USING TM IMAGE TO ESTIMATE THE QUANTITY OF SAND SEDIMENT IN POYANG LAKE: A CASE IN NANJI XIANG VILAGE

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ABSTRACT:

In this thesis, we build a relationship between Remote Sensing information and water depth to calculate and analyze the elevation of the riverbed. Combining with the water level elevation data, we can obtain the height being raised by soil loss and infer the soil loss quantity in different years. Nanjishan wetland which locates in the middle of Poyang Lake is selected as the research area. We choose three TM images which were taken by Landsat in almost same temporal season but in different years as the research object. In order to find out the soil loss quantity change status conveniently, we pick out the year of 1976, 1988, 2000 as the research duration. We first do some preparation on the original TM images to make sure each corresponding bands to be normalized. Because of the band 1, band 2 and band 3 of TM image can detect the water body and water depth in shallow water surface, we uses this characteristics to build a formula to obtain the depth of water in the riverbed. We choose three-band linear regression algorithm to calculate the water depths. Because the three-band linear regression algorithm can attenuate the affection of water quality and riverbed type. So we get the water depths of each year in 1976, 1988, 2000. At last we get the result, that during 80s and 90s, the sand accumulation in research area is more serious than that during 90s and 2000s.

1. INTRODUCTION

It is an effective way to obtain the depth of water by using the technique of Remote Sensing. The technique can solve the problem of surveying the flooded water, achieving the first hand data of water cover area, as well as assessing flood distribution hazard (D. Zhang, W. Wang, Y. Zhang, 1998). The way is suitable not only to the wide sea area, but also to most Chinese inland lake area, especial for the shallow water covered alluvion, bottomland in low water level, and swampy water area. The way is also to be used to analyze the coast line evolvement, calculate water conservancy project earthwork, assess, monitor and dredge up reclamation of flooded or marshy land (Y. Zhang, 1998), and so on.

Poyang Lake is the biggest fresh lake in Jiangxi province, P.R.China. Being affected by Yangtze river and other five rivers, Poyang lake always appears the phenomenon of a flooding basin and a low water marsh area. Soil loss is very serious in Jiangxi province (X.L. Chen, et al, 2007). Most of the loss sands will converge into Poyang Lake. Some will accumulate in Poyang Lake, some will flux into Yangtze river. Plenty of sands accumulation raise the riverbed, block the runway, change the watercourse, even lead to bank slide (L.Y. Ma, C.Y. Xiong, W.P. Yi, 2003). All of the effect will destroy the current eco-environment around the Poyang Lake seriously. In this thesis, we build a relationship between Remote Sensing information and water depth by three-band linear regression algorithm to calculate and analyze the elevation of the riverbed.

Combining with the water level elevation data, we can obtain the height being raised by soil loss and infer the sand sediment quantity in year of 1976, 1988, 2000. This method is valuable to monitor the sand sediment in Poyang Lake. It will be helpful for the local government to take measure to develop the complex area of Poyang Lake.

2. APPROACH

2.1 Advance Development in Remote Sensing of Water Depth Technology

At the end of 1960s, a research group from environmental research institute of Michiganite in America started to explore the water depth by Remote Sensing Technology (D. R., Lyzenga, 1978, F J. Tanis, 1984). The members of the group studied the data which is surveyed from the broad sea area by MSS, TM and air-photo and the other multi-spectral data. At last, the group putted forward of Bottom reflection-based remote bathy metric theory (M.E. Nordman, 1990). The theory is the beginning of the remote sensing of water depth technology (D. R, Lyzenga, 1981).

After 1970s, the scholars of all over the word explored more methods to achieve the water depth by remote sensing technology, and worked out a serial of model and approached of water depth survey to map the sea depth in the shallow shore. Given the uniform base of researching area in the sea bottom and the same attenuation coefficient of water body, Jerlov used

a single band to build the model to recover water depth(N. G.Jerlov, 1978). Lygenga worked out a new method, which could make up to the shortage of band ratio to achieve the water depth , to calculate the water depth and to attain the information of water bottom (D R, Lyzenga 1978, 1981). Benny and Dawson (1983) improved the water depth recovery algorithm by special consideration of the attenuation from the bottom reflection (A. H. Benny, G. J. Dawson, 1983). Paredes and Spero used the multi-band to recover water depth according to the different types of bottom bases of sea water (J. M. Paredes, R. E. Spero, 1983). Based on the optical pattern of e exponential attenuation, John and the others inferred out water depth recovery model of multi bands which was not affected by the types of water bottom(M.P. John, E.S. Robert, 1983). Stove constructed the regression formulation between parameters of water depth reflectivity and the actual water depth which was measured by machinery (G. C. Stove, 1985). Clark and others used the method of linear multi-bands to draw out the water depth (R.K. Clark, et al, 1987). Based on a two-flow radiation model, Spitzer and others putted forward some algorithm to recover the water depth from different water bottom bases (D. Spitzer, R. W. J. Dirks, 1987).

In order to attain the more accurate information of water depth , some scholars worked out the combination of different bands to protrude the new information from water depth spectrums. Walker and Kalcic recover the water depth based on the orthogonalization transformation from bands of Landsat imagery (C. Walker, M. Kalcic, 1989). Khan and his colleagues analyzed the principal components of the image to recover the water depth (M. A. Khan, , Y. H.Fadlallah, K. G. Al-Hinai, 1992).

Some scholars in China had studied the similar theories, and practised a plenty of application on remote sensing of water depth. Ying Zhang did the studies on remote sensing methods of water depth by SPOT/HRV, Landsat/TM and NOAA/AVHRR image in the area of Wuchang Lake in Anhui

province and in the Yangtze river estuary. He worked out the terrain beneath the water and analyzed the change of sand flux and sediment (Y. Zhang, 1998). Jiazhu Huang and his team members constructed a remote sensing model of water depth in the Nantong River which is one of the branches of Yangtze River. The output indicated that TM image data have a certain effect on surveying the shallow water depth of Yangtze River estuary which filled with sandiness (J.Z. Huang and Y.M. You, 2002). Ming Chen and his members worked out the segment model of Yangtze River by water depth remote sensing methods. He utilized the water and sand characteristic of Yangtze River estuary to find out that the depth from the research is corresponded with the actual surveyed depth (M. Chen, S.H. Li, Q.F. Kong, 2003). Huhui Zhong and his group analyzed the water depth to achieve the sand sediment around the sea shore by remote sensing and Geo-information system methods (H.S. Zhong and D. Guo, 2000).

2.2 Study Area

Nanjixiang village is selected as the study area (see figure 1). Nanjixiang village belongs to Xinjian County, Nanchang city, Jiangxi province, P.R.China. NanjiXiang village locates at south-west of Poyang Lake, which is 60 km far from Nanchang city and 65 km far from Xinjian County. To the east of Nanjixiang village is Lianghu village of Poyang County and Kangshan village of Yugan County. To the west of Nanjixiang village is Zhugang farm. To the south of Nanjixiang village is Jiangxiang village of Nanchang County. To the north of Nanjixiang village is Zhouxi village of Douchang County. The geography coordination of Nanjixiang village is ranged east longitude from 116°10′33″ to 116°25′05″, latitude from 28°52′05″ to 29°06′50″. The whole area is 300 square kilometre including 47square kilometre marshy land and 227 square kilometre lake area.
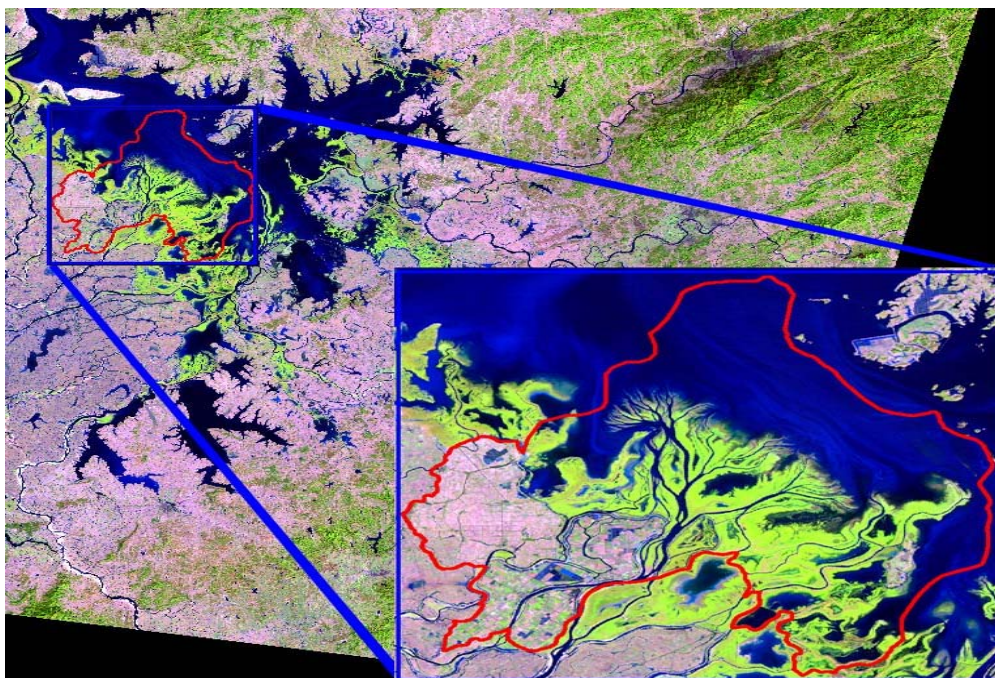

Figure 1．Nanjixiang village around the Poyang Lake

Nanjixiang village is one of the biggest village for conservation wet land in Jiangxi province. The terrain in the south-east of Nanjixiang village is higher than that of the north-east area of Nanjixiang village. There are only 1367 households. The number of population in Nanjixiang village is about 4800.Nanjixiang village is also the estuary of Ganjiang River. When in the season of low water, a plenty of grassland, marshy land, water pool and wetland will take on your eyes. In the flooding season, Nanjixiang village will covered with the flood water which takes a lot of sand to Poyang Lake. The area is abundant of rich wetland resource and wild animal resource.

Nanjixiang village is seleced as the study area not only because of its geography location but also because of its special terrain. Ganjiang River have three deltas in Nanjixiang village. The sand from Ganjiang River is easy to accumulate in the deltas area which will lead to raising the water bed and withering the lake body. The population of Nanjixiang village is very small compared with the others village. So this means that human beings activities have little effect on the study.

2.3 Datasets

2.3.1   The lake bottom relief map: The map was surveyed in 1974, and was published in 1976. The lake bottom relief map is on the scale of 250,000. The distance of the contour line is 1 meter. The data from the map is used to check the actual water depth in the Poyang Lake. The map can also be used to control the points on the TM image.

2.3.2   The land terrain relief map: The map was survey in 1981, and was published in 1984. The map scale is 10,000. The map is mainly used to control the points on the TM image.

2.3.3   TM image data: Three different periods TM image data is selected to study the water depth. They are individually in Oct. 6th, 1976, Apr. 23rd, 1988 and Dec. 7th, 2000. The grey of TM image is used to calculate the three bands linear regression model coefficients. Band1, band 2 and band 3 is selected from TM image to build the model.

2.3.4   Water level data: TM image can achieve the water depth. But the water level is not in the same level in the three different periods. The water depth can't be directly used to assess sand sediment unless the water level is unified. The water level data is surveyed by committee of water conservancy in Jiangxi province (see table 1: water data in study area). The water level is based on the Wusong altitude system.

Time	water level (unit: meter)	Surveying station
Oct. 6th, 1976	13.9	Jiujiang station
Apr.23rd, 1988	12.39	Jiujiang station
Dec. 7th, 2000	11.84	Jiujiang station

Table 1: water level data in study area

2.3.5   Land use map: The border line of Nanjixiang village is digitalized from land use map in 1992. The border line data of Nanjixiang village is used to clip TM image.

2.4 Method

2.4.1   Theory of remote sensing water depth: The method to survey the depth of shallow water by remote sensing technology is dependent on the physics theory that light can penetrate through some part of the water. The different electromagnetic wave with different wavelength has different penetration ratio to atmosphere and different attenuation coefficient to water. So the physical phenomena can be show on remote sensing image by the value of grey. That means the grey of remote sensing image is related with many factors including the depth of water, the reflection of the water bottom, the thickness of water with the suspending impurity, the condition of atmosphere, and so on. When the water body is adequate limpidity with the uniform quality of water bottom and the good condition of atmosphere, the grey of remote sensing imagery has some kind relationship with the depth of water. In the TM image, normally, band 1 can penetrate the deepest thickness in the water. Band 2 has the second penetration to the water. If water is purity, Band 1can reach the depth of water 30 meters, and band 2 can reach the depth of water 10 meters. Although band 2 is weaker than band 1 in penetrating the water, the water depth resolution of band 2 is better than that of band 1. Band 3 can penetrate the water depth 5 meters. Band 4 is weak to penetrate the water body. But band 4 and band 5 can be used to draw out the water surface from TM image (K.C. Di, et al, 1999). This means band 4 and band 5 can distinguish the land from the water.

Poyang Lake belongs to the fresh water. When Poyang Lake is in average water level and low water level, the quality of water is limpidity with little sand and suspending impurity. The light has little effect on the attenuation coefficient in the water. The bottom of the lake is mainly flat sand area. The depth of Poyang Lake is less than 20 meters (S. C. Chen and S.G. Wang, 2002). All the characteristic of Poyang Lake is favourable to survey the depth by remote sensing.

2.4.2   The linear regression models to survey water depth by remote sensing technology: The Linear Regression models have developed from single band model to double band model. The multi band model can inferred from double band model. Although the more bands be used to calculate, the more accurate will the result be (S. Xu, et al, 2006). In the actual application, three-band regression model can satisfy the project.

● Single band model
In the single band model, it is supposed that the attenuation coefficient and the reflection ratio of the bottom basis is a constant when light penetrates into the water. The basic theory is Bouguer theorem, as the following:

$$I = I_0 \times e^{(-\alpha l)} \qquad (1)$$

Where I_0 = light luminous flux from water surface

I = light luminous flux in water depth of "l"
meters

l = photics length

α = attenuation coefficient of light

The reflection intensity of single band indicates the depth information of water. So the "i" band radiation luminance which received from remote sensing sensor can be denoted as the following:

$$L_i = L_{si} + \tau_i R_{bi} e^{(-k_i f Z)} \qquad (2)$$

Where L_{si} = radiation luminance in the deep water

L_i = the "i" band radiation luminance

τ_i = radiant intensity of sun

R_{bi} = reflection ratio of water bottom

k_i = attenuation coefficient of light in the water

f = path length in the water (normally the value is 2)

Z = the depth of water

The formula (2) can transform into formulate (3):

$$Z = (1/fk_i)(\ln R_{bi} - X_i) \qquad (3)$$

Where $X_i = \ln[(L_i - L_{si})/\tau_i]$, which is just related the grey of image and radiant intensity of sun.
So formula (3) can be expressed as single band linear regression model, that is following:

$$Z = AX_i + B \qquad (4)$$

Where $A = -1/fk_i$
$B = \ln R_{bi}/fk_i$

● Double band model
In the actual application, it is difficult to meet with the absolute limpidity water and uniform bottom base. So utilizing the simple attenuation model to calculate the water depth in impurity water and non-uniform bottom base will produce a great error. In order to deduce the error, Paredes and Spero developed the single band linear regression into double bands linear regression model.

It is supposed that the double bands 1 and 2 reflect from the different bottom base A, B, ……, the reflection ratio of the double bands is a constant, that is

$$R_{A1}/R_{A2} = R_{B1}/R_{B2} \cdots \qquad (5)$$

The formula (5) can transform into formula (6):

$$R_{A1}(R_{A2})^{-1} = R_{B1}(R_{B2})^{-1} \cdots \qquad (6)$$

The formula (6) is the special formula to the formula (7)

$$R_{A1}{}^{c1}(R_{A2})^{c2} = R_{B1}{}^{c1}(R_{B2})^{c2} = \alpha \cdots \qquad (7)$$

So the depth of water can be expressed like this:

$$Z = (W_1/fk_1)(\ln R_{b1} - X_1) + (W_2/fk_2)(\ln R_{b2} - X_2) \qquad (8)$$

Where $X_i = \ln[(L_i - L_{si})/\tau_i]$, and (i=1,2)

W_1 = proportion of the band 1

W_2 = proportion of the band 1

And $W_1 + W_2 = 1$

If $C_1 k_1/(C_1 k_1 + C_2 k_2)$ takes the place of W_1 and $C_2 k_2/(C_1 k_1 + C_2 k_2)$ takes the place of W_2, then Z can be changed like this:

$$Z = [(1/f(C_1 k_1 + C_2 k_2)][C_1 \ln R_{b1} + C_2 \ln R_{b2} - (C_1 X_1 + C_2 X_2)] \qquad (9)$$

Where $W_1 = C_1 k_1/(C_1 k_1 + C_2 k_2)$
$W_2 = C_2 k_2/(C_1 k_1 + C_2 k_2)$

Formula (7) can transform into formula (10) as the following:

$$C_1 \ln R_{b1} + C_2 \ln R_{b2} = \ln \alpha \qquad (10)$$

Putting formula (10) into formula (9) can get formula (11). Formula (11) is sampler than formula (9)

$$Z = [(1/f(C_1 k_1 + C_2 k_2)][\ln \alpha - (C_1 X_1 + C_2 X_2)] \qquad (11)$$

In order to make formula (11) to be more like as linear regression model, formula (11) can be expressed as following:

$$Z = A_0 + A_1 X_1 + A_2 X_2 \qquad (12)$$

Where $A_0 = (C_1 \ln R_{b1} + C_2 \ln R_{b2})/f(C_1 k_1 + C_2 k_2)$
$A_1 = -C_1/f(C_1 k_1 + C_2 k_2)$
$A_2 = -C_2/f(C_1 k_1 + C_2 k_2)$

From formula (12), water depth is related with X_1 and X_2. That means water depth is related with the grey of image bands. A_0, A_1, A_2 is related with attenuation coefficient of light in the water k_1, k_2 and reflection ratio of water bottom R_{b1}, R_{b2}. Formula (12) is a typical linear regression equation if A_0, A_1, A_2 can be identified. During the practical application, using the grey of image X_1, X_2 and the Surveyed data Z to calculate A_0, A_1, A_2. Once the model has been build up, the model can be widely used in the study area.

- Multi bands linear regression model

The double bands linear regression model can be developed into multi bands linear regression model. Formula (11) can extend into formula (13). Formula (13) can be used to build the relationship with different bands and different water bottom base.

$$Z = (1/f\sum_{i=1}^{n} C_i k_i)(1 - C_1 X_1 - C_2 X_2 - \cdots C_n X_n) \qquad (13)$$

If A_0 takes the place of $1/f\sum_{i=1}^{n} C_i k_i$, A_i takes the place of $-Ci/f\sum_{i=1}^{n} C_i k_i (i \geq 1)$, formula (13) can transform into the linear regression formula (14),

$$Z = A_0 + A_1 X_1 + \cdots + A_n X_n \qquad (14)$$

Where
$$A_0 = 1/f\sum_{i=1}^{n} C_i k_i$$
$$Ai = -Ci/f\sum_{i=1}^{n} C_i k_i (i \geq 1)$$
$$X_i = \ln[(L_i - L_{si})\tau_i](i \geq 1)$$

During the practical application, using more than n+1 groups of he Surveyed data Z and grey value X_0, X_1, ... X_n to calculate A_0, A_1, ... A_n. Putting the value of A_0, A_1, ... A_n back into the formula (14), multi bands Multi bands linear regression model can be constructed. The model can be widely used in the study area to access water depth.

2.4.3   The detail steps:

- TM image pretreatment

Original TM data format is imported to IMG format by ERDAS software. Ground control points are collected from TM image. The corresponding reference points are collected from terrain relief map whose scale is 10,000. All the collected points are used to compute transformations in order to resample or calibrate the image. The type of the correct resampling method is cubic convolution. The method will improve the precision of the calibration image. See to that each pixel shall be corrected within the calibration precision. Only the qualified calibration data can be used to calculate the water depth.

- Clipping the image

Because all the study is in one sheet of TM image, no mosaic will be handled with. The next step is clipping the image. Before clipping the image, all the images and maps shall uniform their coordination system. Here using Nanjixiang village administration border line to clip TM image. The step will get rid of the unrelated data.

- Removing the terrestrial area

Band3, band4 and band 5of TM image can be used to classify the land use into three types. The three types are water area, grass area and terrestrial area. Here using supervised classification method to remove the terrestrial area in different periods. The supervised classification method is ruled by maximum likelihood principle (see Fig 2: TM image of water area and grass area).

- Drawing out the study water area

The image includes just grass area and water area. According to the lowest water level, the water area shall be below the 11.84 meter. DEM data can be worked out from the lake bottom relief map. The contour of 11.84 meter can be drawn out from DEM data. Get rid of the area where is above 11.84 and keep the area below 11.84 as study area. This will make sure TM image can be overlay with each other.

- Working out the three bands linear regression model

In order to work out the value of A_0, A_1, A_2, A_3, grey of band1, band 2,band3 shall combine with the water depth value Z which be measured from the lake bottom relief map whose scale is 25000. So the three bands linear regression model equation can be worked out for three different periods. The most import here is the selected points for value Z. In order to select the reasonable points for value Z, the water area is separated into the deep water area and the shallow water area which is based on the slope in the study area. In the shallow water area, the selected points for value Z shall be less than that in the deep water area, because sand sediment of shallow water area accumulates more than in the deep water area. The suggestive proportion is two to one based on the selected density on study area.

According to Ye's research data, the sand sediment which Poyang Lake accumulates will be 0.0032 meter thick each year (C.K. Ye, H.Z. Zhang, X.Y. Wang, 1991). The value Z measured from the lake bottom relief map can be adopted for the model of 1976. While calculating the model of 1988, the value Z need add 0.03 meter to take the place the original one. When calculating the model of 2000, the value Z need add 0.06 meter to take the place the original one for the same reason. After doing this, the regression equation is more effective according to the value of relation coefficient.

- The new DEM and the fathom line

The value of water depth in each pixel can be worked out, based on the regression model equation and the grey of the image. Theoretically, the value of water depth in each pixel should be close. But in the fact, it is always some pixels that the value of depth is abrupt higher than the other pixels around it. The way to get rid of this kind pixel is selecting a threshold. If the absolute value of the subtraction from the

pixel water depth value and close pixels water depth is out of the threshold, the pixel will remove the water depth value and

not be allowed to calculate DEM. The fathom line can be drawn out from DEM data.

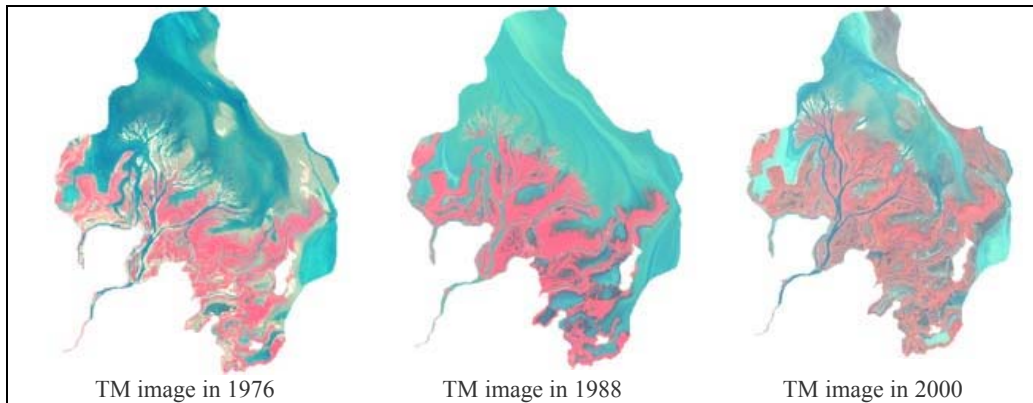| TM image in 1976 | TM image in 1988 | TM image in 2000 |

Figure 2: TM image of water area and grass area

● Calculating distribution map of sand sediment

Using the DEM of 1988 overlay the DEM of 1976 can get the distribution of sand sediment during the year of 1976 and the year of 1988. When on the detail operation, do not forget the different water level between the year of 1976 and the year of 1988. Using the same way can get the distribution of sand sediment during the year of 1988 and the year of 2000. Based on the thickness of sand sediment, the distribution result is classified into 4 types. The four types are the high-sediment area whose sediment thickness is bigger than 0.2 meter, the mid-sediment area whose sediment thickness is between 0.2 meter and 0.05 meter, the low-sediment area whose sediment thickness is between 0.05 meter and 0.01 meter, the non-sediment area whose sediment thickness is less than 0.01 meter.

● Statistic of sediment quantity

Generally, the formula of cubage is the area of bottom multiplying the corresponding height. This can be used to calculate the sediment quantity. The whole course can be operated by raster data. Using each sediment value of pixel multiples the area of pixel can get the result of a pixel sand sediment quantity. Summing up each pixel sand sediment quantity can get the sand sediment quantity of the study area.

3. RESULTS

● Three model equation

Three bands linear regression model is reasonable in term of their relation coefficient value (see table 2: Equations of three bands linear regression model). The three relation coefficient of the three models is very close.

time	Model equation	Relation coefficient
Oct. 6th, 1976	$Z=3.437+0.312X1+0.235X2+0.433X3$	0.693
Apr.23rd, 1988	$Z=1.027+0.134X1+0.328X2+0.355X3$	0.712
Dec. 7th, 2000	$Z=3.032+0.218X1+0.256X2+0.269X3$	0.684

Table 2: Equations of three bands linear regression model

● Fathom line map

From the fathom line, we can see the bottom terrain change. The fathom line is dense near the shore. While far from the shore, fathom line becomes sparse. The phenomenon is sensible to the common lake. The fathom line of the three periods has some change (see figure 3: Fathom line in 1976, figure 4: Fathom line in 1988, figure 5: Fathom line in 2000).
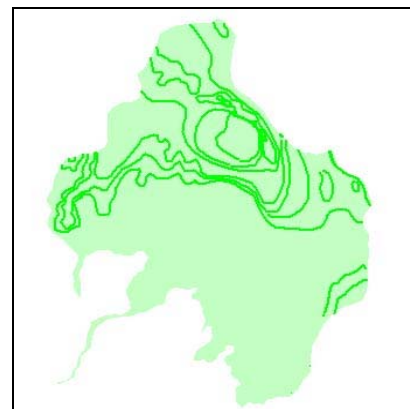

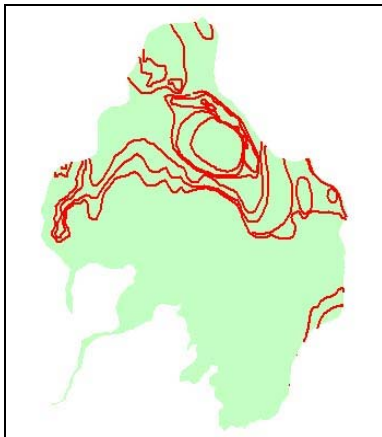Figure 3. Fathom line in 1976

Figure 4. Fathom line in 1988

Figure 5. Fathom line in 2000

● Distribution map of sand sediment
According to the distribution map of sand sediment, the serious sand sediment mainly accumulates near the shore. On one side or two sides of the estuary, the sand sediment is easy to accumulate (see Figure 6. The distribution of sand sediment from 1976 to 1988； Figure 7. The distribution of sand sediment from 1988 to 2000).
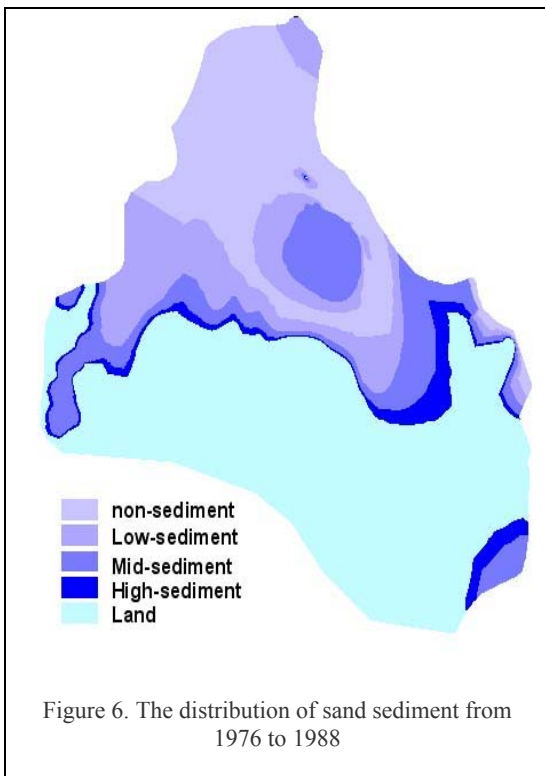

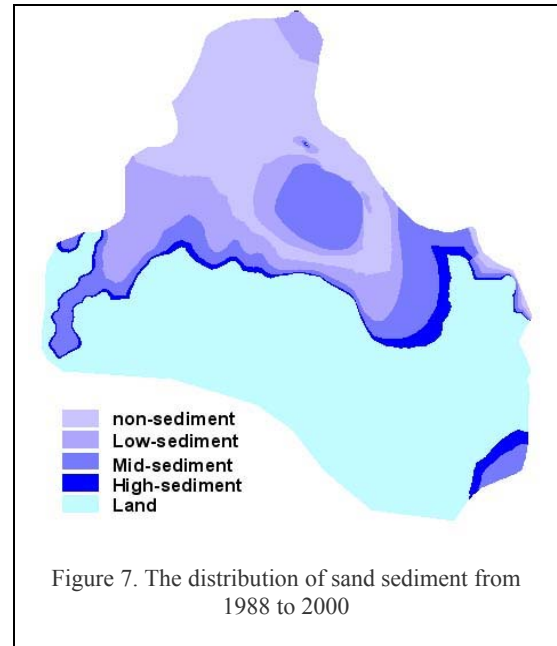Figure 6. The distribution of sand sediment from 1976 to 1988

Figure 7. The distribution of sand sediment from 1988 to 2000

● The quantity of sand sediment
During 1976 to 1988, it is about 67.22 percent quantity of sand sediment accumulating near the shore whose area is about 25.93 percent. During 1988 to 2000, it is about 65.46 percent quantity of sang sediment accumulating near the shore whose area is about 24.92%. Although the accumulating speed becomes slow, the sand accumulation is going on. In the high-sediment area, the average sand accumulation thickness reach 0.437 meter during 1976 to 2000 (see Table 3. The quantity of sand sediment during 1976 to1988； Table 4. The quantity of sand sediment during 1988 to2000).

period	From 1976 to 1988			
Sediment grade	High-sediment	Mid-sediment	Low-sediment	Non-sediment
Area(unit: meter)	11230812	35001859	53994659	77916258
Summary of Sediment area(square meter)	178143588			
Proportion of sediment area	6.30%	19.65%	30.31%	43.74%
Quantity of sediment (cubic meter)	2504471	2870152	1997802	623330
Average thickness of sediment(meter)	0.223	0.082	0.037	0.008
Summary of sediment (cubic meter)	7995756			
Proportion of sediment quantity	31.32%	35.90%	24.99%	7.80%

Table 3. The quantity of sand sediment during 1976 to1988

period	From 1988 to 2000			
Sediment grade	High-sediment	Mid-sediment	Low-sediment	Non-sediment
Area(unit: meter)	8980072	32538028	50642118	74443114
Summary of Sediment area(square meter)	166603332			
Proportion of sediment area	5.39%	19.53%	30.40%	44.68%
Quantity of sediment (cubic meter)	1921735	2603042	1772474	595545
Average thickness of sediment(meter)	0.214	0.08	0.035	0.008
Summary of sediment (cubic meter)	6892797			
Proportion of sediment quantity	27.88%	37.76%	25.71%	8.64%

Table 4. The quantity of sand sediment during 1988 to2000

4. DISCUSSION

It is an effective way to obtain the depth of water by using the technique of Remote Sensing. But there are some shortcomings. The actual water depth should be accurate. Here is used an estimated data. Maybe it isn't accurate, but feasible. The threshold is the key to draw out the new DEM.

This method can just monitor the sand sediment, but can't monitor the dynamic soil loss. If MODIS data is used here, the water level, water depth and soil loss in the water can be monitored.

5. CONCLUSIONS

It shows that the quantity of sand loss around Poyang lake attenuated. The eco-environment of Poyang Lake turns into better. But the sand accumulation in Poyang Lake is still going on. The phenomenon will lead to the riverbed rising more higher. It is the cause of water flooding. There should be a kind of balance for sand loss to accumulate and flux out of Poyang Lake. Otherwise, Poyang Lake may disappear (H. R. Tan, 2007). So, there shall be some measure to be taken by the local government.

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