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Investigation and application of GIS for management of Cu De river water quality in central Vietnam

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Abstract: With management, data analysis and spatial information, GIS is now an effective tool in addressing the problem of spatial distribution and environmental change. The research and application of GIS in conjunction with the collection of environment data and water quality into an integrated technology, help managers to make decisions based way, is a need to study the problem research in the framework of environmental protection and sustainable development of the rivers. This topic focuses research and propose integrated solutions and feasible to protect water river in central Vietnam, to ensure the safety of the water supply as well as serving the purpose of sustainable development throughout the river basin, it is necessary to have a good database of spatial distribution of water resources of the basin, the river water quality as well as the potential sources of pollutants.

Keywords: GIS, Water Quality, Spatial Distribution, Environmental Change, Pollutant, Central Vietnam

1. Introduction

The general surface water (rivers in particular) plays an important role in economic life, society of the local or national. That role is reflected in the climate regulation; domestic water supply, agricultural irrigation, industrial water supply, water transport, tourism, sports, entertainment .etc [1], [3], [4].

Today, along with economic development, population growth, the demand for water is increasing in both volume and quality. The overexploitation of water resources to serve the daily needs without protection plan will lead to the risk of depletion. On the other hand, the surface water is also where most of the reception of waste and therefore, the risk of water contamination are unavoidable. The thing that will reduce water quality, adversely affected the lives of organisms, biological diversity, ecological balance of aquatic ecosystems and, more importantly, affect human health. To protect water resources, protection of animals and human health, need to set up strategies to protect water resources, management and rational exploitation of water resources. GIS can support evaluation of groundwater, rivers and lakes simulation systems and applications related to other water resource management [2], [5].

Some studies GIS applications in water resources management abroad:

1.1. Management of River Basins

Basin system is a sensitive and complex. River basin management requires adequate water flow, maintaining the stability of the ecosystem, flood control.

Waste Management Corporation and the Swedish Nuclear Energy and Nespak, Pakistan uses a combination of GIS management support Torrent Basin in Pakistan. GIS is used to model the water balance, erosion, and flood control for the area.

1.2. Analysis of river systems

Geological Institute in Zagreb, Croatia, has used GIS to analyze river system as a whole Drava Basin. GIS technology can build network simulating rivers of the region and specific parameters for each flow and analyze the impact that they can take effect [2].

1.3. Evaluate the sanitary sewer system

We can use GIS to assess current needs and future water and sewer issues. Black & Veatch used GIS to manage the sewer system of the city of Garland. GIS combines computational flow of land use data, total population, number of employees of each drainage area. GIS will then run the different models and show the results of the

evaluation sanitary condition [6].

1.4. Inventory and monitoring of water and wastewater systems

Board of Public Works (BPW) for Holland, Michigan, has replaced water control systems/wastewater old craft with GIS. GIS allows each unit updates its data integrity and preservation automatically.

Louisville and Jefferson province has used GIS program supports setting typical wastewater. GIS is used to locate certain stations, sewage pumping stations, pipelines and other major projects in the waste water. For identification, properties, projects are mapped in the entire system [8].

1.5. Assessment of water quality

Province King, Washington, has used GIS to assess water quality in the province. GIS provides users the ability to gather all water quality samples or only a selected number of samples in the analysis process. Then the sample is analyzed and displayed by GIS [9].

1.6. Identify problems affecting water and wastewater on roads

GIS can help locate and identify the impact of incidents such as earthquakes. Los Angeles City using GIS to locate the sewer line was damaged in the Northridge earthquake in 1994 to take on repair projects [10].

2. General Conditions Natural River Basin Cu De

2.1. Geographical Location

Cu De River in the north of Danang, Central Vietnam, with a total catchment area is 426 km^2 shed Danang Bay. Two upstream tributaries is the River North and the South River, downstream estuaries also close to Family Circle from the south branch into. The total length of the river (including River North and River Cu De) has a length of 37 km [7].

2.2. Topography

Cu De rivers originates from the western mountain regions - North of the city at an altitude of about 700-800 m. Basin stream network feather shape, inclination northwest - southeast. Upstream have small rivers and streams twisting and change direction constantly under the high canyon.

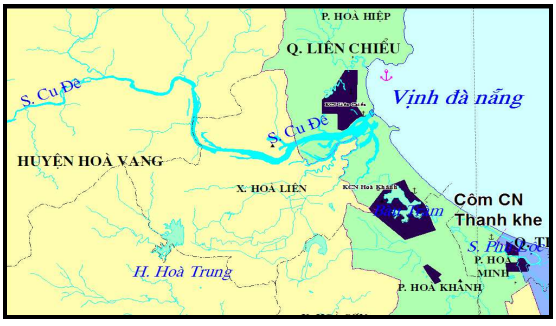

Figure 1. *Study area map.*

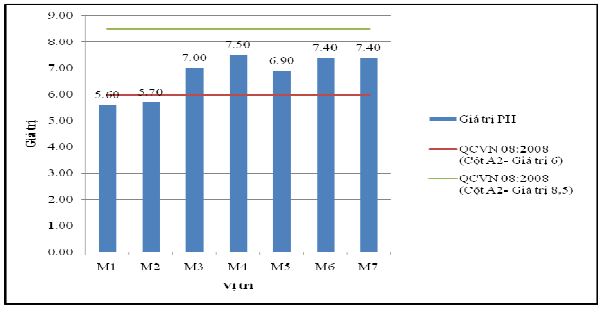

Figure 2. *PH values measured in the downstream region of Cu De in the dry season.*

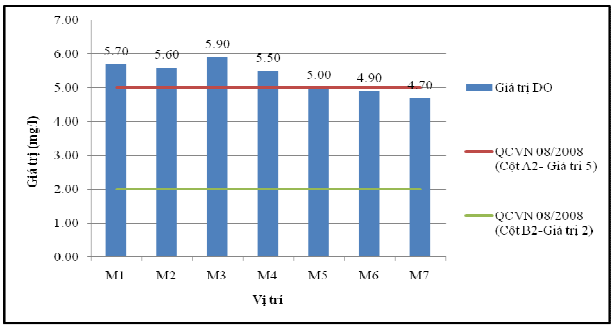

Figure 3. *DO values measured in the downstream region of Cu De in the dry season.*

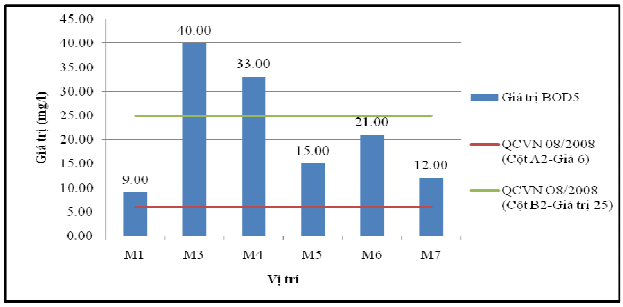

Figure 4. *BOD_5 values measured in the downstream region of Cu De in the dry season.*

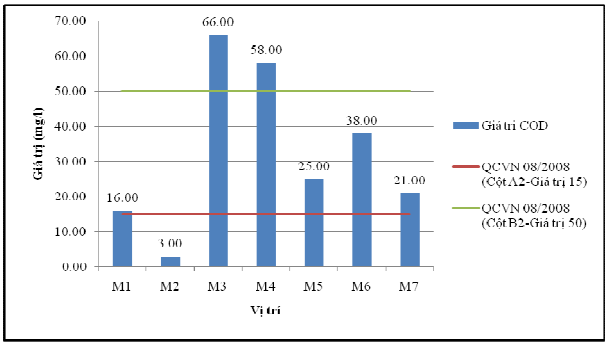

Figure 5. *COD values measured in the downstream region of Cu De in the dry season.*

After you reach the lowland plains, the general flow towards the West - East Bay Danang poured in place 108008'00 "E-16007'30" N. 47km length of river; controlled area up to 472 km^2 marine doors, by Hoa Lien is 257 km2; Basin average height is 353m; basin average slope of 26.6%; 37 km length of the basin; average width is

12.8 km basin. Cu De has two upstream tributaries of a level.

2.3. Geology

The South River North has the Tan Lam formations belonging to Devon, Paleozoic world. Tan Lam formation covers the entire South Basin. Lithological composition includes coarse sand, fine sand particles containing quartz, siltstone, calcareous clay, the hotel, conglomerate, color infection, shale. Thickness changes from 300 - 500m. Under the New Forest Formation is Atlek Bol formation (bat OS) of Ocdovic-Silurian system, Paleozoic world.

Formation in northern bat OS and runs parallel to the River North. Lithological composition is characterized by schist, quartz mica schist, mica schist quartz Xerixit, ash gray, dark gray, light gray, solid.

Complex nose stretching along the Hai-Van-Bach. Ingredients are mostly granite and biotite granite mica particles arrived two adults. Stone light gray, pink, dark spots, solid massive structure. Thin crust layer 1-5m, including clay containing sand, gravel and granite remnant pieces Administration, soft friable [7].

3. GIS Applications in Water Quality Management Downstream Cu De

The GIS database for the management of river basin water quality Cu De layer data including spatial distribution and properties of the natural factors (topographic, hydrographic network, .etc.), socio-economic (transport networks, population...); Surface water monitoring stations waste industry, canals due to environmental monitoring center of Da-Nang City in central Vietnam offers; Additional points measured water quality data done by students. Database is organized according to the type of relationship structure in MapInfo software and computation, analysis, interpolation by Vertical Mapper and ILWIS software. The data included in the database are taken from various sources and are moving on the same basis of mathematical projection VN 2000.

3.1. Soft-Wave Used

MapInfo 9.0 software is the product of MapInfo Corporation of America companies. It is pretty useful software for managing databases. This software is a relatively lightweight, easy to use, can be used to develop geographic information to show maps on the computer and let's make some queries, analyze data.

Vertical Mapper 3.1: a tool to be integrated into MapInfo environment. Vertical Mapper provides tools and analysis of spatial data interpolation grid network and three-dimensional (3D). With the ability to analyze, interpolation, Vertical Mapper allows users to define the parameters continuously changing data related to spatial position.

Vertical Mapper main function is to provide all the functions used to interpolate the values from the input data (e.g. data of the surface water monitoring stations). Results of thematic interpolation allow creation of a continuous background thematic raster data formats, each of the pixel values are interpolated from the original data table.

3.2. The Stages in the Process of Conducting Research

- Created the Vertical Mapper 3.1 tools.
- Tool Use in MapInfo Vertical Mapper 9.0 conduct interpolation of water quality parameters.

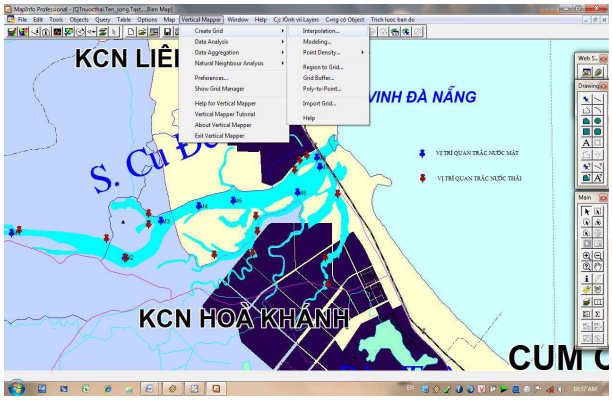

Figure 6. *Boot Screen tool in MapInfo Vertical Mapper*

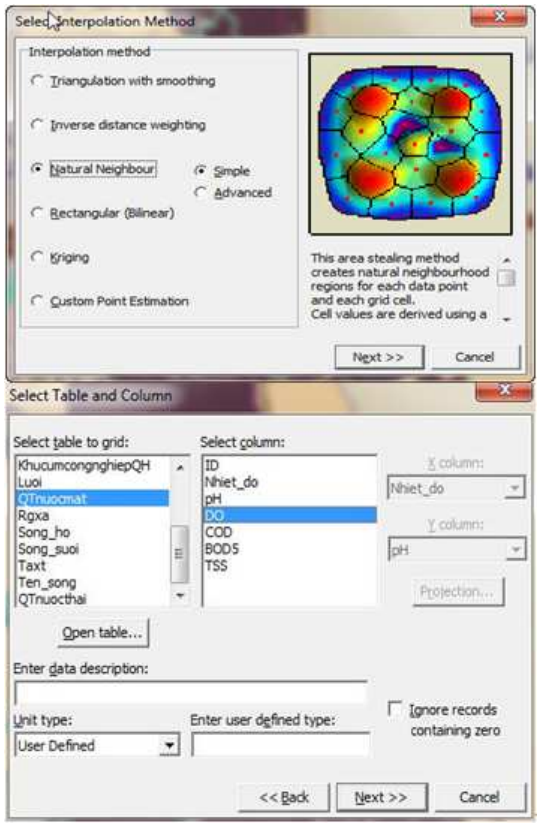

Figure 7. *Choose parameters (DO) interpolation according to Vertical Mapper*

- Vertical Mapper program will calculate the water quality index of selected parameters (e.g, DO) over time for all surface water monitoring stations.

- Interpolation results of water quality parameters using Vertical Mapper tool.

3.3. Using Quality Indicators, Overall Water (NSF-WQI) Evaluation of Water Quality Downstream Cu De

NSF-WQI is an assessment tool CLN is widely used around the world. However, the construction of WQI for each region or a country requires more time, more effort, more experts. Thus, some regions or countries often apply WQI has built or available WQI apply and adjust the parameters of water quality decisions. This allows reducing research time, effort and simultaneously allows rapid assessment based on WQI CLN.

WQI of river downstream Cu De models are NSF - WQI using the general formula:

$$\text{WA-WQI} = \sum_{i=1}^{9} w_i q_i \quad (1)$$

Among them:

q_i: subindex of the parameters i, the value in the range 0 đến 100 and is determined from the subindex for function parameters i. To ease the calculations, the authors have used the available software [29] for fast calculation values q_i entering into values x_i.

w_i: weighting the contribution of parameters i, the value in the range 0 to 1;

$w_i = 1$

n: number of selected parameters.

Figure 8, 9 shows the results of analysing the WQI of river downstream Cu De datas.

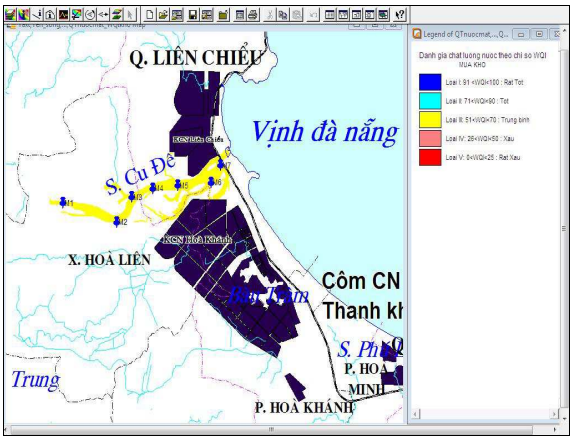

Figure 8. *Partition diagram water quality indices WQI dry season.*

4. Discussion

Water quality downstream Cu De decreased from station to station M1 M8 (Cu De station 500m from the estuary upstream). The main reason was due to receive waste from coastal residential activities, agricultural activities (M1, M2), sands mining operations, aquaculture activities (M3, M4, M5, M6) and wastewater from Lien Chieu and Hoa Khanh Industrial Zone in river flow into estuaries located 500m (M7).

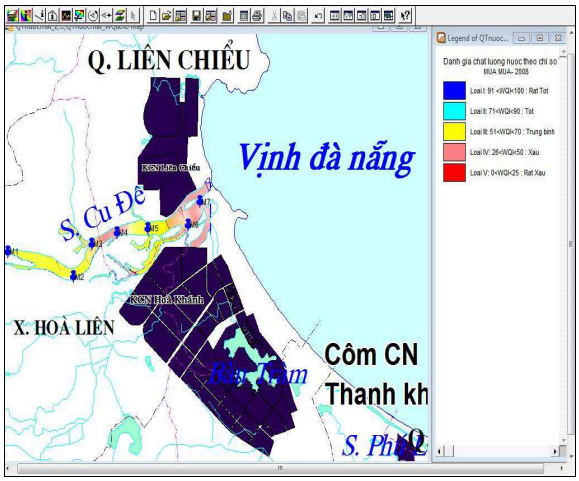

Figure 9. *Monitor water quality partitions WQI index rainy season*

Water quality downstream Cu De fluctuated over time according to the month of big changes, especially at the monitoring location M3, M4 and M6 (receiving aquaculture waste resources). The main reason the concentration of BOD5, COD reached its maximum value at 2.3 months (dry season) and October (the rainy season), this is the end of the harvest shrimp and started to prepare for shrimp So we think that the new cleaning waste pond has an amount of food leftover shrimp and they may be the reason causing increasing concentrations of BOD5, COD in river water.

Evolution of water quality in downstream river Cu De has also changed markedly between the dry and rainy seasons. DO water quality parameters tend to decline over time in areas downstream Cu De. At the M7 position (receiving waste industry) DO levels decline almost half of the batch of the dry season, showed DO levels decline over time is very clear. During the rainy season, the BOD_5 concentration changes, can COD in at M7, the concentration of BOD_5, COD than double batch of the dry season. Evolution of organic indicators measured in the downstream region is very complex.

Based on the water quality classification models modeled NSF - WQI shown in Figure 8 and Figure 9 from M1, M2 medium water quality, segment M3, M4 poor water quality is a source of waste of aquaculture zones should need to apply the appropriate treatment technology. Similar segments M7, M8 also cause poor water quality is primarily due to emissions from 2 Hoa Khanh and Lien Chieu should need to invest wastewater treatment technology in this area.

The industrial activities, agriculture, aquaculture, transport and domestic wastewater is the major source of the increase in the concentration of water quality parameters in the Cu De river water.

Table 1. *The quality indicators, overall water (NSF-WQI) evaluation of water quality downstream Cu De*

Data analysis	Unit	Results		QCVN	Number of times in excess of standards
		NM1	NM2		
pH	mg/l	6,7	6,8	5,5 – 9	Standards
DO	mg/l	5,3	4,2	>2	Standards
TSS	mg/l	32,8	41,7	100	Standards
COD	mg/l	6,9	14,6	50	Standards
BOD_5	mg/l	4,3	8,7	25	Standards
NH_3	mg/l	0,01	0,49	1	Standards
Total Photpho	mg/l	0,09	0,53	-	
Nitơ	mg/l	0,97	1,36	-	
Mineral oil	mg/l	0,10	0,59	0,3	NM3 Standards NM4 exceed 1.97 times
Fe	mg/l	0,07	0,32	2	Standards
Zn	mg/l	0,01	0,63	2	Standards
Pb	mg/l	0,02	0,02	0,05	Standards
Cu	mg/l	0,04	0,06	1	Standards

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