STUDY GROUND WATER RESOURCE ON RED RIVER DELTA ZONE BY REMOTE SENSING AND GIS

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ABSTRACT

Recently In field of natural resources research, remote sensing method and GIS have apply widely. Because of this method assistance, the investigation of natural conditions, natural resources will be carry out rapidly and favourable. Especially some areas where the topography is complicated therefore field observations cope with many difficulties. In this situation, the application of remote sensing method brings many advantages.

Remote sensing method seem to be efficient for investigating water resources field. With this method, researcher can get easily general information about features of topography, geomophology, geology in order determine ground water aquifer for different purposes.

Institute of Geography has get some results from applying remote sensing and GIS method in investigating water resources included ground water. Our report is synthetic based on all previous results of Institute and my experiences in applying remote sensing and GIS technique for investigating ground water resource.

1. INTRODUCTION

The coastal zones of Red river deltas were chosen for the pilot project occupies an area between $106^{0}00$ and $107^{0}00$ east longitude and $19^{0}45$ and $21^{0}00$ north latitude.

The Red river delta has a tropical climate with cold winters. There are two seasons: cold and hot. The cold season is from November to April and hot season from May to October. The average temperature is 23^{0}C. The annual average precipitation varies from 1.600mm to 1.800mm.

The area selected for the project work cover an area about 1200 sq.km having the major tributaries like Song Hong river, Song Da river and Thai Binh river. The major towns are like Quang Ninh, Thai Binh, Nam Dinh, Nam Ha and Hanoi capital, Hai Phong city.

2. MATERIAL USED

The data used in this study is included The data used in this study is included the following: Landsat MSS scene (available in a series from 1984 to 1988), SPOT prints on a scale of 1:250,000 images, Soyuz photos, topographic maps and ground-truth data.

3. METHODOLOGY

As a rule, investigations using remote sensing techniques for ground water identification should be based mainly on the visual interpretation of black-and-white and false colour prints or the interpretation of multispectral films with a colour viewer.

Due to the lack of a field check period, the interpretation results were checked against geological archives and information accumulated from conventional investigations on geology and ground water.

Because almost all of the area study is gentle slope, therefore the interpretation and the compilation of the final maps were conducted in the following order:

- Lithology interpretation
- Structural interpretation
- Vegetation cover interpretation
- Extrapolation of the interpretation results and identification of the different ground water bearing units
- GIS analysis
- Comparison of the result with ground truth information
- Compilation of the final maps

4. FINAL RESULTS

4.1. *By remote sensing study and field data*

On the final ground water maps compiled for the study area, the following ground water bearing units were defined:

* Moderate in ground water (recent fluvial, fluvial-marine and/or fluvial-marine-lacustrine accumulative deposits) consisted sand medium side to small side, occupy larger in area study, q = 0.4 l/sm to 5.0 l/sm.

Ground Water type: Cl-SO_4-HCO_3, Cl.

* Aquiclude (recent marine and/or marine-fluvial-lacustrine accumulative deposits) consisted sand small side to medium side, appear in north area study, q = 0.03 l/sm to 0.3 l/sm.

Ground Water type: Cl-HCO_3, HCO_3-Cl.

* Moderate in ground water (recent fluvial-marine and/or eolian-marine accumulative deposits) consisted gravel, sand medium side, thickness 10-15m to 70-80m in Thai Binh province, appear in central area study, q = 0.03 l/sm to 5.9 l/sm.

Ground Water type: HCO_3-Cl, Cl-HCO_3.

* Aquiclude (Neogene cemented alluvial deposits) composed of conglomerates and gravelite interbeding with some lenses of coal shale, show up in northeast area study, q = 0.2 l/sm to 3 l/sm.

Ground Water type: Cl.

* Aquiclude (Triassic cemented alluvial deposits) consisted conglomerates, gravelite, sandstone, shale, appear scattered in the area study, q = 0.1 l/sm to 4 l/sm. Water had low pressure with good quality (HCO_3-Cl)

* Scanty in ground water (karst fissure zones of Triassic limestones) consisted conglomerates tuf, sandstones, shale and limestone. Appear in southwest area study, q = 0.6 l/sm to 3 l/sm.

Ground Water type: HCO_3-Cl

* Scanty in ground water (karst fissure zones of Carbon-Permian limestones) consisted limestone. Only appear in northeast area study, q = 0.1 l/sm to 3.92 l/sm, but almost salt water, therefore possibility of supplying fresh water limited.

Ground Water type: Cl

* Scanty in ground water (karst fissure Devonian sandstone and shale) consisted aleurolite, sandstone, shalestone, quartzite shaped, sandstone with intercalation of some limestone lenses. Appear in Hai Phong city, Do Son province, q = 0.03 l/sm.

Ground Water type: HCO_3-Cl, Cl-HCO_3.

* Moderate in ground water (karst fissure Silurian-Devonian sandstone and limestone) composed of sandstone, quartzite shaped sandstone, aleurolite, shale with intercalation of some limestone lenses, schist and gravelite. Only show up around Kien An township, q = 0.3 l/sm to 5.29 l/sm.

Ground Water type: HCO_3-Cl.

* Aquitard (Proterozoic crystallized schists) composed of micaschists, quartzite micaschists, gneiss, crystalline. This unit appear in south area study and this unit had not ground water.

As for digital processing, digital image analysis may be divided into two main activities: image enhancement and image classification. Algorithms such as histogram modification, spatial filtering, spectral band combination, nearest neighbour and parallelepied are usually used.

In order to reduce the processing time, algorithms were selected for a sample area and field checking was carried out on the same. If the result were good, these algorithms were used for the whole scene. If not, other algorithms were selected.

4.2. *By database organisation and analysis*

To fulfil the set objective of the present study, suitable methodology was carried out. It is also inevitable to create a data compatible to the methodology. Thus it becomes mandatory to thoughtfully organise the database to enable smoother analysis and trying out every possibility of inter-thematic and inter class dependencies and variability operating in nature. GIS, is the most powerful tool to handle all types of spatial and non-spatial data. This is an attempt to use the capabilities of GIS (MapInfo 6.0 and ILWIS 3.0) along with decision support system to generate the output for groundwater potential zonation.

Thematic maps such as geology, geomorphology, soil map with vegetation cover, generated after visual interpretation were closely scrutinized and then digitized. The digitized

maps were then edited and rasterised to suite as an input variable in GIS analysis. This whole process has given an output of digital database required for the study.

4.2.1. Analysis for ground water potential zonation

The input layers, which mainly considered for the analysis of ground water potential zonation are Geology, Geomorphology, Soil map with vegetation cover. There are several methods available. Here an attempt has been made to use Multi Criteria Evaluation (MCE) technique which allows continuous factor, to combine weights linearly.

4.2.2. Create weight tables

One of the classic problems in decision theory or multi-parameter analysis is the determination of the relative importance (weights) of each parameter with respect to the other. This is a problem, which requires human judgement supplemented by mathematical tools. As all parameters cannot be weighted equal for the suitability assessment, it is essential that a weighed method needs to be employed where the relative importance of the parameters defines the weight table.

TABLE No.1 WEIGHT GEOLOGY

GEOLOGY	**WEIGHT**
Thai Binh formation: marine fluvial origine containing grey, aleurite, clay.	5
Hai Hung formation: marine fluvio-marine/marshy marine origin.	4
Sandy deposits of marine-eolian/marine origin including coastal ancient.	5
Dong Ho suite: composed of conglom-erates and gravelite.	3.5
Hong Gai suite: composed of conglom-erates, gravelite, sandstone, siltstone.	3.5

GEOLOGY	WEIGHT
Dong Giao suite: composed mainly of limestone, marlstone	3
Limestone	3
Aleurolite, sandstone, shalestone, quar-tzite shaped sandstone.	3
Xuan Son formation: composed of sand-stone, quartzite, aleurolite, shale.	4
Song Hong complex: composed of micaschists, quartz micaschists, gneiss.	2

TABLE No.2 WEIGHT GEOMORPHOLOGY

GEOMORPHOLOGY	WEIGHT
Overall denudation slopes of residual mountains.	2
Accumulative demolitian alluvial piedmonts.	3.5
Dissolvent landforms on cacbonate rocks	2
Modern alluvial plains	4
Elevated fluvial-marine accumulative deltaic plains often covered with thin alluvium.	4
Low-lying deltaic plains.	4
Elevated marine fluvial accumulative plains.	5

GEOMORPHOLOGY	WEIGHT
Low-lying deltaic plains.	4
Elevated marine fluvial accumulative plains.	5
Low-lying marine fluvial accumulative plains.	5
Accumulative plains of multive genesis	5
Biologo-marine accumulative plains.	3.5
Karine-fluvial accumulative tide flooded beaches.	4
Elevated marine-accumulated ramparty	4

TABLE No.5 WEIGHT SOIL

SOIL	WEIGHT
Old marine sandy soils.	4
Mangrove saline soils.	3.5
Strongly saline soils.	3.5
Moderrately and slightly saline soils.	3.5
Moderrately and slightly acid-sulphate soils.	3
Recent alluvial soils.	5
Alluvial soils.	4
Grey alluvial soils.	4

SOIL	WEIGHT
Red yellow mottling alluvial soils.	3.5
Pale yellow soils on sandy stone.	3

4.2.3. Weight map preparation and ground water potential zonation

Following the above steps the individual class weights were assigned in attribute table of each maps and six attribute maps named as weight geology, weight geomorphology, weight soil were generated using the operation “Attribute Raster”. These maps have been put in the linear combination equation to obtain the final weight which is as follows:

Final Weight = (weight geology + weight geomorphology + weight soil)

The output thus generated is a final weighted map having the weight values ranging from 1 to 15. This map is further classified by using the operation Slicing in to four classes as follows:

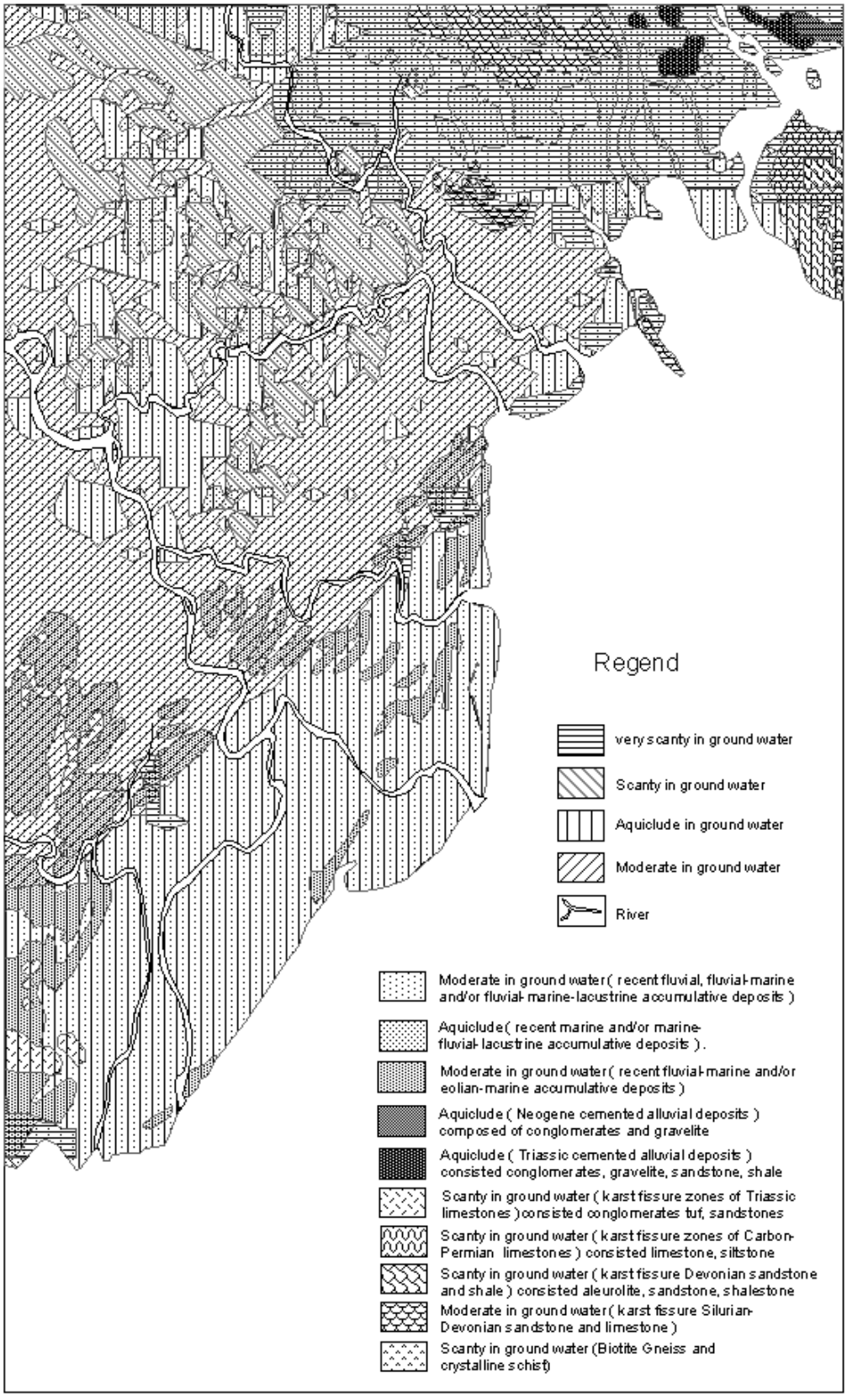
CLASS	WEIGHT VALUES
Moderate in Ground Water	10 to 15
Aquiclude	6 to 10
Scanty in ground water	4 to 6
Aquitard	1 to 4

5. CONCLUSION

Remote sensing techniques are an important tool for investigating the ground water of deltaic plain. The vigorous, continuously developing (under humid tropical conditions) hydrogeological phenomena are reliable indicators for identifying the type, formation and distribution of ground water in an area.

For application in ground water investigations, false colour composites have advantages over black-and-white images, allowing more detailed and accurate interpretation.

HYDROGEOLOGICAL MAP OF RED RIVER DELTA ZONE



6. REFERENCES

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