# APPLICATION OF SWAT MODEL FOR ASSESSING WATER QUALITY IN TA TRACH WATERSHED, CENTRAL VIETNAM

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## ABSTRACT

*Nowaday, one of the urgent issues in water resources management in Ta Trach river basin is environmental degradation, including water pollution and deforestation. Therefore, this study evaluated water quality in upstream Ta Trach watershed which locates in Thua Thien Hue provinces in both 2005 and 2010 by using the SWAT model. Data required for this study were compiled from different sources, including DEM data that extracted from SRTM (Shuttle Radar Topographic Mission) data, land use was obtained from land use map 2005 and 2010 of Thua thien Hue province, soil map was obtained from the Thua Thua Hue soil map of the FAO in 2009, weather input data was obtained from the hydrometeorological center of Thua Thien Hue. Five water quality parameters from the simulation in SWAT were assessed, including DO, $NH^{+}_{4}$, $NO^{-}_{2}$, $NO^{-}_{3}$, $PO^{3-}_{4}$. By comparing the above parameters with National Technical Standards for surface water quality (QCVN 08:2008/MONRE), indicating that water quality in Ta Trach rivers flowing through Huong Thuy and Nam Dong district (Thua Thien Hue) were heavily contaminated, water sources is suitable for transportation purposes or other purposes requiring low water quality.*

## 1. INTRODUCTION

Water management is indispensable factor to get economic sustainable growth in agriculture, industry and other fields in basinal region *(Geoff Wright et al.,2006).*One of urgent problems in water management is the environmental degradation in water as well as forest destruction in basinal region.

Basin of Huong River is biggest basin of central region in Vietnam and this river is main water resources provide for social economic activities of Thua Thien Hue province. Among them, Ta Trach River – A small river with belong to Huong basin – has important role in supply and adjustment water for lowlands region. However, the quality of water environment in this river reduced by time due to the wastewater elimination directly from industrial zone to river as well as chemical elements from fertilizer and insecticide of farming activities (Vietnam Water Management Department, 2010). Therefore, assessment of water quality for sub basin is very important. In many researches, SWAT has proven to be a useful tool for research in water management *(ManojJha, 2009).* Starting from these, our team conducted the research with the topic "Application of swat model for assessing water quality in Ta Trach watershed, central Vietnam".

Study site is basin of Ta Trach River across Huong Thuy and Nam Dong district with the area total is 95,201.54 hectare (ha). Ta Trach river is one of main branch of Huong river, start from medium elevation area belong to Nam Dong district (Elevation is 900 metter). Almost the part of river (75%) flows go over upland region with the length about 14.5 km and small, slope and sinuous. Lower reaches start from Hai Nhat stream to Thuong Nhat station

with 2.2 km in the length, big river-bed and more smooth than other area. (*Thua Thien Hue geography*).

Basin of river include 9 sub river with total 94km in the length. The part of river inside the district boundary is 32 km and river grid density is 0.20km/km$^2$. The avarage length approximately 30km, meanwhile width arround 40km. Yearly rainfall about 3300-3400mm, provided big amount of water for Ta Trach river. The total of water quanlity yearly is 24,896,106m$^3$, however, the used volumn just 0.9%. *(Institute of resources, environment and subtainable,2011).*

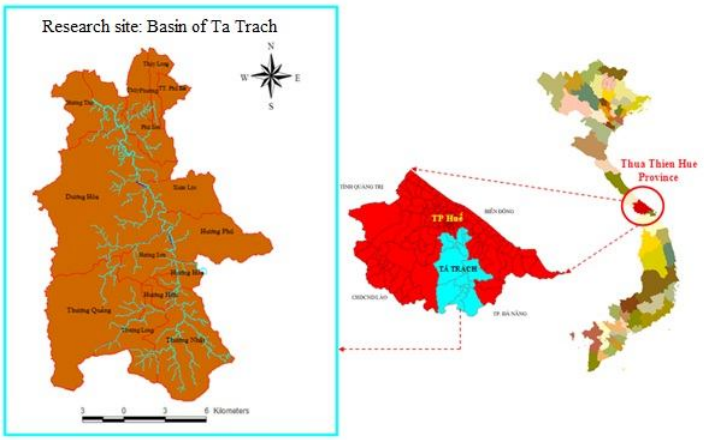


**Figure 1. Research site.**

## 2. METHODOLOGY

### 2.1 Assessment of water quality

The methodology to assess the water quality presented by fig.2, are include: Identify the basin, hydrology unit analysis, get the input data, modeling and compare with the water parameter

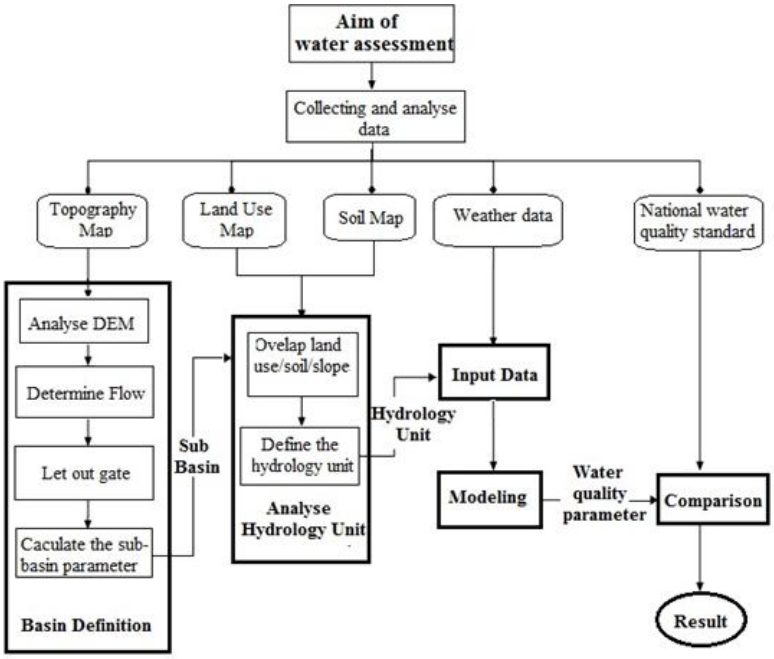


**Figure 2. Methodology diagram.**

## 2.2 Data collecting

DEM data got from SRTM data (Shuttle Rada Topographic Mission) of USGS/NASA with spatial resolution is 30 meters. Elevation change from 10 meters to 509 meter and average elevation approximately 147 meters. Current land use was edited from land use map of Thua Thien Hue province in year 2005 and 2010. All of land use type was divided to 7 types as table 1.

**Table 1. Land use type in 2010.**

| Code SWAT* | Land use type | Area (ha) | Percent |
|---|---|---|---|
| **ORCD** | Dry Agriculture land | 40978.13 | 43.13 |
| **RNGB** | Bare land | 1185.88 | 1.25 |
| **WATR** | Water body | 3805.95 | 4.01 |
| **RICE** | Paddy land | 1898.78 | 2.00 |
| **AGRR** | Yearly crop land | 884.72 | 0.93 |
| **URBN** | Residential land | 5203.63 | 5.48 |
| **FRST** | Forest-mixed | 41064.44 | 43.22 |

*(Sources: *Neitsch et al,2009*)

Soil land inherited from Vietnam soil map in 2003, in the research site, there are 11 types of soil and Humic Ferralsols is majority. The weather data are include: location of weather station, rainfall, air temperature in daily format was provided by Department of resources and environment of Thua Thien Hue. In this researh, we used the data of Thuong Nhat station ($16^0$07' N and $107^0$41' E, elevation 415 meter), from 2005 to 2010.

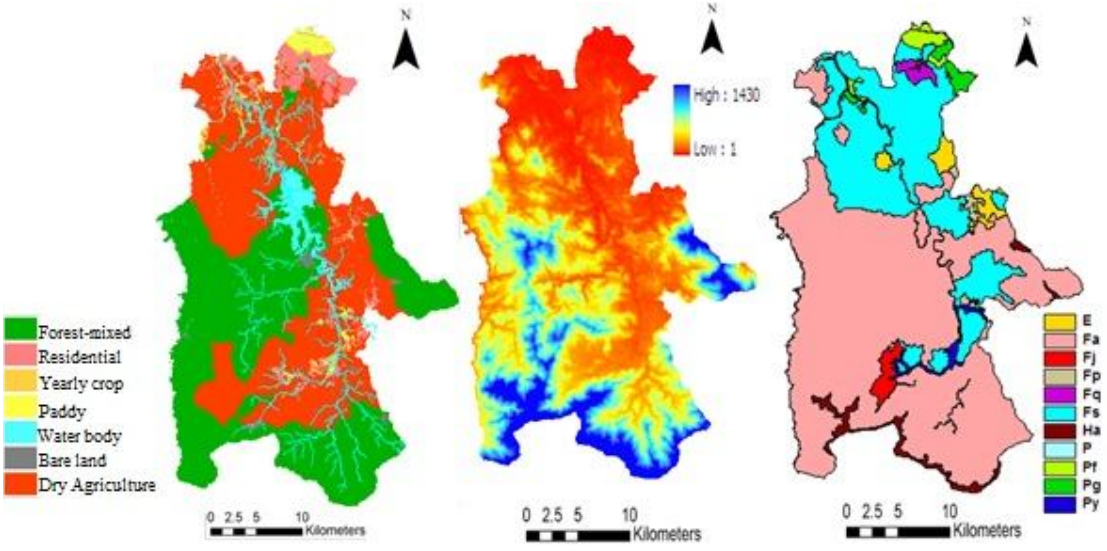


**Figure 3. Maps: Land use, Slope, Soil of the year 2010.**

All of spatial data was analysed by ArcGIS9.3 to make the DEM, mapping the soil as well as current land use. The weather data was caculated by Excel while ForTRAN is the

software use to transfer from excel format into input data form of SWAT. All of result that caculated in SWAT presented by Swatplot and excel.

## 3. RESULT AND DISCUSSION

There are many parameters to assess the sufer water quality follow the national water quality standard of Vietnam (QCVN 08:2008/MONRE) and they classify to 4 levels as belows: A1-Use for human life and other purpose; A2- Must analyse by technology before provide water for human life; B1- Use for irrigation; B2- River traffic. In this research, we focus on assessment 5 fators: Dissolved Oxygen DO, amoni $NH_4^+$, nitrit $NO_2^-$, nitrat $NO_3^-$ , phosphate $PO_4^{3-}$ of the year 2010. Beside, we conducted in 5 sub-basins in 35 sub-basins of Ta Trach river are include: $5^{th}$ ,$6^{th}$ sub-basin acrrossing Phu Bai industrial zone; $10^{th}$ sub-basin is very nature and people effect is very small, $25^{th}$ and $27^{th}$ is intersect to residential zone.

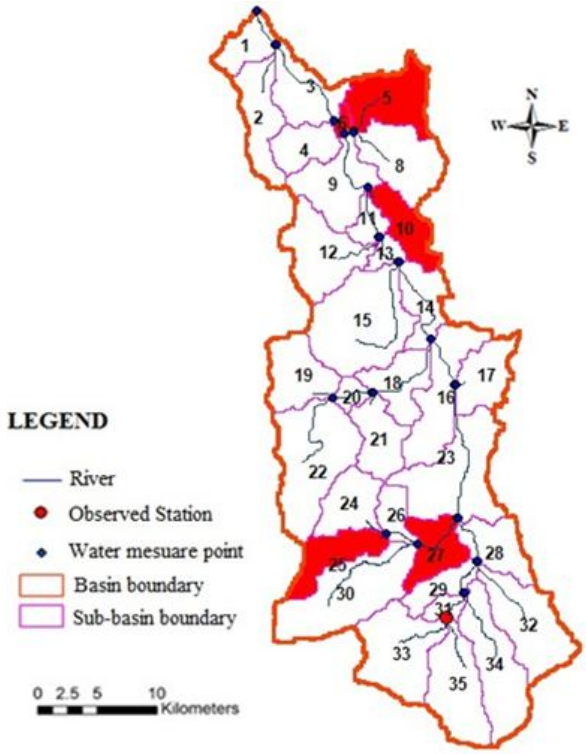


**Figure 4. Location of reach inside of basin and the effected sub-basin.**

Due to the parameter in SWAT is kg, however, follow the national water quality is mg/l therefore, first, must be change the parameter units.

Total monthly flow W ($m^3$): W = Q × T. Where: Q is monthly flow ($m^3/s$), Q is value in FLOW_OUT from SWAT changed to m/s, T is number of second in the month.

- Determine the concentration: (mg/l):

+ Concentration of DO = (DISOX_OUT/W) × $10^3$
+ Concentration of $NH_4^+$ = (NH4_OUT/W) × $10^3$
+ Concentration of $NO_2^-$ = (NO4_OUT/W) × $10^3$
+ Concentration of $NO_3^-$ = (NO3_OUT/W) × $10^3$
+ Concentration of $PO_4^{3-}$ = (MINP_OUT/W) × $10^3$

Summary and classification water quality of 5 sub-basin.

We can see that the quality of 5 sub-basin changed in each month of year and depend on rainfall during the Jan/2010 to Dec/2010.

**Table 2. Water quality in each parameter of 5 sub-basin.**

| Month | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DO** | | | | | | | | | | | | |
| Sub-Basin 5 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 |
| Sub-Basin 6 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 |
| Sub-Basin 10 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 |
| Sub-Basin 25 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 |
| Sub-Basin 27 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 |
| **$NO_2^-$** | | | | | | | | | | | | |
| Sub-Basin 5 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 |
| Sub-Basin 6 | B2 | A2 | B1 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| Sub-Basin 10 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 |
| Sub-Basin 25 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 |
| Sub-Basin 27 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | B1 | A1 | A1 |
| **$NO_3^-$** | | | | | | | | | | | | |
| Sub-Basin 5 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| Sub-Basin 6 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| Sub-Basin 10 | A2 | A2 | A2 | B1 | B1 | B2 | B2 | B2 | B2 | B1 | B1 | B1 |
| Sub-Basin 25 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| Sub-Basin 27 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| **$PO_4^{3-}$** | | | | | | | | | | | | |
| Sub-Basin 5 | B2 | A1 | A1 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | A2 |
| Sub-Basin 6 | B2 | A1 | A1 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B1 |
| Sub-Basin 10 | B2 | A1 | A1 | B1 | B1 | B1 | B1 | B1 | B1 | B2 | B2 | A1 |
| Sub-Basin 25 | B2 | A2 | A2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| Sub-Basin 27 | B2 | A1 | A1 | A1 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | A2 |
| **$NH_4^+$** | | | | | | | | | | | | |
| Sub-Basin 5 | A1 | A1 | A1 | A2 | B1 | B1 | B1 | B1 | B1 | B1 | A2 | A1 |
| Sub-Basin 6 | B2 | B1 | B1 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| Sub-Basin 10 | A1 | A1 | A1 | A1 | A1 | A1 | A1 | A2 | A1 | A2 | A1 | A1 |
| Sub-Basin 25 | A1 | A1 | A1 | A1 | A2 | A2 | A2 | B1 | A2 | A2 | A1 | A1 |
| Sub-Basin 27 | B1 | A2 | A2 | B1 | B2 | B2 | B2 | B2 | B2 | B2 | B1 | A2 |

**Table 3. Classification water quality of 5 sub-basin.**

| **Month** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sub-Basin 5 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| Sub-Basin 6 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| Sub-Basin 10 | A2 | A2 | A2 | B1 | B1 | B2 | B2 | B2 | B2 | B1 | B1 | B1 |
| Sub-Basin 25 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |
| Sub-Basin 27 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 | B2 |

## 4. CONCLUSION

Rely on the result of modeling by SWAT, 5 water quality paremeter: Dissolved Oxygen DO, amoni $NH_4^+$, nitrit $NO_2^-$, nitrat $NO_3^-$, phosphate $PO_4^{3-}$ presented the water quality of 5 sub- basin is bad and just accord for river traffic or other purpose which need the low water quality. Only $10^{th}$ sub-basin, from January to March can provide water for human after processed by technique and from October to December can use for irrigation. The outputs from the simulation of water quality in SWAT has not been calibrated and validated. So, the next development of the subject is to use data accuracy, details concerning management practices (level applied fertilizer, pesticides, tillage management) for water quality simulation Ta Trach river basin. Besides, will collect additional data measured water quality in the basin to calibrate and test the model results.

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