Design and Implementation of Coastal Zone Remote Sensing Information Extraction Platform

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Abstract: At present, there is no dedicated software platform for the coastal zone remote sensing information extraction. For the complexity of the coastal zone targets which contains shoreline, vegetation and coastal zone types and so on, users can not extract information automatically by computers, so users need operate extraction by comparing to interpreting marks and remote sense images frequently. In other side, when users classify the information, they have to look through the information type code table to get the code value firstly. In one word, the current coastal zone remote sensing information extraction is very complicated and low efficient. In view of the characteristics of coastal zone information extraction, this article analyzes the requirements of coastal zone information extraction software, designs the coastal zone information extraction software. The function of the software includes management of the targets interpreting marks and displaying in extracting procession, management of target type codes and evaluation code value automatically, editing coastal zone vector data, shorelines extraction automatically, 3D terrain displaying and reference for the information etc. At last, this article builds coastal zone remote sensing information extraction platform based on .NET and ArcEngine development platform. The software is applied in the project of offshore islands and coastal zones remote sensing survey and research of China.

***Index Terms*: Coastal Zone Interpreting Library, Information Extraction, Automatic extraction, Coastal Zone Mapping**

I. INTRODUCTION

At present, there is no dedicated software platform for the coastal zone remote sensing information extraction, mainly based on ArcGIS platform. It needs operation under ArcMap when information extraction, under ArcCatalog when data management, which is complex-operation and heavy-workload. For example, when to extract information of a coastal zone area, firstly, create personal database or shapefile in ArcCatalog, then create specified featureclasse according to standard of classification, at the same time set user-defined coordinate system for featureclass. After these we can open the featureclass in ArcMap and conduct graph data extraction and attribute setting. Complexity of coastal zone information, the process needs to switch constantly between ArcMap and ArcCatalog to complete the information extraction and information management.

Some special applications are unable to realize such as the references of feature identification and interpretation information, the choice of feature type and etc. For example, in the extraction of coastline, the choice of interpretation is not the same in different purposes of their interpretation; the position of shoreline will vary greatly as different interpretation key [9]. Complex classification of coastal zone interpretation library, varieties of text description and illustrations, it needs a lot of literature references in the extraction of coastline, which is heavy-workload and error-prone. Urgently, there is a demand to develop a dedicated software platform for coastal zone information extraction to improve work efficiency and product quality.

In coastal zone, the coastline is irregular, the topography is complex, and there are numerous islands there. [7] The extraction of remote sensing information there is heavy-workload and high accuracy demand, moreover complex management. To establish coastal zone remote sensing information extraction platform can achieve the combination of automatic extraction and manual extraction, two-dimensional extraction and three-dimensional extraction, and improve efficiency, product accuracy and management efficiency.

II. SYSTEM DESIGN

Mainly based on remote sensing image and Coastal Zone Interpreting Library, coastal zone remote sensing information extraction extracts useful data into a personal database or shapefile, manages in classification and mappings output. It is easy management and retrieval that storing coastal zone remote sensing information in personal geodatabase.

In order to improve visual effects and interpretable of remote sensing image, we developed viewing image in different combination of bands and image enhancement functions. Since the island boundary and island domain data overlapped, we developed polygon boundary

extraction and construct polygon from lines functions to reduce duplication of work. In order to facilitate the distribution of data, we develop export featureclass to shapefile function.

Extraction of shoreline based on remote sensing is heavy-workload and low-accuracy, so we developed automatic extraction and three-dimension extraction module using authoritative DEM data issued by Survey and Mapping Department. According to complex Coastal Zone Interpreting Library, big influenced by the environment actual features, hard information extraction, we build the search and query of Coastal Zone Interpreting Library in the form of picture and tree classification system, which is easy, fast and accurate to select feature type.

Coastal Zone Remote Sensing Mapping has its own dedicated mapping standards and mapping process, for example, pictures in an atlas has fixed format text and map decoration elements in fixed position. For proprietary characteristics, we developed special functions such as set print region, set page, add title, mapping description, mapping institutions, label text and map surround (mapscale, legend, north arrow, mapgrid), export map in format. The functions above has its own proprietary format in Coastal Zone Remote Sensing Mapping or a atlas, this system encapsulated this default format, completed Coastal Zone Remote Sensing Mapping, and improved mapping efficiency.

III. FUNCTION REALIZATION

The system is designed including six main modules—file management, image management, Graphics editing, shoreline extraction, three-dimension display, remote sensing mapping.

A. File management

In this system, management for vector data of coastal zone remote sensing information mainly based on the way of ArcGIS personal geodatabase. The management of coastal zone vector information is divided by regions, and the capacity and management efficiency of personal geodatabase is very appropriate. In order to facilitate the distribution of data, we developed export featureclass to shapefile, and store.

Due to the management of data product must be in accordance with the national standards in setting Geographics Coordinate System and Projected Coordinate System, the choice of coordinate system is important in the management of coastal zone information. At present, the coordinate system of collected data is projected WGS84. Before extracting information, obtain the projection information of the image, and then set this projection to be the coordinate system for shapfile used for storing extraction.

Coordinate system of coastal zone data is always chosen the Gauss Kruger Projection. In this projection, the central meridian is projected to linear; there is no distortion in length, equal with the actual length of the sphere. The other warps are arc convergence to the pole, the farther away from the central meridian, the greater the distortion.

As coastal zone mapping is always for small islands or coast, the choice of position of the central meridian directly affects the size of projection distortion, so we achieved the projection transformation function, through adding user-defined parameters of Gauss Kruger Projection, including false easting, false northing, central meridian, latitude of origin, scale factor (default is 1, no scale), this ensure the mapping accuracy in position and shape.

Polygon boundary extraction and construct polygon from lines function is mainly based on the extracted vector data, this function reduced duplication of extracting work that the island boundary and island domain data overlapped.

B. Image Management

This platform needs image as background when extracting information, which has processed by geometrical correction and image registration. Pre-processing in this system is aiming at display effect and view efficiency, including image enhancement processing, viewing image in different combinations of bands to and build pyramids for image.

Based on the redevelop technology of IDL, image enhancement processing use the histogram equalization method to stretch the coastal zone remote sensing image, and improve visual effects and interpretable of remote sensing image, which can facilitate the extraction of useful features. Bands combination uses the RGB rendering method, realizes viewing image in different combination of bands, and makes it convenient to extract different features. [2] Because the size of image in different regions is differ, large data has low view efficiency, this will affect extraction efficiency. Building pyramids of default parameters for image can meet the requirement.

Figure.1 Effect comparison figures of different bands combinations. Figure 1.1 is the image before processing; the bands combination is default 1, 2, 3. Figure 1.2 is the image of bands combination of 4,1,2, In this result image, detailed characters of the features are more clear, tonal is more outstanding, vegetation cover is more clear. We can distinguish the different vegetation types and growing conditions from the color, for example, the texture and color is clearly obvious between cultivated land and woodland (in figure above, A is woodland and B, C is cultivated land), in cultivated land, paddy fields and upland also show clear contrast in tonal (comparison can be seen in C), vegetation in built-up area hardly affected by tonal of built-up area (in D), water performance is also better (in E).

C. Information Extraction

The standardization and complexity of coastal zone information management require to ensure accuracy and efficiency when extracting information. In this article, the way of extracting coastal zone information is combination of automatic extraction and manual extraction, combination of two-dimensional extraction and three-dimensional extraction.
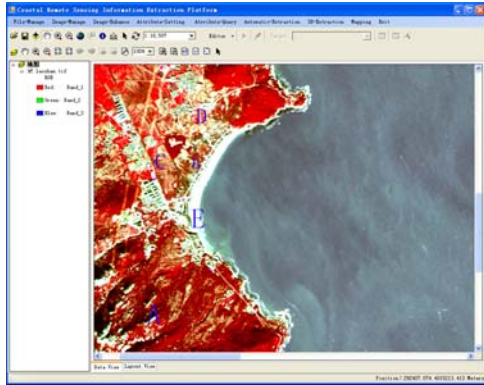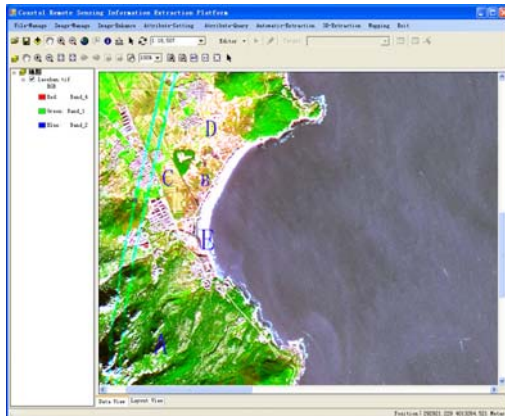
Figure 1.1. The default bands combination of 1, 2, 3

Figure 1.2. The bands combination of 4, 1, 2

A   MANUAL EXTRACTION

Coastal Zone remote sensing information includes the extraction of graphic data and attributes data. The extraction of graphic data is based on the ArcEngine Editor tool, realized basic viewing and editing functions. Based on these functions, develop the split line function to complete the edit of shoreline. Jointly with shoreline Attributes Setting toolbar and shoreline automatic extraction which will be mentioned below, completed the extraction of the shoreline information.

Editing of the attributes data mainly includes feature type and its corresponding code and describing information. For the editing of describing information, we can use Editor Tool in ArcEngine to assign for specified field. For the editing of feature type and corresponding code, reference the Coastal Zone Interpreting Library, and build the search and query of Coastal Zone Interpreting Library in the form of picture and tree classification system. Interpreting Library uses Access database to store data, builds three levels of classification and constraints for coastal zone features to store name, code, description, sample pictures, and update selected feature after getting feature type from database.

Figure 2.1-2.4 shows sample figures of updating coastline process, firstly open the coastline attribute setting toolbar (figure 2.1), and then select feature needed to be updated in mapcontrol, as shown in figure 2.2 for the selected coastline of Lingshan island, at the same time obtain the layer name and coastline name of the coastline

and   fill them into the coastline attribute setting toolbar, if the coastline has been assigned, it will also gain coastline type and corresponding code at the same time; If the coastline type needs to be modified or assigned, click "get coastline type" button to open get coastline type form as shown in figure 2.3 , choose the coastline type (muddy shoreline) in the left classification system, corresponding code of coastline type (" 2301010400") and sample picture (as the figure above)appears on the right, click "ok" to obtain the name and corresponding code and fill them into coastline attribute setting toolbar, as shown in figure 2.4, among them, code is the only identification and shouldn't be modified. Click "update coastline" and complete assignment process.
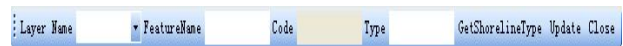

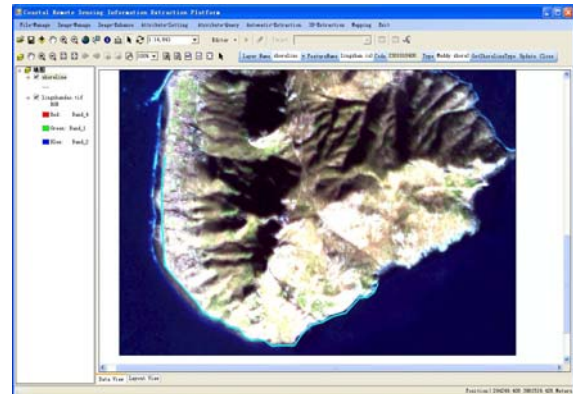Figure 2.1. Coastline Attribute Setting toolbar initially.

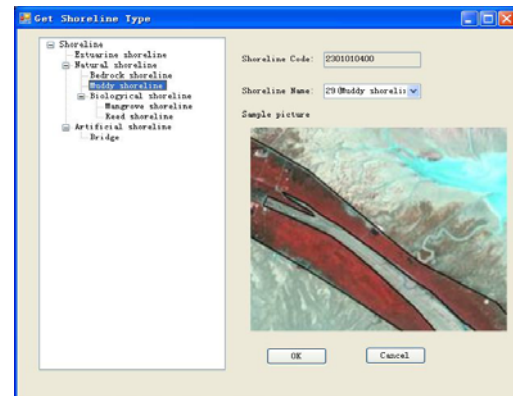Figure 2.2. Selected feature to be assigned in mapcontrol.

Figure 2.3. Get shoreline type form in the form of picture and tree classification system.

Figure 2.4. Coastline Attribute Setting toolbar after get coastline type.

B   AUTOMATIC EXTRACTION

Automatic extraction mainly aims at the shoreline. Extraction of shoreline is an important part in coastal zone information extraction. Due to the complex and changeable coastline shape and position, manual extraction of shoreline is heavy-workload and low-accuracy. This platform provides a solution; first use the DEM data published by surveying and mapping

departments, with 0 meters isobath as the shoreline, extract elevation equivalent points and obtain a reference of the shoreline, as a basis, then modify it in the reference of image, this solution improves efficiency.

The specific flow as follows:

First do automatic extraction of the shoreline based on DEM data. If we have a known position of shoreline, choose get isoline by click and obtain a isoline (namely the shoreline) passing the click-point along with the coordinates and elevation of the click-point; If we know the shoreline elevation in DEM data, choose get isoline by value and obtain one or more isoline of the input value elevation and this elevation value. In this process we can also get contour by inputting start elevation and elevation interval, storing this interval value and start and end elevation.

Then open the extracted reference shoreline in mapcontrol, add it onto the image for processing. Because the extracted shoreline in this process is a feature object, it can be divided into different categories according to its actual situation around (such as muddy shoreline, mangrove shoreline). For the shoreline, first use the split line tools mentioned above applied for handling to shoreline, then use the coastline attribute setting toolbar mentioned above for assignment to shoreline.

After that, set the base height for image in 3D Display form, modify the extracted coastline under the contrast in two-dimension display and in three-dimension display. Specific methods will be considered below in detail.
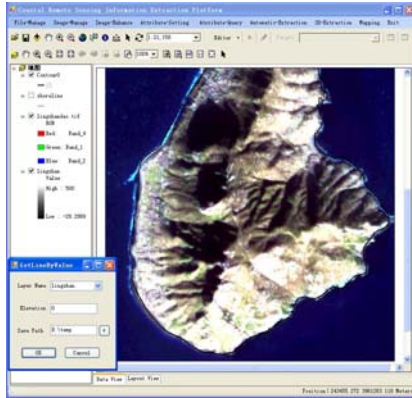

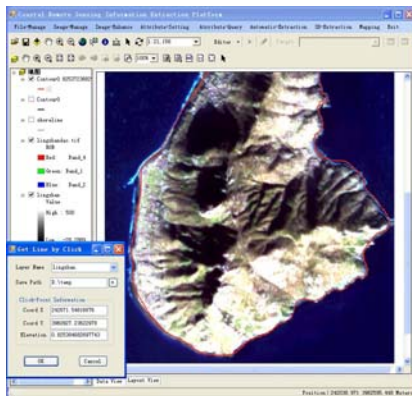Figure 3.1.   The extracted coastline with a known elevation.

Figure 3.2.   The extracted coastline passing a known point

D.   Three-dimension Extraction

Three-dimension extraction makes up for the deficiency of automatic shoreline extraction in two-dimension , mainly aims at two cases : one, in the flat landscape, elevation precision of Digital Elevation Model may cause that the extracted shoreline is a region or a calculated line according to the pixel value of the region, thus affect the accuracy of the location of extractive shoreline . An accurate judgment of shoreline position and its information can be got in three dimension visual scene, correct it in contrast with the shoreline that two dimension generates. The other, in topography that changes remarkably (such as escarpments, cliffs and so on) , contour lines are very dense, and elevation precision of Digital Elevation Model may cause coastline to change greatly in elevation and even lost, and affect the elevation accuracy of extracted coastline. Different perspectives for precise location of elevation can be adjusted in a three dimensional visual scene, correct it in contrast with the shoreline that two dimension generates.

Three-dimensional display uses the SceneControl control in ArceEngine to set base height for image. [6] In order to increase 3D browsing rate, ArcGIS deals with the texture and resolution before showing the grid data, such three-dimensional display strategy improves display efficiency, however, decreases display precision. The data that this module deals with is mostly islands data that the areas of them are not large, the amount of the data is small and doesn't affect the efficiency of display, but asked a high requirement of position accuracy. In order to make users select the location accurately, the three-dimensional display effect must be ensured.

In order to strengthen the three-dimensional display effect, set the grid resolution and grid texture fidelity of the three-dimensional surface. Set grid sampling rate the same as the row-column numbers of the image, ensure not to lose accuracy, set texture fidelity highest.

The correction process of this module about two-dimensional is : when making visual correction of the reference shoreline extracted in two-dimension, if the accurate position of shoreline is not determined due to the special terrain or surface in this place, open the three-dimensional display and set base-height for image, then located the uncertain position of shoreline; if terrain is flat, find the edge zone of this terrain or characteristics division position of this surface feature, click here and obtain the position and elevation of this point, compare this value with the elevation of this point in two-dimension. If the difference is not big, then move the point in the two-dimensional display to revised position in three-dimensional display. If the topography is steep, then adjust the viewing angle for approaching eye level, find accurate location of shoreline and get the isoline through this point and its elevation, then add this line to the two-dimensional display to be compared to modify.
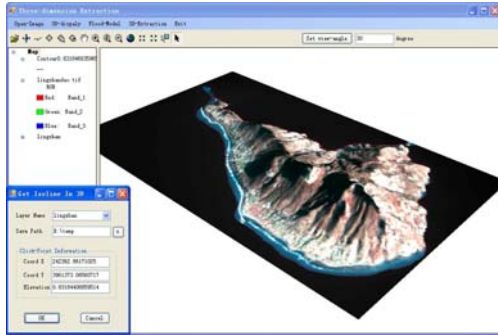
Figture 4. The extacted coastline in three-dimension extraction

E.   Flood Model

Flux and reflux, marine meteorology or disasters and so on, all have effect on the waterline of the island. Because the level of the islands is fairly low, the condition that the sea water inundated has a direct impact on the planning and utilization of the island. This article, in order to make users see the sea water area flooding and influences of the changes intuitively, imitates the condition that the sea water engulfed under elevation changes of geoid-surface, and provides the exploitation of the island with policy support.

The function of this module is: generated geoid-surface temporary vector files with same range as input layer. Determine the start, end and interval properties of the timer control by setting the start elevation, end elevation and rising speed. Then use I3DProperties interface to set base height for temporary geoid-surface, and complete the flooding simulation.
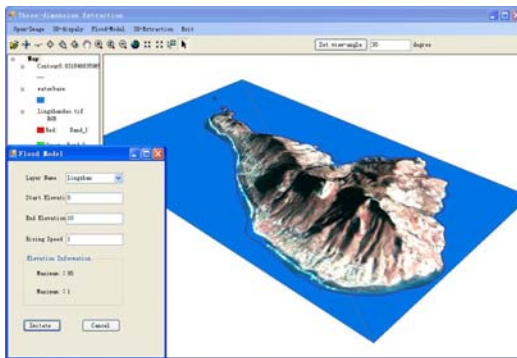

Figure 5. The location of the extracted shoreline and sea surface

The figure shows the location of the extracted shoreline and sea surface, flood situation of island can be seen clearly in figure.

F.   Mapping

Mapping is to output the results of information extraction and image in accordance with the requirements of map appearance. This platform is an independent development platform; mapping output must be in strict accordance with the dedicated mapping standards and mapping process of Coastal Zone Remote Sensing, including Page Setup, Map Appearance and Printout. Based on PageLayoutControl mapping technique, aiming at dedicated mapping standards and characteristics of Coastal Zone Remote Sensing, this system encapsulated fixed format, and formed streamline processing of mapping.

Page Setup includes the set of page border, background style, background color, printing area (width, height, portrait or landscape).

Map Appearance includes adding legend, north arrow, scale, mapgrid and label text. And the legend, north arrow, scale and mapgrid have fixed position and style, the label text includes the title, chart name, mapping institutions, mapping description, user-defined label text, these label texts have fixed position and specific format. According to the existence of differences in regional characteristics, sometimes it needs to change the font format, and then change it by double-clicking.

Printout achieved mapping out of remote sensing image, export as image (including JPEG, PNG, TIFF, etc) by inputting resolution value (dpi), then print out the map.
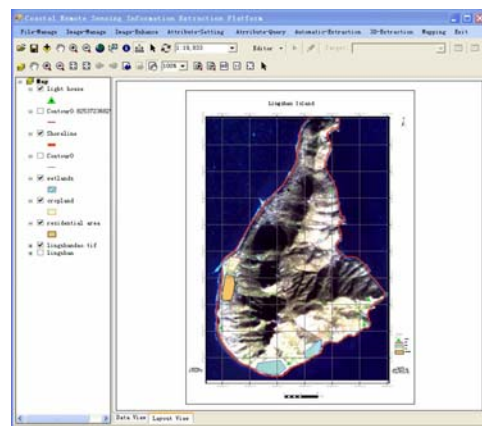

Figure 6.A sample of mapping of coastal zone remote sensing

IV.   APPLICATIONS

Coastal Zone Remote Sensing Information Extraction Platform designed in this article has already been applied in the project of offshore islands and coastal zone zones remote sensing survey and research of China.

File management module realized the unified management of coastal zone remote sensing information, and improved manage efficiency. Polygon boundary extraction and construct polygon from lines functions reduced duplication of extracting work, and save time.

The design of Coastline Attribute Setting toolbar realized fast query of Coastal Zone Interpreting Library and reduced heavy workload and uncertainty of artificially visual interpreting, improved the efficiency. Along with the Editor tool in ArcEngine, it completed the manual extraction of coastal zone information.

This platform unified extraction and management of coastal zone information to a platform, changed the previous way that manages in ArcCatalog and extracts and in ArcMap respectively.

The design of mapping encapsulated special format according to dedicated mapping standards and characteristics of coastal zone remote sensing, formed streamline processing of mapping and improved mapping efficiency.

V.CONCLUSIONS

This article finished the requirements analysis of coastal zone information extraction, in view of the characteristics of coastal zone information, developed extracting ways and means aiming at particular characteristics, realized the search and query of Coastal Zone Interpreting Library, in the way of combination of automatic extraction and manual extraction and combination of two-dimensional extraction and three-dimensional extraction, designed and developed Coastal Zone Remote Sensing Information Extraction Platform based on . NET and ArcEngine, improved extraction efficiency of coastal zone remote sensing information and ensured product quality, and this system has been applied in practical work.

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