

The Establishment of Map Supporting Environmental Management in Bacgiang Province

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Key words: Environmental map, Environment Management, GIS, Vietnam

SUMMARY

In recent years, list of thematic maps is expanding with the emergence of series of environmental maps all kind. These environmental maps present the status and quality of environment, the assessment results and the forecast of hazardous pollution levels. These assessment and forecast are carried out based on the comparison and analysis of data monitored and gathered in several years or at a certain time with environmental standard parameters and permitted levels regulated in National Environmental Standards. Those maps with theirs database built by using GIS are the effective tool for environment management. With the support of computer and GIS technology, the storage, update and process of information, the measurement on maps, creation of secondary maps, and application of mathematic model to analyze environmental information have became easier and more convenience. Maps are playing an important role and effectively supporting the management and update of information, the assessment of environmental status, as well as the forecast of environmental incidents and hazards. Vietnam is developing general regulations regarding the establishment of environmental maps. This paper introduces some environmental maps of Bac Giang province, which were established by a group of authors in Institute of Geography, VAST, and can be used for environmental management in Bac Giang province.

SUMMARY

Trong những năm gần đây bổ sung vào hệ thống các bản đồ chuyên đề xuất hiện một loạt các loại bản đồ về môi trường. Đây là những bản đồ phản ánh hiện trạng, chất lượng môi trường, đánh giá, dự báo mức độ ô nhiễm các chất độc hại, dựa trên việc so sánh và phân tích các số liệu quan trắc nhiều năm, hoặc tại một thời điểm nhất định, với các giá trị tiêu chuẩn và giới hạn các thông số cơ bản được quy định trong các Tiêu chuẩn về môi trường của các nước. Các bản đồ này với cơ sở dữ liệu được thành lập bằng công nghệ GIS, là công cụ hữu hiệu để quản lý các thông tin về môi trường. Với sự trợ giúp của máy tính và công nghệ hệ thống tin địa lý, việc lưu trữ, cập nhật, xử lý các thông tin, đo đạc trên bản đồ, tạo các bản đồ dẫn xuất, dùng mô hình toán học để nội suy bản đồ ... đã trở nên dễ dàng và hữu hiệu hơn rất nhiều. Các bản đồ đang đóng một vai trò quan trọng, phục vụ đắc lực cho công tác quản lý cập nhật thông tin và đánh giá tình hình môi trường, cũng như dự báo những tai biến và thảm họa môi trường.

Việt Nam đang tiến hành xây dựng quy định chung về thành lập các bản đồ chuyên đề về môi trường. Bài báo giới thiệu một số bản đồ môi trường của tỉnh Bắc Giang, được thực hiện tại Viện Địa lý, Viện Khoa học và Công nghệ Việt Nam, với các nội dung, phương pháp thành lập và ý nghĩa sử dụng của chúng trong quản lý môi trường.

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1. INTRODUCTION

With interest from many countries, environmental problems have become an international issue. It is now routine to monitor and forecast environmental conditions in each country. In Vietnam, environmental maps, an effective tool for environment evaluation and management, has similarly garnered much interest. In particular, in provinces with radical changes in economic development, urban expansion and industrial zones development, environmental issues attract even more attention.

Bacgiang is a mountainous province in the Northeast of Vietnam with natural land area of 3.822 km² and a population of 1.58 million (2005). Bacgiang is conveniently located not too far from major cities and industrial centers of Vietnam's key economic zones in the North: Hanoi – Haiphong – Quangninh. The city of Bacgiang is 50 km North of Hanoi Capital and about 100km from the Vietnam-China border. This location has given the province great advantage in developing its economic relationship with other provinces in the Red River Delta and in the Northeast of Vietnam. In 2005, Bacgiang's economy remains agricultural. Its agriculture, foresting and fishing sector accounts for 43.5% of the province's GDP, industry and construction 22% and services 34.5%. In the coming years the province aims to become strong in processing, electronics, fertilizers manufacturing, and in exporting agricultural products.

To build better foundations for environmental management in the period of 2015-2020 and better analyze current conditions, Bacgiang has carried out surveys and investigations on the environment and established several environmental maps. These surveys result in a group of maps on environment quality, sources of pollutants and synthetic maps which evaluate and forecast environmental conditions.

This article discusses Bacgiang's environmental conditions, and the contents and methods of establishing environmental maps for Bacgiang province. From this discussion, we hope to open further dialogues on map representation criteria, data analysis methods, and models to evaluate the environment quality using GIS.

2. ENVIRONMENT CONDITION OF BACGIANG PROVINCE.

Surveys have shown the following environmental problems in Bacgiang:

- **Water and air quality:** water surface and air in several locations have been polluted. The waters in downstream of major rivers are polluted from light to medium level. Major lakes and ponds in Bacgiang city are heavily polluted too.

High pollution intensity occurs locally in hot industrial zones and urban areas. Water surface and air in areas surrounding manufacturers of fertilizers, beer and soft drinks, pulp processors, and handicraft villages are all polluted. Only the remote rural areas, far away from urban and industrial zones have good environment quality.

- **Biodiversity and forest resources:** In this province forest degradation has reached a new peak. Rich and median forest (the high-quality forest) accounts for only 5.248 ha, or 3.7% of land covered by forests. Precious trees, such as ironwood, chestnut, etc., though not extinct, but have decreased significantly in number. Trees with more than 60-70 cm in diameters are very rare. Deterioration in the ecosystems has lead to degradation of biodiversity. In particular, the number of species has decreased significantly, especially many precious and rare species with high economic and scientific values.

- **Land resources:** Land usage in Bac Giang has seen great changes in all 3 types of land: agricultural, non-agricultural, and un-exploited land. Agricultural land is shrinking significantly as a great proportion is transformed into industrial and urban land. It is forecast that in 2010 urban land will increase from 1.7 to 1.9 times in comparison to 2005, and in 2020, from 4.2 to 4.3 times. Urban development will greatly affect food security and the lives of people in suburban areas due to land loss and job loss. This can initiate social problems and conflicts. Many areas with previous high-quality environment can be turned into polluted areas.

- **Natural hazards:** Land erosion at riverbanks occurs often due to soil and sand exploitation. In many areas, soil is eroded and washed away, due to annual plantation on hills and construction of industrial and urban zones. Flooding occurs often in low land near major rivers, especially during rainy seasons.

- **Sources of pollution and hazards:** The big volume of diverse untreated wastes discharged from industrial and manufacturing activities is the major source of water and air pollution. These wastes originate from both Bacgiang and neighboring areas. Industrial wastewater mostly come from the manufacturing of chemicals, fertilizers, pulp, cement, mineral and construction materials exploitations, and from outside, for example, polluted waste carried by Cau River from Thai Nguyen province, and air pollutants from Pha Lai Power Plant. Hospital wastes are not processed due to a lack in solide and liquid wastes equipment. Wastes also come from handicraft villages, breeding farms, and urban zones. In addition, since monitoring is not effective, waste management does not follow national standards.

3. TYPE OF ENVIRONMENTAL MAPS

The above conditions of Bacgiang's environment were reflected in the following environmental maps of the province:

- Surface water quality map
- Ground water quality map
- Air quality map
- Natural hazards map

- Sources of pollutants map
- Environmental quality assessment map

3.1 Mapping Documentations.

All maps are combined on a 1:100,000 scale, from digital topographic maps of 1: 50.000 scale and from observation and surveying data.

Environmental monitoring data before 2002 are collected from provincial reports and Annual Environment Monitor. Data from 2003 to 2005 are monitoring data and surveying work of Institute of Geography.

The data consists of the following information:

- Locations of observation points and points of sample collections of air, water and soil.
- Locations of industrial zones, manufacturing sites and handcraft villages being the sources of pollutants.
- Locations and remaining traces of natural disasters such as flash flood, floods, landslides, mud flows and forest fires.
- The analytic results from samples of air, water and soil on the parameters defined by the Vietnam Environment Standards (TCVN).

The data is managed in two ways: spatial data is a system of maps by GIS software such as MapInfo and Arcview; and the rest are either Excel or thematic reports. Two thematic data groups are:

- Data on natural conditions, resources and socio-economic conditions
- Data on the condition and quality of environment

3.2 Contents and Representation Methods.

- Surface Water Quality Map:

In Bacgiang province the analytic results indicate that among 29 parameters of the Vietnam Standards for water, the concentration of 7 ones are the main sources of pollution. They are nutrient and organic elements and have been shown by the following indicators: Ammonia-nitrogen (NH₄ – N), Nitrogen dioxide (NO₂), Nitrogen oxide (NO₃), Biochemical Oxygen Demand (BOD₅), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), and oil. These parameters of almost all samples on the main rivers exceed national water quality class A standards (TCVN5942-1995).

Parameter	Unit	Class A Standard	OP. 1	OP. 2	OP. 3	OP. 4	OP. 5	OP. 6	OP. 7
BOD ₅	mg/l	< 4	11	12	12	11	9	8	11
COD	mg/l	<10	21.8	24.2	26.4	31.2	24.8	20.8	16.8
DO	mg/l	>6	5.1	4.5	4.8	5.4	5.6	5.3	5.4
NO ₃ ⁻	mg/l	10	2.307	2.078	1.84	0.92	1.33	1.16	0.96
NH ₄ ⁺	mg/l	0.05	0.36	0.54	0.9	0.36	0.36	0.36	0.32
NO ₂ ⁻	mg/l	0.01	0.017	0.025	0.669	0.4	0.11	0.04	0.072
Oil	mg/l	0.0	0.06	0.02	0.1	0.01	0.01	0.01	0.262

Table 1: Water quality in observation points (OP) from upstream to downstream sections of Thuong River (year 2004)

The maps of water quality are made for three main rivers Cau River, Thuong River and Lucnam river and some lakes in Bac Giang city. On the map it shows drainage systems, distribution of hydrological stations and points of water sample collection and water assessment (in river and lakes).

There are 4 categories of water pollution: highly, moderate, slightly and no pollution, depending on total Index of Water Quality of 7 above indicators calculated as follows:

$$I_{\text{SUM}} = I_{\text{BOD}_5} + I_{\text{DO}} + I_{\text{COD}} + I_{\text{NO}_3^-} + I_{\text{NH}_4^+} + I_{\text{NO}_2^-} + I_{\text{oil}} \quad (1)$$

$$\text{and} \quad I_i = \frac{I}{I_{\text{TCCP}}} \quad (2)$$

Where I_i : quality index of parameter, C : sample value and C_{TCCP} Vietnam Standard value.

The maps show that the upstream water of Lucnam River, ahead of Anchau Town, remains good while light pollution affects most other main rivers of the province. Downstream of main rivers running throughout the urban and industrial areas are heavily polluted. Water of major lakes and ponds in Bacgiang city are severely polluted with high BOD and DO levels.

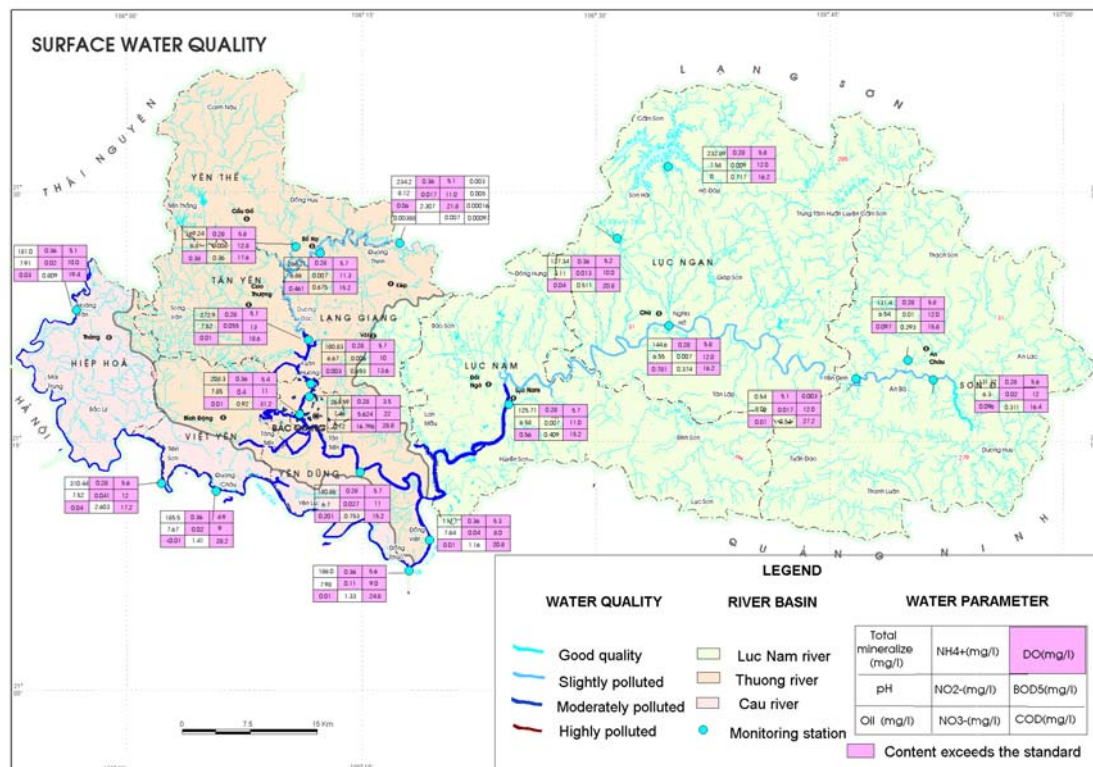


Figure 1. Water quality map of the main rivers of Bacgiang.

- Groundwater Quality Map.

Data on ground water quality is poor. Quality is only assessed at point of collection (15 points), such as dumping and house wells. The analytic results show that groundwater quality in this province is not very good. The concentration of PO_4^{3-} exceeds the National Standard by 1.2 – 6.5 times, and of Cr 20-57 times in all samples. In addition, ground water in province is contaminated mainly by coliform, in some cases, it exceeds the standard by 25-88 times. Therefore ground water needs to be treated before use as nutrition.

The map represents the analytic parameters and flags values exceeding permission by the Vietnam Standard 1995 for each sample point.

- Air Quality Map.

The investigation shows that air quality of Bacgiang province mainly depend on following facts:

- Effects of the transportation system (emissions from cars, trucks and buses on highway, main car route, road and rail).
- Effects of air pollutant from manufacturing, handicraft and service sites.
- Geographic and atmospheric conditions which affect the distribution of the pollutants from the source of discharge into the air.

- Wind characteristics of Bacgiang province: Northeast and East wind in the winter and Southeast wind in the summer

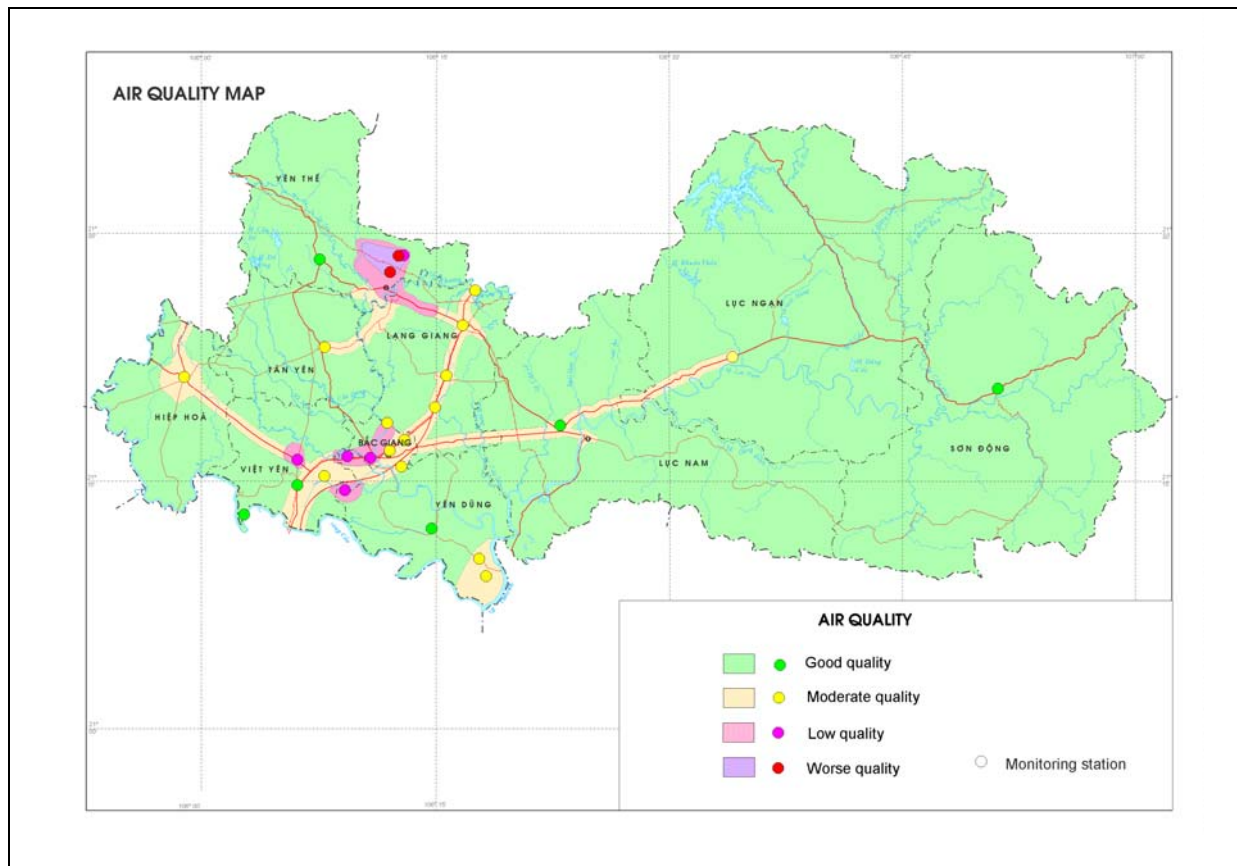


Figure 2. Air quality map of Bacgiang province.

The map is established based on index K of air quality, which is calculated separately for seven common air pollutants: coarse dust particles, lead (Pb), noise and poisonous gases: CO, NO₂, SO₂, NH₃ at selected monitoring sites. It is the ratio between the sample and the Vietnam Standard value:

$$K_i = \frac{N}{N_{TCCP}} \quad (3)$$

Where K_i is quality index, N: sample value and N_{TCCP}: Vietnam Standard value for outdoor air. If the K value is smaller than 1, this parameter is satisfactory. The higher the K value is, the greater the level of air pollution.

The map shows 4 levels of air quality assessment:

- Good: air quality is considered satisfactory (all K_i indexes are smaller than 1).
- Moderate: air quality is acceptable (one K index exceeds the standard but less than 2 times, K=1-2).

- Low quality: air quality is slightly polluted (two or three Ki indexes exceed the standard but less than 2 times).
- Bad quality: air quality is seriously polluted (two or four Ki indexes exceed the standard by 3-5 times).

The most polluted areas are the place surroundings Bacgiang Nitrogen fertilizer plant and Huongvi village of Boha district, where many lime-kilns are situated.

- Map of Pollutant Sources.

The pollutant sources in Bacgiang are industrial enterprises, industrial parks, craft villages, hospitals, clinics, urban area, tourist sites, runway and car stations, the landfills and breeding farms... These sources are represented on the map by different symbols for the type of industrial processes such as metals processing, chemical, food, fertilizer, pulp, cement manufacturing... and by color of the symbols for type of pollutant discharged like solid waste, wastewater and gases.

These maps play a great practical role in environmental management of Bacgiang. They show the distribution, concentration, and risks of pollutions from wastes for whole province.

- Natural Disaster Map.

The map represents the following hazards:

- Flooding is categorized into 3 levels: heavily flooded (areas with more than 5 months flooded); moderate (areas flooded from heavy rain), slightly flooded (areas flooded from very heavy rain). Information is collected from field survey, satellite images and statistics.
- Areas with frequent forest fires, affected by storms, riverbank erosion, landslide, etc.

- Environmental Quality Assessment Map.

It is the synthetic map, resulted from assessment of all environmental parameters of Bacgiang such as surface water quality, groundwater quality, air quality and natural hazards by using GIS data processing.

It categorizes the environment of province into 4 types: good quality environment (not polluted), normal quality environment (one parameter is slightly polluted), low quality environment (two parameters polluted) and lower quality environment (occurrence of natural hazards and more than three parameters polluted).

In general, the environment quality of Bacgiang remains good in rural and mountainous areas. Lower quality environments are often in urban zones and in craft villages.

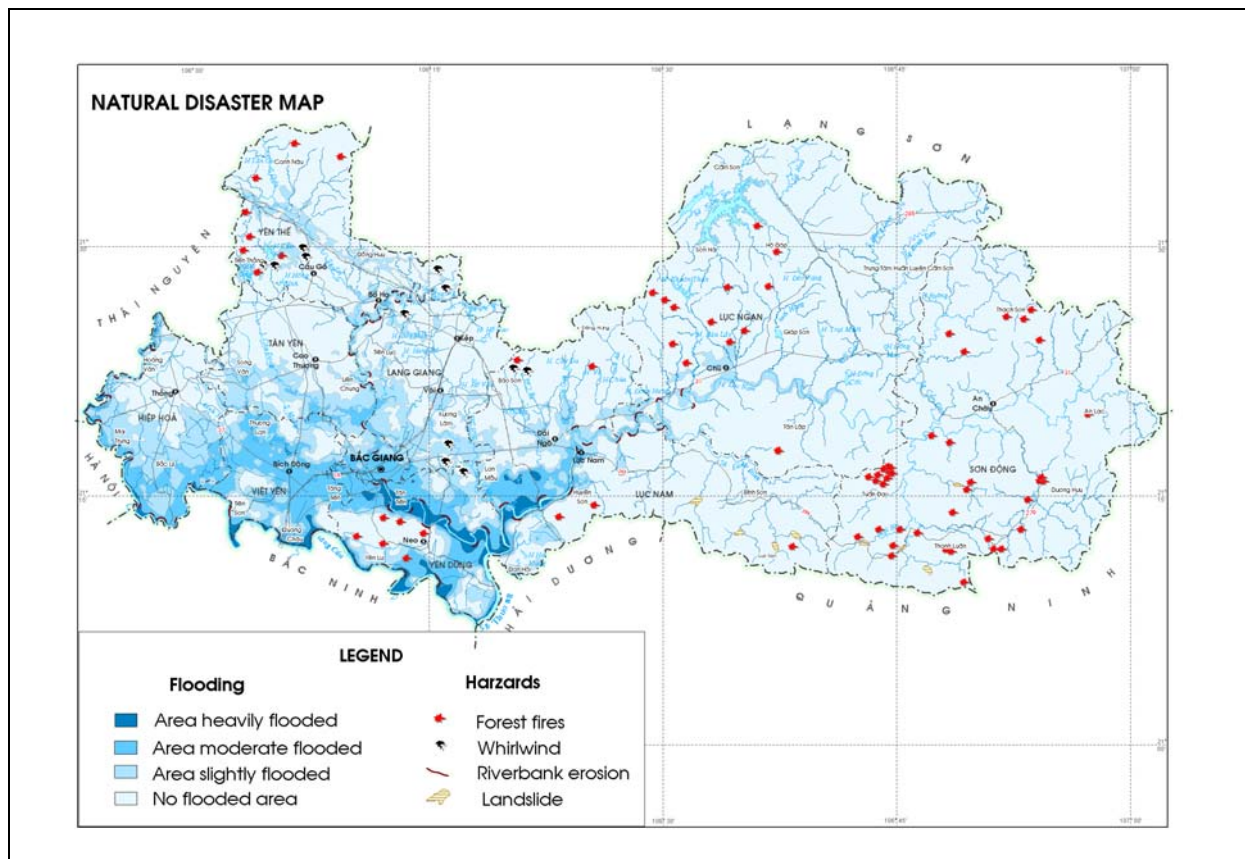


Figure 3: Natural disaster map of Bacgiang province

4. DISSCUSSION

Our recent experiences in building Bacgiang's environmental maps have shown that these maps are useful for environmental monitoring and management.

The advantage of these environmental maps is their rich contents, reflected most prominently in the following areas:

- Quality of each element of the environment such as water, air and soil
- Distribution of the pollutants, types and forms of wastes (solid, liquid, gas, radioactive wastes...)
- Types of natural hazards and environmental accidents
- Assessment of environment quality and suggestion for solutions to protect the environment.

However, there are a number of limitations:

- These maps don't belong to a standardized categorization. Approved guidelines about the contents of these maps have not existed either.

- Representation and data processing methods remain too simple. For example, many maps only represent the locations of observation and compare the observed data with given criteria, without showing the pollutant dispersion and migration in air and water.
- Pollution effect on habitant's health has yet been depicted on the map.

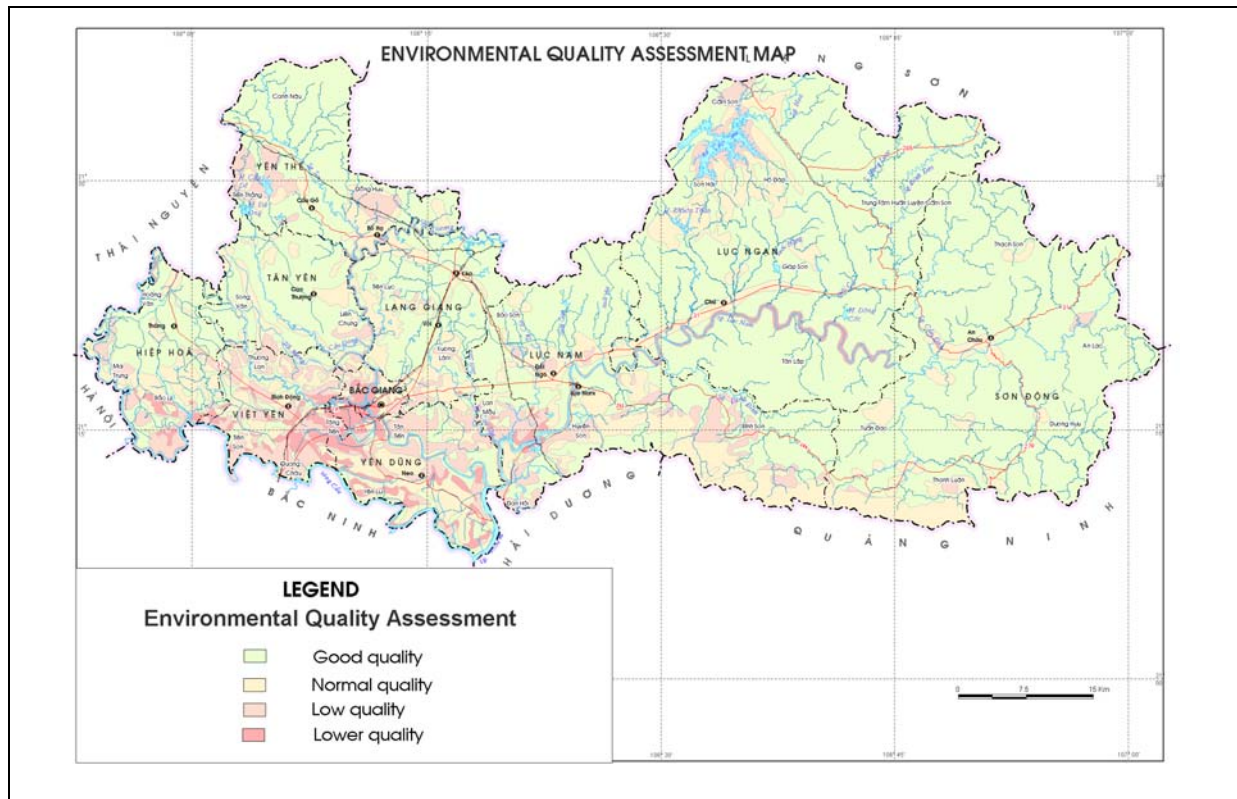


Figure 4: Environmental quality assessment map of Bacgiang province.

5. CONCLUSION

The environmental data have a different characteristics, type and standards. So only using GIS we can collect, analyze and cartography all kind of pollution clearly. In practice, GIS has been used as the main tool for constructing database and mapping the distribution of pollution for Bacgiang province. Now these maps are updated and used for annual environment monitoring and management.

The map system and GIS technology have already confirmed their important role in environment management. However, the establishment and usage of these maps as analyzed above have left open a few questions for further investigation. In the future, we need to continue to analyze and make clearer the contents, methods and the standard for establishing environmental maps, so that we can build a better GIS database and improve the ability of using maps in environment preservation.

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BIOGRAPHICAL NOTES

The author is a member of VGCR, graduated from Moscow University of Geodesy Photogrammetry and Cartography, and is now working as a researcher and head of Cartographic Division at the Institute of Geography, and teaching at University of Mining and Geology.

Her main activities and experiences focus on the use of Cartography, Remote sensing and GIS to support natural resources and environment management.

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