

MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT
**VIETNAM INSTITUTE OF METEOROLOGY,
HYDROLOGY AND CLIMATE CHANGE**

CAI ANH TU

**RESEARCH ON DEVELOPING A SCIENTIFIC BASIS FOR
ZONING RIVER WATER QUALITY ACCORDING TO USE
PURPOSES - APPLY FOR NHUE RIVER - DAY RIVER**

Major: Natural Resources and Environment management

Code: 9850101

**SUMMARY OF THE DISSERTATION
NATURAL RESOURCES AND ENVIRONMENT
MANAGEMENT**

Ha Noi, 2020

The dissertation was completed at:

Viet Nam Institute of Meteorology, Hydrology and Climate Change

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The dissertation shall be defended in front of the dissertation Committee at Viet Nam Institute of Meteorology, Hydrology and Climate Change

At.....hour, date...../...../2020

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INTRODUCTION

1. The necessity of the dissertation:

Effective activities that are often used to manage water pollution are control of waste sources, planning of drainage and wastewater treatment systems, planning of water resources, etc. The above action should be based on the results of zoning of water quality according to use purposes or in other words, zoning of river water quality (RWQ) according to use purposes (UPS) contributes to the effective implementation of the water environment management and protection activities.

However, at present, the zoning of RWQ according to UPS has not been implemented comprehensively and systematically, based on a scientific and practical basis. This is partly reflected in the judgment made in the report "National environmental status, 2018" as "An important basis for implementing water protection in river basins is to determine the use purpose of the water source, which is still open." [7]. The zoning has not been agreed in the same river basin as well as between river basins across the country, that making it difficult for water resources management activities in river basins. From the reason and practice mentioned above, the author implements the dissertation *"Research on developing a scientific basis for zoning river water quality according to use purposes – Apply for Nhue river – Day river"*

2. Research objectives and research contents

- Research objectives

- + To identify and clarify the scientific basis for implementing the zoning of RWQ according to UPS.

- + To propose criteria, process, and content of the implementation of zoning of RWQ according to UPS.

- + To study and apply the process for zoning RWQ according to UPS for Nhue and Day rivers.

- Research contents

To achieve the above objectives, the dissertation deals with the following contents:

- + Overview of studies on the scientific basis for zoning RWQ according to UPS of some countries in the world and Vietnam, and overview of studies on water quality (WQ) in Nhue and Day rivers.

- + To approach and build the scientific basis for the zoning of RWQ according to UPS.

- + To apply and adjust the scientific basis for the zoning of RWQ according to UPS into practice (for Nhue and Day rivers).

3. Research subject and research scope

- Research subject: The scientific basis for the zoning of RWQ according to UPS is applied to all rivers.

- Research scope: For all rivers (the scope of the dissertation is Nhue and Day rivers).

4. Approach to the scientific basis for zoning WQ according to UPS.

The approach to the study of the dissertation includes synthetic; systematic and ecological management.

5. The scientific and practical significance of the dissertation

- *Scientific significance:* The dissertation determined and clarified the methodology and research methods for zoning RWQ according to UPS such as:

+ The zoning of WQ according to UPS is defined as a form of the environmental functional zoning with unit "region" corresponding to river and "sub-region" corresponding to river sections.

+ Assessing the WQ in the zoning of WQ according to UPS is not merely based on the comparison of the results of WQ monitoring with QCVN 08-MT:2015/BTNMT (National technical regulation on surface WQ) and WQI (Water Quality Index) but also need to be associated with the specific characteristics of internal and external factors in the river/river section as well as linked with tools of the indicators (WQI_{aq}, WQI_{hi}, DR_o) to assess.

+ The process of implementing the zoning of RWQ according to UPS was proposed by the dissertation based on consideration and evaluation of 19 criteria belonging to three groups of natural, social, and environmental characteristics. The criteria were proposed to meet scientific requirements, practical conditions, and feasibility with the condition of managing surface water resources of Vietnam.

- *Practical significance:* The research results of the dissertation are useful documents for surface water resources management, including the development of environmental

protection planning, socio-economic development planning, water resources planning, water drainage, and water treatment planning. The document also provides support for more effective implementation of other environmental management activities related to environmental protection of river water.

6. New contributions of the dissertation

- Developed a set of criteria for zoning RWQ according to UPS belonging to 3 groups of natural, social, and environmental characteristics.

- The process and contents of implementing the zoning of RWQ according to UPS have been developed and successfully applied to Nhue and Day rivers.

7. Structure of the dissertation

In addition to the introduction and conclusion, the dissertation consists of four chapters.

Chapter 1: Overview of studies related to the scientific basis and implementation for zoning RWQ according to UPS

Chapter 2: Object, scope, and research method

Chapter 3: Developing the scientific basis for zoning of RWQ according to UPS

Chapter 4: Applying the scientific basis for zoning of RWQ according to UPS for Nhue, Day rivers

**CHAPTER 1. OVERVIEW OF STUDIES RELATED TO
THE SCIENTIFIC BASIS AND IMPLEMENTATION
FOR THE ZONING OF RIVER WATER QUALITY
ACCORDING TO USE PURPOSES**

1.1. Overview of studies related to the scientific basis for the zoning of river water quality according to use purposes

1.1.1. Overview of studies related to the scientific basis for the zoning of river water quality according to use purposes of some countries in the world

Australia [79], [82], [97]: Australia (2000 and 2005) issued a national action plan on WQ and the purposes of WQ. Determining the purposes of WQ was divided into 2 phases with 10 steps of implementation.

Federal Republic of Germany [89], [90]: Guidelines for defining the purposes of WQ for river sections based on the results of monitoring 18 parameters in the classification system (Elbe, Rhine, and Danube rivers).

United States [88]: The scientific basis for the zoning of RWQ according to UPS is given by considering the factors of natural and socio-economic characteristics.

Japan [75]: Standards of water environment quality are stipulated in the Law on Water Pollution Control. In particular, WQ standards include 37 parameters.

World Health Organization (WHO) [107]: WHO issued guidelines for the protection of the recreational environment (2003). The guidelines only focus on protecting the entertainment environment, while there are many other purposes of water sources that need attention that has not been mentioned by WHO.

1.1.2. Overview of studies related to the scientific basis for zoning river water quality according to use purposes in Viet Nam

- Le Trinh et al. (2008) [58]; Pham The Quang, Duong Hong Son et al. (2010) [33]; Department of Natural Resources and Environment of Thai Nguyen (2011) [37]; Center for Environmental Monitoring (2012 and 2016) [43], [62].

From the overview of the related studies, the dissertation found that the main issues that are still open about the contents related to the scientific basis and the process of zoning WQ according to UPS. These issues have not yet been implemented in a uniform, systematic way. So there are some major limitations as follows:

+ The approach of most studies focuses on using results of monitoring WQ to assess the ability to receive wastewater from the water source and have not gone into depth to consider the synthesis of internal and external factors affecting WQ according to UPS.

+ Results of zoning WQ for river sections in the study area have not shown the relationship with the use purposes of the water source.

1.2. Overview of studies on the water quality and current status of water use of Nhue river and Day river

1.2.1. Studies on the water quality of Nhue river and Day river

Le Vu Viet Phong, Tran Hong Thai (2006) [32]; Department of Water Resources Management (2007) [17]; Nguyen Van Cu et al. (2004-2009) [18]; Dang Dinh Duc (2009) [21]; Department of Waste Management and Environmental Improvement (2009) [19]; Van Thi Hang (2010) [24]; Trinh Minh Ngoc et al. (2013) [31]; Le Hung (2012) [27]; Committee for environmental protection of Nhue-Day river basin (2013-2014) [70]; Nguyen Toan Thang (2016) [54]. From the results of studies on WQ of Nhue river, Day river showed that:

Studies based on QCVN 08-MT: 2008/BTNMT (now QCVN 08-MT: 2015/BTNMT) to analyze, compare and evaluate with each environmental parameter and apply the tools such as WQI, QUAL2E model, MIKE 11 model to solve research problems.

- The WQ of Day river is better than Nhue river (The WQ of Nhue river is heavily polluted, The WQ of Day river is mainly polluted locally in some areas passing residential areas, industrial parks, where receiving large sources of waste).

1.2.2. Studies on the current status of water use of Nhue river and Day river

In Nam Dinh Water Resources Planning Report (2017) [73]; Ninh Binh Water Resources Planning Report (2017) [74]; Center for Environmental Monitoring, Vietnam Environment Administration (2016) [62]. Result of studies on the current status of water use of Nhue river and Day river showed that:

- On Day river, most of the river water is used for 2 purposes or more (using water for daily life, irrigation, aquaculture).
- Comparing with the water use of Nhue river, Day river water is used for many purposes. Even many river sections in Ha Nam and Ninh Binh province, water river is used for domestic purposes.

CONCLUSION OF CHAPTER 1

Chapter 1 of the dissertation reviewed the studies related to the scientific basis for zoning RWQ according to UPS in the world and Vietnam. From that, drawing on international experiences and practical situation in Vietnam to clarify gaps in this study.

To contribute to perfecting the scientific basis for zoning RWQ according to UPS in Vietnam, the dissertation proposes an approach, method, and content of implementation to overcome the above-mentioned issues. The research diagram of the dissertation is shown in Figure 1.5.

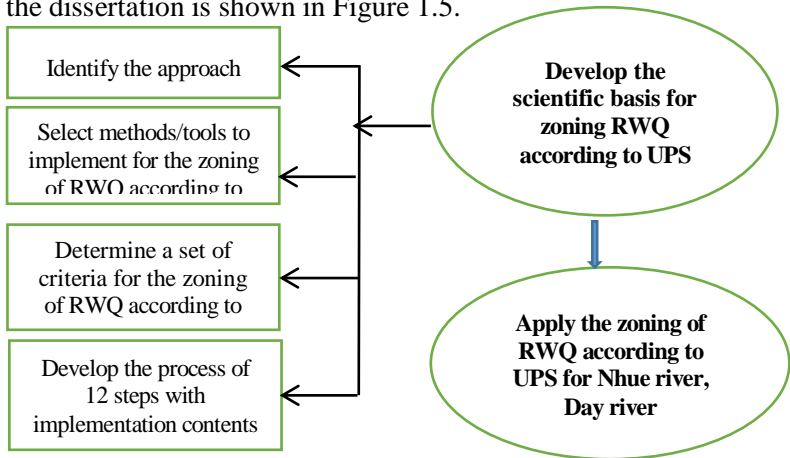


Figure 1.5. Research diagram of the dissertation

CHAPTER 2. OBJECT, SCOPE, AND RESEARCH METHODS

2.1. Research object and scope

Table 2.1. Research object and scope

Scope	Object
All rivers	Develop the scientific basis and process for zoning RWQ according to UPS
Nhue river and Day river	Apply the process to zone water river sections

2.2. Research methods

2.2.1. Method of data collection and synthesis

The method is used to collect, synthesize, and analyze relevant information such as natural conditions and socio-economic of the study areas, legal documents on protection and management of surface water, ...

2.2.2. Methods of Field survey, sampling, analyzing water samples in the laboratory

The monitoring method is implemented under Circular No. 29/2011/MONRE dated August 1, 2011.

- Inheriting results of the analysis of WQ of Nhue river and Day river from Center of Environmental Monitoring, General Department of Environment (period of 2010 - 2014) [43].

The dissertation monitored 126 samples (72 water samples of Nhue river and Day river in 2019 to compare WQ with the period of 2010 - 2014 and 54 water samples of Nhue river and

Day river from 2015 to 2016 to assess the self-cleaning capacity of a river).

2.2.3. Methods/tools indicators to assess water quality

The dissertation proposed and applied the following tools to evaluate WQ in the WQ zoning.

(i) Method/Tool for assessing WQ according to QCVN 08-MT: 2015/BTNMT [6].

(ii) A tool to evaluate WQ based on the WQI [45], [46].

(iii) Methods for assessing WQ based on the "river health index" (WQIaq, WQIhi, DRo) proposed by the Mekong association (2011) [84], [89], [91], [93].

2.2.4. Method for calculating the demand for using water according to coefficient/norms

This method relies on water supply coefficients/norms for each water user in which data sources are collected reliably [9], [10], [56], [57], [80], [95].

2.2.5. Method of estimating pollution amount and load

To estimate the amount and load of pollutant discharged from waste sources in Nhue - Day river basin, the dissertation used the quick identification method that Vietnam is still applying [94], [95], [103].

2.2.6. Expert and Delphi method

Expert method: Collect the opinion of 30 experts to select criteria and level/class for each criterion.

Delphi method: implemented to support the group discussion process to quantify the selection, classification of criteria, and

to rank the zoning of RWQ according to UPS.

2.2.7. Modeling method

The modeling method is used in the dissertation through the WASP model tool [108] to calculate the self-cleaning capacity in the river/river section.

CONCLUSION OF CHAPTER 2

Chapter 2 has clarified the issues related to the object, scope, and research methods for implementing the zoning of RWQ according to UPS:

The dissertation had been done based on synthesizing from the main research methods as follows: Collecting, analyzing, synthesizing and inheriting research materials; sampling, analyzing water samples in the laboratory and field survey; applying methods/tools of indicator to assess WQ; using Delphi and expert methods; modeling method. The above methods applied in the study were selected based on analysis and evaluation following actual conditions in Vietnam.

CHAPTER 3. DEVELOPING THE SCIENTIFIC BASIS FOR ZONING RIVER WATER QUALITY ACCORDING TO USE PURPOSES

3.1. Relationship between the zoning of river water quality according to use purposes and the environmental zoning in environmental planning.

In environmental planning [52], [57] often divided into:

+ Four types of environmental zoning: Landscape zoning; environmental functional zoning; quality status zoning; zoning according to the use of purpose.

+ Zoning units: Region, sub-region, and area.

+ Four types of sub-regions: Sub-region for conservation and protection; sub-region for developing priority towards environmentally friendly; Sub-region for developing the level of permission; Sub-region for rehabilitating.

During the study process, PhD candidate found:

- *The zoning of RWQ according to UPS is a form of environmental functional zoning.*

- *Proposed WQ characteristics of 4 sub-regions*

- *The zoning of WQ is a step of the zoning of RWQ according to UPS.*

The dissertation also proposed that the time to review the zoning of RWQ according to UPS is 5 years/time.

3.2. Principles of the zoning of river water quality according to use purposes

According to the general principle of environmental

planning, the zoning of RWQ according to UPS has the following main principles: Relatively uniformity of the sub-region, the zoning of RWQ according to UPS is integrated but not entirely dependent on socio-economic development planning and other types of planning involved; using a multi-criteria assessment tool, can integrate many different indicators; the WQ and zoning of RWQ according to UPS are closely related to each other; The purposes of using water need to be feasible and, effective, and in line with management requirements.

3.3. Relationship between internal and external factors with river water quality

1) The relationship between internal factors with river WQ

The main internal factors include Characteristics of internal natural conditions of the river; self-cleaning capacity of the river; Characteristics of river ecosystems.

2) The relationship between external factors with river WQ

The main external factors include Features of natural conditions outside of the river; Socio-economic characteristics; objectives and activities of environmental protection in a river basin.

3.4. Selecting standards/regulations and parameters of the water environment in the zoning of river water quality according to use purposes

1) Choosing standards/regulations

2) Selecting water environment parameters

With the arguments detailed in the dissertation, based on

that, the parameters to be selected and applied calculation for the four tools of indicator (WQI, WQIaq, WQIhi, and DRo) include 12 parameters: Temperature, pH, TSS, TDS, DO, BOD5, COD, NH₄⁺, PO₄³⁻, NO₃⁻, Coliform, Fecal Coliform.

3.5. Proposing criteria and level/class for zoning river water quality according to use purposes

1) Proposing criteria

Three bases for giving the criteria in zoning of RWQ according to UPS are: Meet the scientific; suitable with actual conditions; feasible.

For zoning RWQ according to UPS, the dissertation proposed 3 groups with 9 criteria (specified in Table 3.1), including Group of criteria on natural characteristics with 3 criteria; Group of criteria on social characteristics with 2 criteria; Group of environmental criteria with 4 criteria.

2) Proposing to classify the zoning of RWQ according to UPS

≤ 13 points belong to Group 1 - Suitable for sub-areas with good WQ according to use purposes (≤ 50% compared to the total score).

> 13 - <19 points belong to group 2 - Suitable for sub-region with medium WQ according to use purposes (about> 50% -> 70% compared to the total score).

≥ 19 points belong to group 3 - Suitable for sub-areas with bad WQ according to use purposes (about> 70% of the total score).

3) Proposing an identification of point scale in the zoning of RWQ according to UPS

The dissertation proposed criteria and their point scale in Table 3.2.

Table 3.2. Proposing criteria and their point scale

No	Criteria	Point scale		
		1	2	3
Internal factors				
1	Position of sub-region	Upstream/within the protection area of the water exploitation works to supply water for daily life (Circular 24/2016/BTNMT [50]).	Middle stream	Downstream
2	Value of conservation and protection of the sub-region	- The river section is an habitat of rare, precious creatures, and has diverse ecosystems in estuaries and mangroves.	Historic sites, scenic spots are near the river	
3	Current status of WQ	A1 – A2	< A2 – B1	< B1 - < B2
4	Expected future WQ	The quality Improved	The quality remains the same	The quality dropped
5	Self-cleaning capacity	High (> 1 higher than the average of Self-cleaning capacity)	Medium ($\leq 0,8 - 1$)	Low (< 0,8)
External factors				
6	Current demand for water use (8)	WQ (A1 – A2)	WQ (< A2 – B1)	WQ (< B1 - < B2)
7	Demand for water use in the future(*)	A1 – A2	< A2 – B1	< B1 - < B2
8	WQ after receiving confluence river	The quality Improved	The quality does not change much	The quality dropped
9	Drainage planning and wastewater treatment system	> 70% of treated wastewater meets the effluent standards	> 50% - 70 %	< 50%

3.6. Proposing a process of zoning river water quality according to use purposes

The proposed process with 12 steps to follow (Figure 3.4).

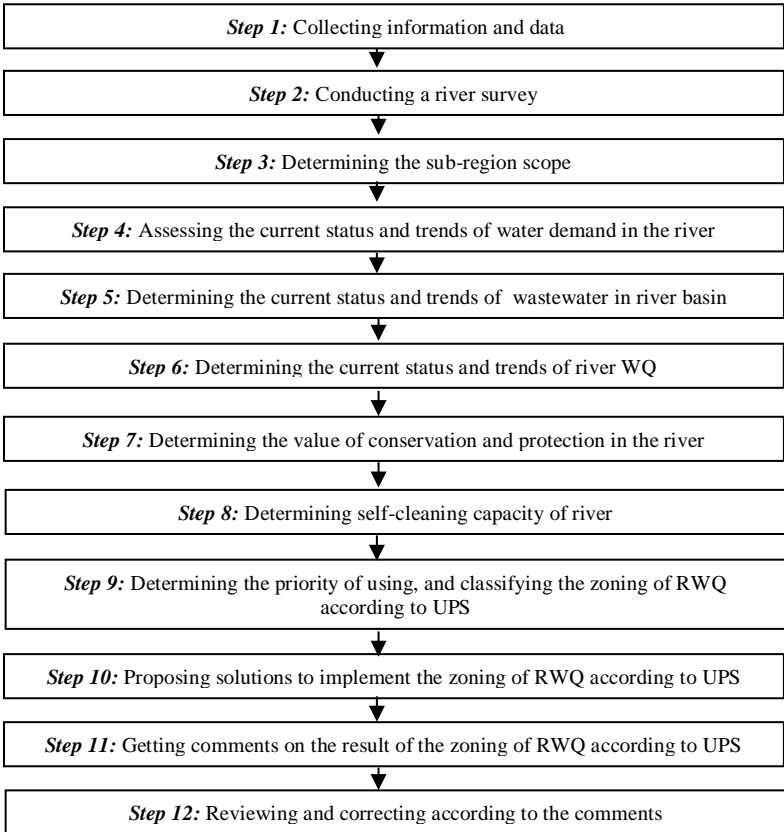


Figure 3.4. The process for zoning RWQ according to PUS

CONCLUSION OF CHAPTER 3

Chapter 3 had solved the objectives of the dissertation to develop a scientific basis and process of the zoning of RWQ according to UPS. In addition to the content and methodology related, the study also provided the approach, criteria, indicators, and parameters for assessing river WQ which are also mentioned on a scientific basis. On that basis, the process was proposed with 12 steps (Figure 3.4).

CHAPTER 4. APPLYING THE SCIENTIFIC BASIS FOR ZONING RIVER WATER QUALITY ACCORDING TO USE PURPOSES FOR NHUE RIVER, DAY RIVER

4.1. Some main characteristics of natural and socio-economic conditions of the Nhue-Day river basin

The flow regime of Day River is not only influenced by climatic factors (rainfall regime, ...), the water regime of the Red river but also depends on the tide regime in the Gulf of Tonkin with the amplitude decreasing from the North to the South. At Day estuary, the amplitude is only from 2.0 to 3.0 m, etc. The tide also has a great influence on the drainage and flood drainage capacity of the river [28]. At downstream of Nhue - Day river basin with distributaries of Dao river, Nam Dinh river, Ninh Co river and tributaries of Hoang Long river, Vac river. The intertwined river networks of this region are greatly influenced by tides, especially in the dry season. [25].

The average population density across the basin is nearly 1,000 people/km², which is 3.6 times higher than the national average (277 people/km²) [68].

4.2. Process of zoning river water quality according to use purposes for Nhue river and Day river

Implementing the process of zoning RWQ according to UPS with 12 steps. From there, it serves as a basis for ranking the WQ zoning of Nhue river and Day river.

4.3. Results of classifying the water quality zoning of Nhue river and Day river according to use purposes

Results are shown in Table 4.32, 4.33, and Figure 4.17.

From the results of classifying by groups in Table 4.32 can see:

- In Nhue river:

+ Three sub-regions of type for conserving and protecting (due to having the categories of conservation and protection near the river): N1 (Lien Mac - Phuc La), N2 (Phuc La – Chiec bridge) and N3 (Chiec bridge – Cong Than)

+ One sub-region of type for developing sub-region with permission level/Sub-region limited development: N4 (Cong Than – Hong Phu bridge) is in group 3 (Suitable for sub-region with bad WQ according to UPS) suitable to supply water for poor quality requirements

From the results of ranking by groups in Table 4.33 can see:

- In Day river:

+ Three sub-regions of developing priority towards environmentally-friendly: D5 (Que bridge - Gian Khau bridge), D6 (Gian Khau bridge - Yen Tri) and D7 (Yen Tri - Thuong Kiem) are in group 1 (Suitable for ranking sub-region with good WQ according to UPS) suitable to supply water for good quality requirements such as domestic water supply, conservation of aquatic flora and fauna and other cultural values.

+ One sub-region of type for conservating and protecting is D8 (Thuong Kiem - Cua Day): The river section needs to be

concerned with managing the unique ecosystems due to its position as estuaries and saline area.

+ Two sub-regions of type for restoration are D2 (Mai Linh - Ba Tha bridge) and D3 (Ba Tha - Te Tieu bridge) (Characteristics to note here are: The river section has poor WQ and negative impact on human health and the ecosystem. The priority is to restore WQ to a safe level) and one sub-region with permission level/sub-region limited development is D4 (Te Tieu bridge - Que bridge) all belong to group 3 (Suitable to divide into sub-region with poor WQ according to UPS). It is important to note here: The sub-region/river section in the position that affects the WQ for supplying domestic water of sub-regions in the downstream, so if further economic development than the present, there are risks to the environment and the human health (Table 4.32, figure 4.17)

4.4. Commenting on the appropriateness between the results of zoning of RWQ according to UPS with the socio-economic development planning, and adjusting the scientific basis, criteria, and process after applying to Nhue river, Day river.

4.4.1. Commenting on the appropriateness between the results of zoning of RWQ according to UPS proposed by the dissertation with the socio-economic development planning

Zoning of RWQ according to UPS proposed by the dissertation is suitable basically to the current status and also to the development planning of Ha Nam province as well as other provinces in the Nhue and Day river basins.

4.4.2. Adjusting the scientific basis, criteria, and process of zoning of RWQ according to UPS after applying to Nhue river, Day river

After the application of the scientific basis of zoning RWQ according to UPS to Nhue river and Day river, the dissertation has made some adjustments to the scientific basis, the set of criteria, the process as follow: Clarifying the basis for commenting on the classification of zoning RWQ according to UPS belong to the environmental functional planning; adding 3 principles in a total of 5 and adding 3 steps to Implement in the process.

Table 4.32. Classification and zoning WQ of Nhue river according to use purposes

River Section	Position			Value of conversation, protection			Current status of WQ			Expected WQ			Current status of demand for using water			demand for using water in the future			Self-cleaning capacity of a river			WQ after river confluence			WQ according to WRP, WWTP			Total Score
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
1	x					x			x			x			x			x	x			x					x	19
2		x				x			x			x			x			x	x				x				x	21
3		x				x			x			x			x			x			x	x					x	23
4			x						x			x			x		x				x			x			x	21

Bảng 4.33. Classification and zoning WQ of Day river according to use purposes

River Section	Position			Value of conversation, protection			Current status of WQ			Expected WQ			Current status of demand for using water			demand for using water in the future			Self-cleaning capacity of a river			WQ after river confluence			WQ according to WRP, WWTP			Total Score
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
2	x					x			x	x					x			x			x			x	x			21
3		x				x			x	x					x			x		x			x		x			20
4		x				x			x	x					x			x		x			x		x			20
5	X					x			x				x					x				x			x			12
6	X				x				x				x					x				x			x			11
7	X			x					x				x					x				x			x			10
8				x					x						x			x						x			x	16

Notes: WQ - Water quality; WWTP - Wastewater treatment planning; WRP - water resources planning
 ≤ 13 points: Group 1; $> 13 - < 19$ points: Group 2; ≥ 19 points: Group 3



Ghi chú:

- █ Sub-region for conservation and protection – Group 1
- █ Sub-region for developing priority towards environmentally friendly- Group 2
- █ Sub-region/river section for developing the level of permission(Sub-region limited development)- Group 3
- █ Sub-region for rehabilitating– Group 4

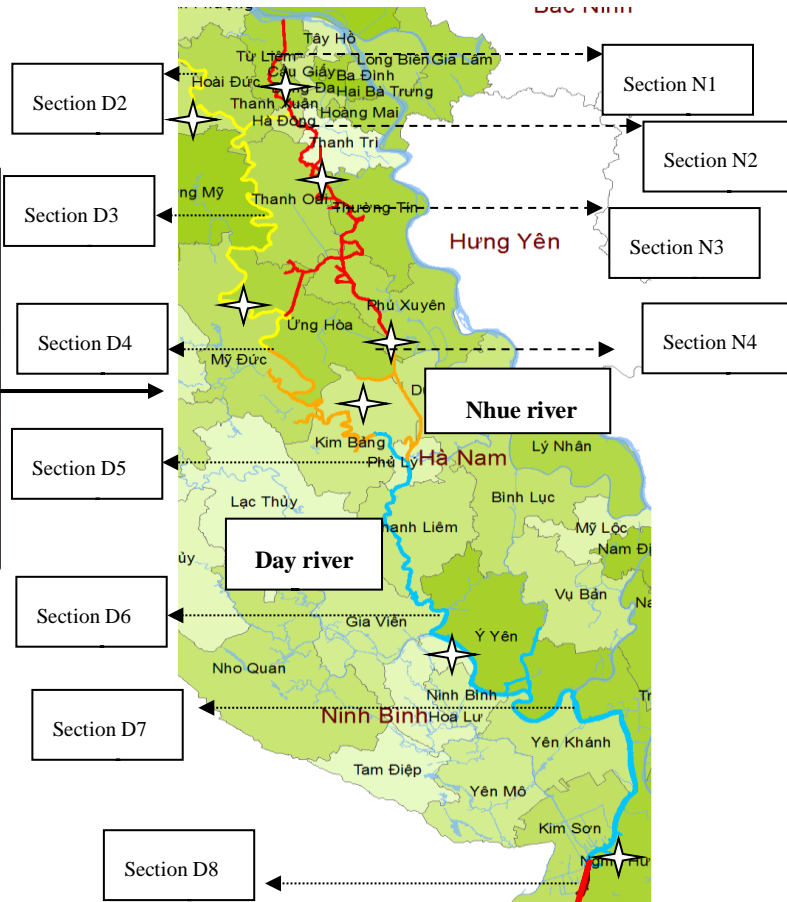


Figure 4.13. Map of zoning of water quality for Nue and Day rivers according to use purposes

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1) The scientific basis for zoning RWQ according to UPS was developed on the following views and main contents:

- The approach for zoning RWQ according to UPS is to approach the synthetic; systematic and ecological management.

- Proposed 9 criteria for zoning RWQ according to UPS include 3 criteria for natural characteristics: (i) Conservation and protection value of the river section, (ii) the location of the river section, (iii) self-cleaning capacity of the river section; 2 criteria on social characteristics: (i) Current status of demand for using water, (ii) demand for using water in future and 4 environmental criteria: (i) Current status of WQ of the river section, (ii) expected WQ of the river section, (iii) WQ after river confluence, (iv) WQ according to water resources planning, water waste treatment.

- Assessing the WQ in zoning of RWQ according to UPS was performed from the tools of WQI, WQIaq, WQIhi, DRo, and WAPS model to determine the self-cleaning capacity of river; classifying WQ on 3 levels according to a scale of points to compare with QCVN 08-MT: 2015/BTNMT.

- Proposed the process for zoning RWQ according to UPS with 12 steps: (i) Collecting information, data, main characteristics of natural and socio-economic conditions, environmental protection plans related to WQ in the basin; (ii) Conduct river surveys; (iii) Determining sub-regional scope; (iv) Assess the current status and trends in demand of using water in the river; (v) Identify the current status and trends in wastewater volume in the basin; (vi) Identify the current status and trends of river WQ; (vii) Determine the value of conservation and protection in the river; (viii) Determine the self-cleaning capacity of the river; (ix) Determine the priority of using water , classify the WQ and the zoning of RWQ according to UPS.

2) *Based on the process for zoning RWQ according to UPS, the dissertation has identified 4 sub-regions for Nhue river and 7 sub-regions for Day river.*

- In Nhue river: Three sub-region of conservation and protection due to having categories/works close to the river: Lien Mac - Phuc La, Phuc La – Chiec bridge, Chiec bridge – Cong Than and 1 Sub-region for developing the level of permission/sub-region limited development (Cong Than - Hong Phu bridge).

- In Day river: Three sub-region for developing priority towards environmentally friendly are Que bridge - Gian Khau bridge, Gian Khau bridge - Yen Tri, Yen Tri - Thuong Kiem; one sub-region of conservation and protection due to the need to care for specific ecosystems or the location of the estuary, the saline water: Thuong Kiem - Cua Day; two sub-regions for rehabilitating: Mai Linh - Ba Tha, Ba Tha - Te Tieu bridge; one sub-region for developing the level of permission also known as a Sub-region limited development: Te Tieu - Que bridge.

Recommendations

The dissertation proposed the following recommendations:

1) The tools WQI_{aq}, WQI_{hi}, DR_o were used by the dissertation to determine the WQ that has shown a certain exact efficiency. However, more in-depth and systematic studies are needed for further testing and comparing with QCVN 08-MT: 2015 BTNMT.

2) The WASP modeling method is free software that is effective when applied in zoning of RWQ according to UPS, so the model should encourage the use and further verification in different rivers.

3) There should be in-depth studies to give a set of weights for the criteria in zoning of RWQ according to UPS.

4) The process for zoning RWQ according to UPS should also be applied to other rivers and basins for better verification.

**LIST OF SCIENTIFIC ARTICLES OF THE AUTHOR
RELATED TO THE DISSERTATION**

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2. Trinh Thi Thanh, Cai Anh Tu (2015), *Some suggestions for improving the efficiency of calculation of river water quality index*, Viet Nam Environment Administration Magazine, No 8, 2015, p. 63 – 66.
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