EVALUATION of TMAP DATA HANDLING

for

THE TRILATERAL WADDEN SEA COOPERATION

Prepared by

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CONTENTS

ANNEXES (in separate volume)

1. PERSONS CONTACTED

2. REFERENCE DOCUMENTS

3. TOP-DOWN ANALYSIS OF MANDATE FOR TMAP DATA HANDLING

4. CONSIDERATIONS FOR FUTURE TECHNICAL DEVELOPMENT

5. END-TO-END DATA MANAGEMENT

6. PRINCIPAL ENVIRONMENTAL INSTRUMENTS RELATED TO THE WADDEN SEA

7. REPORTING OBLIGATIONS OF KEY INSTRUMENTS

ABBREVIATIONS and ACRONYMS

AEWA	Afro-Eurasian Waterbirds Agreement
AMAP	Arctic Monitoring and Assessment Programme
BD	Birds Directive
CBD	Convention on Biological Diversity
CEC	Commission for Environmental Cooperation (North American)
CMS	Convention on Migratory Species
CWSS	Common Wadden Sea Secretariat
DEM	Data Exchange Module (of EEIS)
DEMOWAD	(Project) to demonstrate concept of TMAP
DHC	Data Handling Coordinator
DIPSR	Driving forces, Impacts, Pressure, State, Response (indicator framework of EEA)
DK	Denmark
EC	European Commission (or Community)
EEA	European Environment Agency
EEIS	European Environmental Information System
EIONET	European environment Information Observation Network
EJB	Enterprise Java Beans
ETC/NPB	European Topic Centre - Nature Protection and Biodiversity
EU	European Union
EUNIS	European Nature Information System (of EEA)
G	Germany
GCMD	Global Master Change Directory
GCOS	Global Climate Observing System
GEMS	Global Environmental Monitoring System
GEO	Global Environmental Outlook
GIS	Geographic Information System
GOOS	Global Oceans Observing System
GTOS	Global Terrestrial Observing System
HARP-NUT	Harmonised Quantification and Reporting Procedures for Nutrients (of OSPAR)
HD	Habitats Directive
HTML	Hypertext Markup Language
IMO	International Maritime Organization
IOC	International Oceanic Commission
IT	Information Technology
JAMP	Joint Assessment and Monitoring Programme (of OSPAR)
JSP	Java Server Pages
LS	Lower Saxony (State)
MEA	Multinational Environmental Agreement
MS	MicroSoft (trade name)
MUDAB	Meeresumwelt Datenbank (Federal German Marine Environment Database)
NASA	National Aeronautical and Space Administration (USA)
NGO	Non-Government Organization
NL	Netherlands
NOVANA	National Monitoring Program for Water and Nature (Danish)
OSPAR	Oslo and Paris Convention (for the Protection of the Marine Environment of the North-East Atlantic)
PSSA	Particularly Sensitive Sea Area
QSR	Quality Status Report

RBD	River Basin District (with reference to the Water Framework Directive)
RDB	Relational Data Base
RDBMS	Relational Data Base Management System
Reportnet	Network to assist with EU Dataflows (EEA)
RMI	Remote Method Invocation
ROD	Reporting Obligations Database (of EEA)
SAC	Special Area of Concern (Habitats Directive)
SH/HH	Schleswig-Holstein and Hamburg (States)
SO	Senior Officials
SOAP	Simple Object Application Protocol
SPA	Special Protection Area (Birds Directive)
TDG	Trilateral Data (Handling) Group
TEMS	Terrestrial Ecosystem Monitoring Sites (database of GTOS)
TMAG	Trilateral Monitoring and Assessment Group
TMAP	Trilateral Monitoring and Assessment Program
TMAP-DH	TMAP Data Handling
TMEG	Trilateral Monitoring Expert Group
TWG	Trilateral Working Group
TWSC	Trilateral Wadden Sea Cooperation
UNEP	United Nations Environment Programme
UNEP-GRID	UNEP Global Resource Information Database
UNESCO	United Nations Education, Scientific and Cultural Organization
WFD	Water Framework Directive
WHC	World Heritage Convention
XML	Extensible Markup Language
XSLT	Extensible Stylesheet Language Transfer

EXECUTIVE SUMMARY

The TMAP data handling system has been developed and implemented in a series of stages spanning ten years commencing with the EC-funded demonstration pilot project, DEMOWAD. Since that time, a common data model and practical harmonisation procedures have been agreed, and TMAP Data Units have been established in each of the three countries. This evaluation is timely because the TMAP data handling has reached a very critical stage - the long-sought milestone of harmonised data availability, effectively achieving the Esbjerg Declaration target of having an "*operational data handling system*".

The evaluation was carried out during the period 16th March to 30th August 2004, and was originally conceived as mainly a "desk" study, based on available documents. It was recognized, however, that it was also essential to consult with key participants in the process, including those who are involved with the operation of the data handling system, and those who are users of the data for project and policy purposes. For this reason site visits and group interviews were conducted during April, 2004.

The evaluation methodology is based on the United Nations Environment Programme project evaluation methodology that strives to determine, as systematically and objectively as possible, the achievement of results or outcomes against four criteria. Assessment matrices were prepared for each main element of the evaluation and can be found in the body of the report.

The recommendations arising from the evaluation are mainly in the form of suggested actions for improvements and enhancements of the system and its management and, consistent with the structure of the evaluation, are organised in the four main areas "technical concept", "organisational structure", "cost efficiency" (split into benefits to the TWSC and value added potential). Implementation of the recommendations will require a planning process, including scoping, needs analysis and resource estimation in order to quantify anticipated costs. Plans will span various time-frames and require a range of levels of investment. While these cannot be specified precisely at this time, approximate time frames for each recommendation are noted in broad terms as *Short* (within 1 year), *Medium* (1 to 3 years) and *Long term* (3 years or more). Indicative levels of required investment are noted using the relative terms "*modest*", "*significant*" and "*high*".

Adequate and effectively employed resources are essential to the continued operation of TMAP-DH and current levels are dangerously small and dispersed. It is essential that the Trilateral countries make their commitment to the TWSC principles more tangible through ensuring dedicated funding in support of activities at the national level, and contributing jointly to provide resources to support continued system enhancements. For implementation of any of the recommended actions, resource issues are paramount hence over-arching recommendations concerning resources are presented first. In addition, while the assessment of the appropriateness of the Common Package was not within the scope of the evaluation, various observations during the study have included concern for streamlining and adjusting the data content. Additional recommendations relating to this follow the four topic areas.

Recommendations concerning resources:

Rec 1. Review the needs and alternatives for resourcing of Data Units so as to ensure full continuity of service at a qualified level. Options include dedicated full time national resources, a jointly administered contract to an IT company, or a suitable combination. Suggested resourcing level is 0.5 person years (or equivalent) per Data Unit. It should be recognised that this level would be adequate for a well-established operational system. However, it is minimal in the current situation where there is considerable development yet to be undertaken, and procedures are not well established.
(Short term, Significant investment)

Rec 2. The CWSS should continue to actively coordinate TMAP-DH maintenance and enhancements, and administer pooled resources for TMAP-DH development under the management control of TWG and TMAG. To achieve this, the position of Data Handling Coordinator requires permanent funding along with the addition of other resources in CWSS to carry out TMAP-DH development projects as they are identified.
(Short to Medium term, Significant investment)

Findings with regard to the Technical Concept

There are many positive aspects to the underlying technical approach that has been taken for TMAP Data Handling. The use of a common relational model, incorporation of a catalogue level of information, and adoption of a database extension to use in managing the user interface are all sound design decisions. The Java applet approach was a valid technical decision at the time, but the technology could now evolve to take advantage of newer developments, particularly in dealing with the user interface. These improvements should not be "technology driven', but be made in the context of current best practices, functional needs, cost-effectiveness, and the potential to inter-operate with other key systems.

The technical implementation would have been more efficient to accomplish if the database had been located at a single location, or even if the same RDBMS platform had been used by all Data Units.

The two areas of the data handling system that could benefit most from enhanced development are in data input to populate the database, and the user interface to deliver outputs. The DEMOWAD project and subsequent design made very little provision for these, concentrating on the data structure and harmonisation rules. Further, more coordinated development of data loading and delivery functions would improve performance, cost-effectiveness and services to users.

Recommendations concerning the Technical Concept:

Rec 3. Improve the documentation of the Database Extension in the TMAP Manual, including instructions and illustrations of how it can be used.
(Short term, Modest investment)

Rec 4. Review the data structure of TMAP-DH with a view to simplification (including the related "database extension" component). This should be done by an external consultant, and in conjunction with, or following, a review of the data content.
(Medium term, Modest investment)

Rec 5. Using the experience to-date of the individual Data Units, develop more streamlined and better documented procedures (and common approaches across the Data Units) for the transfer for data from national systems into the TMAP database. This could include consideration of a standard data entry format.
(Medium term, Significant investment)

Rec 6. Take technical steps to increase the degree of centralisation of data handling. Specifically, a first step could be to manage access and product delivery at the CWSS while leaving the physical databases in the national Data Units.
(Medium term, Significant investment)

Rec 7. Develop technical "mappings" between national databases and TMAP Data Unit databases that would enable (where possible) periodic automated and secure data loading directly from source databases.
(Long term, High investment)

Rec 8. Evolve the technology of the TMAP-DH away from Java applets to take advantage of newer technological developments, particularly in dealing with the user interface "presentation layer" (see Annex 4). This should be done in a phased manner, with targeted benefits.
(Long term, High investment)

Findings with regard to the Organisational Structure

The basic structure of the governance organisation of TMAP-DH is sound and there are many examples of similar structures for environmental conventions, and monitoring programmes. Vertical information flow works effectively to move issues originating in the TDG to the appropriate level for resolution.

The working group structure has kept to a minimum the excessive frequency, size, and formality that typifies other multilateral programmes, especially the international conventions, and so expenditure levels for meetings are modest, hence efficiency is good.

On the other hand, the TWG-TMAG-TDG structure lacks horizontal connections with the result that national commitments to TMAP principles are not always easily translated into funded concrete actions at the Data Unit level, nor is support from national data sources always evident. This has meant that the "impact" has not been fully obtained – the actual implementation of operational Data Units has been slow, and population of the Common Package is still incomplete.

Providing the working group structure with increased authority to operate as project managers for approved jointly funded projects would allow for more cost effective implementation and operation of the data handling system.

Recommendations concerning the Organisational Structure:

Rec 9. Augment the terms of reference of the TWG, TMAG and TDG to provide for appropriate hierarchical authority over decision-making and resource allocation. The function of serving as a project steering committee (TWG) and project management group (TMAG) and expert working group (TDG) should be added to the ToRs of the groups, in such a way as to empower these bodies to manage projects resourced jointly by the countries.
(Short term, Modest investment)

Rec 10. The Trilateral partners should strengthen and formalise national coordinating mechanisms relative to the Wadden Sea (such as national Wadden Sea Coordinating Committees) that interact regularly with the national representatives on TMAG and TWG to ensure that all relevant institutions are informed and participating.
(Short to Medium term, Modest investment)

Rec 11. CWSS should continue to coordinate TMAG-DH maintenance and enhancements, and pooled resources for TMAP-DH should be administered by CWSS under the management control of TWG and TMAG. To achieve this, the role definition of the Data Handling Coordinator should be amended to clearly indicate project coordination and management functions.
(Short to Medium term, Modest investment)

Rec 12. All national institutions that have databases that are sources for TMAP data should be made aware of their roles and make formal commitments as to their responsibilities as data providers.
(Medium term, Modest investment)

Rec 13. Take organisational measures appropriate to technical steps taken to increase the degree of centralisation of data handling. This could include taking full responsibility at the CWSS for the management of data access technology, and output product delivery. *(Medium term, Modest investment)*

Findings with regard to Cost-Efficiency – Maximising the Value to TWSC

The TMAP data holdings are a high quality scientific time-series of harmonised observations, that, even incomplete, are of significant real and potential value as information for decision-making and a base for joint policy, programmes, and actions that address the identified Issues of Concern in the Wadden Sea Plan.

The TMAP-DH now just meets the needs as intended in support of the TWSC. There is limited user experience so far, but every evidence that TMAP-DH will constitute a base to support the desired outcomes – good ecosystem assessments that lead to good joint decisions and continued conservation of the Wadden Sea ecosystem. Enhancements to the user interface are needed to improve effectiveness, and could be accomplished incrementally with relatively moderate investment.

The cost efficiency of the development is assessed as good. There is no evidence of poorly controlled or excessive expenditure; if anything, TMAP-DH has been under-funded. The intermittent nature of the work at Data Units has caused some inefficiency due to losses of continuity and reduced opportunity for synergies between Units, but in summary, much has been successfully achieved at a reasonable cost. Costs compare favourably to other international situations.

Obtaining, harmonising and loading the "general" parameter groups is proving difficult, and a range of alternatives could be considered, before committing more resources.

Improving the cost-efficiency of data loading requires both technical improvements and more project management authority and control for the Working Group structure.

Recommendations concerning Cost Efficiency – Maximising the Value to TWSC:

Rec 14. Invite and encourage the use of the TMAP data through the newly available User Interface and document case study experiences for Wadden Sea assessments and other purposes.
(Short term, Modest investment)

Rec 15. Identify incremental steps to improve the current user interface for increased convenience of use for QSR and other Wadden Sea assessments, for instance, by making available a pre-designed Access Database to users for analysis of downloaded data.
(Medium term, Modest investment)

Rec 16. To support the use of TMAP Common Package for assessments, consider adding to the TMAP-DH functionality available from the CWSS, such capacity as a keyworded index to research reports concerning the Wadden Sea available from national institutes, NGOs, universities and so on, especially those containing studies of ecosystem processes.
(Medium term, Significant investment)

Rec 17. Following an assessment of the needs of Wadden Sea experts and interest groups, improve the usability of the current user interface to facilitate data discovery and access for trilateral, national and local assessments and research regarding the Wadden Sea. This would include making significant additions to functional capabilities, such as:

- Catalogue search by keyword

- Ability to select retrieval of data by geographic areas, including, but not limited to, Wadden Sea habitats, protected areas, QSR sub-areas, seal and bird data collection areas, and administrative boundaries
- Availability of pre-packaged datasets, on thematic topics
- Making available for download, the data tables that form the basis of the charts and graphs in the published QSR, and selected graphics materials from the QSR and other TWSC reports
- Making available for download the TMAP GIS based datasets in a generic format.

(Medium term, High investment)

Findings with regard to Cost-Efficiency - Potential Value-Added Use

The TMAP data archive of harmonised time series, as is, has great potential to support the assessments, indicators and data inputs to EC Directives and International Conventions. There has already been considerable harmonisation with the needs of the Birds and Habitats Directives and the OSPAR Convention. The CWSS is currently engaged in trilateral consultations on approaches to provide support to the Water Framework Directive, and this type of consultation should be continued and made more proactive.

The technical concept of TMAP-DH with its "database extension" allows for the introduction of new parameters or adjustments to existing content with relative ease. Thus TMAP-DH is capable of adaptation to changing requirements, and the base of harmonised time-series data can contribute to assessments beyond the original intent of the TWSC and the Wadden Sea Plan, and in that way will make multiple value-added use of the data.

Close involvement of the CWSS in national implementation processes, especially for the WFD, is essential to ensure coordinated approaches and standards for monitoring. From such a consultation could come stepwise plans to adjust and tune TMAP-DH parameters to better serve the Directives.

Incremental enhancements to the user interface will be required to enable use for purposes of assessment, policy development or reporting to the WFD and allied instruments, and can likely be accomplished with moderate levels of investment as a natural extension of current technology. On the other hand, extending services to broader, less expert, audiences, such as educators, and the general public, this would represent a significant step away from the original intent and mandate of TMAP-DH, and require major investment in system development.

Recommendations concerning Cost Efficiency - Potential Value Added Use:

Rec 18. The CWSS and TMAG should confer with the ETC/NPB and other bodies on establishing conformance of marine and coastal habitats as applicable to the Habitats Directive and WFD, and useful to Wadden Sea monitoring.
(Short term, Modest investment)

Rec 19. The CWSS should have a prescribed role for participation in (for example) national implementation processes for the EC Directives most relevant to the Wadden Sea, particularly with regard to promoting consistency of approach in implementation.
(Short to Medium term, Modest investment)

Rec 20. The CWSS should be mandated to continue to encourage trilateral consultation and coordination of some specific aspects of the implementation of the Water Framework Directive, regarding the establishment of management plans, monitoring programmes, reference levels and "status" indicators for the RBDs that empty into the Wadden Sea.
(Short to Medium term, Modest investment)

Rec 21. Initiate a dialogue with the EEA to consider how to achieve closer ties to the Reportnet and EEIS, for example by identifying TMAP-DH as a "European Data Warehouse" with some sort of official status as part of Reportnet. This association could lead to funding and cooperative activities to take advantage of EEA efforts to support harmonisation of technology infrastructure.
(Short to Medium term, Modest investment)

Rec 22. Once the three countries have agreed on common approaches to implementation of monitoring programmes for the Water Framework Directive, plan for and implement suitable adaptation to TMAP monitoring as required, for instance, to tune sampling locations and frequencies, particularly with regard to the essential role that TMAP data can play in establishing the "reference conditions", and monitoring ecological and chemical status of transitional and coastal waters.
(Medium term, Significant investment)

Rec 23. Conduct a study of how the water chemistry data in TMAP could be linked formally with the "Waterbase" European Data Warehouse, and thereby establish harmonised water chemistry monitoring across the three countries (for the Wadden Sea and all RBDs). Further consider how the historic TMAP database will be valuable in setting reference conditions for the WFD implementation, and how the national water related "repositories" in the three countries are suited to technological linkage to the EEIS.
(Medium term, Significant investment)

Rec 24. Further expand the functionality of the user interface (following Recommendation 17) to support a wider set of users concerned with EC Directives and International Conventions. This should commence with an assessment of user needs, followed by the development of additional functional capabilities, such as:

- Ability to select data retrieval by SPA, SAC, Ramsar site, or "listed" species of Habitats Directive, Bonn Convention, AEWA Agreement, and so on
- Availability of pre-package datasets, e.g. suitable for OSPAR the Habitats Directive, the Water Framework Directive, AEWA, and so on
- Making available for download, the data tables that form the basis of the charts and graphs in all published CWSS materials in formats suitable for use in statistical analysis and graphics applications packages
- Making available for download in a generic format GIS based datasets including protected areas and habitat boundaries, species distribution maps, etc.

(Medium to Long term, High investment)

Rec 25. Consider carefully the further development of a user interface and information system that could support a wider audience of users including for education and the general public. This would provide some benefits, but is seen as a long-term possibility and certainly is only recommended following extensive consultation and planning. Such development should only be considered in partnership (jointly funded) with an appropriate stakeholder group (such as the Wadden Sea Forum) aimed at well defined needs and employing a standard system development methodology.
(Long term, High investment)

Additional Recommendations concerning Data Content:

Rec 26. Conduct a review of the status of input of the subset of Common Package referred to as "General" parameters that still remain unloaded in most Data Units. The review should consider:

- the extent to which these parameters are required to address TWSC targets (or are essential to WFD), and ruthlessly discard those that are non-essential
- alternative ways of obtaining equivalent data, such as the use of volunteer local observers or industry associations (the Wadden Sea Forum could possibly suggest means)
- alternative approaches to measurement – such as aggregated indicators or surrogates, or singular statistics measured at one location that can be considered representative of the Wadden Sea as a whole
- methods of obtaining the data by connecting to national statistical databases using the geo-spatial GIS data sets held by the CWSS.

(Medium term, Significant investment)

Rec 27. Review and add measurable performance indicators to the Targets, and in consequence adjust TMAP parameters so that they can contribute to TWSC assessment more specifically.
(Medium term, Significant investment)

Rec 28. Conduct a jointly funded review of the QSR process and the needs and uses for TMAP parameters. Adjust TMAP parameter groups accordingly, but with a view to the continuity and stability of the time-series wherever possible.
(Medium term, Significant investment)

Rec 29. The TMAG should resist the addition of more TMAP parameters (such as socio-economic) unless there is a very clear need, for instance as determined from the above studies.
(Long term, Modest investment)

Cross-cutting Themes

Although the recommendations have been presented in six distinct groups, there are three main cross-cutting themes that link the suggested implementation actions, and might indicate useful ways to group recommendations for the development of action plans:

- Improving the data input process
Investment in development of automated procedures, at least partially, for data transfer from national sources to the TMAP database should reduce operating costs and hence increase efficiency in the longer term.

- Improving the delivery of products (including an improved user interface)
The determination, and prioritisation, of new and current user audiences and their needs is an essential first step, with a clear definition of the processes required to deliver the specified products.

- Review of Parameters
Several factors are to be considered – the difficulties of acquiring and harmonising the data values, how parameters may need to be modified to meet new requirements, and the possible addition of new parameters.

All three themes imply the need for systems development effort that will require resource investment beyond the current levels, which are barely adequate for on-going maintenance. These improvements should be planned in an incremental fashion using a stepwise development cycle under trilateral management. It is vital to keep a realistic vision of what is feasible, set priorities and provide clearly planned incremental products and service benefits.

In Summary

The current operational state of TMAP-DH has been achieved relatively efficiently and with an admirable approach with clear top-down logic from broad objectives, through issues of concern to generally specified targets. The TMAP data handling system is clearly designed to maintain a time-series of key parameters relevant to the conservation of the Wadden Sea. An enormously valuable data repository has resulted that is just beginning to show its worth, and will be useful for many years to come. The principles behind TMAP-DH are valid, the data are essential to achieving the goals of the TWSC. Therefore, the system should be continued and enhanced in various ways to ensure that it can achieve its potential, and that investment made to date is not lost.

The TMAP data handling system has just reached a key base milestone of initial on-line capability but, for the benefits of TMAP-DH to be realised, resources must be stabilized and increased, organisational arrangements strengthened and value-added uses pursued (to ensure cost-effectiveness).

1 INTRODUCTION

1.1 Objectives and Scope

In the 1982 Joint Declaration on the Protection of the Wadden Sea, the Netherlands, Denmark and Germany recognized:

> "*their responsibilities for the conservation of the ecosystem and the biological values of this region and its components as well as natural beauty*" and agreed to
> "*consult with each other in order to coordinate their activities and measures to implement ... legal instruments with regard to the comprehensive protection of the Wadden Sea region as a whole including its fauna (marine terrestrial and avian) and flora with special emphasis on ... seals and waterfowl*"

The Declaration created what is now referred to as the Trilateral Wadden Sea Cooperation (TWSC) and this marked the beginning of considerations of joint monitoring of the environment of the Wadden Sea.

The general principles and outline of a trilateral joint monitoring program, including the associated data management, were adopted by the Senior Officials in 1993. At the Eighth Trilateral Governmental Conference on the Protection of the Wadden Sea in 1997, the results of the DEMOWAD project (1995-98), which developed TMAP monitoring guidelines and a prototype of TMAP data management, led to the ministerial agreement to implement the "Common Package" of 28 TMAP parameter groups, including the associated data management (Stade Declaration, para 21).

In the Esbjerg Declaration 2001, "*gaps in the implementation*" of the data handling system were noted and the Ministers agreed:

> "*To reiterate their commitment that having trilateral data on the Wadden Sea stands at the core of the trilateral cooperation and, therefore, to finalize the work on the Common Package by implementing the remaining parameters of the TMAP Common Package and establishing an operational data handling system by the end of 2002, taking into account the wish to optimize that system and to have it evaluated by 2004.*"

This evaluation responds to that identified and scheduled requirement.

As stated in the request for proposals, the objective of the evaluation is to:

> "*assess whether the data handling system is technically up-to-date, organizationally adequate, and cost-efficient within the TMAP framework.*"

Four principal tasks were identified:

> *a. To evaluate the technical concept of the TMAP data handling with regard to requirements of the Trilateral Cooperation, especially concerning the chosen hard- and software solutions.*
>
> *b. To evaluate the organizational framework and the implementation process of the TMAP data handling.*
>
> *c. To consider the added value of the TMAP data handling for the Trilateral Cooperation, especially with regard to the preparation of the trilateral Quality Status Reports, national reporting obligations under the relevant EU Directives (Bird, Habitat, Water) and other international conventions (Ramsar, Bonn, Bern, AEWA, CBD).*
>
> *d. To develop recommendations for the future development of the TMAP data handling on the basis of a – c.*

Some circumscription of the scope is evident from these stated objectives and tasks:

The evaluation is of the **TMAP Data Handling** (TMAP-DH), that is, not to deal with questions of the principles and value of the TWSC to the participating states.

The evaluation will focus on the extent to which the TMAP data handling supports the TWSC with respect to monitoring the state of the Wadden Sea.

The evaluation will also assess the value-added potential and need to optimise TMAP to support EU Directives and relevant international conventions, and the implications this might have on future development of TMAP.

The evaluation will focus on how efficiently and effectively TMAP has been implemented as a practical operational information system.

The evaluation will not review the appropriateness of the established Targets, rather it will take these as givens.

The evaluation will not consider in great detail the scientific value and validity of the selected parameters, noting particularly that the TMAP Evaluation of 2001 considered parameter selection and how these supported the Targets, and made a number of recommendations in this regard.

1.2   Current Situation – Reason for Evaluation

The TMAP data handling has been developed and implemented in a series of stages over 10 years (see Section 5.3), commencing with an EC-funded demonstration pilot project called DEMOWAD.

Since that time, a common data model and practical harmonisation procedures have been agreed, and TMAP Data Units have been established in each of the three countries (2 in Germany for a total of 4 locations). At each of the four Data Units, a relational database has been established following the common model, and national time-series data have been entered for many of the Common Package of parameters, and most importantly, a common Internet-based data access service has been developed making the data available for download.

The current evaluation is not only appropriate because it was scheduled by the Esbjerg Declaration, but as well because the TMAP data handling has reached a very critical stage - the long-sought milestone of harmonised data availability, effectively achieving the Esbjerg Declaration target of having an "*operational data handling system*".

It should be noted that it is only possible to assess the **use** of the data access and the downloading capabilities of the system in a limited way, since these features have only been available since March 2004, and so there is little accumulated user experience.

2   APPROACH

2.1   Evaluation Principles

Any evaluation should be conducted against a systematic assessment framework, preferably one that is widely accepted and relevant to the type of endeavour. For this evaluation, the criteria used by the United Nations Environment Programme project evaluation methodology are applied.

The methodology (paraphrasing from the UNEP Project Manual Ch 12.1) focuses on achievements and outcomes rather than specific output delivery. The evaluation is meant to assist with the identification and solution of problems, and is a service to on-going programmes and their management. This evaluation approach attempts to determine, as systematically and objectively as possible, the achievement of results or outcomes against the criteria of:

- Appropriateness and Relevance (is this a useful and correct thing to do?)

- Effectiveness (does it do the intended job?)

- Efficiency (does it provide value for money?)

- Impact (does it have the intended result?)

There are no absolute standards for information systems implementations against which to evaluate. TMAP-DH will be viewed in light of international good practices, accepted up-to-date technology, and the approaches and resource expenditures of similar operational implementations of environmental monitoring programmes.

2.2   Structure of the Evaluation Report

The Terms of Reference called for four primary tasks:

1. Evaluation of the technical concept

2. Evaluation of the organizational concept

3. Cost benefit and potential added value of the Data Handling System

4. Development of recommendations.

The structure of the evaluation (and this report) corresponds overall to these tasks, with some minor variations. Within each of the first three tasks, a number of "issues" to be addressed were identified in the Terms of Reference and discussion of these is presented in separate sections as far as possible. It has not been found possible (or appropriate) to completely separate all issues, or to divorce "technical" issues from "organisational" considerations as the latter may greatly affect the former, particularly with regard to the effectiveness and efficiency of the implementation of the technical concept.

This report is structured as follows.

Chapter 1 Introduction

- Clarifies the objectives and scope of the evaluation

Chapter 2 Approach

- Defines the basic principles, criteria and framework for the evaluation

- Rationale for the report structure

- Steps and actions taken to conduct the evaluation

Chapter 3 Issues and General Observations

- Overall relevance of TMAP – Top-down analysis

- Evolving issues to be addressed

- Key evaluation questions

Chapter 4 Evaluation of the Technical Concept

- Assessment of the technical elements of the system design and development, both conceptually and in terms of its practical realisation in the context of modern IT practices

- Potential evolutionary paths for the technical architecture

Chapter 5 Evaluation of the Organisational Structure

- Assessment of the organisational structure both as a concept and for its operational effectiveness

- Assessment of the human resource requirements for the effective operation and coordination of TMAP-DH

Chapter 6 Cost Efficiency of the Data Handling System

- Values and benefits of the TMAP data time series

- Costs of TMAP data handling

- Efficiency of using TMAP-DH in meeting Trilateral needs, such as QSR

Chapter 7 Potential Value-Added Use of TMAP Data

- Potential value-added support to EU Directives and International Conventions

- Other potential value-added uses

Chapter 8 Recommendations

- Recommendations organised by main evaluation components

Chapter 9 Summary Evaluation

- Qualitative assessment against the evaluation criteria and the key evaluation questions

2.3 Evaluation Activities and Process

The evaluation was carried out during the period 16th March to 30th August 2004. Activities have been undertaken according to the proposed workplan shown in Figure 1 below, i.e. as overlapping phases, each addressing one of the four tasks identified in the Terms of Reference.
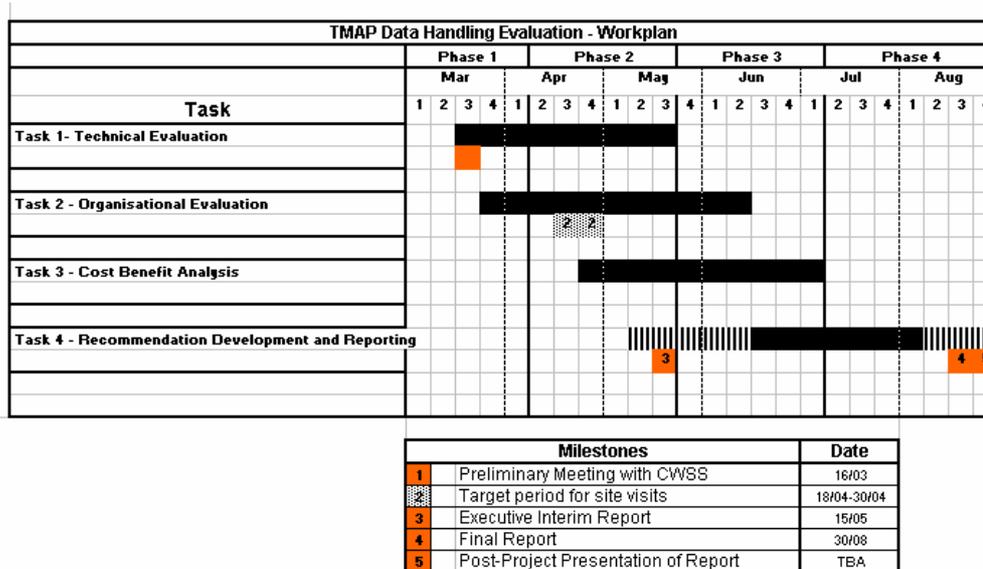
Figure 1: TMAP Evaluation Workplan

The evaluation was originally conceived as mainly a "desk" study, based on available documents. Although a great deal of relevant information can be obtained from documentation (particularly with regard to the system technical details, data standards and operations), it was recognized that it was essential to consult with key participants in the process, including those who are involved with the various aspects of operation of the data handling system, and those who use the data for project and policy purposes. The latter was particularly required to gain insight into future directions and needs for information in support of policy, and to identify opportunities to make better use of TMAP data for multiple purposes. The site visits met that objective and have been followed by email communication and telephone contacts as required.

The following milestones were identified in the original workplan above and outline the process followed.

- Project Start-up Meeting: March 16th, 2004 (see Interim Report for details)

- Site Visits: April 21st – 30th, 2004 (see Interim Report for details)

- Executive Interim Report: May 15th, 2004 (available from CWSS)

- Final Report: August 30th, 2004.

Annex 1 provides a list of all persons contacted and consulted.

Annex 2 lists the principal documents used as reference materials.

3   ISSUES AND GENERAL OBSERVATIONS

3.1   TMAP Data Handling - Appropriateness and Relevance

As described in the previous section, "Appropriateness and Relevance" is one of the four identified key criteria for the evaluation. It is best considered in a general way – i.e. not specific to the separate elements of technical concept, organisational concept etc. Appropriate and relevant in this case means:

- is TMAP mandated?

- is it supporting the intent and purpose of the TWSC?

- is it unique (does not duplicate another processes or service)?

- is it appropriate in the sense that it is necessary to achieve the desired objectives?

A useful structured way to examine appropriateness and relevance is a "Top-down" analysis, that is, to begin with the overall mandate and intent of the Trilateral cooperation and follow down the flow of logic that leads to TMAP data handling. This serves to establish the position of TMAP in the overall framework and ensure that it is a mandated, required, and non-redundant function.

The TWSC is not formalised as an international treaty or convention ratified by national legislative bodies. It is an agreement in the form of a declaration of intent jointly signed at the ministerial level, with an indefinite time frame and no authority, embodied by the "Joint Declaration on the Protection of the Wadden Sea" of 1982. A small support secretariat, the Common Wadden Sea Secretariat (CWSS) was established in 1987 with the primary tasks to "*support, initiate, facilitate and coordinate the activities of the collaboration*". The top down or hierarchical analysis leading towards TMAP Data Handling essentially proceeds in a time sequence of successive joint Declarations and Working Group decisions. The sequence is presented in Annex 3, beginning with the starting point of the first Joint Declaration.

3.2   Assessment

The analysis confirms that TMAP Data Handling is correctly mandated and fully relevant. To trace the analysis in reverse order:

- A "data handling system" is essential to organise and manage the quantitative data resulting from monitoring activities.

- Monitoring data is recognized as being the "core" and the selected 28 parameter groups are agreed to be appropriate and necessary.

- The monitoring activities are essential to assessment of the achievement of the established Ecological Targets mandated in the Wadden Sea Plan.

- The Wadden Sea Plan is a direct response to the primary objectives of the Cooperation with regard to "conservation of the ecosystem" and "protection of the Wadden Sea area as a whole".

The logical flow is therefore correct – the Ecological Targets evolve from identification of Issues of Concern; the monitoring programme was developed to gather the required data; parameters have been selected to help assess the Targets; the data handling system was developed to manage the selected parameter data.

Further, TMAP data handling is unique, there is no other service within the TWSC or at the regional level that coordinates, integrates and manages data in support of ecological

assessment, and no obvious other way to achieve the desired results. It is appropriate that this data handling be done by a computerised information system.

TMAP data handling is therefore assessed as being both fully relevant and appropriate.

How well the TMAP Data handling delivers useful and timely services in a technically sound manner (effectiveness) at a reasonable cost (efficiency) are examined in later Chapters of this evaluation report.

3.3   Evolving Issues

3.3.1   Introduction

As evident in the top-down analysis, TMAP was designed to collect, maintain and provide access to observations on the state of the Wadden Sea in order to measure progress towards agreed targets, which in turn derive from a set of priority issues aimed at the conservation of the Wadden Sea as "*an ecosystem in which natural processes proceed in an undisturbed way*". The essence of the original trilateral Declaration was concerned strictly with cooperative efforts to conserve the ecosystem in a pristine state, and hence to have data that measured the state of the flora and fauna and aquatic regime (e.g. water chemistry), along with some measurement of pressures on the ecosystem, such as nutrient loads. This data was to provide an integrated understanding of the Wadden Sea as a whole in order to inform unilateral and multilateral policies and actions to protect it.

Over the years this conservationist view has evolved in two significant ways, leading to two broad issues that ultimately affect TMAP data and data handling requirements. These two evolutions are:

1. a move from "conservation" towards "sustainable development"

2. a move to integrate Wadden Sea monitoring with obligations of broader international commitments, particularly the EC Habitats, Birds and Water Framework Directives.

While both these evolutions are recorded to some extent in documents, further insight into the associated issues was obtained through discussions with government officials and other stakeholders during the site visit process.

3.3.2   Conservation to Sustainable Development

Development pressures (such as tourism, gas extraction, mussel production, wind power generation) have caused nations to consider to what extent these activities are permissible on the basis of sustainability, within some allowable limits of deviation from a "natural state". This has created a demand to add more parameter groups to TMAP to measure anthropogenic pressures and the economic and social effects on local populations. This issue was documented in the 2001 TMAP Evaluation along with recommendations for pilot studies on the addition of, *inter alia*, tourism statistics. These have proved even more difficult than biological data to harmonise between the three countries, and present some challenges for incorporation into a data handling system planned for scientific rather than socio-economic data. It is clear from discussions that national park managers, NGOs and interest groups would like to see more of this kind of information available in order to argue for and against particular development activities.

The issue for TMAP is therefore to what extent should more (or less) socio-economic data be incorporated into the Common Parameter Groups. This issue is dealt with in Section 6.4 below.

3.3.3   Integration with EC Directives and International Conventions

This evolution is evident to some extent in the successive Declarations of periodic Trilateral Conferences (for instance the Esbjerg Declaration of 2001 is very specific that monitoring should reflect the requirements of the Habitats Directive (HD) and the Water Framework Directive (WFD)). Subsequent TWG and TMAG discussions indicate the potential need to adapt TMAP to better support these directives and other instruments. Note has been taken of the specific request in the Terms of Reference to address this issue

From discussions with officials, it is clear that **all** Trilateral participants agree that TMAP should be used to support reporting obligations to the EC Directives (Birds, Habitats and Water Framework), and that TMAP may need to evolve to ensure this. There is a divergence of view, however, on what this means in a practical sense for TMAP – fewer parameters or more?, changes in frequency?, more or less aggregation?, development of indicators? Views range from greatly reducing TMAP data to **only** that which is essential for EC Directives and "dataflows", through to the addition of parameters and functions to support EC Directives and a range of other international commitments, with the intermediate view that TMAP should remain unchanged and contribute where and when it can. The issue of how TMAP can be adapted to better support EU and international instruments is discussed in Chapter 7 below.

3.4   Key Questions for the Evaluation

The discussions with officials and other stakeholders that led to the identification of the issues above also allowed for the outlining of a number of key questions that the Evaluation should answer. Put in more informal words than the Terms of Reference, these are:

- Does TMAP-DH provide the information needed by decision-makers regarding the Wadden Sea ecosystem?

- Does TMAP-DH work operationally?

- Can TMAP-DH effectively contribute to reporting to EC Directives?

- Are the costs justified?

The Summary Evaluation of Chapter 9 will return to these questions.

4 EVALUATION OF THE TECHNICAL CONCEPT

4.1 Overview

As stated in the terms of Reference, the overall purpose of the development and implementation of the TMAP data handling system is

> *"to provide trilateral and national experts and managers with the necessary harmonised monitoring data for assessment of the status of the Wadden Sea."*

National monitoring programs do not produce trilaterally comparable monitoring data directly. This has meant that any assessment of the Wadden Sea ecosystems whether broad in scope like the periodic QSRs, or specific to one issue or species of concern, required time-consuming and expensive ad-hoc efforts in data extraction, harmonisation and integration. Data models, content, technical platforms etc. vary considerably within and between countries. The data relevant to TMAP resides in a large number of institutes that are physically and organisationally distinct. Content harmonisation aside, a technical IT solution is needed to make the data accessible for expert assessment.

Underlying criteria for the overall approach taken to system development included:

- building on the use of existing national data sources and systems,
- adopting or adapting international standards and formats, and
- enabling national custodianship and authority over data.

The design concept and implementation involved the establishment of 4 TMAP Data Units at a national level: one in the Netherlands, one in Denmark, and two in Germany (Schleswig-Holstein/Hamburg and Lower Saxony). These use the following:

- identical data models for a database to manage the Common Package of TMAP parameters in a harmonised form
- an integrated catalogue, holding metadata describing the TMAP data currently available in that Unit
- a common Web (WWW) interface through which users can access a Data Unit and download data in a standard trilateral exchange format.

This approach keeps data custodianship within national/state boundaries, providing a number of benefits:

- independent management of national data, including local control over access rights
- enhanced data quality due to local responsibilities for the data preparation process and proximity of the data preparation personnel to the data storage
- integration into the existing infrastructure (administrative and technical).

From a user viewpoint, access to harmonised trilateral data is through the CWSS website in which there is a page offering the choice of which Data Unit is to be accessed. Selecting a Unit opens a connection to that national site and the user then can specify the subject matter of interest and refine that selection through filters (such as for a specified area or time period). The system uses the data catalogue to guide the user selection process - for instance, checking whether any existing data meets the selection criteria and by showing only items relevant to the user selection. Authorised users may go further and request that selected data is downloaded. These data consist of multiple files in the trilateral "data exchange" format, and are delivered as a compressed file from which the user has to extract the data for their specific uses.

More technically, as described in the TMAP manual, each TMAP Data Unit implements a 3-tier architecture, as follows:

- tier 1: a Java applet which is downloaded into the client browser and executes within that browser,
- tier 2: an application server which receives requests from the applet and returns data to the applet, and
- tier3: a database server that provides storage and retrieval.

Technical issues are discussed in the following sections.

4.2 Database Concept

4.2.1 Relational Model

The structure of the database of harmonised trilateral data follows a relational model and has taken this approach from the beginning of the DEMOWAD project in 1995. Since most database management systems in common use are relational, implementation is not dependent upon any specific software package. Relational systems range from the relatively simple packages such as Microsoft Access to the more sophisticated levels of Oracle and Ingres. Prices and capabilities range accordingly.

Thus the TMAP database structure, including both parameter and catalogue data, can be implemented using a variety of software packages. This has meant that national agencies could use whatever was already in place – and it could be reasonably expected that a relational database management system (RDBMS) would be part of the IT infrastructure – with minimal incremental costs. There would also be expertise already established.

The Data Units have been established in this way. As implemented, in fact, all 4 data units use different database packages with Denmark and Lower-Saxony using Microsoft Access, and the Netherlands and Schleswig-Holstein using Oracle (though different versions of Access and Oracle are used). The use of different software with a common relational database (RDB) model is technically sound and commonly practiced. A practical disadvantage is the lack of clear opportunity for commonality at the detailed technical level.

Clearly, extensive analysis of the parameters and all the associated data items was done to arrive at what was essentially a **theoretical** data model. As the data units have worked on implementation of the database, it is inevitable that modifications have been required, both to correct errors detected in the model and to take practical considerations into account. This is the normal course of implementing an RDB. However, the data model appears to have grown in an iterative fashion and, as currently documented, has a very high degree of complexity with extensive cross-linking of tables with foreign keys. The addition of further parameters could compound the problem.

A complex model also has potential to make retrieval times longer than a user would accept. There has not yet been enough experience with user access to say whether or not this is the case.

4.2.2 Catalogue and Parameter Levels

The TMAP database consists of two logical components: the catalogue and the parameter storage.

The catalogue component holds what is referred to as metadata, i.e. information about the content of the parameter data in the database. The user interface is designed to allow public access to this level. The parameter storage component contains the subject-oriented "raw" monitoring data values. These are available for download, only to registered trilateral users. In addition, the parameter component includes tables comprising the "database extension" and that is discussed separately (see Section 4.4 below).

The use of a directory, or catalogue, using metadata is a common approach to give users the capability to "discover" the existence of data, and assess whether it is useful and available. For example, the Global Master Change Directory (GCMD) of NASA is a comprehensive directory of existing material relevant to global change research; the UNEP-GRID programme developed a metadatabase which could be used to find out about global and regional scale environmental datasets; the Canadian government GeoConnections programme offers a "discovery portal" for spatial data infrastructure i.e. concerning organisations, available data, services, etc relevant to geographically referenced data handling.

In general, metadata are at two levels. The first, referred to as "directory level", identifies the dataset through such items as a general description (including geographic coverage, date, etc.), details of availability, costs of acquisition, contact point, etc. These are items that are essentially common to all types of dataset, regardless of the subject matter. The second or "dataset level", is subject matter specific, for instance, instrument settings, calibration data, adjustment factors, classification systems and legends, reference standards, taxonomies, etc.

In summary, directory level metadata enables a potential user to explore, in a very general way, what data is available and how to obtain it; the dataset level metadata allows the data to be used correctly, once obtained.

In TMAP-DH, the catalogue component is the basis on which information about what exists in the parameter component is presented to a user. It is used in the same way to assist registered trilateral users to focus in on the exact monitoring data that they wish to download. The appearance of the interface and the options available are discussed in more detail in Section 4.6 below.

Summary:

The use of an RDBMS, and the two logical components within the database, make up a best practice design for the TMAP database.

The common structure of the database in each of the TMAP Data Units allows for decentralized access with a standard user interface.

The database structure seems more complicated than it needs to be given the nature of the data. This is an area that could receive attention in the future.

Associated recommendation in Chapter 8: **Rec 4**

4.3   Populating and Maintaining the Database

The TMAP data handling system provides for storage of trilaterally harmonised parameter data, gives an interface which allows user access, and provides for delivery of the data in a standard format. This has to be contrasted with what would usually expected to be included in an "end-to-end" information management system as outlined for reference in Annex 5.

Specifically, there is no standard tool or process for converting national data into the TMAP data structure. For TMAP data, this includes both data archaeology (assembling the existing historical data) and the continuing assembly of new data as it is accumulated (with regular updates from national databases).

In the original design of the overall TMAP system architecture, the process of bringing data into the TMAP database was only described in very high-level terms. National monitoring programs do not produce comparable monitoring data directly and the methods and tools used to manage the data vary, thus the ways in which data will be transferred need to be customised for each Data Unit. The approach taken was to leave all tools and procedures to be developed by the individual Data Units i.e. development of common input processes was not planned as an integral component of the TMAP-DH system.

However, it has always been recognised that *"high efforts are needed to make data available for the TMAP databases"* (1997 Implementation of TMAP) and further, the "efforts" require knowledge and understanding of the data content and data structures to ensure that the transfer produces harmonised data of consistent high-quality. Since this is a continuing requirement as new data is collected in national programs, it is logical to implement loading procedures that will minimise the resources needed on an on-going basis. This implies the development of **documented procedures** and (as far as feasible) **automated routines** for the tasks i.e. the development of a data loading "system". In the short-term, it is a more substantial investment than loading existing data in an ad-hoc fashion, but it is clearly beneficial to establish trilateral data handling on a continuing basis and would be the desirable approach.

Note that the Netherlands has adopted this approach and the contractor formulated suggestions (in a paper "TMAP Data Unit Potential for Synergy", 2003) for more cooperative efforts among Data Units. However, a major element in the proposal was that the Units should adopt identical RDBMS (Oracle) platforms which could prove difficult or costly.

This is strongly linked to organisational factors and is discussed further in the next chapter of the report (see Section 5.4 below).

The difficulties in extracting the national data and assembling the values for input to TMAP should not be underestimated. In some cases, the data exists in a well-established database in an institution clearly recognised as the authoritative national source for those parameters, and procedures for loading into TMAP can be clearly defined and potentially automated to a large extent. In other cases, the data are in disparate institutions, in personal or project-oriented databases or spreadsheets where the contents vary as objectives shift. For these, effort is needed to locate the data and identify exactly what is needed to compile and harmonise them for TMAP i.e. the transfer process may require expert interpretation and custom programming. Clearly, the more well-defined and established the national data management systems are, the greater the potential for procedural transfer to TMAP.

Having said that, and also acknowledging that national systems vary from country to country, a more unified approach to data loading and assembly would strengthen the data handling system. There are two aspects that should be considered to give a more unified and synergistic approach.

i) Definition of an input mapping process.

A "mapping" is a set of rules about which data fields from an external database can be copied to a specific field in a specific table within the TMAP database. Mappings would be required for each TMAP Data Unit and multiple mappings may be needed for a Unit, depending on how many different national databases are involved to get the data required for the TMAP database. The benefit of defining these rules is the potential to automate the process of updating the TMAP database, reducing the amount of time and resources needed for the update process.

During the process of setting up the existing transfer processes, some of this has already been done, but not necessarily in a formal way.

ii) Development of a standard input format

In general, the process of transferring data from national sources and into the TMAP database will involve several steps of which the final should be loading from input files. Adopting a standard input format (or formats, if different formats are needed for specific parameters) would be advantageous. Consideration may be given to the existing trilateral exchange format or some derivation of that.

An automated update process could be run by individual Data Units, but it is also possible for that process to be handled by one central location, such as the Secretariat, and run on a

scheduled basis. This would not lessen the national authority that would remain in a position to authorise such a process. This centralized approach could reduce personnel requirements for all TMAP Data Units even further. The update process would be triggered from the Secretariat, using a web interface to each of the TMAP web servers and forcing the update to run in each TMAP Data Unit.

Summary:

The process of converting and entering data from national sources has developed separately for each Data Unit. It is recognised that this is necessary because of the intrinsic differences in national systems, but the process has been time-consuming and the source of many delays in entering the parameter groups. The effort required for data entry seems to have been underestimated and few common design elements or approaches have been taken.

These processes could be streamlined and made more efficient through increased automation and formalisation, and by adopting more common approaches such as an input format.

Associated recommendations in Chapter 8: **Recs 5, 7**

4.4   Database Extension

Databases are most commonly used to store and retrieve application data, which is typically displayed for an end-user so that they can act upon that data. A further refinement to an application is to remove configuration data, and sometimes business logic, from the application and store that information in a database. Generic logic in the application reads the configuration data from the database and acts upon it.

This is known as a data-driven application. The look and feel of the application, screen displays based on data and even business logic can be changed by manipulating the database, without changing any code in the application. It can be extremely efficient in terms of resources needed to effect changes.

In TMAP the database extension enables this data-driven approach and is used for the TMAP-DH Java applet – for instance the applet will reflect the addition or deletion of parameters in the database without needing itself to be changed. However, the overhead of a data-driven application in the database can be quite high. For the TMAP Java applet there are 14 tables used to hold the configuration data. The configuration data covers display information, search information, and export information.

This method should be well-documented – more extensively than in the current TMAP Manual (Annex 3-1-2) so that maintenance by future support personnel can be done effectively. The documentation certainly details the tables, their contents and shows an entity-relationship diagram. Further documentation is required that gives a concrete example of exactly how new configuration information is added to these tables, and what the resulting system effect will be.

Summary:

The approach taken to use the "Database Extension" to create a data-driven application is good practice and is commonly used. It provides a number of benefits, including ease of addition of new parameters and, in this case, facilitates central maintenance and quality control of the decentralized databases.

More explicit documentation of the Database Extension in the TMAP Manual is needed to ensure that it can be managed by any qualified individual, and that the full benefits are achieved.

The database extension contributes to the complexity of the data model and could be reviewed in the context of overall simplification of the model.

Associated recommendations in Chapter 8: **Recs 3, 4**

4.5   User Interface (applet and server)

The 3-tier architecture adopted for TMAP-DH uses a Java applet executing within the client browser, an application server and a database server. This is an accepted standard approach to take for a geographically distributed system, or web service, such as TMAP-DH is intended to be. Several benefits come out of this design:

- there are no client application distribution issues because the browser always loads the most current applet code directly from the Data Unit server,
- the application server and the database server can be located on separate physical machines, improving the performance of the system,
- a proxy server front-end can improve the overall security of the system by putting the application server one step removed from direct internet access,
- database security can be enhanced by being located on a separate physical machine from the application server, and
- the scalability of the system can be enhanced by implementing load balancing and failover support among multiple application servers.

Although this is a solid approach, the current practice for web services makes distinct divisions between the different operational layers. The following diagram shows these layers with three options for the mechanisms of delivery to the client (at the presentation layer).

EJB: Enterprise Java Beans   SOAP: Simple Object Application Protocol
JSP: Java Server Pages   RMI: Remote Method Invocation
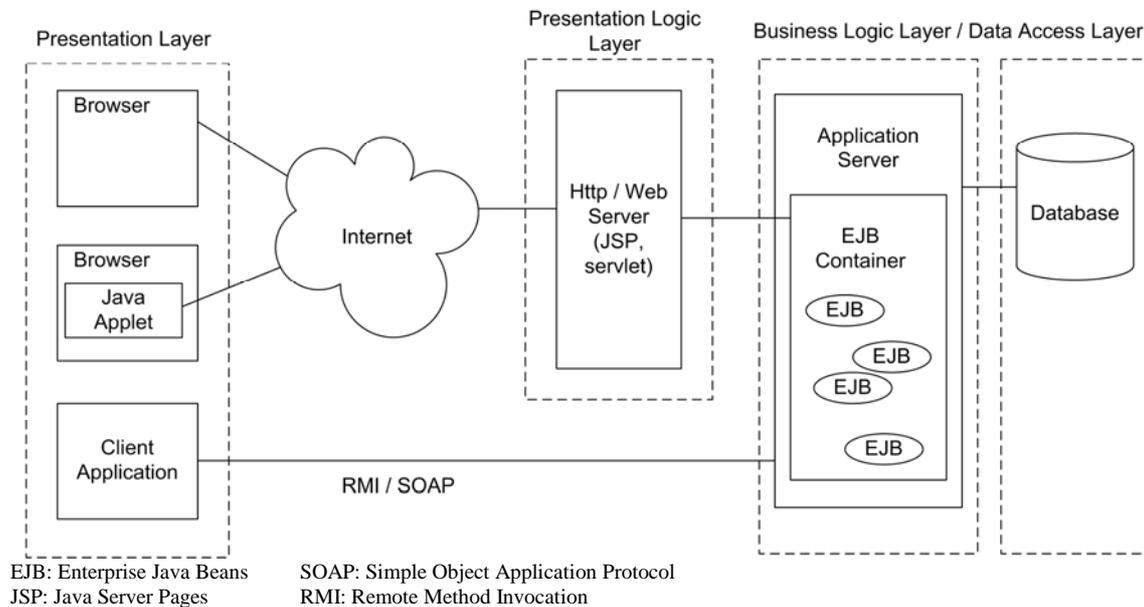
Figure 2: Layers in System Architecture

With the advances in browsers over the last few years, most web service systems are implemented as browser applications. The trend is to stay away from the use of Java applets, preferring frameworks like "Cocoon" or "Velocity" or "Struts" in order to minimize the custom coding required in the JSPs or servlets that implement the presentation logic. Deployment of a browser application is also preferable to a client application as it eliminates the overhead of software update that comes with the use of heavy client applications. This is discussed further in Annex 4, Section A.

Summary:

The use of a Java applet was a good choice at the time. Technological developments of recent years mean that there are now better tools available for the development of the presentation layer and associated logic in a system. These should be considered in any redevelopment planning, noting also that there is potential for re-use of existing Java code.

Associated recommendations in Chapter 8: **Recs 6, 8, 13**

4.6   Product Delivery

This section deals with the "outputs" which a user can obtain from the TMAP data handling system – the product generation section of the end-to-end process outlined in Annex 5.

Essentially there are two successive levels of operation:

- "data exploration" (publicly available) using only the catalogue component of the database to indicate what data are available

- obtaining downloaded files of actual values from the parameter component of the database (available only to registered users).

The user view that guides these is not entirely easy to use without considerable knowledge of TMAP (the programme) and the datasets. Unless already very familiar with TMAP data, the TMAP Manual is an essential companion.

The overall architecture means that a user must access each Data Unit separately. If the requirement is to undertake examination or analysis of area-wide datasets, this is cumbersome.

As noted in Section 4.2 above, the data catalogue is used to drive the process of data exploration. The exploration process is managed by successive searches of the catalogue as the user applies a series of filters. For example, having selected a subject and parameters of interest, the user can initiate a search the catalogue and will be shown the time period, geographic area, etc for which those data exist. Although this is a somewhat restricted way to browse the catalogue, not allowing general queries such as "what chemical data is available for 1991-1995", it does in effect allow a user to find out what data exists. It also enables registered users to focus in on data of interest (by applying a series of selection criteria) before initiating any downloading operation.

For the downloading of data, a harmonised trilateral exchange format is used. This was developed to provide *"…a sophisticated data exchange system, a commonly agreed and standardized data exchange format…"*. The exchange format is physically simple (character delimited fields), but logically sophisticated, reflecting the relational data model and its linkages. This means the output from TMAP is difficult to use in the state that it is delivered to the user. The output files need to be manipulated by another tool before they can be considered useful.

For example, the instructions provided with the downloaded files suggest using MS Excel to process the files. The files are linked by the key parameter values within the files and substantial knowledge of the data content is needed to ensure those linkages are used correctly. Another potentially useful tool for manipulating these files would be MS Access. The files could be loaded into Access as tables, using the foreign keys to link the tables (echoing the linkages in the TMAP database) and reports would be easily generated. A further development is suggested in Annex 4, Section B.

Whatever application tool is used, examination and analysis of the downloaded data requires considerable prior knowledge of the data and their structure, as well as expertise with tools such as Excel and Access.

Although there are references in various documents to more general requirements for access, the one specific requirement of TMAP data handling was to serve the compilation of the

QSR. For this, users **would** be knowledgeable and so would be able to handle the interface and the downloaded data. Although experience to date is minimal, first indications are that this is so and the outputs have indeed been useful (see Section 6.5 below).

However further systems development work would be required to cater to the less-knowledgeable user and to deliver higher level information products. This latter is in line with the 2001 Evaluation Report in which further development work was proposed using *"mapping, graphical and statistical tools … to visualise and analyse the TMAP data for presentation to users"*. This is an expansion of the current data-handling system to an information system as has been referred to at the beginning of this section and amplified in Annex 5.

The first step in any such expansion should be to identify and prioritise the requirements in detail.

Summary:

The current user interface can effectively deliver the TMAP data to a knowledgeable user. This meets the requirement *"to provide trilateral and national experts and managers with the necessary harmonised monitoring data for assessment of the status of the Wadden Sea"* quoted in Section 4.1 above. It adequately serves the primary identified audience of the experts who prepare assessments as part of the QSR process, and as well as specialised assessments as needed to address national or Trilateral issues.

It is a good base that could, with further development effort, be enhanced to provide this audience with more convenience and flexibility in data exploration and selection.

On the other hand, significant development effort is needed to provide a user interface that could provide access to less expert audiences, such as journalists, educators and the general public.

The output product that can be downloaded also meets the basics of the identified requirements. The facility was used successfully for the chemical data for the recent QSR. The output files are, however, difficult to use and require considerable knowledge of the TMAP data and database structures, as well as expertise in how to load such data into application tools such as Access, Excel or statistical and graphics packages.

With some further investment, application tools such as a pre-designed Access database could be offered to users in order to simply deliver much more useable data ready for analysis.

Associated recommendations in Chapter 8: **Recs 14, 15, 17, 24, 25, 26**

4.7   Decentralised Approach

The reasons for adopting a decentralised approach were predominantly non-technical (see Section 5.3 below). As discussed above (Section 4.2), decentralisation presents no major **technical** problem. The adoption of a relational model means that it is feasible to establish four separate Data Units, each holding part of the TMAP data in their own RDBMS, but following the same structure. Access is organised through a common web-enabled interface. This underlying design would not change if part or all of the database were in a single central location.

Associated recommendations in Chapter 8: **Recs 6, 13**

4.8   Conclusions and Assessment

There are many positive aspects to the underlying approach that has been taken for the TMAP-DH system. The use of a common relational model, incorporation of a catalogue level of information, and adoption of a database extension to use in managing the user interface are all sound design decisions.

The implementation would have been more efficient to accomplish if the database had been located at a single location, or even if the same RDBMS platform had been used by all Data Units.

The TMAP-DH system does not include processes for populating the database (left as a responsibility of the individual Data Units) and provides only limited capabilities for product delivery (to meet basic needs of experts assembling QSRs). In the context of a general framework for end-to-end data management, the additional requirements for these two areas need to be addressed. Further development to provide such capabilities would improve the performance, cost-effectiveness and functionality of the system.

Some opportunities for strengthening the system that could be considered include:

- Evolving the system to take advantage of newer technological developments, particularly in dealing with the user interface. (This should be done in a phased manner with targeted benefits, i.e. newer technology is not an end in itself.)

- Simplification of the data model which appears to have grown to be unnecessarily complex.

- With the experience of the individual Units to date, development of more streamlined procedures for transfer of data from national systems into the TMAP database.

- An analysis of user needs for output products and development of further system capabilities to meet agreed priorities.

The above opportunities are identified strictly from a technical viewpoint and are considered in conjunction with other factors (including costs) in formulating definite recommendations for future actions (see Chapter 8 below).

Assessment Against Criteria – Technical Concept

Criterion	Rating	Justification
Appropriateness and Relevance	Good	The technical concept is valid and follows an accepted and appropriate model. (See also Section 3.2)
Effectiveness	Satisfactory	The technical concept can support the requirements of archiving and providing basic access to the TMAP data. Provisions in the concept for data loading are weak.
Efficiency	Satisfactory	The concept is not extravagant. The concept would have been more efficient to accomplish if there had been more consistency in the technical platform. Centralization would have provided improved technical efficiency.
Impact	Good	Technical concept has achieved intended impact of local authority and responsibility, while providing integrated access to harmonised data.

5 EVALUATION OF THE ORGANISATIONAL STRUCTURE

5.1 Overview

In 1993, following recommendations by the Trilateral Monitoring Expert Group (TMEG), the Senior Officials (SO) endorsed the establishment of the Trilateral Monitoring and Assessment Group (TMAG) and the Trilateral Data Handling Group (TDG). The TMAG was envisaged to be responsible for the monitoring program as a whole and the TDG was to carry out tasks specific to data handling. As shown in the diagram below (from the Terms of Reference for this evaluation), these groups are the basis of the current organisational structure.

TWG
Trilateral Working Group

↕ [Policy level]

TMAG
Trilateral Monitoring and
Assessment Group

↕ [Monitoring level]

TDG
Trilateral Data Handling Group

↕ [Implementation level]

Implementation projects
DEMOWAD, German, Dutch, Danish projects
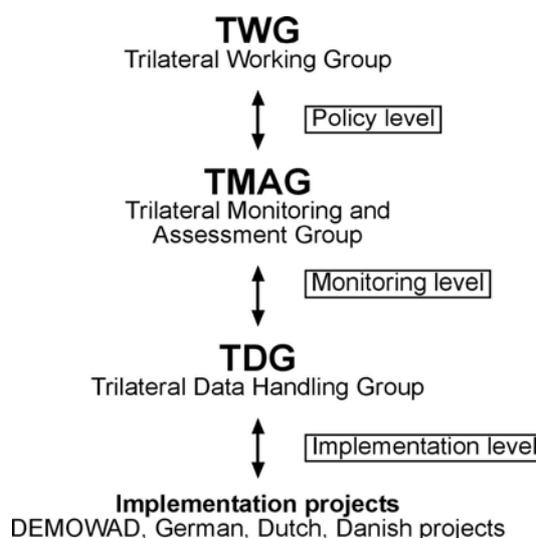
Figure 3: Organisational Structure

The organisational structure as shown also involves the implementation projects to develop the data handling system and to establish national TMAP Data Units. The sources of the data are the national activities and programmes that collect and manage relevant data, so the organisation as a whole must include linkages with the many cooperating institutes in each of the countries.

Not shown in the diagram is the CWSS, which has a coordination function in all Trilateral activities. In particular, with regard to data handling, the role of the Data Handling Coordinator placed in the Secretariat, has been key to the progress made in establishment of the TMAP data handling system.

5.2 Overall Management Structure (TWG-TMAG-TDG)

The TMAG is described as a permanent working group, operating under the direction of the TWG, and the TDG in turn works under TMAG. Although referred to as an "ad-hoc" group, the TDG has been in operation since its inception in 1994. The original recommendations from TMEG laid out terms of reference for both groups and these have been amended over time to reflect changing requirements. Both Groups have clearly defined responsibilities and levels of authority.

Membership of the TMAG allows for up to three delegates from each country and this appears to be adequate, although perhaps limiting for Germany where both State and Federal representation is important. Current membership appears appropriate to the mandate of the

respective groups as does the frequency of meetings. As reflected in the minutes, the level of participation appears high.

Overall, chairmanship and administrative arrangements for the working groups are effective and have not been the source of any concern.

The Common Wadden Sea Secretariat has been kept modest in size and supports all three working groups, as well as the Senior Officials Meetings and periodic Trilateral Conferences. The overall mandate of the CWSS is quite general, describing its primary role *"to support, initiate, facilitate and coordinate the activities of the collaboration"*. The CWSS also acts as the secretariat for the Seals Agreement of the Convention on Migratory Species.

A position of Data Handling Coordinator (DHC) was established in the Secretariat at the completion of the DEMOWAD project and this arrangement has worked very well, with the same person in that position in Wilhelmshaven since that time. The coordination function is very important and its placement in the CWSS is appropriate. The Coordinator has served an enormously valuable role in providing continuity (especially during periods of inactivity of various Data Units), in resolving technical issues, and in preparing the essential TMAP Manual as operational level guidance to all Data Units. The DHC acts as Secretary to the TDG, and is also responsible for development and maintenance of the common portions of the TMAP-DH, including shared-use GIS data.

The concept of a hierarchical committee structure with executive, policy and operational levels is commonly used in multilateral endeavours. For example, the Arctic Monitoring and Assessment Program, AMAP, (involving eight countries) is managed overall by the AMAP Working Group, under the auspices of the Arctic Council, with an Assessment Steering Group cooperating with National Institutions at the operational level. The Ramsar Bureau has both secretariat and operational functions, working with National Focal Points and responsible through a Standing Committee to the Conference of Contracting Parties. The World Heritage Centre in UNESCO is within a similar structure.

In a recent analysis of strategies of long-term programs related to governance of large ecosystems at the regional scale (Olsen and Nickerson, 2003), all three initiatives considered (The Wadden Sea, Chesapeake Bay and the Great Barrier Reef) had a similar structure.

This three-tier structure is also common for the management of a multi-participant project where there would be an executive steering committee that sets overall goals and outcomes within a general budgetary framework, a project management committee that deals with major resource allocations and deliverables, and one or more development teams (or task forces) dealing with operational deadlines and implementation. Each has decision-making authority over different levels of resource allocation as well as technical specification. Note that though the structure appears similar, the mandates and authority over usage of resources is markedly different.

In terms of issue flow and resolution, the structure permits issues relating to data handling to be identified at the working level (in the Data Units and by the Data Coordinator), and the TDG provides a forum for discussion among those with the specialised technical knowledge. Matters may then be raised at the TMAG and, as required, taken forward to the TWG. It can be seen from the minutes of TMAG and TWG meetings that this process is working well, i.e. items are carried up to an appropriate level in a meaningful way. For example, over the past two years, the TDG has brought the difficulties and delays in establishing operational Data Units forward for discussion in TMAG meetings. When judged necessary by TMAG, these have in turn been flagged in briefings to the TWG.

While the three level hierarchy is a common approach and is functioning well in terms of vertical communication, there are potential difficulties in smooth and transparent horizontal communication between the trilateral groups and national institutions whose cooperation is needed in providing the source data for TMAP. There are a number of source-data agencies

identified in each country and in each case, considerations of how the data will be provided to the national TMAP Data Unit require considerations of policy elements (release, access provisions, etc), and technical details of content, format and technical platform. If items cannot be effectively resolved between TDG and TMAG members and counterparts in agencies, these can certainly be passed up to the TWG but then need to be carried forward (and "downwards" to specific agencies within a country) for action. The priority given to any such request will likely be influenced by how closely the agency (and its mandate) is involved with the TWSC (e.g. through an SO or representative on the TWG or TMAG), as well as the magnitude of other demands being made at the time. Germany and the Netherlands have national working groups that usually meet prior to TMAG and TWG meetings to support delegates. These working groups are, however, informal and do not appear to be effective in coordinating national actions. As pointed out in the Oxford Brookes Study, the TWSC as represented by the Stade Declaration *"lacks sufficient enforceable legitimate authority"*.

This can be particularly problematical when the allocation of resources is required. Although the establishment of national Data Units is agreed in principle by the three countries, the resourcing of these units is the responsibility of the host agency in each country. Again, although clearly a priority from the trilateral viewpoint, there may be conflicting demands on that agency and not necessarily a mandate and accompanying authorised resources to expend on TMAP. None of the three working groups (even the relatively operational TDG) have any authority to commit or expend resources.

Summary:

The overall organisational structure is sound. It follows a commonly used model. Terms of reference and membership are appropriate, and the structure functions well in the vertical movement of issues between the policy, monitoring and implementation level.

Two factors limit the overall effectiveness:

1) Lack of horizontal connections

The lack of formal horizontal connections at intermediate levels require all decisions on policy implementation to first be elevated to the highest level within a country where it can lose focus in the process of cascading top-down to effective implementation.

2) Lack of authority over resources

The working group structure essentially deals with agreements in principle and cannot in any way ensure that agreements and policies are converted to fully resourced actions at the implementation level. The TDG in particular has no authority to expend resources on Data Unit operations, or even enforce agreed technical standards and approaches. As a result there are in fact no joint implementation projects or activities that use pooled resources. The TDG does not act as a project management committee, nor do the TMAG (or TWG) as project steering committees.

The CWSS acts in this regard from time-to-time with limited external resources, but with only the DHC as a resource for the implementation or enhancement of TMAP-DH.

Associated recommendations in Chapter 8: **Recs 2, 9, 10, 11**

5.3   Implementation Process

The term "implementation" when referring to a data management system would usually include establishment of all the features required in an end-to-end operational system, encompassing data acquisition, quality management, integration, distribution, product generation and archiving (see Annex 5). However, as has been described above (see Section 4.3 above), the design of the TMAP data handling system did not include the loading of data

(acquisition) from national sources into the TMAP database (the harmonised data). In this context, references to the "implementation of the TMAP data handling system" may be interpreted as the establishment of the database structure and access capabilities. The actual population of the database and procedures for updating the data (or making TMAP-DH "operational") are then an additional task. Every effort has been made to made this distinction clear in the following.

In the TMEG report (1993), six options were considered for the trilateral data handling. These ranged from a single centralised database serving both national and trilateral purposes, through various levels of decentralisation, to using only separate national facilities. Although the options were first rated on criteria that were predominantly technical, the addition of considerations of existing data handling policies and resource requirements led to the favouring the option of *"decentralised long-term storage of trilaterally harmonised data at three national databases"*. This left clear ownership of the data with each country and had the benefit of keeping the data close to the providers, potentially improving the quality. The DEMOWAD prototype followed this path and led to the current implementation of the system in the four Data Units.

> **Note**: The TMEG also recommended at the time that the *"longer-term goal"* should be the option of *"central long-term storage of trilaterally harmonised data in one trilateral database"* and went so far as to propose that a decision be taken in 1997, taking into account experiences gathered in the meantime. This recommendation has never been acted on.

Implementation of the data handling system has had a number of stages over the past ten years. It began with an EU funded project (DEMOWAD) that involved the three countries and ran from 1995 to 1998, with TMAP-DH activities concentrated in 1996-97. The total budget was approximately 1.36 M Euros of which about 820K was spent on development of the monitoring guidelines (parameters, frequencies, methods, sites, etc.), and 540K on the data handling system *per se* (including only "minimum" expenditures on hardware and software). The project resulted in a "proof of concept", that is, a prototype TMAP database demonstrating the feasibility of decentralised Data Units using identical catalogue and database structure, and giving user access through the Internet.

From this point (1997), activities related primarily to the establishment of the individual Data Units and varied from country to country. As shown in the implementation history (Figure 4 below, derived from materials produced by CWSS):

- In Germany, a project funded by the Federal Government (480,000 Euros) in 1998-99 involved the Data Units in Schleswig Holstein/Hamburg and Lower Saxony (and the CWSS Data Handling Coordinator). This resulted in refinement of the data model, introduction of the Database Extension and use of more sophisticated technology for the user interface

- Lower Saxony resumed its activity in February 2003 (when a contract employee was hired)

- Schleswig-Holstein restarted in 2004 (with the part-time commitment of an existing post)

- Denmark was active from September 2000 to September 2002 and then resumed activities in 2004 (both with part-time commitments of a person)

- Netherlands has maintained a fairly steady stream of activities since December 2000 (through contracting to a commercial company)

- The German Federal Government was active in 2003 when they contracted work to develop mechanisms to transfer data from the federal database (MUDAB) to the TMAP Data Units in Lower Saxony and Schleswig-Holstein.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
SH/HH										
LS										
G (Federal)		Demowad								
DK										
NL										
CWSS										

Figure 4: Implementation History

These timelines show very sporadic and uneven efforts which means that there has been little opportunity to build momentum. On the contrary, there is an additional cost to picking up all the threads of the process after a hiatus. This is exacerbated further when, as has happened, the person or persons who are charged with duties have had no previous involvement with the system. There has also been little opportunity for development of synergies between the Data Units when they are at different levels of experience.

At this point, all four Data Units have installed the TMAP data handling system, i.e. have installed the harmonised TMAP database structure with catalogue and database extension, and made it web-accessible. Variable progress has been made in loading harmonised data into these facilities, although substantial data is now available from all Data Units, particularly for chemical parameters. The following table (based on material obtained from CWSS) summarises the current status of data holdings.

Data Class	No.	Parameter	Data in database			
			DK	SH/HH	LS	NL
Biological parameter groups (6)	8	Macrozoobenthos	1980-2003	-	-	-
	11	Phytoplankton	1989-2003	-	1999-2002	*
	15	Breeding birds	1989-2003		-	*
	17	Migratory birds	-	1987-2002	-	*
	18	Beached birds	1997-2003		1993-2002	-
	19	Seals	1975-2003	1987-2003	1991-2002	*
Chemical parameter groups (6)	1	TBT	2000-2004	-	1997-2003	1988-2003
	2	Metals in sediment	2000-2004	-	1997-2003	1988-2002
	3	Nutrients in water	1986-2004	-	1999-2002	1971-2003
	10	Contam. in mussels	1998-2003	1995-2001-	-	1980-2002
	12	Contam. in flounder	1979-2003	1995-1997-	-	1979-2002
	16	Contam. in bird eggs	1999-2002	-	1991-2003	1998-2002
Geographical Parameter groups (7)	4	Salt marshes	-	*	*	*
	6	Macroalgae	-	-	-	-
	7	Eelgrass	-	*	*	*
	9	Blue mussel beds	-	*	*	*
	14	Beaches and dunes	-	-	-	-
	24	Geomorphology	-	-	-	-

Data Class	No.	Parameter	Data in database			
			DK	SH/HH	LS	NL
	26	Land use	-	-	-	-
General Parameter groups (9)	5	Agricultural utilization	-	-	-	-
	13	Fishery	-	-	-	-
	20	Boats at sea	-	-	-	-
	21	Guided tours	-	-	-	-
	22	Air traffic	-	-	-	*
	23	Coastal protection	-	-	-	-
	25	Flooding	-	-	-	-
	27	Weather conditions	-	-	-	*
	28	Hydrology	-	-	-	-

* Data in database but not yet available via Internet

Figure 5: Current Status of Available Time-Series in Data Units

The geographic parameter group data is the product of centralised data activities undertaken by CWSS. The DHC has compiled and harmonised geographic data from the three countries to produce a trilateral map and worked with expert groups to define attributes, delineate areas and integrate other data layers. The products have been distributed to the Data Units for common use in the decentralised database.

The on-going role of the Data Handling Coordinator has been crucial during this period of technical implementation for the Data Units, ensuring some consistency in approach and helping to adjust the data model for practical considerations and resolve technical issues as they arose. This was in parallel with coordinating data harmonisation agreements and the continuous process of development of the TMAP Manual.

Summary:

The uneven timing of the technical implementation of the data units (for the most part, all four units were never actively being developed at one time) meant that there were few opportunities for synergy or to take advantage of practical solutions found in one Unit that could be applied to another. Overall momentum was lacking and efforts at data loading and at implementing the data access service functionality were often delayed. The target to establish *"an operational data handling system by the end of 2002"* (ref Esbjerg 2001) was not effectively achieved until early 2004.

Associated recommendations in Chapter 8: **Recs 1, 6, 12, 13**

5.4   Operation of National Data Units

Each Data Unit is housed in a national agency and, as far as possible, uses the established IT infrastructure, i.e. the hardware and software in place in the host agency, with some commitment of human resources for operation (see Figure 6).

	Netherlands	Germany		Denmark
		Schleswig-Holstein/Hamburg	Lower Saxony	
Responsible agency	National Institute for Coastal and Marine Management, Haren	National Park Authority, Tönning	National Park Authority, Wilhelmshaven	National Environmental Research Institute, Roskilde
RDBMS in use	Oracle (v8i)	Oracle (v7)	MS Access (2000)	MS Access (97)
Current human resource commitment (2004)	External contract (value approx 100000 Euros per annum)	Approx 24 days per annum	1 person	Approx 60 days per annum

Figure 6: Operational Setting of National Data Units

As has been described above (see Section 4.3), the design of the TMAP data handling system did not address the conversion and loading of the data from national sources into the TMAP database (the harmonised data). This task was to be addressed by each Data Unit taking into account the particular national context and mix of structured databases and more informal data sources. Data Units have at times found this to be difficult and have often been behind schedule in data entry. This draws attention to the need to put in place documented standard procedures and (to the extent possible) **automated** processes for the transfer of national data into the TMAP database with the objective of minimising the resources required on an on-going basis.

In fact, the Netherlands has established some automated loading procedures and has actively promoted the approach with TDG members. The unit in Lower Saxony has also loaded available data in an automated fashion. In Denmark and Schleswig-Holstein, data loading has been more of a manual process, manipulating records based on individual knowledge and judgement (i.e. subjectively). Also, as recorded in the minutes of the TMAG meeting in February this year, a federal German project to develop an automatic export of chemical data from the MUDAB database into the TMAP format was completed.

The question of available resources (or lack thereof) plays a large part in this as the development of automated loading processes needs a significant investment of effort up-front to be traded-off against later on-going effort. (The question of human resources is discussed in the next section.)

Another issue is the effect of changes to national source programmes and systems on the operation of the Data Units. As recently discussed in TMAG meetings, the new NOVANA program in Denmark may have a major impact at the policy level, but even minor technical changes in the data handling regime of a source agency may have to be reflected in TMAP transfer and loading procedures.

There is every indication that the TMAP data handling is seen as an additional burden rather than additional resource for national activities. As a consequence, the transfer of national data to the TMAP database may not seen as a priority in the operation of those national databases and therefore the impact on Data Unit procedures may not even be considered by the national authorities. As data transfer processes are developed they should be "embedded" in the overall national operations. For instance, the important implication of the MUDAB export capacity mentioned above is that it is identified as a function of that system, so will be maintained as part of the operation of that national database. Note - this is only implied and remains to be verified.

Summary:

All 4 Data Units can now be considered to be operational. The development to this key stage has taken longer than planned, and been less efficient and less synergistic than it might have been. The agreed decentralised concept recognised that differing national data sources and underlying systems would require the four units to have separate solutions within a common model. While it is true in theory that modern RDBMS systems can tolerate this heterogeneity, the uneven development cycle has contributed to having both little technological similarity (even where the same basic product, like Oracle, is used, the versions are different) and few, if any, analogous data conversion and loading processes. This makes the coordination function heavier than necessary and an added tax on future coordinated development.

Commitment to the principles of the TWSC and TMAP may not have penetrated to the national data management programmes, so that priorities for considering the effect of changes on TMAP Data Units are limited.

Associated recommendations in Chapter 8: **Recs 5, 6, 7, 12, 13**

5.5 Human Resource Requirements

The implementation (and making "operational") of the TMAP data handling system as outlined above has only recently been completed. The operation and maintenance of the system requires effort at both the national level, in the Data Units, and at the trilateral level, in the Secretariat. The resource level which has been suggested is a half-person year at each Unit, plus a full-time coordinator at the Secretariat.

In the Data Units, activities include:

- ensuring regular transfer of data from national sources into TMAP
- user registration
- regular communication with the TDG and other Data Units
- modification and update of the TMAP system to meet agreed changes
- system management including documentation, data security and back-up.

At the trilateral level, there is responsibility for:

- coordination of all TMAP technical activities to ensure Units continue to operate with a unified approach
- planning system modifications and developments to meet evolving trilateral requirements
- maintenance of the Database Extension and User Interface
- maintenance of common shared datasets – for example, common species tables, and GIS files
- user support and coordination of user registration
- maintenance of the TMAP Manual for agreed common approaches and harmonisation measures.

These duties require the human resources in the CWSS and the Data Units to have knowledge of both the data content and a range of IT areas (database, WWW, telecommunications, etc), plus the ability to work at a range of levels from planning and priority setting to hands-on detail of data entry.

Currently in Denmark, Schleswig-Holstein and Lower Saxony, the responsibilities lie with a single person with, as shown in Figure 6, only a part-time commitment in 2 cases. A single individual (especially part-time) responsible for the Data Unit poses some risks:

- difficult to have the full range of skills and experience

- lack of back-up if ill or on-leave

- potential conflicting priorities

- loss of "corporate memory" when a post is vacated

- little opportunity for synergy.

The TMAP structure has some provisions to mitigate these problems, such as the TDG (and informal contact between members) and the DHC. The co-location of the Lower Saxony Data Unit with the CWSS provides some level of back-up and synergy, and the use of a large contracted IT company for the Haren Data Unit should alleviate some of the back-up and continuity problems.

Furthermore, it is clear that the TMAP-DH as implemented is at a basic level (only a starting point) and that further development is needed to realise benefits e.g. to streamline data transfer procedures and to expand output capabilities, and to obtain possible "added-value" (see Chapter 7 below). Resources will be needed for such development.

Overall, three to four people should be sufficient in total to effectively operate the TMAP-DH and to support modest enhancements - **if** it were housed in one institution. The current fragmentation requires an extra resource overhead to be effective and secure.

Summary:

The human resources currently available for TMAP data handling are dangerously small and dispersed to meet the requirements. The dependence on a single person (often part-time) presents dangers for the continuity and security of the system and data. The DHC position and the TDG only partially mitigate this.

Streamlining and automation of technical processes of data loading (discussed in Section 4.3) would reduce the human resource requirements in the longer term.

Consideration of alternative resourcing approaches is needed to ensure cost-effective operation. This is particularly a concern in the context of the general reduction of resource availability for long-term monitoring discussed in the next chapter.

Associated recommendations in Chapter 8: **Recs 1, 2, 5, 7, 11, 21**

5.6   Conclusions and Assessment

The basic three-tier structure of the governance organisation relative to TMAP is sound and there are many examples of similar structures for environmental conventions, and monitoring programmes. The structure works effectively to move issues originating in the TDG to the appropriate level for resolution. On the other hand, the lack of horizontal connections means that the national commitment to TMAP principles is not always easily translated into actions and funding at the Data Unit level, nor is support from national data sources always evident. This has meant that the "impact" has not been satisfactorily obtained – the actual implementation of operational Data Units has been slow, and population of the Common Package is still incomplete.

Providing the working group structure with increased authority to operate as project managers for approved jointly funded projects would allow for more cost-effective implementation and, ultimately, operation of the data handling system.

The working group structure has avoided the excessive frequency, size and formality that typifies other multilateral programmes, especially the international conventions, and so expenditure levels for meetings are modest, hence efficiency is good.

Assessment against criteria – Organisational structure:

Criterion	Rating	Justification
Appropriateness and Relevance	Good	The organisational structure follows an accepted and appropriate model and is appropriate in size and membership for the situation. (See also Section 3.2)
Effectiveness	Satisfactory	Vertical information flow between levels works well. Ability to ensure implementation of decisions is hampered by lack of authority over resources, and limited horizontal connections.
Efficiency	Good	Membership and meeting frequency is modest and appropriate; support from the CWSS is efficient.
Impact	Poor	Difficult to transform TWG-TMAG-TDG decisions and recommendations into funded concrete actions

6 COST-EFFICIENCY OF THE DATA HANDLING SYSTEM

6.1 Introduction

6.1.1 Overview

There are two main streams to the evaluation of the "cost-efficiency" of the data handling:

- The cost-efficiency of the implementation of TMAP-DH to date to support the identified Trilateral Cooperation requirements such as the Quality Status Reports, status of Targets and other assessments.

- The extent to which harmonised TMAP data can be re-used to support other obligations and activities such as EC Directives, international conventions, education and public information.

The latter relates to questions of future directions to take further advantage of the value of the harmonised data for purposes beyond the Wadden Sea Cooperation, with (ideally) minimal additional cost, and that is the subject of the following chapter.

The former mainly relates to the question of past expenditures and processes that have taken TMAP-DH to the current stage of implementation. The principal issues considered are:

- Values and benefits of the TMAP data and data handling to the TWSC

- Costs of TMAP-DH, leading to assessment of whether funding been efficiently used to implement the data handling

- Completeness and appropriateness of TMAP data

- How is TMAP data used currently; is TMAP-DH data handling an effective solution to support national monitoring, as well as QSRs and other trilateral and national assessments?

Each of these are addressed in the following sections.

6.2 Values and Benefits

6.2.1 General Values of Monitoring

It has been recognised for many decades that systematic long-term monitoring of environmental conditions is essential for effective decision-making on conservation and sustainable development. The scientifically based data serve three main purposes – creating an understanding of cause-and effect-relationships (hence informed decisions on mitigation of problems), early warning of potential problems (enabling timely decisions on avoidance measures), and assessment of the impact of decisions (enabling adjustment and refinement).

These purposes lead to the key characteristics necessary of monitoring data (and data handling):

- **Scientific** validity – systematic collection, valid measurement methods

- **Continuous** time series on a consistent basis

- **Harmonised** data so that they can be aggregated and meaningfully interpreted.

6.2.2 The Global Picture of Monitoring

Long term monitoring of the environment is now frequently undertaken by governmental bodies at all levels, from local community to global, by NGOs, and through volunteer programs. At the global level, monitoring was one of the early cornerstones of UNEP and its

"Earthwatch" concept. Shortly after the inauguration of UNEP, the Global Environmental Monitoring System (GEMS) was formed and became one of the primary Programme Activity Centres of UNEP. GEMS had components that monitored air, water, radiation, human health (as related to the environment) and terrestrial ecosystems. The latter spawned the Global Resource Information Database (GRID) project that evolved into a number of regional centres using remote sensing and Geographic Information System (GIS) technology to accumulate information on land cover and change, and to provide capacity building at regional and national levels.

Many countries have introduced national environmental statistical systems, and various approaches to State-of the-Environment monitoring. Many of the international conventions explicitly recognise the need for monitoring, and there are several international initiatives such as the Global Environmental Outlook ("GEO Process") and the Millennium Ecosystem Assessment, as well as regional efforts such as the "Environment for Europe" process that are currently active.

In spite of the known benefits and current global activities, long term ecological monitoring is not well established overall, nor consistently funded and supported. In the 1990s, for instance, UNEP-GEMS was dismantled and devolved in part to more specialised agencies, with the formation of three linked "observing systems" – Global Ocean Observing System (GOOS), Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS). The first two of these have clear focus – GOOS under IOC, and GCOS under WMO linking to Climate Change Convention activities. GTOS (which would include coastal marine monitoring such as TMAP) is less focussed and weakly supported. One specific GTOS product is the Terrestrial Ecosystem Monitoring Site (TEMS) database. Building from initial work in GEMS, this is now a web-accessible system containing information (primarily metadata) on over 800 sites that carry out long-term monitoring activities. The website allows users to query and browse through a variety of access paths and allows site managers to update their information directly. This is a very loosely connected network with no effective harmonisation or standards and relies entirely on the voluntary participation of the site managers.

Many national monitoring programmes have started and then failed to continue, and examples of regional monitoring programmes are rare. Lack of funding and support for monitoring is a universal problem. Some of the issues and problems are:

- Lack of universal agreement on what needs to be monitored

- Underestimation of the effort required to achieve harmonisation

- Underestimation of the effort required to organise, manage and provide access to the information base

- Dependency on NGOs and volunteers for data collection

- Lack of demonstrable immediate value – that is, monitoring not being tied to a specific issue of concern or question of interest to legislators

- Disconnection from high-level indicators – it is often unclear how the 'scientific" data should be interpreted, and how data could or should be aggregated into useful indicators.

The lack of support forces long-term monitoring programmes to "partner" in an opportunistic (not necessarily strategic) way, often with minimal resources to introduce the standards needed for long-term consistency, or to develop appropriate information systems for information analysis, synthesis, and communication. This limits the value of the information that has not been collected with a particular goal in mind, or is assembled from programme information and research studies that have no integrated systematic framework. This results

in circularity – these weaknesses in the monitoring data quality further reduce the potential for support.

6.2.3   Specific Values of TMAP

Monitoring is at the core of the Trilateral Wadden Sea Cooperation; it is recognised as essential to being able to treat the ecosystem as a whole. The values that TMAP monitoring data can provide include:

- Support for research studies
- Support for national decision-making and policy development
- Support for public awareness and NGO activities
- Support for conservation management at the local level (e.g. national park) in an ecosystem context
- Supporting data for assessment against the Ecological Targets (e.g. the QSRs)
- Support for other Wadden Sea assessments as required
- Rapid identification of abnormal or alarming situations
- Enabling of joint projects, actions and harmonised legislation
- Facilitation in meeting international conservation obligations
- Raw data for aggregation to assist with national, European and international reporting obligations.

The successful harmonisation, and long term time-series are the two key characteristics that make the TMAP data sets much more valuable than the national datasets from which they are derived. The logical top-down process by which TMAP parameters have been selected, and harmonisation measures developed and implemented (and documented in the TMAP Manual) ensure that many of the pitfalls noted in the previous section have been avoided. The TMAP parameters have been selected with the specific intent of supporting assessment of Ecological Targets that in turn derive from identified issues of concern for the Wadden Sea ecosystem (see Annex 3).

Essentially the coordination and harmonisation of TMAP permits a broadening of the range of questions and decisions that the data can support. These benefits or values are very substantial, but still largely theoretical, since on-line availability of the harmonised time-series is only very recent.

The TMAP Evaluation of 2001 paid specific attention to the potential of the TMAP parameters to be used in assessment of the Ecological Targets with positive findings, although with recommendations on making the targets more quantifiable and subject to measurement. It should be emphasised that TMAP time-series monitoring data is necessary, but not sufficient, for assessment of the Targets – there will always be a need for other kinds of observations (such as localised research studies on processes) which need not be, or should not be "monitored" in multiple locations, or at regular specified time intervals. TMAP data handling provides an important part of the information base, but it must be augmented by other time-series (such as socio-economic data) and one-time research studies.

Of the list of values or uses given above perhaps only the first three could be achieved without the TMAP data handling, indicating that the added effort of harmonisation provides many (potential) benefits – benefits that are directly connected to the objectives of the TWSC, as well as potential value-added benefits. At the risk of being repetitive, much of the value of the TMAP data comes from them being collected in systematic programmes, with harmonised methods consistently over a continuous period of time – so that baselines can be established and trends extracted and tested for significance. This contrasts sharply with the limited value of equally large collections of data that might be assembled from disparate research studies of unsystematic observations over periods of time, where interpretation is difficult due to unrepresentative sampling methodologies and unknown amounts of observer bias. TMAP data has been specifically selected from systematic programmes with known

methodologies and sampling protocols, and that process of selection and harmonisation has involved considerable investment. While, as mentioned above, the data must be **augmented** from time to time by specific research studies, such one-time investigations cannot be a substitute for the time-series data when making assessments and consequent policy decisions and actions.

World-wide there are few examples of harmonised multi-national ecological monitoring time-series for comparison. The trilateral USA-Canada-Mexico Commission for Environmental Cooperation (CEC) has some relatively short (8 years) time-series on pollution from hazardous chemicals, as do some of the European river agreements. Consistent monitoring data for the Joint Assessment and Monitoring Programme (JAMP) of the OSPAR Convention is only starting. For a number of the reasons noted in Section 6.2 above, harmonised environmental time-series are rare and hence valuable in that way alone.

There is no accepted way to place a "value" on data collections or archived time-series. Currently held in TMAP are some 70 data sets with time spans varying from a few years, up to 25 years. Some of these have only one or a few data values per year, others are much more dense (for example, the Schleswig-Holstein Data Unit has indicated they may have over 1M migratory bird observations). Without doing a detailed inventory, we estimate that there are 1,350,000 observations recorded, and further speculate that when all parameters and backlog are entered the total will exceed 2,000,000. Some examples of data volumes for a few parameter groups are shown in Figure 7 for illustrative purposes.

Data class	Parameter	No. of data records in database			
		DK	SH/HH	LS	NL
Biological parameter groups	Macrozoobenthos	18,600			
	Phytoplankton	8,700		5,500	
	Breeding birds	4,090			
	Beached birds	189		6,100	
	Seals	46	11,000	928	
Chemical parameter groups	TBT	34		2,750	1,350
	Metals in sediment	402		2,800	1,400
	Nutrients in water	13,400		1,900	31,600
	Contam. in mussels	1,700	470		8,800
	Contam. in flounder	268	6300		16,100
	Contam. in bird eggs	3,100		34,300	24,000

Figure 7: Data Volumes for Some Selected Parameters.

Almost all of these observations were made as part of existing national programmes or NGO processes so that the costs of data collection are not attributable to TMAP. The data collection costs are however very substantial, even where collected using volunteer networks, and translate into one view of the "value" of the data, that is the cost of acquisition (or "replacement cost", even though the data is irreplaceable if lost). With little solid basis (only many years of experience with environmental data collection programmes) we would suggest 50 to 100 Million Euros as the cost (hence value) of the TMAP data holdings. This data, originally collected for national purposes has now had its value enhanced through the harmonisation and organisation into the TMAP-DH system.

Summary:

Harmonised multi-national time-series like TMAP are rare and the TMAP data represents an extremely valuable and irreplaceable resource for baseline reference, change detection and environmental assessment of the Wadden Sea ecosystem.

Associated recommendation in Chapter 8: **Rec 29**

6.3 Costs and Efficiency

6.3.1 Introduction

The "costs" of TMAP-DH are considered to be incremental to the national programme costs, that is, the additional costs that would not have been incurred had the country not participated in the TWSC. Further, only those incremental costs associated with TMAP Data handling are included, hence not all the functions and activities of TMAG and the CWSS. It is not always easy to precisely identify these costs (which are mainly for human resources) as, even in TMAP Data Units, duties are mixed and involve parts of the time of various people. Some of these have been discussed in Section 5.4 above and are summarised here. The costs can be roughly divided into "sunk costs" i.e. the investment to date, and "on-going operational costs" which are those required to maintain the current operational system.

6.3.2 Sunk Costs

Sunk costs (the total past investment in development) include the early DEMOWAD project (cofinanced by the EC), the subsequent continued design and development of the TMAP database and associated access mechanisms, the establishment of the Data Units and their data conversion and entry activities, and the coordination tasks of the DHC in the CWSS. No attempt has been made to include any additional costs for such things as TDG and TMAG meetings.

Cost component	Time period	Estimated cost (excludes personnel overheads) (000 €)
DEMOWAD	1995-1998	1360
National TMAP-DH database development		
German Federal Project	1998-1999	480
Netherlands	2000-2004	390
Schleswig-Holstein	2004	15
Lower Saxony	2003-2004	120
Denmark	2000-2002	100
	2004	25
German project to automate extraction from MUDAB	2003	110
CWSS system development & coordination (including GIS)	1998-2004	420
Total		**3020**

Figure 8: Sunk Costs (estimated to end of 2004)

The rough estimates in Figure 8 are based on examination of reference materials and discussions held during the site-visits and are extrapolated to the end of 2004. Costs for hardware, software and communications are not included, nor are personnel overheads.

Of the total 3.02 Million Euros, approximately two-thirds (1.96 Million) were costs incurred prior to the year 2000 and the bulk of that was in the DEMOWAD project. As noted in Section 5.3, a significant percentage of DEMOWAD involved the definition and adoption of the parameter groups and the harmonisation required, not on the data handling system *per se*. The two are inextricably linked.

6.3.3   On-going Operational Costs

The on-going operational costs are those required to carry on TMAP-DH operations in the current manner. These will be incurred for activities as detailed in Section 5.5, i.e. including database entry and maintenance by the Data Units, GIS preparation and maintenance by the DHC, and all system maintenance and coordination between the Units and the DHC. Costs for preparing the QSR using TMAP data are **not** included. The figures below include an allowance for modest enhancements to the functionality of the system (such as improvements in specific TMAP database input procedures), but not for major developments of additional functionality (such as significant expansion of the product delivery). An average cost of 100,000 Euros per person-year is assumed (includes personnel overheads) and costs for hardware, software and communications are **not** included.

Cost component	Estimated annual cost (includes personnel overheads) (000 €)
Data Units – entry of new data and system maintenance	200
CWSS system maintenance & coordination, GIS	100
Total	**300**

Figure 9: On-going Operational Cost Estimates

Summary:

The sunk costs to date for the development of TMAP-DH and population of the database to its current level have totalled approximately 3 M Euros over the past 10 years. Over 2/3 of the costs were expended before 2000 on system design and development as well as major efforts in parameter selection and harmonisation.

On-going annual costs to continue data input and maintenance are estimated at 300,000 Euros. (Development costs for any additional functionality are not included.) Many of these costs could be considered to be offset by savings in the preparation of the QSRs and in other assessments for the TWSC.

Associated recommendations in Chapter 8: **Recs 1, 2, 21**

6.4   TMAP Data

6.4.1   Completeness of Parameter Groups

Over the past several years, staff have been entering selected TMAP data into the databases of the four national TMAP Data Units. Time-series of various lengths have been entered for most of the biological and chemical parameter groups. The time-series start mainly in the early to late 1990s, although much of the seals data dates from as early as 1975. The longest

time series is for nutrients in water in the Netherlands that dates from 1971. Almost all the data entered into the databases has been made available for catalogue searching and downloading through the Java applet interface. In addition, the CWSS has collected and harmonised (in GIS format) information on salt marshes, eelgrass, blue mussel beds, (geographical parameter groups), plus a number of key boundaries (of protected areas and data collection zones) and these are available for common use. As a result, 15 of the 28 parameter groups are fairly thoroughly covered. This represents an estimated 350,000 observations spanning 33 years.

The current situation was summarised in Figure 5 above.

Although there are some obvious gaps, it could be said that about 75% of the biological and chemical parameters are now available for use in a harmonised way. Work is underway to fill the gaps, for instance the chemical data for Schleswig-Holstein. The principal missing parameters are related to resource extraction and other pressures on the ecosystem, and to background conditions (the "general parameter" groups). Obtaining these data in a systematic way and achieving harmonisation has been proving difficult. The issues surrounding the general parameter groups and whether it would be cost effective to pursue them further are discussed in the next section.

6.4.2   Cost-effectiveness of Human Pressure Information

The TMAP Evaluation of 2001 noted some key data gaps that hampered the assessment of the status of Ecological Targets, and indeed recommended some increases in data collection as well as completion of implementation of agreed parameters. Difficulties have been encountered in achieving harmonisation of a number of the parameter groups classified as "general". In part this may be because they are held by a different group of government departments and programmes than those commonly associated with biological/ecological matters. Information on such topics as agricultural utilization, fisheries, boat and air traffic, and tourism may be useful in correlating change in ecological status variables with increased pressures, hence establishing potential causal relationships – and informing consequent decision-making on appropriate controls.

From the site visits, it was also clear that some NGOs and some government authorities would like to see additional socio-economic data available through TMAP (such as occupation and income statistics of coastal and island residents, profiles of tourists and other users of the environment, and so on.). There is no doubt that such data has potential value to local and regional decision-making, but the question arises as to what extent it should be included in TMAP in the same way as the biological parameters, and whether it is cost-effective to do so given the difficulties already encountered. The biological and chemical parameters are largely the subjects of national programmes of data collection (or pre-existing government-NGO alliances such as for the bird and seal monitoring), whereas there may not be such a clear-cut connection for the socio-economic information. As well, the data collection and management regimes for socio-economic data frequently are tied to administrative boundaries and/or industry sectors, rather than being particular to the Wadden Sea and its constituent parts. In any event, it would be necessary to broaden the base of partner agencies and working groups in order to address parameter selection and harmonisation issues. This will take time and resources, and may not be a cost-effective approach.

Summary:

The TMAP data, now accessible through the user interface, meets many of the planned needs for assessing the status of the Ecological targets, and the QSR production. There is some backlog of chemical and biological data to be completed, and continuing issues with the entry of general parameter groups. Completion of the parameter groups related to pressures, and

the addition of new socio-economic parameters raises issues of cost-effectiveness that require further examination of alternative methods of achieving the goals.

Associated recommendations in Chapter 8: **Recs 26, 27, 28, 29**

6.5   Current Uses of TMAP data

6.5.1   Trilateral Cooperative Uses

The main original intent of the TMAP Data Handling was to provide an information base for TWSC needs, for instance to support the preparation of the Quality Status Reports and, in particular, to assess the status of the Ecological Targets.

The preparation of the QSR in 1999 encountered a number of problems and delays with regard to obtaining data from a broad range of national institutions and in assembling and harmonising them in a form suitable for assessment and presentation. For this and previous QSRs, data assembly was completed on an ad hoc basis using spreadsheets with undocumented steps and procedures. One of the key objectives of the TMAP-DH was to facilitate the QSR process in future by providing a common source of harmonised data that could be incorporated into standard documented compilation processes that could be used in subsequent analyses, thus reducing time and costs and improving the quality and consistency of QSRs.

This has now been achieved and the harmonised data is available for download. (For instance, all relevant chemical data is now assembled with reliable quality, trilaterally approved.) While the downloadable files have only been available since early in 2004, they have been tested and recently used in current preparations for the latest QSR. A consultant author for the QSR used the TMAP Web interface and "exchange format" to extract and download all the chemical parameters for use in assessments and graphics for several chapters of the Report. The downloaded data files in the "exchange format" were input into spreadsheets and MS-Access databases. In spite of the potential complexities noted in Section 4.6, this user reported that the downloading and subsequent conversion was easy and convenient, and presented no significant problems. Further it was indicated that this was a significant step forward from the previous QSR in saving time and effort in data assembly, and that it would be easier next time. It should be mentioned that this particular user would have to be considered an "expert", that is, was highly familiar with the TMAP data, its structure, content and context, and experienced with the loading of "character delimited" data into application software.

It is expected that in future similar use will be made to extract the biological parameters, possibly contributing to the current QSR. This points to a tangible benefit of the TMAP data handling – offsetting the costs of TMAP are (or will be) cost reductions in the preparation of QSRs as well as ad hoc assessments of particular issues.

Another major purpose of having the harmonised TMAP data is to support and enable activities for management and conservation of the Wadden Sea ecosystem. In this regard, the TMAP data (as assembled in the 1999 QSR) was used as a basis for several agreements at the Ministers Conference 2001 regarding conservation policies (general) on such things as reduction of nutrients, pollutants, sand and shell extraction, shellfish fisheries, bird and seal protection. Specific resulting actions included the formation of ad-hoc expert groups on salt marshes and blue mussels.

On the other hand, **no** examples can be found of **jointly funded** conservation projects, coordinated legislation or administrative actions that clearly derive from the opportunity provided by the TMAP data to take a unified ecosystems view. In this regard the TMAP data appears to be under-utilized.

6.5.2   National Uses

One of the factors involved in the decision to establish separate Data Units was that these could be a data source to support **national** actions regarding the Wadden Sea. In Germany, the Data Units are co-located with the authorities responsible for the protected areas of the Wadden Sea (and are nearby for the Netherlands). This makes it natural that TMAP data held in the Data Unit will be used for park management and planning. This appears to be the case with these units, although the park management also separately use both national data sets and locally acquired data that is not technically integrated with the TMAP data.

National policy and activities regarding environmental matters generally employ data from national programmes in various sectors – water, agriculture, fisheries, wildlife, etc – that is maintained by a range of government departments and agencies. These are the source agencies for TMAP data, but national use is essentially in parallel and the selected harmonised data is entered into TMAP as a side issue or after-thought. It would appear that in general, information is not extracted from the TMAP database to inform national policy decisions that may affect the Wadden Sea. This may change now that TMAP data is more easily available for download.

Some officials noted the use of TMAP data to provide information relevant to European policy issues, and the normal source was from the integrated and interpreted information of the QSRs. Where the TMAP database was used, it was through an intermediary who would extract the data in cooperation with the Data Unit and summarize and provide interpreted information to the official. Given the relatively low level (or 'raw data") in TMAP, this process is expected to be common, that is, it is unlikely that a senior staff member would directly download data from the TMAP access service – even if it can be made more user-friendly.

In that regard it has been noted that use of TMAP data to assess the status of the Wadden Sea Targets (even in aggregated form from the QSRs) is problematical because of the rather vague and non-quantitative nature of the targets.

National authorities for the countries of the TWSC report to the Birds and Habitats Directives and the Ramsar Convention various data related to the specific designated areas (SPAs, SACs and Ramsar sites) in the Wadden Sea using data that is essentially identical to that held in TMAP. This is however accomplished by each country independently, and in parallel with the TMAP-DH. The same national source data is used, but in almost all cases the entry of the data into the TMAP databases is a separate exercise; the data are not first entered into TMAP and then extracted to use in reports. The availability of the user interface for TMAP now makes it feasible to extract the **harmonised** data for incorporation into these reporting obligations, hence producing information of more value and consistency.

Summary:

The limited user experience so far has show the TMAP-DH to be effective in extracting required information for expert assessments for the QSR. There is little history of use of TMAP data (or QSR summaries) for joint trilateral projects or activities. As yet TMAP-DH is not recognised as a substitute for maintaining equivalent national datasets.

Associated recommendations in Chapter 8: **Recs 14, 15, 16, 17, 28**

6.6   Conclusions and Assessment

The TMAP-DH has just reached the point of being operational and permitting the downloading of harmonised datasets for use by experts in assessment. All Data Units are staffed and functional. The TMAP-DH now meets the needs as intended in support of the TWSC. There is limited user experience so far, but every evidence that TMAP-DH will produce the desired outcomes – good ecosystem assessments that lead to good joint decisions and continued conservation of the Wadden Sea ecosystem. Enhancements to the user interface would improve effectiveness.

The TMAP data holdings are a high quality scientific time-series of harmonised observations, that even incomplete, are of significant real and potential value as information for decision-making and a base for joint policy, programmes, and actions that address the identified Issues of Concern in the Wadden Sea Plan.

The cost efficiency of the development is assessed as **good**. Certainly there is no evidence of poorly controlled or excessive expenditure, in fact delays and slow progress can be attributed to periods of limited and intermittent funding, particularly for conversion and loading at national Data Units. It is only in early 2004 that the target of an "operational" TMAP-DH was achieved versus the Esbjerg target of early 2002. The intermittent nature of the work at Data Units has caused some inefficiency due to losses of continuity and reduced opportunity for synergies between Units, but in summary, a great deal has been successfully achieved at a reasonable cost.

By way of comparison the North American CEC "Taking Stock" programme that monitors the release of pollutants has cost an estimated 1Million Euros for development of the database and website access facility, and has on-going update and operational costs for the user interface of approximately 300,000 Euros, contracted to an IT company. Not included in these costs is the support from a relatively large secretariat with a substantial IT group as well as scientific staff. Project Proteus of the UNEP World Conservation Monitoring Centre that seeks to provide integrated on-line access to a range of **existing** biological databases (on several RDBMS platforms) will cost £7 Million for development over a five year period. The "Reporting Obligations Database", part of the EEA Reportnet, that is essentially metadata on reporting requirements, is still in development and has cost an estimated 500,000 Euros so far.

Obtaining, harmonising and loading the "general" parameter groups is proving difficult, and a range of alternatives could be considered, before committing excessive resources. Note is taken of the expectations of the Esbjerg Declaration (para 81) *"to make use of data from existing monitoring programs and to evaluate possibilities of including them into the TMAP without additional costs"*. Cost-effective solutions (not **without** cost) may involve the use of volunteers, industry statistics (such as from tourism groups), summary or surrogate statistics, or the use of GIS to connect to existing statistical data sources.

Assessment against criteria – Cost-efficiency of the Data Handling system

Criterion	Rating	Justification
Appropriateness and Relevance	Satisfactory	Implementation of computer-based system is appropriate (See also Section 3.2)
Effectiveness	Satisfactory	The current implementation just meets the basic requirements for operational data access. Functionality of the user interface is limited. Input of the Common Package of parameters is incomplete.
Efficiency	Good	Much has been successfully achieved at a reasonable cost, with no evidence of poorly controlled or excessive expenditure. Costs compare favourably with similar developments elsewhere. The intermittent nature of the work at Data Units has caused some inefficiency due to losses of continuity and reduced opportunity for synergies between Data Units.
Impact	Not rateable	The opportunity for the operational system to impact has been limited since the facility has only been available briefly. One documented use in support of QSR assessments has been reported as very successful.

7 POTENTIAL VALUE-ADDED USE OF TMAP DATA

7.1 Introduction

As outlined in Section 3.3, the potential (some might say the necessity) of using TMAP data to contribute to national reporting obligations to EC Directives and Multilateral Environmental Agreements (MEAs) is an important issue. Whereas the original conception of TMAP-DH was to support the Wadden Sea Plan and inform the TWSC in decision-making concerning the conservation of the Wadden Sea ecosystem as a whole, one of the directions of evolution of the Cooperation has been to invite consideration of how TMAP (the programme) can better support obligations to other multilateral instruments that may affect the conservation of the ecosystem. The Esbjerg Declaration of 2001 makes a specific reference to considering how TMAP-DH can be optimised "*for future requirements, in particular with regard to the Targets, the EU Habitats Directive and the EU Water Framework Directive*". The concept is to re-use TMAP data to support inputs to other instruments in such a way that national costs are avoided, or that TMAP could provide parallel functionality both with regard to multilateral as well as trilateral commitments. The value of TMAP is then increased by the cost offsets. This value-added is only realised if some current process of data management and international reporting can be eliminated, or costs of some future data management requirement can be avoided.

The recent Oxford Brookes report commissioned by the Wadden Sea Forum (Review of International Legal Instruments, Policies and Management in respect of the Wadden Sea Region – Wadden Sea Forum Report No 1, 2003) conducted a thorough review from a legal and management point of view of a range of instruments (with an emphasis on the EC Directives) and how they interact in the region. That study noted a number of organisational and administrative issues that present concerns and barriers to effective interaction. This evaluation emphasises the potential use of TMAP data in support of reporting obligations to these instruments, rather than the jurisdictional and policy issues.

In considering this, it is important to note that, in general, MEAs require reporting of progress towards implementation or indicators of compliance with the terms of the instrument. This includes such information as the existence of legislation, policies, action plans and management plans. Quantitative information is rarely demanded and if so, usually in the form of highly aggregated indicators that may be relative rather than absolute, such as achieving "favourable" status. Science based monitoring data such as held in TMAP-DH has potential use in calculating these indicators and providing support for expert assessments, but is rarely directly submitted in national reporting.

Further to the legal oriented assessment of the Oxford Brookes study, this evaluation has examined in detail the implications of a range of legal instruments from the point of view of data and reporting requirements and the potential value of TMAP to support these. The three countries of the TWSC are parties to a long list of MEAs (70 by our analysis), including global and regional conventions, as well as being subject to all EC Directives. Annex 6 lists the 18 most significant with an assessment of their significance to the Wadden Sea and the goals of the TWSC.

Those that our analysis shows have high relevance are:

International Conventions and Agreements;

- Convention on Wetlands of International Importance (Ramsar Convention)

- Convention on the Protection of World Cultural and Natural Heritage (WHC)

- Convention on the Conservation of Migratory Species (Bonn Convention)

- Agreement on the Conservation of Seals in the Wadden Sea

- Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)

- Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)

- IMO – International Convention for the Prevention of Marine Pollution from Ships, Designation of Particularly Sensitive Sea Areas

EC Directives:

- Council Directive on the Conservation of Wild Birds, 1979 (Birds Directive)

- Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora, 1992 (Habitats Directive)

- Council Directive establishing a Framework for the community action in the field of Water Policy, 2000 (Water Framework Directive)

Annex 7 provides profiles of the principal reporting obligations under each of these instruments. Recognising the importance of aligning TMAP with the EC Directives and other instruments, this Annex contains considerable detail, potentially useful as reference material for future needs assessment and adjustment of TMAP parameters.

The parameter groups of TMAP have been chosen specifically to be useful in addressing the Issues of Concern for the Wadden Sea. It is therefore not surprising that many of them would be reflective of, and potentially useful to, addressing areas of concern more generally for marine and river basin ecosystems, and for migratory species, and other species of conservation concern.

Attention is also drawn to the potential expansion of the use (and hence value) of TMAP data for wider audiences, including better use by interested NGOs, for public participation and for educational purposes.

The following sections assess the potentials for such value-added use for international conventions, EC Directives and public audiences.

7.2 Potential of TMAP Data to Support Reporting to International Conventions and Agreements

International Conventions relevant to the Wadden Sea place obligations on nations to report on treaty implementation for the nation as a whole, and hence will normally need inputs from a range of national institutions dealing with different geographic areas. The reports are required on relatively long frequencies (3 to 6 years) and are generally summarised, although many expect detail on specific sites such as designated protected areas. Quantitative data from TMAP-DH will in most cases be a contribution to a national process, and cannot be expected to provide the entire base of data. The following sections have brief descriptions of the correspondence of TMAP data with some key International Conventions.

Ramsar Convention

There are currently 9 designated Ramsar sites in the Wadden Sea (1 in Denmark, 5 in Germany, and 3 in the Netherlands) and more are pending. One of the principles of the Ramsar Convention is to *"protect the ecological character of listed sites"*. This is fully in concordance with the aims of the TWSC. On nomination of the site, an "Information Sheet" is submitted requiring a range of information on the biogeography of the site, population information on the species (mainly birds) that make the site considered important, and factors (past, present and future) adversely affecting the site's ecological character. Measurable information is encouraged. Subsequently, triennial reporting requirements ask *inter alia* for "Inventory and Assessment". A reporting format is specified in a general way, not dissimilar

to the Wadden Sea QSRs. TMAP data on breeding and migratory birds, seals, salt marshes and eelgrass are all highly relevant and suitable.

World Heritage Convention

This has "high" relevance to TWSC only in the sense that a World Heritage designation is being considered for all or part of the Wadden Sea Conservation Area. Considerable information, including historic, is required on inscription of the site and subsequent reports would require updates that relate to the cultural or natural values for which the site was inscribed. These would include natural factors that could be provided by TMAP as well as non-quantitative "measures for identification, protection conservation and rehabilitation". Should such a nomination go forward, TMAP data would be extremely useful both in the inscription process and in subsequent monitoring reports. The TMAP data will be especially relevant if the site is proposed under Trilateral jurisdiction, and hence can provide a harmonised view.

Bonn Convention

This is the parent convention to the Seals Agreement and the Afro-Eurasian Waterbirds Agreement (AEWA). On accession to the Convention "range states" are required to provide information on the status of "listed" species, and thereafter to update this information on a triennial basis. TMAP breeding birds, migratory birds and seals monitoring data can provide all necessary quantitative information, as well as support more general information requests such as *"measures to protect the species and their habitats"*.

Seals Agreement

The Agreement on the Conservation of Seals in the Wadden Sea under the Bonn Convention on Migratory Species (CMS) calls for close cooperation in achieving and maintaining a favourable conservation status for the common seal population of the Wadden Sea. The associated Seal Management Plan (2002-2006) focuses on conservation and management measures regarding habitats, pollution control, research and monitoring, taking and exemptions from taking, and public information. The seal counting statistics of TMAP constitute the definitive source for monitoring implementation of the Agreement. It should be noted that the Wadden Sea Seal Agreement and the Conservation and Management Plan for the Wadden Sea Seal Population 1991-1995 were concerned only with the common seal (*Phoca vitulina*). However, since the Seal Management Plan 1996-2000, additional measures for the protection of the grey seal (*Halichoerus grypus*) in the Wadden Sea are also included. Provisions have been made to add grey seal counts to the TMAP parameters.

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) is particularly concerned with ship and land-based contaminants and with excessive nutrient loads. TMAP-DH parameters are closely aligned to the information requirements of OSPAR. TMAP data is fully harmonised with the Joint Assessment and Monitoring Programme (JAMP), Guidelines for monitoring contaminants in sediments (see TMAP Manual), and similarly with the OSPAR Guidelines for Harmonised Quantification and Reporting Procedures for Nutrients (HARP-NUT). TMAP data can therefore be used **directly** for input (on behalf of the three countries jointly) to those two reporting requirements. Having harmonised data across the Wadden Sea as a whole is particularly valuable and in the spirit of OSPAR.

AEWA

TMAP monitoring of migratory birds has obvious relevance to the Afro-Eurasian Waterbirds Agreement under the Bonn Convention on Migratory Species. The TWSC countries are "range states" for a number of AEWA listed species and these correspond to the populations monitored under TMAP. Reporting is triennial, and the migratory bird population statistics

are valuable source material for reporting on species conservation status and progress of Action Plans. The reporting also requires "habitat inventories", conservation (protected) areas, management of human activities, and conservation measures. TMAP data can form a base to fulfil most of these requirements in regard to the Wadden Sea area.

PSSA Designation

It is not clear what the environmental reporting requirements under the designation as a Particularly Sensitive Sea Area may be. The principal emphasis of the PSSA designation is on the ability to apply additional measures regarding ship traffic and discharges. Although the Southampton Institute Feasibility Study identified "reporting requirements" as a potential burden, no specific requirement for ecological monitoring and reporting seems to have been elaborated by the IMO. The previous QSRs were used in the application for designation, and it would seem likely that TMAP data would be adequate for the ecological component of any subsequent reporting. The designation does imply "incident" reporting of various kinds regarding pollution events from shipping. TMAP data is not well placed to contribute to reporting of that nature.

Summary:

TMAP data in its current form, without additional parameters, can supply direct input to many of the reports to international conventions, and can provide support for less quantitative assessments of conservation status and ecosystem condition. The fact of harmonisation across the Wadden Sea adds recognisable value and responds to the principles of conservation and management of ecosystems as a whole that are eschewed by these treaties. The weakest areas of TMAP support are on measures of human activity that may pose threats, as these are poorly developed in TMAP.

TMAP data are already being used to support assessment and reporting to the these instruments, and the newly available user interface now makes the data much more accessible for integration into national reports to the conventions. It remains to be seen whether national authorities responsible for these reporting requirements take advantage of this potential.

Associated recommendations in Chapter 8: **Recs 15, 17, 18, 24, 26, 29**

7.3   Potential of TMAP Data to Support Reporting to EC Directives

7.3.1   Introduction

The EC Directives are binding on the nations of the TWSC. The Directives are therefore important policy drivers and of high priority for national response. As noted in Section 7.1, three Directives are of high relevance to the conservation of the Wadden Sea. The Birds and Habitats Directives have been in force for some time and TMAP–DH has already taken cognisance of them. The Water Framework Directive (WFD) is currently in the process of implementation by the EU member states. The growing importance of these to the TWSC is evidenced in recent Trilateral Declarations, and is one of the evolving issues as noted in Section 3.3 above.

It is therefore essential to consider to what extent value-added use can be made of TMAP data to support reporting obligations under these Directives. The focus of this evaluation is on data and data handling issues, whereas in considering the implementation of the Directives, broader policy and Trilateral coordination and policy issues arise. It is important to have realistic expectations of the potential influence and input a regional monitoring programme like TMAP can have on national obligations to the EC. The Wadden Sea conservation area, for all its environmental importance, is only one instance out of many of each nation's suite of concerns and the implementation of the Directives necessarily requires a national perspective. National solutions must be found that suit national policies, processes and institutions that are geographically and contextually remote from the Wadden Sea. One

result is that TMAP-DH cannot direct or determine the implementation of monitoring and reporting programmes under the Directives, rather the data handling system can:

- look to how existing monitoring and data can support national processes

- consider how to adapt to the changing requirements, and

- provide experience and guidance based on a successful monitoring and data handling regime.

While it is possible that major changes will be required to adapt TMAP-DH to EC Directives, two factors make the necessity for revolutionary change unlikely:

- TMAP databases hold scientific observational fact (rather than aggregated indicators) designed to support decision-making on a range of issues, including those as yet unanticipated

- The technical design of TMAP-DH is such that additional parameters can be added with relative ease without significant change in the system.

As further context it should be noted that TMAP-DH is not a "reporting obligation" on the three countries of the TWSC, but is a time-series database of observations designed to support assessments and reporting, i.e. it is not an end product, but an intermediate product (a data archive) that can contribute to a number of end-products.

The specifics of potential support to the key EC directives are discussed in the following sections.

7.3.2   Birds and Habitats Directives

These Directives call for countries to designate a series of protected sites. These are Special Protected Areas (SPAs) for birds, and Special Areas for Conservation (SACs) for habitats. In establishing the sites, nations submit detailed information on a consolidated form referred to as the Natura 2000 Questionnaire. This approach serves to integrate and harmonise data input for the two types of site – and there is further harmonisation with the network of sites of non-EU countries called the Emerald Network. Harmonisation for the habitat classification and listed species is facilitated by the European Topic Centre for Nature Protection and Biodiversity (ETC/NPB). The three Trilateral countries have completed nomination of the sites and hence provided comprehensive data and assessments in the Natura 2000 format. It is not certain if regular updates of the Natura 2000 Questionnaire will be required, but if so, a great deal of this information can be obtained from the TMAP data, although as usual, assessment and interpretation is required, along with additional information regarding legal and administrative measures on protection.

These designations and initial information submissions have not been done jointly, and the Oxford Brookes report indicates that approaches to designation and interpretation of the Directives are not consistent between the Wadden Sea countries. Within countries, the SPAs and SACs overlap and do not precisely coincide, nor do they exactly coincide in all cases with Ramsar sites and other designated areas in the Wadden Sea.

It is not entirely clear what on-going reporting will be required in respect of these Directives. A report every six years is prescribed ("Report on Implementation Measures") which is to include an assessment of the "conservation status" of the specified habitat types and listed species, along with results of "surveillance" (monitoring). While there is an agreed need to clarify and possibly subdivide marine habitat classes, it is clear that TMAP data are a solid base to support such reporting as well as for the generation of indicators and/or assessments of conservation status of habitats and species. The spatial framework of the TMAP data (observations related to a specific sample location or collection area) make them highly suitable for referencing against particular SPAs, or SACs, or habitat types, through the use of

the common GIS datasets maintained centrally. As well as being directly useful for site-specific reporting, the harmonised nature of the data allows it to respond to Directives requests for information on the *"relation of the sites to other sites at the national and regional level"*. TMAP data as it now stands well supports assessments of conservation status, but is weaker in support of "impacts" on the sites, as the pressure-related datasets are not as well evolved. It may be beneficial to add to the functionality of the User Interface the capability of selecting ("filtering") data by SPA or SAC.

The Oxford Brookes report also notes that *"there is a complex web of agencies responsible for implementing the key Directives..."*. This points to further value of the harmonised data that can be accessed by all the various tiers of government responsible for various aspects of implementation and reporting, so that each works from the same information base.

7.3.3   Water Framework Directive

The WFD calls for countries to delineate River Basin Districts (RBDs), characterise them, develop River Basin Management Plans and associated monitoring programmes. The management plans are to include "environmental objectives" – the status of which would be assessed through the monitoring programme. There is clearly considerable latitude permitted in implementation, and in interpretation of just what constitutes a management plan or a monitoring programme, and this may vary between RBDs as well. On the other hand the Directive does specify, in its Appendix V, a list of variables that should be measured, and how these might related to assessment of "status" of a RBD. This list closely parallels the TMAP parameters, so it will be necessary to "tune" rather than radically change TMAP to be in concordance.

Like the Birds and Habitats Directives, the WFD requires the assessment of the "ecological status" and the "chemical status" of the RBDs. These status assessments are to be against defined quality elements and relative to "reference conditions".

For assessment (high, good, moderate or poor) of the ecological status the following elements are required (for transitional and coastal waters):

- Phytoplankton
- Macroalgae
- Angiosperms
- Benthic Invertebrate fauna
- Fish fauna (not applicable to coastal waters)
- Tidal regime
- Morphological conditions
- General conditions (general phyisco-chemical, nutrients, etc)
- Specific synthetic pollutants
- Specific non-synthetic pollutants.

These are to be monitored and assessed against "reference conditions" i.e. levels "normally associated with undisturbed conditions".

TMAP monitoring and the WFD meet at the estuaries (transitional water) and to some extent overlap (e.g. "coastal waters"), so it is clearly important that there is correspondence in these overlap areas. The estuaries and coastal areas of the Wadden Sea are of high importance in that they essentially integrate the total nutrient and pollutant outflow of the RBD, so the TMAP data serves as a summary of the net result. It is clear that TMAP data is closely aligned with these requirements. There may be differences in detail with regard to the guidelines on sample locations and monitoring frequency that will need to be aligned.

There is also a very important potential value in TMAP of helping to determine the "reference conditions" to establish a baseline for the RBDs that discharge into the Wadden Sea. This is made all the more valuable because of the relatively long time series available.

There is then a future key role in coordinated monitoring (and inter-calibration) and assistance with setting thresholds for assessments of both ecological and chemical status.

While delineation of RBDs is not finalised, it would appear that in relation the Wadden Sea there will be two in the Netherlands (Rhine and Ems (joint with Germany)), four in Germany (Ems, Weser, Elbe and Eider) and an as yet unspecified number in Denmark (perhaps three). Two Trilateral workshops sponsored by the CWSS have already been held on this topic and it is essential that the TWSC continues to be closely involved in the steps towards implementation of the WFD. The TMAP has considerable experience to offer in regard to the establishment and operation of monitoring programmes. Among the issues still to be resolved is the typification of water bodies (and relationship to "habitat" types) which might affect the location of Wadden Sea sample stations and require adjustments and additions to parameters and spatial frameworks to be held in the common GIS.

A danger for TMAP would be inconsistent implementation of the Directive and in interpretation of monitoring programmes, assessment techniques and thresholds between countries and RBDs. TMAP-DH cannot adjust or adapt to 3 (or worse 8) different measurement regimes and norms. The value of its harmonised data would be neutralised if there are not consistent standards and approaches taken across the relevant RDBs. The Oxford Brookes report identified some key factors that need to be in place, including *"enforceable legal authority"* (for various policy elements), *"horizontal and vertical cooperation"* and *"consistency in decision-making"*, and expressed concern that in regard to the WFD many of these elements were **not** in place.

Summary:

TMAP is in a good position to support the assessment of the status of sites, species, habitats, and ecosystems under the Birds and Habitats Directives, and is already considerably harmonised with these Directives although no directly usable products are currently easily available to users. To a lesser extent it can contribute to the required assessments of pressures and impacts.

TMAP data is already closely aligned to the monitoring needs of WFD and likely only needs tuning of TMAP parameters (sample locations, frequency) to be fully compatible. There is a potential important role for TMAP data in establishing "reference conditions" for transitional and coastal waters.

There is a strong need for countries to coordinate their approaches to implementation of the directives, including for site designation, design of management plans, RBD designation, and monitoring regimes, and hence a requirement for horizontal cooperation between the responsible bodies in the three countries. TMAP cannot lead this process, but must be closely and more formally involved, and has much to contribute.

Associated recommendations in Chapter 8: **Recs 17, 18, 19, 20, 22, 24**

## 7.4   TMAP-DH and the EU Dataflows

7.4.1   Introduction

The previous two Sections (7.2 and 7.3) deal with the potential value that can be added to TMAP by supporting national reporting obligations to conventions and directives. Another consideration is whether recent developments by the EEA to streamline "dataflows" could contribute to the TMAP-DH, thus increasing efficiencies, and potentially reducing requirements to hold and manage TMAP data. The issue has been raised in some previous discussions in the TWG and TMAG meetings, and Denmark have indicated that they may plan to put forward a proposal to reduce data inputs to TMAP.

This is the inverse of the considerations of Section 7.3 above in which TMAP data contributes towards reporting needs to Directives and MEAs, i.e. this looks at whether the EEA "Reportnet" process can provide data **to** TMAP. In the extreme is the contention that TMAP-DH will become redundant, and all required information to achieve the goals of the TWSC could be obtained from national inputs (or "dataflows") to Reportnet.

7.4.2   Reportnet and EEIS in the Context of TMAP

European countries are parties to an overlapping network of conventions, treaties, agreements and other instruments, as well as binding EC Directives. Many of these have obligations to report various kinds of data and narrative information at varying frequencies to a range of different authorities. This, coupled with the programmes to assess the state of the European environment and associated "DIPSR" indicators, create an information exchange and delivery process of labyrinthine complexity. The need to reduce this complexity and minimise reporting burdens on countries has been recognised for some time. The response has been a far reaching programme, coordinated by the EEA, to streamline European "dataflows" – particularly as related to indicators and reporting obligations. The very laudable goal is "*deliver once – report to many*", that is, countries should only have to provide data once and have it distributed to appropriate authorities to satisfy multiple obligations.

The overarching system is referred to as the European Environmental Information System (EEIS). Conceptually, the EEIS interacts with various international institutions and the EEA to meet reporting obligations, and to provide information for decision-makers and the public, as shown in Figure 10 below (Diagram from EEA, Powerpoint presentation "eEnvironment Infrastructures", 2002).
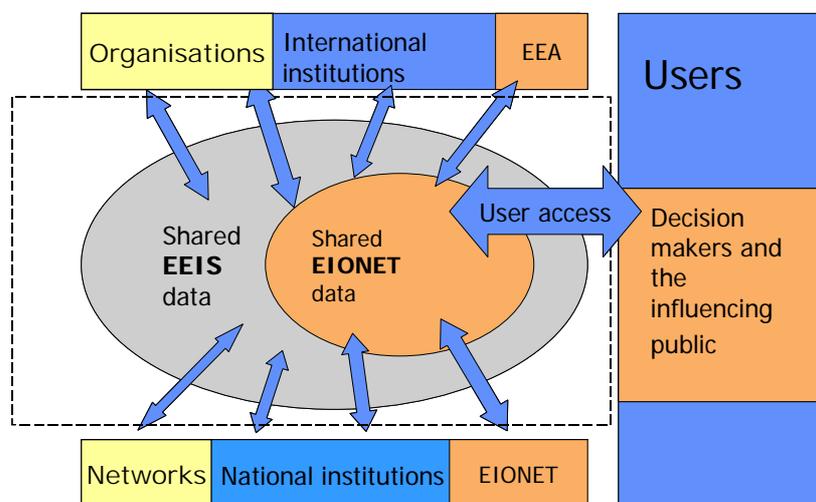
Figure 10: Concept of the European Environmental Information System

The related Reportnet is defined as a "*suite of IT tools optimized to support the business processes of a data collection network building on a shared information infrastructure*", and comprises a number of components aimed at facilitating information harmonisation and reporting. These include a Reporting Obligations Database (ROD), Data Exchange Modules (DEMs), and a Data Dictionary that link National Repositories and European Data Warehouses to promote harmonisation and consistency in the development of relevant indicators. It is expected that countries will have similar national networks and processes to link national data repositories, and will link institutions through EIONET. The Reportnet

concept is shown in Figure 11 below (Diagram from EEA, Powerpoint presentation "eEnvironment Infrastructures", 2002).
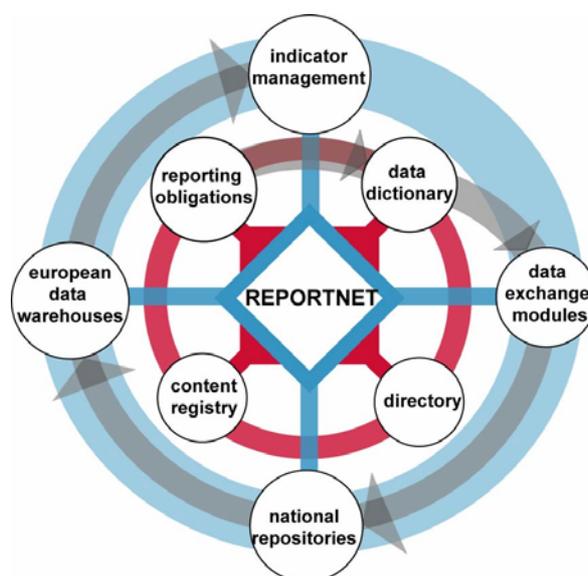
Figure 11: Model Dataflows in Reportnet

The result of this approach to streamlining is an EEIS that is itself very complex. Implementation of the concept has advanced unevenly on many fronts and there are a number of issues of technological harmonisation still being addressed. For example, the "Content Registry" can extract metadata from national repositories provided they are available in a "*harmonised XML/RDF structure*". The ROD identifies reporting obligations in a fairly general way and is most complete for water (chemistry) and waste. Biological and nature conservation obligations have recently been added but do not specify the data content of required reporting. (Annex 7 of this report provides more detail than ROD). The Data Dictionary for "parameters" is being reconsidered in this regard, and there are many issues relating to how to classify and typify biological data and narrative information requirements of reporting obligations. The European Topic Centre for Nature Conservation and Biodiversity (ETC/NCB) are working to develop harmonisation tools with regard to habitats, synonymy of species, etc.

Reportnet is partially operational for mature and well defined data flows, and considers the already established data warehouses (such as Airbase, Wastebase, Waterbase and EUNIS) to be part of the architecture. In this way, national submissions to these data warehouses provide integrated dataflows to EEA indicator processes and some Directives. The "*deliver once – report to many*" ideal has not yet extended to provision of national reports to international conventions. It will always remain the prerogative of sovereign states to meet their own reporting obligations and the extent to which member states will allow the EC to report on their behalf is an open question. It does mean, however, that reporting to certain Directives is done in parallel with indicators for state of the environment with no additional separate report required. There has also been considerable harmonisation between the Birds and Habitats Directives (under "Natura 2000"), assisted by the ETC/NCB and with selected other environmental reporting obligations such as to the OECD.

The EEIS and Reportnet concepts have significant similarities in principle to TMAP-DH, including a Directory and content register, and data exchange modules to allow the effective integration (and possible sharing) of data held in decentralised databases. Automated extraction of relevant data from National Repositories is proposed using technology and the concept of "mapping" similar to that proposed for TMAP-DH in Section 4.3, and a layered

delivery structure as proposed in Section 4.5 and Annex 4 (EEA Technical Report No 83 (2002) provides background on the evolving technology of Reportnet).

The emphasis of the EEIS and Reportnet process is on meeting **reporting** obligations to various instruments, rather than assessing the status of targets based on issues of concern. This is a distinct difference from the intent of TMAP and affects the data content and level of aggregation. Many of these reporting obligations (as noted in Section 7.1 and detailed in Annex 7) require highly aggregated statistics and indicators, as well as narrative assessments of status, provision of legal transpositions (e.g. submissions of laws and regulations), and descriptions of actions and plans. The TMAP database, on the other hand, is a time series of mainly un-aggregated science-based observations – designed to be a base for developing indicators and assessments (through aggregation and interpretation) to support reporting, such as the Quality Status Reports and others. The provision of data in a harmonised form to the TMAP-DH is not a "Reporting Obligation" and is not identified in the ROD as such.

As noted above, there have been initial discussions in TWG and TMAG meetings on the possibility of reducing or eliminating inputs to the TMAP database on the basis that Reportnet and EEIS may serve the purpose. In theory there are potential advantages to taking this approach – that is to extend the "*deliver once – report to many*" concept to deliver data to Reportnet for subsequent use for TWSC assessments. If feasible, it could eliminate the need for TMAP Data Units, and TMAP-DH would be replaced by some service of the EEA Reportnet process, to be used for TWSC assessment activities and production of the QSRs.

Achieving this (at least in the short to medium term) would appear to be problematical in a number of ways:

- The general "European" level of harmonisation is likely be unsatisfactory for TWSC purposes as now defined. For instance, "*habitats and species of Community interest*" may not coincide with those of concern in the Wadden Sea, where, for instance, it has been deemed important to distinguish between grazed and un-grazed salt marches.

- The levels of aggregation and frequency of reporting required of the Directives, and hence Reportnet are not designed to address (and are likely inadequate to address) the specified Wadden Sea Targets. For example, the Habitats Directive requires reporting of the "Conservation Status" of "habitats" and SACs every six years. The exact reporting requirements are still being developed, but drafts indicate reporting of very general data on the distribution of identified habitats of concern aggregated by "Biogeographic Region", along with assessments of the "conservation status" on an A to C rating scale against a guidance matrix for both the habitat condition and the "typical species" (summarised well in the Overview Paper of the ETC/NPB by Romão, 2004).

- National monitoring systems will have to continue. For instance, the requirement for "surveillance" under Article 11 of the HD implies the need for long term systematic monitoring, hence data time-series like TMAP, in order to determine and provide supporting evidence for the assessments of conservation status. In order to establish and report on trends the monitoring must be maintained at a higher frequency than the 6-year reporting cycle (see, for instance, EC DG Environment, Note to the Habitats Committee, 2004).

- Harmonisation measures between the national systems will still be required. If this monitoring is conducted independently without harmonisation measures specific to the Wadden Sea, the ability to take an ecosystems perspective will be not be possible unless the three countries can take **identical** national approaches to the implementation of the key EC Directives. The Oxford Brookes Report has indicated clearly that this is **not** the case, for instance in the designation of SPA and SACs, and

it is yet to be seen for the WFD, but it is clear that the WFD provides considerable latitude in interpretation and implementation even between WBDs within a country.

It does not appear that the Reportnet process would be able to provide the information necessary for the TWSC to assess Targets as they now stand, and for achieving the principle of considering the Wadden Sea ecosystem as a whole. Therefore eliminating TMAP-DH through the use of Reportnet cannot be achieved without significant changes to the principles of the TWSC. Consideration of how these could possibly be altered is beyond the scope of this Evaluation (Section 1.1).

However there are some aspects of closer integration with the EEIS that could in the longer term prove beneficial in terms of operational efficiency and technology development.

- The WFD implementation currently in progress presents an opportunity to link closely with the "Waterbase" European Data Warehouse, and establish harmonised water chemistry monitoring across the three countries (for the Wadden Sea and all RBDs). This could perhaps allow in the longer term for the elimination of a range of chemical parameters from the TMAP-DH, **provided equivalent data handling and retrieval tools are made available from Reportnet**. The historic TMAP database will be valuable in setting reference conditions. In this regard the national water related "repositories" in the three countries are well suited to technological linkage to the EEIS. Again it is emphasised that this requires trilateral agreement on fully harmonised monitoring protocols and inter-calibration, as well as technical interoperability of national data repositories, otherwise the "ecosystem as a whole" principle for the Wadden Sea will be lost.

- For key parameters other than water chemistry, consideration could be given to establishing closer ties with the EEIS, for example by identifying TMAP-DH as a "European Data Warehouse" with some sort of official status as part of Reportnet. This association could lead to funding and cooperative activities to take advantage of EEA efforts to support harmonisation of technology infrastructure. There is, however, no precedent for a trilateral or regional warehouses, as these are currently defined on a thematic basis (such as, water, waste, and air). The TMAP database renamed as a "Wadden Sea Warehouse" would lie in an intermediate position between a "National Repository" and a "European Data Warehouse", but could form a model for multilateral monitoring of regional seas like the Baltic and Mediterranean that would be of relevance to the EEIS process.

Summary:

In the short to medium term it does not appear that the Reportnet process would be able to provide the information necessary for the TWSC to assess Targets as they now stand. One of the key principles of the TWSC is to consider the Wadden Sea as a single ecosystem – hence the requirements for harmonised monitoring. These aspects will almost surely be lost if data submission to the Reportnet process (and hence available for TWSC assessments) are limited to those necessary under the EC Directives.

National monitoring systems similar to TMAP will continue to be required to support the aggregated assessments delivered to the EEIS, and must be harmonised in order to meet the principle of the TWSC to consider the Wadden Sea as a whole. Therefore replacing the TMAP-DH with services of the Reportnet cannot be done without changes to the principles, and hence the Targets and Common Data Package.

Consideration could be given, however, to establishing closer ties with the EEIS, through linkage to the "Waterbase" warehouse in the context of the WFD, and possibly identifying TMAP-DH as a "European Data Warehouse" with official status as part of Reportnet. This

association could lead to funding and cooperative activities to take advantage of EEA efforts to support harmonisation of technology infrastructure.

Associated recommendations in Chapter 8: **Recs 18, 21, 22, 23**

7.5   Other Potential Value-Added Expansion of the Uses of TMAP Data

Harmonised data on the Wadden Sea is of interest (and potential value) to wider audiences than "Wadden Sea experts", and for purposes beyond assessment of status and policy decision-making. Some other potential audiences include: NGOs, education, the media, private sector companies, and civil society. Each has a range of needs and potential uses for TMAP data.

The smallest step from the "experts" would be environmental NGOs. Various NGOs and consultative fora such as the Wadden Sea Forum need summarised information on the status of various elements for assessments similar to the QSR – with the difference that they would normally want to be selective by topic (waterbirds, seals, water quality) and/or by geographic region (country or island or coastal reach), and require more frequent assessment than the QSRs can provide. Another expressed need was for improved access to research and assessment reports originating from government, NGO and academic studies.

Availability of information for the media and general public is in the spirit of the Aarhus Convention and has considerable potential value in increasing awareness, interest and support for Wadden Sea conservation. The needs of these audiences are for more packaged and interpreted information, rather than the relatively raw data levels of TMAP-DH. Serving these needs will require significant development of the User Interface, interpretation and re-packaging of data, and provision of easy-to-use analysis and visualisation tools.

Private industry has needs related to environmental impact assessment, and of the administrative and legal regime (protected areas and conditions etc). Some TMAP data is of potential benefit for these purposes. While private sector scientists can be considered similar to some extent to Wadden Sea "experts", enhancements to the User interface delivery would be required to effectively serve this audience - for instance the provision of GIS boundary data of protected areas.

There is also great potential to use the TMAP data for educational purposes, but development of means and materials suitable, for instance for secondary education, require investment in system enhancement as well as expanding the human resource capacity of CWSS.

Summary:

There is significant potential of TMAP data to be of interest and benefit to wider audiences. Such expansion requires an major investment in system development to provide improved selection and retrieval functions and re-packaging of interpreted information. Some of this development would be useful as well, to the original intended TMAP-DH audience, and a natural step forward from the current basic facility. The investment required for expansion to meet requirements of education, the media and general public needs careful consideration in light of the TWSC mandate and of possible partnerships to ensure cost-effectiveness.

Associated recommendations in Chapter 8: **Recs 16, 17, 24, 25**

7.6   Conclusions and Assessment

The TMAP data archive of harmonised time series has great potential to support the assessments, indicators and data inputs to EC Directives and International Conventions. There has already been some considerable harmonisation with the needs of the Birds and Habitats Directives and the OSPAR Convention. The CWSS is currently engaged in trilateral consultations on approaches to provide support to the Water Framework Directive, and this type of consultation should be continued and made more proactive. The technical concept of

TMAP-DH with its "database extension" allows for the introduction of new parameters or adjustments to existing with relative ease. Thus TMAP-DH is capable of adaptation to changing requirements, and the base of harmonised time-series data can contribute to assessments beyond the original intent of the TWSC and the Wadden Sea Plan, and in that way make multiple value-added use of the data. However, a cautionary note should be sounded – to avoid unrealistic expectations of the audiences and purposes that TMAP can serve.

It does not appear that the Reportnet process would be able to provide the information necessary for the TWSC to assess Targets as they now stand. However, there are some aspects of closer integration with the EEIS that could in the longer term prove beneficial in terms of operational efficiency and technology development. Possibilities include linking TMAP water data to the European "Waterbase" and identification of TMAP-DH as a European data warehouse. Closer association with European dataflows could lead to funding and cooperative activities to take advantage of EEA efforts to support harmonisation of technology infrastructure.

The current facilities for retrieving data are basic and limited, and need enhancement of functionality in order to better support users other than Wadden Sea "experts". Enhancements to better serve a knowledgeable audience for purposes of assessment, policy development or reporting to allied instruments can be accomplished with moderate levels of investment as a natural extension of current technology.

While there are opportunities to extend services to educators, and the general public, this would represent a significant step away from the original intent and mandate of TMAP-DH, and require major investment in system development.

It should be noted that this section of the evaluation has essentially dealt with potential **future** opportunities for value-added uses of TMAP data, and hence it is not amenable to "assessment" against the evaluation framework criteria.

8 RECOMMENDATIONS

8.1 Introduction

The TMAP data holdings and associated data handling system are a valuable asset and essential to the Trilateral Cooperation. The TMAP data handling system has just reached a key base milestone of initial on-line capability, but for the benefits of TMAP-DH to be realised, resources must be stabilised and increased, organisational arrangements strengthened and the technology improved. At the same time, streamlining the data content and structures, and multiple value-added uses should be pursued to ensure cost-effectiveness.

The current operational state of TMAP-DH has been achieved relatively efficiently and with the admirable approach of clear top-down logic from broad objectives, through issues of concern to generally specified targets. The TMAP data handling system is clearly designed to maintain a time-series of key parameters relevant to the conservation of the Wadden Sea. An enormously valuable data repository has resulted that is just beginning to show its worth, and will be useful for many years to come. The principles behind TMAP-DH are valid, the data are essential to achieving the goals of the TWSC. Therefore, the system should be continued and enhanced in various ways to ensure that it can achieve its potential, and that investment made to date is not lost.

The recommendations in the following sections are mainly in the form of suggested actions for improvements and enhancements of the system and its management. Given the structure of the Evaluation, it is logical to consider recommendations related to four main areas "technical concept", "organisational structure", "cost efficiency" (split into benefits to the TWSC and value added potential). Adequate and effectively employed resources are essential to the continued operation of TMAP-DH. For implementation of any of the recommended actions, resource issues are paramount and therefore resource-related recommendations are presented prior to the four topic areas above. In addition, in the course of the study a number of observations have been made of potential opportunities to improve and streamline TMAP-DH (for instance concerning adjustments to the parameter groups, or to data collection regimes) which, while possibly outside the intended the scope of the evaluation, merit consideration. Some recommendations on these issues have also been included.

The recommendations are therefore structured as follows:

1. Concerning resources

Derived from the resource-related findings of Chapters 4 through 7

2. Concerning the Technical Concept

Derived mainly from the findings of Chapter 4

3. Concerning the Organisational Structure

Derived mainly from the findings of Chapter 5

4. Concerning Cost Efficiency - Maximising the Value to TWSC

Derived mainly from the findings of Chapter 6

5. Concerning Cost Efficiency - Potential Value-added Use

Derived mainly from the findings of Chapter 7

6. Additional Recommendations Concerning Data Content

Derived mainly from the findings of Chapters 4, 6 and 7

The recommendations mainly imply actions or activities and their implementation will require a planning process, including scoping, needs analysis and resource estimation in order to quantify anticipated costs. They will therefore require various time-frames and a range of levels of investment. While these cannot be specified precisely at this time, approximate time frames are noted in broad terms as *Short* (within 1 year), *Medium* (1 to 3 years) and *Long term* (3 years or more). Indicative levels of required investment are noted using the relative terms "*modest*", "*significant*" and "*high*".

It must be noted that the recommendations cannot be considered mutually independent – changes to the technical architecture may affect the organisational structure; improvements of the technology and extensions to provide value added will both have organisational implications, and so on.

8.2   Recommendations

8.2.1   Concerning Resources

It is essential that the Trilateral countries make their commitment to the TWSC principles more tangible through:

- ensuring dedicated funding in support of trilateral activities at the national level, and

- contributing jointly to provide resources to support continued system enhancements.

Rec 1. Review the needs and alternatives for resourcing of Data Units so as to ensure full continuity of service at a qualified level. Options include dedicated full time national resources, a jointly administered contract to an IT company, or a suitable combination. Suggested resourcing level is 0.5 person years (or equivalent) per Data Unit. It should be recognised that this level would be adequate for a well-established operational system. However, it is minimal in the current situation where there is considerable development yet to be undertaken, and procedures are not well established.
(Short term, Significant investment)

Rec 2. The CWSS should continue to actively coordinate TMAP-DH maintenance and enhancements, and administer pooled resources for TMAP-DH development under the management control of TWG and TMAG. To achieve this, the position of Data Handling Coordinator requires permanent funding along with the addition of other resources in CWSS to carry out TMAP-DH development projects as they are identified.
(Short to Medium term, Significant investment)

8.2.2   Concerning the Technical Concept

TMAP-DH has been implemented with a sound technical concept and now could benefit from some technical enhancements to improve robustness, ease (and cost-effectiveness) of maintenance, and future flexibility. These improvements should not be "technology driven', but be made in the context of current best practices, functional needs, cost-effectiveness, and the potential to inter-operate with other key systems.

Rec 3. Improve the documentation of the Database Extension in the TMAP Manual, including instructions and illustrations of how it can be used.
(Short term, Modest investment)

Rec 4. Review the data structure of TMAP-DH with a view to simplification (including the related "database extension" component). This should be done by an external consultant, and in conjunction with, or following, a review of the data content.
(Medium term, Modest investment)

Rec 5. Using the experience to-date of the individual Data Units, develop more streamlined and better documented procedures (and common approaches across the Data Units) for the transfer for data from national systems into the TMAP database. This could include consideration of a standard data entry format.
(Medium term, Significant investment)

Rec 6. Take technical steps to increase the degree of centralisation of data handling. Specifically, a first step could be to manage access and product delivery at the CWSS while leaving the physical databases in the national Data Units.
(Medium term, Significant investment)

Rec 7. Develop technical "mappings" between national databases and TMAP Data Unit databases that would enable (where possible) periodic automated and secure data loading directly from source databases.
(Long term, High investment)

Rec 8. Evolve the technology of the TMAP-DH away from Java applets to take advantage of newer technological developments, particularly in dealing with the user interface "presentation layer" (see Annex 4). This should be done in a phased manner, with targeted benefits.
(Long term, High investment)

8.2.3   Concerning the Organisational Structure

In general, the TWSC should maintain and strengthen the currently sound TWG-TMAG-TDG structure, while building and strengthening horizontal connections to national processes and institutions:

- To ensure that TMAG and TWG and SO decisions are translated into national commitments to implementation

- To ensure integration with the national implementing authorities for EC Directives and international conventions (particularly Habitats, Birds and Water Framework Directives and the OSPAR, Ramsar and Bonn Conventions)

- To ensure coordination of all national authorities with responsibilities for various aspects of Wadden Sea conservation

- To ensure that the potential impact on TMAP-DH of changes to national databases is routinely given consideration.

Rec 9. Augment the terms of reference of the TWG, TMAG and TDG to provide for appropriate hierarchical authority over decision-making and resource allocation. The function of serving as a project steering committee (TWG) and project management group (TMAG) and expert working group (TDG) should be added to the ToRs of the groups, in such a way as to empower these bodies to manage projects resourced jointly by the countries.
(Short term, Modest investment)

Rec 10. The Trilateral partners should strengthen and formalise national coordinating mechanisms relative to the Wadden Sea (such as national Wadden Sea Coordinating Committees) that interact regularly with the national representatives on TMAG and TWG to ensure that all relevant institutions are informed and participating.
(Short to Medium term, Modest investment)

Rec 11. CWSS should continue to coordinate TMAG-DH maintenance and enhancements, and pooled resources for TMAP-DH should be administered by CWSS under the

management control of TWG and TMAG. To achieve this, the role definition of the Data Handling Coordinator should be amended to clearly indicate project coordination and management functions.
(Short to Medium term, Modest investment)

Rec 12. All national institutions that have databases that are sources for TMAP data should be made aware of their roles and make formal commitments as to their responsibilities as data providers.
(Medium term, Modest investment)

Rec 13. Take organisational measures appropriate to technical steps taken to increase the degree of centralisation of data handling. This could include taking full responsibility at the CWSS for the management of data access technology, and output product delivery.
(Medium term, Modest investment)

8.2.4 Concerning Cost Efficiency – Maximising the Value to TWSC

Recognising that TMAP-DH has just achieved a basic operational level, the next steps should build on the current technology base to improve the functionality of the system to maximise benefits to the TWSC and associated assessment activities.

Rec 14. Invite and encourage the use of the TMAP data through the newly available User Interface and document case study experiences for Wadden Sea assessments and other purposes.
(Short term, Modest investment)

Rec 15. Identify incremental steps to improve the current user interface for increased convenience of use for QSR and other Wadden Sea assessments, for instance, by making available a pre-designed Access Database to users for analysis of downloaded data.
(Medium term, Modest investment)

Rec 16. To support the use of TMAP Common Package for assessments, consider adding to the TMAP-DH functionality available from the CWSS, such capacity as a keyworded index to research reports concerning the Wadden Sea available from national institutes, NGOs, universities and so on, especially those containing studies of ecosystem processes.
(Medium term, Significant investment)

Rec 17. Following an assessment of the needs of Wadden Sea experts and interest groups, improve the usability of the current user interface to facilitate data discovery and access for trilateral, national and local assessments and research regarding the Wadden Sea. This would include making significant additions to functional capabilities, such as:

- Catalogue search by keyword
- Ability to select retrieval of data by geographic areas, including, but not limited to, Wadden Sea habitats, protected areas, QSR sub-areas, seal and bird data collection areas, and administrative boundaries
- Availability of pre-packaged datasets, on thematic topics
- Making available for download, the data tables that form the basis of the charts and graphs in the published QSR, and selected graphics materials from the QSR and other TWSC reports
- Making available for download the TMAP GIS based datasets in a generic format.

(Medium term, High investment)

8.2.5   Concerning Cost Efficiency - Potential Value Added Use

It is clearly of value to TWSC to continue to assess the needs to improve the TMAP-DH capacity and functionality in order to realise value-added benefits with respect to supporting implementation of, and reporting to, the EC Directives and International Conventions, and expanding to other audiences, and subsequently define, plan and manage jointly funded projects for implementation.

Rec 18. The CWSS and TMAG should confer with the ETC/NPB and other bodies on establishing conformance of marine and coastal habitats as applicable to the Habitats Directive and WFD, and useful to Wadden Sea monitoring.
(Short term, Modest investment)

Rec 19. The CWSS should have a prescribed role for participation in (for example) national implementation processes for the EC Directives most relevant to the Wadden Sea, particularly with regard to promoting consistency of approach in implementation.
(Short to Medium term, Modest investment)

Rec 20. The CWSS should be mandated to continue to encourage trilateral consultation and coordination of some specific aspects of the implementation of the Water Framework Directive, regarding the establishment of management plans, monitoring programmes, reference levels and "status" indicators for the RBDs that empty into the Wadden Sea.
(Short to Medium term, Modest investment)

Rec 21. Initiate a dialogue with the EEA to consider how to achieve closer ties to the Reportnet and EEIS, for example by identifying TMAP-DH as a "European Data Warehouse" with some sort of official status as part of Reportnet. This association could lead to funding and cooperative activities to take advantage of EEA efforts to support harmonisation of technology infrastructure.
(Short to Medium term, Modest investment)

Rec 22. Once the three countries have agreed on common approaches to implementation of monitoring programmes for the Water Framework Directive, plan for and implement suitable adaptation to TMAP monitoring as required, for instance, to tune sampling locations and frequencies, particularly with regard to the essential role that TMAP data can play in establishing the "reference conditions", and monitoring ecological and chemical status of transitional and coastal waters.
(Medium term, Significant investment)

Rec 23. Conduct a study of how the water chemistry data in TMAP could be linked formally with the "Waterbase" European Data Warehouse, and thereby establish harmonised water chemistry monitoring across the three countries (for the Wadden Sea and all RBDs). Further consider how the historic TMAP database will be valuable in setting reference conditions for the WFD implementation, and how the national water related "repositories" in the three countries are suited to technological linkage to the EEIS.
(Medium term, Significant investment)

Rec 24. Further expand the functionality of the user interface (following Recommendation 17) to support a wider set of users concerned with EC Directives and International Conventions. This should commence with an assessment of user needs, followed by the development of additional functional capabilities, such as:

- Ability to select data retrieval by SPA, SAC, Ramsar site, or "listed" species of Habitats Directive, Bonn Convention, AEWA Agreement, and so on

- Availability of pre-package datasets, e.g. suitable for OSPAR the Habitats Directive, the Water Framework Directive, AEWA, and so on
- Making available for download, the data tables that form the basis of the charts and graphs in all published CWSS materials in formats suitable for use in statistical analysis and graphics applications packages
- Making available for download in a generic format GIS based datasets including protected areas and habitat boundaries, species distribution maps, etc.

(Medium to Long term, High investment)

Rec 25. Consider carefully the further development of a user interface and information system that could support a wider audience of users including for education and the general public. This would provide some benefits, but is seen as a long-term possibility and certainly is only recommended following extensive consultation and planning. Such development should only be considered in partnership (jointly funded) with an appropriate stakeholder group (such as the Wadden Sea Forum) aimed at well defined needs and employing a standard system development methodology.
(Long term, High investment)

8.2.6 Additional Recommendations Concerning Data Content

While the assessment of the appropriateness of the Common Package was not within the scope of the evaluation, various observations during the study have included concern for the need to simplify the data model and form stronger connections with European dataflow processes. This leads inevitably to recommendations concerning streamlining and adjusting the data content and hence the Common Package – in the interests of improving efficiency and effectiveness – in effect, an overall review of the Common Package (with a view to simplifying where possible) and its relationship to the TWSC Targets in the context of the broader picture of European data flows.

(Such a review should always keep in mind the intrinsic value of maintaining the continuity of existing time-series.)

Rec 26. Conduct a review of the status of input of the subset of Common Package referred to as "General" parameters that still remain unloaded in most Data Units. The review should consider:

- the extent to which these parameters are required to address TWSC targets (or are essential to WFD), and ruthlessly discard those that are non-essential
- alternative ways of obtaining equivalent data, such as the use of volunteer local observers or industry associations (the Wadden Sea Forum could possibly suggest means)
- alternative approaches to measurement – such as aggregated indicators or surrogates, or singular statistics measured at one location that can be considered representative of the Wadden Sea as a whole
- methods of obtaining the data by connecting to national statistical databases using the geo-spatial GIS data sets held by the CWSS.

(Medium term, Significant investment)

Rec 27. Review and add measurable performance indicators to the Targets, and in consequence adjust TMAP parameters so that they can contribute to TWSC assessment more specifically.
(Medium term, Significant investment)

Rec 28. Conduct a jointly funded review of the QSR process and the needs and uses for TMAP parameters. Adjust TMAP parameter groups accordingly, but with a view to the continuity and stability of the time-series wherever possible.
(Medium term, Significant investment)

Rec 29. The TMAG should resist the addition of more TMAP parameters (such as socio-economic) unless there is a very clear need, for instance as determined from the above studies.
(Long term, Modest investment)

8.3   Cross-Cutting Themes

Although the recommendations have been presented as six distinct areas, there are three main cross-cutting themes that link the suggested implementation actions, and might indicate useful ways to group recommendations for the development of action plans:

- Improving the data input process

Investment in development of automated procedures, at least partially, for data transfer from national sources to the TMAP database should reduce operating costs, and hence increase efficiency in the longer term.

(Recommendations 1, 5, 7, 12)

- Improving the delivery of products (including an improved user interface)

The determination, and prioritisation, of new and current user audiences and their needs is an essential first step, with a clear definition of the processes required to deliver the specified products.

(Recommendations 8, 14, 15, 17, 24, 25)

- Review of Parameters

Several factors are to be considered – the difficulties of acquiring and harmonising the data values, how parameters may need to be modified to meet new requirements, and the possible addition of new parameters.

(Recommendations 4, 18, 22, 26, 27, 28, 29)

All three themes imply the need for systems development effort that will require resource investment beyond the current levels, which are barely adequate for on-going maintenance. These improvements should be planned in an incremental fashion using a stepwise development cycle under trilateral management. It is vital to keep a realistic vision of what is feasible, set priorities and provide clearly planned incremental products and service benefits.

9   SUMMARY EVALUATION

9.1   Overview

This chapter looks at bringing together the various elements of the evaluation. As noted in Section 3.4, the evaluation is taking place at a critical stage for TMAP-DH – data is now available on-line through a user interface. The current operational state of TMAP-DH has been achieved relatively efficiently and with an admirable approach of clear top-down logic from broad objectives, through issues of concern to generally specified targets. The TMAP data handling system is clearly designed to maintain a time-series of key parameters relevant to the conservation of the Wadden Sea. An enormously valuable data repository has resulted that is just beginning to show its worth, and will be useful for many years to come. The principles behind TMAP-DH are valid, the data are essential to achieving the goals of the TWSC. Therefore, the system should be continued and enhanced in various ways to ensure that it can achieve its potential, and investment made to date is not lost.

The developments of TMAP-DH that are essential to have a cost-effective facility to support the TWSC and EC Directives cannot be achieved with the current resource levels. Augmented investment is needed by the trilateral partners.

9.2   Overall Assessment Against Criteria

Criterion	Rating	Justification
Appropriateness and Relevance	Very Good	As detailed in Section 3.2, The logical flow is correct – the Ecological Targets are derived from identification of Issues of Concern; the monitoring programme was developed to gather the required data; parameters have been selected to help assess the Targets; the data handling system was developed to manage the selected parameter data. Relevance would be clearer if Targets were more specific and measureable. Further, TMAP data handling is unique, there is no other service within the TWSC that coordinates, integrates and manages data in support of ecological assessment, and no obvious other way to achieve the desired results.
Effectiveness	Satisfactory	The TMAP-DH just meets the basic requirements of being an operational system that can provide downloadable data files to support assessments of the Wadden Sea Ecosystem. The design and concept is solid and functional. Parameter input is incomplete and loading processes are insufficiently developed. The user interface provides a basic rudimentary facility.
Efficiency	Good	Much has been successfully achieved at a reasonable cost, with no evidence of poorly controlled or excessive expenditure. Costs compare favourably with similar developments elsewhere. Chronic under-funding has caused the work to be intermittent, resulting in delays and some inefficiency due to losses of continuity and reduced opportunity for synergies between Data Units.
Impact	Un-rateable	The impact of the TMAP-DH is just beginning to be realised. It has contributed positively to assessments for the current QSR. The large potential to use TMAP data for other value-added national and international purposes is as yet un-tried, and needs further investment to be realised.

9.3   Responses to Key Questions

In a more informal way than the above evaluation matrix, four key questions were posed in Section 3.4 that the evaluation can now answer.

1. Does TMAP-DH provide the information needed by decision-makers regarding the Wadden Sea ecosystem?

Yes. TMAP data handling can now provide harmonised time-series to support assessments for policy decision-making leading to national and joint actions to protect and sustainably manage the Wadden Sea ecosystem as a whole. The data that TMAP-DH can supply may not always be totally sufficient; the monitoring data may need to be augmented by research studies on ecological processes that establish cause-and-effect relationships, thus instruct on what measures are needed to reverse trends seen in the TMAP data. The TMAP User Interface is not well suited to direct queries from senior decision-makers. The data would normally be accessed by a subject-matter expert as an intermediary.

2) Does the TMAP-DH work operationally?

Yes – just. TMAP-DH can now be considered an operational system that can deliver data from all four Data Units in a basic, but useable, format. Without enhancement, it will serve mainly experts who are already familiar with the data and data structures. Enhancement of the functionality of the user interface is required to increase usability of the data.

3) Can the TMAP-DH effectively contribute to reporting to EC Directives?

Yes, there is strong potential. Already, TMAP data is harmonised well with the Birds and Habitats Directives, the OSPAR Convention, and the Seals Agreement. Although little use seems to have been made of it so far, TMAP-DH can assist in reporting to the Ramsar Convention, the Bonn Convention and its Afro-Eurasian Waterbirds Agreement, as well as for reporting, as yet unspecified, under the IMO "Particularly Sensitive Sea Area" designation. Because of great similarities in the parameters likely to be required for monitoring, TMAP-DH has great potential to support the Water Framework Directive, and to contribute to the key issue of establishing reference levels. There is sufficient built-in technical flexibility in TMAP to adapt to additional or changed parameters required. Realising this potential will require investment in system development, particularly for the user interface.

4) Are the costs justified?

Yes. Costs have been relatively low so far, and compare favourably to international situations. In fact, frugality has contributed to delays and reduced opportunity to achieve synergies. Harmonised data is essential to achieving the Wadden Sea Plan and the expenditure on developing the data handling system essential to making that data available. There is no other way to achieve these goals. Many costs will be offset by reductions in the cost of QSR preparation and other assessments required for decision-making. The current expenditure, and additions required to make the system more effective, continue to be justified as long as the countries place value on their commitment to the principles of the Trilateral Cooperation.