

User requirements for REVAMP chlorophyll products:

Phase 1 - Initial requirements inventory

H.J. van der Woerd, M.A. Eleveld, and S.W.M. Peters

Report number REVAMP Deliverable 31.1 Version 0.2

August 30, 2002

IVM
Institute for Environmental Studies
Vrije Universiteit
De Boelelaan 1115
1081 HV Amsterdam
The Netherlands

Tel. +31-(0)20-4449 555
Fax. +31-(0)20-4449 553
E-mail: secr@ivm.vu.nl

Copyright © 2002, Institute for Environmental Studies

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior written permission of the copyright holder.

DOCUMENT STATUS SHEET

This report is the initial requirements inventory, based on existing documents, as described in WP 5 of the REVAMP project.

Contract No. EVG1-CT-2001-00049

Creation: 21 May 2002

Last Modification: August 30, 2002

Authors Affiliation: Institute for Environmental Studies

Distribution: Public

Contents

DOCUMENT STATUS SHEET	3
Abstract	iii
1. Introduction	1
1.1 Background	1
1.2 Scope	1
1.3 Project objectives	1
1.4 Contents of this report	2
1.5 Definitions, acronyms, abbreviations	3
2. Definition and Approach of the User	5
2.1 Review of existing documents (POWERS, CoastBase, SISCAL)	5
2.1.1 POWERS	5
2.1.2 CoastBase	11
2.1.3 SISCAL	18
2.2 The researcher, coastal manager, policy advisor, decision maker, and public	21
2.3 From local to European scale	21
2.4 Dissemination	22
3. Specification of Products	23
3.1 Introduction to relevant aspects	23
3.2 The chlorophyll ‘maps’	24
3.3 Metadata and meta-information	28
3.4 Value added products	28
4. Discussion of the Requirements	33
4.1 Tables and discussion per item	33
4.2 The Must-should-may approach	33
5. Follow-up	35
6. References	37
Appendix I. Form	39
Appendix II. Individual users	49

Abstract

REVAMP is an EC-project aiming at regional validation of MERIS chlorophyll (CHL) products in North Sea coastal waters. REVAMP is co-funded by the European Commission within the Fifth Framework EESD Programme. REVAMP will develop a value added product from MERIS data, namely an atlas containing maps of validated chlorophyll concentrations for the North Sea. This report discusses a study of user requirements for chlorophyll products. It defines technical specifications of the chlorophyll products that will be created within the REVAMP project, and it lists the demands of different user groups for content, accuracy, and presentation of the final product.

REVAMP aims to satisfy a variety of users, which are interested in data and information on various aggregation levels. Their requirements were initially extracted from literature. Institutional user groups were formed based on the focus of the organisations (on local, national, regional, and European issues, respectively). Individual users were grouped according to their function (as Researcher, Policy advisor, Coastal manager, Decision maker, or member of the Public, respectively).

The literature survey has shown that the user groups differed in their preferences for content, accuracy, and presentation of the data. Implications for the REVAMP project are addressed in a comprehensive list of requirements and recommendations for further technical specifications of the REVAMP products. In addition, tables for the matching of user requirements with chlorophyll products are provided.

In the next step of the user requirements study, interested users will be confronted with these preliminary results, through interviews on the phone or a web-based questionnaire. They will be asked if they feel they fit their profile, and if they agree with the requirements and recommendations for further technical specifications of the REVAMP products of their interest. Preliminary results will be updated, and the tables that describe the users will be completed.

Subsequently (in phase 2), the users will be confronted with the first actual REVAMP results in a REVAMP workshop, which is planned to take place later on in the project. During the workshop, the prototype thematic CHL maps (WP4.4) together with the Value Added Products (VAPs) of WP5.1 will be demonstrated to end users to define the form of the final products concerning, *e.g.*, legend, accuracy, format, and georeferencing standards (REVAMP, 2002). This will result in a follow-up report.

1. Introduction

1.1 Background

REVAMP is a research project aiming at REgional VALidation of MERIS chlorophyll Products in North Sea coastal waters. REVAMP is co-funded by the European Commission within the Fifth Framework EESD Programme. REVAMP will develop a value added product from MERIS, namely an atlas containing maps of validated chlorophyll (CHL) concentrations for the North Sea.

1.2 Scope

From a user (operational) point of view the primary objectives of the REVAMP project are (REVAMP, 2002):

- To support the monitoring of the eutrophication status of the North Sea and the effects of nutrient reduction by measuring and validating a key bio-geo-physical parameter (chlorophyll concentration) using ENVISAT/MERIS satellite observations;
- To establish, strengthen, and build on the European potential in Earth observation (EO) technologies that will be used to monitor, understand and protect the environment of the North Sea and related coastal waters. This will be achieved through cooperation between remote sensing institutes on all borders of the North Sea, private companies and end users.

1.3 Project objectives

REVAMP will develop an improved product from MERIS, namely an atlas containing maps of validated chlorophyll (CHL) concentrations for the North Sea. There exists little experience in the operational application of satellite data for monitoring the quality of coastal waters. Additionally, coastal processes induce natural variations in optical properties and concentrations on a regional scale. REVAMP will follow a regional approach where parts of the North Sea will be described by the same algorithm with different parameters. CHL algorithms are still far from well established for turbid coastal waters, where bulk optical properties depend not only on phytoplankton and its degradation products (Case 1 waters) but also on other optically active constituents such as non-phytoplanktonic particulate matter and coloured dissolved organic matter (Case 2 waters). For Case 2 waters the conventional blue-green band ratio algorithms fail. Therefore the MERIS standard neural network approach will be considered together with alterna-

tive innovative methods such as multi-spectral matrix inversion methods. Parameterisation of these algorithms and validation of the end products will require high quality *in situ* data on concentrations and optical properties. REVAMP will gather these data in a number of relevant regions in the North Sea. In concert with the end-user, REVAMP will define and produce relevant information products (Value Added Products) based on the CHL-maps.

1.4 Contents of this report

This report aims to introduce a method for deriving specifications for REVAMP results through the matching of typical user requirements with product specification experience from previous projects. This report describes an initial inventory: from existing user requirements studies (*e.g.*, the German MAPP project and the ESA-DUP POWERS project) initial user requirements will be distilled regarding the form (content and presentation) and the quality of the CHL products. The report serves as a discussion piece for the exchange of ideas about user requirements within the consortium, and as information for additional potentially interested users. In the report, user requirements for REVAMP chlorophyll products are discussed taking thematic as well as technical considerations into account.

The report addresses the following topics in subsequent chapters:

- Definition and approach of the users;
- Specification of chlorophyll products;
- Matching of user requirements with chlorophyll products;
- The follow-up from this discussion.

1.5 Definitions, acronyms, abbreviations

CHL	Chlorophyll
Coastbase	European virtual coastal and marine data warehouse – CoastBase
DP	Derived Product (derived from chlorophyll concentration ‘maps’)
EuroGOOS	European Global Ocean Observing System
MAPP	MERIS Application and regional Products Project
MERIS	Medium Resolution Imaging Spectrometer
MUMM	Management Unit of the North Sea Mathematical Models and the Scheldt estuary
NSD	North Sea Directorate
POWERS	Pre-Operational Water and Environment Regional Service
REVAMP	Regional Validation of MERIS Chlorophyll Products in North Sea coastal waters
REWANET	Remote Sensing of Water Quality in the Netherlands
RIKZ	National Institute for Coastal and Marine Management
SISCAL	Satellite-based Information System on Coastal Areas and Lakes
TSM	Total Suspended Matter
VAP	Value Added Product

2. Definition and Approach of the User

This section aims to identify users of REVAMP products. This is done through a literature review of existing user requirement studies that compliment each other. POWERS gives insight into TSM and CHL user characteristics, focusing on the role of MERIS for identification of eutrophication problem areas. Whereas CoastBase provides: a method for user requirements studies, users that are interested in eutrophication of the North Sea, and ideas about dissemination of results over the Internet. SISCAL gives both parameters of interest in marine monitoring and management, and technical suggestions concerning distribution through the Internet. The implications from this review for the characterisation of potential REVAMP users are summarised in 2.2, 2.3 and 2.4.

2.1 Review of existing documents (POWERS, CoastBase, SISCAL)

2.1.1 POWERS

POWERS is the acronym of Pre-Operational Water and Environment Regional Service. The aim of the POWERS project (URL <http://ivm5.ivm.vu.nl/RS/POWERS/index.html>) is to prepare a service for water quality information based on MERIS observations. During the POWERS project the MERIS instrument on ENVISAT was not yet operational, but the data of the MOS (phase-I) and SeaWiFS (phase-II) were used. These are instruments with characteristics similar to MERIS. Phase I of the POWERS project mainly focused on user requirements and the potential of ocean colour instruments to provide an accurate end product. In phase II thematic maps of Total Suspended Matter (TSM) for the North Sea coast were generated. The targeted end-user in this project was the National Institute for the Coastal and Marine Management (RIKZ), part of The Ministry of Public Works and Water Management in The Netherlands. This institute has critically assessed the prototype products and from the discussions an improved product has been established that is currently being used. A market prospective has been established. The second phase has resulted in the generation of a value-added product that is in line with the demand by the client. The maps are fully integrated with additional metadata in an ArcView product (Van der Woerd et al., 2000).

In the framework of the ESA/DUP/POWERS project the actual user requirements on monitoring of water quality parameters were investigated, and an assessment of the possible contribution of space-based water-quality information to monitoring programs was made. The main parameters of interest in POWERS were chlorophyll and suspended matter. The following aspects of the POWERS study are of interest for REVAMP:

- POWERS user characteristics;

- Summary of user requirements, focusing on the role of MERIS for identification of eutrophication problem areas.

User characteristics

The following POWERS users deal with the North Sea and are consequently of interest for REVAMP:

- For the Netherlands, two Directorates of The Dutch Ministry of Public Works and Water Management (V&W): The Directorate for Coastal and Marine Management (RIKZ), and the North Sea Directorate (NSD);
- For Belgium, the Management Unit of the Mathematical Models of the North Sea and Scheldt Estuary (MUMM).

RIKZ

RIKZ provides advice and information on the sustainable use of estuaries, coasts and seas and the coastal flood protection. For this purpose the institute develops and maintains a knowledge and information infrastructure. RIKZ is the national knowledge centre for integral coastal and marine management. As a knowledge bank, the RIKZ is also at the service of other parts of central government and it co-operates with various agencies and organisations at international level. The monitoring of coast and sea involves physical, chemical and biological properties. Measurement methods and instruments are continuously being developed and innovated. Optimal information about water systems is acquired by using, so called, integrated observation systems; by applying a combination of remote sensing, mathematical models and *in situ* measurements a complete picture of the status of water systems is achieved and changes are revealed. Water quality monitoring and management is also an important issue. Satellite remote sensing is considered to be a well-suited technique to fill up data gaps that traditional data acquisition methods leave.

NSD

The North Sea Directorate (NSD) is the managing directorate of a part of the North Sea, of which the area is roughly 1.5 times the area of the Netherlands. Main responsibilities of this Directorate are:

- Water and bottom properties of the North Sea;
- Infrastructure (mainly fairways) on the North Sea;
- Acquisition and provision of measurement data and other information on the North Sea.

The Directorate has the disposal of a small fleet of vessels for research and routine monitoring. During all seasons cruises are being undertaken for *in situ* sampling of e.g., water quality parameters to acquire insight into the water quality and changes therein.

The hyperspectral scanner EPS-A will fly on the NSD aircraft that performs routine flights almost every day.

MUMM

The Management Unit of the Mathematical Models of the North Sea and Scheldt Estuary (MUMM) is a department of the Belgian government responsible for water quality data management and provision of scientific advice to environmental decision-makers. MUMM is the Belgian representative for the Oslo and Paris Commission (OSPARCOM). The main source of information for assessment of eutrophication status consists of *in situ* measurements made by French oceanographic ships (for 3 cross-shore transects, one near the Belgo-French border, 16 times a year for the last five years and for the next five years) and by a Belgian oceanographic ship over a network of about thirty stations in the Belgian waters and in the Scheldt estuary four to eight times a year, every year. The MUMM monitoring group Meetdienst (Measurement Service) in Oostende is responsible for management of this research vessel, R.V. Belgica. The MUMM monitoring group itself therefore a related end-user.

Summary of user requirements

The following user requirements are of interest for REVAMP. For chlorophyll in coastal areas the focus lies, in general, in the concentration range of 1 to 30 ($\mu\text{g l}^{-1}$) CHL. In general, at lower concentrations a higher accuracy is required, this is expressed efficiently as a 10 % required accuracy: at 5 $\mu\text{g l}^{-1}$ CHL the required accuracy is 0.5 $\mu\text{g l}^{-1}$ but at 200 $\mu\text{g l}^{-1}$ the required accuracy is 20 ($\mu\text{g l}^{-1}$). The main end-user requirement is for eutrophication assessment, although also aspects such as primary production are mentioned. For total suspended matter (TSM) the requirements are in fact, more relaxed than for CHL because TSM is desired in units of mg l^{-1} . The range in coastal water is higher than that for inland waters, due to wave and tidal effects. The average range of interest is 1 to 20 mg l^{-1} . The demand for this type of information is either related to sedimentation rates and shipping lanes or to model the pollution dispersion.

Moderate temporal and spatial resolution are required. For CHL the frequency on a yearly basis is not too high and feasible with the recurrence time of the ENVISAT platform. There is, however, a special requirement to detect the springtime maximum in algal bloom. This observation can be interfered by cloudiness. The spatial resolution of MERIS (300 m at Nadir) is sufficient for most applications. The end users ask for processed products including expert judgement. This indicates that a centralised processing of the information is adequate and no local arrangements (installation of workstations and specialised software) are required.

A need has been expressed for near-real time products to support ship measurements. For example, the MUMM monitoring group requires knowledge of the occurrence of the spring phytoplankton bloom (possibly as a function of location) in order to optimise the *in situ* monitoring campaign. In this respect the availability of CHL maps from MERIS could assist the operations of the R.V. Belgica. For such an application the possibility of

near real-time imagery is an advantage. Off-line post-cruise reception of imagery is probably sufficient for monitoring campaigns, where the spatial coverage of the cruise is not normally open to modification. However, when the Belgica is used for other research projects, on-board reception of imagery may be advantageous in guiding scientists to regions of particular interest, *e.g.*, fronts.

Researchers versus coastal managers

The POWERS project was focused on the operational production of reliable TSM maps. However, the user requirements can be taken as a template for the expected CHL-related requirements.

Researchers, especially those involved in modelling, are interested in a series of TSM maps for quantifying the natural variability. Now that more than 10 TSM maps can be produced per month, sufficient data become available to perform statistically significant analyses. The need for information covers mainly historical data and there is no great urgency to deliver fast. This is called the 'offline product' and is considered the main product for RIKZ. After delivery of the TSM maps to RIKZ, additional steps are required to extract information. These steps are not part of the operational remote sensing service but will be the responsibility of RIKZ. What steps are necessary depends on the information needed. Possible steps are:

- Comparison with other information sources by RIKZ. TSM maps from remote sensing have most to offer when implemented in a monitoring system, which integrates measurements from ships, buoys, ferries, airborne platforms and satellites;
- An extra quality control of the remote sensing products by the Survey Department of Rijkswaterstaat;
- Format conversions, *e.g.*, from a standard grid to a grid used in hydrodynamic models;
- Spatial and temporal analysis in ArcView;
- Data-assimilation into sediment transport models.

The main difference between monitoring for policymaking and research on the one hand and for water management on the other hand is the time of delivery of the remote sensing products. Managers need up-to-date information about their region; during events such as storms or algae blooms recent information is vital. Quick scan products can be used to direct monitoring ships to make additional measurements.

Delimitation of eutrophication problem areas

The requirements for data with a spatial coverage comprising the North Sea are illustrated through the following example (Van der Woerd, 1998). The Belgian/Dutch coastal zone has been defined as a eutrophication problem area (OSPARCOM, 1995) with the consequence that these countries are obliged to take steps to reduce nutrient inputs into this area. Taking account of both the direct costs of construction and operation of water treatment plants and the indirect costs to agriculture of restrictions on the use of fertilis-

ers, the economic impact of measures to preserve water quality is considerable. Powerful lobbies exist for both sides. However, there exists no objective criterion to establish whether an area is a “eutrophication problem area” or not – the decision is left mainly to the national representatives, advised by scientific experts. Thus, according to the OSPARCOM maps, there is a eutrophication problem area extending from the Northern tip of Denmark, down the coasts of Western Denmark, Western Germany, the Netherlands and Belgium, stopping abruptly at the Belgo-French border (see Figure 1).

While it is clearly acknowledged by the Belgian and French authorities that there can be no scientific reason for the border of a eutrophication problem area to coincide with an international border, there is no objective criterion available to establish the exact location of the eutrophication border.

During the French and Belgium ship cruises a large set of water quality parameters is measured, including nutrients, CHL pigments, dissolved oxygen, etc. It is not possible, at present, to define a single parameter as a “eutrophication index”, though important direct effects of nutrient enrichment include increased phytoplankton biomass (for which indicators include total organic carbon, CHL, and cell numbers), increased frequency and duration of blooms, increased annual primary production, and shifts in species composition (*e.g.*, from diatoms to flagellates, and in particular *Phaeocystis*) (Lancelot and Wassmann, 1994).

It seems clear that MERIS or other ocean colour data will not provide alone the eutrophication index, but will provide either directly one of a number of eutrophication indices, the others coming primarily from measured data, or ocean colour data will contribute to a eutrophication index by a suitable assimilation with measured data. Of the possible eutrophication indices that could be provided wholly or partially by MERIS the following might be feasible:

- Annual peak CHL concentration (in g m^{-3});
- Duration of phytoplankton bloom (in days);
- Annual primary production (in $\text{g carbon m}^{-2} \text{ year}^{-1}$).

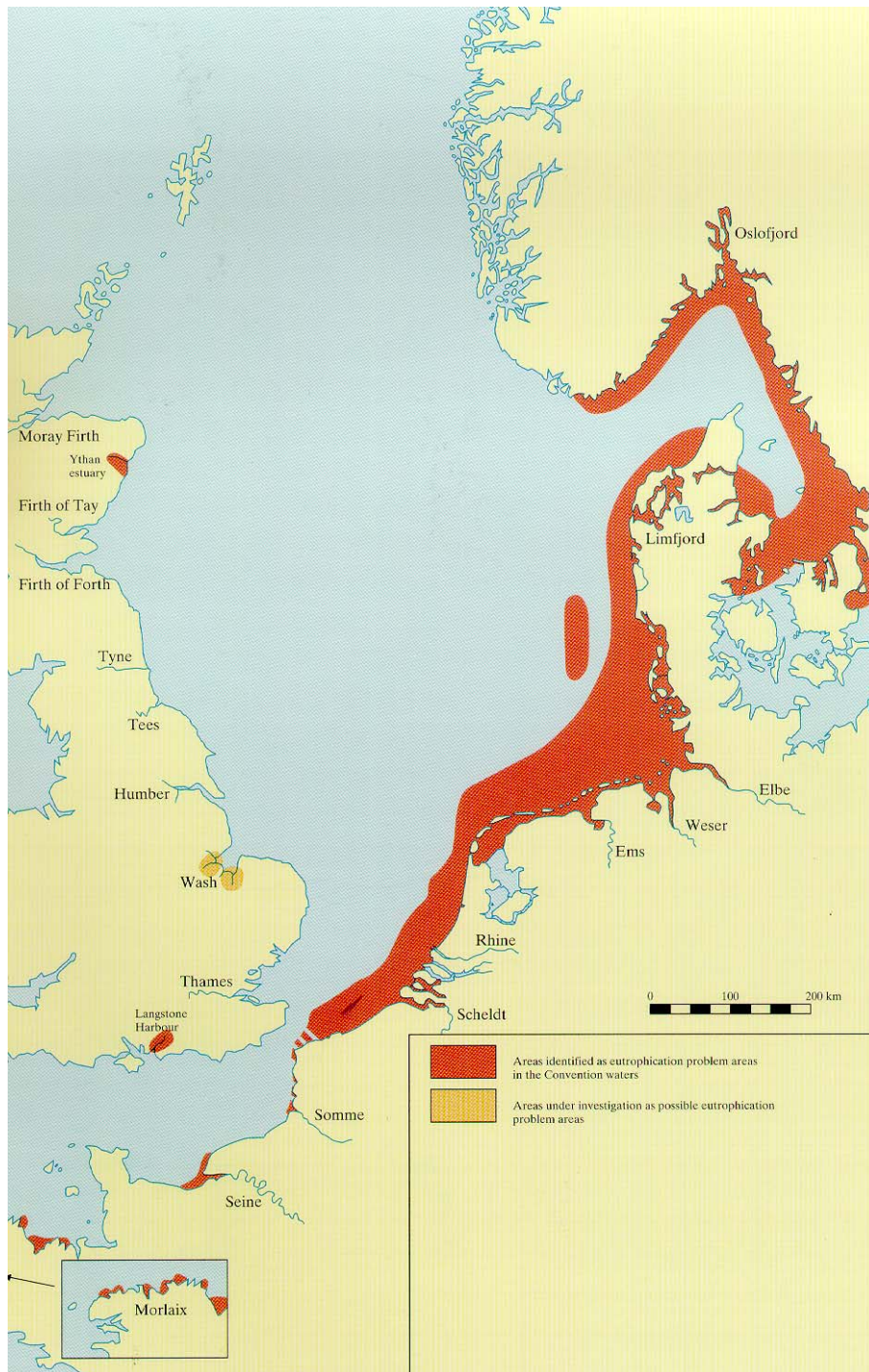


Fig. 1. Eutrophication problem areas (OSPARCOM, 1995).

2.1.2 CoastBase

Optimal access to data and information, and good communication between stakeholders are preconditions for wise coastal and marine management. To stimulate developments in these fields, the European Commission supported the creation of a European Virtual Coastal and Marine Data Warehouse – CoastBase – which is being executed by a multi-disciplinary consortium of eleven organisations (Table 1). CoastBase aims to improve European coastal and marine information search and exchange by the development of a distributed data warehouse. This data warehouse is accessible via the Internet (URL <http://www.coastbase.org>) and links existing databases as well as provides place for new, aggregated data (Niesing et al., 2000; Niesing et al. 2001).

The development of CoastBase started with a study of user requirements and with a definition of relevant and obtainable data and information. The aim of these surveys was to form a picture of potential CoastBase users and potential data providers, and of the type of data and information that would be required from, and could be available for, the CoastBase project (Eleveld et al, 2000; Eleveld et al., 2002).

Interesting results for REVAMP are:

- The method that was developed in the CoastBase user requirements study;
- Identification of CoastBase users that showed an interest in REVAMP related topics;
- CoastBase ideas about dissemination of results that i.a. consist of maps created from remote sensing imagery, which is similar to certain REVAMP results.

These results are summarised in the following sections.

Overview of user profiles and user requirements

One of CoastBases objectives is to provide easy Internet access to coastal and marine data and information to stakeholders, for example, authorities, research institutes, universities, private sector and public. Hence, CoastBase aims to satisfy a variety of users who have dissimilar needs for data and information. Potential users interested in data and information on various aggregation levels are represented within the consortium. For the development of a working prototype, the CoastBase partners representing these users were identified: these are ETC/MCE (represented by ENEA and RIKZ), JRC, ICES, ENEA, RIKZ, PETA, IMR, MIG and EUCC (see Table 1).

Table 1. Roles and full names of the participating organisations

<i>European</i>	
ETC/MCE	European Topic Centre on Coastal and Marine Environment (a consortium represented by ENEA and RIKZ)
JRC (SAI) (EU)	Joint Research Centre of the European Commission, Space Applications Institute (SAI) (EU) <i>CoastBase intends to support</i>
EEA	European Environment Agency (EU)
<i>Regional</i>	
ICES	International Council for Exploration of the Sea (DK)
<i>National</i>	
ENEA	Italian National Agency for New Technology, Energy and Environment (I); leader of European Topic Centre on Coastal and Marine Environment – ETC/MCE
RIKZ	National Institute for Coastal and Marine Management (NL); partner in ETC/MCE
PETA	Information Training Local Development in co-operation with the Greek Ministry of Environment (EL): representing the Greek partner in ETC/MCE
IMR	Institute of Marine Research (N)
MIG	Maritime Institute Gdansk (PL)
<i>Local</i>	
EUCC	European Union for Coastal Conservation (NL); representing many local users from all over Europe
<i>Technical partners</i>	
FZI	Forschungszentrum Informatik an der Universität Karlsruhe (D) (a research centre in computer science)
MATRA	Matra System & Information (F)
MELS	Ministry of Lower Saxony (D); home of European Topic Centre on Catalogue of Data Sources – ETC/CDS

Institutional user profiles

Initially, the users specified their institutional user requirements. The organisations were categorised according to their focus on European, regional, national and local issues (see categories European to Local in Table 1).

Within the groups, both European organisations have users working in multidisciplinary teams consisting of individuals with different backgrounds, technical knowledge and interests. Both organisations use spatial information (maps, classified imagery), and temporal information (time-series). All national organisations analyse their measurements (samples) statistically, spatially and temporally. Several national users expressed an interest in comparing data and monitoring methods with those of other countries.

Between the groups, users working on a European, regional, national and local level all have the following in common: they are all dealing with spatio-temporal issues, and they are all somehow involved in, or supporting, policy-making.

Most organisations also provided examples that demonstrate how actual users in their organisation could use CoastBase. These examples had in common that highly disparate

data are used, compared and integrated. The institutional preferences for topic and geographical area were also diverse (see Table 3 and 4, Organisation).

Individual user profiles

To obtain user profiles from an individual point of view, a questionnaire directed to individual users (that was accompanied by a completed example) addressed the following topics:

- Function and daily work of the participant;
- Spatio-temporal scale of work;
- Hard- and software used;
- Data and information flow (input, manipulation and processing of input data, output);
- Individual objectives for using CoastBase.

A similar procedure as in the analysis of feedback from institutional users was followed; the feedback was elaborated into user profiles for several groups (Table 2).

Work of the Decision & policy makers involves project management and document preparation. The Internet is already being used to present some of their information, and this might increase in future. The Researchers all use a variety of data sources and perform many dissimilar manipulations. The Researchers and the Database administrator & programmer are prepared to upload results into CoastBase.

The four groups have the following in common: they are all dealing with spatio-temporal issues, they all use a similar PC, and they all produce output in the form of reports. Table 3 (Individual) shows the variety of topics that were of interest for the users, whereas Table 4 (Individual) demonstrates the mixed user interest in geographical area; (in both tables, users are identified by function and by organisation).

Table 2. Individuals grouped per function

<i>Category</i>	<i>Respondent</i>
Decision & policy maker (Dpm)	PETA1, PETA3, EUCC1
Policy advisor & project manager (Ppm)	EUCC2, RIKZ1, RIKZ2, RIKZ4, RIKZ5
Researcher (Res)	JRC, MIG, IMR
Database administrator & programmer (Dap)	PETA2, RIKZ3

Objectives of the users

The aims of the organisations, and the individual user, had to be served in the user requirement analysis. The institutional and individual user's expectations from CoastBase can be summarised as: getting access to data, presenting results, and getting informed about the CoastBase structure and method.

Table 3. Extracted REVAMP related topics of user interest (See Table 1 and 2 for explanation of abbreviations)

<i>Topic</i>	<i>Organisation</i>	<i>Individual</i>
Management and protection of marine waters	ETC/MCE	
Environmental issues		Dpm-PETA3, Ppm-RIKZ2, Ppm-RIKZ5
Pollution/Water quality	ETC/MCE, ICES, MIG, PETA	Res-MIG, Dpm-PETA1, Dap-PETA2, Ppm-RIKZ2, Dap-RIKZ3
Eutrophication	ETC/MCE, JRC	Ppm-RIKZ2, Dap-RIKZ3
Protection of natural areas	ETC/MCE, EUCC	
Biodiversity	EUCC	Res-IMR, Dap-RIKZ3
Fisheries	ICES, IMR	Res-IMR, Ppm-RIKZ4
Human impact		Ppm-RIKZ2, Ppm-RIKZ5
Economic development		Ppm-RIKZ2

Table 4. Extracted responses for the North Sea (See Table 1 and 2 for explanation of abbreviations)

<i>Area</i>	<i>Organisation</i>	<i>Individual</i>
North Sea	ETC/MCE, RIKZ, EUCC	Dpm-EUCC1, Ppm-EUCC2, Res-JRC, Ppm-RIKZ2, Dap-RIKZ3, Ppm-RIKZ4, Ppm-RIKZ5

Implications of user requirements: information and system definition

User interest in data and information

User preferences for data of different aggregation levels and for information were identified to enable a 'user focus' in building the system. Organisations with a European focus need to provide information about the state of the environment (by reporting on indicators) for the whole of Europe. For this task, they need CoastBase to provide comparable aggregated information originating from regional organisations or the Member States of the EU. The regional organisation needs CoastBase to help presenting the metadata and data from national laboratories contained in its databases. National organisations report about the status of their environment, and need CoastBase to help them to compare their data to those of neighbouring countries. Additionally, they need advise on structuring their information flow from measurements towards reporting. Local organisations need CoastBase to be a metadata system that provides information on a variety of issues in management and planning.

Individual user groups prefer data of different interpretation levels (Fig. 2).

A forecast of the use of CoastBase by different user groups was also required for the system design process (Fig. 3). The Researcher combines data from different sources on a local computer, or on-line. The secondary data and report can be submitted back into CoastBase after filling out a metadata form. A Policy advisor or project manager who is interested in a similar topic finds, amongst others, the report of this Researcher via a metadata search, downloads it or views it on-line, and compiles a small report or a memo that is also submitted to CoastBase. Finally, a Decision & policy maker searches the

metadata database, finds these memos, and uses this information in management decisions. Hence, all users will use CoastBase in a way that underpins European policy making in the marine and coastal environment.

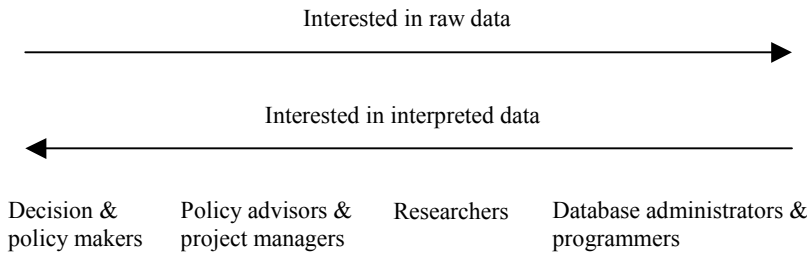


Fig. 2. Preference for aggregation level of data by different individual user groups (Eleveld et al., 2000, 2002).

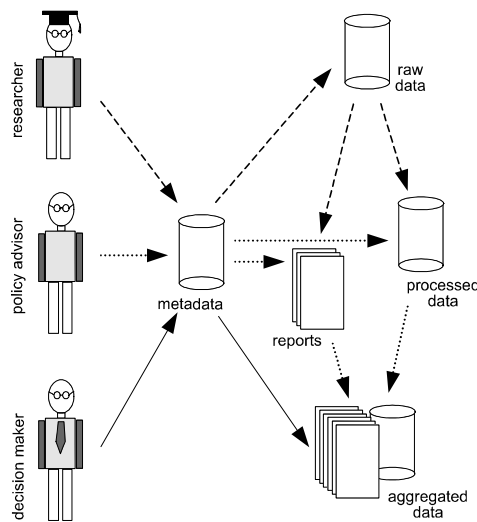


Fig. 3. Envisioned CoastBase data use by different individual user groups (Eleveld et al., 2000, 2002).

Topics and geographical areas

For practical reasons, matching data and information needs from users with the provision of these data and information was anticipated for creation of a prototype of the Coast-Base system. Based on the number of responses, two case studies were selected: Eutrophication in the North Sea, and Planning in the North Sea and Mediterranean coastal zone.

For REVAMP, the following information about the elaboration of the Eutrophication in the North Sea is of interest. This scenario also illustrates the aggregation process that accompanies the data flow from national and regional organisations towards the European

Environment Agency (EEA). National databases that comprise raw data feed regional databases consisting of aggregated data, and both feed the EEA database comprising aggregated data (indicators) for reporting. The data for this scenario originate from different distributed sources. They cover many of the variables for eutrophication studies, and match partially in space and time. The CoastBase prototype provides access to several of these sources. Eutrophication in the North Sea is a data-driven supply-limited scenario focussing on access, retrieval, manipulation, aggregation and feedback. However, automating the aggregation process itself is not feasible within the CoastBase system because of required expert judgement. Therefore, the scenario does not fully incorporate this entire aggregation process. For this scenario interaction with the graphical User Interface (GUI) is envisioned as follows:

- For an expert as: searching metadata, retrieving raw data, displaying the results for interpretation, accessing and manipulating the results (partly outside CoastBase) for aggregation into indicators (as done for ETC/MCE and EEA), and uploading the products on the CoastBase server;
- For a 'general' user as: searching metadata, displaying and downloading aggregated data, combining aggregated data (e.g., maps from JRC, ICES, RIKZ and IMR) and performing some basic GIS analyses.

Technical requirements

To provide a comprehensive checklist, requirements extracted from the CoastBase proposal, this user requirements study, and previous experience have been translated into three categories: MUST, SHOULD and MAY. This led to requirements ranging from general, visionary requirements (e.g., The CoastBase system MUST demonstrate the required features in a fully operational system) to user-oriented requirements (e.g., The use of CoastBase MUST be user-friendly and require no specific knowledge of informatics) and practical requirements (e.g., CoastBase MUST work with Netscape 4.7 and Internet Explorer 5 under Windows NT, 98 and 2000 and SHOULD work with newer versions of these browsers and operating systems).

Some extracted requirements that might also be interesting for the presentation of REVAMP-results on the Internet are given in Table 5. Where it says CoastBase you should read the REVAMP server.

Table 5. Checklist for CoastBase system specifications and evaluation (Where it says CoastBase it should read the REVAMP server)

Checklist:

1. CoastBase MUST be accessible via the Internet
2. The Welcome pages of CoastBase SHOULD be readable on any browser and MUST comply with the HTML 4.01 standard as published by the W3 Consortium
3. CoastBase MUST allow concurrent operations of different users
4. The use of CoastBase MUST be user-friendly and require no specific knowledge of informatics
5. The use SHOULD be intuitive and MUST NOT require any preparatory training

6. CoastBase SHOULD NOT require user hardware faster than 150 MHz Pentium, with 64 MB memory, and a browser with Java 1.2 plug-in installed
 7. CoastBase SHOULD NOT require Internet connection speed over 56 Kb
 8. CoastBase MUST work with Netscape 4.7 and Internet Explorer 5 under Windows NT, 98 and 2000 and SHOULD work with newer versions of these browsers and operating systems
 9. Java applets and Browser plug-ins MAY be used but SHOULD NOT require assistance of a system administrator, or user-side configuration changes
 10. Animations MAY be used to give insight into temporal changes
 11. CoastBase SHOULD facilitate international comparison of data and information
-

2.1.3 SISCAL

The overall objective of EU project SISCAL (URL <http://www.siscal.net>) is to create a software processor for providing near-real-time (NRT) maps of water-related parameters derived from satellite data and ancillary GIS-based digital information. These maps will be transmitted to the end user over the Internet.

Local authorities dealing with water-quality related issues were approached as first user group for the SISCAL data processor. Such authorities have a strong interest in continuous monitoring of “their” coastal areas or lakes in Near-Real-Time, but very often do not dispose of the expertise and computer power required for the processing of earth observation data.

The SISCAL user requirements study aimed to allow end users to define their needs for monitoring the environment with the help of remotely sensed images (Johnsen, 2001). Although some of the requirements seem more directed towards a generic request for more spatial data for coastal management, than focussed towards the specific possibilities that MERIS can offer, the following elements of this study are of interest for REVAMP:

- Identified parameters of interest in marine monitoring and of relevance in management (Table 6);
- Technical suggestions for dissemination of the finalized data product from SISCAL users.

Table 6. SISCAL remotely sensed products for marine monitoring and for relevance in management

Ocean colour

TSM - Total Suspended Matter (incl. sediments, turbidity m^{-1})

Secchi - Secchi depth, i.e. visibility in water - seen by human eye (m)

YS - Yellow Substance (DOC, m^{-1})

WW - Wastewater (relative)

[Chl a] - Chlorophyll a concentration (mg m^{-3})

HAB - Harmful Algal Blooms (million cells L^{-1} or [Chl a])

PPB - Phytoplankton blooms (e.g. non-harmful spring blooms, million cells L^{-1} or

[Chl a])

AG - Algal groups (different pigment groups gives different optical signature, relative colour ratios)

E PAR Irradiance (Photosynthetic Active Radiation (PAR) 400-700 nm, $\mu\text{mol quanta m}^{-2} \text{ s}^{-1}$ or in W m^{-2}).

E (λ) Spectral irradiance ($\mu\text{mol quanta m}^{-2} \text{ s}^{-1} \text{ nm}^{-1}$ or $\text{W m}^{-2} \text{ nm}^{-1}$).

D Daylength (h)

Physics & chemistry

WSD - Wind speed/direction (m s^{-1})Cu - Currents speed/direction (m s^{-1})

WA - Wave height (m)

SST - Sea Surface Temperature ($^{\circ}\text{C}$)

Sa Salinity - (PSU, Practical Salinity Unit or per million)

BB - Bathymetry & bottom classification

SSR - Sea Surface Roughness (highly related to wind stress/oil pollution)

Oil slicks - Related to "Sea Surface Roughness"

Macro - Macroalgae (distr. of kelp forest along coastline, relative)

SBE - Special Biological Events (e.g. harmful jellyfish, salps, algae, relative).

F - Fronts

DB - Database

Aqua - Aquaculture (eg. mussels, fish)

Trends - Trends over time – incl. historical data (e.g. changes in salinity, temperature at a given area)

HIM - High resolution images for general purposes

STAT - Statistics, functions tbd

RADAR - Radar measurements - to detect wind speed/direction

SISCAL users also had requirements concerning spatial and temporal resolution of the remote sensing data, and concerning additional data for management.

Mostly they wanted spatial resolution to be as high as possible, and revisiting time to be less than a week (and preferably daily), to register events, like algal blooms, adequately. If needed, a combination of imagery with high spatial and low temporal resolution (IKONOS), and medium spatial and high temporal resolution (MERIS) is proposed.

Concerning these matters, MERIS offers the following possibilities for SISAL users:

- Potential water-related products are chlorophyll, algal blooms, currents and fronts, sediments, and ice cover,
- Spatial resolution is 0,3 – 1,0 km,
- Revisit time for the middle latitudes is about 3 days.

Additional SISCAL related information that is of importance for end users:

- Geography (morphology and landscape of the research location);
- Wind/wave climate and information on the weather;
- Physical and chemical properties of the water;
- Sediments (transport and quantification);
- Marine & Fresh water Biology;
- Human activities.

Technical dissemination suggestions from SISCAL users:

- The data are to be presented in a ready to use GIS format (ArcView), with additional metadata;
- The images are to be received through a regular Internet browser; some could use ftp transfer.

2.2 The researcher, coastal manager, policy advisor, decision maker, and public

From these reviews (Section 2.1.1 to 2.1.3) we can expect a variety of users to be interested in REVAMP products, just as it was the case in CoastBase (Section 2.1.2). Therefore a similar structure has been used for analysing the REVAMP user requirements.

Individual users from the following categories should be contacted: researcher, coastal manager, policy advisor, decision maker, and the public.

Table 7. Individuals grouped per function

<i>Category</i>	<i>Respondent</i>
Researcher	ULB-ESA1 & 2; NERI1; VC1; SOC1; SOC2; PML1; PML2
Coastal manager	NERI2; EA1
Policy advisor	RIKZ1; DEFRA1
Decision maker	
Public	IMS1

2.3 From local to European scale

REVAMP deals with the implications of local problems (*e.g.*, a local algal bloom) for European legislation (*e.g.*, trans-boundary migration of the bloom). Previous studies (section 2.1) have shown that RIKZ, OSPAR, EEA and EuroGOOS, are typical users of REVAMP products, and therefore users from these organisations should be contacted.

Table 8. Roles and full names of the participating organisations

<i>Local</i>	
VC	Vejle County (DK)
<i>National</i>	
DEFRA	Department for Environment, Food & Rural Affairs - Veterinary, Fisheries & Aquatic Science Division (UK)
EA	Environment Agency (UK)
IMS	University of Plymouth - Institute of Marine Studies
NERI	National Environmental Research Institute (DK)
PML	Plymouth Marine Laboratory (and Natural Environment Research Council) (UK)
RIKZ	National Institute for Coastal and Marine Management (NL)
SOC	University of Southampton (and Natural Environment Research Council) - Southampton Oceanography Centre (UK)
ULB-ESA	Université Libre de Bruxelles - Ecologie des Systèmes Aquatiques (B)

Regional

OSPAR	The joint OSlo and PARis commission
-------	-------------------------------------

European

EEA	European Environment Agency
-----	-----------------------------

EuroGOOS	European Global Ocean Observing System
----------	--

2.4 Dissemination

The review (section 2.1) has shown that different users prefer different products and ways of dissemination of these products. It is recommended that some of the products will be distributed through the Internet.

3. Specification of Products

3.1 Introduction to relevant aspects

This section defines the products that will be produced in REVAMP (Fig. 4). This definition is compliant with the REVAMP Description of Work (REVAMP, 2002) and with the ideas of the REVAMP partners working on the algorithms (Ruddick et al., 2002). This chapter will focus on maps, metadata and the specifications for an atlas. In addition, it gives an outlook to the products that can be derived if requested by users and if the added value of these products for the users is clear.

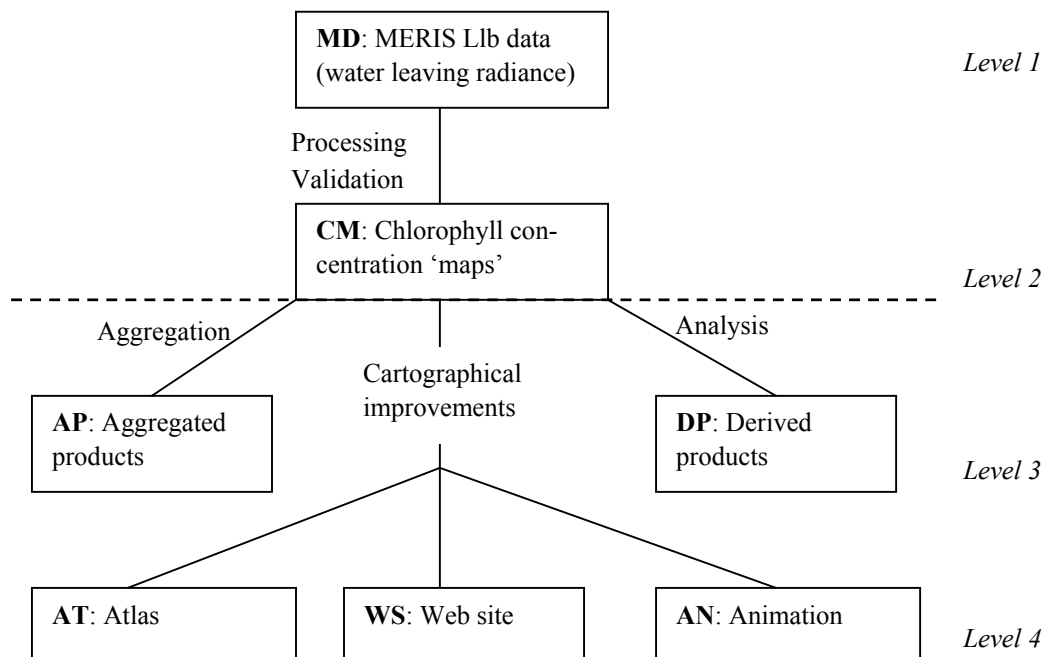


Fig. 4. REVAMP's chlorophyll products workflow. All products below the dashed line are Value Added Products.

3.2 The chlorophyll 'maps'

The POWERS project (van der Woerd et al, 2000) has shown how maps can be a first step towards an operational service:

- In the POWERS project a selection of ten SeaWiFS images was elaborated into TSM maps. During this project, also specifications for these maps were developed. Though these specifications were elaborated for TSM, similarities for CHL can be expected. These specifications are elaborated in this section;
- In the next step, end users (at RIKZ) investigated how they use the spatial information in their work. Therefore a compiled set of maps was offered in the form of an atlas (discussed in section 3.4).

For the description of technical aspects of REVAMP Level 2 products (chlorophyll concentration maps) information from the POWERS project (Van der Woerd, 1998) can be used (Table 9). POWERS aimed at both CHL and TSM products. Once CHL and TSM are determined it is possible to estimate the parameters related to the subsurface radiation field like Secchi Depth, FTU and Kdpar.

For chlorophyll-a (CHL) the concentration ranges between 1 to 50 ($\mu\text{g l}^{-1}$) CHL. The main end-user requirement is for eutrophication assessment, although also aspects such as primary production are mentioned.

The range for Total Suspended Matter (TSM) in coastal water is 1 to 20 mg l^{-1} . However, higher concentrations do occur due to wave and tidal effects. The demand for this type of information is either related to sedimentation rates near shipping lanes or to model the pollution dispersion.

The required accuracy is 10%.

There is quite a large range in end-user requirements related to spatial and temporal resolution. As the frequency of traditional measurement increases the desired frequency of Remote Sensing images tends to increase too. The current frequency using non-remote sensing methods is 5-20 times per year. The required spatial resolution is fully dictated by the underlying problem. The requirement ranges between 10 meters for detailed planning of dredging activities to 1 km for estimation of transport on a large scale. Of course the traditional methods only provide point measurements.

The latter is an interesting also with respect to the required accuracy. REVAMP might not produce CHL products in the range of 0.1 – 10 $\mu\text{g l}^{-1}$ with 10% accuracy on each sample point. REVAMP does however give an accurate overview of the distribution of CHL.

Finally different users often have different ways of determining CHL concentrations in the lab: HPLC, spectrophotometric analysis, or spectrofluorimetric analysis. These different methods give slightly values for CHL concentrations.

Table 9. End-user requirements for remote sensing derived water quality (Source: POWERS Project - Coastal Waters (Van der Woerd, 1998))

Parameter	Unit	Range of Interest	Accuracy	MERIS Potential	Remarks
CHL	($\mu\text{g l}^{-1}$)	0.1-30	(10%)	Yes	eutrophication area, optimum measurement strategy
TSM	(mg l^{-1})	1-1000	(10%)	Yes	sediment budget, pollutants
SD	(m)	+		Probably	General interest
FTU		-			
$K_{d\text{PAR}}$	(m^{-1})	+			General interest
other Pigments		+		No	General interest related to algal blooms
CDOM	(mg l^{-1})	0.1-10	(0.2)		
macrophytes		+		No	General interest
Resolution Aspects	unit				
MERIS global	(1200 m)	There is a preference for higher resolution, but for most applications, with exception of dredging lanes, this is OK.			
MERIS full resolution	(300 m)	High demand for this type of resolution			
future resolution	(< 300 m)	Preference to go for typically 100 m resolution			
number of scenes required	(yr^{-1})	20 to 50		Probably	important to catch April maximum
current non-RS sampling frequency	(yr^{-1})	5 to 20		Yes	year to year changes due to cloud statistics

Specification of products

Geo-reference and geo-correction

In order to calculate statistics, such as monthly averages, the maps should be well geo-referenced, i.e. every pixel must have a latitude and longitude co-ordinate. Moreover, the maps must be well geo-corrected (resampled) to a standard grid, so that temporal statistical analyses can be performed on a pixel by pixel basis. At RIKZ this analysis is carried out in ArcInfo or ArcView. Latitude and Longitude with degrees, minutes and decimal seconds is best suited as reference co-ordinates in the coastal waters. For inland waters a standard kilometre grid is more convenient.

Spatial resolution

The required spatial resolution depends on the information needed and the water of interest. For the North Sea a 1-km resolution suffices, although in the first kilometres near the coast a steep gradient can be present. This would require a higher resolution of say 250 m. For the Wadden Sea, a resolution of 1 km² is sufficient. However, for monitoring local hydrodynamic processes in inter-tidal areas, e.g., Marsdiep and Western Scheldt, high-resolution data with a resolution of 25 meters is necessary. Also for rivers, harbours and small lakes the spatial resolution must be higher, e.g., 10-30 m. This means that

MERIS/SeaWiFS is best suited for the North Sea, Wadden Sea and Lake IJsselmeer and Lake Markermeer. For distinguishing shipping lanes in Belgian waters for dredging lanes a resolution of 100-200 m is preferable.

Legend

It is important to standardise the colours of the legend for all maps, so that each colour represents one fixed interval of concentration. As a rule no more than 8 colours should be used. The legend for the North Sea should cover a range from 0->28 with steps of 4 g m⁻³. If there are specific features that fall within one interval it is recommended to use dark to light transitions of the same colour, or a grey scale. Only if necessary, the standard legends may be different for different waters in order to show more spatial features. Since the variation in TSM is approximately lognormal distributed it can be beneficiary to use a logarithmic classification. It is possible that end-users will prefer a non-linear classification, although it is more difficult to interpret. However, the steps in concentrations must at all times be equal to or larger than the precision of the TSM values.

Note that a legend of 8 classes affects only the colours and does not mean that the values within the images are classified, as for example in land use. The original TSM concentrations are stored in the images, either as floats or integers, so that other classifications made by RIKZ remain possible.

Non-water features

In order to enable a GIS analyst to interpret the TSM map, land and other non-water features (esp. clouds) must be recognised, preferably by overlaying a greyscale image of the land and clouds. However, areas flagged due to, *e.g.*, clouds should not interfere with analysis, so their numerical values should be such that there is no misunderstanding what is a non-water feature and what is TSM concentration. As a consequence it may be necessary to split the remote sensing product into two layers: the TSM map and the land/cloud map.

Quality

For the acceptance of remote sensing products it is essential that there is a standard quality assessment of the TSM maps. For every map there should be a standard quality indicator in the meta-information.

Meta-information

The meta-information accompanying each remote sensing product, must meet a meta-information standard, such as set by the Centre of Earth Observation (CEO). In particular it must be clear which processing steps for atmospheric correction and TSM retrieval are used, *e.g.*, specification of the TSM algorithm, the bands that are used as input etc. This meta-information is important for quality assessment of the TSM maps afterwards. As stated before, it is strongly recommended that the meta-information includes an indicator for the accuracy of the TSM map.

Specification of service

Time of delivery

The time of delivery depends on the end user within RIKZ. As a rule of thumb, policy makers demand products on a yearly basis, researchers on a monthly basis, and water and monitoring managers on a daily basis. For the main product, a time of delivery should be less than one month. Only in the case of quick scan products is a delivery time of one day required. Since there is a trade off between speed and quality, it is inevitable that the products will be less polished compared to the final product described in the previous section. Also for the quick scan product it is important that the image is geo-referenced, especially if optimum measurement locations or transects must be derived from it.

Requirements on meta-information database

A good meta-information database is very valuable for the remote sensing contact person at RIKZ. First of all, a good database must be complete and up to date. Second, it must have user-friendly search facilities, including the possibility to save a user profile. Besides the standard meta-information required for queries, true colour quick looks should be provided that help in selection of images for ordering.

Number of products

It is critical that the flow of information is stable and continuous for operational monitoring. This means that if remote sensing is to be used as a monitoring tool the production of water quality maps must be guaranteed. Although a remote sensing instrument is not easily replaced, the number of ocean colour sensors that are and will be operational is three or more, so the risk of no data is small. The main limitation will be clouds. For policy-making and research an average of one image per week is usually sufficient. Only for highly dynamic blooms are more frequent images required.

Cost

Cost is an important criterion in ordering TSM maps. The price of TSM maps from remote sensing has been steadily decreasing because raw images become cheaper due to the market and because processing is now largely automated. It is noted that the term 'good value' does not mean that remote sensing products must be cheap but their information content is worth the price.

Summary

The POWERS project was focused on the operational production of reliable TSM maps. However, the user requirements can be taken as a template for the expected CHL-related requirements.

From the consultation of end users within RIKZ it follows that the main product is a series of high quality maps of TSM for policy makers and researchers. The maps must be resampled to a standard grid. Clouds and other non-water features are omitted or are

converted to a “No Data” value. Meta-information, including an indicator for the quality of the data must be provided. A delivery time of several weeks is acceptable.

In addition, a second product that may be valuable for water management and monitoring is a quick scan of the TSM map that has the status of temporary product. This TSM map is based on fully automated processing and can be delivered in one day after recording. The use of this second product remains to be tested in practice but its quality is already similar to that of the primary product since the only non-automatic processing steps are possible minor improvements of, for example, geo-correction and atmospheric correction, and subjective quality assessment (of, *e.g.*, haziness).

3.3 Metadata and meta-information

The user needs background information about the characteristics of the original MERIS data, on the processing of the data (see 3.2), but also on the conditions during acquisition of the data, such as surface temperature for the interpretation of the maps. Such additional meta-information can be integrated into a value added product: an annotated atlas (see Table 10).

3.4 Value added products

REVAMP aims to produce a regional MERIS processor that transfers MERIS data into classified MERIS imagery / chlorophyll ‘maps’. All extra processing that is performed on these chlorophyll data leads to Value Added Products (Fig. 4).

All CHL maps of 2002 will be used to derive the final VAPs. VAP files will be produced in their final form, collected in a GIS-database and converted into thematic map sheets with topographic overlays. For overlays, use will be made of data that are available on the Internet, such as the Digital Chart of the World. The VAP map sheets will be included into the final Atlas (REVAMP, 2002).

Because of the condensed form, the value added products are suitable for dissemination through the Internet, either as a clickable map or as a series of thematic maps. A web site will be set up and maintained to display the valued added products. After the project, all web pages will be transferred to either ESA or national web sites (such as the Dutch NEONET/WAQUARIUS web infrastructures) to guarantee continuous access and maintenance for a prolonged period (REVAMP, 2002).

Specific attention is given here to the atlas, because of the availability of example specifications. Another point of interest concerns the derived products. Both will be discussed below.

3.4.1 Atlas and derived products

In Table 10 the specifications as used for the production of TSM the Noordzee-atlas (RIKZ & IVM, 2001a) are listed. Fig. 5 gives an example of one of the sheets extracted from the newest atlas (RIKZ & IVM, 2001b). This atlas is also as a .pdf file available at URL <http://www.watermarkt.nl/>, select 'productcatalogus' look for 'atlas'. In addition, an 'Interactieve Noordzee-Atlas' was created with web mapping in ArcIMS, and a Flash animation was also made. Both value added products are available at URL http://www.feweb.vu.nl/gis/SPINlab/mapservice/Noordzee_atlas/noordzeeatlas.asp.

Other VAP's, or the so-called DPs (derived products), can be produced on request as, *e.g.*, potential demonstration products. These products can be targeted to specific regions or specific events, or they can be customised for eutrophication indices or trends analysis. Table 11 provides some examples.

Table 10. Specifications for the production of the TSM atlas (RIKZ & IVM, 2001a)

<i>Nr</i>	<i>Subject</i>	<i>Description</i>
<i>1</i>	<i>Images</i>	
1.1	Sensor	SeaWiFS (NASA)
1.2	Images	List of images to be included in the atlas
1.3	Coverage	Process and store data of the entire North Sea, select an area for the maps
1.4	Projection	WGS 84
1.5	Geo-reference	UTM 31
1.6	Geo-correction	1 km
1.7	Spatial resolution	1 km
<i>2</i>	<i>TSM information</i>	
2.1	TSM data format	Integers
2.2	Precision	1 gm ⁻³
2.3	Accuracy	Accuracy in percentages or gm ⁻³ (in meta-information file)
2.4	Range	0-35 gm ⁻³
2.5	Legend	8 colours, linear scale
2.6	Clouds	White
2.7	Land	1 land mask or topographical map
2.8	Other waters	Non-North Sea water light blue (or grey)
<i>3</i>	<i>Meta-information</i>	
3.1	Date	dd mmmm jjjj (Julian day)
3.2	Time	UTC
3.3	Wind	In m s ⁻¹ and in directions (e.g., N, NE) based on meteorological data
3.4	Tide	Relative to Dutch Ordnance Level (NAP), Time from 8:00-18:00 UTC, Astronomical tide of Flushing (Vlissingen) and Den Helder
3.5	Sensor	Name SeaWiFS (NASA)
3.6	File	Filename Arc_Info file
<i>4</i>	<i>Map layout</i>	
4.1	Format paper	A4 landscape
4.2	Margins	Left 2 cm, other 1 cm
4.3	Area	Southern North Sea (Dutch Territorial Waters): LL: 51 NB 0 EL, UR 56 NB 9 EL
4.4	Title	Concentration total suspended matter
4.5	Grid	UTM (yellow crosses)
4.6	Measurement points	Points on overview map
4.7	Logo	Logo Rijkswaterstaat with RIKZ
<i>5</i>	<i>Delivery</i>	
5.1	Format	Arc_Info project, TIFF file
5.2	Storage	CDROM
5.3	Name	Unambiguous
5.4	Metadata file	

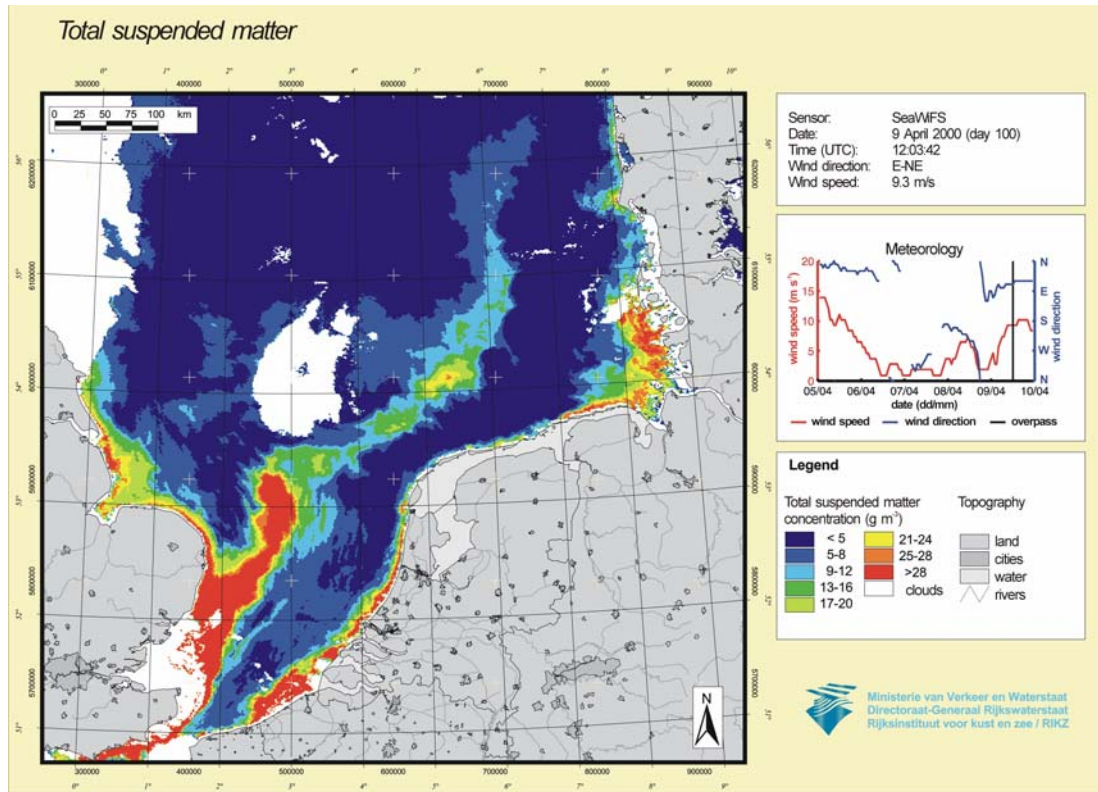


Fig. 5. Example extracted from the Noordzee-atlas (RIKZ & IVM, 2001b)

Table 11. Definition of possibilities for DPs (derived products)

Specific regions	Specific events	Eutrophication related variables	Trends
		Mean CHL concentration (maybe median)	Time series (e.g., days, weeks, months, seasons)
Trans-boundary areas	Storms	Peak CHL concentration	Growth and decline of blooms
Coastal rivers (residual currents with high sediment concentrations)	Dredging activities	Bloom duration	
Estuaries		Primary production	
Harbours			
Shipping lanes			

4. Discussion of the Requirements

4.1 Tables and discussion per item

From literature study and previous experience the users were interested in the following chlorophyll products. In the inventory of actual users have to be asked if they agree that they fit their profile. Subsequently they can check if they agree with the product specifications (MUSTs, SHOULDs, and MAYs) for the levels of their interest.

Table 12. User requirement versus chlorophyll product

<i>Chlorophyll product</i>	<i>Researcher</i>	<i>Coastal manager</i>	<i>Policy advisor</i>	<i>Decision maker</i>	<i>Public</i>
L1	X				
L2	X	X			
L3	X	X	X	X	X
L4	X	X	X	X	X

4.2 The Must-should-may approach

To provide a comprehensive checklist, user requirements have been translated into three categories: MUST, SHOULD and MAY. The definition of the categories was derived from RFC 1123 (Internet Engineering Task Force, 1989):

- *MUST* means that the item is an absolute requirement of a specification;
- *SHOULD* means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course;
- *MAY* means that this item is truly optional.

A REVAMP CHL product that satisfies all the MUST and all the SHOULD requirements is said to be Unconditionally compliant; one that satisfies all the MUST requirements but not all the SHOULD requirements is said to be Conditionally compliant. A product Not compliant if it fails to satisfy one or more of the MUST requirements.

For Level 2 the technical requirements were mainly derived from Table 9. These are also the requirements for Level 3 products. For Level 4 presentation and cartographic requirements (Table 10) become more important.

Table 13. Checklist

Level 2 and Level 3 products: Chlorophyll concentration 'maps', Aggregated and Derived products

1. The CHL algorithms MUST produce reliable CHL concentration values in the range of 0.1 – 30 μm
2. The accuracy of the CHL products MUST be at least 10%
3. The product MUST be accompanied by metadata
4. A quality indicator MUST be delivered with the product
5. MERIS full resolution imagery SHOULD be used
6. All scenes covering the North Sea SHOULD be processed, and the April maximum MUST be captured

Level 4 products: Atlas, Web site, and Animation

1. The entire North Sea SHOULD be covered
2. The projection MUST be in WGS 84
3. The CHL product SHOULD be projected on a grid with a spatial resolution of 300 m (full resolution)
4. The legend MUST consist of 8 colours
5. Clouds MUST be indicated in white, a land mask or topographical map MUST cover land, other waters MUST be indicated in blue (or grey)
6. Metadata MUST be given, and meta-information SHOULD be added to the product, information on temperature and PAR MAY be added to the product
7. Date MUST be in dd mmmm jjjj (Julian day)
8. Time MUST be in UTC
9. The maps must fit on A4 paper, and MUST have a standard layout
10. The title SHOULD be Chlorophyll concentration
11. The REVAMP logo MUST be on the maps
12. The delivery formats MUST consist of a TIFF and in ArcInfo/ArcView 3.2 (ESRI) project format

5. Follow-up

The follow-up of this report consists of interviews with actual users (Fig. 6). Because most of the user analysis was already elaborated through this literature study, effort from the interviewer and the actual users is limited. A form on the web site that allows potential users to interactively express their views on REVAMP (Annex 1) can support the interviews, and can possibly also attract new potential users.

Finally, in Phase 2 of the user requirements study, actual users have the opportunity to give feedback at a workshop where the first REVAMP results are presented.

Information to be requested from the users via an interview and/or the web site (Annex 1) should consist of:

- Name, organisation, function and daily work of the participant (Table 7);
- Spatio-temporal scale of work (Table 8);
- Hard- and software used;
- Data and information flow (input, manipulation and processing of input data, output);
- Reaction on the user profile (Fig. 4, Table 12);
- Reaction on REVAMP-related specifications (Tables 9 & 10 & Fig. 5, Table 13);
- Reaction on possible dissemination requirements (Table 5);
- Individual objectives for using REVAMP products.

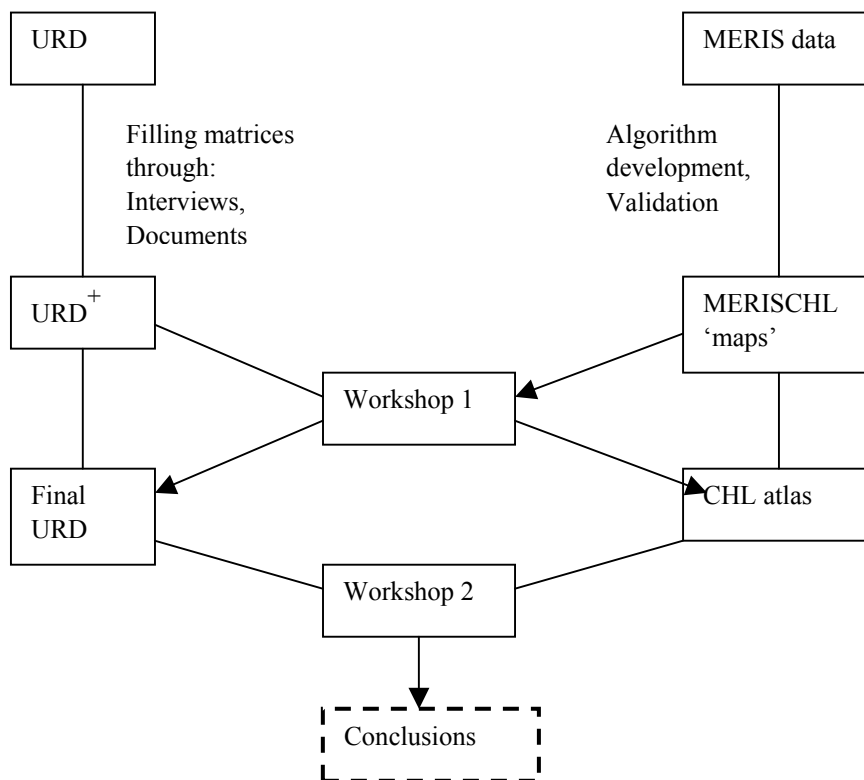


Fig. 6. URD workflow.

6. References

- Eleveld, M.A., Schrimpf, W.B.H. & Siegert, A.G.**, 2002. User requirements and information definition for a virtual coastal and marine data warehouse. *Ocean & Coastal Management*, in press.
- Eleveld, M.A., Siegert, A.G. & Schrimpf, W.B.H.**, 2000. CoastBase. Information definition and user requirements. Deliverable WP4 for EU Contract Number IST-1999-11406. JRC. Ispra, 64 pp. + Annexes. (The report is on-line available at URL <http://www.coastbase.org/> and was also published in the European Commission's EUR series as EUR 19732 EN.)
- Internet Engineering Task Force**, 1989. RFC 1123. URL: <http://www.ietf.org/rfc.html>, (98 pp.).
- Johnsen, G. (ed.)**, 2001. SISCAL End user requirement document. Report Norwegian University of Technology and Science, Trondhjem Biological Station, Trondhjem, 48 pp.
- Lancelot, C. & Wassmann, P. (eds)**, 1994. "The ecology of Phaeocystis-dominated ecosystems", *J. Mar. Sys.*, Special Issue, 5(1), p1-100.
- Niesing, H., Eleveld, M.A., & Schrimpf, W.B.H.**, 2000. Towards European tailor made information regarding Marine and Coastal Environments. Proceedings Monitoring Tailor Made III, Nunspeet, 25-28 September 2000. RIZA, Lelystad, pp. 385-390. URL <http://www.minvenw.nl/rws/riza/home/index.html>
- Niesing, H., Dembski, M. & Eleveld, M.A.**, 2001. CoastBase – access to European marine and coastal information through a virtual system. Proceedings First International Congress of Seas and Oceans, Szczecin and Miedzyzdroje (PL), 18-22 Sept. 2001. Publ. House Maritime University of Szczecin, Szczecin, Vol. 1, pp. 429-434.
- OSPARCOM**, 1995. Nutrients in the Convention Area - Overview of implementation of PARCOM recommendation 88/2, ISBN 0-946956 41-3.
- REVAMP**, 2002. REVAMP. Description of work, Issue 4.0 (also known as Technical Annex). IVM-VU, Amsterdam, 46 pp. (Available from: VU-IVM, De Boelelaan 1087, 1081 HV Amsterdam, the Netherlands)
- RIKZ & IVM**, 2001a. Noordzee-atlas voor zwevende stof. Een overzicht op basis van SeaWiFS satellietbeelden uit 1999, Rapport RIKZ/2001.013, Rijksinstituut voor Kust en Zee (RIKZ), The Hague, The Netherlands, 41 p.
- RIKZ & IVM**, 2001b. Noordzee-atlas voor zwevend stof op basis van SeaWiFS satellietbeelden in 2000, RIKZ/2002.102, Rijksinstituut voor Kust en Zee (RIKZ), The Hague, The Netherlands, 33 p.
- Ruddick, K., Aas, E., Block, T., Doerffer, R., Jans, S., Jørgensen, P., Kraseman, H., Laanen, M., Moore, G., Pasterkamp, R., Peters, S., Sørensen, K., and Van der Woerd, H.**, 2002. REVAMP Regional algorithm requirements (First draft of Deliverable D2.1). MUMM, Brussels, 24 pp.
- Van der Woerd, H. (ed.)**, 1998. POWERS - User Requirements Document. IVM Report W-98/16, VU-IVM, Amsterdam, 41 pp.+ annexes.
- Van der Woerd, H., Hakvoort, J.H.M., Hoogenboom, H.J., Omzigt, N., Pasterkamp, R., Peters, S.W.M., Ruddick, K., De Valk, C. & Vos, R.J.**, 2000. Towards an operational monitoring system for turbid waters: POWERS Final Report. Rapportnummer O-00/16, VU-IVM, Amsterdam, 35 pp.

Form

REVAMP User Requirements

REVAMP is an EC-project aiming at REgional validation of MERIS chlorophyll Products in North Sea coastal waters. Users can have an important say on the products that REVAMP will deliver. We kindly ask for your opinion on REVAMP. The results from this questionnaire will be used within the REVAMP project; your identity will not be revealed in any external publications.

The "Reset" button below will empty all fields. The "Send" button sends the form to the User Requirements responsible.

1. Please provide your contact data

Name	<input type="text"/>
Organisation	<input type="text"/>
Address	<input type="text"/>
P.O. Box	<input type="text"/>
Postal code City	<input type="text"/>
Country	<input type="text"/>
Tel.	<input type="text"/>
Fax.	<input type="text"/>
E-mail	<input type="text"/>

2. Please supply us with some information about your work and your computer

- Function
- Researcher
 - Coastal manager
 - Policy advisor

- Decision maker
- Public

Scale on which you work (spatial)

Scale on which you work (temporal)

Daily work

Hardware

Operating system

Software

Browser

3. Please supply us with some information about your organisation

On which level does your institute focus?

- Local
- National
- Regional
- European

4. Please have a look at the [Users](#) slides (click)

Does Slide 3 (Matching) apply in your case?

Other remarks

5. Please supply us with some information about your method for determining CHL concentration.

- Method
- HPLC
 - Spectrophotometric
 - Spectrofluorimetric
 - Other

Other remarks

6. What's your reaction on the [Specification](#) slides (click). Do you agree with the listed specifications? Which additional specifications would you like to request?

It is very likely that REVAMP cannot give CHL products in the range from 0.1-30 microgram/liter with an accuracy of 10%. REVAMP does however give an accurate overview of the distribution of CHL. Which concentration and accuracy values would be acceptable for you?

L2&3 CHL products

Other remarks

The logo on the maps will be the REVAMP logo. Which other specifications would you like to see changed.

L4 CHL products (1)

L4 CHL products (2)

Example of a L4 product

Other remarks

7. What's your reaction on the [Checklist](#) slides (click). Would you agree with all listed requirements?

L2&3 CHL products

L4 CHL products

Dissemination requirements

Other remarks

8. Other remarks (e.g., individual objectives for considering using REVAMP products)

When electronic submission does not work, please print this page, and send it filled out to

Hans van der Woerd

VU-IVM

De Boelelaan 1087

NL 1081 HV Amsterdam

The Netherlands

Fax +31 (0)20 444 9553

E-mail: revamp.webmaster@ivm.vu.nl

12/08/2001

User slides

REVAMP REVAMP meeting Plymouth 14 June 2002

Users

Organisations ordered by focus

Category	Institute
Local	
National	RIKZ
Regional	OSPAR
European	EEA

Individuals grouped per function

Category	Respondent
Researcher	
Coastal manager	
Policy advisor	RIKZ1, OSPAR1?
Decision maker	
Public	

vrije Universiteit amsterdam Institute for Environmental Studies (IVM)

REVAMP REVAMP meeting Plymouth 14 June 2002

Specification CHL products

```


    graph TD
      MD["MD: MERIS L1b data  
(water leaving radiance)"] -- "Processing  
Validation" --> CM["CM: Chlorophyll  
concentration 'maps'"]
      CM -.-> AP["AP: Aggregated  
products"]
      CM -.-> DP["DP: Derived  
products"]
      CM -- "Cartographical  
improvements" --> AT["AT: Atlas"]
      CM -- "Cartographical  
improvements" --> WS["WS: Web site"]
      CM -- "Cartographical  
improvements" --> AN["AN: Animation"]
      style MD stroke-dasharray: none
      style CM stroke-dasharray: 5 5
      style AP stroke-dasharray: none
      style DP stroke-dasharray: none
      style AT stroke-dasharray: none
      style WS stroke-dasharray: none
      style AN stroke-dasharray: none
  
```

vrije Universiteit amsterdam Institute for Environmental Studies (IVM)

REVAMP REVAMP meeting Plymouth 14 June 2002

Matching – User requirements v CHL product

<i>Chlorophyll product</i>	<i>Researcher</i>	<i>Coastal manager</i>	<i>Policy advisor</i>	<i>Decision maker</i>	<i>Public</i>
L1	X				
L2	X	X			
L3	X	X	X	X	X
L4	X	X	X	X	X


 *vrije Universiteit amsterdam* Institute for Environmental Studies (IVM)

Specification slides

REVAMP REVAMP meeting Plymouth 14 June 2002

Specification L2&3 CHL products


Parameter	Unit	Range of Interest	Accuracy	MERIS Potential	Remarks
CHL	($\mu\text{g l}^{-1}$)	0.1-30	(10%)	Yes	eutrophication area, optimum measurement strategy
TSM	(mg l^{-1})	1-1000	(10%)	Yes	sediment budget, pollutants
SD	(m)	+		Probably	General interest
FTU		-			
$K_{d\text{PAR}}$	(m^{-1})	+			General interest
other Pigments		+		No	General interest related to algal blooms
CDOM	(mg l^{-1})	0.1-10	(0.2)		
macrophytes		+		No	General interest
Resolution Aspects	unit				
MERIS global	(1200 m)	There is a preference for higher resolution, but for most applications, with exception of dredging lanes, this is OK.			
MERIS full resolution	(300 m)	High demand for this type of resolution			
future resolution	(< 300 m)	Preference to go for typically 100 m resolution			
number of scenes required	(yr^{-1})	20 to 50		Probably	important to catch April maximum
current non-RS sampling frequency	(yr^{-1})	5 to 20		Yes	year to year changes due to cloud statistics

 **vrije Universiteit amsterdam** **Institute for Environmental Studies (IVM)**

REVAMP REVAMP meeting Plymouth 14 June 2002

Specification L4 CHL products

Nr	Subject	Description
1	Images	
1.1	Sensor	SeaWiFS (NASA)
1.2	Images	List of images to be included in the atlas
1.3	Coverage	Process and store date of the entire North sea, select an area for the maps
1.4	Projection	WGS 84
1.5	Geo-reference	UTM 31
1.6	Geo-correction	1 km
1.7	Spatial resolution	1 km
2	TSM information	
2.1	TSM data format	Integers
2.2	Precision	1 gm^{-3}
2.3	Accuracy	Accuracy in percentages or gm^{-3} (in meta-information file)
2.4	Range	$0-35 \text{ gm}^{-3}$
2.5	Legend	8 colours, linear scale
2.6	Clouds	White
2.7	Land	1 land mask or topographical map?
2.8	Other waters	Non-North Sea water light blue (of grey)
3	Meta-information	
3.1	Date	dd mmmm jjjj (Julian day)
3.2	Time	UTC
3.3	Wind	In m s^{-1} and in directions (e.g., N, NE) based on meteorological data
3.4	Tide	Relative to Dutch Ordnance Level (NAP), Time from 8:00-18:00 UTC, Astronomical tide of Flushing (Vlissingen) and Den Helder
3.5	Sensor	Name SeaWiFS (NASA)
3.6	File	Filename Arc_Info file

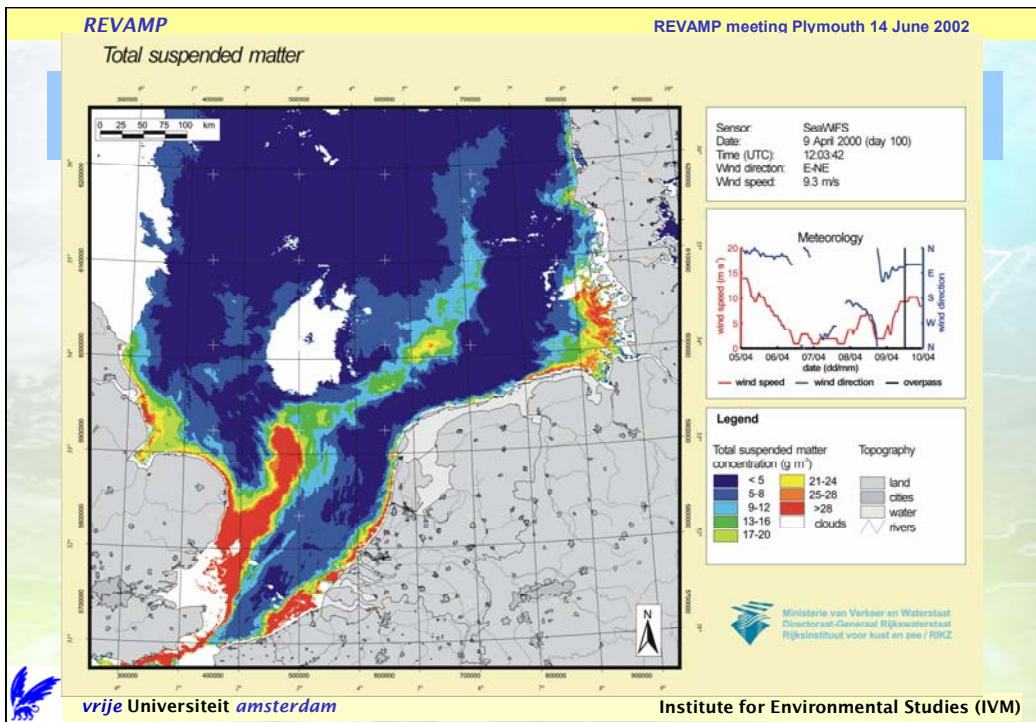
 **vrije Universiteit amsterdam** **Institute for Environmental Studies (IVM)**

REVAMP REVAMP meeting Plymouth 14 June 2002

Specification L4 CHL products

Nr	Subject	Description
4	Map layout	
4.1	Format paper	A4 landscape
4.2	Margins	Left 2 cm, other 1 cm
4.3	Area	Southern North Sea (Dutch Territorial Waters): LL: 51 NB 0 EL, UR 56 NB 9 EL
4.4	Title	Concentration total suspended matter
4.5	Grid	UTM (yellow crosses)
4.6	MWTL measurement points	Points on overview map
4.7	Logo	Logo Rijkswaterstaat with RIKZ
5	Delivery	
5.1	Format	Arc_Info project, TIFF file
5.2	Storage	CDROM
5.3	Name	Unambiguous
5.4	Metadata file	

vrije Universiteit amsterdam Institute for Environmental Studies (IVM)




[Checklist slides](#)

REVAMP REVAMP meeting Plymouth 14 June 2002

Matching – Checklist

Level 2 and Level 3 products: Chlorophyll concentration 'maps', Aggregated and Derived products

1. The CHL algorithms **MUST** produce reliable CHL concentration values in the range of 0.1 – 30 μm
2. The accuracy of the CHL products **MUST** be at least 10%
3. The product **MUST** be accompanied by metadata
4. A quality indicator **MUST** be delivered with the product
5. MERIS full resolution imagery **SHOULD** be used
6. All scenes covering the North Sea **SHOULD** be processed, and the April maximum **MUST** be caught


 Institute for Environmental Studies (IVM)

REVAMP REVAMP meeting Plymouth 14 June 2002

Matching - Checklist

Level 4 products: Atlas, Web site, and Animation

1. The entire North Sea **SHOULD** be covered
2. The projection **MUST** be in WGS 84
3. The CHL product **SHOULD** be projected on a grid with a spatial resolution of 300 m (full resolution)
4. The legend **MUST** consist of 8 colours
5. Clouds **MUST** be indicated in white, a land mask or topographical map **MUST** cover land, other waters **MUST** be indicated in blue (or grey)
6. Metadata **MUST** be given, and meta-information **SHOULD** be added to the product, information on temperature and PAR **MAY** be added to the product
7. Date **MUST** be in dd mmmm jjjj (Julian day)
8. Time **MUST** be in UTC
9. The maps **MUST** fit on A4 paper, and **MUST** have a standard layout
10. The title **SHOULD** be Chlorophyll concentration
11. The REVAMP logo **MUST** be on the maps
12. The delivery formats **MUST** consist of a TIFF and in ArcInfo / ArcView 3.2 (ESRI) project format

 Institute for Environmental Studies (IVM)

Dissemination requirements

Checklist

1. Final REVAMP products MUST be accessible via the Internet
2. The Welcome pages of REVAMP SHOULD be readable on any browser and MUST comply with the HTML 4.01 standard as published by the W3 Consortium
3. The REVAMP web server MUST allow concurrent operations of different users
4. The use of the REVAMP web site MUST be user-friendly and require no specific knowledge of informatics
5. The use SHOULD be intuitive and MUST NOT require any preparatory training
6. The REVAMP web site SHOULD NOT require user hardware faster than 150 MHz Pentium, with 64 MB memory, and a browser with Java 1.2 plug-in installed
7. The REVAMP web site SHOULD NOT require Internet connection speed over 56 Kb
8. The REVAMP web site MUST work with Netscape 4.7 and Internet Explorer 5 under Windows NT, 98 and 2000 and SHOULD work with newer versions of these browsers and operating systems
9. Java applets and Browser plug-ins MAY be used but SHOULD NOT require assistance of a system administrator, or user side configuration changes
10. Animations MAY be used to give insight in temporal changes
11. REVAMP products SHOULD facilitate international comparison of data and information



Appendix II. Individual users

(Not to be revealed outside the REVAMP project)