



Benguela Current Large Marine Ecosystem Programme

Transboundary Diagnostic Analysis

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The Benguela

BACKGROUND AND INTRODUCTION

A Unique Environment

The Benguela Current Large Marine Ecosystem (BCLME) is situated along the coast of south-western Africa, stretching from east of the Cape of Good Hope in the south equatorwards to the Angola Front, near the northern geopolitical boundary of Angola (see Figure 1). It encompasses one of the four major coastal upwelling ecosystems of the world which lie at the eastern boundaries of the oceans. Like the Humboldt, California and Canary systems, the Benguela is an important centre of marine biodiversity and marine food production. The BCLME's distinctive bathymetry, hydrography, chemistry and trophodynamics combine to make it one of the most productive ocean areas in the world, with a mean annual primary productivity of 1.25 grams of carbon per square metre per year – about six times higher than the North Sea ecosystem. This high level of primary productivity of the BCLME supports an important global reservoir of biodiversity and biomass of zooplankton, fish, sea birds and marine mammals, while near-shore and off-shore sediments hold rich deposits of precious minerals (particularly diamonds), as well as oil and gas reserves. The natural beauty of the coastal regions, many of which are still pristine by global standards, have also enabled the development of significant tourism in some areas. Pollution from industries and poorly planned and managed coastal developments and near-shore activities is, however, resulting in a rapid degradation of vulnerable coastal habitats.

The Namib Desert, which forms the landward boundary of a large part of the BCLME, is one of the oldest deserts in the world, predating the commencement of persistent upwelling in the Benguela (12 million years before present) by at least 40 million years. The upwelling system in the form in which we know it today is about 2 million years old. The principal upwelling centre in the Benguela, which is situated near Lüderitz in southern Namibia, is the most concentrated and intense found in any upwelling regime. What also makes the Benguela upwelling system so unique in the global context is that it is bounded at both northern and southern ends by warm water systems, viz the tropical/equatorial Eastern Atlantic and the Indian Ocean's Agulhas Current respectively. Sharp horizontal gradients (fronts) exist at these boundaries of the upwelling system, but these display substantial variability in time and in space – at times pulsating in phase and at others not. Interaction between the BCLME and the adjacent ocean systems occurs over thousands of kilometers. For example, much of the BCLME, in particular off Namibia and Angola, is naturally hypoxic – even anoxic – at depth as a consequence of subsurface flow southwards from the tropical Atlantic. This is compounded by depletion of oxygen

from more localised biological decay processes. There are also teleconnections between the Benguela and processes in the North Atlantic and Indo-Pacific Oceans (e.g. El Niño). Moreover, the southern Benguela lies at a major choke point in the "Global Climate Conveyor Belt" whereby on timescales of decades to centuries warm surface waters move from the Pacific via the Indian Ocean through into the North Atlantic. (The South Atlantic is the only ocean in which there is a net transport of heat towards the equator!) As a consequence, not only is the Benguela at a critical location in terms of the global climate system, but it is also potentially extremely vulnerable to any future climate change or increasing variability in climate.

Centuries before the arrival in southern Africa of the first European explorers and settlers, indigenous coastal peoples harvested intertidal and near-shore marine life. Commercial exploitation in the BCLME commenced in the first part of the seventeenth century with the harvesting of fur seals, and was followed by extensive whaling operations in the eighteenth and nineteenth centuries. Commercial trawling started around 1900 and commercial purse-seine fishing for sardine some 50 years later. Fisheries expanded rapidly in the 1960s and 1970s during a period when there was heavy exploitation of resources by foreign fleets – resulting in the severe depletion and collapse of several fish stocks. Superimposed on this fishing pressure was the impact of the inherent natural environmental ecosystem variability and change. Together with the other factors mentioned in the following paragraphs, this has made the sustainable use and management of BCLME living resources difficult.

Fragmented Management: A Legacy of the Colonial and Political Past

Following the establishment of European settlements at strategic coastal locations where victuals and water could be procured to supply fleets trading with the East Indies, the potential wealth of the African continent became apparent. This resulted in the great rush for territories and the colonisation of the continent – mostly during the nineteenth century. Boundaries between colonies were hastily established, often arbitrarily and generally with little regard for indigenous inhabitants and natural habitats. Colonial land boundaries in the Benguela region were established at rivers (Cunene, Orange). Not only were the languages and cultures of the foreign occupiers different (Portuguese, German, English, Dutch) but so were the management systems and laws which evolved in the three now independent and democratic countries of the region – Angola, Namibia and South Africa. Moreover, not only were the governance frameworks very different, but a further

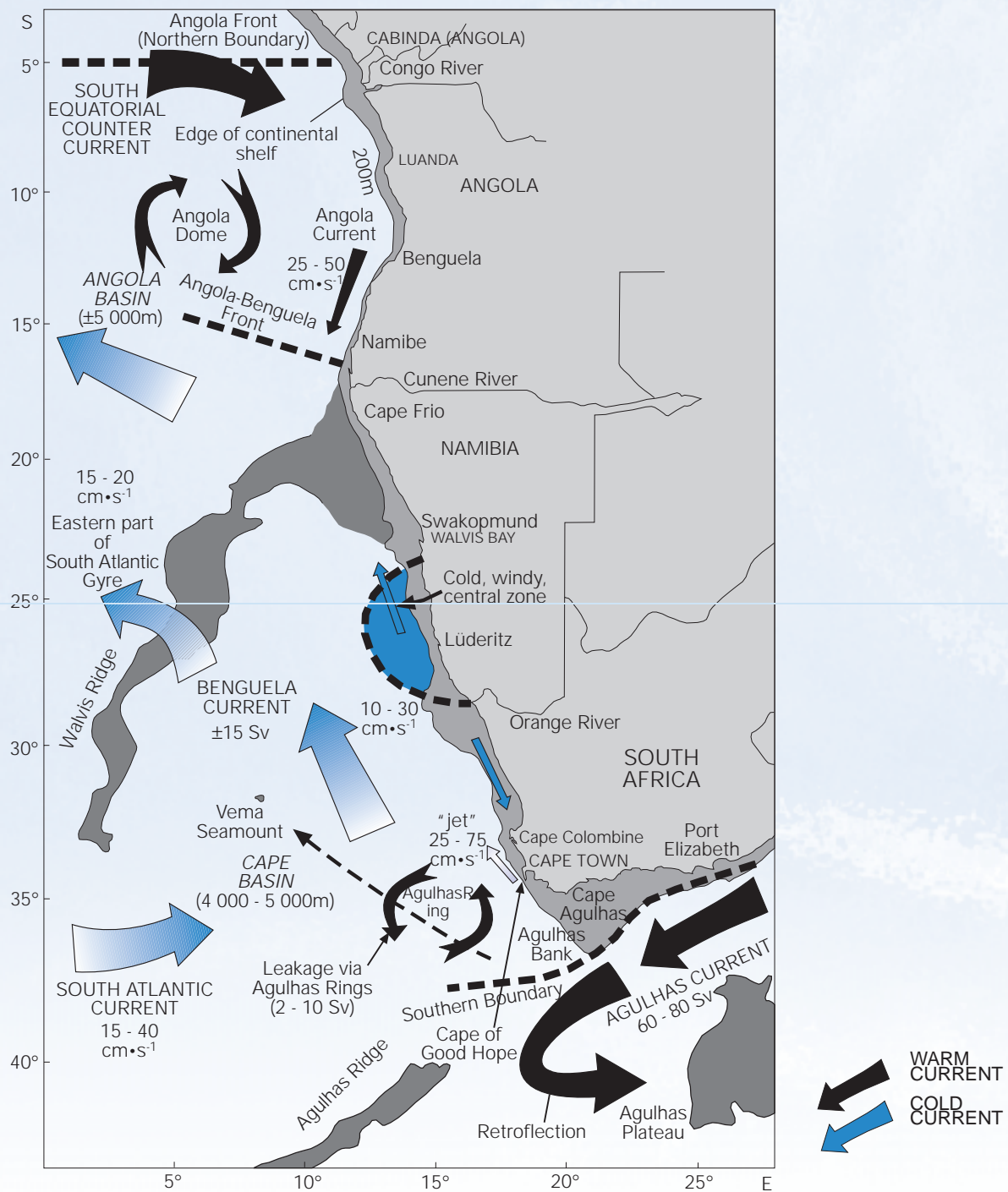


FIGURE 1 Ocean currents in the Benguela region

consequence of European influence was the relative absence of inter-agency (or inter-ministerial) frameworks for management of the marine environment and its resources, and scant regard for sustainability. To this day mining concessions, oil/gas exploration, fishing rights and coastal development have taken place with little or no proper integration or regard for other users. For example, exploratory wells have been sunk in established fishing grounds and the well-heads (which stand proud of the sea bed) subsequently abandoned. Likewise the impact of habitat alterations due to mining activities, and ecosystem alteration (including biodiversity impacts) due to fishing, have not been properly assessed.

Prior to the coming into being of the United Nations Convention on the Law of the Sea and declaration and respecting of sovereign rights within individual countries' Exclusive Economic (or Fishing) Zones, there was an explosion of foreign fleets fishing off Angola, Namibia and South Africa during the 1960s and 1970s – an effective imperialism and colonisation by mainly First World countries of the BCLME, and the rape of its resources. This period also coincided with liberation struggles in all three countries, and associated civil wars. In the case of Namibia, over whom the mandate by South Africa was not internationally recognised, there was an added problem in that prior to independence in 1990, an EEZ could not be proclaimed. In an attempt to control the foreign exploitation of Namibia's fish resources, the International Commission for the South-east Atlantic Fisheries (ICSEAF) was established, but this proved to be relatively ineffectual at husbanding the fish stocks. In South Africa prior to 1994, environmental issues and sustainable management were low on the political agenda. Moreover, the legacy of the past has resulted in a marked gradient in capacity from south to north in the region. Consequences of the civil wars have been the human population migration to the coast, localised pressure on marine and coastal resources (e.g. destruction of coastal forests and mangroves), and severe pollution of some embayments.

While mineral exploration and extraction and development in the coastal zone obviously occurs within the geographic boundaries of the three countries (i.e. within the EEZs), and can to a large degree be independently managed by each of the countries, mobile living marine resources do not respect the arbitrary geographic borders. This has obvious implications for the sustainable use of these resources, particularly so in the case of straddling and shared fish stocks.

Thus the legacy of the colonial and political past is that the management of resources in the greater Benguela area has not been integrated within countries or within the region. The real challenge of the BCLME will be to

develop a viable joint and integrative mechanism for the sustainable environmental management of the region as a whole, i.e. at the ecosystem level.

The Need for International Action

In the BCLME the issue of sustainable ecosystem management, under conditions of environmental variability and uncertainty within a developing regional context, provides an ideal opportunity for the international community to provide material assistance to enable the three countries, via a joint partnership, to establish and implement the appropriate framework for management actions. Countries such as Norway and Germany are already providing much-needed expertise and assistance through the co-ordinated regional BENEFIT mechanism (discussed in the next section), but there is a clear need for greater international involvement to enable the region to, for example, repair the damage done by the ravages of gross over-exploitation of fish resources by foreign fleets in the 1960s, 1970s and 1980s. As previously mentioned, there exists a sharp capacity gradient (human and infrastructure) from south to north in the BCLME, and while there is a very obvious willingness in the region to share knowledge, expertise and facilities with those who are more disadvantaged, international commitment from the Global Environment Facility (GEF) International Waters Programme towards capacity and institutional strengthening and integrated management will greatly help to accelerate this process.

As has been noted, the mobile components of the BCLME do not respect the arbitrary geopolitical (country) boundaries. Several fish stocks straddle or are shared between the countries or otherwise migrate through the Benguela. Actions by one country, e.g. over-exploitation or habitat destruction of their part of a migrating or shared resource, could in effect negatively impact on one or both neighbouring countries. Joint management and protection of shared stocks is one of the few available options to the countries bordering the BCLME. In this manner, a better sense of ownership of the region's resources can be attained, and "owners" tend to protect their property more so than those enjoying a free service. There is thus a strong need for harmonising legal and policy objectives and for developing common strategies for resource surveys, and investment in sustainable ecosystem management for the benefit of all the people in the Benguela region. Only concerted regional action and enablement from the international community to develop regional agreements, and legal frameworks and assessment/implementation strategies, will in the longer term protect the biological diversity of the greater Benguela.

While shared living resources present the most obvious case for co-management, there are many activities and issues which can benefit from expertise and management structures developed and implemented in individual countries. These include *inter alia* mining, declining coastal water quality (pollution abatement and control, oil spill clean-up technology), oil/gas extraction, coastal zone development, tourism and eco-tourism development, mitigation of the effects of introduced species (aliens) and harmful algal blooms – which can also have system-wide impacts.

The BCLME Programme, which builds on existing regional capacity and goodwill, could serve as a blueprint for the design and implementation of LME initiatives in other upwelling regions and elsewhere in the developing world. Moreover, the BCLME Programme will address key regional environmental variability issues that are expected to make a major contribution towards understanding global fluctuations in the marine environment, including climate change.

The Success Story of BENEFIT

In April 1997 a major regional co-operative initiative was launched jointly by Angola, Namibia and South Africa together with foreign partners "To develop the enhanced science capacity required for the optimal and sustainable utilisation of living resources of the Benguela ecosystem by (a) improving knowledge and understanding of the dynamics of important commercial stocks, their environment and linkages between the environmental processes and the stock dynamics, and (b) building appropriate human and material capacity for marine science and technology in the countries bordering the Benguela ecosystem". This BENEFIT (BENGuela-Environment-Fisheries-Interaction & Training) Programme evolved out of a Workshop/Seminar on "Fisheries Resource Dynamics in the Benguela Current Ecosystem" held in Swakopmund in mid-1995. The workshop was hosted by the Namibian Ministry of Fisheries and Marine Resources in partnership with the Norwegian Agency for Development Co-operation (NORAD), the German Organisation for Technical Co-operation (GTZ) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. BENEFIT was developed in the region by Angola, Namibia and South Africa and is jointly managed and directed by the three countries. BENEFIT has attracted substantial incremental support from overseas countries and international donor agencies. It remains, however, essentially a regional "self help" initiative, and has been endorsed by the Southern African Development Community (SADC) and accepted as a SADC programme. It is providing a unique opportunity for development of partnerships within and beyond the southern African region in science and technology,

to promote optimum utilisation of natural resources and thereby greater food security in the region.

BENEFIT has been planned in two five-year phases (1997-2002, 2002-2007). The science and technology component of BENEFIT has three foci, viz resource dynamics, the environment (of the resources) and linkages between resources and the environment. These foci are increasing knowledge of resource dynamics through improved research on the resources and their variable environment. The capacity development component of the Programme is being addressed through a suite of task-orientated framework activities to (a) build human capacity, particularly in areas of greatest need and greatest historical disadvantage, (b) develop, enhance and maintain regional infrastructure and co-operation, and (c) make the countries in the region and the region as a whole more self-sufficient in science and technology. The BENEFIT Secretariat is based in Namibia, while management meetings are held on a rotating basis in Angola, Namibia and South Africa.

The launch of BENEFIT in April 1997 coincided with two major research cruises/surveys that focused on the fisheries and environment of the Angola-Benguela Front. (This front is situated west of Angola and is thought to play an important role as a permeable internal "boundary" within the BCLME, demarcating the northern extent of pronounced coastal upwelling.) During the past two years BENEFIT increasingly gathered momentum with funding for priority projects being allocated and real progress in human capacity development being made. Some recent achievements are briefly as follows:

- Several reports and scientific/technical papers have been published on the results of the 1997 Angola-Benguela Front surveys, and several regional scientists and technicians received hands-on training at sea, in the laboratory and in data analysis
- A German sponsored BENEFIT Training Course was conducted in Namibia in 1997 and a number of regional scientists received further training subsequently in Germany and in Norway
- Fifteen fisheries and fisheries-environment (incremental) projects have been approved for funding in 1999
- Two training workshops have taken place (1998 and 1999) and a BENEFIT Training Plan to complement the Science Plan is under development this year
- In the first half of 1999 over 50 persons from the broad SADC region have been trained during three BENEFIT cruises, including a 40-day survey of resources and the environment, which extended between Cape Town and Luanda, primarily funded by the African Development Bank and the World Bank.

In addition to the above, strong links have been built between BENEFIT and three parallel (but distinctly different) programmes, viz South Africa's established and internationally acclaimed Benguela Ecology Programme (BEP), ENVIFISH (a three-year European Union funded project between seven EU states and Angola, Namibia and South Africa, focussing primarily on the application of satellite data in environment – fisheries research and management, and which commenced in October 1998) and VIBES (a bilateral French-South African initiative focussing on the variability of pelagic fish resources in the Benguela, and the environment and spatial aspects of the system, which also commenced in 1998). In all of these initiatives the emphasis is on science and technology per se, and not on the much-needed transboundary management issues.

BENEFIT and related activities provide clear evidence of the desire and capability of Angola, Namibia and South Africa to work together to solve common problems in the Benguela region in partnership with the international community. This can form a strong base on which to develop integrated management structures.

The Emerging BCLME Programme

The seed for the BCLME Programme was sown at the Workshop/Seminar on Fisheries Resource Dynamics in the Benguela Current Ecosystem, held in Swakopmund, Namibia, in May/June 1995 – the same meeting which laid the foundation for BENEFIT. However, whereas BENEFIT focuses on science and technology as applied to fisheries and the fish environment, and science capacity development, the focus of the BCLME Programme is different. In contrast to BENEFIT, the Benguela Current LME programme is a broad-based multi-sectoral initiative aimed at sustainable integrated management of the Benguela Current ecosystem as a whole. It will focus on a number of key sectors including fisheries and environmental variability, sea-bed mining, oil and gas exploration and production, coastal zone management, ecosystem health, and socio-economics and governance. Transboundary management issues, environmental protection and capacity strengthening will be of primary concern to the BCLME programme.

Inspired by the 1995 Workshop/Seminar and the progress being made on sustainable management of other LMEs – the Black Sea LME in particular – and in order to develop a viable action plan to ensure the sustainable management of the greater Benguela ecosystem, the three countries bordering the Benguela (Angola, Namibia and South Africa) requested support from the Global Environment Facility (GEF), a fund established in 1991 under the management of The

World Bank, the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP). An embryonic GEF/PDF Block B Grant application was developed by a small group in late 1995, subsequently refined with the assistance of UNDP staff, and submitted to the GEF. Following grant approval, US\$344 000 was made available by the GEF in 1998 to enable the development of a comprehensive project proposal including the necessary instruments, such as the synthesis and assessment of information on the BCLME (contained in six comprehensive Thematic Reports), a Transboundary Diagnostic Analysis (this document), a Strategic Action Programme and Project Brief.

What Has Been Achieved?

Following the approval of the PDF Block B Grant, a small Management Committee was established, with members being appointed to represent the governments of the three countries, UNDP and some donors. A Project Co-ordinator was appointed, based in Windhoek, Namibia, with logistical, administrative and infrastructure support provided by the Namibian Ministry of Fisheries and Marine Resources (as implementing agency) and administrative assistance by the UNDP Office in Windhoek.

In July 1998 the First Regional BCLME Workshop was held in Cape Town, which was followed by a formal meeting of key stakeholders. The Workshop was attended by approximately 100 regional and international experts and stakeholders representing a broad cross-section of the public and private sectors in Angola, Namibia and South Africa. The following were among the organisations in the three countries represented at the workshop:

From Angola: Ministry of Fisheries, Ministry of Environmental Affairs, Ministry of Science and Technology, Augustino Neto University, TEXACO, National Oil Company (SONANGOL), National Fishing Industry, Swedish International Development Agency (SIDA)

From Namibia: Ministry of Environment and Tourism, Ministry of Fisheries and Marine Resources, Ministry of Agriculture, Water and Rural Development, Ministry of Works, Transport and Communication, Ministry of Trade and Industry, Ministry of Mines and Energy, NAMPORT, Meteorological Service, BENEFIT Secretariat, Southern African Development Community (SADC), Desert Research Foundation, National Petroleum Corporation of Namibia (NAMCOR), Shell Exploration Namibia, Lalandii, UNDP, Namibian Minerals Corporation (NAMCO), German Organisation for Technical Co-operation (GTZ).

From South Africa: Department of Environmental Affairs and Tourism, Department of Mineral and Energy Affairs, National Parks Board, Cape Nature Conservation, Western Cape Provincial Administration, Northern Cape Provincial Administration, SA Pelagic Fishing Industry Association, SA Deep Sea Trawling Industry Association, University of Cape Town, Port Nolloth Sea Farms, Eco-Africa, University of the Western Cape, SOEKOR, CSIR, PORTNET, Ocean Diamond Mining, South-east Coast Inshore Fishing Association, Tuna and Linefish Association, De Beers Marine, various consultancies.

The Workshop, which was moderated by an independent international facilitator, generated a wealth of information and ideas relevant to the development of a viable BCLME Programme. The objectives of the Workshop were to identify issues and problems/constraints in the Benguela, to attempt to prioritise these and propose possible solutions, to forge consensus among the various stakeholders and roleplayers, to develop an implementable work plan and a mechanism for consultation and co-operation. At the Workshop, keynote addresses were delivered on other LMEs (Yellow Sea, Baltic, Bay of Bengal, Gulf of Guinea), the LME concept, International Waters and the GEF, and on various aspects of the Benguela per se, viz the environment, fisheries, oil and gas industries, mining, coastal zone management and pollution. These overviews provided useful inputs for the subsequent group discussions from which the consensus on problems and priorities emerged. The Stakeholders Meeting held after the conclusion of the Workshop addressed issues such as communication, the budget, donor involvement, studies/consultancies, project co-ordination and the work plan.

Subsequent to the First Regional Workshop, consultants were appointed to prepare comprehensive syntheses and assessments of information on the BCLME. This resulted in the production of six Thematic Reports ("Integrated Overviews") on:

- Fisheries
- Oceanography and Environmental Variability
- Diamond Mining
- Coastal Environments
- Off-shore Oil and Gas Exploration/Production
- Socio-economics of Some Key Maritime Industries

A Second Regional BCLME Workshop was held at Okahandja near Windhoek, Namibia, during April 1999. At this Workshop the Thematic Reports were briefly reviewed. These syntheses, together with the output from the First Workshop, served as a basis for the development of a draft Transboundary Diagnostic Analysis (TDA). Many of those who had attended the

First Regional BCLME Workshop participated in the Second Workshop, and this provided a fair balance across the various stakeholders in the three countries. Although there were necessarily fewer participants (40), all were either acknowledged regional experts on the BCLME representing the main stakeholders or international LME experts (refer to the Report of the Second Regional Workshop for more comprehensive information). At the Workshop the participants divided into three groups to address the three major issues in the BCLME, viz (1) utilisation of resources, (2) environmental variability and (3) ecosystem health and pollution. A breakdown of the sectoral and stakeholders' involvement in each of these three groups is shown in Table D. Excellent progress was made at the Workshop thanks to the quality of leadership provided by the facilitator, the guidance by the international representatives of UNDP-GEF and NOAA (LME concept), and the spirit of co-operation and goodwill of the participants. The essential elements for the TDA were formulated (and prioritised) as per the path: issues > problems > causes > impact > uncertainties > socio-economic consequences > transboundary consequences > activities/solutions > priority > outputs > costs. This consensus Workshop product forms the basis for the present TDA. Prior to the conclusion of the Workshop, the framework for the Strategic Action Programme was defined and a Work Plan to finalise the BCLME project development phase was formulated.

A small task team was appointed to draft a TDA document based on the output of the Second Regional BCLME Workshop. The draft TDA was circulated to the members of the BCLME Management Committee for comment in July 1999, and was revised so as to comply with GEFSEC requirements, before being endorsed at a meeting of the Management Committee held in Cape Town on 30 September - 1 October 1999.

Towards a Sustainable Future: The Next Steps

What was clear by the end of the Second Regional Workshop was that an enormous amount of goodwill, information and ideas has been generated within the region relevant to the sustainable management of the Benguela Current ecosystem. This bodes well for the future and provides a strong foundation, not only to develop a really viable LME approach to the Benguela Current region, but also to provide a blueprint for how "convex" or open-system LMEs should be developed internationally. This contrasts the approaches for the existing predominantly "concave" or closed-system LMEs that have already been developed; in other words, sustainable integrated management of a highly variable open-boundary ecosystem.

Correcting decades of over-exploitation of resources in the Benguela ecosystem and fragmented management actions (the consequence of the colonial/political past and greed) will require a substantial co-ordinated effort during the next decade, to be followed by sustained action on a permanent basis. A task of this magnitude will require careful planning not only by the government agencies in the three countries bordering the Benguela Current, but also by all the other stakeholders. There already exists the willingness on the part of the key players to collaborate to achieve this objective, but the real challenge will be to develop systems and structures that take cognisance of the naturally highly variable and potentially fragile nature of the BCLME and its coastal environments within the context of a changing society and world. The many issues and problems, as well as possible solutions, have been identified and prioritised in the Transboundary Diagnostic Analysis tables. The resolve of the governments of Angola, Namibia and South Africa to correct the wrongs of the past, and move forward with a new vision to ensure that the BCLME can be sustainably utilised and enjoyed by future generations for the benefit of all, is embodied in the elements of the Strategic Action Programme. The SAP is much more than just a piece of paper; it is a pragmatic, workable framework and unambiguous statement of common goals and objectives and the means of their achievement. Success will depend on thorough implementation of the principles, commitments and actions embodied in the SAP, both explicit and implicit.

In the TDA synthesis and analysis tables a number of major transboundary problems in the BCLME have been identified. These include *inter alia*, non-optimal harvesting of living resources, uncertainty regarding ecosystem status and yields in a highly variable environment, deterioration in water quality, habitat destruction and alteration, loss of biotic integrity and threat to biodiversity, harmful algal blooms, introduction of alien species and inadequate regional capacity (human and infrastructure). Over-arching generic actions which are needed to address these transboundary problems must focus on capacity strengthening and training, policy development and harmonisation, and development of regional collaboration or networking in respect of surveys and assessment of the ecosystem status. These actions are appropriate within the context of a GEF project and it is envisaged that the role of the GEF in the implementation phase of the BCLME Programme will take the form of institution building, strengthening capacity needed in the region to facilitate integrated management, and sharing the costs of the actions with the three governments and donors. The GEF should be catalytic in helping to leverage sustainable (long-term) funding and mobilise private-sector funding. Through such a process it is anticipated that, following the conclusion of the GEF-funded BCLME component, the necessary capacity and institu-

tional structures and sustainable funding will be available in the region to ensure the on-going integrated management of the BCLME. Specific actions in which the GEF will play a role will include *inter alia*:

- Development of appropriate transboundary frameworks and mechanisms at both regional, national and local levels for consultation, co-ordination and co-operation
- Development of institutional capacities of the key agencies and institutions in the region that contribute to the integrated sustainable management of the BCLME
- Effective ecosystem assessment and development of an early warning system for ecosystem change
- Actions to fill the gaps in our understanding of the BCLME, its functioning, and the factors which affect it (biophysical, social, economic and political)
- Harmonisation of policies and legislation relating to activities affecting the BCLME
- Increased external support for activities to minimise and mitigate the negative impacts of development (mining, urbanisation, tourism development, resource exploitation) through the promotion of sustainable approaches and the use of appropriate tools
- Measures to improve sustainable resource management
- Measures to protect biological diversity
- Quantification of the role of the BCLME as a source/sink of CO₂ and clarification of the role of the BCLME as a targeted early warning site for global change.

This is seen as compatible with the three elements of the GEF-funded International Waters activities to meet incremental costs of:

1. Assisting groups of countries to better understand the environmental concerns of their international waters and work collaboratively to address them
2. Building capacity of existing institutions, or through new institutional arrangements, to utilise a more comprehensive approach for addressing transboundary water-related environmental concerns, and
3. Implementing sustainable measures that address priority transboundary environmental concerns.

Policies, structures and actions developed during the implementation phase of the BCLME Programme, i.e. over the next five years, must by the end of the period be self-sustainable in the region. To achieve this it is essential that mechanisms be in place to encourage – indeed ensure – a substantial degree of co-financing of activities. This can best be done by involving and developing partnerships with maritime and coastal industries, the international community, and present and future beneficiaries, i.e. all those who have a stake in the long-term health and viability of the Benguela as an LME.

Users' Guide to the TDA

Definitions and TDA Objective

A Transboundary Diagnostic Analysis is a scientific and technical assessment, through which the water-related environmental issues and problems of a region are identified and quantified, their causes analysed and their impacts, both environmental and economic, assessed. The analysis involves the identification of causes and impacts (and uncertainties associated with these) at national, regional and global levels, and the socio-economic, political and institutional context within which they occur. The identification of the causes should, where appropriate, specify sources, locations and sectors. The TDA assessment should indicate which elements are clearly transboundary in character and list and prioritise activities or solutions to address the issue/problem and the root causes.

Within the context of the TDA, transboundary environmental issues include *inter alia*:

- regional/national issues with transboundary causes/sources
- transboundary issues with national causes/sources
- national issues that are common to at least two of the countries and that require a common strategy and collective action to address
- issues that have transboundary elements or implications (e.g. fishery practices on biodiversity/ecosystem resilience).

The objective of the Benguela Current TDA is to provide, on the basis of clearly established evidence, structured information relating to the degradation and changing state of the Benguela Current LME, to scale the relative importance of the causes and sources of the transboundary water-related problems, and to elucidate practical preventative and remedial actions to ensure the sustainable integrated management of this unique environment. The TDA provides the technical basis for the development of a Strategic Action Programme (SAP), and the Project Brief, for the BCLME within the International Waters Area of the GEF.

Design of the TDA

Comprehensive information about the status of the BCLME, the principal issues and problems, and their causes and impacts generated at the First Regional BCLME Workshop in mid-1998 and through a suite of Thematic Reports subsequently prepared by regional/international experts, was examined at the

Second Regional BCLME Workshop (April 1999), synthesised and then condensed into a series of analytical tables. These are presented in this document.

The current TDA has been designed at two operational levels. These are as follows:

- (a) *Level One: Synthesis*: The issues and perceived main transboundary problems, root causes and areas where action is proposed.

This level, consisting of a Synthesis Matrix and some explanatory text about the transboundary characteristics of the BCLME, serves as a logistical "map" for the TDA. It considers the main issues and major perceived environmental problems which must be addressed for the sustainable integrated management of the BCLME. It examines the transboundary elements of the problems (i.e. elements shared by at least two of the three countries) and then relates them to their major underlying institutional, societal or global root causes. In all cases the root causes are common to a large number of problems and require changes to the role given to environmental issues within the priorities of the governments and the public in general. The matrix identifies three generic areas (issues) where proposals for action can be formulated, viz utilisation of resources, environmental variability and pollution/ecosystem health. For each of these generic areas a number of more specific issues ("sub-issues") are identified, which are developed at the next level of the TDA. A simplified version of the Synthesis Matrix is given in Figure 2.

- (b) *Level Two: Specifics*: Comprehensive information on the issues, sub-issues, problems, causes, impacts, uncertainties, socio-economic consequences, the perceived solutions, priorities, outputs and costs.

Working on the basis of the issues and major problems perceived in Level One, the tables and text which comprise Level Two examine the nature of the specific problems identified as contributors to ecosystem degradation and change in the Benguela Current region. They examine the management uncertainties (in the case of environmental variability, the uncertainty of the variability per se) and knowledge gaps which need to be filled. They present priority practical and implementable proposals for inclusion in the BCLME SAP and the cost of the required international action where possible. Finally the series of tables identify the outputs (products) which should be obtained through the successful implementation of the action and lists the stakeholders for each problem and action area identified. Explanatory text is provided for each sub-issue table.

More Information

Readers requiring more information about the BCLME, present state of knowledge about ecosystem structure and functioning, its complexity, ecosystem status, ongoing work and principal management problems are referred to the following:

- Report on the First Regional BCLME Workshop
- Report on the Second Regional BCLME Workshop
- Background Papers for the First Regional BCLME Workshop
- Synthesis and Assessment of Information on the BCLME: Thematic Reports 1-6
- Proceedings of the International Symposium on Environmental Variability in the South-east Atlantic, March/April 1998 (approx 600pp)
- Proceedings of the Workshop on Environmental Variability, Environmental Monitoring and Environmental Strategic Planning, April 1998 (28pp)
- The Benguela and Comparable Ecosystems (*South African Journal of Marine Science*, Vol.5, 1987: 957pp)
- Benguela Trophic Functioning (*South African Journal of Marine Science*, Vol.12, 1992: 1108pp)
- Benguela Dynamics (*South African Journal of Marine Science*, Vol.19, 1999: 512pp)

BCLME Transboundary Diagnostic Analysis

Geographic Scope & Ecosystem Boundaries

Conducting a comprehensive transboundary analysis is only possible if the entire LME, including all inputs to the system, is covered in the study. In the case of the Benguela, which is a very open system where the environmental variability is predominantly remotely forced, this should then include the tropical Atlantic *sensu lato*, the Agulhas Current (and its link with the Indo-Pacific), the Southern Ocean, and the drainage basins of all major rivers which discharge into the greater Benguela Current region, including the Congo River. Clearly such an approach is impracticable, and more realistic and pragmatic system boundaries have to be defined in order to develop and implement a viable ecosystem management framework. The principal external and internal system boundaries are shown in Figure 1.

➤ *Landward boundary:* With the exception of the Congo River, the main impact of discharges from rivers flowing into the South-east Atlantic tends to be episodic in nature, i.e. in terms of significant transboundary concerns, these are limited to extreme flood events. (Their drainage basins nevertheless do include a major part of the southern African hinterland.) The Congo River, however, exerts an influence which can be detected over thousands of kilometers of the South Atlantic and drains much of Central Africa. From a practical point of view, it is quite beyond the scope of the BCLME to attempt to include the development of any management structures for a river such as the Congo. With respect to land sources of pollution in the BCLME (excluding the Congo River area), these are only really significant in the proximity of the principal port-cities (e.g. Cape Town, Luanda, Walvis Bay), and the effects are generally very localised. Nevertheless, some of the problems experienced in these areas are common in nature and could be addressed through similar remedial actions. Like coastal development, their impacts generally do not have a transboundary character. (In contrast, pollution from ships, major oil spills, introduction of alien species and associated harmful algal blooms, etc. are transboundary concerns.) From a BCLME perspective, the landward boundary can thus, for all practical purposes, be taken as the high water mark at the coast. Specific allowances can be made in some areas on a case by case basis (e.g. during episodic flooding from the Orange and Cunene Rivers, which are situated at the country boundaries of South Africa-Namibia and Namibia-Angola respectively).

- *Western boundary:* The Benguela Current is generally defined as the integrated equatorward flow in the upper layers of the ocean in the South-east Atlantic between the coast and the 0° meridian. The BCLME Programme will accordingly use 0° as the western boundary, but for practical management purposes the focus will be on the areas over which the three countries have some jurisdiction, i.e. their Exclusive Economic Zones extending 200 nautical miles seawards from the land.
- *Southern/Eastern boundary:* The upwelling area of the BCLME extends around the Cape of Good Hope, seasonally as far east as Port Elizabeth. This extreme southern part of the ecosystem is substantially influenced by the Agulhas Current, its Retroflexion (turning back) and leakage of Indian Ocean water into the Atlantic south of the continent. As the variability of the BCLME is very much a function of the complex ocean processes occurring in the Agulhas Current – Retroflexion area, this will be taken as the southern boundary with 27°E longitude (near Port Elizabeth) being at the extreme eastern end.
- *Northern boundary:* While the Angola-Benguela Front (more correctly a series of fronts) comprises the northern extent of the main coastal upwelling zone, upwelling can occur seasonally along the entire coast of Angola. There are, in any event, strong linkages between the behaviour of the Angola-Benguela Front (and the oceanography of the area to the south of it) and processes occurring off Angola, especially the Angola Dome and the Angola Current. Unless these are considered as an integral part of the BCLME, it will not be feasible to evolve a sustainable integrated management approach for the Benguela. Moreover, there is a well-defined front at about 5°S, viz the Angola Front, which is apparent at sub-surface depths. It is this front which is the true boundary between the Benguela part of the South Atlantic and the tropical/equatorial Gulf of Guinea system. A northern boundary at 5°S would thus encompass the Angola Dome, the coastal Angola Current, and the area in which the main oxygen minimum forms and the full extent of the upwelling system in the South-east Atlantic. A pragmatic northern boundary is thus at 5°S latitude, which is in the vicinity of the northern boundary of Angola (Cabinda) and the southern extent of the Gulf of Guinea Large Marine Ecosystem (GOGLME). Strong links will need to be built between the BCLME and the GOGLME (and other initiatives in the tropical Atlantic) in order to develop an eventual holistic approach to the management of the South-east Atlantic Ocean.

Level One: Synthesis

The Issues and Perceived Main Transboundary Problems, Root Causes and Areas where Action is Proposed

Seven perceived major transboundary problems have been identified. These are listed below, together with a short description of the transboundary characteristics of each of them. The Synthesis Matrix or "logistical map" and Figure 2, which follow the description, encapsulate the essence of the TDA. They highlight the transboundary elements and root causes associated with each problem and schematically show how the proposed actions serve to address the causes and help solve the problems.

Problem (i): Decline in BCLME commercial fish stocks and non-optimal harvesting of living resources

Transboundary Characteristics: Country boundaries do not coincide with ecosystem sub-boundaries; most of the region's important harvested resources are shared between countries, or move across national boundaries at times. Over-harvesting of a species in one country can therefore lead to depletion of that species in another, and in changes to the ecosystem as a whole. Moreover, many resource management difficulties are common to all the countries.

Problem (ii): Uncertainty regarding ecosystem status and yields in a highly variable environment

Transboundary Characteristics: The Benguela environment is highly variable and the ecosystem is naturally adapted to this. However, sustained large-scale environmental events – such as Benguela Niños, episodic hypoxia/anoxia, Agulhas intrusions and changes in winds – affect the ecosystem as a whole, compounding the negative effects of fishing. These events and changes generally have their origin and cause outside the BCLME, but are of such a scale that the impacts occur in the international water areas of all three countries, i.e. the changes propagate across external BCLME boundaries and internal geopolitical boundaries. The poor ability to predict the events and change limits the capacity to manage effectively system-wide. In addition, the BCLME is believed to play a significant role in global ocean and climate processes and may be an important site for the early detection of global climate change.

Problem (iii): Deterioration in water quality – chronic and catastrophic

Transboundary Characteristics: Although most impacts of chronic deterioration in water quality are localised (national issues), they are common to all of the countries

and require collective action to address. Moreover, chronic pollution can favour the development of less desirable species, and result in species migration. Catastrophic events (major oil spills, mari-time accidents) can impact across country boundaries, requiring co-operative management and sharing of clean-up equipment and manpower.

Problem (iv): Habitat destruction and alteration, including *inter alia* modification of seabed and coastal zone, and degradation of coastscapes

Transboundary Characteristics: Although most impacts may appear localised, habitat alteration or loss due to fishing and mining can cause migration of fauna and system-wide ecosystem change. Uncertainties exist about the regional cumulative impact on benthos resulting from mining and associated sediment remobilisation. Moreover, certain mining activities are conducted close to national boundaries and negative consequences may be transmitted across into the adjacent country's EEZ. Inadequately planned coastal developments result in degradation of coastscapes and reduce the regional value of tourism. Shallow water/beach mining is a major environmental concern.

Problem (v): Loss of biotic integrity (changes in community composition, species and diversity, introduction of alien species, etc.) and threat to biodiversity/ endangered and vulnerable species

Transboundary Characteristics: Most harvested fish species are shared between countries and straddle geopolitical boundaries. Past over-exploitation of targeted fish species has altered the ecosystem as a whole, impacting at all levels – including top predators – and reducing the gene pool. Some species (e.g. African penguin), are threatened or endangered. Exotic species have been introduced into the Benguela. (This is recognised as a global transboundary problem.)

Problem (vi): Inadequate human and infrastructure capacity to assess the health of the ecosystem as a whole (resources and environment, and variability thereof)

Transboundary Characteristics: There is inadequate capacity, expertise and ability in the region to monitor and assess adequately the shared living resources and system-wide environmental variability. Moreover, there is unequal distribution of this capacity between the three countries.

Problem (vii): Harmful algal blooms (HABs)

Transboundary Characteristics: HABs occur in all three countries, which face similar problems in terms of impacts and management, and which require collective regional action to address.

SYNTHESIS MATRIX

<i>Perceived Major Problem</i>	<i>Transboundary Elements</i>	<i>Major Root Causes</i>	<i>Action Areas</i>
Decline in BCLME commercial fish stocks and non-optimal harvesting of living resources	Most of the region's important harvested resources are shared between countries, or move across national boundaries at times, requiring joint management effort	1,2,3,4,5,6,7	A,B (C)
Uncertainty regarding ecosystem status and yields in a highly variable environment	Environmental variability/change impacts on ecosystem as a whole, and poor predictive ability limits effective management. The BCLME may also be important to global climate change	1,2,3,7	A,B,C
Deterioration in water quality – chronic and catastrophic	While most impacts are localised, the problems are common to all three countries and require collective action to address	2,3,4,5,7	C
Habitat destruction and alteration, including <i>inter alia</i> modification of seabed and coastal zone, and degradation of coastscapes	Uncertainties exist about the regional cumulative impact from mining on benthos and ecosystem effect of fishing. Degradation of coastscapes reduce regional value of tourism	2,3,5,6,7	A,C (B)
Loss of biotic integrity* and threat to biodiversity/endangered and vulnerable species <small>*Changes in community composition, species diversity, introduction of alien species etc.</small>	Fishing has altered the ecosystem as a whole, reduced the gene pool, and caused some species to become endangered or threatened. Introduced alien species are a global transboundary problem	1,3,5,6	A,C (B)
Inadequate capacity to assess ecosystem health (resources and environment, and variability thereof)	There is inadequate capacity in the region to monitor the shared resources and the system-wide environmental variability, and unequal distribution of the capacity between countries	1,2,5,7	A,B,C
Harmful algal blooms (HABs)	HABs are a common problem in all three countries and require collective action to address	1,2,3,6,7	A,B,C

<i>Main Root Cause</i>	<i>Areas where Action is Proposed</i>
<p>1. Complexity of ecosystem and high degree of variability (resources and environment)</p> <ul style="list-style-type: none"> • Changing state of the Benguela • Inadequate information and understanding • Difficulty in monitoring and assessment • Poor predictability 	<p>A. Sustainable management and utilisation of resources</p> <ul style="list-style-type: none"> • Facilitation of optimal harvesting of living resources • Assessment of mining and drilling impacts and policy harmonisation • Responsible development of mariculture • Protection of vulnerable species and habitats • Assessment of non-harvested species and role
<p>2. Inadequate capacity development (human and infrastructure) and training</p> <ul style="list-style-type: none"> • Colonial/political past • Institutional downsizing and brain-drain • Limited inter-country exchange (training) 	
<p>3. Poor legal framework at the regional and national levels</p> <ul style="list-style-type: none"> • Regionally incompatible laws and regulations • Ineffective environmental laws and regulations 	<p>B. Assessment of environmental variability, ecosystem impacts and improvement of predictability</p> <ul style="list-style-type: none"> • Reducing uncertainty and improving predictability • Capacity strengthening and training • Management of consequence of harmful algal blooms
<p>4. Inadequate implementation of available regulatory instruments</p> <ul style="list-style-type: none"> • Inadequate compliance and enforcement (over-fishing, pollution) • Indifference and poor communication • Posts not filled (some inappropriately) 	
<p>5. Inadequate planning at all levels</p> <ul style="list-style-type: none"> • Inadequate intersectoral co-ordination • Poorly planned coastal developments • Limited time horizon of planners • Rapid urbanisation and informal settlements 	<p>C. Maintenance of ecosystem health and management of pollution</p> <ul style="list-style-type: none"> • Improvement of water quality • Prevention and management of oil spills • Reduction of marine litter • Retardation/reversal of habitat destruction/alteration • Conservation of biodiversity
<p>6. Insufficient public involvement</p> <ul style="list-style-type: none"> • Lack of awareness, and public apathy • Conflicts about rights of access 	
<p>7. Inadequate financial mechanisms and support</p> <ul style="list-style-type: none"> • Low country GDPs • Ineffective economic instruments • Insufficient funding for infrastructure and management; poor salaries 	