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Research and Comparison of Algorithm for Contiguous Zone and Exclusive Economic Zone

Research and Comparison of Algorithm for Contiguous Zone and Exclusive Economic Zone

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Abstract. The paper uses the ellipsoidal distance equalization method and the Bessel method for the calculation of the contiguous zone and the exclusive economic zone. The study finds that the high-precision distance equalization method based on the ellipsoidal buffer is used to calculate the time is short, but it cannot meet the requirements of the contiguous zone and the exclusive economic zone for the high precision of the boundary points. The Bessel method based on the forward and reverse solutions of the earth theme can determine the geodetic latitude and longitude coordinate mode at any point on the straight-line baseline, accurately and quickly determine the boundary point, and more effectively eliminate the measurement fixed point error.

1. Introduction

The territorial sea baseline is the baseline for a country to measure its territorial sea area. The baseline of the territorial waters of the People's Republic of China is delineated by the straight-line baseline method and consists of straight lines connecting adjacent base points. On May 15, 1996, the People's Republic of China issued a statement announcing part of the baseline of the mainland's territorial seas and the territorial seas baseline of the Xisha Islands, and announced two batches of 77 linear base points [1]. The People's Republic of China will start from these straight baselines. Measure the width of its territorial sea, contiguous zone, exclusive economic zone and other sea areas claimed. Due to different sea areas, the legal status in international law is different. It is of great significance to accurately determine the internal and external boundaries of the territorial sea, the contiguous area, and the exclusive economic zone.

2. Bessel method to determine the linear coordinate algorithm of linear sea-collecting

Select any segment of the baseline to analyze, starting point P_1 (B_1, L_1); the latitude and longitude of the end point P_3 (B_3, L_3) is known, the point P_2 (B_2, L_2) to be found is on the ground line P_1P_3, so the azimuth angle $\angle PP_1P_3$ = azimuth $\angle PP_1P_2 = A_1$, latitude B_2 is known, and longitude L_2 is obtained.

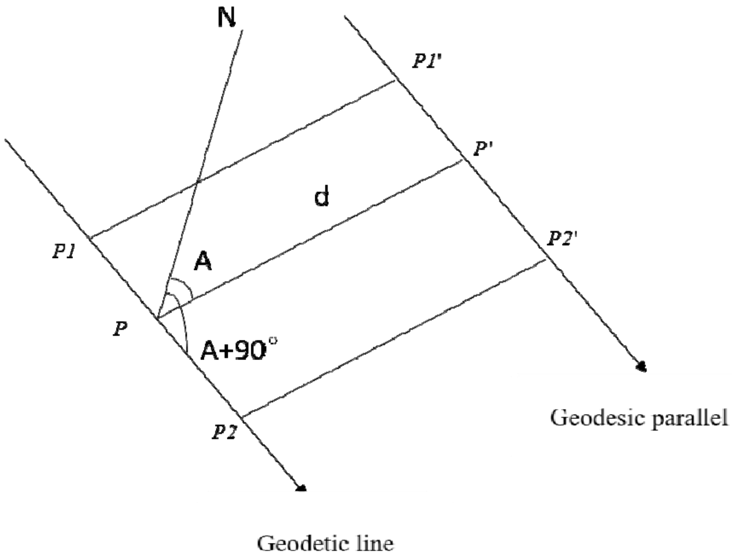

Fig 1 Baseline Bessel method for determining the baseline of the straight-line collar sea

Step 1: Calculate the azimuth of the baseline (earth line). First, the azimuth angle A_1 of the ground line P_1P_2 is calculated according to the Bessel method earth theme inverse solution method.

Step 2: Calculate the naturalization latitude. In this case, the latitude B_1B_2 is known, so

$$W_1 = arctan\left[\frac{sinA_1 sin\sigma}{cos\mu_1 cos\sigma - sin\mu_1 sin\sigma \cos A_1}\right] \tag{1}$$

$$sinu_1 = \frac{sinB_1\sqrt{1-e^2}}{W_1} \tag{2}$$

$$cosu_1 = \frac{cosB_1}{W_1} \tag{3}$$

Similarly, the expression of B_2 is as above.

Step 3: Calculate the helper function.

$$A = \left[b_1 + \frac{k^2}{4} - \frac{-3k^4}{64} + \frac{5k^6}{256} - ...\right] \tag{4}$$

$$B = \left[\frac{bk^2}{8} - \frac{k^4}{32} + \frac{15k^6}{1024} - ...\right] \tag{5}$$

$$C = \left[\frac{bk^4}{128} - \frac{3k^6}{512} + ...\right] \tag{6}$$

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$$k=e^2cos^2A_0 \tag{7}$$

Step 4: Calculate the spherical length σ.

$$sin\sigma = \frac{cosu_1sinu_2cosA_1}{sin^2u_1+cos^2u_1cos^2A_1} \pm \frac{sinu_1\ (sin^2u_1\text{-}sin^2u_2+cos^2u_1\text{-}cos^2A_2\ )}{sin^2u_1+cos^2u_1cos^2A_1} \tag{8}$$

The sign of sinσ is determined by the quadrant in which the angle is located.

Step 5: Calculate the longitude difference correction number δ

For China's territorial sea baseline, the effect of δ is very small, generally within three thousandths of a degree. If the accuracy requirement is not high, it can be approximated to zero. Here we use the substitution approach method to correct L_2, that is, the δ = 0 is calculated after the target longitude L_2, and then

Step 6: Calculate the geodetic longitude coordinates of the point to be sought.

Step 7: Perform longitude correction.

After obtaining L_2 from step 6, substituting into the earth theme inverse solution formula to calculate the length of the ground line S between P_1P_2, and then calculating the longitude correction number δ according to the positive solution of the earth theme, and substituting into the formula $L_2=L_1+\lambda-\delta$ After the corrected longitude L_2', after calculation, the calculation result of the territorial sea of China is calculated, and the error is reduced to less than one thousandth of a second [2].

3. Establishment of equal-scale baseline demarcation model for ellipsoidal distance

Just as the high-precision mid-line/equidistant line generation technique is the key to implementing the maritime delimitation of the intermediate line/isometric line method, the key to implementing the contour line method for ocean demarcation is the establishment and solution of the high-precision distance contour line model [3]. Therefore, the high-precision distance ISO-scale model based on the earth ellipsoid is taken as the main research content of this paper. The analysis shows that the principle and technology of waterline generation can be applied to the construction of the ISO-line model.

Step 1: For the natural shoreline feature point set N, the bump is selected by the vector cross product formula and stored in the point set M.

The TM image is processed by remote sensing image processing software PC17.0, which mainly includes geometric correction of image, mosaic color matching, cropping and enhancement. The processed image is supported by the ARCVIEW software, and the image raster file is used as the interpretation background. The method of visual interpretation is mainly used, and the computer automatically classifies as a supplementary method [4]. According to the image interpretation marks, such as hue, shape, size, shadow, etc., the land use coverage information is extracted separately, according to the use, management characteristics, utilization mode and Covering characteristics and other factors as the classification basis of land use, distinguishing differences, summing commonality, dividing from high to low level, dividing land use types into rivers, river beaches, bare grounds, bare rocks, fields, glaciers, woodlands, grasslands , Gobi, sand, wetland and saline-alkali land, and according to the database structure design, assign value to the property sheet, the work flow chart is as follows.

$$(x_i - x_{i-1}) \times (y_{i+1} - y_i) - (x_{i+1} - x_i) \times (y_i - y_{i-1}) > 0 \tag{9}$$

Where (x_i, y_i) is the geographic coordinate of point i.

Step 2: Calculate the triangle area value S composed of the points in the point set M and the adjacent two points in the point set S in turn, and set the area threshold S_0. If $S \geq S_0$, the point is stored

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in the segment point set T. Among them, the curve end point does not need to be judged directly into the point set T.

Step 3: For the data point set between adjacent segment points, the least squares curve is used to fit the relationship between the distance threshold and the number of reserved points, and the optimal distance threshold D of each segment is selected.

Step 4: The adjacent two points in the point set T are respectively used as the first and last points of each segment, and the optimal threshold D of each segment is used as the initial distance threshold.

Step 5: Based on the optimal threshold, adjust some segmentation thresholds to obtain the direction line. Where: S0 is the area threshold, D is the distance threshold, i, j is the coordinate point subscript, and P_{start} and P_{end} are the end and end points of each segment respectively.

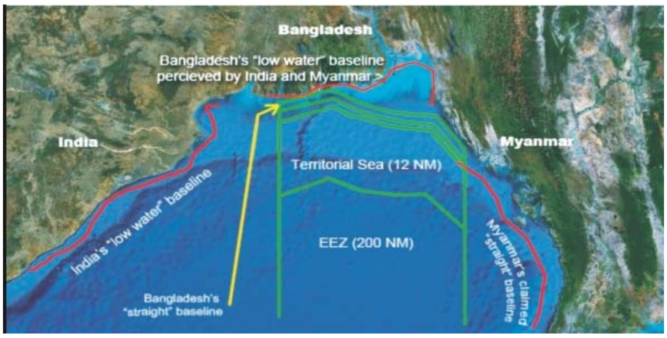

Fig.2 Territorial sea related sea area analysis

4. Case analysis

4.1. Experimental area determination

In this paper, a measurement sub-area is selected in the experimental area, and the comparison operation is performed by using the Bessel method and the ellipsoidal distance and the proportional baseline method. The evaluation factors of the performance of the algorithm include: 1 area ratio: the ratio of the sea line to the inner line and the inland area of the direction line and the natural shore line respectively, that is, the direction line and the natural shore line in Fig. 3 are surrounded by the straight lines AB and AC respectively. The area ratio of the polygon, the horizontal and vertical coordinates of point A are the minimum and minimum ordinates of the feature points on the natural shoreline, respectively, and the points B and C are the first and last points of the sub-area one; 2 compression ratio: the vector data is compressed. The ratio of the amount of data to the amount of data before compression [5].

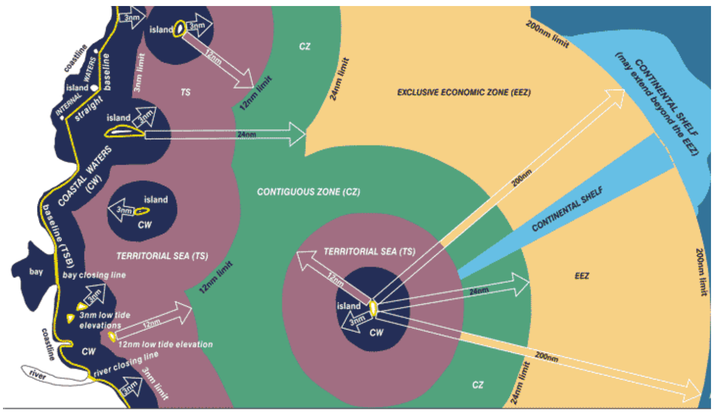

Fig 3. The land and sea area of the direction line and the natural shore line respectively bound to the inner and inland areas

4.2. Analysis of experimental results

When D=600m, the area obtained by using the Bessel method to determine the baseline coordinate of the linear sea-collar sea is increased by 1.73% compared with the ellipsoidal distance method; when D=400m, it is increased by 0.07%; when D=340m, an increase of 0.03%; when D = 300m, an increase of 6.40%. When D=600m and D=340m, the direction line obtained by the Bessel method for determining the linear sea-collar baseline coordinate algorithm is closer to the natural shoreline than the ellipsoidal distance. The error area is equal to the ellipsoidal distance. It is reduced by 0.39km^2 and 0.11km^2. However, the other two thresholds are not as close to the natural shoreline as the ellipsoidal distance. The error area is increased by 0.14km^2 and 0.48km^2 respectively. The scope of the sacrifice of precision [6].

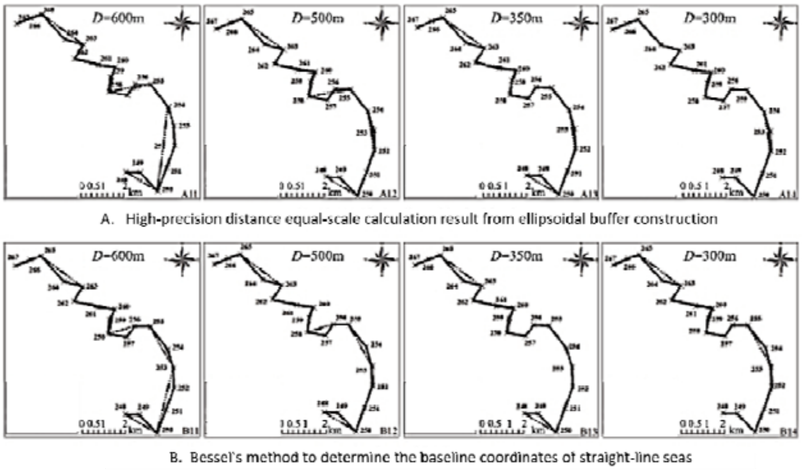

Fig 4. Measurement results obtained by two different algorithms

5. Conclusion

In this paper, the Bessel method is used to determine the straight-line sea-collecting baseline coordinate algorithm and the ellipsoidal distance equal-scale baseline method for the contiguous zone and the exclusive economic boundary. The following conclusions are obtained.

1) Area ratio: Under the various thresholds, the Bessel method is used to determine the baseline coordinate method of the straight-line sea-collecting sea and the ellipsoidal distance. The ratio of the area ratio of the entire coastline is between 1.037 and 1.0196. It can be seen that the area ratio obtained by the algorithm is greater than 1. The ellipsoidal distance is equal to the baseline rule of less than one, and the area ratio obtained by the Selfa method to determine the baseline coordinate of the straight-line sea is greater than the corresponding area ratio of the ellipsoidal distance equal-scale baseline method. It is shown that using the Selfa method to determine the linear sea-collecting baseline coordinate algorithm for the natural shoreline determination is more effective than the ellipsoidal distance and the proportional baseline method to effectively protect the national maritime rights and interests [7].

2) Compression ratio: The Bessel method determines the compression ratio of the straight-line sea-collecting baseline coordinate algorithm under the various thresholds for the entire section of the coastline to be thinner than the ellipsoidal distance. The average compression rate is 13.22%. Explain that the Bessel method determines the linear sea-collecting baseline coordinate algorithm to achieve higher compression ratio while protecting the national maritime rights.

3) Error area: Among the 12 thresholds of the three sub-areas in the experiment, the Bessel method determines the error area obtained by the linear-collar sea baseline coordinate algorithm. In most cases, the small ellipsoidal distance is equal to the baseline method, and the precision is better. Under the four thresholds of the shoreline, the Bessel method determines that the error area of the linear-coastal

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baseline coordinate algorithm is smaller than the traditional algorithm, and the average error area is reduced by 2.23km^2. A few undesired results that occur locally do not affect the overall effect.

It can be seen from the analysis of the above experimental results that although the Bessel method determines that the linear sea-collecting baseline coordinate algorithm cannot guarantee the accuracy and area ratio at the same time in some sub-areas of the natural shoreline, it is sometimes necessary to guarantee one of the factors while sacrificing another. One, but since this situation only accounts for a small part of the whole and can be improved by adjusting the threshold, balance can be achieved throughout the entire coastline, considering the requirements of high precision and area ratio. The experiment proves that the Bessel method can determine the baseline coordinate system of the straight-line sea-collecting sea to ensure the integrity of the sea area under the condition of ensuring high precision and compression rate. The performance is obviously better than the ellipsoidal distance and other proportional baseline method, and the better application effect is obtained.

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