TECHNICAL SOLUTIONS TO ESTABLISH MAP 1: 5000 OF SEABED NEAR THE SHORE

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Abstract
This paper focuses on technical solutions for nearshore seabed. Establishment of topographic map of the sea bed near the coast of the scale of 1: 5000 currently does not have National Technical Regulation. Deployment technology has its own characteristics and is different from traditional practices. We have successfully implemented the 1: 5000 mapping at Van Don area, Quang Ninh province. The solution applied is a combination of many deep measuring techniques such as wire sweep, single beam echo sounder, multibeam echo sounder, incorporating many positioning techniques such as GPS-RTK, DGPS reference satellite subscriber or nearshore station reference. Measurement results are compared in the coverage area of the two measurement techniques, and selected from the results of statistical analysis.

Key words: map 1:5000, nearshore seabed.

1. Introduction

The requirement to use a 1:5000 seabed topographic map and a terrain database for geographical information systems of islands and island groups is important for planning development of the national economy. The anchorages, storm shelters for fishing vessels, development of the seaport system and planning of economic development of the island to 2020, orientation to 2030 by the Prime Minister, contributing to maintaining national sovereignty, security and defense.
The surveyed areas near the shore have the same terrain as the upper part of the sloping island, which can mask the direction of measurement, is difficul for us surveying.
In this areas. The seabed's terrain is quite diverse, which is eroded into the mainland, the seabed is shallow, is mainly sand, gravel, rock, which is very dangerous in the process of surveying.
The map is edited by the Vietnamese People's Navy with small scale, low precision, old material. Some of the new maps are available in military port areas, which do not cover important marine economic areas. In addition, there are some shortcomings such as the coordinates on the map are not consistent with the national coordinates VN2000, the reference elevation is the lowest astronomical sea level, but not the national elevation Hon Dau.
Several map published by the Ministry of Natural Resources and Environment has a scale of 1: 10000 in some areas such as Do Son - Cat Ba, Thai Binh, Xuan Dai Bay, Phu Yen, Vung Tau, Phu Quoc. These maps do not guarantee the required data density for sea and island planning, economic development and security and defense. These documents are used to design the tracks of surveying on the sea and determine the boundaries of the measurements.
To establish seabed topography map scale of 1: 5000, we have to make:
- Marine equipment testing such as singlebeam echosounders (SBES), multibeam echosounders (MBES); Determining the speed of sound in seawater at the survey site;
- Build a testing area for deep measuring equipment;
- Build a tidal stations;
- Monitor sea level and determine hight water and low water.

2. Overview of terrain characteristics

The area of Co To Island and Van Don district in Quang Ninh Province ranges from 20 degrees 44 minutes north to 21 degrees 18 minutes north, and from 107 degrees 15 minutes east to 108 degrees 02 minutes east. The terrain on the island is steep, mostly rocky or sandy soils. Many terrain areas have obscured visibility, difficult to deploy terrain measurements.
The seabed topography is quite diverse. The topography of the seabed around island is strongly eroded. The dent is the erosion of seawater over time. The bottom of sea is mainly sand and gravel, or mud, sandy mud, and coral. This area also has some rocky beds, which are very dangerous during the sea bed survey.
The tide in this area is typical diurnal tide, high water and low water difference about 3 m – 4 m.

The depth of the seabed in this area is about 30 m. Sometimes the seabed is several meters deep and clamped with rocks. This makes it very difficult for deep measurement vessels to operate. The design of deep measurement lines also faces many obstacles due to the coastal terrain is very dangerous.
The deep measurement line often interrupted due to dangerous terrain, or by fishing activities of man. We have to add depth surveys by direct method, depth measurement by poles with small vessels.

3. Technical requirements and measurement methods

3.1. Technical requirements

The map was established in the coordinate system VN 2000, Hon Dau elevation system, 3 degrees of projection, central meridian 105^0, 108^0 depending on the area of the drawing.
Reference points for horizontal and height for mapping:

- State coordinates of rank I, II, III;
- Basic cadastral points; and
- State elevation of rank I, II, III.

The shoreline, the waterline:

- For sloping land areas (the waterline is considered to be the same as the shoreline), the measurement is close to the current water edge.
- For areas with gently sloping, with waterline on the beach. We define some terrain points with GPS-RTK.
- For areas with waterline on the beach continuously changing (tide). We use remote sensing photography and combined featured points on the beach to define water edge. With conditions, we have to time synchronization for 3 to 5 featured points.
- Terrain of seabed presented with depth contour and deep points. The density of deep points are 20 to 30 points for square decimeter on map, depend on seabed is complex or flat.

Marine measuring equipment is carefully checked, include: GPS receiver trimble R4, R7, 4000SSi, Beacon SPS351; Single beam echo sounder CEE Echo 200 kHZ transducer.

3.2. Measurement methods

In the area of Van Don island cluster selected 2 points. These two points are located in the Cai Rong port area, a point mounted on the wharf, a convenient location for landmarking, GPS tracking and long-term use. These two points have the number: TP1 TDD3, TP1TDB4.
Tidal information is thoroughly reviewed and tide gauge locations chosen for the area of Van Don island (coded NTCR and NTQL).

- NTCR point at Cai Rong port, Cai Rong town, Van Don district, Quang Ninh province. The determination of the "0" point elevation of the NTCR point is made by means of geometric measurement, precision as technical standards. The original point used for high-altitude navigation is 2 points for testing the sea level measuring equipment TP1TDB3 and TP1TDB4. The length of the route is about 2 km.
- NTQL point built at the old port of Quan Lan island, Quan Lan commune, Van Don district, Quang Ninh province. The determination of the "0" elevation of the NTQL is done by the geometric measurement method. Accurately equivalent to IV rank. The reference point used for elevation is the "tide station 2" near Quan Lan port. The length of the route is about 2 km.

Locating and adjustment points of sea chart were selected at specific locations of the terrain in the field (corners of piers, lighthouses, etc.), at intersecting points of intersection (intersection, Road junction ...) on the sea chart. In cases where the above locations are not selected (due to islands with too few point of orientation), they may be selected at the meandering points of roads, rivers, streams, Waterline ...

Points of orientation are marked with paint or wood piles in the field, ensuring their survival throughout the measurement and inspection. Adjustment points of sea chart on each island (each large island has 3 points) must be controlled all over and spread evenly around the island.

Using the Trimble SPS-351, OmniStar 8200HP ... to determine the coordinates of the points of orientation. Duration of signal reception within 30 minutes / point with 10 second interval. Measurements are stored as digital files, the location map must be fully displayed to ensure the recognition of the processing and submission of results.

To determine the sound velocity profile, use the SVP-15 to determine the sound velocity at the deepest position of each measuring area to correct for all map fragments in that region, or, taking the result is measured in the deepest part to repair in that map.

The lines base and direction of vessell on sea have been designed the East-West direction, the distance between two deep measurement lines in the field is 50m. Line deflection in the field should not be more than 20 meters away from the design. In case of deviation exceeding 20 m, additional measurements must be taken to ensure the data. The distance between two consecutive fix points on the same depth track is 10 m in the field. For areas with complex terrains such as canals, creeks, or small islands close together .... It is possible to change the direction of the depth gauge, but it is necessary to guaranteed the gap requirements between two consecutive lines, the distance between two consecutive fixes on a given line.

Checkings lines designed in the North - South direction, perpendicular to the deep measurement lines. Due to the influence of external factors (waves, wind, etc.), the angle of intersection between the checking track and the deep measurement lines shall not exceed ± 30^0 over the design angle. The distance between two consecutive checking lines in the field is 400m. Applying the principle that the total length of the checking line should not be less than 10% of the total length of the deep measurement lines, the checking lines shall be distributed evenly over the area. Distance between two consecutive fix points on the same line is 10m in the field.

4. Results at the Vandon area

4.1. Base networks

GPS resever: Trimble R4 (serial number 2421, 2433, Antenna

R4-2 internal), Trimble R7 (serial number 2882, 2879. Antenna Zephyr Geodetic), Trimble 4000 SSi (serial number 31706, 26617. Antenna Compack L1/L2).

Establish new points: BS02, BS 03, BS 04, BS 05, BS 06, BS 07, TP1TDB4, TP1TDB3.

Table 1. coordinates and elevations of reference points

Work: Vandon - Quangninh

VN2000, meridian 108 ° 00, region of 3 deg, F = 0.9999					
No	Name	**ID**	**North (m)**	**East (m)**	**Leveling (m)**
	Thôn một	107444	2333743.336	443349.332	2.271
	Cửa Ông	107447	2326331.335	434326.839	57.538
		TP1TDB3	2329930.231	440688.036	2.312
		TP1TDB4	2329671.903	440615.419	3.065
WGS84					
	Thôn một	107444	21º05'47.642176	107º27'23.768375	
	Cửa Ông	107447	21º01'45.54854	107º22'12.160327	

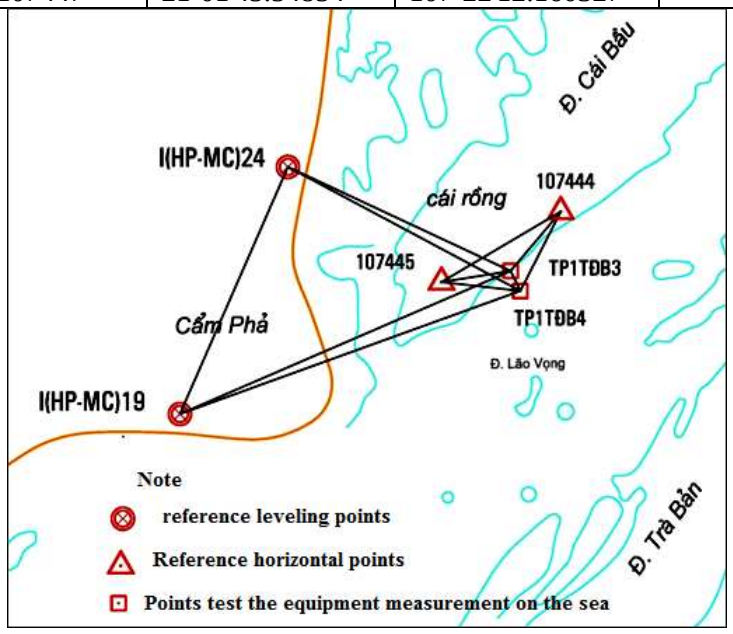

Figure 1. Points TP1TDB3, TP1TDB4 on map

Depth was determined by CEE Echo 200 kHZ transducer (SBES); The coordinates are determined by the Trimble SPS 351.

The tide-testing station serving the Van Don island is the Cai Rong tide gauge (NTCR), built at Cai Rong - Cai Rong town - Van Don district - Quang Ninh province.

Read the number on the board staff every 30 minutes, before and after the high water or low water, every 10 minutes read the number once.

In the survey, the total lines deep measurement is 70 routes, the distance between the deep survey lines is 50m, the distance between the consecutive fix points on the same deep survey line is 10m. The number of checking lines is 6, the distance between the checking lines is 400m, the distance between successive fix points on the same checking line is 10m.

Figure 2. Trimble SPS 351 on the vessel

Figure 3. Antenna on the vessel

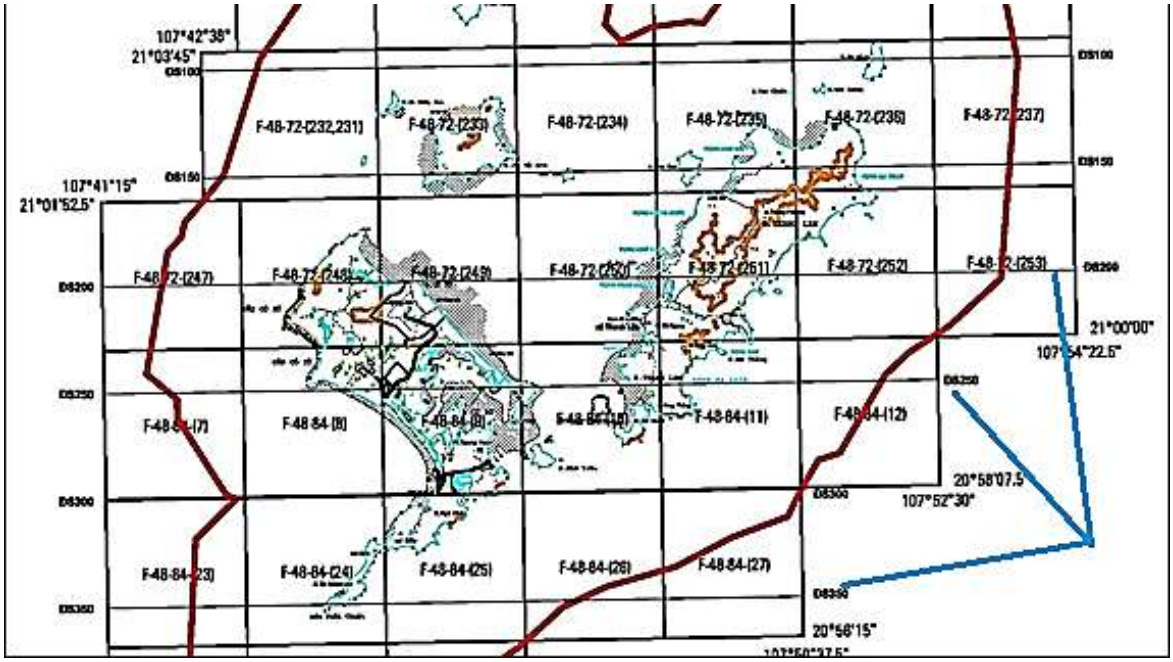

Figure 4. The plan of the deep measurement line at Coto Island

The integration of DGPS with bathymetric measurements may produce a more reliable data set which contributes to the knowledge of the seafloor topography in areas where hydrographic survey sparse.

The systems studied up until now perform indirect measurements and are sensitive to seawater characteristics. In typical conditions, gross errors in the depth measurements are likely to occur, these are generated by echoes from within the water column and therefore they do not related to the seafloor, for instance they can be caused by: kelp, schools of fish, deep scattering layer, thermal plumes and sediments in suspension. Additionally errors may occur near piers, where echo detection occurs from the returns of side lobes from the pier itself.

Mechanical methods (lead line or pile) are not sensitive to these particular enviroconditions and may provide an alternatively method.

Bar or wire sweep or pile methods are an unambiguous way to detect depths over stone orphaned obstructions.

Some of the nearshore areas are less than 3 meters deep, near cage fisheries, or fishing, or reefs, which greatly affect progresing the deep measurement on the sea. We have to use a pile with a GPS antenna to determine the depth of the seabed, coordinates determined by the GPS-RTK technique. Base stations onshore are points TP1TDB3, TP1TDB4. These are reference points for coordinates and heights, which have been measured up to the coordinates and elevation of the state.

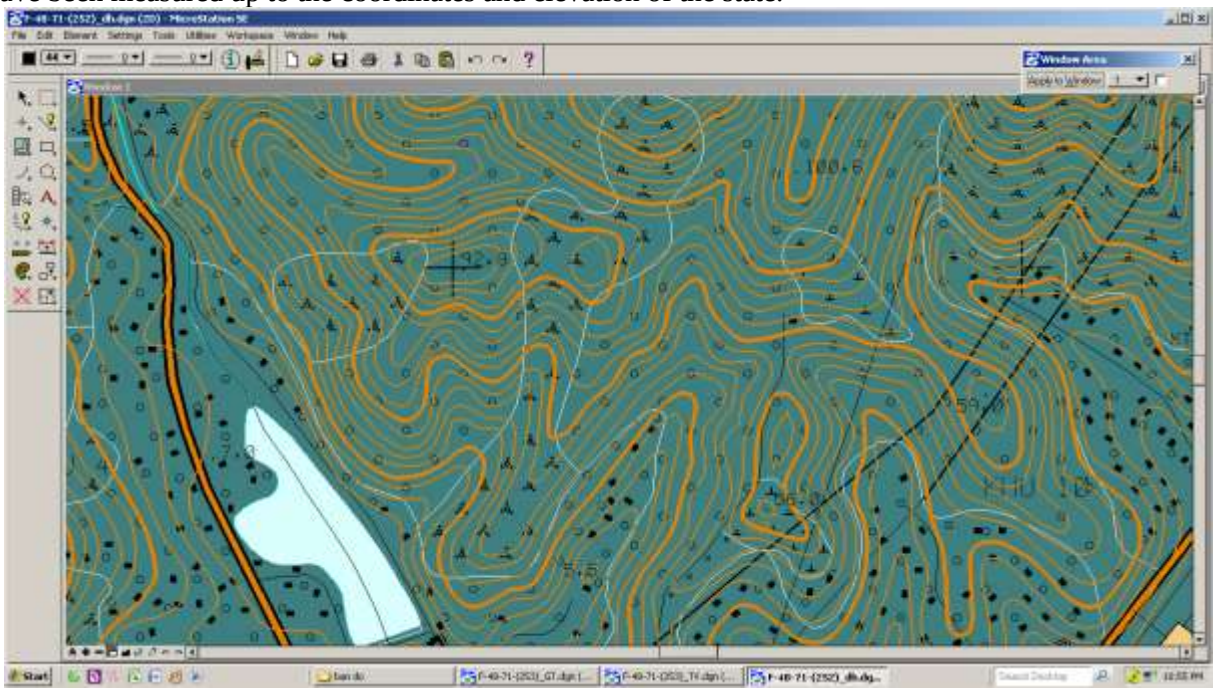

Figure 5. Part of the map 1:5000 of Coto island (in Microstation SE)

5. Conclude

- We have surveyed sea bottom terrain with many combined technologies: single beam echo shound, tidal information is thoroughly reviewed at tide gauge locations chosen, using kinematic GPS technical with instrument Trimble SPS351 beacon, technical GPS-RTK, and the pile with antenna GPS-RTK.
- During the measurement process, we encountered many difficulties due to complex terrain of the seabed, fishing activities and activities of coastal navigation.
- Local vertical control data is reviewed to see if it meets the expected accuracy standards, so the tide gauges can be linked to the vertical datum used for the survey. Horizontal control is reviewed to check for accuracy and discrepancies and to determine sites for local positioning systems to be used in the survey.
- Some deep measurement lines have to be supplemented because of the impact of fishing activities.
- The nearshore area is often measured with technical GPS-RTK and pile, due to its shallow depth and complex terrain.
- Measurements overlap 25%, ensure continuation of the map and cross-check between different measurement techniques.

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TÓM TẮT

GIẢI PHÁP KỸ THUẬT THÀNH LẬP BẢN ĐỒ ĐÁY BIỂN GẦN BỜ TỶ LỆ 1:5000

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Bài báo này tập trung vào giải pháp kỹ thuật đối với công tác đo vẽ thành lập bản đồ đáy biển gần bờ. Việc thành lập bản đồ địa hình đáy biển gần bờ tỷ lệ 1:5000 hiện nay vẫn chưa có Quy chuẩn Quốc gia. Công nghệ đo vẽ bản đồ 1:5000 có những đặc điểm riêng và khác với thành lập bản đồ tỷ lệ nhỏ hơn. Chúng tôi đã tiến hành đo vẽ thành công bản đồ tỷ lệ 1:5000 tại Vân Đồn, Quảng Ninh. Giải pháp chúng tôi áp dụng là sự kết hợp của nhiều kỹ thuật, như Máy đo sâu hồi âm đơn tia, hồi âm đa tia, dây hoặc cọc đo sâu, định vị GPS-RTK, DGPS với thuê bao vệ tinh hoặc trạm vi phân ven bờ. Thành quả được so sánh và tổ hợp từ hai kỹ thuật đo khác nhau, bao gồm kỹ thuật phân tích thống kê dữ liệu đo.

Từ khóa: bản đồ 1:5000, đáy biển gần bờ.