

SAFETY OF MODERN SHIPPING AND REQUIREMENTS IN HYDROGRAPHIC SURVEYING AND NAUTICAL CHARTING

by Jean-Nicolas PASQUAY
Ingénieur Général de l'Armement (Hydrographe) (*)

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ABSTRACT

With the increase of ship's draught in the sixties and the changing pattern of shipping it became quite obvious, twenty years ago, that both the status of hydrographic surveys in the world and the status of available charts were not meeting the requirements for safety of navigation.

Many parts of coastal areas are as yet unsurveyed, or very scarcely surveyed, or have not been resurveyed since the lead line surveys of the last century. The paper gives the example of the state of surveys in the North Sea and indicates measures taken by the bordering countries to improve the hydrographic situation. Other parts of the world are also considered. For some parts of the world, the situation of nautical charting and nautical information has considerably deteriorated in the last 30 years, whereas the standards to meet the requirements of shipping are higher than before.

Emphasis is placed on the fact that routeing measures had been designed, until recently, without careful consideration of hydrographic conditions. An unfortunate case in the Gulf of Suez is given as example.

Main efforts made by the International Hydrographic Organization to improve hydrography and charting are reviewed : international chart, regional hydrographic

(*) Service Hydrographique et Océanographique de la Marine, 3, avenue Octave-Gréard, 75200 Paris Naval, France.

commissions, technical assistance, cooperation with the International Maritime Organization.

An insight into the use of recent techniques in order to improve quality and completeness of surveys is given. The role of automation in speeding up the process of surveys, chart production, and dissemination of nautical information is underlined. Indications on what the mariner can expect from the electronic chart complete the article.

The article concludes that modern techniques by themselves are unable to narrow the present gap between navigational requirements and the state of hydrography. More coastal States must become aware of the situation and its risks and must have the will to use the means to face the challenge.

1. INTRODUCTION

Until 1950, the largest ships of the merchant fleet and major warships had the same draught : about 12 m. Hydrographic offices concentrated their efforts on those areas likely to contain hazards to such shipping, that is to say, the areas extending from shallow waters to the 20 m contour line. The maximum draught of warships has been stable, whereas the draught of merchant vessels has increased considerably, up to 30 m in recent years. A VLCC may risk grounding after having crossed the 30 m line or even the 40 m line. Nowadays, the part of the continental shelf which is best known is the part in which the largest vessels are unable to operate.

On the other hand, trade has changed : new harbours and offshore terminals have been established in areas which had never seen international traffic, and which had, in fact, never been surveyed.

For reasons of economical effectiveness, masters have to venture into harbour approaches with less underkeel allowance than before. Thus, there is a requirement for very detailed surveys of those approaches, making sure that no rock or artificial obstruction rising 2 or 3 metres above the general seabed remains undetected. For the same reason, accuracy of tidal predictions must be improved.

In short, the changes in the pattern of shipping have produced both a shift and a tremendous widening of hydrographic needs.

2. THE STATUS OF SURVEYS

Mariners use charts, not survey sheets. But the quality of a chart depends on the quality of the surveys upon which it is based. Surveying is a preliminary and never-ending task. Surveys depend on : the state of surveying technology and the methods used; the needs of shipping at the time they are carried out; and the time and resources available. Natural changes of the seabed (in sand and mud areas), dredging, and appearance of new wrecks, are other strong reasons for resurveying.

We do not have, at the moment, a comprehensive picture of the status of surveying worldwide. Some significant examples can be cited, relating to the following areas : the North Sea and the English Channel, France including its overseas departments and territories, former French territories and the South China Sea.

2.1. North Sea and English Channel [1]

The North Sea and the Channel are among the areas with the highest amount of shipping traffic in the world. About 10 % of accidents and 50 % of collisions at sea occur in these areas, in which the weather is sometimes rather rough. If we add the casualties at sea of the last wars, it is hardly surprising to anybody that these areas are graveyards for wrecks. (20,000 wrecks are located in the N.W. European waters, out of a world total of some 100,000).

In the early sixties, it became quite obvious to the Hydrographers of the bordering countries that the hydrographic knowledge of the North Sea was inadequate for the safe navigation of the new large, deepdraught vessels. The North Sea Hydrographic Commission (NSHC) was created in 1963 in order to face the challenge with co-operation. Later on, the Channel was included in the area of interest of the NSHC. The state of surveys, assessed in 1963, was alarming : very few detailed surveys by echo-sounder; some detailed surveys by lead-line; most of the central part of the North Sea was covered by open surveys (exploratory surveys) and some areas had never been surveyed at all. Efforts had to be concentrated first on defining and surveying recommended tracks likely to be used by deep-draught vessels. The careful survey of such deep-water routes was a lengthy task : all wrecks, or pieces of dispersed wrecks, had to be located and "heighted" with accuracy; every shallowing of the seabed had to be depicted.

After twenty years of work a considerable amount of progress has been achieved. The centre of the North Sea is no longer an unknown area : modern exploratory surveys have been carried out. This does not mean that every danger for VLCCs is known in this area, but it is reasonably safe for ships of about 10 m draught. Hydrographers defined what they called areas with "adequate comprehensive surveys", which are areas where existing surveys are of such a standard that detailed re-examination is unlikely to be required in the foreseeable future. In the southern part of the North Sea and in the Channel there are changing areas which require periodic resurvey (at 1-year intervals for the most critical areas, at 3- or 5-year intervals for others). NSHC members agreed to share this task in the interests of international shipping.

2.2. France and its former territories

France's Hydrographic Service was established in 1720, and one could expect at least France's European waters to be adequately surveyed. Unfortunately, this is not the case. France had an Empire, and a great part of its hydrographic resources in the last century and until the early 1960's were spent overseas.

Figure 1 represents the state of hydrographic surveys in France's exclusive economic zone (EEZ). In France's European waters, 50 % of the area between the coast and the 50 m contour line are adequately surveyed ("black area"). In our EEZ 30 % of the deep waters (depths greater than 200 m) have not been systematically surveyed or are still unsurveyed ("white area"). The state of surveys in our Atlantic overseas departments is very similar to that of our mainland waters. However, in our Pacific territories, the "grey areas" (old surveys) or "white areas" are of considerable extent. In the Indian Ocean, the situation is very poor indeed.

For territories which belonged to France's Empire, and which are now independent countries, the situation is varied (see fig. 2, 3 and 4). There, France stopped its hydrographic activities in the early sixties and, since then, very little has been done in some parts, nothing in others. Some countries like the Congo, Gabon or Senegal compare favorably with those of our overseas departments and territories which are relatively well-surveyed. Others are in the same poor situation as our territories in the Pacific or the Indian Oceans.

2.3. The South China Sea

The U.K. Hydrographic Department has made an interesting study on the state of surveys in the South China Sea, through which the main shipping routes connecting the Pacific and the Indian Ocean pass. Figure 5 (chartlet produced by U.K.) shows vast areas, with numerous potential hazards, which have not been systematically surveyed, and others which have only had lead-line surveys. There is, for example, a real need for surveys in Selat Gelasa (Java Sea) which is an important passage for traffic from the Indian Ocean to Singapore, Hong-Kong, Manila and Japan. To avoid the danger of striking an uncharted reef, the alternatives are to take a much longer route through Selat Karimata or through Selat Bangka (See fig. 6).

3. QUALITY, ADEQUACY AND AVAILABILITY OF CHARTS

After this rather grim outlook on the state of surveys, we can conclude that the charts available are mainly based upon old surveys, a large part of which are open spaced or exploratory; a number of charts have large "blanks".

For many years chartmakers included in the title of their charts such formulae as : "From the latest information available to the Hydrographic Office, 1977". This meant only that, for the 1977 edition, all information reported to the Office had been taken into account, even if, in fact, no information of substance had been reported since the 1877 or 1827 surveys from which the chart was derived. Nowadays, numerous charts include a "source diagram" indicating the date and scale of the surveys used in their compilation and, if necessary, some comments which may help the mariner in appreciating the degree of reliance to be placed on the chart. Furthermore, for very good reasons, such as the use of the new chart specifications, or the use of the latest land surveys and new geodetic references,

STATE OF HYDROGRAPHIC SURVEYS FRANCE

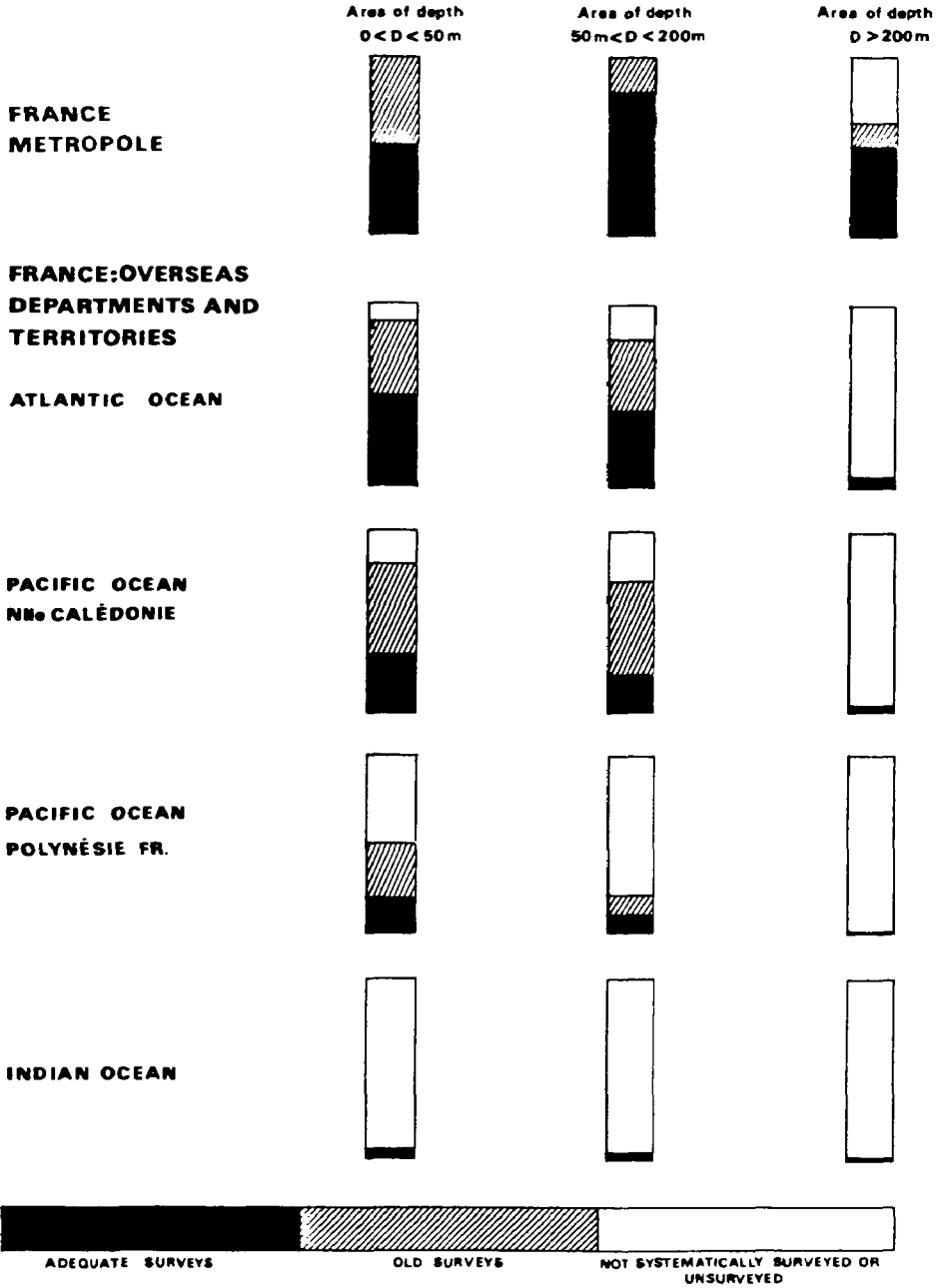


FIG. 1

STATE OF HYDROGRAPHIC SURVEYS

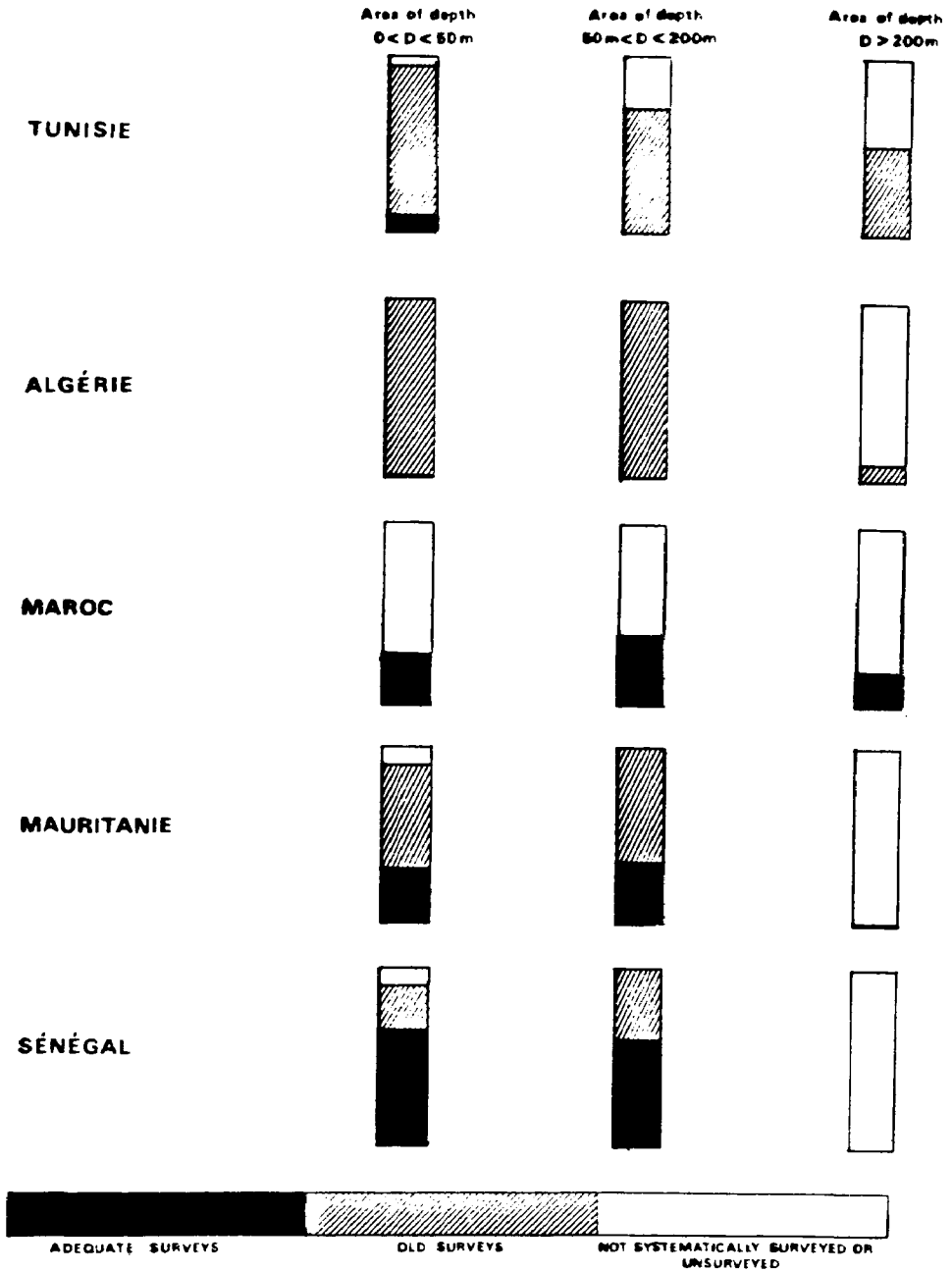


FIG. 2
Tunisia, Algeria, Morocco, Mauritania, Senegal.

STATE OF HYDROGRAPHIC SURVEYS

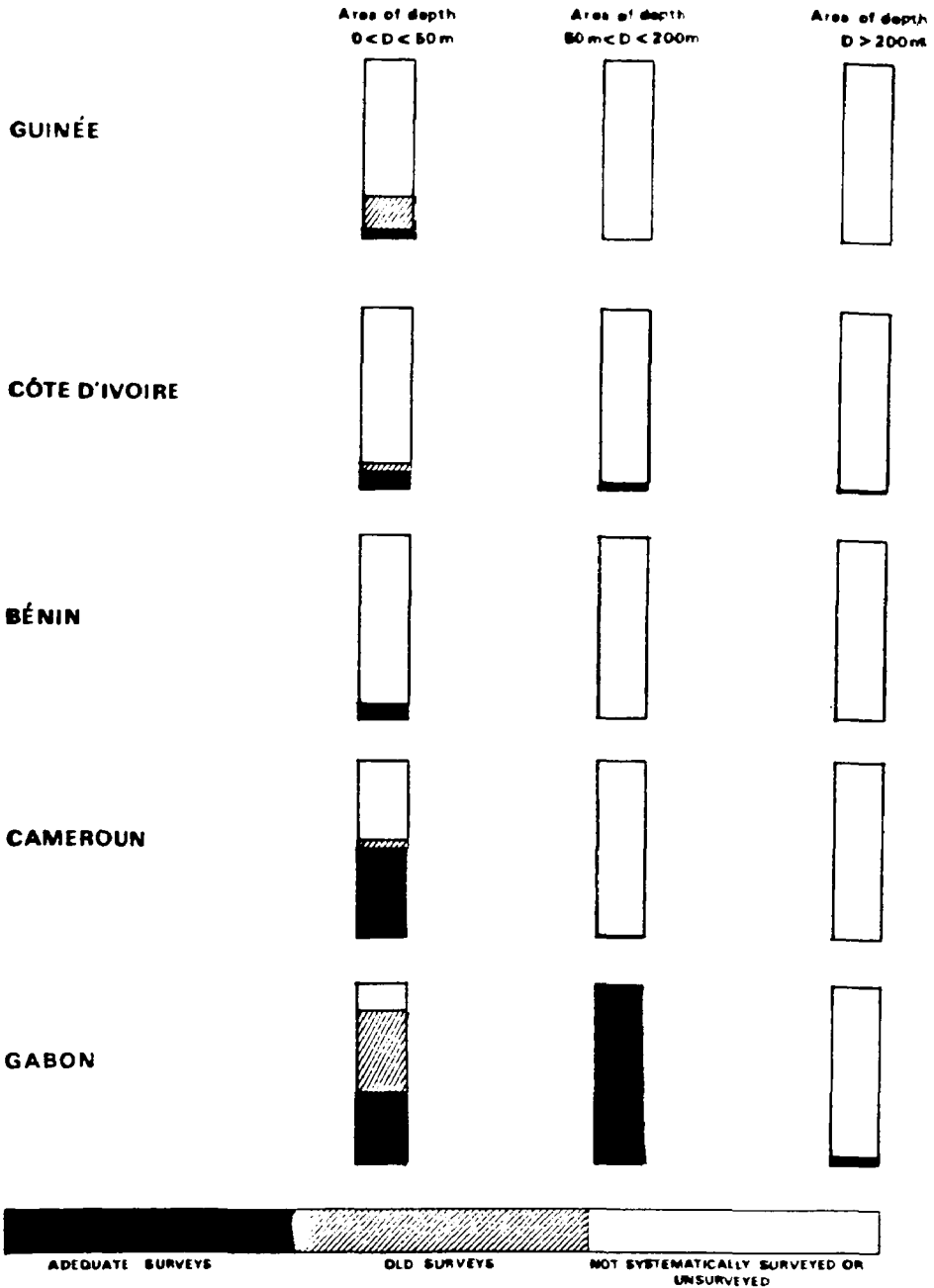


FIG. 3

Guinea, Ivory Coast, Benin, Cameroun, Gabon.

STATE OF HYDROGRAPHIC SURVEYS

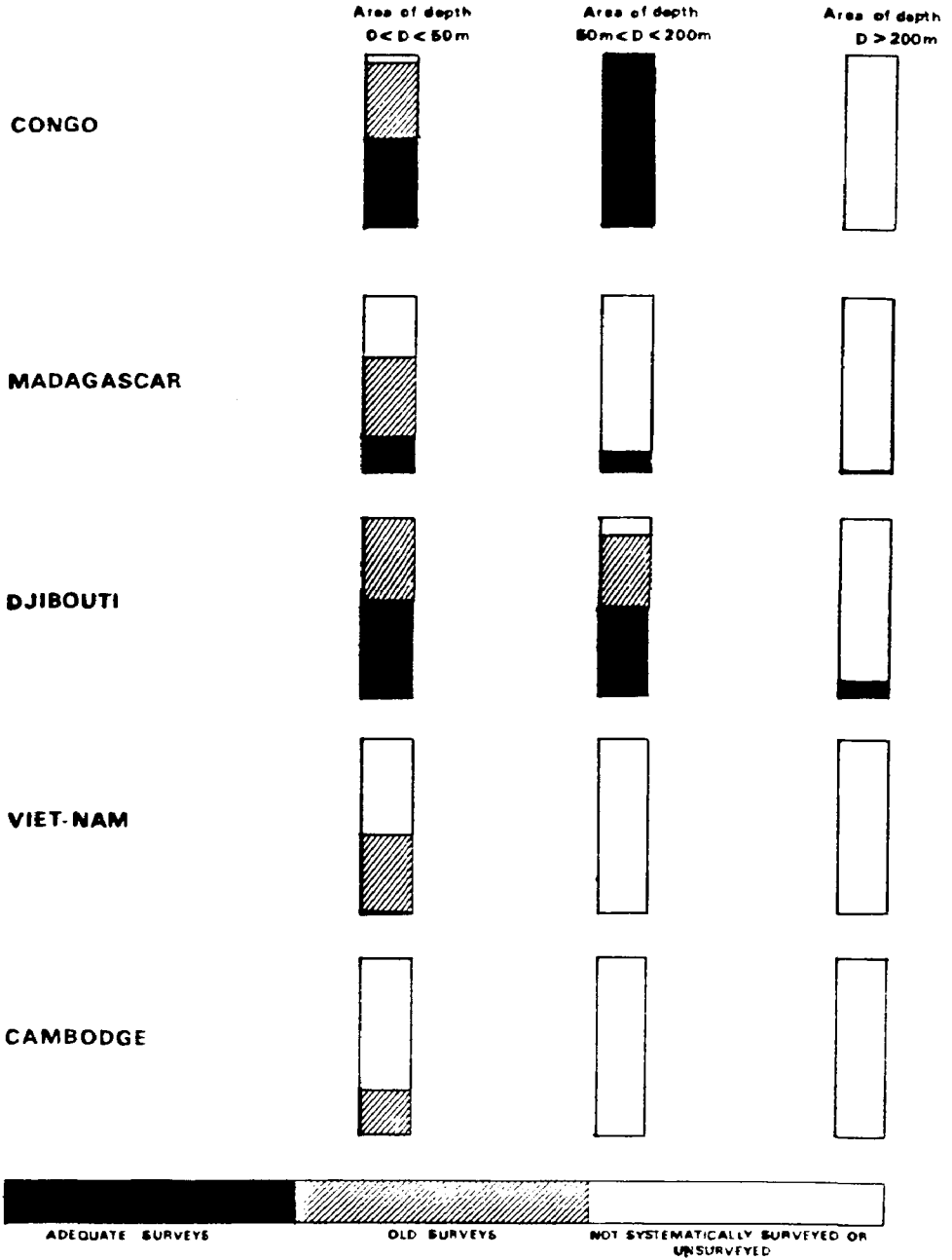


FIG. 4

Congo, Madagascar, Djibouti, Viet Nam, Cambodia.

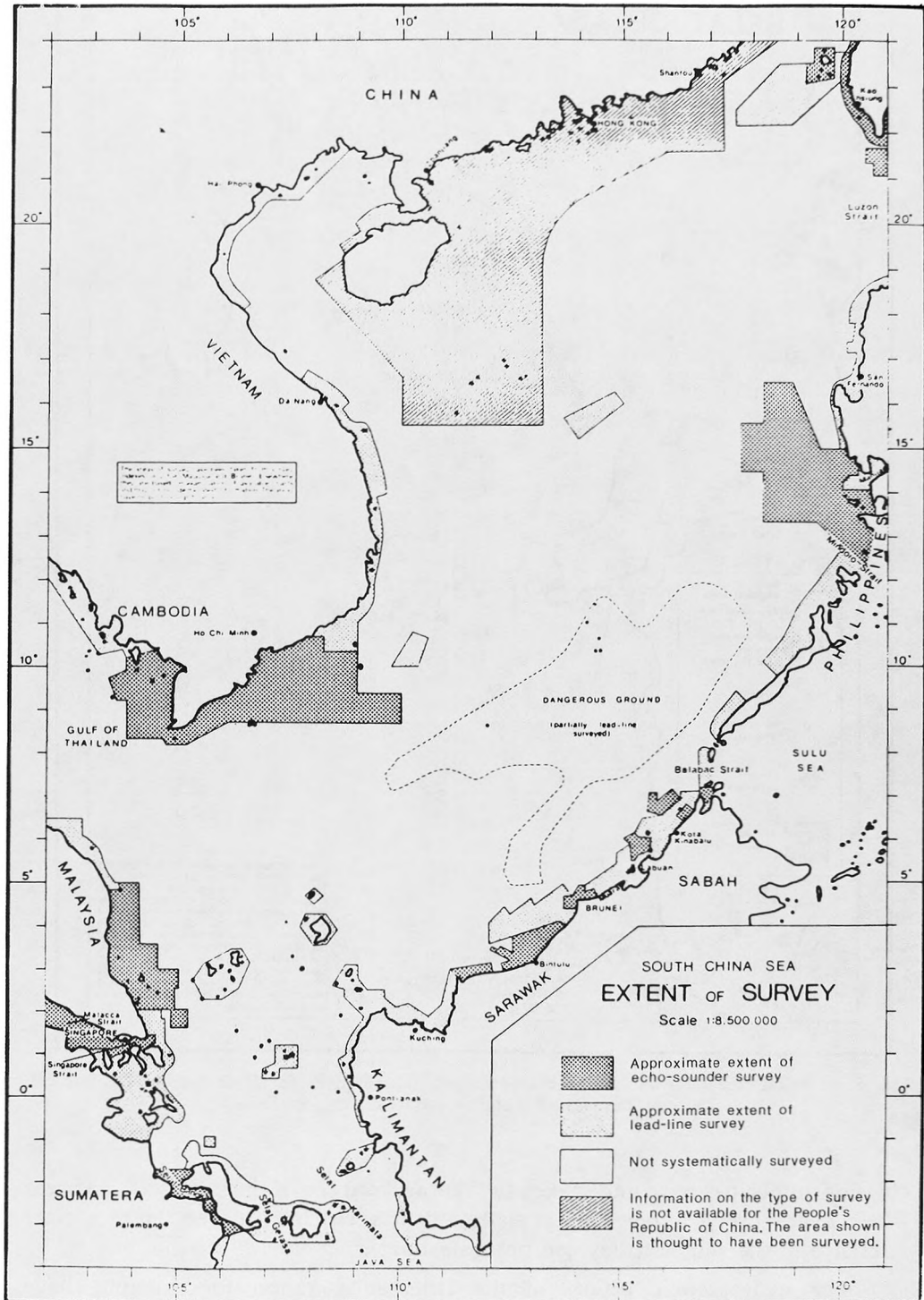


FIG. 5. (Prepared by the Hydrographic Department, Taunton [Ref. H 4412/83] and reproduced with permission).

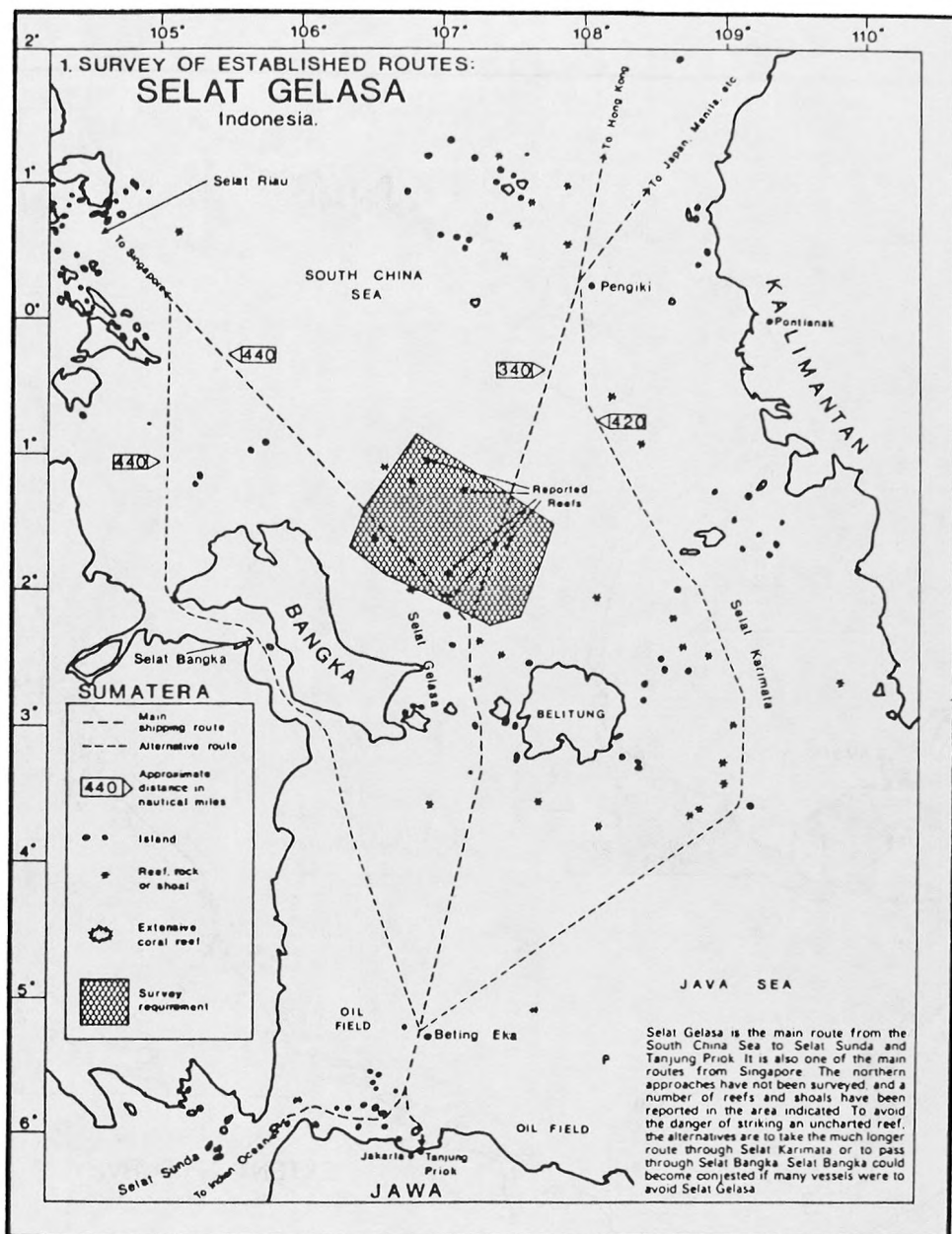


FIG. 6. — Requirement for survey (an example case). (Prepared by the Hydrographic Department, Taunton [Ref. 4412/83] and reproduced with permission).

charting authorities have undertaken to “redraw” old charts in a new style, in areas where hydrographic surveys are actually old. If such charts do not make a clear reference to the sources, they can be misleading.

The hydrographic offices of the U.K. and France, for example, have worldwide chart series, and once had wide-ranging surveying responsibilities they no longer have today. Both offices face difficulties in updating their charts. They lack information on elementary but essential items such as : new landmarks, new

buoyage, new harbours, etc., not to speak of newly discovered shoals, wrecks or changes in the seabed which can only be notified by coastal States with a surveying capability. For some parts of the world, the situation of nautical charting and nautical information has deteriorated in the last 30 years, whereas the standards to meet the requirements of shipping are higher than before.

In 1982, Captain MAYBOURN [2] outlined the general requirements as they are seen by shipping companies. These requirements can be summarized as follows. The first need is an access to up-to-date charts and corrections : a comprehensive chart cover in a suitable range of scales, but using no more charts than necessary, the presentation being in standard format. Experience shows that the commercial arrangements for the supply of both charts and notices to mariners in the major ports of the world are far from being adequate.

4. NAUTICAL CHARTS AND OTHER PUBLICATIONS AND SAFETY AT SEA

Nautical charts and other nautical publications are essential tools for safe navigation. The mariner's duty in this field is defined in SOLAS 1974 as follows : "All ships shall carry adequate and up-to-date charts, sailing directions, lists of lights, notices to mariners, tide tables and all other nautical publications for the intended voyage". Conditions for safety are both existence of adequate charts and other publications and the seamanlike use of those documents. Safety at sea is a main concern for the International Maritime Organization (IMO). Ship's routeing is one of IMO's achievements. Whereas deep water routes have been, since the beginning, established after detailed surveys, no such measures have been taken, until recently, for traffic separation schemes (TSS). So the mariner should be aware that there may be risks of grounding inside a TSS in areas of inadequate surveys. Anyway, inside the designated lane, the mariner must look carefully at the charted seabed to assess whether he can proceed safely in the whole lane or whether the draught of his vessel precludes the use of part of the lane.

For illustration, let us consider the unfortunate case of the Liberian tanker *Al Diriyah* (draught 22.9 m) which on 18th May 1983 struck an uncharted rock in the northbound lane of the Gulf of Suez — TSS — Part B — Strait of Jubal. There was substantial damage to the ship and considerable pollution. The incident occurred in an area which was last surveyed in 1870, and where mariners could expect 30 to 35 m of water. The TSS had been adopted by the Maritime Safety Committee (IMO) without prior consideration by the Sub-Committee on Safety of Navigation and became effective on 15th March 1983. Before that date, deep-draught vessels used to follow a route without shoals, in the west of the northbound traffic lane. Lessons have been drawn from this incident. The IMO guidance document on routeing measures was amended to clarify the responsibilities of governments in proposing a routeing measure and that of IMO in adopting it : adequate hydrographic knowledge of the area affected is now considered an essential pre-requisite.

5. ACTION BY THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION (IHO)

Let us now give a more optimistic picture, considering the endeavours made by the IHO to bridge the wide gap between the requirements of modern shipping and what is available today [3].

New chart specifications were adopted by the IHO in 1982. This should result in a more homogeneous presentation of charts, which should greatly facilitate the use of charts published by the various hydrographic offices. The first step towards standardization was the production of an international set of charts (INT charts) at small scales (1:10M and 1:3.5M) which started 15 years ago and is now completed. In recent years, INT chart schemes on medium and large scales were devised and adopted within regional charting groups which are part of Regional Hydrographic Commissions (RHC). The concept of INT charts is to meet the needs of international shipping at the lowest cost by sharing the burden of compiling those charts between different agreed producers. RHCs are not only concerned with charting. Their work includes cooperation in all fields of hydrography. And since non-IHO Member States can be RHC associated members, a bridge exists toward technical assistance.

Technical assistance to developing countries has become, in recent years, a major task of the IHO, which advises and assists them in the formulation, development and implementation of hydrographic projects or the strengthening of their hydrographic facilities.

IMO is the first international organization interested in the products of hydrographers, so that close cooperation between IMO and IHO is of major importance for safety at sea. To meet part of a demand by IMO, a catalogue of chart agents worldwide has been published by the International Hydrographic Bureau (IHB) and disseminated among the international maritime community. Of course, this does not solve the whole problem of availability of adequate charts. These final objectives cannot be reached before all other actions still in progress and mentioned above have achieved substantial results. In the same context, IMO has adopted a resolution on RHCs and charting groups which had been prepared by the IHB.

6. TECHNICAL MEANS IN MODERN HYDROGRAPHY

Progress in hydrography is not only a matter of policy; it depends on the technical means used to face the challenge. The hydrographic survey vessel and its soundings boats are, and will continue to remain, a major part of the data collection process. Whereas the traditional echo-sounder covers only a narrow strip under the track of the vessel, side-scan sonars (see fig. 7, 8 and 9) and multibeam

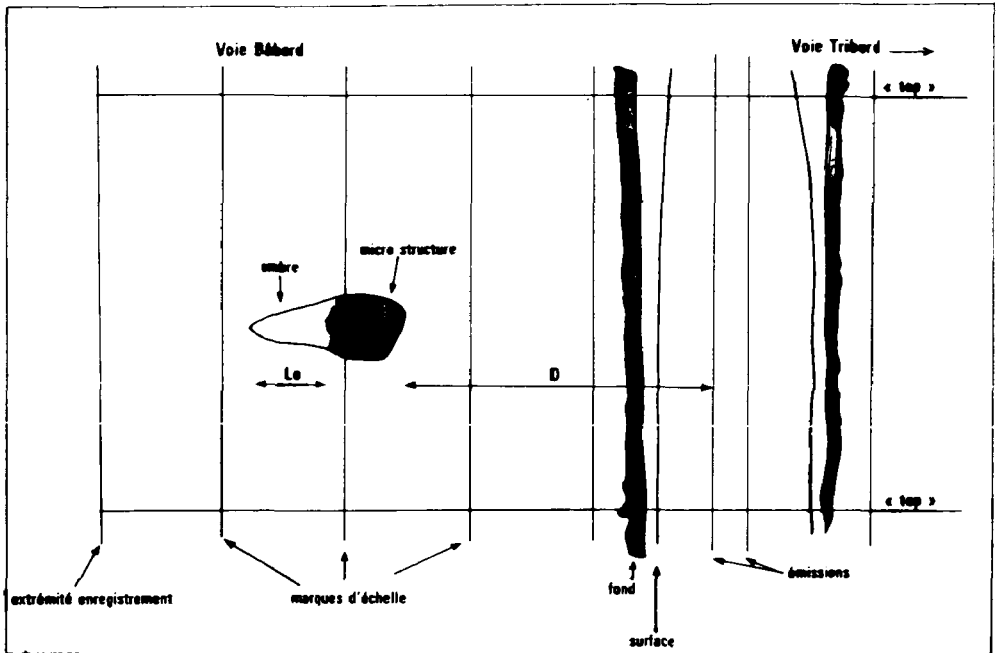


FIG. 9. — Sonar processing. (Read from top to bottom and from left to right : port side; starboard side; shadow; micro structure; limit of recording; scales; bottom; surface; transmissions).

echo-sounders (see fig. 10) have the ability to cover very large areas on either side of the ship's track. The old surveyor's dream of making a 100 % coverage of the seabed so that no part of it has escaped detection is now a reality. Hull-mounted sector-scan sonars are used to detect hazards : wrecks, shoals and pilings. But for comprehensive investigations, vessels proceed generally at low speed, so that the surveying of critical areas is rather slow. In fact, the use of these methods does not significantly increase the speed of surveying, but leads to a definite gain in reliability, completeness and cost-effectiveness of surveys.

Promising survey techniques consist in using space sensors such as the multispectral scanner flown aboard the LANDSAT series, or the synthetic aperture radar. The use of aircraft with LASER depth sounders to supplement surface vessels for coastal surveys is pursued by several countries. Remote sensing techniques are not yet at an operational stage. They are used for "reconnaissance work", which is very useful for survey planning by vessels.

The use of GPS NAVSTAR should greatly facilitate hydrographic surveying everywhere in the future. The extensive preparatory geodetic operations and the maintenance of shore-based electronic positioning systems should not survive this "revolution".

My paper would not be "fashionable" if I did not mention automation. The early efforts towards automated hydrographic data acquisition and processing began in the late sixties. But today a lot has to be done to reap substantial benefits

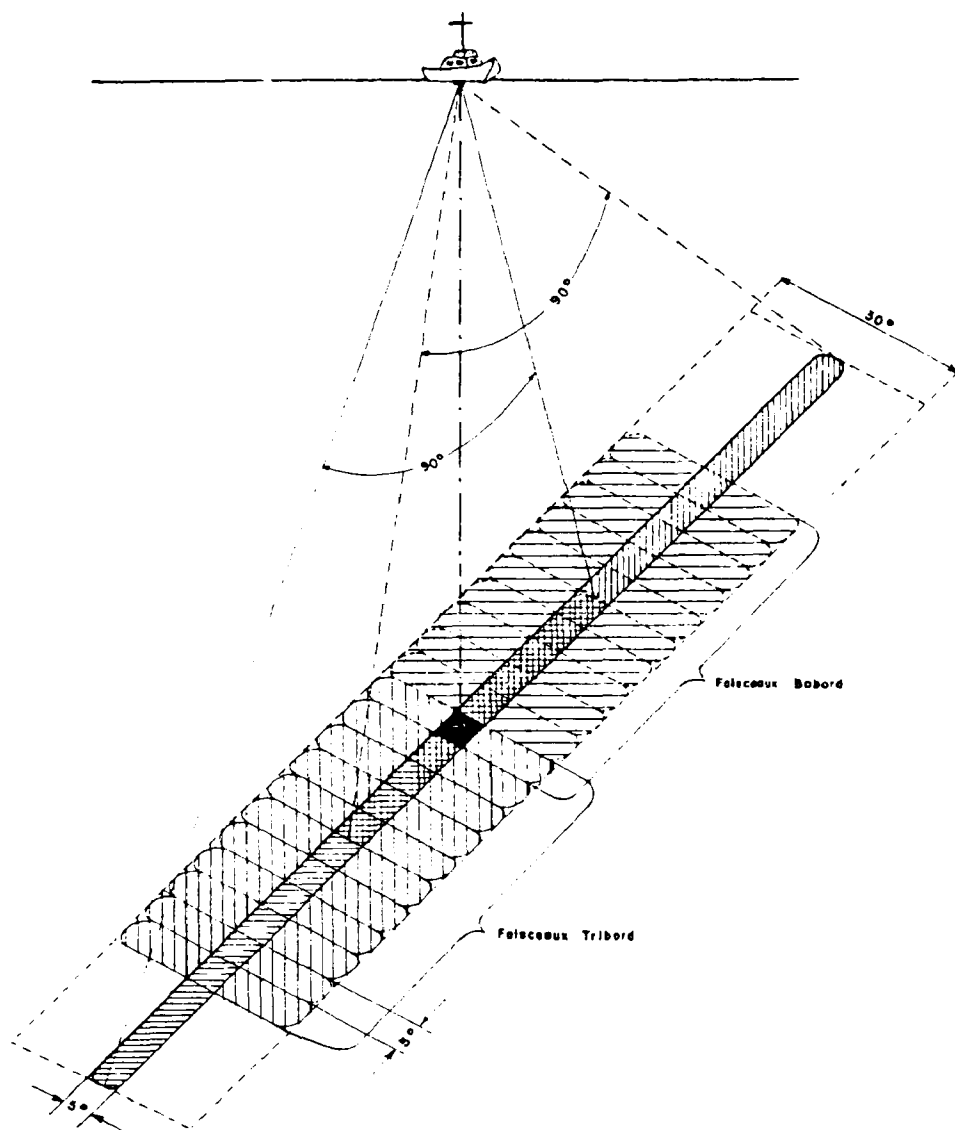


FIG. 10. — Multibeam sounder. (Faisceaux babord = port beams; faisceaux tribord = starboard beams).

from automation, which should be a faster, easier, more economical means of operation, while improving quality and accuracy. In the near future, results of the survey will be stored in a field sheet data base, then transferred to a chart data base from which the chart will be compiled. Given the state of surveys worldwide and the requirements of shipping, the need for speeding up the whole survey process, as well as the production of charts and the dissemination of nautical information, is obvious.

7. THE "ELECTRONIC CHART"

On the user's side, automation prompted by an information overload on the bridge is already in progress. With more traffic, higher speeds, nav aids and traffic control, the overstrained officer of the watch may have no time left to put his head to the chart table plotting his ship's position. No wonder we see some imaginative manufacturers proposing "electronic charts" (E.C.). The concept of the so-called E.C. is that all chart data needed on the bridge would be stored in a computer memory and would be instantly available for display. The E.C. is part of an integrated navigation system, and perhaps, at the end of the century, will be part of a fully integrated bridge system. The existing ECs are far from giving all information presently on paper charts. The risk of cluttering does not really exist because one of the advantages of the electronic display is the possibility of selection. We just need to define categories such as : soundings, contours, shipping lanes, topography, lights, etc.; the officer of the watch may call the appropriate categories to gain a clear picture. For safety reasons, there is a strong need for a permanent display of some essential information (shoals, danger contour-line, buoys, etc.).

The development of these systems is, or should be, a matter of concern to hydrographers and also to those responsible for establishing and enforcing safety regulations at sea. The paper chart displays prominently dangers to navigation and is always at a smaller scale than the survey. Magnified displays are risky. The correction or updating of the E.C. should relieve the mariner of the burden of hand corrections. But speedy and safe updating of the onboard data base is a pre-requisite. We have seen that chart production increasingly uses computers and digital data files. Going one step further, providing digital files to mariners should be possible in the future.

However, the paper charts should not disappear in the next decades. In the year 2000, a cautious VLCC master should have paper charts on board, in case a failure should occur in his integrated bridge system.

8. CONCLUSION

New technologies should in the future both back up the production capabilities of the existing hydrographic offices and facilitate the on-bridge use of charts and other nautical publications in appropriate form. But unless all coastal States are aware of their obligation to survey their EEZ in order to provide adequate information to modern shipping, the wide gap between mariners' requirements and hydrographic data will remain. The national and international cost of the present situation, and the benefits to maritime development of any improvement in this field, should be assessed (in addition to the interests of exploration of EEZ resources). IMO's and IHO's endeavours to promote hydrography would then have better chances of success.

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