Terrain Pre-process the Lower Reaches Yellow River and Delta Estuary Coast of Two Dimensional Numerical Model

Ma Liangchao¹,², Jiang Caodong¹,², Li Dongfeng²,⁴, Zhang Hongwu³,⁵, Li Zihao²

¹Zhejiang Ocean University, School of Naval Architecture and Maritime, China
²Key Laboratory for Technology in Rural Water Management of Zhejiang Province, Zhejiang University of Water Resources and Electric Power, China
³State Key Laboratory of Hydroscience and Engineering, Tsinghua University, Beijing 100084, China
⁴Corresponding authors: lidf@zjweu.edu.cn
⁵Corresponding authors: zhhw@mail.tsinghua.edu.cn

Abstract. Mike21 is a professional engineering software package for simulating the flow, wave, sediment and environmental problems of rivers, lakes, estuaries, bays, coasts and oceans. The pre-processing of the terrain in the study area is an important foundation for constructing the Mike21 model. In order to improve the calculation accuracy of the Mike21 model, taking the lower Yellow River estuary channel and the Bohai Bay area as an example, the use of Google Earth satellite images and the AutoCAD topographic map to extract the terrain boundary is discussed, and the terrain interpolation problem in terrain pre-processing is discussed. The two terrain pre-processing methods can effectively improve the terrain pre-processing efficiency and make the terrain processing result file more realistic.

1. Introduction
In recent years, Mike21 software developed by Danish Institute of Water Conservancy has been widely used in river and ocean numerical simulation, such as large-scale tidal current field simulation in Bohai Bay, tidal current field simulation in harbor basin of Tianjin Port International Cruise Terminal and construction of Hong Kong New Airport [1]. Terrain pre-processing is a key step in Mike21 numerical simulation. The results of terrain pre-processing directly affect the establishment and calculation results of Mike21 model. Therefore, how to improve the efficiency and accuracy of terrain pre-processing is the primary problem to be solved in Mike21 numerical simulation [2].

2. Introduction to Google Earth
Google Earth is a free software developed by Google in the United States. It is one of the best Earth information systems at present. With the characteristics of practicality and humanization, Google Earth has great advantages in free resource data acquisition compared with other software. It integrates satellite images, remote sensing photographs and actual maps, allowing users to access a wide range of satellite imagery resources. Google Earth has satellite maps of various countries in the world, with high image credibility and constantly changing over time, so users can read a rich geographic information library from Google Earth.

At present, Google Earth has been widely used in processing topographic files due to the advantages of convenient image acquisition, strong practicability and high data credibility [3], KML file as the carrier...
of point, line and plane information, can be used as an independent file to transfer and share in the process of data processing.

3. Analysis of the advantages and disadvantages of Google Earth

3.1 Satellite image
The images of satellite images released by Google Earth are not a single data source, but the data integration of satellite images, aerial photography and maps. Google Earth displays satellite images with different resolutions of the Earth’s surface, allowing users to see things like vertical downwards or inclined rivers and dams. Available resolution depends to some extent on interest points and visibility, with most land (except some islands) having at least 15 metres resolution. Google Earth visually displays maps of satellite imagery coverage, providing the highest resolution images, including 15 cm, in well-known areas such as Melbourne, Victoria, Australia, Las Vegas, Nevada, and Cambridge County, United Kingdom of Great Britain. Google Earth allows users to search for addresses of certain countries / regions, enter coordinates or browse to a location only using a mouse.

3.2 Obtaining vector information from Google Earth \(^5\)
Google Earth not only provides satellite images of various regions, but also provides vectorized electronic sub-images. It shows rich geographic information and can display the longitude and latitude coordinates and altitude data of the target area. Google Earth can also measure the distance between two target points and so on, so Google Earth is widely used in engineering measurement.

Google Earth uses the WGS84 geocentric coordinate system, but it cannot use the WGS-84 coordinate system in the numerical simulation of Mike21. Therefore, before importing the boundary extracted by Google Earth into Mike21, it is necessary to transform the above two coordinate systems, that is, it is necessary to transform the boundary control point coordinates under the WGS84 coordinate system into the coordinates under the Beijing 54 coordinate system.

3.3 shortcomings and defects
Firstly, the elevation accuracy of Google Earth is far less than its plane accuracy, and its WGS84 ellipsoid elevation cannot be accurately converted to the commonly used elevation system. There will be some errors after conversion, so this method is only applicable to the collection of plane geographical elements. In addition, due to the low image resolution of Google Earth in most regions of China so far, it is far from reaching its 1 m resolution level in large and medium-sized cities in Europe and the United States, so it is only used in the production of small and medium-sized maps at this stage. For most areas of the earth’s surface, vertical photography can only provide 2D satellite photos. From a tilted point of view, there is a perspective in a sense that you can see objects farther horizontally smaller, like looking at large photos rather than 3D views.

4. KML data exchange file

4.1 Brief introduction of KML file
Keyhole Markup Language is an XML representation for geographic annotation and visualization in two-dimensional map and three-dimensional Earth browser based on Internet. KML uses tags containing basic elements such as landmarks, image overlay, paths, polygons and network links to describe the geographic information of the study area. This file type can be identified and displayed by Google Earth.

4.2 Create a KML file
The KML file can be created and saved in the Google Earth client interface using the functions of 'adding landmarks', 'adding paths' and 'adding polygons'. Or you can use XML or simple document editor to create KML files according to personal needs. If you have files in shp format, you can also use ArcGIS to generate KML files.
4.3 Importing KML files into Google Earth using ArcGIS

Taking the estuary channel of the lower Yellow River as an example, the file in shp format is imported in ArcGIS, and the ArcToolbox toolbox is opened. The 'to-KML’ tool in the conversion tool is used, and the 'coverage-to-KML' tool is selected. The system is converted to KMZ file by default when output. As shown in Figure 1.

Find the converted KMZ file, modify its file suffix to. zip format and uncompress it to get the KML file. The effect after importing Google Earth is shown in Figure 2.

5. Topographic pre-processing method

5.1 Generate Mike21 boundary file

5.1.1 Using Google Earth to extract boundaries.

Preliminary terrain simulation using satellite images can improve the efficiency of terrain pre-processing in numerical simulation[6]. Google Earth uses WGS84 geocentric coordinate system, but in the process of Mike21 numerical simulation terrain pre-processing, the terrain boundary data uses Beijing 54 reference coordinate system. To apply the Google Earth extracted coordinates to Mike21 software, it is necessary to convert the coordinate system. Taking the Lower Yellow River Estuary as an example, Google Earth is used to extract the topographic boundary of the Yellow River levee as the Mike21 model[7]. The specific steps are as follows:

1. Open Google Earth, select the 'Add Path' button in the toolbar, and press the sure button after a selection point. At this time, the location of the project is saved in the left' s ' location ' tab, select the right key of the drawn project to export, select 'save the location as... ', and select KML for saving type;
2. Open the exported KML file with text file, and the box selection part is the required topographic boundary coordinates, as shown in Figure 3;
3. Copy the coordinate data to Word document, select the replacement, replace the blank area into paragraph mark. Replace ', 0 '. Finally, copy the converted coordinates to the txt text file;
4. Open the COORD software and convert the coordinates in the txt file to the Beijing-54 coordinates we need;
5. Change the converted txt file suffix to. Csv, open and mark 1 and 0 in the last column to facilitate Mike21 to identify boundary features. After labeling, the modified. Csv file is saved as a comma-separated text file;
6. The saved file suffix is modified to xyz, which can be imported into Mike21 as the terrain boundary.
In the process of terrain pre-processing, topographic maps are not reliable enough for a long time, and there is a large gap between topographic maps and on-site terrain. The topographic map can be imported into Google Earth as an image overlay layer to integrate satellite maps and topographic maps to depict terrain boundaries [8]. Select the menu 'Add - Image Superposition Layer' to add the image coordinate control points and satellite image calibration to Google Earth. As shown in Figure 4.

5.1.2 Extract boundary from existing DWG files.
In practical work, the topographic data and cross-section data of rivers are mostly stored in AutoCAD files. The AutoCAD boundary topographic file drawn by field measurement has high accuracy. The simple method is to output the data in AutoCAD into various xyz files for Mike 21. The steps of extracting boundary coordinates by AutoCAD are as follows:

1. The AutoCAD software is opened and loaded into the existing DWG file, and the boundary that needs to be exported is selected to draw it into a multi-segment line. In order to make the multi-segment line smoother to avoid generating too small grid cells in Mike 21, the multi-segment line can be converted into a spline curve, and the quadratic smoothing or cubic smoothing is selected. Then the spline curve is converted into a multi-segment line. The higher the conversion accuracy of the input in the conversion is, the more end points of the generated multi-segment line are, and the more smoother the multi-segment line is;

2. List endpoint coordinates of multiple segments at the text window using the 'LIST' command [9]; The coordinates are copied to EXCEL for processing, so that the longitude and latitude are in columns A and B, respectively. In column 3, except that the last endpoint of each multi-segment line is input 0, other endpoints are input 1;

3. Save as a text file and modify the extension to xyz as the Mike21 boundary condition.

5.2 Generating terrain files

1. Open Mike Zero and input the boundary data of Yellow River Embankment and Bohai Bay from the xyz file by using the 'Import Boundary' menu item. Some points are very close to other points or are repeatedly defined. Using the Clean menu item, first define a point to point distance less than a very close [10], Then the repeated definition points and very close points can be cleared. This method can only clean the nodes and can not clean the vertices. The cleaning of the vertices needs manual operation.

2. Then the 'Draw Arc' tool is used to close the open boundary between the upper Yellow River and the Bohai Bay. Use the 'Redistribute Vertices' menu item to further smooth the boundary between the Yellow River and the Bohai Bay [11].

Figure 3. Terrain boundary coordinates
Figure 4. Adding image overlay layer
(3) The grid is generated and the 'Break line' is used for terrain interpolation. In interpolation, the elevation of one side of the boundary line is interpolated only by the same side scatter, and the other side of the boundary line is not interpolated. In the figure, the left figure is the interpolation effect by using the boundary, and the right figure is the interpolation effect without using the boundary [12]. It can be seen that after using the boundary, the boundary between the estuary and the ocean has changed, as shown in Figure 5.

5.3 Pre-processing results of terrain
According to the operation steps of the first two sections, the original data of the lower Yellow River and Bohai Bay are pre-processed, and the results are shown in Figure 6.

6. Conclusion
The method of extracting boundary from Google Earth is applied to the large-scale numerical simulation of Mike21, which can flexibly deal with complex terrain and require accurate calculation of the region in a small range. The boundary can be extracted by combining with AutoCAD topographic map, so as to improve the accuracy of terrain boundary. The comparative analysis of the terrain interpolation at the
estuary of the Yellow River shows that when the grid is generated, the reasonable use of the boundary for terrain interpolation in different terrain regions can make the Mike21 model simulation more accurate.

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