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APPRAISING THE CASE FOR A HYDROGRAPHIC SURVEY VESSEL : THE PLANNER'S VIEWPOINT

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INTRODUCTION

Whilst the case for establishing or expanding a national hydrographic service may be readily apparent to the professional hydrographer, this is not often so to those responsible for allocating funds to public sector projects. Economists and planners working in central government departments are called on to assess the relative merits of numerous projects competing for scarce capital resources, often in areas in which they have no specialist knowledge.

Although the distribution of public sector capital resources between different sectors and Ministries is frequently subject to political and historical considerations, the planners will generally attempt to adjudicate between competing claims on the basis of a project's contribution to the national development effort, often defined more specifically in terms of the net increase in national income. Assessment of a project's developmental value is frequently made in terms of an analysis of the project's rate of return (the benefit/cost ratio) which assesses the extent to which benefits exceed costs over the lifetime of a project's assets, using an appropriate discount rate.

Appraising the developmental impact of a survey vessel is complicated by the fact that revenue derived from the sale of its immediate output, data relating to physical and other characteristics of the ocean and sea-bed published mainly in the form of charts, does not adequately indicate the value of the contribution of a hydrographic service to the national economy. The planner too is unlikely to consider the establishment of a hydrographic service as an end in itself. Rather, his concern will be with the nature and value of the activities that the availability of hydrographic data will make possible.

The purpose of this article is:

i. to consider how the benefits deriving from the acquisition of a survey vessel may be identified and assessed;

ii. to argue that careful identification of data users (hereafter 'the customers') and their data requirements is an essential element in the selection of a cost-effective surveying capability;

iii. to illustrate the type of economic justification that can be advanced in support of proposals to establish a hydrographic service or to acquire a survey vessel.

In common with other projects that are of an essentially research or information gathering nature, it is not feasible to quantify the extent of the benefits that may arise from the introduction or enhancement of a hydrographic surveying capacity. Use of a rigorous cost/benefit analysis would therefore normally be avoided. Many of the benefits that are envisaged will necessarily be speculative, their realisation depending on the use that customers will make of the data. Planners will nonetheless be looking for a persuasive presentation which will permit them to make a judgement on the value of a proposal for a survey vessel in relation to other projects of a widely differing character. This article addresses itself to those concerned with the formulation and consideration of such proposals.

THE SETTING

The appearance of this article at this time represents a number of considerations. There is a growing awareness in international forums (for example various wings of the UN family and in the pages of this journal) of the value of marine and maritime resources and their potential contribution to development efforts—but there is equally a feeling that the data base from which to plan the exploitation of these resources is often inadequate, indeed it is not always clear what types of data are required for effective planning. The relationship between data availability and marine development has not been systematically explored. The present article is intended as no more than an opening shot, drawing however on the valuable work of the UN Economic and Social Council "Report of the Group of Experts on Hydrographic Surveying and Nautical Charting" [1].

Second, there is an awareness of the stark contrast between the established and well-equipped hydrographic services of many developed countries and the rudimentary nature or complete absence of a hydrographic capability of many developing countries. The UN Economic and Social Council Report identified 66 coastal States without any hydrographic service at all. The combined theoretical Exclusive Economic Zones of these countries would amount to 14.5 million square kilometres—or approximately 17 % of the total ocean areas claimed as EEZ.

Third, there has been a rapid growth in the exploration and exploitation of offshore mineral resources, both of which require high quality hydrographic data. This rapid growth reflects both continued improvements to offshore technology and fears about the depletion of land-based fossil fuels. The widespread and still growing use of large ocean-going

vessels requires accurate bathymetric data. For many countries the only data available is that collected by former metropolitan powers, and frequently this is now of doubtful value (quite apart from the changes to topographical features that have occurred in the interim, much of the original survey work was carried out before the advent of electronic position fixing and depth measuring equipment).

Finally the most immediate reason for the appearance of this article is that the authors recently completed an appraisal on behalf of the Ministry of Overseas Development, London, of a request for the provision of a hydrographic survey vessel under the British Aid Programme.

THE ISSUES

Very few volumes of the *International Hydrographic Review* published since the end of World War II do not contain at least one article describing a survey vessel of one kind or another. These articles are usually accompanied by photographs or outline design drawings and often contain extensive lists of the equipment carried. However, what would appear to be a more fundamental concern, namely the choice of a particular vessel and the surveying equipment it carries, has been almost ignored. In considering the case for the acquisition of a survey vessel, the starting point should not be the specifications of vessels and equipment that are currently available (or have been in the past). Instead, the problem should be turned round and seen from the viewpoint of the customer. It is the set of tasks that the vessel is expected to undertake in the course of its working life and the physical parameters under which it will operate that must surely form the principal factors determining the specification of a vessel. There are some additional practical considerations, for example the manning practice for vessels in the country concerned and the experience which can be tapped for the operation and maintenance of certain types of vessel and equipment—but these must be seen as subsidiary to the prime concerns.

To start the process of choice by examining the tasks which the vessel is expected to undertake and the physical conditions under which it is to operate assumes even greater significance when it is recognised that construction of a survey vessel is normally a one-off job. Standard designs for a vessel are, of course, available and the on-board survey equipment is often seen in terms of a standard package, but world-wide demand for survey vessels is both limited and erratic, and the construction of a vessel usually takes place only in response to a definite order. It is therefore not only possible but desirable to ensure that vessels are tailored to individual requirements.

DEFINING THE TASKS: THE COMMUNITY OF BENEFICIARIES

To determine a long-range set of survey tasks requires that many questions be asked of a large number of governmental and other agencies. Some of these were indicated in the UN Economic and Social Council Report. In tracing the relationship between the creation or extension of a hydrographic surveying capability and the development of marine and coastal resources, it is valuable to start by considering the extent to which the absence of an adequate hydrographic coverage has constrained the exploitation of these resources.

Proposals to establish a hydrographic capability with the intention of undertaking a blanket coverage of the waters surrounding a country, starting for example at a point in the east and systematically moving westwards, should be considered with reserve. This does not mean that complete coverage of a country's EEZ may not be an ultimate objective of the service, but a more persuasive case will be established by pointing to a set of priority tasks that data users would wish to see accomplished.

The purpose of this section is to suggest some guidelines for identifying priority tasks in order to establish the community of beneficiaries. Criteria for admission to this community are bound to vary from one country to another, but the requirement for a critical assessment is standard. Only thus can it be established whether a project said to be dependent on the availability of hydrographic data is merely a glint in the eyes of its advocates (which regardless of the availability of hydrographic data stands no real chance of ever materialising), or whether there is more concrete evidence demonstrating that the absence of hydrographic data poses a genuine constraint. The appraisers should also be alert to the needs of organisations that have not articulated their requirements or which may not even have fully appreciated the contribution that hydrographic survey data can make to their work. In this sense the appraisal process also serves as a consciousness-raising exercise.

Table 1 attempts to summarise the list of activities that would be expected to benefit from the provision of hydrographic and oceanographic data. Also shown are the sort of corresponding institutions or Central Government Ministries from which details relating to their past and future programmes should be sought.

Only when the future tasks have been adequately defined will it be possible to determine the type of vessel most appropriate to the country's requirements and a decision made whether to select a hydrographic survey vessel engaged mainly on basic charting activities or a research vessel primarily intended to assist in the development of sea-bed and food resources. Information on prospective tasks will help to determine whether to incorporate in the vessel's design such essential features as a bow-thruster, controllable pitch propellers, oceanographic winches and gantries, and laboratories, in addition to requirements in respect of range, endurance and speed.

Data users and data types

Users' activity	Institution	Coastal & inshore areas	Deep water areas	Bathy-metry	Tides	Currents	Sea-bed sampling	Sub-bottom profiling	Gravity	Wave re-cording	Water column sampling	Nutrient concen-tration	Trial fish trawls
1. Marine Transportation and Navigation	Ministry of Shipping, Chamber of Shipping, Ship Owners.	x		x	x	x	x			x			
2. Port Expansion and Construction	Planning Departments, Port Authorities.	x		x	x	x	x			x			
3. Port and Port Approach Maintenance	Port Authorities, Dredging Contractors.	x		x	x	x	x			x			
4. Land Reclamation	Public Works Depart-ment (PWD)	x		x	x	x	x			x			
5. Establishment and Moni-toring of Dumping and Spoil Grounds (including siting of coastal power stations)	PWD, Central Energy Au-thority, Department of Fisheries.	x	x	x	x	x	x				x	x	x
6. Desalination and Barrage Projects	PWD, Central Energy Au-thority, Water Authority.	x		x	x	x	x	x		x		x	
7. Control of Coastal Erosion	PWD	x		x	x	x	x			x			
8. Coastline delineation and EEZ determination	Department of Surveys Ministry of Foreign Affairs.	x		x	x								
9. Sea-bed and sub-bottom mineral resources (eg. gravel, sand, oil, phos-phates)	Geological Survey Dept PWD, Central Energy Au-thority, International Oil Com-panies.	x	x	x	x	x	x	x	x				
10. Marine Structures (eg. drilling rigs, underwater pipelines and cables)	International Oil Com-panies. Telecommunications Dept.	x	x	x	x	x	x	x		x	x		
11. Identification of Food Resources	Department of Fisheries, Fishing Community.	x	x	x							x	x	x
12. Meteorological forecast-ing and warning services	Meteorological Office, Ministry of Internal Affairs.	x	x	x	x	x				x	x		

Table 1 is not intended to be exclusive. Many countries will be able to add further activities and data users, and not all of the beneficiaries listed will be present in all countries. What is more likely to vary from one country to the next than the absence or presence of potential data users is the relative priority that should be accorded to the various customers and the emphasis that they are likely to receive in surveying programmes.

It should be stressed that a survey vessel is a durable asset; a useful working life of at least 20 years can be expected, varying, of course, with the amount of usage, the operating environment and the standard to which the vessel is maintained. The priority accorded to different activities is bound to change over the course of time. A characteristic pattern might be to emphasis coastal work, especially that associated with the development of ports and associated shipping routes in the early years of a vessel's life, whilst increasing the relative emphasis given to oceanographic work in the later years. Where there are good reasons for expecting this type of changing emphasis, a premium would then be placed on a general-purpose, versatile vessel.

In order to arrive at the appropriate capability of a vessel, it is useful to translate a customer's data requirement into a specific hydrographic or oceanographic task (defined in terms of area, scale and type of data required, as in Table 1) and to approximate this task to a corresponding number of operational surveying years (or other appropriate unit of time). This appears to be the most practical and consistent approach to determining the amount of effort required for different tasks and in reaching a view of the relative priority. It is bound to be a fairly rough and ready measure. Translation of tasks into a programme of surveying years is also necessary in order to judge the cost effectiveness of customers' proposals, i.e. the cost of undertaking a task in relation to the value of the benefits that can reasonably be anticipated in response to such data becoming available.

Identification of customers' requirements is likely to reveal a considerable overlap in terms of both geographical coverage and the type of data required. As Table 1 shows, bathymetric data in the coastal areas is a requirement common to all members of the community of beneficiaries. This type of overlap should be allowed for in the formulation of an outline work programme for a vessel and in costing the tasks in terms of the number of years of surveying effort required. There are two additional considerations yielding economies to the time required for individual tasks. First, certain types of data may be collected more or less at the same time within the same geographical area (for example, bathymetry, water temperature, chemical composition). Second, where there is a requirement for inshore survey work (for example in creek areas or port approaches) boats, if suitably equipped, may be detached whilst the parent vessel surveys the deeper waters of an adjacent area.

In planning a future work programme for a survey vessel a distinction should be made between activities that occur only once and those that are of a recurring or continuing nature. Thus the initial construction of a port requires a detailed survey to identify suitable sites and to assist with the establishment of suitable design parameters. The continued operation

of a port, however, requires regular resurveying in order to update charts to allow for changes in sea-bed topography resulting from the action of currents, tides, waves, river deposition, and so on. In the course of such resurveying a requirement for dredging may be identified, and a survey vessel may have yet further application in assisting with specifying and monitoring the work of dredging contractors. Long-range planning of a vessel's work programme needs to allow for this type of linkage.

It should be stressed that this long-range planning is quite distinct from the process of optimising the utilisation of a vessel already available. Short-term planning in the form of an annual work programme is necessary to secure the greatest number of operational surveying days—for example, by undertaking during one season or one cruise the survey of contiguous areas, or leaving survey work in sheltered areas to the period of poorest weather.

PHYSICAL PARAMETERS

Four factors have a special significance in determining the size and type of vessel required:

- the size of the operational area;
- the prevailing weather and sea conditions;
- the available manpower together with their operating and maintenance experience;
- the available shore support.

Whilst these factors are now discussed in turn, there is an interdependence between them that can yield conflicting requirements. A combination of a large operating area and the prevalence of heavy seas over extended periods would both indicate a larger vessel. Where, however, a large operating area combines with limited shore support capacity (i.e. where the existing harbours away from the operating base can accommodate only smaller vessels), it would be necessary to calculate whether the effective surveying capacity delivered by a smaller vessel would exceed that from a larger, faster vessel on account of the former's ability to use the smaller ports, so reducing unproductive passage time whenever repairs or fresh supplies are required. One factor which could be considered is that the practice (common amongst smaller vessels in the coasting trade) of taking the bottom in small ports where there is a large tidal range may be permitted as a design feature in the proposed vessel, especially in countries possessing one or very few major ports.

Operational Area

The EEZ of a country often sets the boundaries to the operating area of a survey vessel. Most countries are aware of the broad limits of the

EEZ, but for some its exact delineation is precisely one of the tasks which a hydrographic service is expected to undertake. For the reasons explained above, the EEZ is likely to be an indication more of the maximum than the minimum extent of the operational area and the definition should more properly focus on the areas of developmental potential within the EEZ. From time to time there may be reasons for the survey vessel to take part in an international oceanic survey project or experiment in which case it would venture well beyond the 200-mile limit, but this is unlikely significantly to affect the size of vessel required. For most countries whose hydrographic service is at an early stage of development there is likely to be an overwhelming concentration of effort on areas within the EEZ.

Weather and Sea Conditions

Of concern here are both the extremity of conditions and their duration. Whilst it is usually sensible to specify the sea-keeping characteristics of a vessel with a view to ensuring the maximum utilisation possible, this does not mean that the vessel must necessarily possess the capacity to operate in the severest circumstances. A certain period (for a new vessel this would not normally exceed one or two months) is required each year for a refit or shore-supported maintenance, and it would be prudent to plan for this to be undertaken when general weather conditions are known from past records to be at their worst. In determining an appropriate specification for the vessel it may be assumed that annual surveying operations will be planned around the weather cycle, so that work in sheltered waters would usually be reserved for those times when bad weather is most likely to limit operations in more exposed waters.

In isolated cases prevailing weather conditions may be a critical factor, determining the minimum size of vessel regardless of all other considerations, but normally operating conditions will not form the maximum constraint.

Shore Support

Not all countries possess a port or harbour that can accommodate survey vessels of all sizes, and even if there is one it does not follow that it possesses the necessary support facilities. (In some cases the development of a port may itself be dependent on the availability of adequate hydrographic data.) However, the absence of adequate facilities for docking or slipping, refitting, repairing, and taking on stores may not itself rule out the establishment of a hydrographic service, because these may be acquired in conjunction with the vessel or, alternatively, arrangements for refitting and maintenance may be made with a neighbouring country. Where facilities are already available an important consideration is the size of vessel they are capable of handling—recalling our earlier observation that advantage may accrue to effective operating capacity by selecting a

smaller vessel that is able to gain access to a large number of harbours as compared to a larger vessel that may depend on a smaller number or even a single shore base. It should be stressed that whatever size and range configuration is finally chosen, it is necessary to be quite certain that logistic support is available commensurate with the size and role of the ship.

EXPERIENCE IN OPERATING AND MAINTENANCE

Whilst a newly formed hydrographic service will usually be able successfully to operate survey boats or small craft drawing on staff with only limited hydrographic experience, this will not hold true if the vessel is of any size. The pool of experience that can be tapped sets definite limits to the size and technical sophistication of the on-board survey equipment that can be carried. Countries without a hydrographic service may still be able to form a nucleus of staff with relevant experience by drawing on existing cartographic and maritime agencies and making appropriate use of the training facilities available in countries with well-established hydrographic services. Specification of a vessel and its on-board survey equipement should therefore take a realistic view of the possibilities for staff development. There is a further consideration arising from the manning of a hydrographic survey vessel in that just as the availability of skilled labour may form a limiting factor to the maximum size and sophistication of a vessel, so pressures to generate employment may require a larger vessel to accommodate a complement in excess of that which would otherwise be indicated by the proposed usage and operating conditions. Since the fixed cost of a sea-going vessel per additional member of crew greatly exceeds the cost of additional land-based jobs—and this ignores operating costs—it is the authors' view that these pressures should be firmly resisted. The intended complement should therefore not be an independent determinant of the size and type of vessel but rather something that follows from the other parameters and considerations discussed in this article.

ON-BOARD SURVEY EQUIPMENT

Like the identification of an appropriate specification for the vessel, identification of the appropriate on-board equipment can only sensibly be tackled once the purposes for which the vessel is to be used have been established.

It would be impracticable and prohibitively expensive to supply a survey vessel at the outset with all the equipment necessary for it to undertake all the tasks on which it is thought the vessel might at some time be

employed. Aspirations to acquire the most modern and sophisticated instrumentation and equipment are unlikely to carry weight without sound justification. For many countries without an existing hydrographic service it is probable that skilled manpower will not be available to operate and maintain complex equipment. The President of the IHB Directing Committee made some useful points in respect of appropriate survey equipment:

> "We in the industrialized nations overlook the needs of the Third World, those very people whom we are urging to start up hydrographical services from scratch. We must try to close this widening gap by giving more impetus to the development of simpler forms of echo-sounding and electronic fixing, with a minimum use of automation and data banking, and with a maximum emphasis on reliability and ease in fault finding." [2]

Whilst the different needs and priorities of individual countries will also influence the selection of equipment it is nonetheless possible to suggest a basic list of standard items required for a minimum hydrographic service of the sort identified by the UN Economic and Social Council [3] which would be capable of charting ports and harbours and their approaches and inner coastal waters:

- a short range electronic position fixing system;
- transportable electronic distance measuring system;
- theodolites;
- levels and tachstaves;
- sextants and station-pointers;
- tide gauges;
- echo sounder and bar-checking device;
- a towed dual channel side-scanning sonar system;
- elementary sea-bed sampling equipment;
- wire sweeping gear;
- drawing boards;
- drawing and plotting instruments;
- portable radio sets.

The possibility of adding to this list at a later stage should always be borne in mind and a prudent design would allow space for subsequent additions. Where specialist equipment is required it will often be necessary to take specialist advice.

THE SPECIFICATION

It is consistent with the preceding argument that the specification should be framed only after the planning process outlined above has been completed. Proposals from commercial organisations offering a complete 'system' or 'package' in answer to a particular country's needs would therefore not normally satisfy this requirement. Adequate assessment of commercial proposals depends on the prospective customer knowing what his true requirements are.

COST EFFECTIVENESS CONSIDERATIONS

When the inventory of proposed survey tasks has been compiled it should be possible to form a view of the aggregate amount of surveying effort required—or more precisely, the number of survey years, working on the basis of a selection of vessels of varying size and range. The value of this aggregative approach may be illustrated. If it is known that only one survey vessel can be afforded and a surveying requirement that exceeds 20 years (or a figure corresponding to the duration of a vessel's expected life) is identified in the course of the planning process, it follows that there is a need either to reassess priorities and trim customers' demands or to extend supply. Supply may be extended for example by increasing operating speed and making the greatest possible use of survey boats for detached duty in shallow waters. However, in cases where the volume of survey work appears to fall short of the number of effective survey years that a vessel is expected to deliver in the course of its life, then consideration should be given to alternative ways of satisfying the requirements for hydrographic data. One alternative may be to hire rather than purchase a surveying capacity (or a combination of purchase and hire, with the purchase limited to only the smaller inshore survey craft). Our calculations, based on knowledge of current prices and a 10 % discount rate, suggest that the hiring option is only likely to be preferred where there is a definite survey requirement of less than approximately 10 years and where the volume of recurrent work is not likely to be significant. Another alternative would be for two or more nations to establish a joint survey capacity.

A further consideration, which can only be realistically assessed once the planning process has yielded the detailed specification, is the possibility of converting an existing vessel for a survey role. Established hydrographic organisations have undertaken this on many occasions. Whilst this option appears attractive (particularly in the short term, offering solutions to the constraints of budget, urgency and the absence of a ship-building capacity) in the longer term it presents a number of different problems (maintenance, inadequate flexibility to accommodate modern survey equipment and the need to meet increased expectations in respect of living and working conditions for the crew).

In presenting a justification for the acquisition of a survey vessel, the alternative options of hiring, collaborating, and converting should at the very least be considered, even if it proves necessary to reject them.

ECONOMIC JUSTIFICATION

It has already been argued that attempts to capture the full range of economic benefits that may potentially emerge as a result of the availability

of hydrographic data are unlikely to succeed. Yet for each of the activities listed in Table 1, the provision of hydrographic data may have profound economic implications. It is suggested that the appraisal of proposals for the acquisition of survey vessels should at least attempt to illustrate the nature of these economic benefits wherever possible. As an example of the approach that might be employed, three of the activities listed in Table 1 have been listed for more detailed consideration.

Maritime Transport

The availability of up-to-date hydrographic data should lead to easier and safer navigation and it may be expected that this will have two possible effects depending on the circumstances of the particular country involved. For ships already operating, running costs should be reduced (as a result of the reduction in steaming time arising from the need to take less circuitous routes and reducing the risk of grounding on uncharted dangers). Where ships are yet operating (or where certain types or size of vessel are not yet in service) the deterrent effect posed by inadequate data may be relieved, with the result that a port is served by larger ships or by a larger number of ships. Rigorous economic analysis might argue that the contribution of hydrographic data to easier navigation should be considered as an economic benefit only if it is reflected in lower freight rates or insurance costs for the *country concerned*. However inadequate the existing hydrographic coverage, one might expect that the impact on freight rates would normally be very slight or negligible where rates are set by the Conference Lines, using as the guiding criterion their assessment of "what the traffic will bear". Even where lower operating costs are not reflected in lower shipping rates, the country providing hydrographic services may still be able to derive some direct economic benefits especially where the ships are owned by nationals of the country or where the availability of improved hydrographic data can be used to increase port dues. In addition, there will be some benefit from the commercial sale of such data in the form of navigational charts and publications.

Interviews with a local Chamber of Shipping and records of accidents may provide some evidence of the deterrent effect of inadequate hydrographic data. Interviews with ship-owners may provide some clues about future freight rates with and without adequate hydrographic coverage.

Fisheries

The immediate value of bathymetric data to fishing communities may not be very great. Local fishermen invariably know the profile of their traditional fishing grounds without referring to hydrographic data. Where, however, fishing is to take place in areas beyond the traditional grounds, then hydrographic data can be of value but this requires the use of complementary navigational aids which may not be available. Adequate hydro-

graphic coverage may make it marginally easier for a country to attract foreign fishing fleets to its waters—should it wish to—with a consequential benefit from royalties. Generally a survey vessel can make a more substantial contribution to the fishing community through specialist surveys for both the initial identification of resources and their conservation (including monitoring for the effects of over-fishing by means of trial trawls; or identifying pollutants and assisting in the choice of sites for activities that discharge pollutants). Identification of fish resources is effective only where there is an easy channel for the dissemination of results to the fishing community.

Quantification of the economic benefits arising from this sort of survey work is not feasible, but tangential evidence can help in the presentation of a case. Thus, in respect of the initial identification of fish resources, reference may be made to the achievements of previous surveys—for example, from visiting survey vessels or from work undertaken in adjacent waters, including, where appropriate, an indication of the type and volume of stocks now known to exist. The potential contribution of a survey vessel to the conservation of existing stocks can be suggested by referring to the volume of fish resources known to be at risk and the corresponding number of livelihoods in the fishing industry (and in industries serving the fishing industry). Depending on local circumstances, it may be useful to stress the value of fish to the economy as a source of protein or of export earnings.

Minerals

A summarised economic justification might take the following form: bathymetric and geomagnetic data are basic requirements for further geological exploration by assisting with the identification of areas lending themselves to more concentrated geophysical efforts. Where subsequent work is undertaken by specialist contractors or by oil companies, the availability of reconnaissance type data may permit a country to negotiate better terms with commercial companies.

Another consideration is that a national survey to which all potential explorers have access represents a more efficient use of global resources than individual organisations undertaking their own piecemeal surveys on a confidential basis.

TAILPIECE

The three examples given above are intended as an illustration of possible approaches to the economic justification for the acquisition of a survey vessel. Each country will have its own set of circumstances requiring its own economic formulation. An appraisal should always

critically consider what is the potential contribution of an improved data coverage to the development of marine resources and then, in turn, the likely impact of the marine resources on the national economy using economic indicators such as the value of production, value of possible export earnings, number of employment opportunities, indications of existing use or consumption of substitute resources.

In addition to the economic justification, the appraisal should investigate the adequacy of the institutional support for hydrographic work. The critical issues here include: the capacity of land-based staff and facilities to process and analyse the increased flow of data which can be expected from a new vessel; the adequacy of the proposed recruitment and training programme and of budgetary resources to operate and maintain a vessel and the associated charting activities; and finally a mechanism (for example an Inter-Ministerial Committee) for planning annual survey programmes in the light of competing claims from various customers.

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