CREATING GEO-DATABASE FOR WATER POLLUTION WARNING BY REMOTE SENSING AND GIS TECHNOLOGY FOR THE NORTHERN KEY ECONOMIC REGION

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ABSTRACT

Industrialization development with the increase in number and density of industrial parks, especially in the key economic sector has contributed to the significant increase of the risk of environmental pollution in general and the water environment in particular. Meanwhile, the ability to provide and update information of the pollution risk warning is still individual, asynchronous and difficult to share for many different user groups. Therefore, it is needed to build a database to support the risk warnings of water pollution to ensure data consistency, traceability in many different ways, and ensure information sharing. Remote sensing materials and monitoring data can be used to extract causing component of water pollution, and assess the status of multi-period pollution levels in water over a large range quickly and consistently. Since then a geo-database on water pollution was built using GIS technology. Result of such technology integrating was a geo-database to support the management, monitoring and warning pollution risk of water resources for the Northern key economic region

1. INTRODUCTION

During the process of social-economic development, influences of natural factors and human activities on environmental issues have been on-going urgent and very complex. These changes in aquatic environment has raised a series of pollution issues, especially water pollution in large cities, industrial parks and residential areas.

Northern key economic regions were located by plenty of industrial areas from previous periods and continuing development. Due to the location distribution and characteristics, many of these industrial zones are close to rivers, such as the Red River, Cau, Nhue, Day, ... Therefore, most of these rivers are the water supply for operation of industrial zones and simultaneously receiving waste water from industrial zones. The concern is that most of the industrial park management boards are not systematic environmental monitoring. As a consequence, the management of industrial zones could not grasp the status of wastewater quality of businesses located in the management area. Until now, across the northern key economic region, development of database system for water resources are limited, such as lack of documentation, basic survey data, missing inventory of existing statistical exploitation of water use per sectors and local communities; lacking underground wate map for each province; data for quantity and quality assessment of water resources is inadequate and hardlu updated or generalised. Most local communities have not designed yet the plan for usage exploitation , utilization, protection and development for water resources.

Under such circumtances, advances in technology in general and technology of remote sensing and GIS for water resources management in particular has allowed combination of remote sensing data and field measurements to monitor and evaluate components and status of pollution in a large scale quickly and accurately. This paper will describe the technology solution for capability of detecting the water pollution components from satellite data and the results in database establishment applying remote sensing and GIS technologies in environmental pollution monitoring and warning caused by waste water from industrial zones and urban areas. From that, warning on risk level and vulnerability of water pollution caused by waste water from industrial areas and urban areas in northern key economic region was performed to serve an environmental monitoring system, from national to local scale.

2. METHODOLOGY

2.1 Data

Input data for geodatabase including: SPOT imagery (figure 1), topo maps scale 1:25000 -1:10000 in VN2000 projection, landuse maps, environment monitoring observation data, statistics data of economic zone (location maps, analysis report of field observed points, maps of waste water system in economic zones, status reports on functions and processing capability of factories, waste water processing function zones..), related document of on-going projects, environement observation reports for 7 provinces in the Northern key economic region from 2003 to 2013.

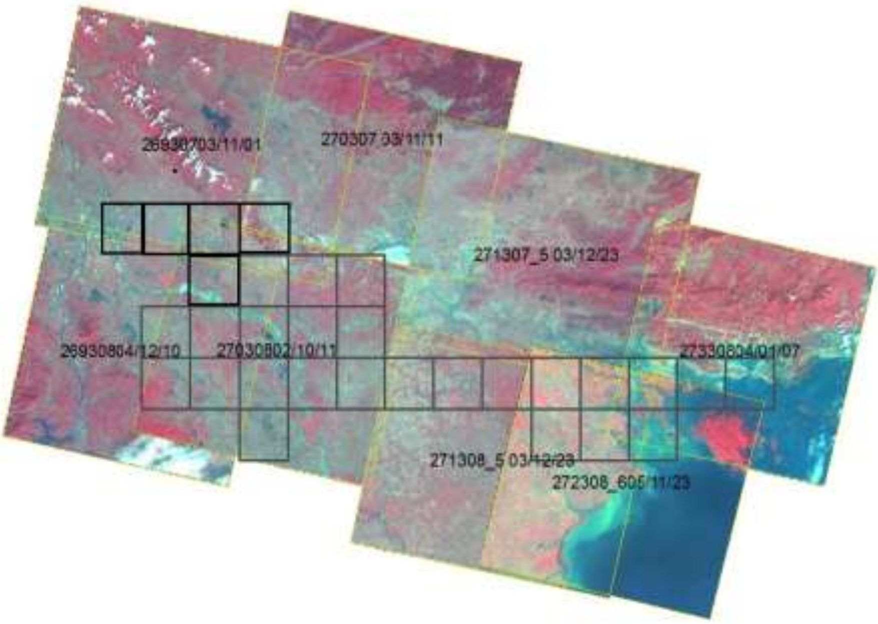

Figure 1: SPOT5 imagery block used in the project

2.2 Database analysis and design

From information collected on the Northern key economic region as well as the existing map data, we analyzed the current situation and choose the necessary data for management of surface water contamination and from that to build database framework using GIS technology in which including spatial data and attribute data. The relational database included data tables which were linked to other and normalized according to standards of relational databases.

These two components must be linked together via a feature code that a feature only has a single object code. Using an unique identifier for each geographic feature of landuse database, changes in water pollution from industrial or urban wastes, presented at scale 1: 25,000, four components are located contiguously. In which, the first part consisting 4 characters is the rate code of the database; the second part including one character is the first letter describes the type of object geometry object class; the third part consists of 4 characters which is the object code in the feature list of establishments; the fourth part is the ID value which is automatically generated when converting data into the geodatabase.

2.3. Building and updating base geographical database

A base geographical database used for the whole project is an important factor for data intergration. Based on current status survey of geographic data, base geographic database was constructed from latest topographic maps scale 1/25000, and updated a number of major changes in the field. This would be the base to build thematic geodatabase later. Geographic database was built according to standards issued by the Ministry of Natural Resources and Environment.

Standardizing and updating topographic database includes reduce unnecessary contents of topographic maps and revision of changes over satellite images and other materials.

The geographical background factors including math class group basis; Traffic; Hydrology; Topography; Levels of administrative boundaries; The object of economic, social and cultural importance; Current status of residential areas, industrial areas, vegetation areas.

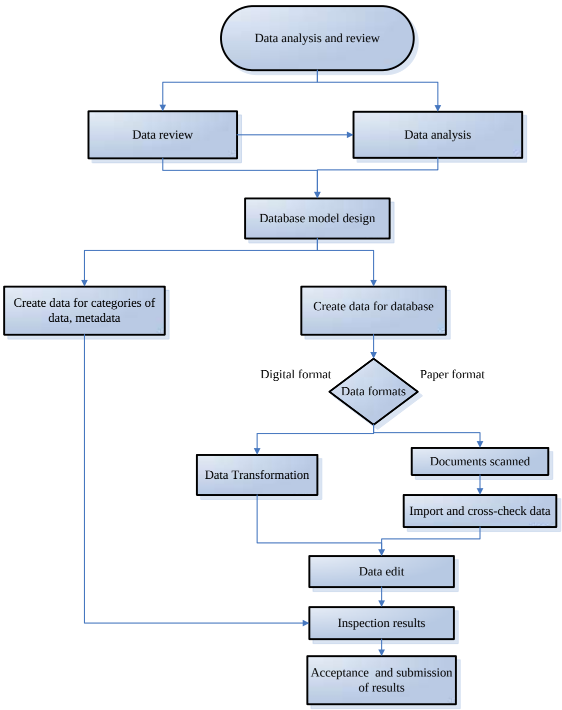

Figure 2: Process flowchart for database establishment

Figure 3: Location of water discharge at Khai Quang industrial zone- Vinh Phuc porvince

2.3 Extracting and updating status pollution information from remote sensing data

2.3.1. Field observation, sampling and water quality analysing

We conducted a detailed survey of the wastewater discharge at industrial parks and urban wastewater receiving river systems in the study area. The survey results for each area included statistical, processing, synthesis, classification reports for each object and summarized for every province in water use exploitation and discharge of wastewater into water sources.

Before conducting sampling, it was needed to determine the discharge location and evaluation, inventory pollution sources, determine the scope and encompass the affected area. In the framework of this project, the sampling and analysis of water quality focus on industrial zones, urban wastewater discharge system and serves for the use of remote sensing technology to detect and identify level of some water pollutants (TSS, BOD, COD, DO, PP, ...). All the sampling will be 2 times conducted during project implementation to analysis and evaluation.

Spectrometry was carried out for three types of surface layers: wastewater at the outlet; clarifier effluent at the wastewater treatment plant; sewage water mixing with the receiving water; water at the source point position of the receiving water; surface water on a confluence of river systems, swamps, lakes and receiving water around industrial areas and urban centers.

2.3.2. Remote sensing image processing for surface water pollution

First of all, we carried out preprocessing for calibration of satellite image receiver, atmospheric, high angle solar radiation on satellite imagery. After that regression analysis using surface reflection and field spectrometer values was performed. Determining the quantity and order as well as the proportion of each band involved to find a suitable mathematical function for the combined images and creating concentration value image for each component of pollution; Identifing, building interactive models for each experimental area. From that, concentration values images for each component of pollution by means of regression value of reflection on the concentration of pollutants measured in the field. Finally, the combination images were created as a high class image of some components of surface water pollution.

2.3.3. Trend analysis and updating pollution information

After creating information layer on the current state of industrial parks and polluted areas from industrial wastewater and urban during the period 2003-2005 and 2010-2012, data processing and calculation of volatility the level and composition of pollution by analysis tools in ArcGIS software system. Selection criteria represent movements of water pollution through two periods is the sum of three pollution parameters were calculated through satellite images, including unpolluted waters, polluted waters and serious polluted water.

3. RESULTS AND DISCUSSION

Database of status and development of pollution from industrial waste and urban was a management and storage information system in digital format. Data of space value is defined location of objects in a unified coordinate system and attribute values describing the nature, spatial relationships between objects.

Database included thematic information layers in vector format, image data in raster format and the other information with the associated attribute information. These data was collected from different sources, through the process of analyzing, processing, standardization and editing to extract maps, statistical tables which can be displayed on screen or printed on paper.

Structural model of database for status content pollution and its changes in the waste water pollution from industrial zones, and urban of northern key economic region was stored in File Geodatabase (* .gdb) of ArcGIS software. Feature dataset includes 9 feature corresponded to 9 layers of data: KhungCoSo, RanhGioiHanhChinh, DiaHinh, ThuyHe, GiaoThong, DanCuCoSoHaTang, HienTrangONhiem01, HienTrangONhiem02 DienBienONhiem and in each dataset contains the Feature Class. Class groups and the corresponding classes were designed to create Domain and enter the domain values for the properties of the object.

Geographic database system consisted of such feture classes: Framework, Topography, Hydrology, Transportation, Residentials, Administration includes all 3 levels: provincial, district and commune.

Status contents were overlaid on the general base information to ensure the overall logic of information. Such factors as industrial and contaminated sites was shown by the method of zoning (when a large area to be plotted in percentage) and notation (if not delineated are in proportion). Each region or each symbol is represented by a different color and attached by additional letter (number). Current land use contents were presented as follows: residential, hydraulic system, vegetation cover, agricultural, industrial park (industrial parks, factories, enterprise, large production base, drain discharge, waste water drainage, sewage treatment tanks), pollution data (pollution of industrial wastewater and urban).

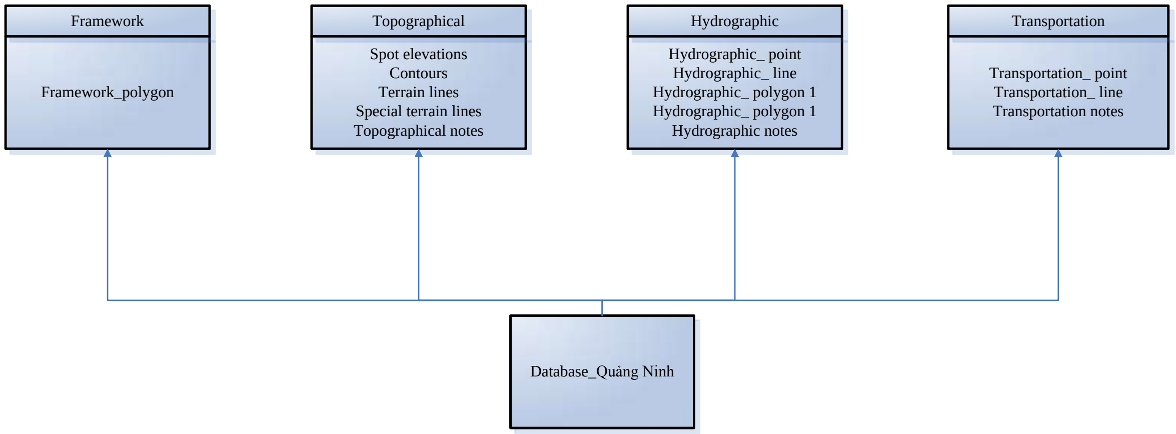

Figure 4: Geographic Database Structure

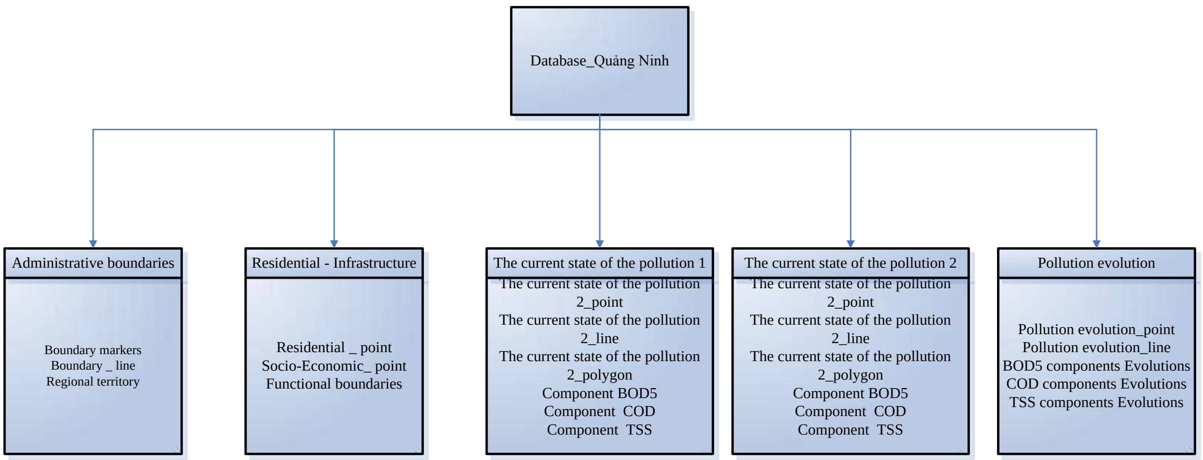

Figure 5: Thematic Database Structure

Polution trend information system included of two groups: monitoring sampling points of environmental parameters on the period from 2010 to 2012 and trend of water pollution through 2 periods , as follows:

- The sampling points of industrial wastewater
- The surface water sampling
- The groundwater sampling
- Unpolluted waters area through two peroids
- The contaminated water area through two periods
- The severely contaminated water area through two periods
- The decreased water pollution area by 1 level (from polluted to unpolluted)
- The decreased water pollution area by 1 level (from the serious polluted to remaining

polluted)
• The decreased water pollution area by 2 levels (from the serious polluted to unpolluted)
• The increased water pollution area by 1 level (from unpolluted to polluted)
• The increased water pollution area by 1 level (from polluted to serious polluted)
• The increased water pollution area by 2 levels (from unpolluted to serious polluted)
• The lack of data area

4. CONCLUSION AND RECOMMENDATIONS

The results showed effectiveness of the remote sensing technology application in combination with GIS for monitoring water pollution from industrial and urban water waste. Information for detecting and warning on contaminated areas was provided in large area at the same time with details to meet the requirements of regulators in monitoring and management of natural resources in general, and water environment in particular. The information provided in such an objective, rapid, regular way for forecasting and warning water pollution and proposing effective and in-time solutions. The multi-satellite data allowed information extracting on status and changes over time.
However, in the future, for updating frequently and sharing easily for multi-users, it is necessary to establish additional modules to automatically update data, generate reports over time and user levels for online sharing publically and support two-way interaction that allows users to participate in monitoring and pollution warnings.

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