# MAPPING SURFACE WATER QUALITY ZONE BY GIS AND SPATIAL INTERPOLATION IDW CASE STUDY IN CAN THO CITY, VIETNAM

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## ABSTRACT

*Can Tho City - a biggest city in the Mekong Delta of Vietnam - has experienced rapid urbanization in recent years. It is also to deal with substantial water and climate change challenges ranging from urban to suburban areas, as well as surface water pollution. This paper calculated the Vietnamese Water Quality Index (WQI) values based on the database of water quality monitoring stations in Can Tho City in five years. Then the QGIS software and the Inverse Distance Weighted tool were applied to map out the surface water quality spatial distribution. The calculation results showed slightly temporal and spatial variation in water quality with WQI values range from 76 to 91 which indicate good condition. The lower WQI values recorded in the dry season and at the areas where concentrate more residential zones and industry factories. The spatial interpolate result showed the good condition of water quality through a thematic and visual map. The surface water quality map could use not only by scientists but also local authorities or decision makers.*

***Keywords:*** *GIS, water quality, WQI, CanTho city*

## 1. INTRODUCTION

Can Tho City is the largest city in the Mekong Delta of Vietnam - has experienced rapid urbanization in recent years. The river network plays an important role in supplying water for domestic use, agricultural production, industry, aquaculture and other activities. Under pressure from domestic and industrial discharge activities in the surface water area, there are signs of pollution. Recently, wastewater afore-mentioned activities which has been directly or indirectly affected to the source water quality; especially densely populated zones and intensive agricultural production (Mekong River Commission, 2013). Monitoring results showed that almost all major water supply and drainage canals are contaminating at an alarming rate in Can Tho City (Natural Resources and Environment Monitoring Center in Can Tho City, 2013). Many studies have evaluated water quality on the section of Hau River flowing through Can Tho in general and tributaries in the inner city in particular have indicated water quality according to each pollution parameter from direct sampling method. The results of these studies have a certain contribution to the forecasting of water quality changes in the region. In order to improve efficiency in water resource management, besides assessing water quality fluctuations by WQI, the study also combines spatial interpolation method of Inverse Distance Weighted (IDW) in the QGIS software to distribute surface water quality on the river system. The results presented in a simple and understandable way is an appropriate source of information for the community and state management agencies in charge of the environment; organizations and individuals involved in the construction, announcing information on environmental quality to the community (Department of Environment, 2019).

## 2. RESEARCH METHODS

### 2.1 Methods of data collection and analysis

Data are collected from the Environmental and Natural Resources Monitoring Center Can Tho City to calculate the WQI indicators. The collected data with sampling frequency in the monsoon wet and dry season from 2014 to 2018 including the water quality parameters such as: pH, Arsenic (As), Chromium (Cr), dissolved oxygen (DO), chemical oxygen demand (COD), biological oxygen demand ($BOD_5$), Ammonium N-($NH_4^+$), Nitrate ($NO_3^-$), Coliform.

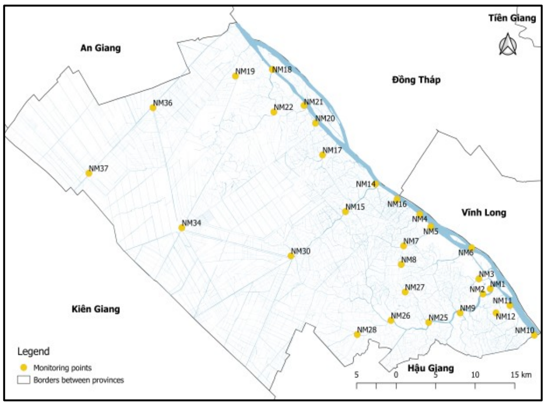


**Figure 1. Monitoring location map**

### 2.2 Calculating the water quality index (WQI)

Method for calculating the water quality index (WQI) adapted to Decision 1460/QĐ-TCMT of the General Department of Environmental in Vietnam is in Table1and as follows:

$$WQI = \frac{WQI_I}{100} \times \frac{\left(\prod_{i=1}^{n} WQI_{II}\right)^{1/n}}{100} \times \frac{\left(\prod_{i=1}^{m} WQI_{III}\right)^{1/nm}}{100} \times \left[\left(\frac{1}{k}\sum_{i=1}^{k}(\mathrm{WQI}_{IV})^2\right) \times \frac{1}{l} \times \sum_{i=1}^{l} WQI_V\right]^{1/3}$$

*In which:*

$WQI_I$*: calculation results for pH parameter (group I)*

$WQI_{II}$*: calculation results for the group of plant protection drug parameters (group II)*

$WQI_{III}$*: calculation results for heavy metal parameters (group III);*

$WQI_{IV}$*: calculation results for groups of organic and nutritional parameters (group IV)*

$WQI_V$*: calculation results for the group of microbiological parameters (group V)*

**Table 1. Water quality rating scale**

| WQI | Quality | Suitable for the intended purposes | Colors |
|---|---|---|---|
| 91 - 100 | Excellent | Good use for domestic water supply purposes | Blue |
| 76 - 90 | Good | Used for domestic water supply purposes, but needed appropriate treatment measures | Green |
| 51 - 75 | Medium | Used for irrigation and other equivalent purposes | Yellow |
| 26 - 50 | Poor | Used for navigation and other equivalent purposes | Orange |
| 10 - 25 | Very poor | Water is severely polluted, needs future treatment measures | Red |
| <10 | Heavy pollution | Poisoned water, need to take measures to overcome and treat | Brown |

*(Source: General Department of Environment, 2019)*

## 2.3 The IDW Spatial Interpolation Method by QGIS

From the results of WQI calculation, mapping water quality zone based on the WQI index was constructed by the IDW in QGIS software (version 3.18).

The IDW method determines the value of unknown points by averaging the distance-weighted values of the points with known values in the vicinity of each pixel. The IDW method has been evaluated optimally when there is no big difference between the interpolated value and the results of sample analysis at the laboratory in the study of constructing interpolated water quality maps (Asadzadeh *et al.,* 2013; Gong & O'Bryant, 2014).

# 3. RESULTS AND DISCUSSIONS

## 3.1 Water quality index in monsoon and dry season

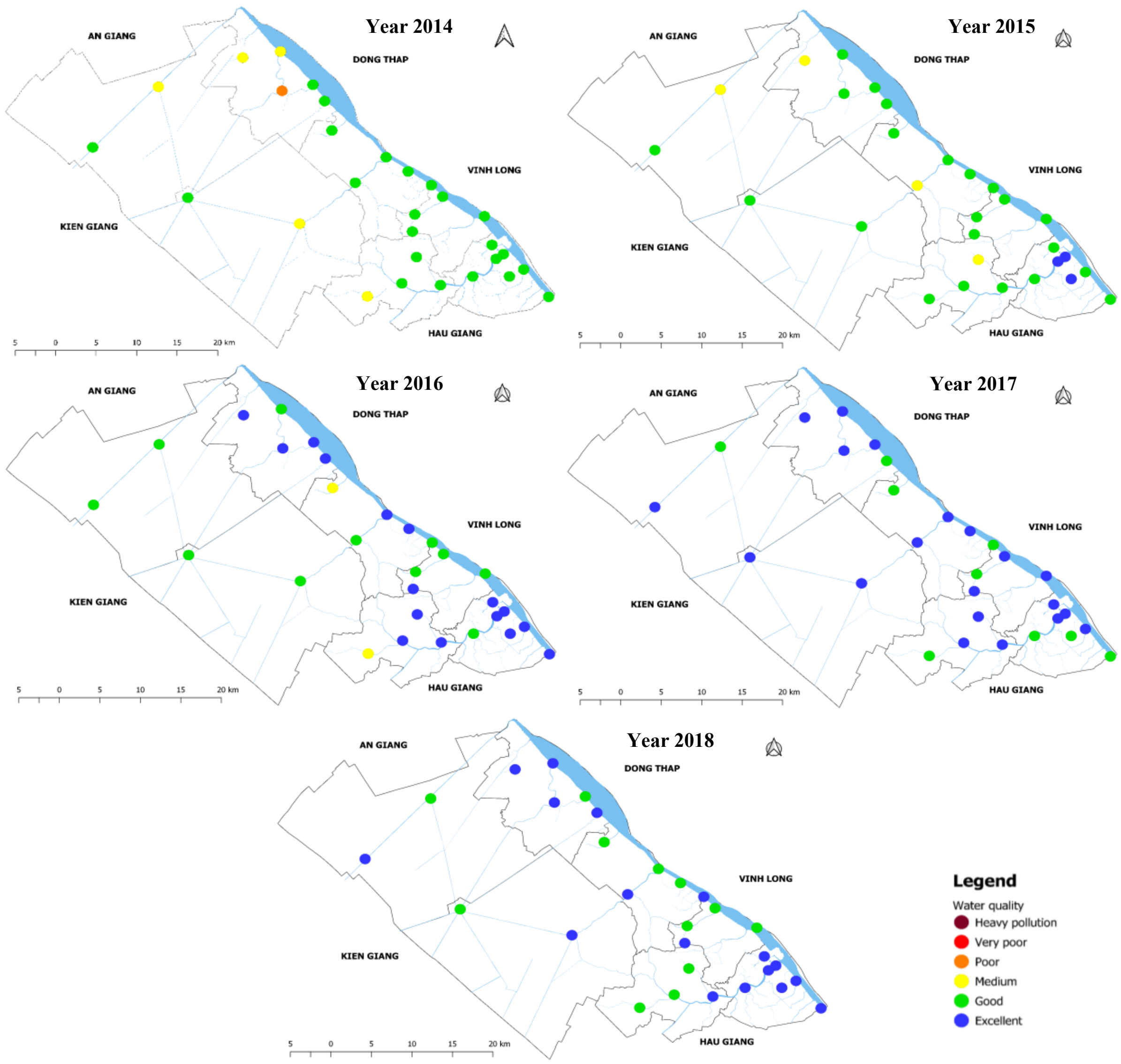


**Figure 2. Water quality in the dry season of 5 years**

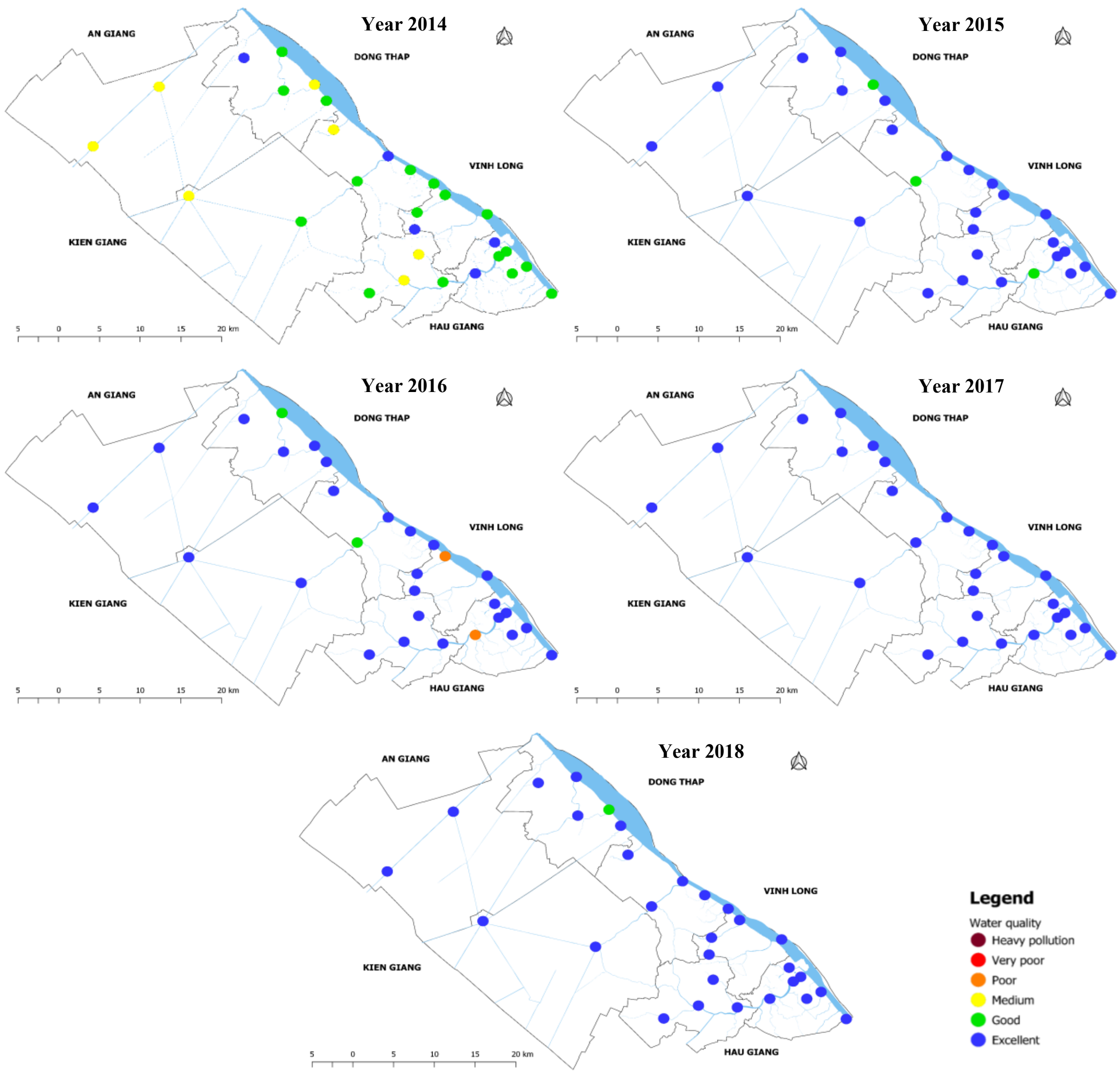


**Figure 3. Water quality in the monsoons of 5 years**

WQI indicated that the low water quality in some monitored points in the monsoon and dry season periods during five years in Can Tho, except for Ninh Kieu District (NM1, NM2, NM3), the remaining districts range from 26 to 75 corresponding to orange and yellow, and it could only be used for navigation purposes, some stations are still at level 25 (NM5). Until 2016, 2017, 2018 water quality will be improved, within range from 71 to 90 (corresponding to green) that can be used for irrigation and good water quality will reach the range from 91 to 100 (corresponding to blue) can be used for domestic water supply purposes.

The dry season and the beginning of the rainy season are the times when the water quality in the region is worse, the dry season period of all three years 2014, 2015, 2016 illustrated that the water quality in the region is mostly low and average. During the monsoon, the water quality recovers

## 3.2 Mapping water quality zone

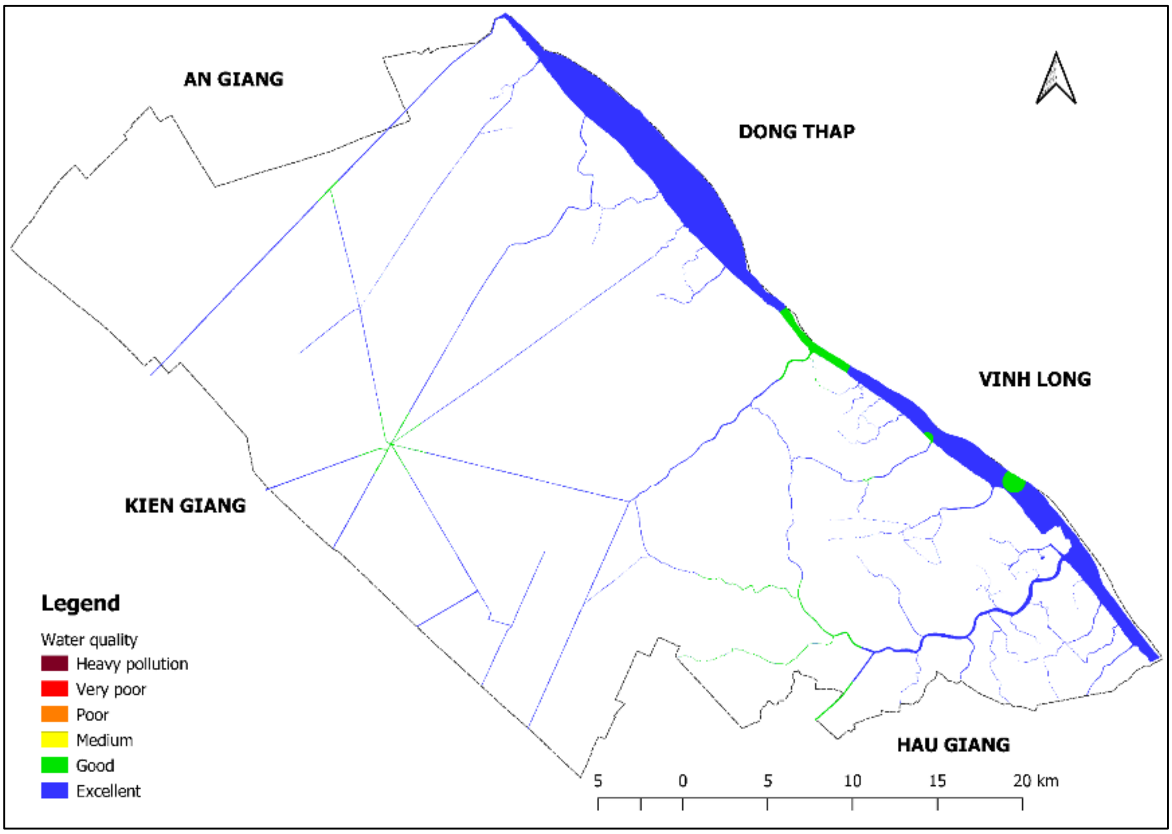


**Figure 4. Actual mapping water quality zone in the dry season**

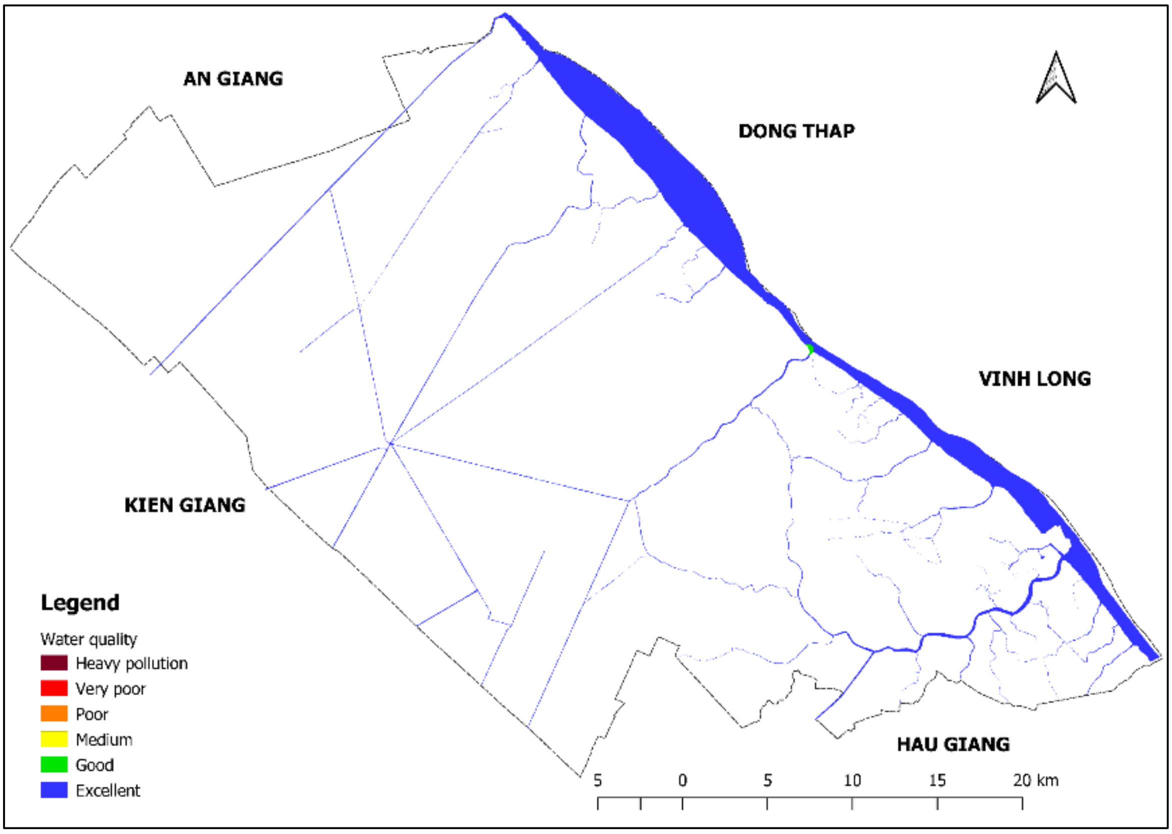


**Figure 5. Actual mapping water quality zone in the monsoon**

The evolution of water quality in the canal system in Can Tho City during the monitoring periods in 2018 showed that the water quality changes between the large river area and the inland area is quite large, the pollution level is non-partial at one site. In Ninh Kieu area, water quality is relatively stable between seasons. The areas of continuous change in quality are mostly in market areas, typical industrial parks such as Tra Noc - Binh Thuy, Cai Rang and Phong Dien areas along the Can Tho river. In the dry season, the canals in this area has poorer water quality than the monsoon. In addition, inland areas such as Vinh Thanh, water quality also decreases during the dry season.

## 4. CONCLUSIONS

Research results indicated that water resources in the study area have uneven quality according to space and time. Water quality during the years 2014, 2015, and 2016 in several regions was only used for navigation. However, until 2017 to 2018 the water quality has improved from good to extremely wonderful and is capable of using water for domestic purposes. The water quality is better improved in the area adjacent to the Hau River, the more inland the water quality decreases. In the dry season and the beginning of the rainy season, the water quality is poor and gradually recovers in the middle and the end of the rainy season, which indicates that the self-healing capacity of the river system in the region is still very good. In some areas, there are signs of pollution, but it gradually improved over many years. Canals with low quality are often situated in the markets and next to large industrial zones. Hence, the fundamental cause of water pollution afore-mentioned is mainly domestic and industrial wastewater.

The reliability of the IDW interpolation method has been proven and used by many authors to evaluate surface water quality in numerous previous publications. However, at points with limited density of monitoring such as Vinh Thanh and Co Do, the interpolation results are not very accurate. Therefore, at these points, the interpolation results from the IDW method are approximate and could be used for reference purposes.

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