Sustainable Management of the North Sea

IDOD

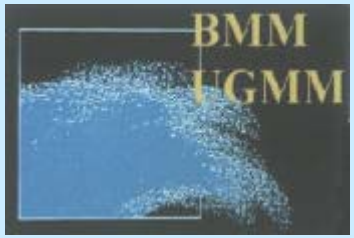
Integrated and Dynamical Oceanographic Data Management

(January 1997 - June 2002)

MUMM Management Unit of the Mathematical Models of the North Sea

IDOD - Integrated and Dynamical Oceanographic Data Management

Teams:

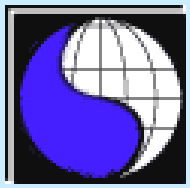


MUMM - Management Unit of the Mathematical Model of the North Sea

K. De Cauwer, M. Devolder, S. Jans, L. Schwind, S. Scory, J. Backers, M. Moens

KUL - Universiteit Centrum voor Statistics

G. Dierckx, B. Plevoets, F. Vastmans, J. Van Dyck



ULg - SURFACES

. Cornet, F. Muller, J.-C. Sainte

IDOD - Integrated and Dynamical Oceanographic Data Management

Data are important

- because they are the basis of any scientific research,
- and, therefore, for any policy making and control in the field of the environment and of a sustainable development

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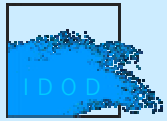
IDOD - Integrated and Dynamical Oceanographic Data Management

- Data are useful
  - when they are quality–controlled, well-documented, easily retrievable (and not lost after a while !)
  - when they form a large –but coherent– data set, spanning over time and space and covering a wide range of parameters
  - when this data set can be analyzed with powerful tools



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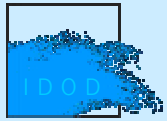
And data acquisition ... costs a lot!

- Example for the year 2000

Belgica	= 502 €/hour
Mean salary cost of scientists on board	= 245 €/hour
Total	= 747 €/hour

Cost of a standard campaign

(from Monday 10 a.m to Friday noon) **= 73.206 €**



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IDOD - Integrated and Dynamical Oceanographic Data Management

Nevertheless, in order to understand the processes and their trends –both in space and time– and to address the complexity of the ecosystem, more data are often needed.

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IDOD - Integrated and Dynamical Oceanographic Data Management

- Statistical significance, and hence the trustability of scientific results, requires appropriate sampling strategies, providing for « sufficient » coverage in space and time and for the measurement of as many relevant parameters as possible.

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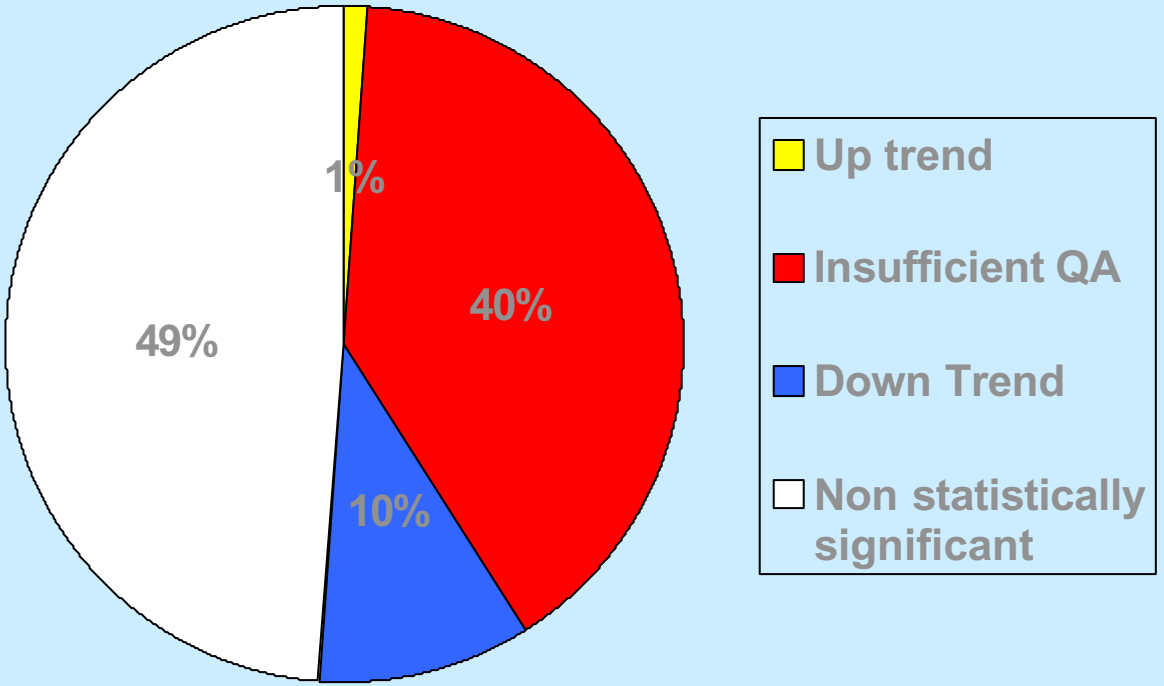

OSPAR trend assessment of contamination in biota

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IDOD - Integrated and Dynamical Oceanographic Data Management

The objectives of the IDOD project underlined these needs :

- *To provide structured, homogenized and validated oceanographic data necessary for any scientific research, decision making and sustainable development...*
- *To establish, to manage and to promote an integrated database of marine environmental data, ensuring a smooth and scientifically sound data flow between the data producers and the end-users*

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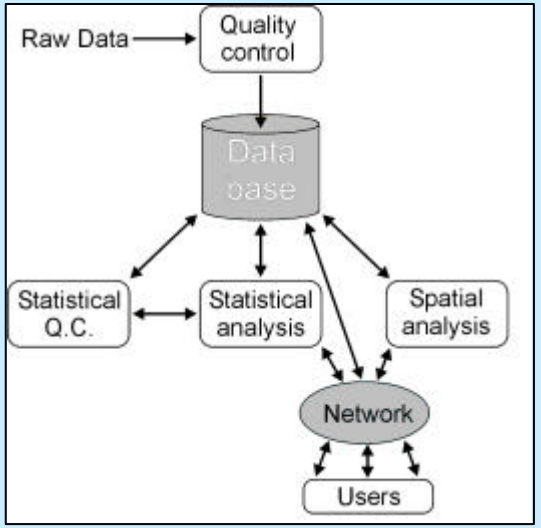
IDOD : An information system

IDOD is made of

- a relational data base,
- manager & user interfaces,
- quality–control utilities,
- statistical and spatial analysis tools



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IDOD : An information system

Technical aspects

- Inventory of data sets and databases
- Set-up of
  - data base
  - quality control
  - data transfer procedures

Users tools (Queries, Statistics, Visualisation, Spatial analysis)

Products and applications

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IDOD - Integrated and Dynamical
Oceanographic Data Management

Technical aspects...

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Data set inventory

(data collected in the frame of the Programme)

		COORDINATOR	Vincx			Van Grieken				Lancelot			Dubois			Bouquegneau			
		PARAMETER	UG	IN	KUL	VUB	UG	UIA	ULB	ULB	VUB	MUMM	ULB	UMH	UMH	Ulg	Ulg	VUB	IN
WATER	Physical	temperature	x (v)						x	x		x (v,c)							
		suspended matter							x	x	x	x							
		depth	x (v)										x	x	x				
		secchi depth										x							
		PAR	x (v)																
	Major inorganic	salinity	x (v)						x	x		x (v,c)	x	x	x				
		dissolved oxygen							x										
		pH							x										
		carbon							x (p)		x (p)								
	Nutrients	nitrate	x			x				x									
		nitrite	x			x				x									
		phosphate	x			x				x									
		silicate				x				x									
		ammonia	x			x				x									
		urea				x													
SEDIMENT	Physical																		
		profile of the pore							x										
		specific surface							x										
		average pore radius							x										
		granulometry	x										x	x	x				
	Interstitial water nutrients	nitrate	x (v)																
		nitrite	x (v)																
		ammonia	x (v)																
		phosphate	x (v)																
	Metals	Cd, Pb, Hg, Zn, Cu											x						
	Chlorobiphenyls	PCBs													x				
BIOTA	Fish - varia	genetic structure			x														
		parasites : spp. and incidence			x														
		stomach analysis			x														
	Starfish																		
	metals	Cd, Cu, Zn, Hg, Pb											x						
	Chlorobiphenyls	PCBs													x				
	biological effect	MFO[1] activity											x?						
		amoebocyte RO[2] species											x						
		embryotoxicity test											x						
		amoebocyte phagocytic activity											x						
		metallothioneins											x						
	Seabirds - marine mammals																		
	metals	Cd, Cu, Zn, Cr, Pb, Ni, Fe, Se, Hg														x			
	organic	hydrocarbons, polar lipids																x	
		PAHs															x		
		total lipids														x			
		PCBs																x	
	organochlorines	DDE, DDT, aldrin, lindane, heptachlor																x	
	ecology	diversity, density																	
	varia	pathology, parasites															x		
		metallothioneins														x			
	Phytoplankton																		
	ecology	composition, enumeration								x									
	Mesozooplankton																		
	ecology	composition, abundabce									x								
	Benthos (meio, macro, epi, hyper)																		
	ecology	diversityindex, # spp, density, biomass	x																
		dominance index	x																
		length & weight freq. distribution	x																
	Birds																		
	ecology	# per species, developm. stage		x															x
		& plumage density																	x

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Identified data types

- concentration (e.g.: nutrients) in water
- concentration (e.g.: heavy metals) in sediment
- concentration (e.g.: PCB's) in biota
- biomass and population densities
- observations on biota : e.g. %coverage with oil, absence/presence of fish diseases
- models results

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Meta Information

- General (date, time, position)
- Methods (sampling, sample handling, analysis...)
- Quality control (Control charts, intercalibration exercises such as Quasimeme, ...)
- Meteorology (wind speed and direction, solar radiation, air temperature...)

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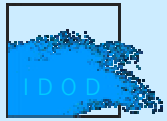
Set-up of the data base

Phase 1: Analysis and design

From the structuration of the information and the identification of the needs...
... definition of the entities and relationships ... description of modules for importing, retrieving and updating data into the dB

a <u>relational data base</u>



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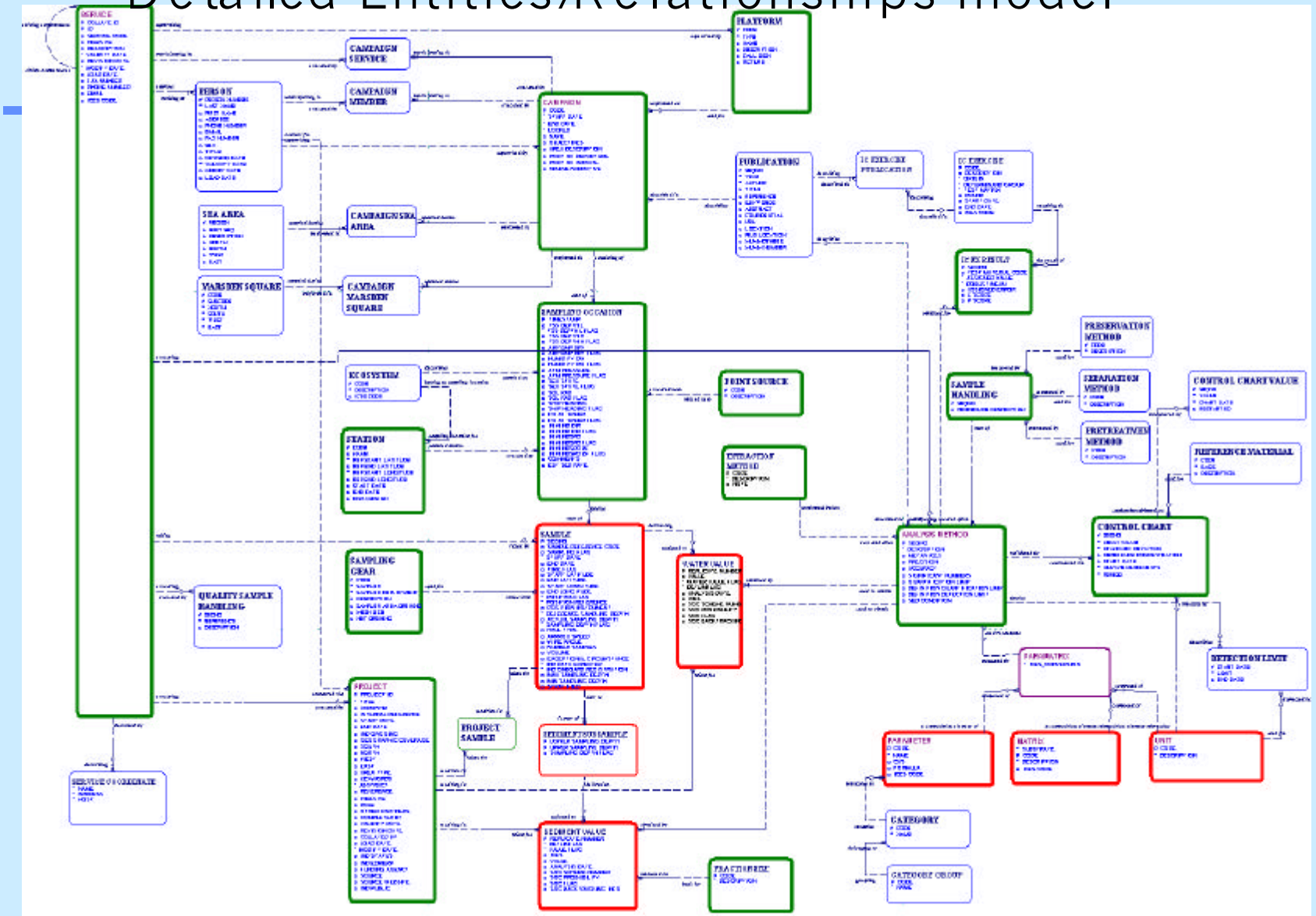
Detailed Entities/Relationships model



Sampling with Niskin bottle

Campaigns — BE2001/03

Sampling occasions — Station 700 - 7/02/2001 09.56 u

Samples — Niskin bottle

Water values

Nitrate 75 µmol/l
Ammonium 2 µmol/l
Dissolved oxygen 9.8 mg/l

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Sampling with boxcorer

Campaigns

BE2001/03
BE2000/07

Sampling occasions

Station 700 - 7/02/2001 09.56 u
Station 700 - 13/03/2000

Samples

Niskin bottle
Van Veen Grab

Water values

Nitrate : 75 µmol/l
Ammonium : 2 µmol/l
Dissolved oxygen : 9.8 mg/l

Sediment subsamples

0-10 cm depth

Sediment values

CB101 : 0.00202 µg/g dry weight
(< 63 µm)

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Fishing net

Campaigns

BE2000/03
BE2000/07
BR2000 (Broodwinner)

Sampling occasions

Station 700 - 7/02/2001 09.56 u
Station 700 - 13/03/2000
BCP - 5/10/2000

Samples

Niskin bottle
Van Veen Grab
Beam trawl

Water values

Nitrate : 75 µmol/l
Ammonium : 2 µmol/l
Dissolved oxygen : 9.8 mg/l

Sediment subsamples

0-10 cm depth

Sediment values

CB101 : 0.00202 µg/g dry weight (< 63 µm)

Biota subsamples

5 Atlantic cod specimens with average weight of 446 g

Tissue

Liver tissue with 58 % lipid weight

Biota values

CB101 = 0.18628 µg/g lipid weight

Observations

2 individuals are males

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grebes

Campaigns

BE2000/03
BE2000/07
BR2000 (Broodwinner)
BE1998/13

Sampling occasions

Station 700 - 7/02/2001 09.56 u
Station 700 - 13/03/2000
BCP - 5/10/2000
Square 9312 - 2/06/1998

Samples

Niskin bottle
Van Veen Grab
Beam trawl
Eye/binocular

Water values

Nitrate : 75 µmol/l
Ammonium : 2 µmol/l
Dissolved oxygen : 9.8 mg/l

Sediment subsamples

0-10 cm depth

Sediment values

CB101 : 0.00202 µg/g dry weight (< 63 µm)

Biota subsamples

5 Atlantic cod specimens with average weight of 446 g

Tissue

Liver tissue with 58 % lipid weight

Biota values

CB101 = 0.18628 µg/g lipid weight

Observations

2 individuals are males

Densities

2.2 Black-headed Gulls/km2
45.12 Common Terns/km2

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Implementation / Production

Phase 2: actual programmation of the database

Software used:

- **DB**: Oracle *8.i* and related designer and development tools
- Windows-NT

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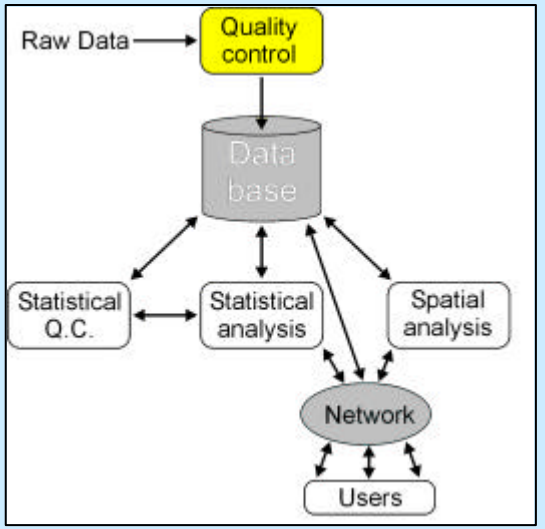
Set-up of quality control

- Quality Control on import and DB integrity checks
  - 33 validation rules



- Statistical Quality Control

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Quality Control on import and DB integrity checks

- Examples of validation rules
  - the start and end dates of a sample must be between the start and end dates of the related campaign
  - the matrix for a water value should be ‘dissolved’, ‘particulate’ or ‘total’
  - the value for dissolved phosphate must be lower than the value for total phosphorus

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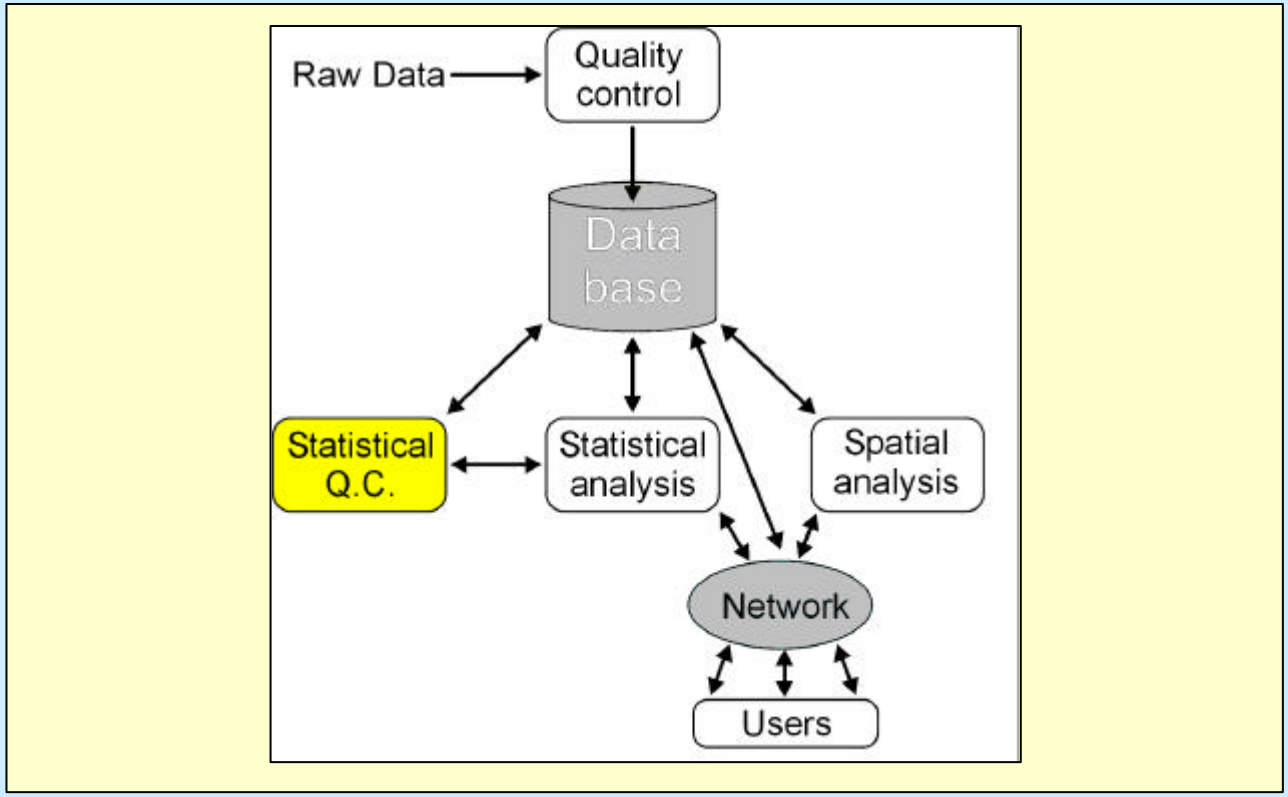
Statistical Quality Control



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SQC: Conceptual Design

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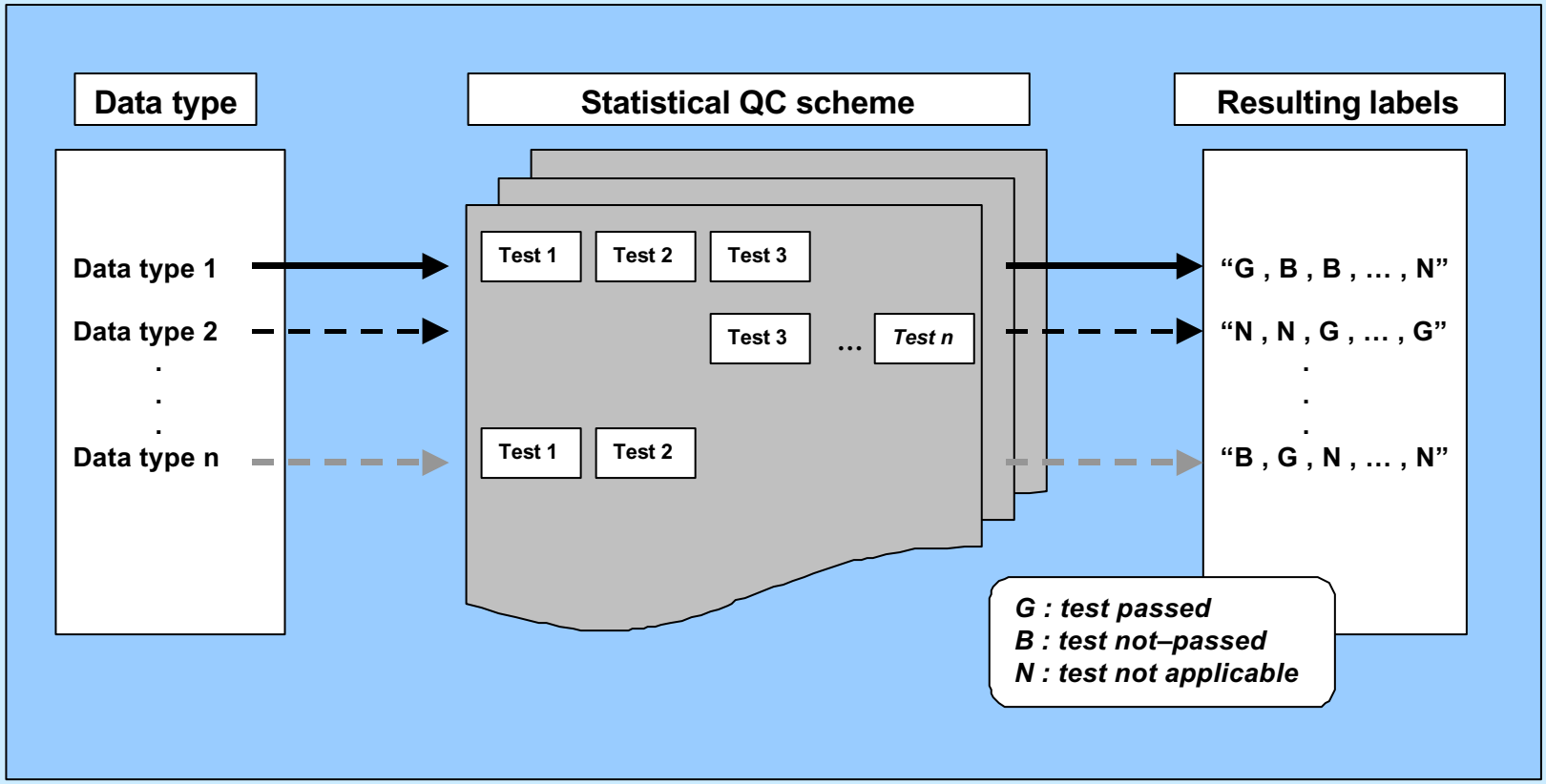

IDOD MUMM

Distribution QC

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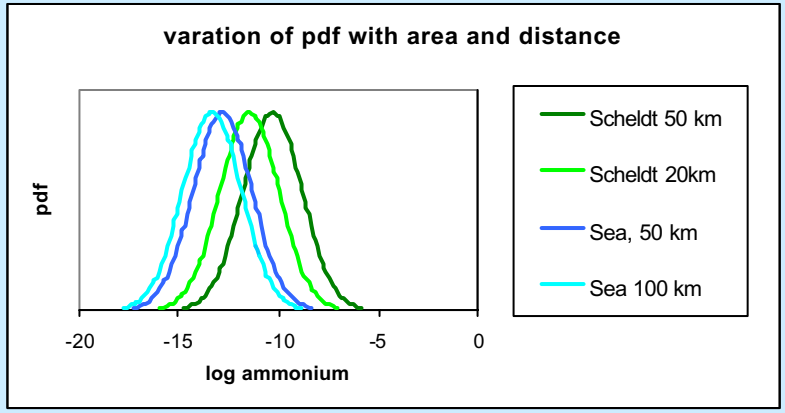

Parameters are function of

- time period
- geographical area
- location within geographical area

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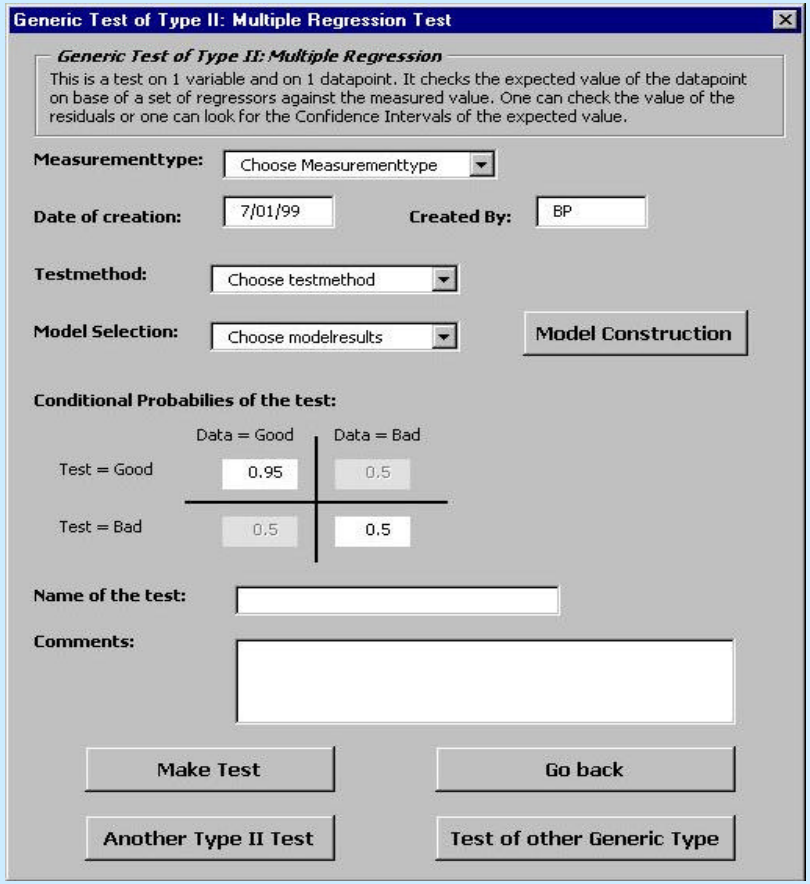

Regression QC

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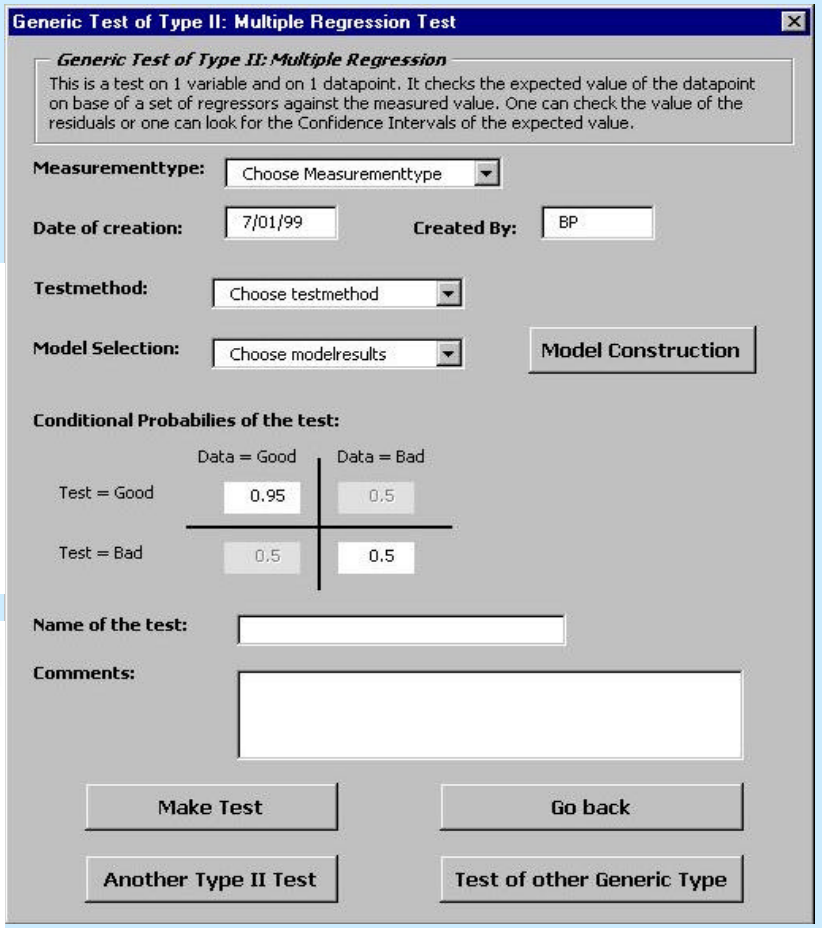
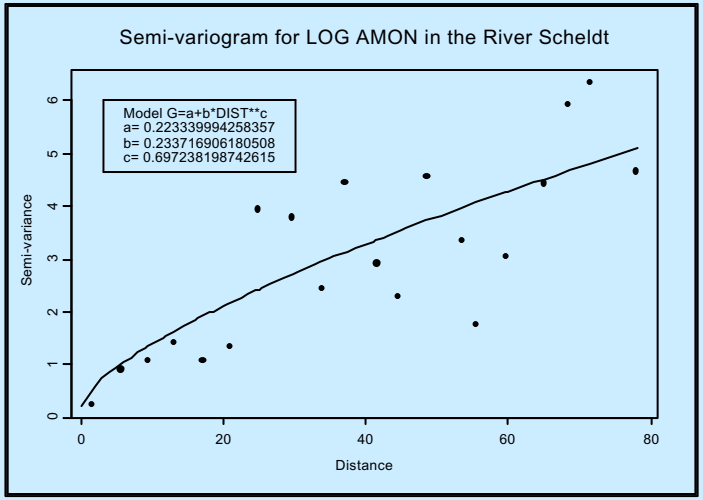
- Check against “best” applicable regression model

Data set	IDOD
Response (y)	logamon
Set of regressors (x) These values should all be separated with a comma	NTRZD35,PHOSD37,PSALAT31,SLCAD38,SUSPP41,TEMPT43

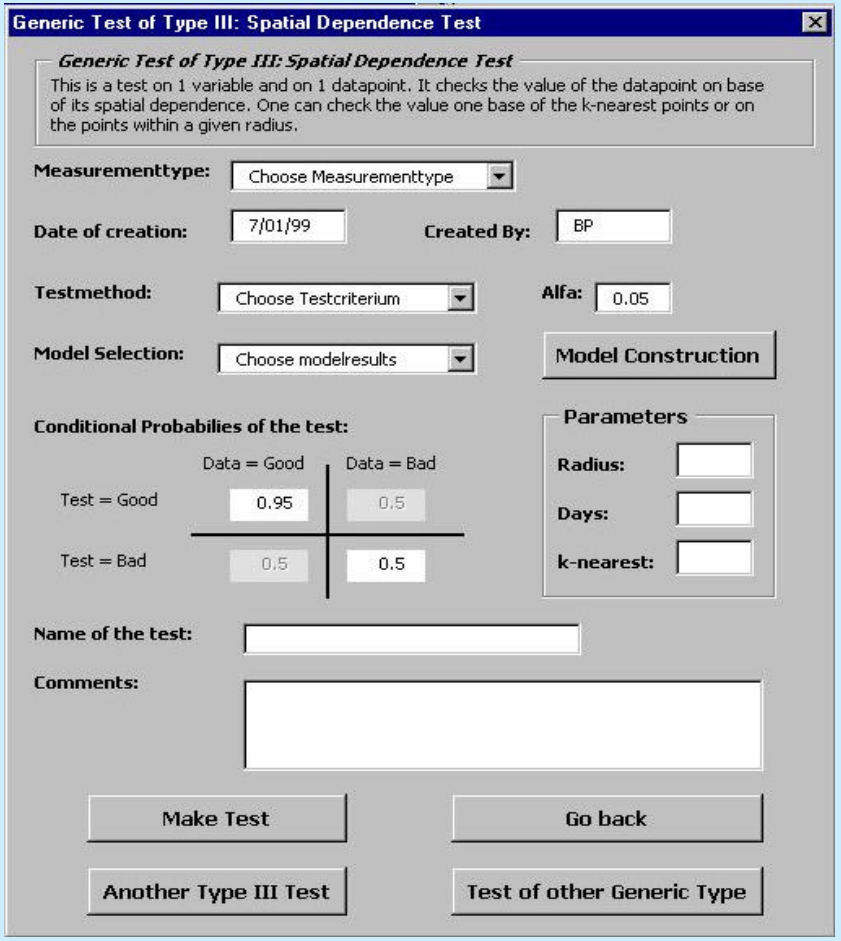
	Radj	Regr 1	Regr 2	Regr 3
1	0.9085914	NTRZD35	PSALAT31	TEMPT43
2	0.8931848	PSALAT31	SUSPP41	TEMPT43
3	0.8916732	PSALAT31	SLCAD38	TEMPT43
4	0.890879	PSALAT31	TEMPT43	-
5	0.8484538	NTRZD35	PSALAT31	SUSPP41



Spatial Interpolation QC



- Check of difference with neighbor(s)



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Combination of test results (Bayesian Approach)

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- Using the test result, the a-priori probability (given by the data manager) that the datapoint is good or not is updated to an a-posteriori probability using the following characteristics:
  - What is the probability that a good datapoint would not pass the test?
  - What is the probability that a bad datapoint would pass the test?

- When the entire test scheme has been finished, the resulting "string" (e.g. "GBNNG") is used to produce a final a-posteriori probability of the datapoint being good, which is stored with the value

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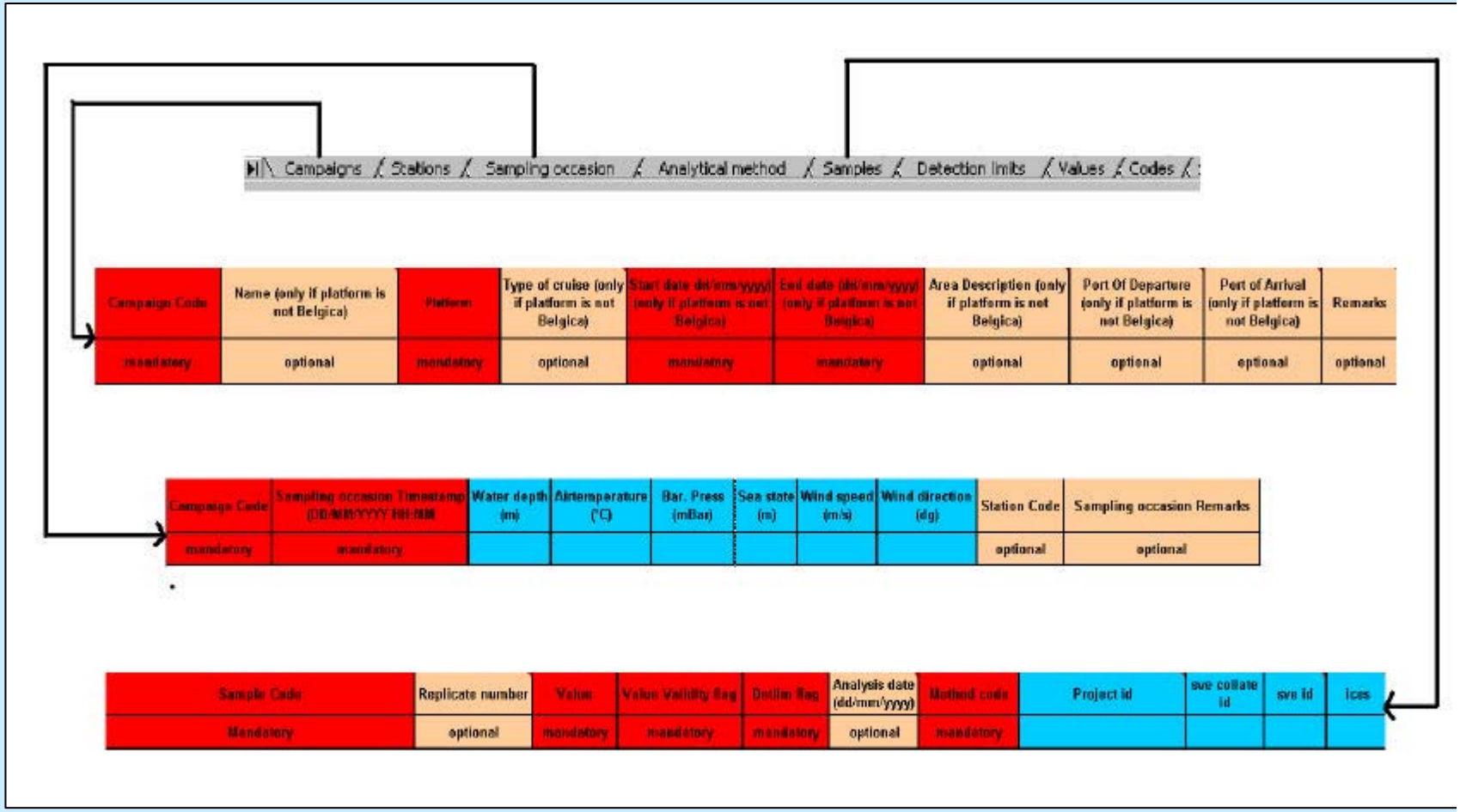
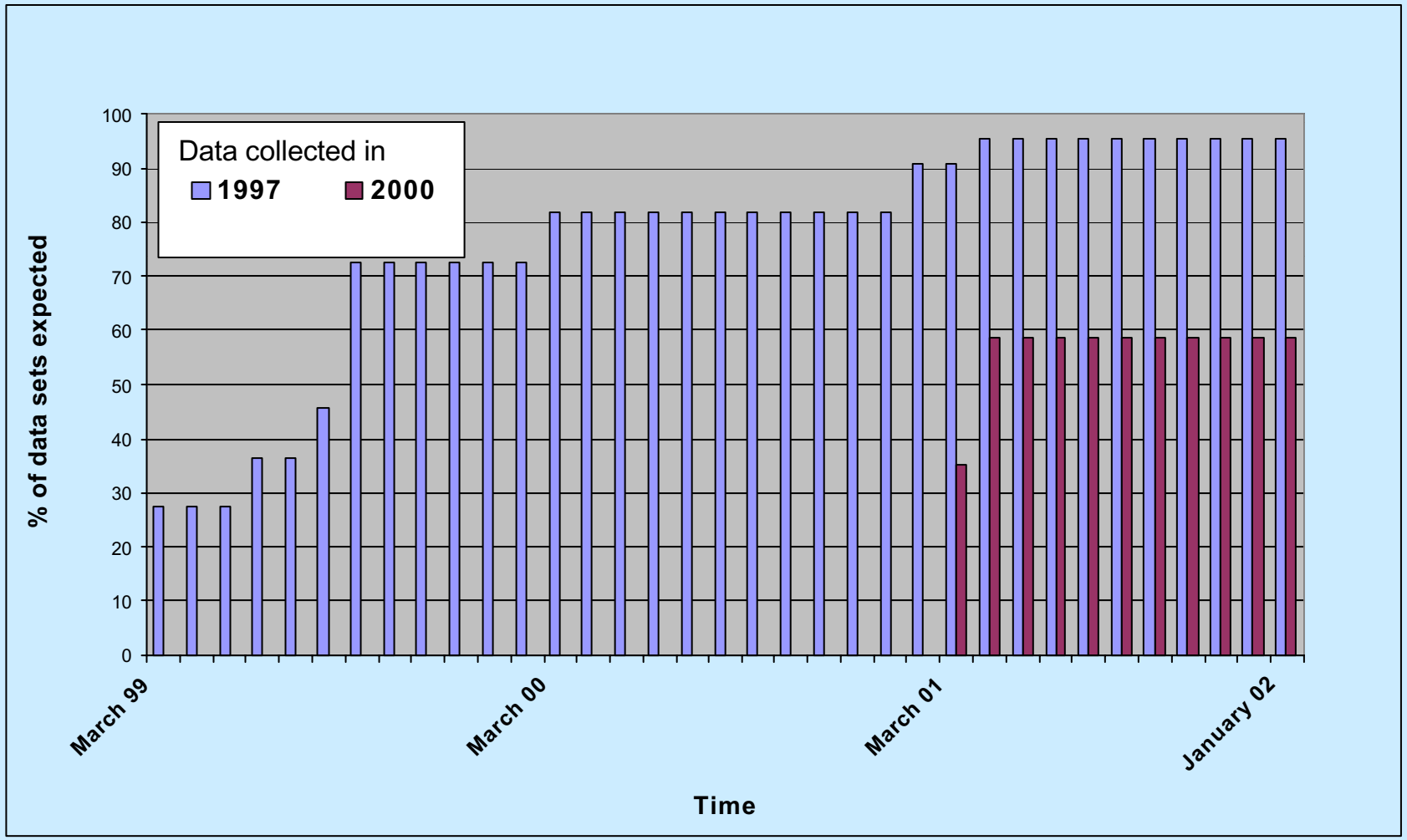
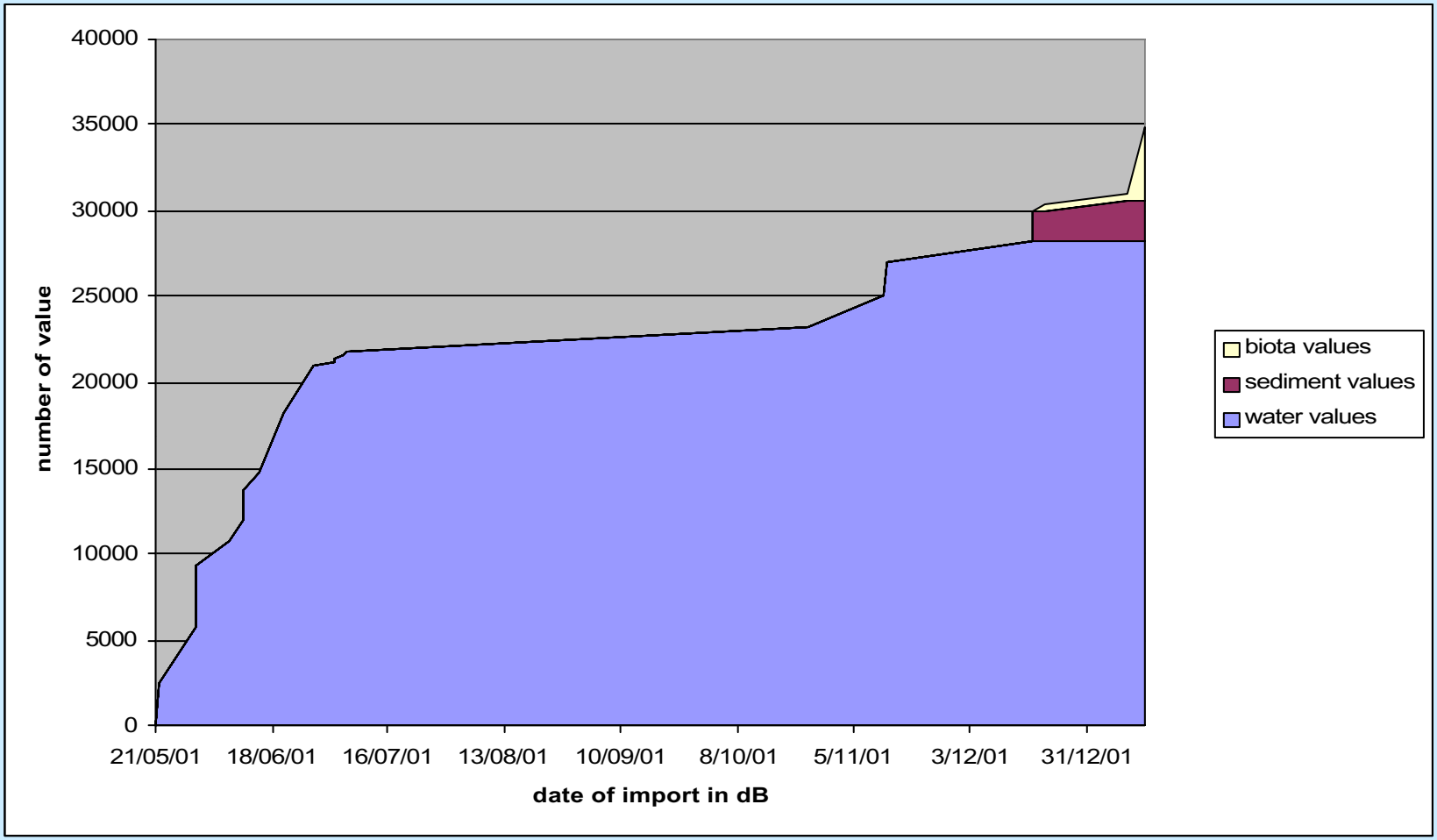
Set-up of data transfer procedures



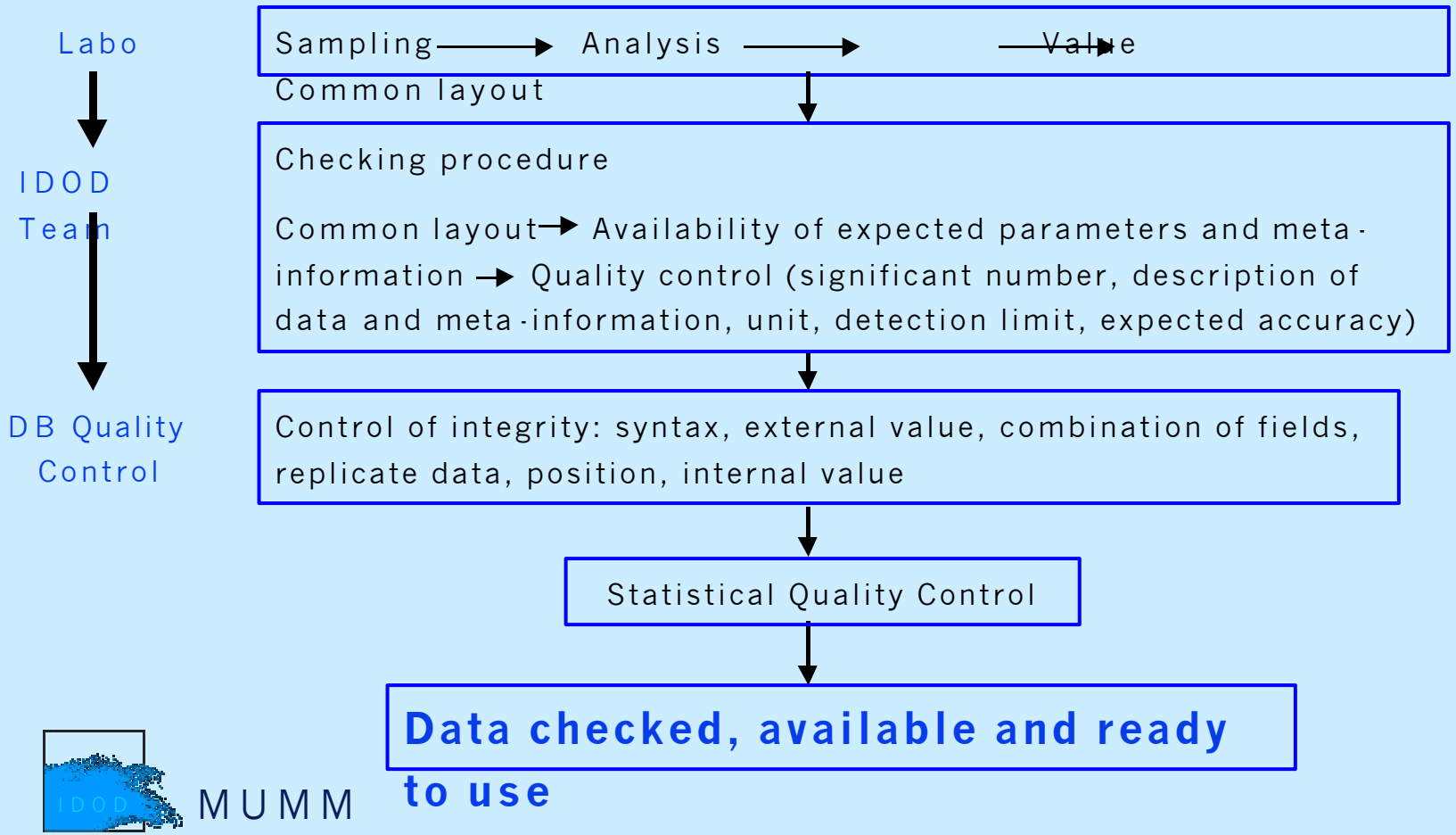
Set-up of data transfer procedures
Data sets received at MUMM



Set-up of data transfer procedures
Import of data in the DB



Data Life


Labo
Sampling
Analysis
Value
Common layout
IDOD Team
Checking procedure
Common layout
Availability of expected parameters and meta-information
Quality control (significant number, description of data and meta-information, unit, detection limit, expected accuracy)
DB Quality Control
Control of integrity: syntax, external value, combination of fields, replicate data, position, internal value
Statistical Quality Control
Data checked, available and ready to use
IDOD
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IDOD - Integrated and Dynamical
Oceanographic Data Management

Users tools...

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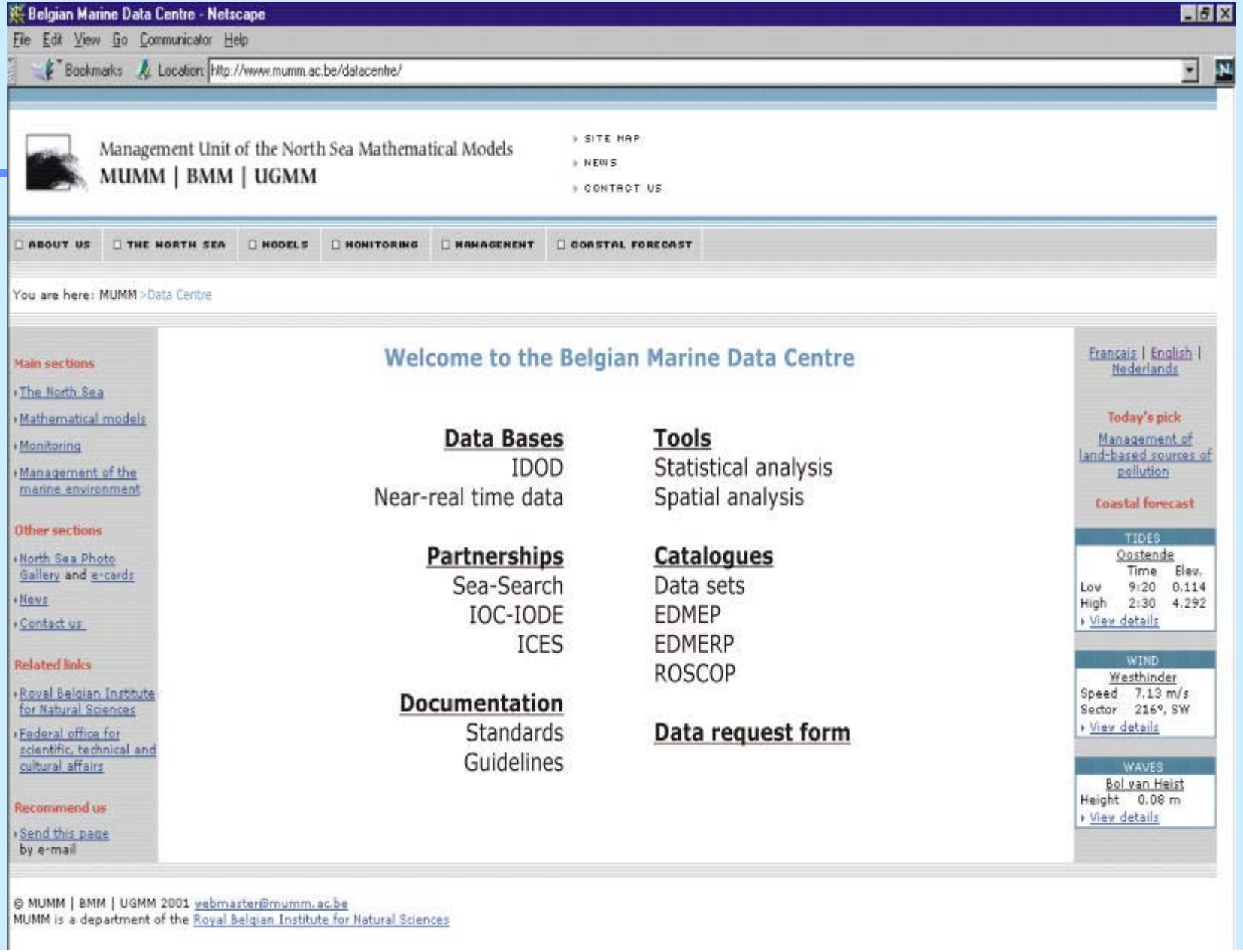
Access rules to the data gathered during the Programme

User	Purpose	Access
The promoter, the author and designated co-workers	Any	Free
Members of other labs financed by the Programme	Own scientific use	Free, provided an explicit agreement from the author of the data
	Other usage	Free, 24 months after the contractual date for transferring the data to the data centre
Members of the federal administration	For activities pertaining to the sustainable development policy	Free
	Other usage	Free, 24 months after the contractual date for transferring the data to the data centre
Other users	Scientific or educational use	Free, 24 months after the contractual date for transferring the data to the data centre
	Other usage	Access granted 24 months after the contractual date for transferring the data to the data centre, on the basis of an ad hoc convention binding the user, the author of the data and the data centre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Catalogues
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EDMERP
ROSCOP
Data request form
Français | English | Nederlands
Today's pick
Management of land-based sources of pollution
Coastal forecast
TIDES
Oostende
Time Elev.
Low 9:20 0.114
High 2:30 4.292
View details
WIND
Westhinder
Speed 7.13 m/s
Sector 216°, SW
View details
WAVES
Bol van Heist
Height 0.08 m
View details
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MUMM is a department of the Royal Belgian Institute for Natural Sciences

IDOD Database functionalities

- Conditional website access with user friendly interface
- Possible requests based on
  - area type
  - geographical coordinates
  - stations
  - time period
  - parameter /category
  - campaign / project
- Different export formats
- Statistical and Spatial Analysis tools to analyse your results

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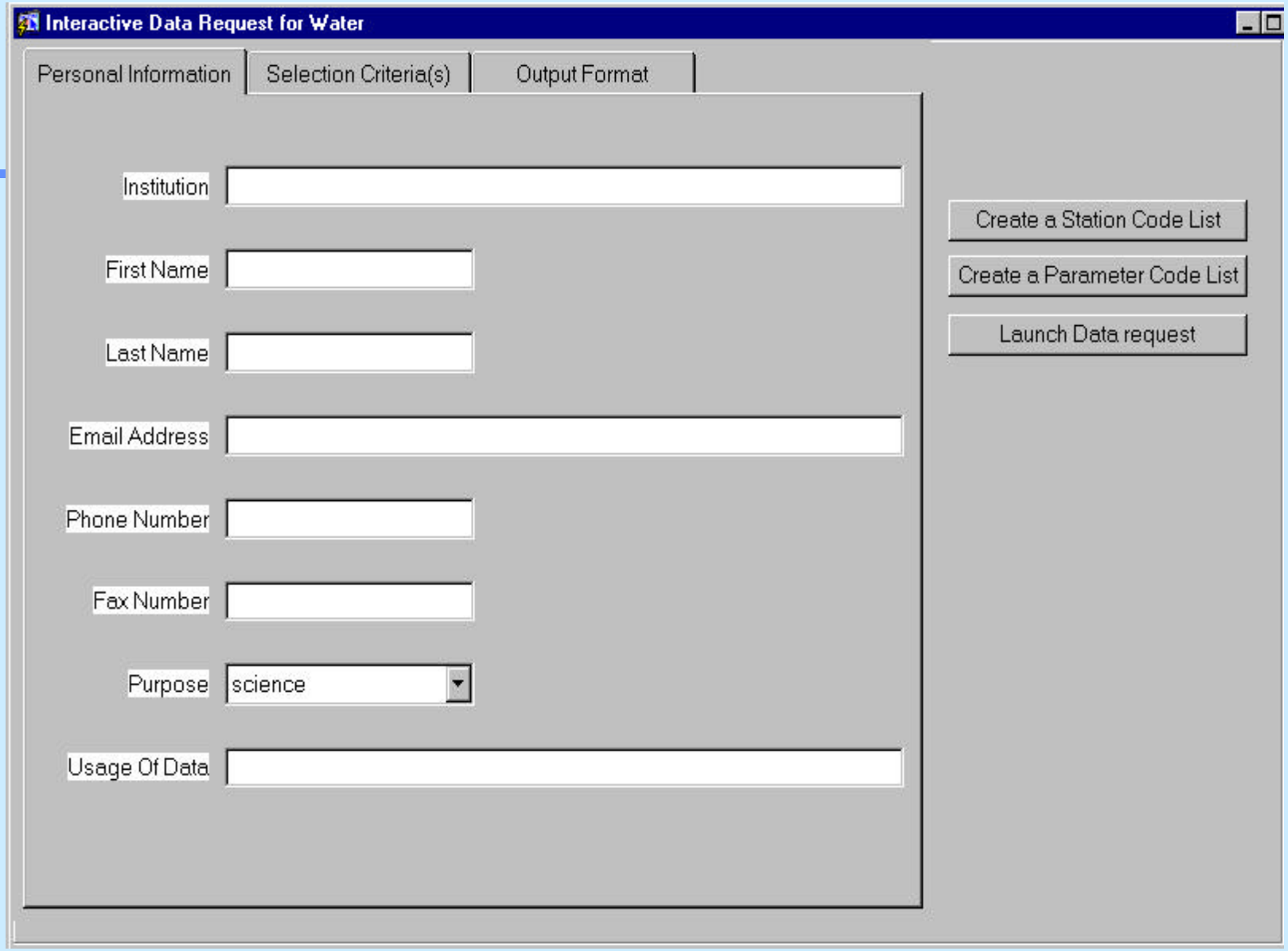
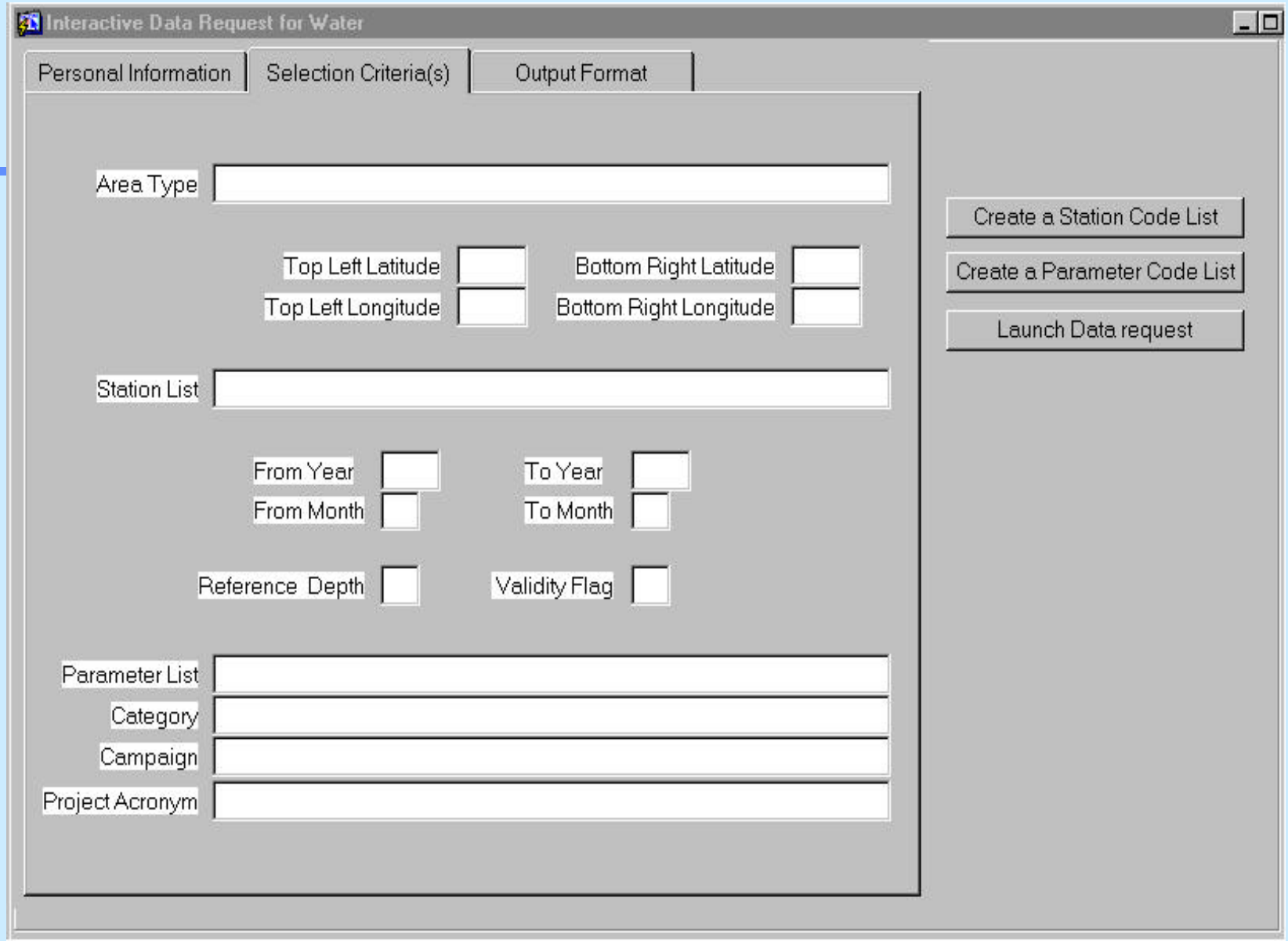
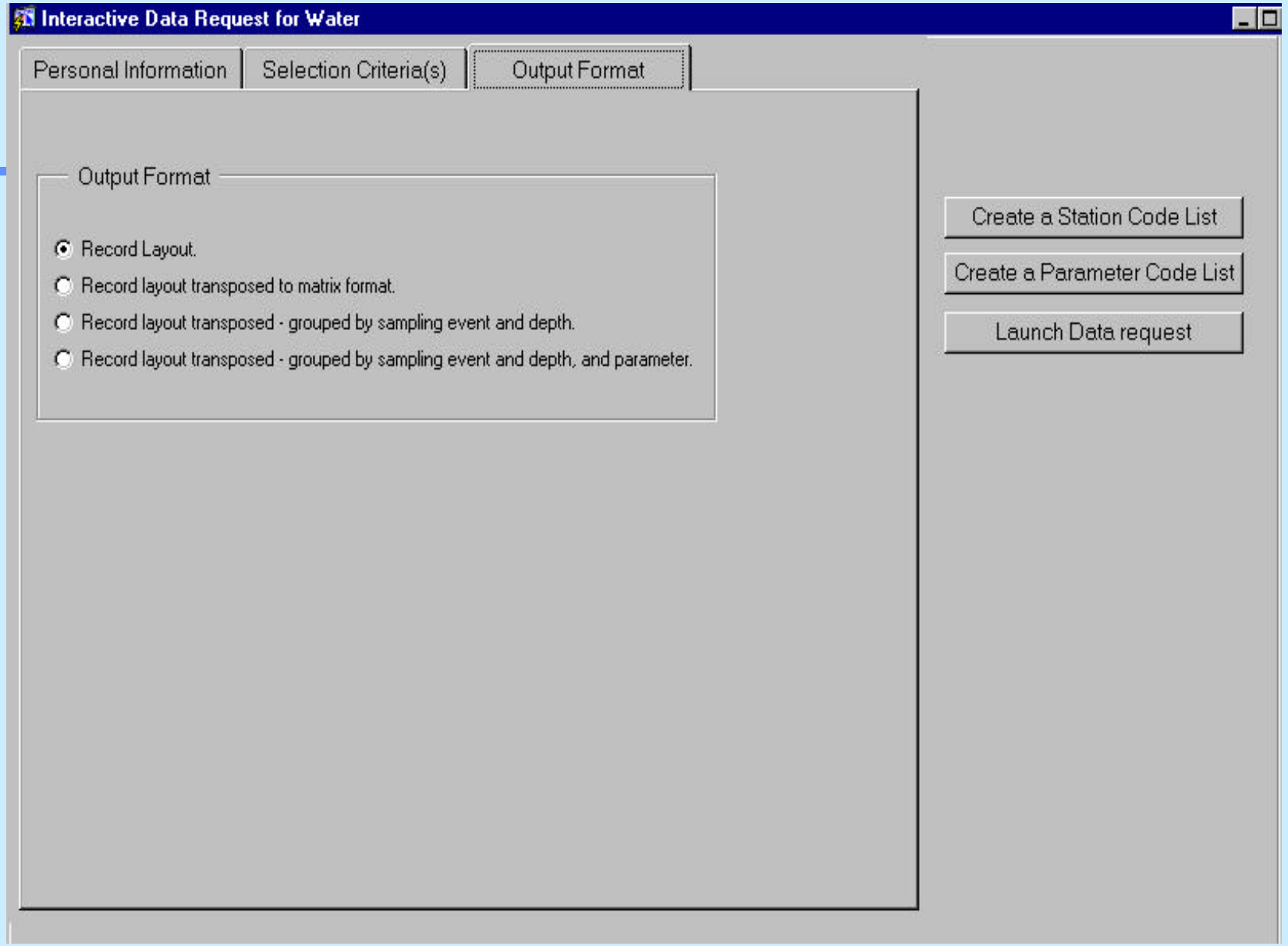
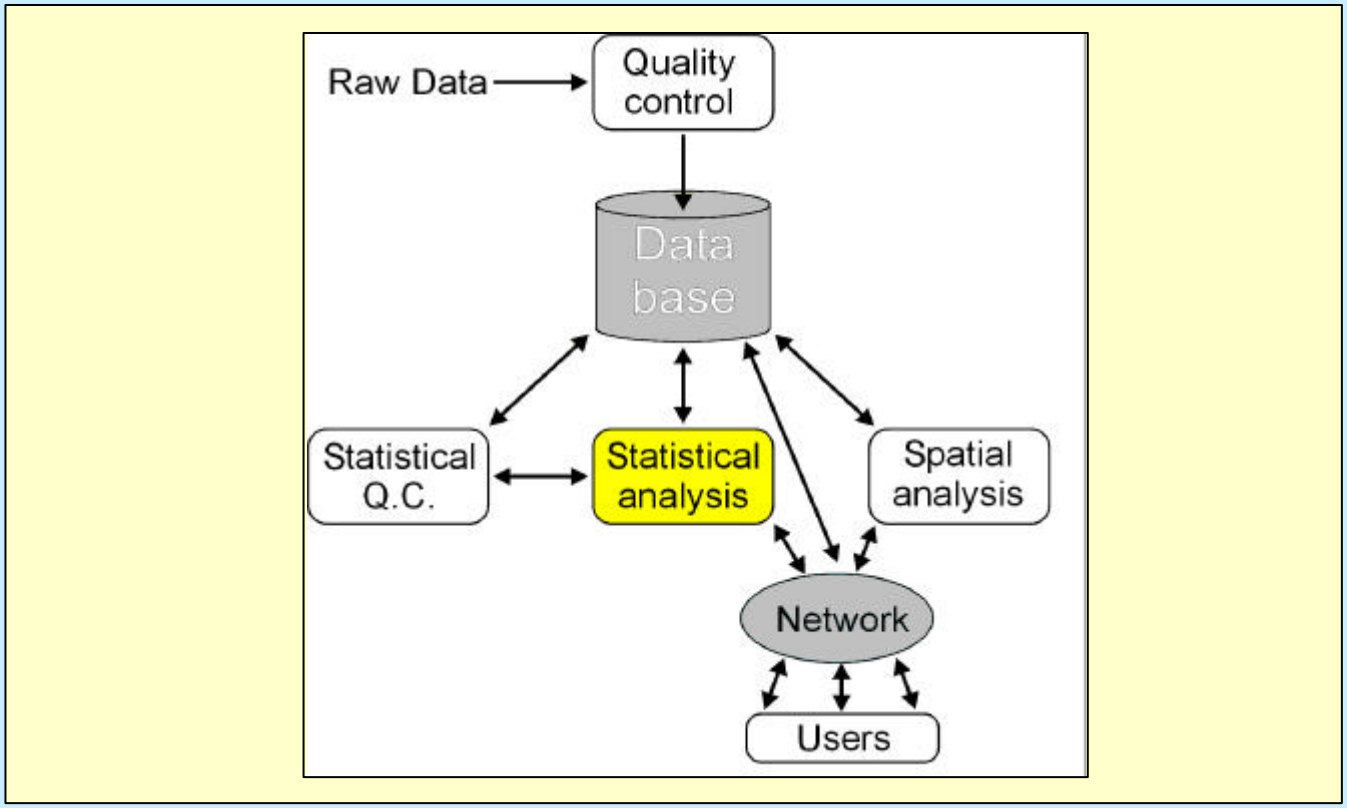

Interactive Data Request for Water
Personal Information
Selection Criteria(s)
Output Format
Institution
First Name
Last Name
Email Address
Phone Number
Fax Number
Purpose
science
Usage Of Data
Create a Station Code List
Create a Parameter Code List
Launch Data request


Interactive Data Request for Water
Personal Information
Selection Criteria(s)
Output Format
Area Type
Top Left Latitude
Bottom Right Latitude
Top Left Longitude
Bottom Right Longitude
Station List
From Year
To Year
From Month
To Month
Reference Depth
Validity Flag
Parameter List
Category
Campaign
Project Acronym
Create a Station Code List
Create a Parameter Code List
Launch Data request


Interactive Data Request for Water
Personal Information
Selection Criteria(s)
Output Format
Output Format
Record Layout.
Record layout transposed to matrix format.
Record layout transposed - grouped by sampling event and depth.
Record layout transposed - grouped by sampling event and depth, and parameter.
Create a Station Code List
Create a Parameter Code List
Launch Data request

Statistical Analysis Tool



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Statistical Menu

- Summary Statistics
  - Numerical Summary Statistics
  - Graphical Summary Statistics
- Normality Check
- Trend Analysis
- Correlation Analysis
  - Correlation Matrix
  - Scatterplot matrix
- Regression Analysis
  - Multiple Regression
  - Subset Regression
- Spatial Analysis
  - Variogram Calculation
  - Variogram Fit
- SQC Modelling
  - Distribution Test
  - Regression Test
  - Spatial Test

Import Menu

- Send Data to Sat
- Reload Data in Sat
- Available Subsets

Data Handling Menu

- Variable Transformation
- Filter the Data Set
- View the Data Set

Main Menu

Exit SAT

SAT: example phosphate

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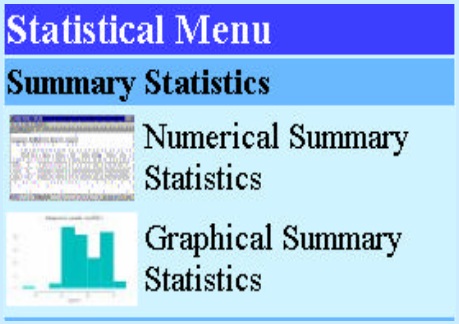
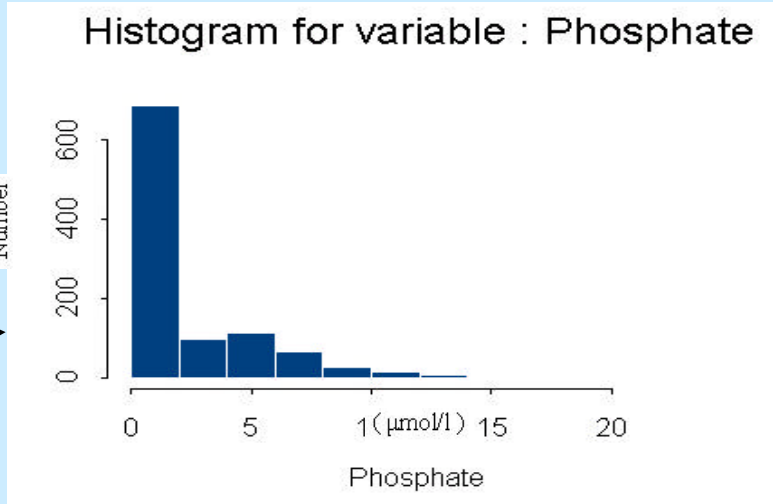
Data set
Wtr44

Campaign	Event	Station	Ecosystem	StartLat	StartLon	Phosphate
BE1991/01A	11340.23	S22	ES	51.22	4.39	6.94
BE1991/01A	11340.26	S18	ES	51.27	4.30	8.76
BE1991/01A	11340.30	S15_a	ES	51.31	4.27	9.07
BE1991/01A	11340.32	S12	ES	51.37	4.22	10.48
BE1991/01A	11343.47	230	C	51.31	2.85	1.57
BE1991/01A	11343.49	130	C	51.27	2.90	1.15
BE1991/01A	11343.64	315	O	51.32	2.46	0.64
BE1991/01A	11343.71	101_a	C	51.14	2.38	0.75
BE1991/01A	11345.14	421	O	51.48	2.45	0.44

Graphical
Summary
Statistics





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SAT: example phosphate

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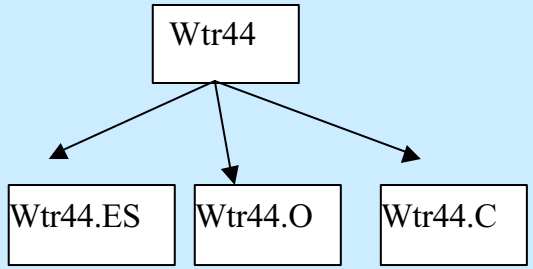
Different Ecosystems

Data Manipulation Menu

- **Variable Transformation**
- **Filter The data Set**
- **View Data Set**

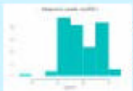


Numerical Summary Statistics

Statistical Menu

Summary Statistics


Numerical Summary Statistics


Graphical Summary Statistics

Summary Statistics for data set: Wtr44.ES

	Total N:	NA's :	Mean:	Std Dev.:	Min:	1st
Phosphate	361	34	**5.34938**	2.994510	0.21000	3.4

Summary Statistics for data set: Wtr44.C

	Total N:	NA's :	Mean:	Std Dev.:	Min:	1st
Phosphate	465	10	**0.87358**	0.8547822	0.020000	0.30

Summary Statistics for data set: Wtr44.O

	Total N:	NA's :	Mean:	Std Dev.:	Min:	1st
Phosphate	235	2	**0.59291**	1.0685896	0.01000	0.10

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SAT: example phosphate

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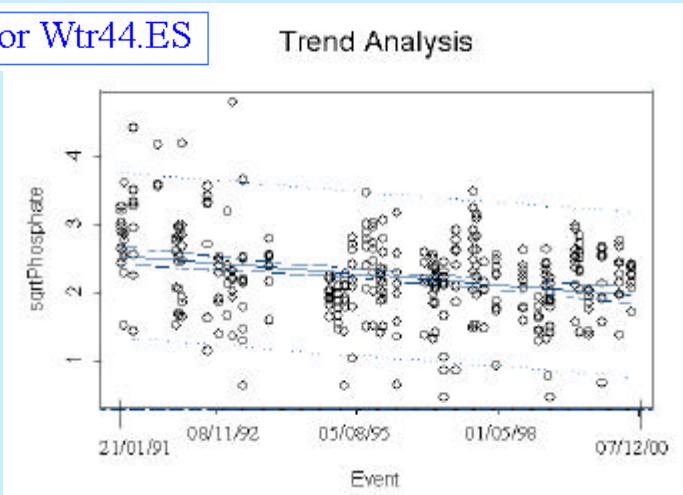
Statistical analysis of phosphate in time

Trend analysis of $\sqrt{Phosphate}$ in function of *Event* (day & time)

Trend Analysis

Trend Fitting

For Wtr44.ES



Linear Regression Results

```
Coefficients:
             Value Std. Error  t value Pr(>|t|)
(Intercept)  4.3225     0.4192  10.3108   0.0000
      regr  -0.0002     0.0000  -5.0194   0.0000
```

significant

For Wtr44.ES

Conclusion : In the Scheldt the amount of Phosphate diminishes in time (from 1991-2000). The decrease is small but significant.

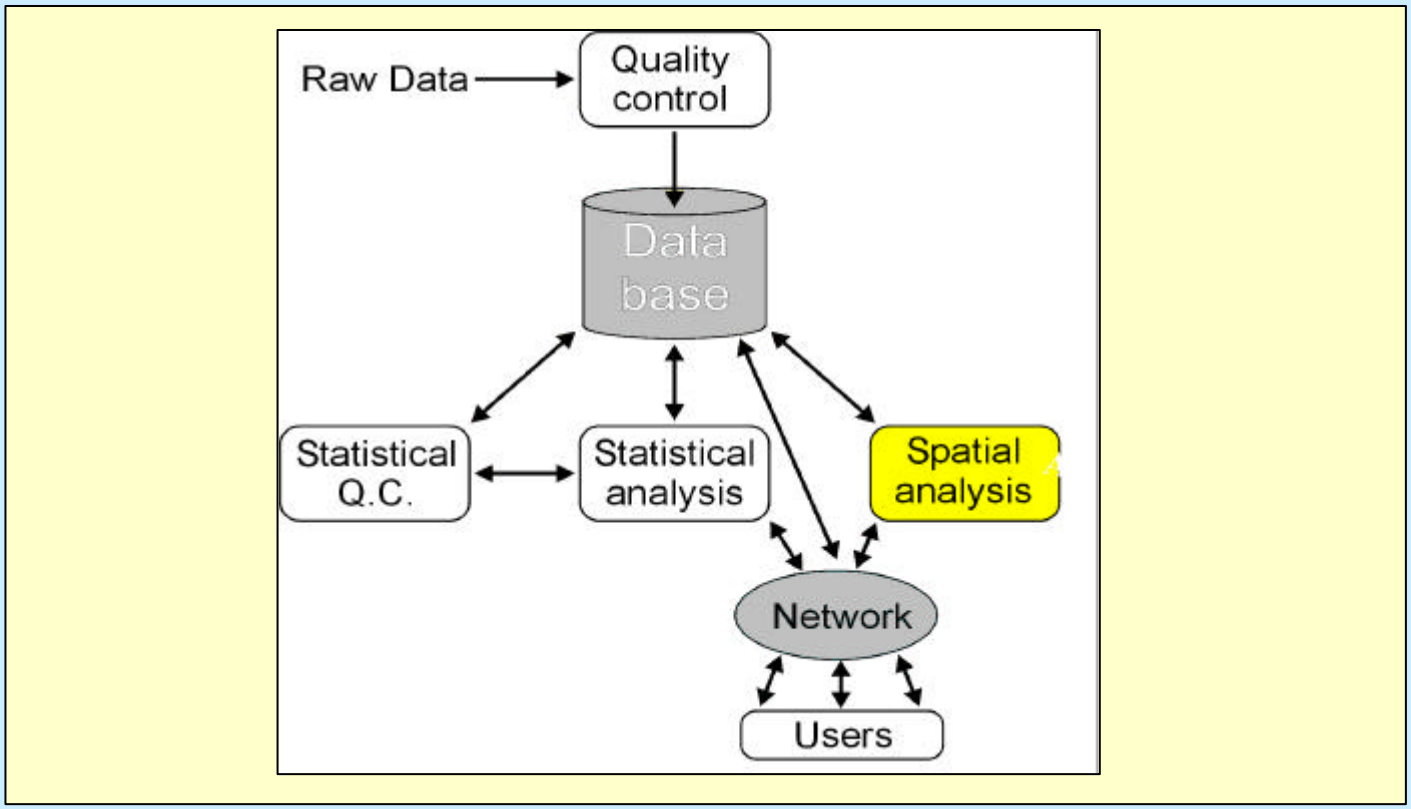
For Wtr44.O and Wtr44.C

Conclusion : Also in the Costal zone and in the Open Sea, the amount of Phosphate diminishes significantly in time. However, the decrease indentified in the Scheldt is twice higher.

For Wtr44.O

```
Coefficients:
             Value Std. Error t value Pr(>|t|)
(Intercept)  2.3156     0.3035  7.6294   0.0000
      regr  -0.0001     0.0000 -5.4885   0.0000
```

Spatial Analysis Tool



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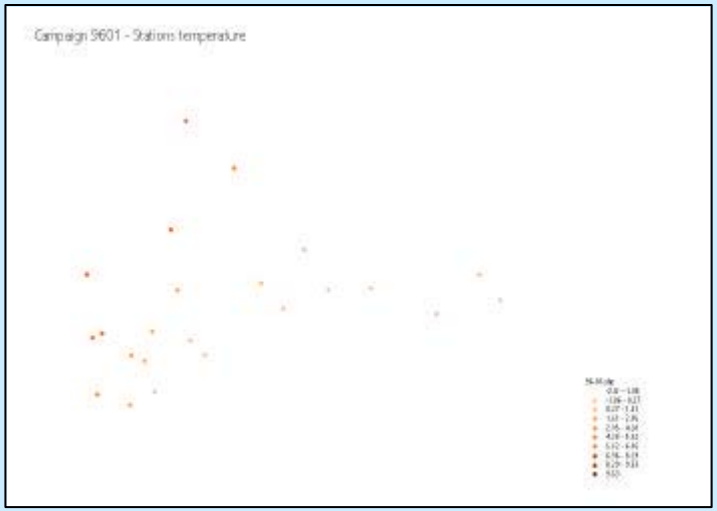
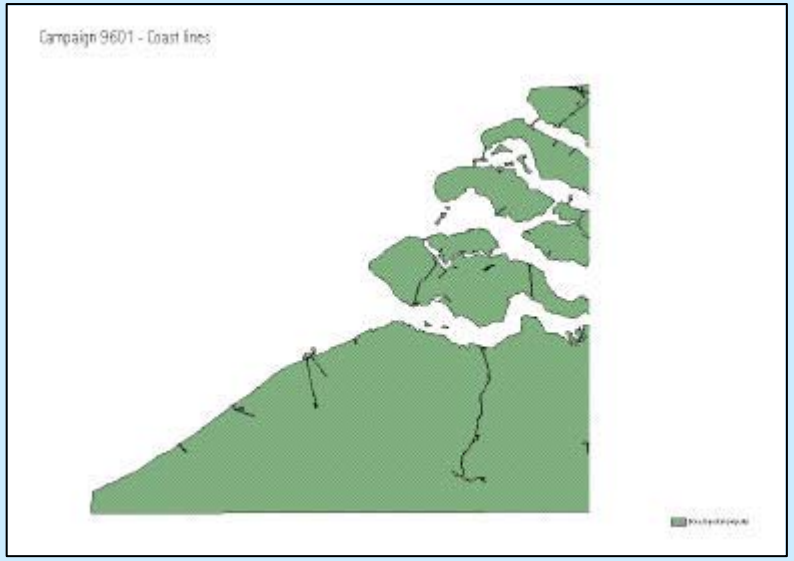
Diversity of geographical objects





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GIS Applications

Interpolation results ... .

Computed variance

Computed mask to eliminate high variance areas

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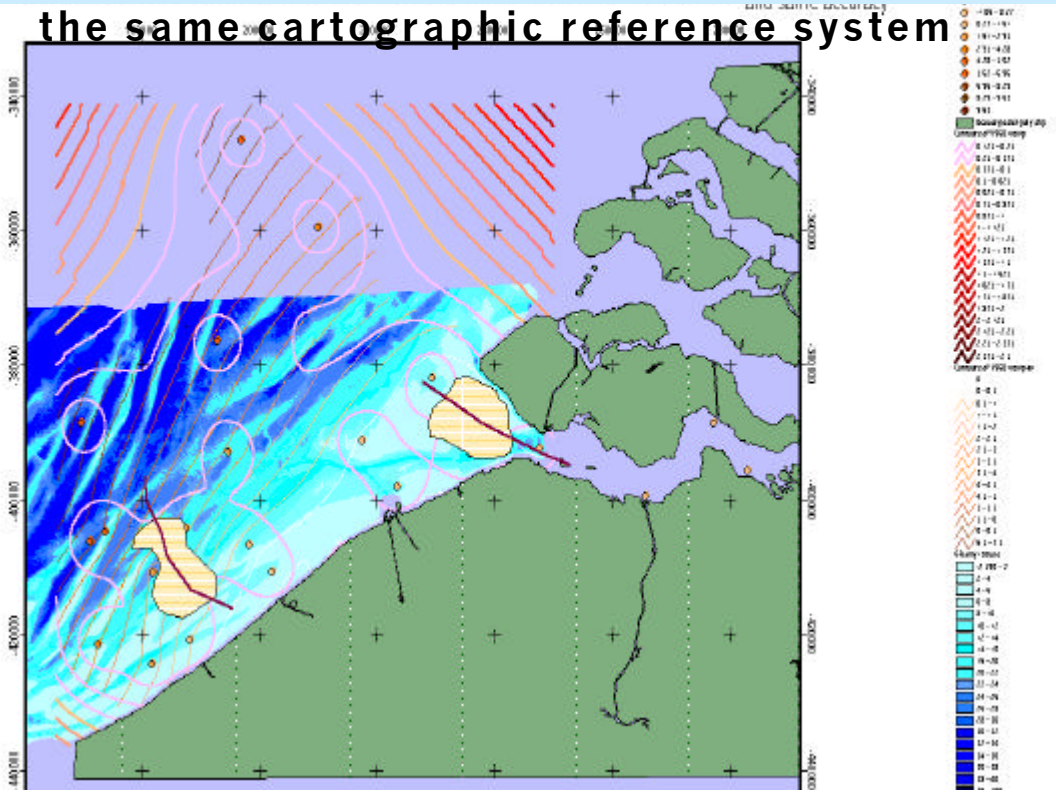
GIS Applications

Computed temperature after application of mask

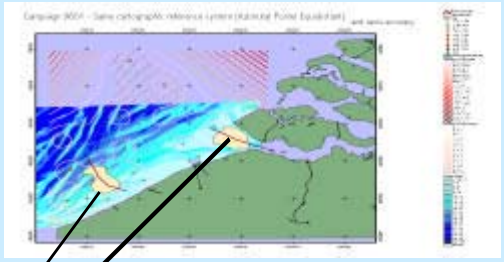
Superposition of layers (different object types), in the same cartographic reference system



Extraction, processing and aggregation of quantitative and qualitative georeferenced informations

Production of 3 kinds of results (examples)

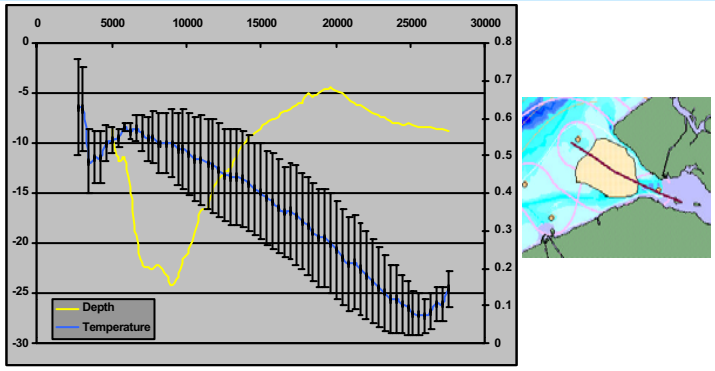
- Tabular



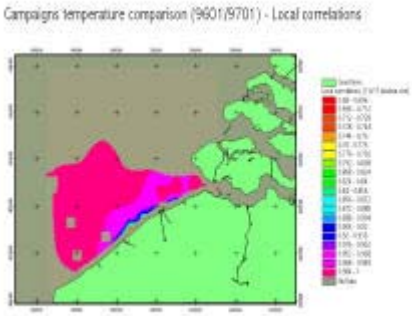
Aggregation - Zonal statistics - Temperature

Id	Count	Area	Min	Max	Range	Mean	Std	Sum
1	791	126560000	0.9942	3.9606	2.9664	2.2054	0.6792	1744.4856
2	771	123360000	0.1101	0.5658	0.4557	0.3175	0.1196	244.7657

- Graphical



- Cartographical



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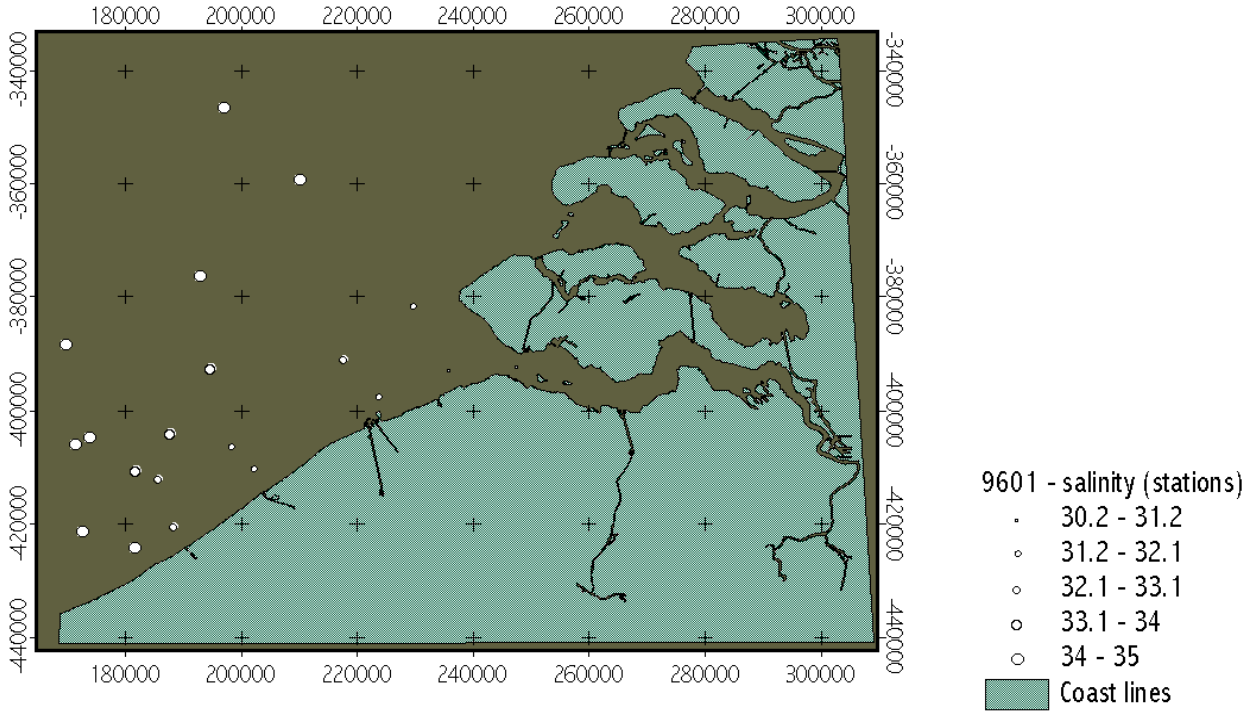
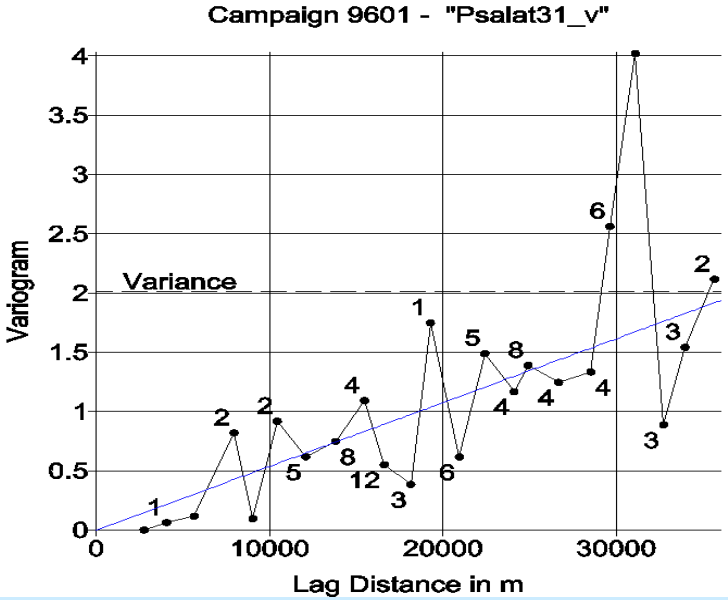
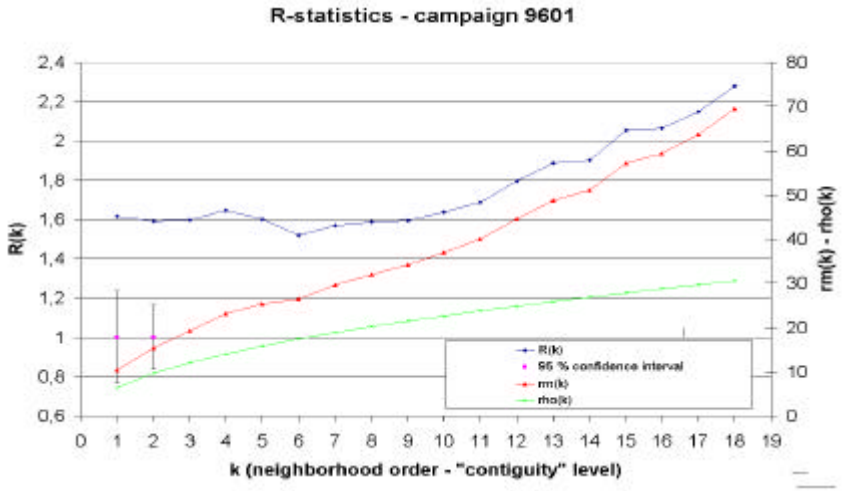
Spatial Analysis

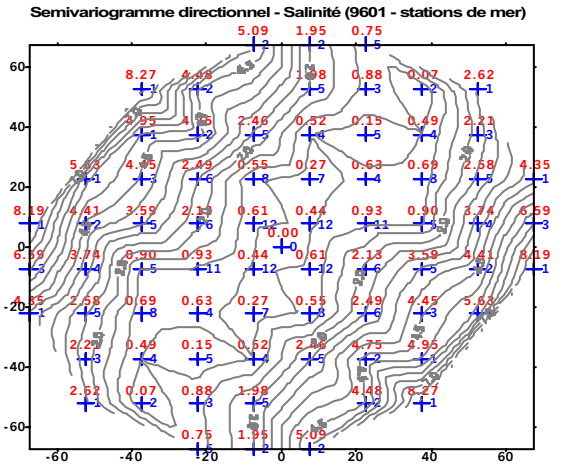
Punctual data set (IDOD)



Spatial properties of the data set







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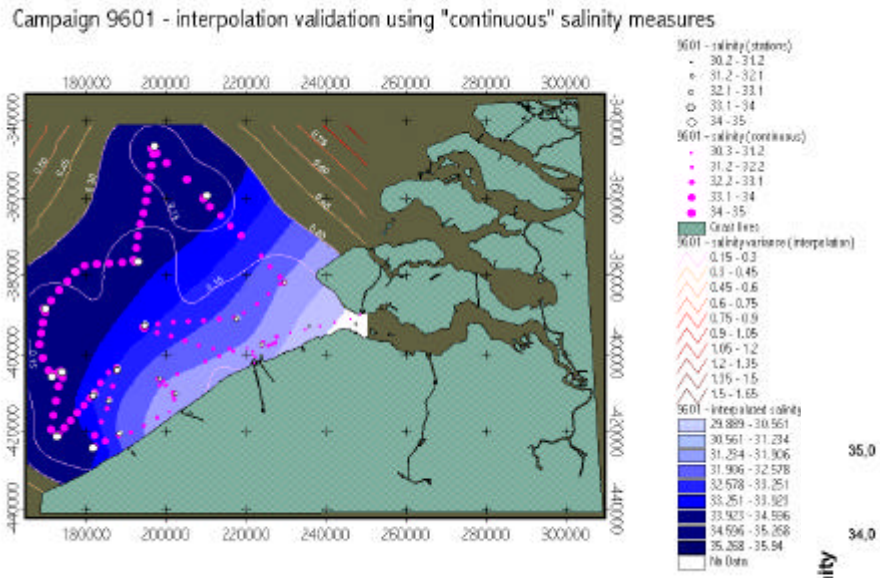
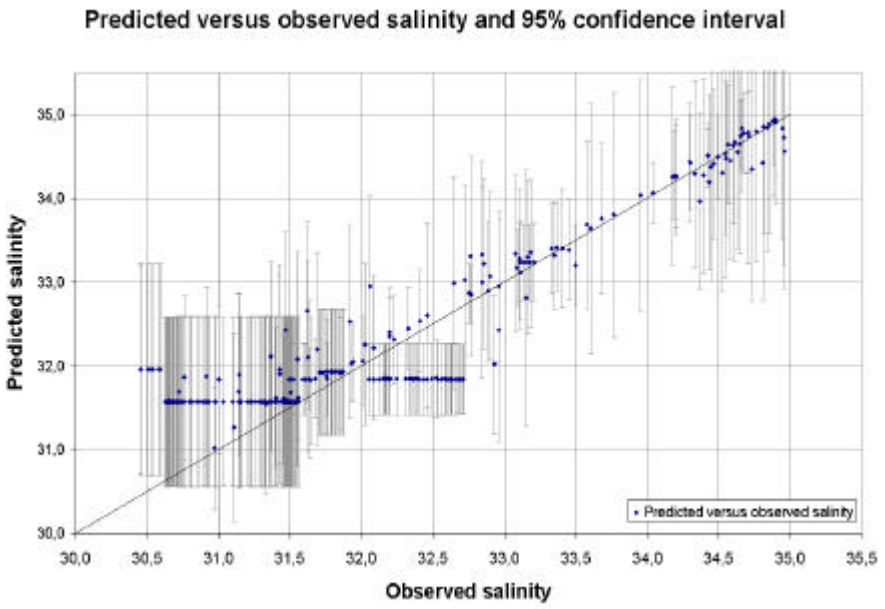
Interpolation and validation





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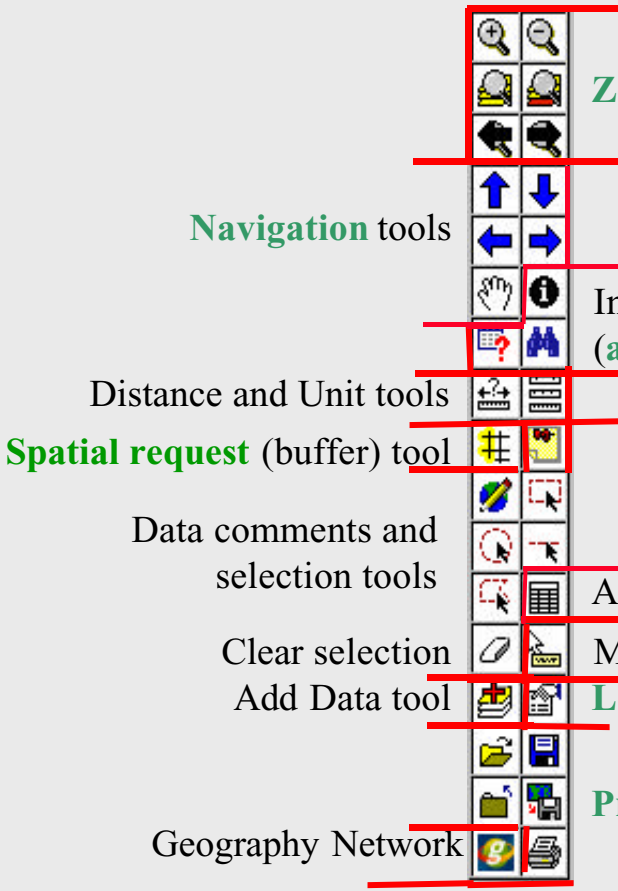
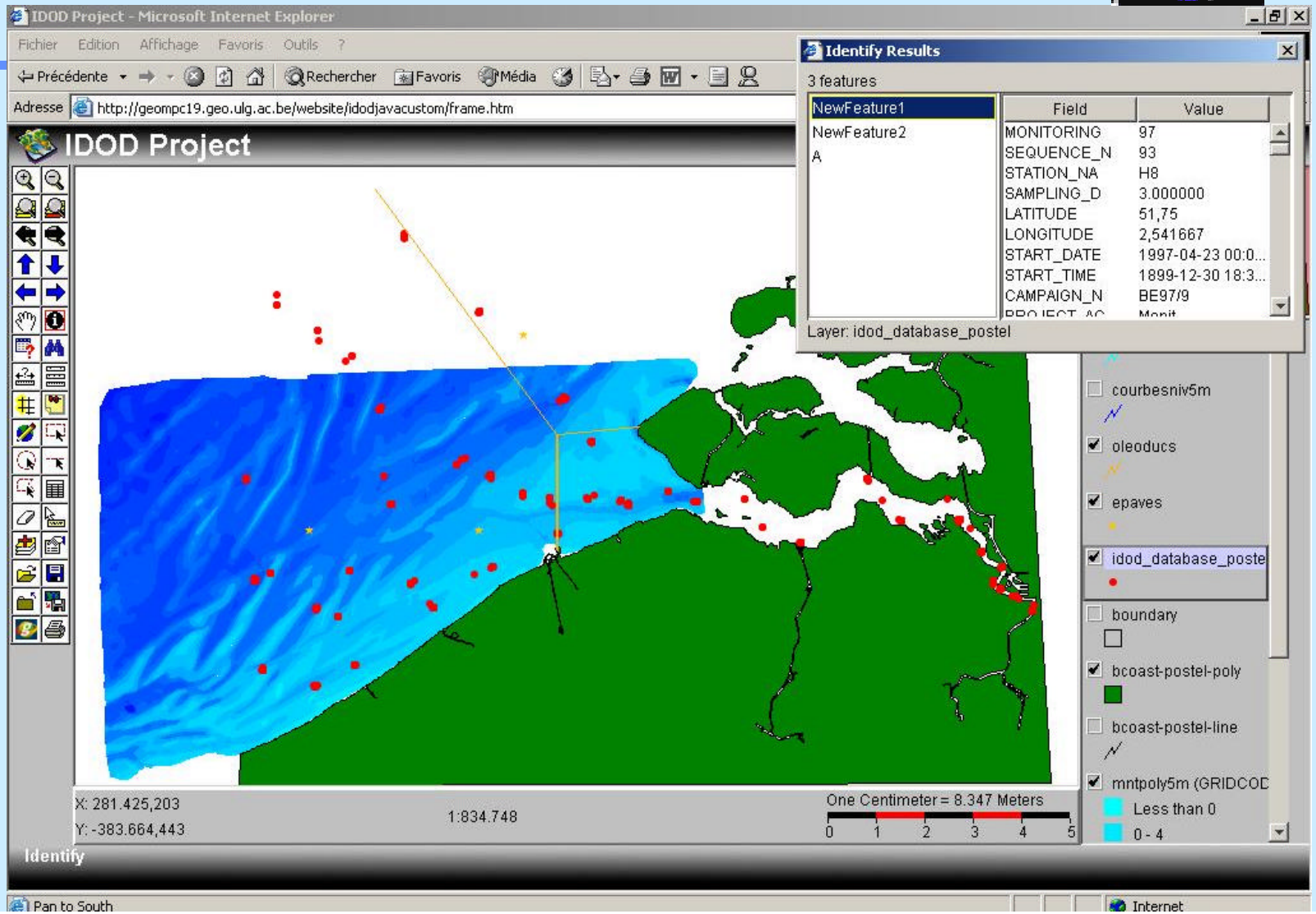
Website utilities (ArcIMS)



ArcIMS is **sufficient for « light » SIG applications** like cartographying vector and raster layers, performing easy requests, etc.

It **does not fit for complex spatial processes** like combined and complex requests, interpolation, geoprocessing, etc.

Website interface (ArcIMS)



Products and Applications...

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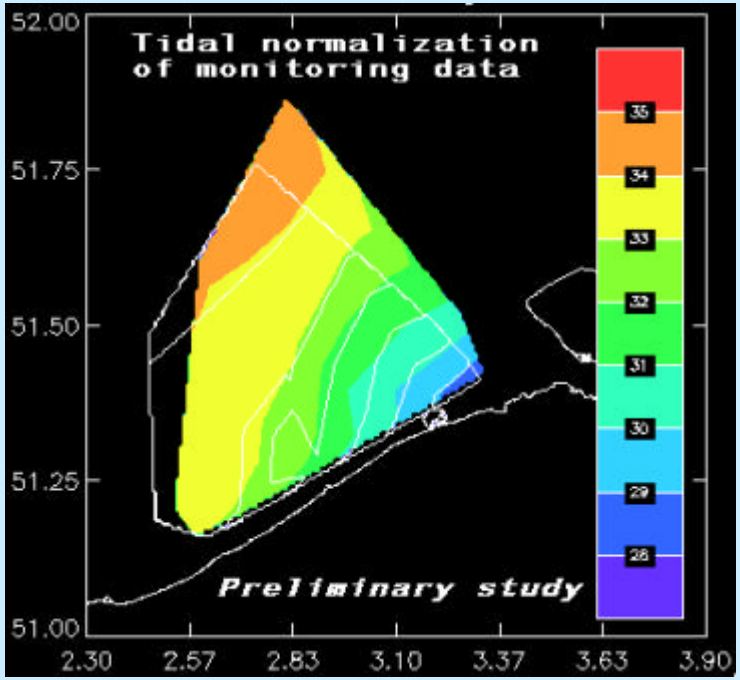
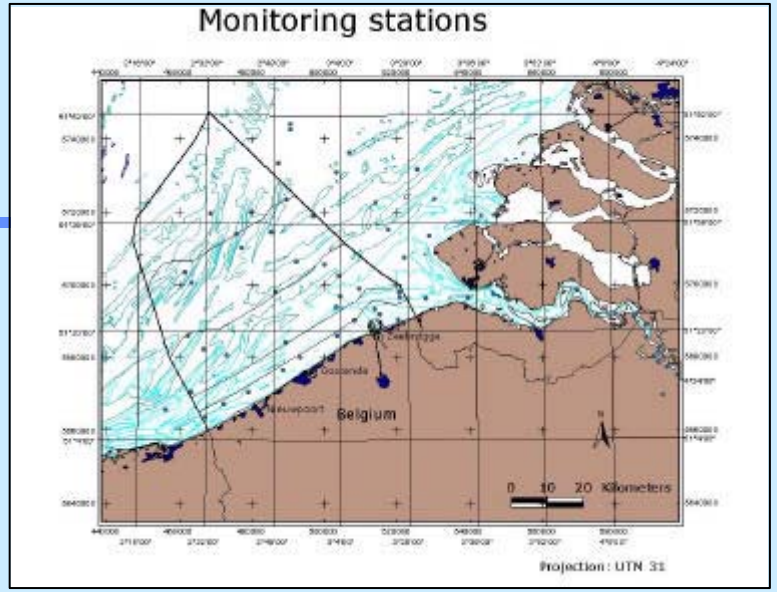
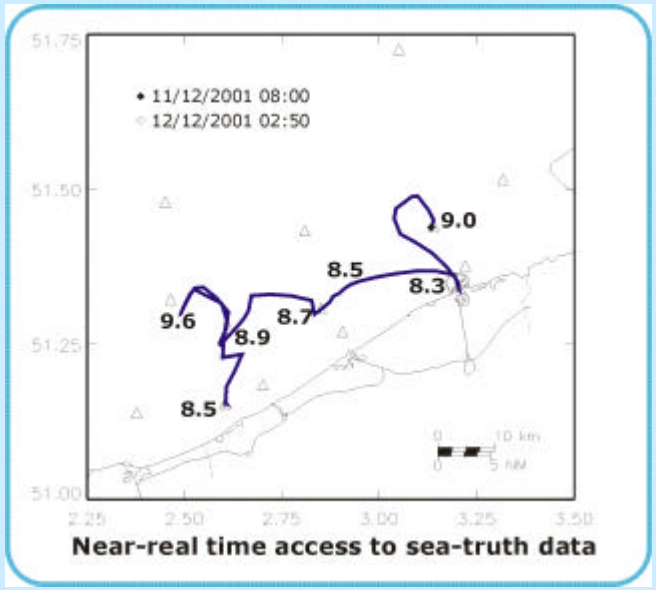
Products







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Application

OSPAR Eutrophication assessment criteria

DIN > 15µmol/l AND/OR DIP > 0.8µmol/l (during winter)	CHL A > 15µg/l (during growing season)		O2 < 6mg/l (during growing season)	STATUS
+	+	AND/OR	+	**PROBLEM AREA**
-	+	AND/OR	+	**PROBLEM AREA**
+	-		-	**POTENTIAL PROBLEM AREA**
-	-		-	**NON PROBLEM AREA**

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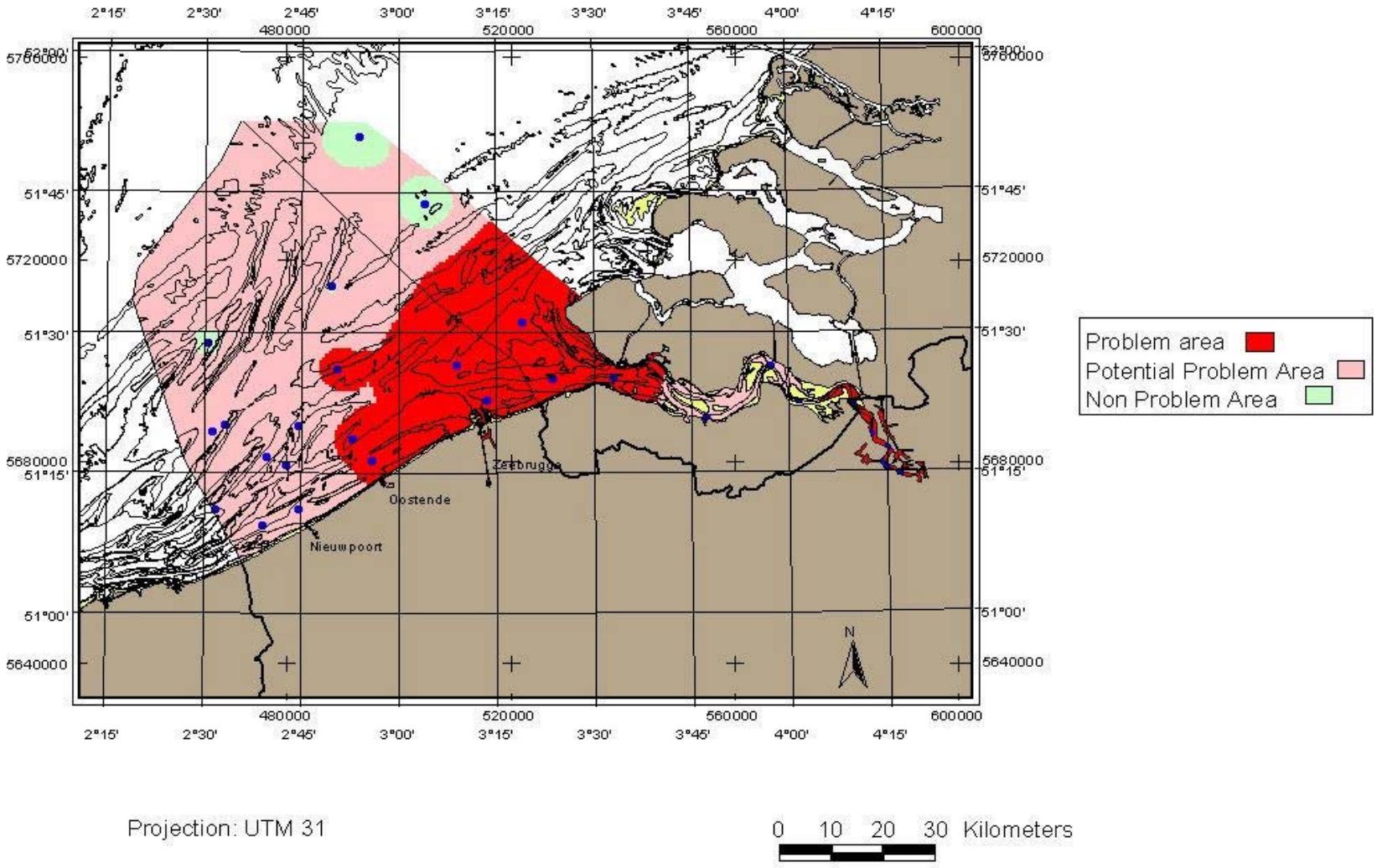
Eutrophisation assessment 1998



IDOD - Integrated and Dynamical
Oceanographic Data Management

Conclusion

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Experience gained from the IDOD project

Added value for...

- ... the partners (scientifc progress, methodology, tools)
- ... the data producers (documentation, procedures, ...)
- ... the authorities (extended data set, extended data management and analysis tools, team of marine data specialists)

→ Added value for the scientific support of a sustainable management policy of the North Sea

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IDOD - Integrated and Dynamical Oceanographic Data Management

BUT

IDOD will really be a success when ...

you will use it!

www.mumm.ac.be/datacentre

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