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Land Cover Change Detection Using Supervised Classification Method of Wuhan in 1991 and 2002

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Abstract: An image of a big city such as Wuhan can best be represented by a model. The image we propose to analyze here is a raster data covering a small part of this big city of China in Hubei Province. We use two times satellite images (1991 and 2002) to examine urban change over that period. To give our study a concrete form, we need classification methods using ER MAPPER software. Finally the result we need to reach is to obtain the impact of the different and main features spreading in the urban area of Wuhan.

Key words: Spatial modeling, thematic mapper, supervised classification, unsupervised classification

INTRODUCTION

The subject we propose concerns spatial modeling of a party of Wuhan city using satellite images (1991 and 2002). The main aim of this study is to show the increasing development of Wuhan City from 1991-2002, through satellite images analysis. In fact this urban space is a statistical surface with green lands, commerce or business places, roads, schools and residential buildings. Wuhan is the biggest and capital city of Hubei province, populated with around 10 million inhabitants. Our subject is about a party of Wuchang.

The urban growth is the result of economic development and social revival. No secret that in China we attend at a great moment of development of industry and trade. That phenomenon has effects on all the cities especially those which are province capitals such as Wuhan. It appeared according to studies that Wuhan urban area has changed. The control of urban sprawl is important, because it allows to care of spatial lack. Urban growth control is a duty for government.

Objective: The main aim of this study, is to show the changes that have taken place in Wuhan urban area and to analyze the importance of each feature. Spatial modeling (DeMers, 2002) occupies a great place in geological and geography studies. In order to succeed in spatial modeling we need some tools to allow us to explain and understand the behavior of the different features existing in the space such as image and computing. For that the main tool we need is Geographic Information System (Tomlin, 1990).

MATERIALS AND METHODS

Wuhan populated with 9 millions inhabitants is the main city and the capital of Hubei province located in the center of People republic of China. Simple city 10 or 20 years before the city Wuhan appears today as a modern city divided in three main places: Hankou, Hanyang and Wuchang. Our subject is about a party of Wuchang extending on 36. km^2.

The main aim of the present study is focused on the changes occurred in Wuhan city spatial occupation from 1991-2002. In fact, we consider only the buildings and roads evolution.

- Let's see the main properties of this image.
- We have worked on the followings data.
- Data Type: Raster; Geodetic Datum: WGS84; Coordinate System Type: UTM.
- Map Projection: UTM50; Number of Bands: 3; Number of Lines: 1393.
- Number of Cells per Line: 1393; Cell Size X: 4 m; Cell Size Y: 4 m.
- EN: 247711,91E; 3381516, 30N; Latitude: 30°32′21.84′′N; Longitude: 114°22′13.5′′E.
- Metric distances: 5.48-5.59 k ms^{-1}.

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- Data Type: Raster; Geodetic Datum: WGS84; Coordinate System Type: UTM.
- Map Projection: NUTM50; Number of Bands: 6; Number of Lines: 202.
- Number of Cells per Line: 202; Cell Size X: 28.5 m; Cell Size Y: 28.5 m.
- Entering the image we have.
- EN: 693636,89E; 3461095, 54 N; Latitude: 31°16′5.05′′ N; Longitude: 113°2′1.85′′E.

RESULTS AND DISCUSSION

The analysis of this image the town of Wuhan concerns the remote sensing. Each object emits electromagnetic energy because of the agitation of the particles charged which are present in any matter. This energy is emitted by the objects, but it can also be transmitted, absorbed and be reflected by these same objects. The remote sensing exploits this property: the analysis of the characteristics of the electromagnetic spectrum reflected by the objects (their spectral signature) allows to a certain extent to determine certain properties of the objects.

The sensors used in remote sensing make it possible however to widen the field of analysis to parts of the electromagnetic spectrum going well beyond the visible light. This enables us to model (on a regional scale) and to evaluate (on a micro scale of the street and the trees) the impacts of the parks on the urban harmful effects and to define scenario of installation where the vegetation plays the part of barriers anti noise and of filters to the air pollution.

Usually the higher resolution of the Landsat TM facilitates better recognition of many individual buildings, downtown layouts, shopping centers, industrial complexes and other landmarks in a city. From the image of Wuhan city we recognize the area. In fact, here the image is about a part of Wuchang, covering 30.63 km^2. In its original state we recognize the main streets, buildings, big shopping centers, green spaces with big wooden places, artificial lakes and other sites. So, we can draw the map for most urban areas. When we enlarge the image to fill the screen, we can make a spatial modeling of all the features represented in Wuhan city especially in this area of 30.63 km^2.

Using algorithm, we have the different bands allowing us to distinguish the roads or streets, the buildings, the green spaces and even the water spaces or lakes. In blue spectrum, the buildings reflect better. In fact in Wuhan image, we have, according to our area of study, many buildings bordering the road axis. Then we distinguish clearly in the image, a big square extending around 200 m. This square is Luxiang Shopping Square, a famous place in Wuchang. From it we have many axes. In red spectrum green space or vegetation reflects better and its natural color. In our image, Wuhan is the city of vegetation. Many green spaces or even wooden areas exist there.

Usually, in an aerial image the naked soils appear in green. In our image these soils are other sites? For the images of Wuhan, according to the data we have, let's make analysis.

Two factors affect the resolution, or size of features that can be detected, in the digital image of the aerial photograph. These factors are:

On Wuhan TM urban image, we have green lands, country lands, residential area and business places.

As most of the big cities in the world, green lands are important. Here the green spaces are located in mountains, around the water points. Also, some trees are located on the big and main roads.

In fact, the most area of the city is occupied by urban features. Urban areas are residential, business buildings areas and main roads.

According the metric distances given by the image measurements, we have 12.15 km of green lands on the top of mountains (Chang *et al*., 1995). Other green spaces like trees garden of flowers a long the main streets are known by their grey appearance. That means Wuhan is wooden city. The business places and other buildings such as universities occupy the remaining spaces in our study area.

Classification: The first element allowing us to model or to compare our different features is the classification. To succeed that we used ER MAPPER classification tools (Thomas and Ralph, 2000). In fact we have two methods: Unsupervised classification and the supervised classification. Allow we use the second one.

Here are the results of classification. In these images the changes appear clearly.

- For example the green spaces in 1991 occupied much more areas than it is in 2002 (Fig. 1 and 2).
- Looking at the water classified images during the 2 periods 1991 and 2002, it appears that many areas firstly occupied by water were replaced by other features such as buildings (Fig. 3 and 4).
- Still about our classification, we have in 2002 an urban traffic very dense than it was in 1991. In fact in 1991, we had only one great axis for this part of Wuhan. In 2002, the area covered by the roads is

Fig. 1: Green spaces in 1991 according to ER MAPPER Supervised classification, Note: Green: Green spaces; Black: non green spaces

Fig. 2: Urban areas 2002: Green areas according to ER MAPPER Supervised classification, Note: Green: Green spaces ; Black: non green spaces

very important showing us the development of the main changes known from 1991 to 2002 (Fig. 5 and 6).

- Finally, there is a great change between the main features located in this urban area. It appears for 1991, that in the urban area the buildings were scattered in a huge space. And it existed between them and some empty spaces which have been filled up in 2002 (Fig. 7 and 8).

Fig. 3: Water spaces in 1991 according to ER MAPPER image Supervised classification, Note: Blue: Water; Black: Non green water

Fig. 4: Urban areas 2002: Water according to ER MAPPER Supervised classification, Note: blue: Water; Black: Non green water

Indeed in 2002, Wuhan is a real big city, with a traffic system more dense, with great buildings and less empty spaces.

Statistics values: According to our ER MAPPER classification we got statistics values about each feature and year (Fig. 9).

Here are these statistics values according two aspects, which are typicality and posterior propbability (Table 1).

Fig. 5: Roads spaces in 1991 according ER MAPPER Supervised classification, Note: Red: Roads; Black: Non roads

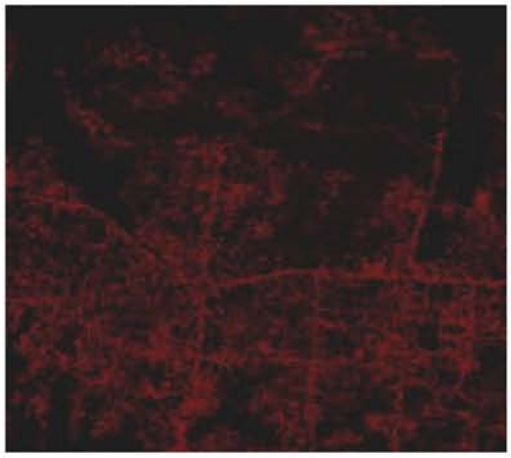

Fig. 6: Urban areas 2002: Roads according ER MAPPER Supervised classification, Note: Red: Roads; Black: Non roads

Features location
Green lands location
Wooden spaces:

- There are 2 big wooden spaces situated by the north of Luxiang shopping at 2.28 km according to the measurements given by algorithm analysis through cells coordinates. These wooden spaces occupy the tops of hills, Nan Wang Shan and Fujia Shan, Miao shan and Yu Jia Shan. On the north are situated less important green spaces, Fengduo shan.

Fig. 7: Urban areas in 1991: Buildings according ER MAPPER image Supervised classification

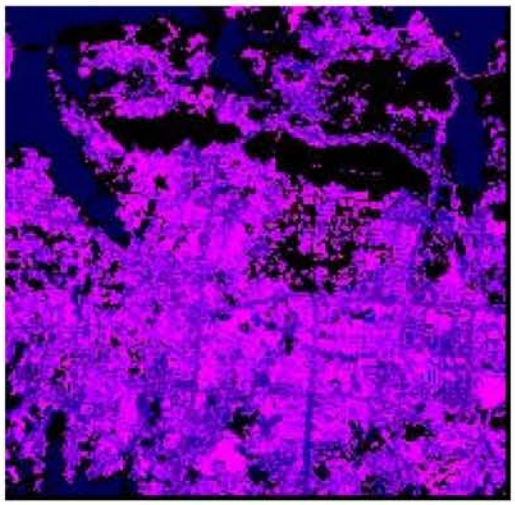

Fig. 8: Urban areas 2002: Buildings according ER MAPPER Supervised classification

- More at the north east of these wooden spaces, on another tops of hills, is green land situated at less than one kilometer from the first and around 3.32 km from Luxiang Shopping square, Futou Shan, Fengzheng Shan and Tuan Shan.

At the opposite of this second wooden place we have small wooden spaces less important.

- The third wooden space is in a wet zone among water. It looks like an island at around 4 kms from Luxiang Shopping in North West.

Table 1: The statistics values according to the aspect, Typicality and posterior probabity

	Standard deviation 1991	Mean 1991	Standard deviation 2002	Mean 2002
Typicality				
Roads	9.211380	2.993358	25.195317	19.665229
Water	17.200924	6.437996	30.061162	11.722405
Green spaces	8.258284	20.072753	25.448149	14.094770
Buildings	25.180406	25.180406	32.254492	36.592957
Posterior probability				
Roads	13.880563	4.764165	25.860636	23.931404
Water	36.230762	17.268160	30.061162	11.722405
Green spaces	44.914340	35.177899	40.836134	25.896530
Buildings	45.327027	45.327027	34.875956	40.521223

Fig. 9: Topographic map with the main features of our classification (which year 1984)

This zone as parks is situated on the other arm of the River Yangtze. It includes 4 great sets. Two first more in north occupying the top of two hills separated by narrow paths. In front of them two others occupy the hills little extended and less elevated, Xujia shan and Dian'an shan. In the south of these 2 sets we have the last wooden zone in this space of study. It covers more than 2 km and is about 1.30 km wide.

Water points: The 1991 map of Wuhan shows that there were many natural water points in most parts of the city.

Wuhan is indeed a low zone with many swampy areas. In fact the topographic map shows that the highest hill tops are between 139.3 m and 149.5 m above sea level. Certain points are located at the lower part of the sea level with curves which vary from -4.8 m has -21.6 m?? The second chart of Wuhan of which we have for the identification the aspects present some similarities with the first has some exceptions near?? The similarities relate to the green zones, the constant and permanent presence of the water points and the habitat. Some parks are here more spatially scattered and do not occupy in the majority of the cases of the tops of hills. The water points are more numerous and they occupy more space.

Urban areas: In this part of the city, the main urban areas are buildings such as big shops, universities, factories, roads etc. We have chosen Luxiang as the center.

CONCLUSION

The comparison of ETM 1991 and TM 2002 images shows us:

TM and ETM images even appearing really fuzzy and can through classification allow a confident analysis.

However, in using image classification, (Verbyla and Chang, 1997). It becomes possible to know exactly the importance of each feature in Wuhan city during these past ten years.

The statistics show a growth of the urban features such as buildings and roads. The immediate results of this phenomenon are the reduction of natural green areas and water spaces.

For example, in 1991 only 10% was occupied by buildings contrary at 33% in 2002.

In fact, the different values of mean and standard deviation show that this part of Wuhan City has experienced 50% of its urban development during the last 10 years, all features taken into consideration.

According this study, it should be important the decision makers of Wuhan take in consideration the increasing of urban sprawl, in order to control it.

REFERENCES

DeMers, M.N., 2002. GIS Modeling in Raster. New York: Wiley.

DeMers, M.N., 1997. Fundamentals of Geographic Information Systems, Wiley New York.

Tomlin, C.D., 1990. Geographic Information Systems and Cartographic Modeling. Englewood Cliffs, NJ:Prentice Hall.

Thomas Lillesand and Ralph W. Kiefer, 2000. Remote sensing and Image Interpretation. 4th Edn. New York Wiley.

Verbyla, D.L. and K. Chang, 1997. Processing Digital Images in GIS. Santa Fe, NM: On Word Press.