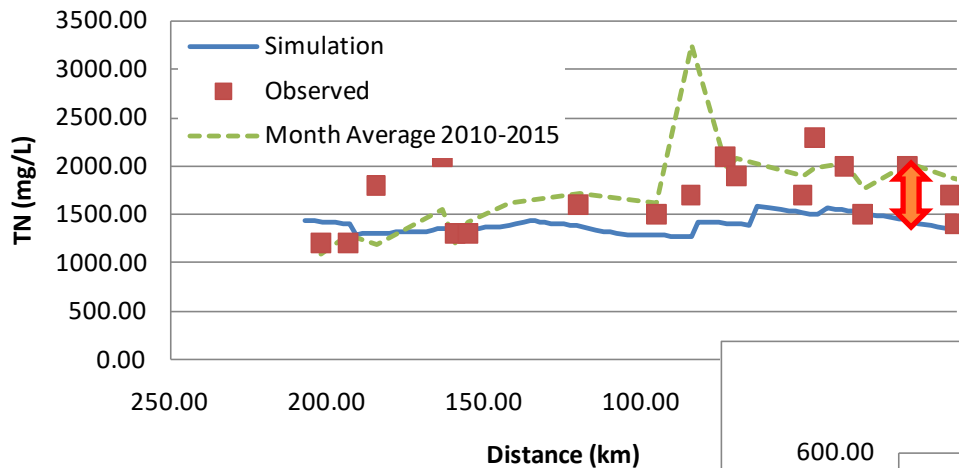# RESULTS

Dry season: 11/03/2014 to 19/03/2014
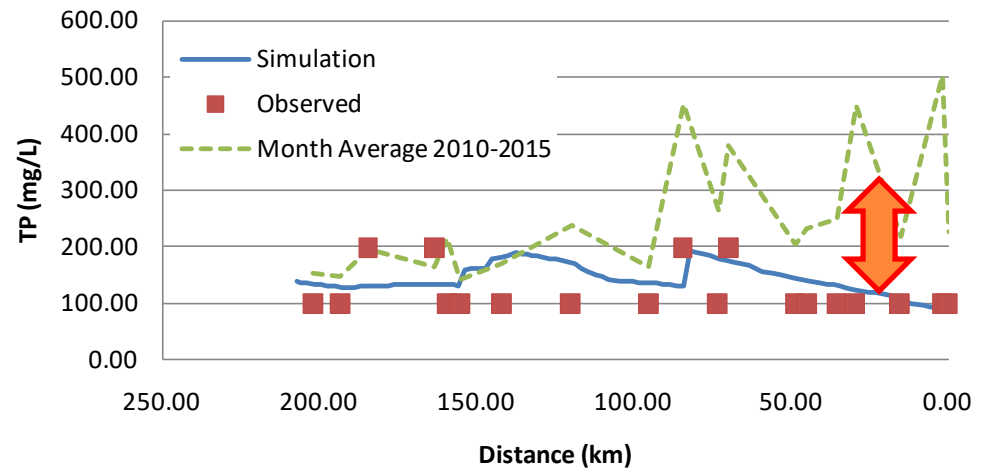
# RESULTS

- End of Rainy season: 03/11/2014 to 09/11/2014

# RESULTS
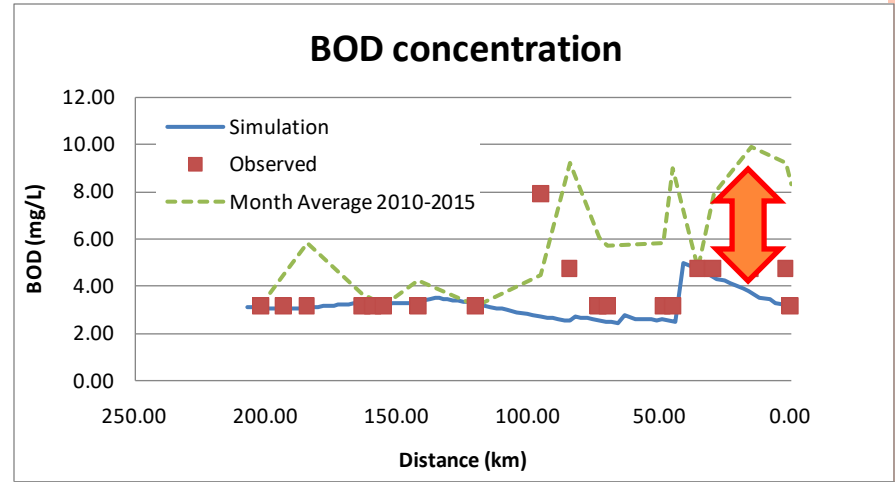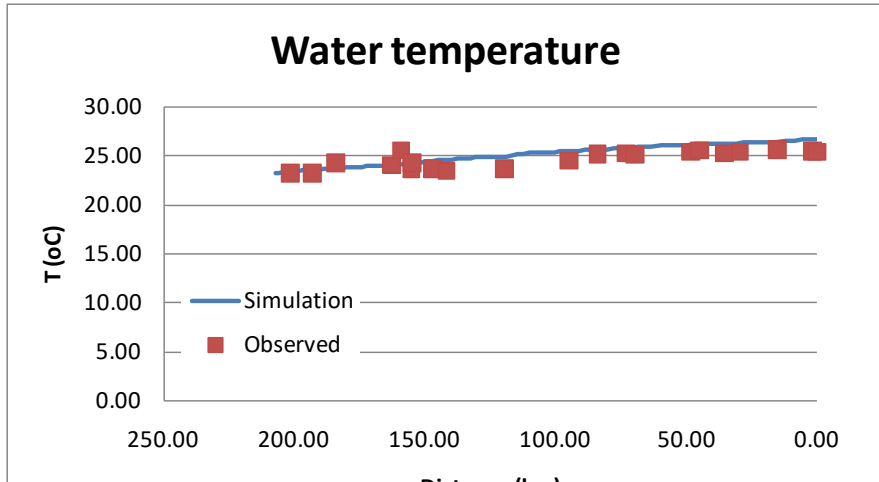
- End of Rainy season: 03/11/2014 to 09/11/2014

# CONCLUSIONS

○ Integration of SWAT and QUAL2K is helpful when spatial data (for landuse, economic activities,…) are limited.

○ Combination of WQ monitoring data and pollution load estimation based on rapid estimation method can improve WQ inputs for QUAL2K.

○ The obtained calibration and validation results are satisfactory.

○ Some inputs data may require some revisit, especially the *reaching ratio coefficients* for sub-watersheds and time operation of pumping station.

# CONCLUSIONS

- The model can be used for TMDL implementation of the watershed.

- The model can be used for assessing pollution contribution ratio of each sub-watershed of the basin in order to partition the TMDL for  sub-watersheds for future environmental planning.

# THANK YOU
# FOR YOUR ATTENTION

## ANY QUESTIONS?