Study on the Nonuniform Spatial Distribution of Water Level in Poyang Lake Based on ASAR Images and DEM

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Abstract

The Poyang Lake is the largest fresh water lake in china and also is the flood-prone belt. It’s very important to extract the water body information of the Poyang Lake from the remote sensing images and real time monitoring the dynamic change of the Poyang Lake with the technology of GIS. The spatial distribution of the water level of the Poyang Lake is nonuniform. We can’t get the water level information of the whole lake area. The ASAR images have advantages of all-weather, weather resistant, sensitive to the water, etc., it’s a good tool to extract the water information. The writer extracts the border line of the Poyang Lake through the ASAR images and combined with the high precision DEM data of the Poyang Lake area to get the water information of the border and reflect the spatial distribution of the water. This method is easy, quick and accurate, and could get the visualized graphic. The results could provide scientific evidences for the disaster prevention and mitigation, the regulation and usage of the reservoir and the production of fish, forestry, animal, husbandry and fishery, etc.

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1. Overview

The Poyang Lake is the largest fresh water lake in china and located in the south bank of the Changjiang River, the north of Jiangxi province. It stretches from 115°49’−116°46’E, 28°24’−29°46’N. The Poyang Lake is a pan-like natural valley and collects Ganjiang River, Fu River, Xinjiang River, Rao River and Xiushui River. It’s a water-carrying, throughput and seasonal lake restricted by the water level of Changjiang River and five rivers below. The water level of the Poyang Lake changes a lot and has a
function of adjust and restore flood and it’s very important for the flood control and disaster mitigation at the mid & up reaches of changjiang River and the exploitation and utilization of the whole lake area[1].

However, because of the unbalance of the north side and south side of the Poyang Lake, and the effects of the five rivers and the Changjiang River, the surface slope of the Poyang Lake is different, with the affection of the morphology of the lake, the spatial distribution of the water level is nonuniform[2]. According to the data of the Poyang Lake from the hydrometric stations, the water level of the Poyang Lake can reach as high as 1m to 2m.

The remote sensing technology is not limited by the time and space, and has many advantages, e.g. real-time, strong macro, accurate and reliable. It’s convenient and accurate to acquire the hydrology information with the technology of RS combined with GIS.

2. The data resources

2.1. The remote sensing images

The water nearly absorbs the entire near-infrared and infrared bang and decelerate the rada wave, so it’s more accurate to acquire the distribution range of the water through the infrared photo and rada images. The Poyang Lake belongs to the subtropical monsoon climate and has a plenty of rainfalls. During the time of the high water level, the weather condition is poor; the optical remote sensing can’t monitor the underlying surface in time [3]. The rada remote sensing is an important mean to acquire the hydrology information of the Poyang Lake.

The Envisat satellite launched in 2002 is the largest earth observation spacecraft and belongs to the ESA. The Envisat observes the soil, the atmosphere, the sea and the ice sheet on earth continuous with 10 groups of optical and radar equipment. The ASAR(Advanced Synthetic Aperture Radar) has advantages of acquire the data in all-weather day and night which is the most important sensor carried on the Envisat-1, it can ensure the continuous of the observe. Besides, the ASAR is very sensitive to the body of the water, and it could confirm the border of the land and water easily, so the ASAR images is very suitable to extract the hydrology information of the Poyang Lake [4-7].

The RS images related to this paper are the ASAR images from the ASAR ground receiving stations in Chinese University of Hong Kong, the form of the raw data is N1, wide-width imaging, and the time of imaging is April 13th, 2004. The images cover the whole area of the Poyang Lake.

2.2 The DEM data

The elevation values used in this paper is the DEM data of the Poyang Lake, the data is the form of RASTER, the projection of the coordinate is UTM/WGS84, the size of the grid is 30m×30m. The data has a high precision and the elevation covers the whole area of the Poyang Lake including the elevation below the water.
3. The study methods and technical routes

3.1 The technical routes

The technical routes. The research about the spatial distribution of the water level of the Poyang Lake in this paper is supported by the ArcGIS and ENVI. We extract the border of the water body of the Poyang Lake with the ASAR images, and acquire the elevation values of the lake from the DEM data, and then we generate the photo of the typical water distribution along the border of the lake, as a result, the spatial distribution of the whole water is reflected. The main technical routes showed in Fig.1 below.

Fig.1 The research flow chart of the spatial distribution of the Poyang Lake

3.2 The preprocess of the data

The ASAR images adopt the Projected Coordinate of UTM/WGS84 which is the same with the DEM data, and resample for the images through the ArcMap. In order to ensure the accuracy of the images and acquire the right elevation information from the extracted border of the water, we match the ASAR images with the DEM data. We can use the tool of Effects in the ArcMap to adjust the clarity of the layer to judge the images and the DEM is matched or not, and then we can know whether we should make geometric correction to the images and the DEM data.

3.3 The hydrology information extraction of the Poyang Lake

3.3.1 The extraction of the water polygon of the Poyang Lake. We extract the hydrology information of the Poyang Lake from the ASAR images with the help of the ENVI. First, we do density slice on the images through the ENVI and classify the images of the water body. Second, we deal with the classified images and turn them into the form of vector and output the Shapefile doc.

3.3.2 The extraction of the border of the Poyang Lake. After acquired the water body polygon of the water in the form of vector, we extract the border of the lake with the ArcMap. Firstly, we delete the water body out of the Poyang Lake with the Editor Tool in the ArcMap and reserve the lake polygon. Secondly, we change the water polygon into lines with the tool of Feature to Line in the ArcToolbox. Lastly, we edit the lines, delete the other lines and reserve the water border lines only with the tool of the Edit Tool.

3.4 The extraction of the elevation information of the Poyang Lake

3.4.1 D line elements three-dimensional. The border line of the Poyang Lake extracted from the ASAR images only contains the 2D coordinate, we change the elevation attribution acquired from the DEM data
into the 3D with the help of the ArcMap. At first, we add the border line doc. and DEM doc. to the ArcMap, and load the 3D Analyst extension module, and then we change the layers and the elevation data resources into 3D with the tool of the Features to 3D in the 3D Analyst tool bar [8].

3.4.2 The picture show of the water level along the water body. The newly generated 3D line attributions have the elevation attribution and the elevation attribution values on the line. We add the 3D line attribution layer into the ArcMap and choose a line of the water body with the help of the attribution choose tool, after that the section icon in the 3D Analyst tool bar is active. We acquire the section picture of the chosen line along the lake automatically by click the icon. The result also shows the spatial distribution of the chosen border line along the lake.

![Diagram of water level distribution](image)

We can also export the profile map in the form of Text, XML, HTML Table, Excel, etc. and deal with it according to your acquirements.

3.4.3 The error analysis of the profile map. After analyzed the generated profile map, we know there are a few errors. The elevation changes from 3m to 30m which is generated from the border line near the Dagao Mountain showed in the Fig.2 and that’s impossible for natural lake.

![Fig.2 The distribution of the water level near the Dagao Mountain](image)

There are two kinds of reasons for the error; one is that when we deal with the data, the man-made mistakes made the RS images can’t match well with the DEM, the other is that parts of the boundary of the Poyang Lake located next to the steep terrains, e.g. mountains. The accuracy of the RS images and DEM data used in this paper is limited, and each grid of the DEM data only contains an elevation value, that’s different from the reality. And that’s why the errors appears.

Thus, we choose the placid areas to generate the profile map of water level elevation in order to reduce the error.

4. The research results and contrast
In order to research and prove the spatial distribution of the water level of the Poyang Lake, we make the water level distribution pictures of outfall of the five rivers near the Poyang Lake and the outfall of the Changjiang River and showed in the Fig.3-10. We choose the placid area to decrease the error.

Fig.3 The terrain image of the Poyang Lake
Fig.4 The water level distribution near the Wusong Mountain
Fig.5 The water level distribution near the duobao village
Fig.6 The water level distribution near the Jiniu Mountain
Fig.7 The water level distribution near the Pengpo ridge
Fig.8 The water level distribution near the Xiaotan Lake
Fig.9 The water level distribution near the Liu Lake
Fig.10 The water level distribution near the Taiyang Lake
From the Fig.4-10, we can know that the water level near the wusong mountain and duobao village range from 10 to 11 meters and the water level near Jiniu Mountain, pengpo ridge, Xiaotan Lake, liuhewei and taiyang lake is 11-12 meters. The Wusong Mountain and the duobao village are near the outfall of the Changjiang River while the jiniu mountain, pengpo ridge, xiaotan lake, liuhewei and taiyang lake are located in the stream outlet of the Poyang Lake of the five lakes. It indicates that the water level near the outlet is 1 meter higher than the water level of the mouth of the Changjiang River.

The RS data used in this paper is the image of the Poyang Lake of April 13th, 2004. At that time, the flood season of the five rivers was come not too long and the flood season of the Changjiang River was not coming yet, the water level of the stream outlets of the five rivers raised quickly due to the flowing water of the five rivers. The surface of the lake formed a certain fall; the water flowed into the Changjiang River [9]. This phenomenon is coincide with the results showed in the pictures, and also proves the method used in this paper has a good actual result.

5. Conclusion and Prospect

5.1 Conclusion.

This paper is aimed to the research of the extraction of the elevation of the water level and the reflection of the spatial distribution of the water level with the tools of ENVI and ArcGIS, and based on the ASAR images and DEM data. The characteristics of the methods used in this paper are showed below:

1) The ASAR images have advantages of all-weather, weather resistant, sensitive to the water, multi-polarization, much incident angles, and etc. which makes it as a good tool to extract the water information.
2) The methods of extract the elevation value of the border of the Poyang Lake based on the ASAR images and DEM data we adopt in this paper is easy, quickly, automatically and could fulfill the requirements.
3) The results of the spatial distribution of the water level are more straightforward and visualized, and good for the comparative analysis and the analysis on the elevation data.

The method in this paper proved to be good for the research of the Poyang Lake. And it is useful for control the flood, the regulation and usage of the reservoir, etc.

5.2 Prospect

Although the method used in this paper is easy and convenient, the errors still exit due to the inaccurate data, especially in the abrupt areas but not the placid areas. So this method can’t adopt in whole area. We should improve the accuracy of the results.

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Reference


