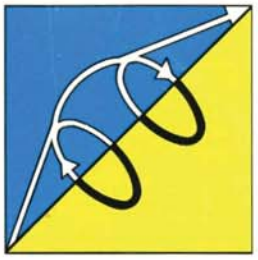
SUSTAINABLE COASTAL ZONE DEVELOPMENT IN HARMONY WITH THE NATURAL ENVIRONMENT

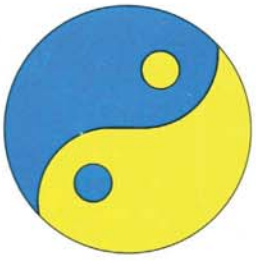
Integrated Coastal Policy via Building with Nature

Flexible integration of land in sea and of water in land, making use of materials and forces present in nature

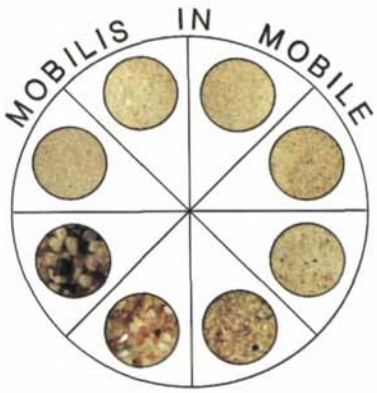
Ronald E. Waterman



TOWARDS AN INTEGRATED COASTAL POLICY VIA BUILDING WITH NATURE, USING FORCES AND MATERIALS PRESENT IN NATURE



ACHIEVING A DYNAMIC EQUILIBRIUM COAST. FLEXIBLE INTEGRATION OF LAND IN WATER AND OF WATER IN LAND



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Delft - Wateringen

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Flexible integration of land in sea and of water in land,
making use of materials and forces present in nature

Ronald E. Waterman


INTEGRATED COASTAL POLICY
FUNCTIONS
DISCIPLINES
01 Safety from:
- flooding (incl. effect of sea level rise)
- coastal erosion
- salt water intrusion.
land subsidence
- natural disasters
- human activities
02 Water Resources Management
03 Climate
04 Agriculture
Horticulture
Forestry
Aquaculture
05 Mining
06 Nature
Landscape
Environment
07 Recreation/Tourism
08 Construction Sites
for living & working:
houses / facilities
offices / industries
09 Infrastructure
ports, rivers, channels,
roads, railroads,
airports, pipelines,
cables
10 Public Utilities
Energy- & Water
Supply, Sewer Systems,
Waste Water
Purification
11 Environment
Environmental friendly
Collection, Storage &
Processing of Wastes
12 Economy
Employment
a Earth Sciences
- Geology
- Geophysics
- Geochemistry
- Climatolgy
- Oceanography
b Mining Engineering
c Civil Engineering
d Agriculture
- Horticulture
- Forestry
e Fishery, Aqua Culture
f Nature Development
g Landscape Architecture
h Biology, Ecology
i Biotechnology
j Chemistry & Chemical Technology
k Environmental Technology
l Urban & Rural Planning
m Architecture
n Physics
o Electrical Eng.
p Mechanical Eng.
q Information Theory
r Data Transmission
Data Processing
s Transport Technology
Traffic Planning
t Recreation Planning
u Geodetics
v Archeology
w Law
x Economy, Business Administration
y Management Science
z Sociology
BUILDING WITH NATURE
Flexible integration of land in water
and of water in land,
using forces and materials
present in nature
Only a limited number of functions & disciplines are presented
© R.E. Waterman

1.

SUSTAINABLE COASTAL ZONE DEVELOPMENT IN HARMONY WITH THE NATURAL ENVIRONMENT

Integrated Coastal Policy via Building with Nature

Flexible integration of land in sea and of water in land, making use of materials and forces present in nature

Ronald E. Waterman

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Senior Adviser to the Ministry of Transport, Public Works and Water Management of The Netherlands
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ABSTRACT

Many civilisations found their origin in the border zone land-water in coastal and deltaic regions. In the year 2000 approximately eighty percent of the largest population centres in the world can be found in those areas. Striking examples can be found in nearly all parts of the world.
There we have to deal with many existing and forthcoming problems that need solutions, but also with challenging opportunities.

In all these cases - without exception - there is only little space available for living, working, infrastructure, tourism & recreation, while there is the need to preserve or expand valuable environment, nature and landscape. Apart from in due time stabilization of the world population, there are in principle three spatial solutions: a) making better use of the 3rd dimension, including multi-functional use within the present available space; b) using space in the existing hinterland; c) land reclamation through flexible integration of land in sea and of water in the new land.

Integrated Multi-Functional Sustainable Coastal Zone Development, based on careful analysis of these regions and their climate, their soil and subsoil characteristics, their river systems, the bordering sea and oceans, flora and fauna, and present use, gives an answer to the question how we can solve existing and future problems in relation to each other and in relation to the hinterland on one hand and in relation to the bordering sea on the other. Thereby, not only solving problems, but also creating added value.

An important element of integrated coastal policy - apart from but also including coastal protection and water resources management - is land reclamation using as much as possible the principle of building with nature.
Existing and forthcoming problems in coastal zone and hinterland can be solved and new opportunities can be found. Learning from mistakes and using the achievements of the past, the challenge of the future can be met, including sustainable development.

FICTUOUS COASTAL ZONE WITH A NUMBER OF FUNCTIONS © J. LENOIR/R.E. WATERMAN

2. INTEGRATED MULTIFUNCTIONAL SUSTAINABLE COASTAL ZONE DEVELOPMENT

Two aspects are essential:

A. An Integrated Approach to coastal zone and hinterland, including old/new land - sea.
Many functions have to be considered carefully, while using many different disciplines.

B. Possible realisation of new land, where nature allows us to do so, using as much as possible the principle of Building with Nature. The essence of this principle is: flexible integration of land in sea and of water in the new land, making use of materials and forces present in nature, taking into account existing and potential nature values.

This approach is of vital importance in many coastal and deltaic regions of the world. The final development should be such that in conjunction the over-all economy is strengthened and the environment is improved.

Many specific functions in the coastal zone are of great importance:

01. Safety from:
flooding (including effects from sea level rise);
drought;
coastal erosion;
salt water intrusion;
land subsidence;
cyclones, storm surges, tsunamis, earth quakes, landslides, active volcanoes;
harmful human activities;

Coupled with these safety aspects are the construction and maintenance of:
- dunes (consisting of sand and vegetation) & beaches;
- dikes (consisting of clay, wood, grasses, seaweed, willow matresses, asphalt, geo-textiles, etc.);
- solid seawall elements, like groynes perpendicular to the coast and breakwaters (above sea level and/or submerged) parallel to the coast, harbour moles, consisting of blocks of basalt, various types of boulders, concrete elements, steel elements, gravel, etc.;
- canals, sluices, locks, river regulation;
- drainage and irrigation systems.

02. Environment in general
this includes the environmental compartments: air, water, land.

03. Nature
monera & protista (including micro-organisms), flora, fauna (including people);
eco-systems;
nature conservation - nature development;
bio-diversity - bio-diversification.

04. Landscape
landscape conservation - landscape development.

05. Water Resources Management
water quality and water quantity;
use of groundwater, surface water (rivers, lakes, sea), dune infiltrated water;
sewer systems and waste water purification.

06. Energy
energy supply and reduction of energy use:
- natural gas, oil, coal, etc.
- biomass (wood, etc.); organic wastes
- nuclear energy
- solar-, wind-, water-, geo-energy
- combined cycle (heat/power), isolation, etc.

07. Agriculture
Agriculture in general, also including horticulture and forestry, cattle and poultry breeding. Aquaculture, Mariculture, Fishery.

08. Mining
Mining is not only of importance with regard to dredging (followed by transport and disposal) of sand/silt/clay/gravel from the seabed for the creation of soft sea-defence structures, for land reclamation, for the creation, deepening and maintenance of approach channels to ports and for the existing and new ports themselves. It is also of importance with regard to the exploration and exploitation of oil, natural gas and other mineral resources in the coastal zone (old land, new land, tidal flats, coastal seabed).

09. Construction sites for living and working
- houses and facilities
- industries & offices and facilities
- city development

10. Recreation and Tourism

11. Transfer/Distribution Centres and Related Activities
- seaport, riverport, lake port, airport, landport

12. Infrastructure
- roads, railroads, waterways, sealanes, airlanes, underground systems

13. Transport modules
- bicycle, motor-car, bus, tram, train, metro, ship, container, airplane, rocket, people mover,

14. Telecommunication
Data Acquisition
Data Transmission
Data Processing

15. Environment in particular
Air-/Water-/Soil-quality through pollution prevention, by improvement of conversion processes and by end of pipe purification

16. Environment in particular
Solid (liquid) waste reduction by improvement of conversion processes and by absolute environmental friendly collection - transport - storage - processing - recycling of these wastes

17. Governmental Institutions / Non-Governmental Institutions
People's Participation / Citizen Groups / Individual Citizens

18. Public Health and Welfare; Sport
History & Culture; Religion

19. Education and Research

20. Defence

21. Economy and Employment

22. Finance
Public Private Participation
Financial Engineering

It is essential to take into account all these categories and their interrelation-ships, since without them neither plan development nor execution is possible. Cost-Benefit analysis of each category and of the sum-total should be carried out and ofcourse the financing of the project, preferably through financial engineering, thereby taking into account public-private partnership.

With regard to the land reclamation application of the method of building with nature should be emphasized, both from a viewpoint of nature as from a viewpoint of cost-effectiveness.
In this method a new flexible dynamic equilibrium coastline is created using sand from the sea, consisting of a new primary range of dunes with a new beach in front and with a minimum of solid sea-wall elements. The method is taking into account all the forces acting on the loose mobile material sand, being the action of tides, waves (specifically in the breaking zone), swell, river outflow (referring to water and sediment), estuarine and ocean currents, gravity & wind & rain, seeing to it that the net resulting force acting on the sand - averaged in time - is relatively small. Use is also made of the interaction vegetation - sand. Another (complex) factor which can be considered is the interaction between marine organisms and sand/silt/clay particles in beach and near shore.
A low maintenance factor of the new coastline is taken into account. Only in those cases where erosion is clearly and strongly dominating accretion, solid sea-wall elements are to be preferred, but only then.

In all cases of land reclamation, of and above a certain scale, multi-functional master concepts are developed in such a way that nature reserve areas are included and that net nature gain is achieved. Methods are applied that at the same time strengthen the economy and improve the environment. A further advantage is that these land reclamations can be carried out phase after phase, segment after segment, all fitting in a master concept.

With regard to environmental affairs we want to stress the following. In the coastal zone we always have to deal with existing and new man-induced conversion processes in the field of industry, power stations for energy-supply, agriculture and aquaculture, transport and distribution, and also the domestic sector.
In the direct future those processes should be developed and implemented, that with less raw materials and with less energy, produce products at a higher yield, with less hazardous emissions to air, water and soil, and with less waste products. In case waste products are formed, they should be recycled or converted to environmental friendly products or safely stored.

Clean Technology (process-integrated clean technology), Clean Products (products that during their lifetime and thereafter are relatively environmental friendly) and Cleaning-up Technology are useful instruments to achieve - in due time - sustainable development.

Harmonious cooperation with all the relevant authorities at the various government levels and with non-governmental institutions and citizen groups is an essential prerequisite to achieve integrated and sustainable coastal zone development.

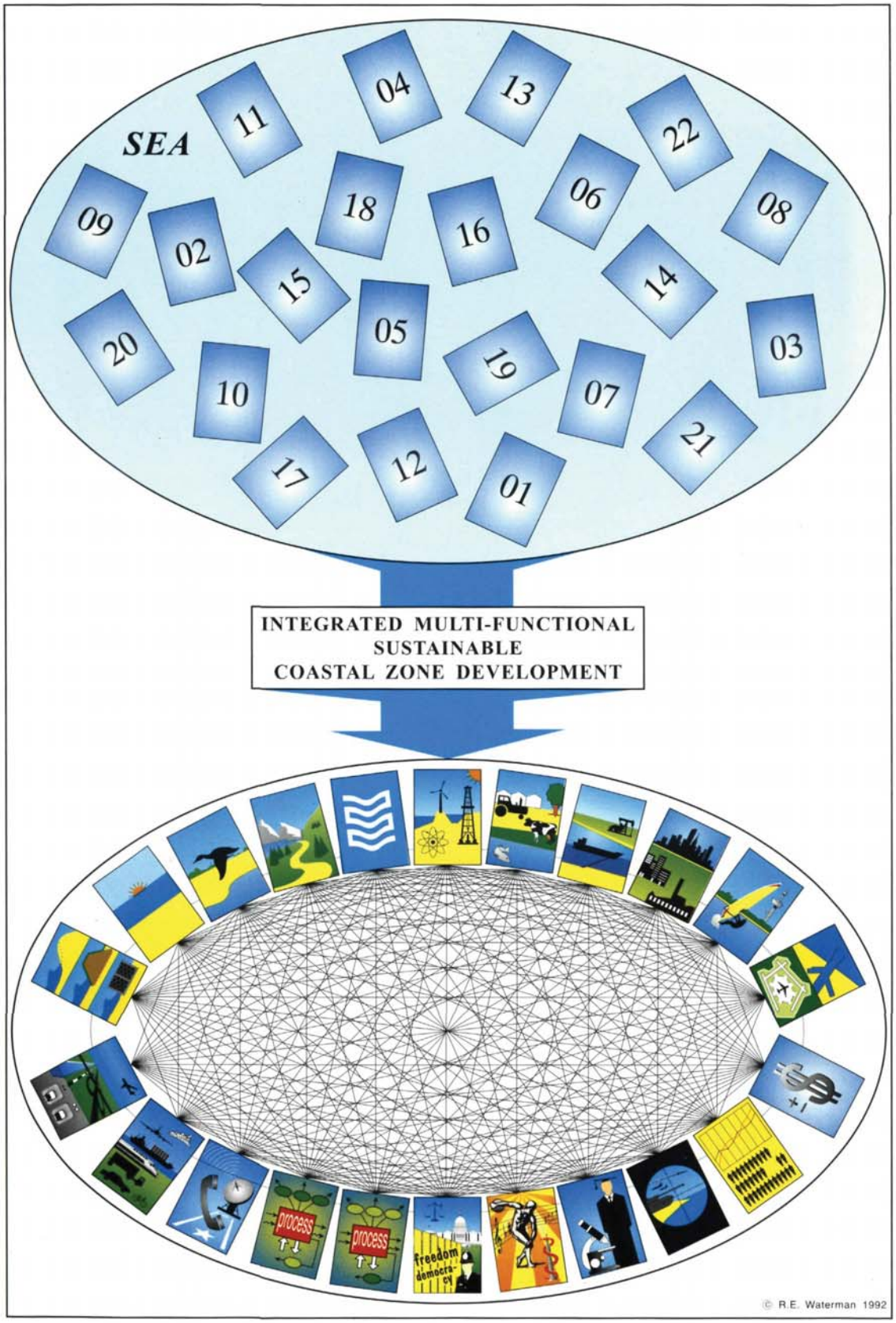
Methods will be discussed in detail, concerning:

a. Analysis of hinterland and bordering sea;
b. Land reclamation via building with nature;
c. Integrated planning of functions in the new land using plan development management systems.

In addition specific examples will be given with regard to sustainable coastal zone development in various parts of the world.

1980 - 2000

PLAN DEVELOPMENT MANAGEMENT SYSTEM PDMS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01
INTEGRATED MULTI-FUNCTIONAL
SUSTAINABLE
COASTAL ZONE DEVELOPMENT
process
process
freedom
democra-
cy
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LEGEND:INTEGRATED MULTI-FUNCTIONAL SUSTAINABLE COASTAL ZONE DEVELOPMENT

01 SAFETY with regard to:
- flooding (incl. effects of sea level rise)
- coastal erosion
- land subsidence
- salt water intrusion
- human activities & natural disasters

02 ENVIRONMENT IN GENERAL
environmental compartments:
air - water - land

03 NATURE
- micro-organisms
- flora, fauna (incl. people)
- eco-systems
- nature conservation & development
- bio-diversity & bio-diversification

04 LANDSCAPE
- landscape conservation
- landscape development

05 WATER RESOURCES MANAGEMENT
- water quantity
- water quality
- drinking water supply
- sewer systems
- waste water purification

06 ENERGY
- natural gas, oil, coal, etc.
- biomass (wood, etc.); organic wastes
- nuclear energy
- solar-, wind-, water-, geo-energy
- combined cycle, isolation, etc.

07 AGRICULTURE
(incl. horticulture, forestry,
cattle & poultry breeding)

AQUACULTURE, MARICULTURE, FISHERY

08 MINING

09 BUILDING SITES FOR LIVING & WORKING:
- houses & apartments + facilities
- industries & offices + facilities
- city development

10 RECREATION & TOURISM

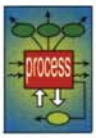
11 TRANSFER / DISTRIBUTION CENTRES
& RELATED ACTIVITIES
- seaport, riverport, lake port,
airport, landport

12 INFRASTRUCTURE
- roads, railroads, waterways,
airlanes, underground systems

13 TRANSPORT MODULES
- bicycle, motor-car, bus, tram,
train, metro, ship, container,
airplane, rocket

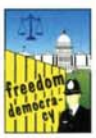
14 TELECOMMUNICATION

DATA ACQUISITION
DATA TRANSMISSION
DATA PROCESSING



15 ENVIRONMENT IN PARTICULAR:
Air- / Water- / Soil-quality
by improvement of conversion processes
and by end of pipe purification

16 ENVIRONMENT IN PARTICULAR:
solid (liquid) waste reduction
by improvement of conversion processes
and by absolute environmental friendly
collection - transport - storage -
processing - recycling - usage



17 GOVERNMENTAL INSTITUTIONS
NON-GOVERNMENTAL INSTITUTIONS
CITIZEN GROUPS
PEOPLE'S PARTICIPATION
INDIVIDUAL CITIZENS

18 PUBLIC HEALTH & WELFARE
SPORT

HISTORY & CULTURE
RELIGION

19 EDUCATION & RESEARCH

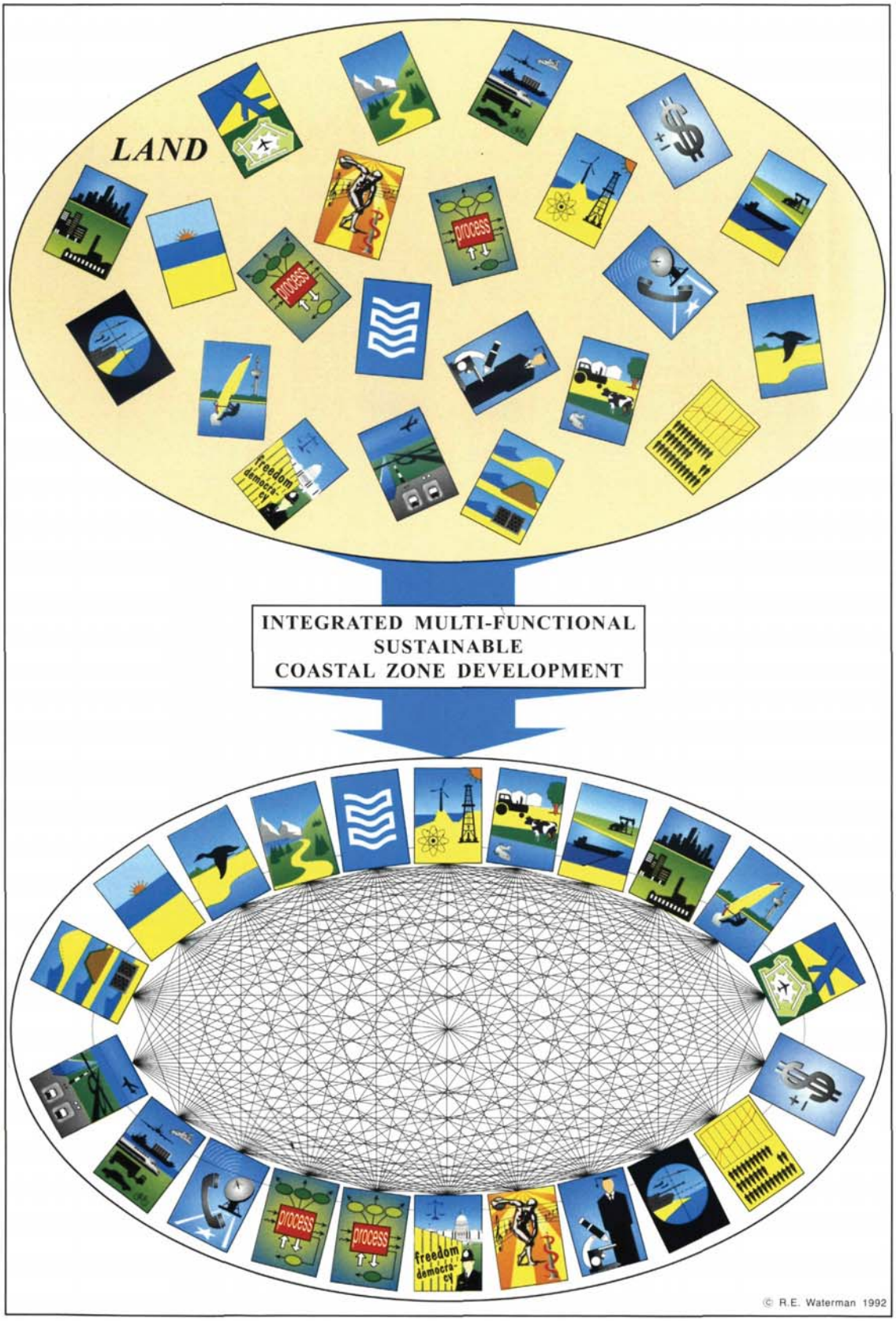
20 DEFENCE

21 ECONOMY & EMPLOYMENT

22 FINANCE

FINANCIAL ENGINEERING

OTHER FUNCTIONS


LAND
process
process
freedom democracy
INTEGRATED MULTI-FUNCTIONAL
SUSTAINABLE
COASTAL ZONE DEVELOPMENT
process
process
freedom democracy
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LEGEND:INTEGRATED MULTI-FUNCTIONAL SUSTAINABLE COASTAL ZONE DEVELOPMENT

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LANDSCAPE
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- drinking water supply
- sewer systems
- waste water purification

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- biomass (wood, etc.); organic wastes
- nuclear energy
- solar-, wind-, water-, geo-energy
- combined cycle, isolation, etc.

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(incl. horticulture, forestry,
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TRANSFER / DISTRIBUTION CENTRES
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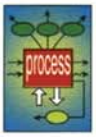
airport, landport

12 
INFRASTRUCTURE
- roads, railroads, waterways,
airlanes, underground systems

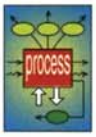
13 
TRANSPORT MODULES
- bicycle, motor-car, bus, tram,
train, metro, ship, container,
airplane, rocket

14 
TELECOMMUNICATION

DATA ACQUISITION
DATA TRANSMISSION
DATA PROCESSING

15 

ENVIRONMENT IN PARTICULAR:
Air- / Water- / Soil-quality
by improvement of conversion processes
and by end of pipe purification

16 

ENVIRONMENT IN PARTICULAR:
solid (liquid) waste reduction
by improvement of conversion processes
and by absolute environmental friendly
collection - transport - storage -
processing - recycling - usage

17 

GOVERNMENTAL INSTITUTIONS
NON-GOVERNMENTAL INSTITUTIONS
CITIZEN GROUPS
PEOPLE'S PARTICIPATION
INDIVIDUAL CITIZENS

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PUBLIC HEALTH & WELFARE
SPORT

HISTORY & CULTURE
RELIGION

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EDUCATION & RESEARCH

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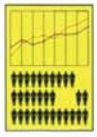
21 
ECONOMY & EMPLOYMENT

22 
FINANCE

FINANCIAL ENGINEERING

OTHER FUNCTIONS

PDMS - FUNCTIONS

01

SAFETY with regard to:
- flooding
(incl. effects of sea level rise)
- coastal erosion
- land subsidence
- salt water intrusion
- natural disasters
- human activities

02

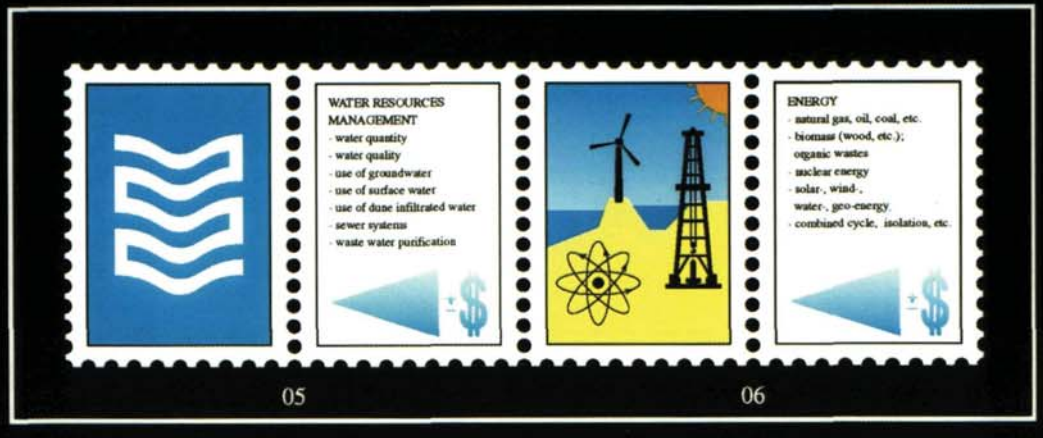
ENVIRONMENT IN GENERAL
environmental compartments:
air - water - land

03

NATURE
- micro-organisms, flora, fauna
(incl. people)
- nature conservation
- nature development
- bio-diversity
- bio-diversification

04

LANDSCAPE
- landscape conservation
- landscape development



05

WATER RESOURCES MANAGEMENT
- water quantity
- water quality
- use of groundwater
- use of surface water
- use of dune infiltrated water
- sewer systems
- waste water purification

06

ENERGY
- natural gas, oil, coal, etc.
- biomass (wood, etc.);
organic wastes
- nuclear energy
- solar-, wind-,
water-, geo-energy
- combined cycle, isolation, etc.

07

AGRICULTURE
(incl. horticulture, forestry,
cattle & poultry breeding)

AQUACULTURE,
MARICULTURE,
FISHERY

08

MINING

Functions 01 / 08

A

09

BUILDING SITES
FOR LIVING & WORKING:
- houses & apartments
  + facilities
- industries & offices
  + facilities
- city development

10

RECREATION & TOURISM

11

TRANSFER /
DISTRIBUTION CENTRES
& RELATED ACTIVITIES
- seaport, riverport,
  lake port, airport,
  landport

12

INFRASTRUCTURE
- roads, railroads,
  waterways, aidanes,
  underground systems

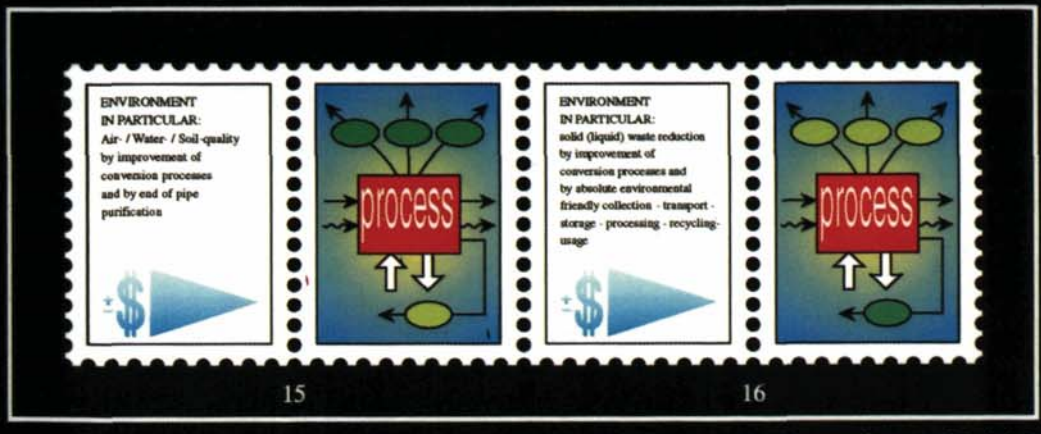
13

TRANSPORT MODULES
- bicycle, motor-car, bus,
  tram, train, metro, ship,
  container, airplane,
  rocket

14

TELECOMMUNICATION

DATA AQUISITION
DATA TRANSMISSION
DATA PROCESSING



15

ENVIRONMENT
IN PARTICULAR:
Air- / Water- / Soil -quality
by improvement of
conversion processes
and by end of pipe
purification

16

ENVIRONMENT
IN PARTICULAR:
solid (liquid) waste reduction
by improvement of
conversion processes and
by absolute environmental
friendly collection - transport -
storage - processing - recycling-
usage

Functions 09 / 16

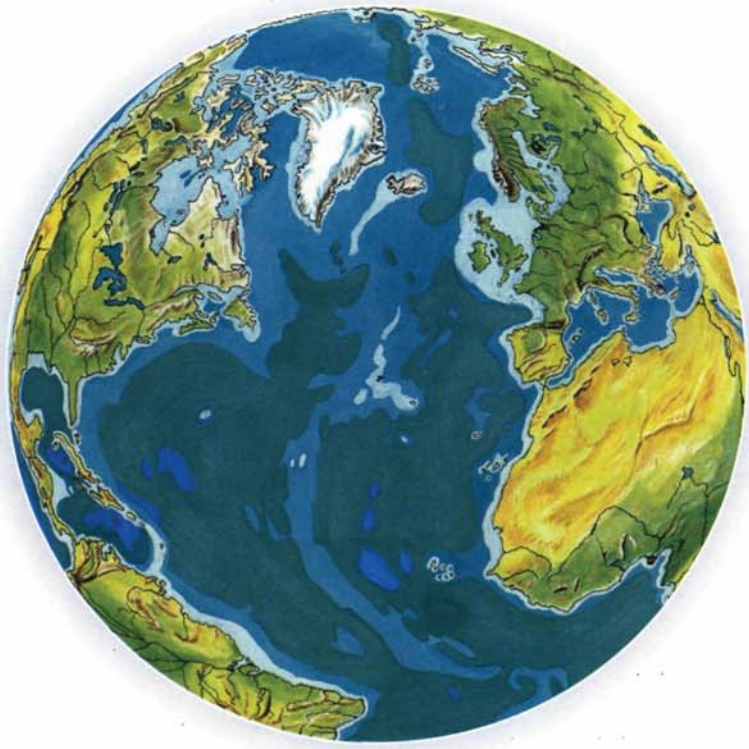
B

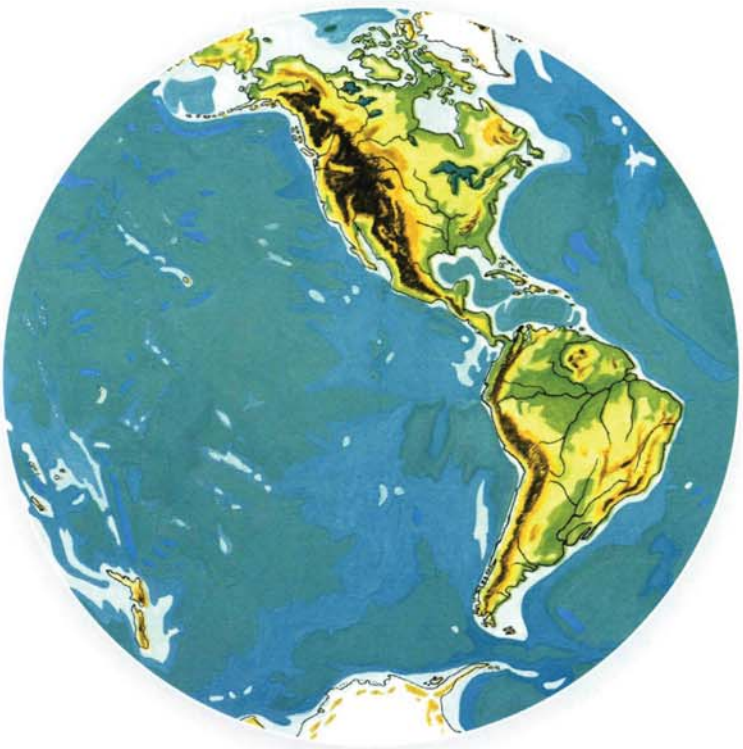
Functions 17 / 22

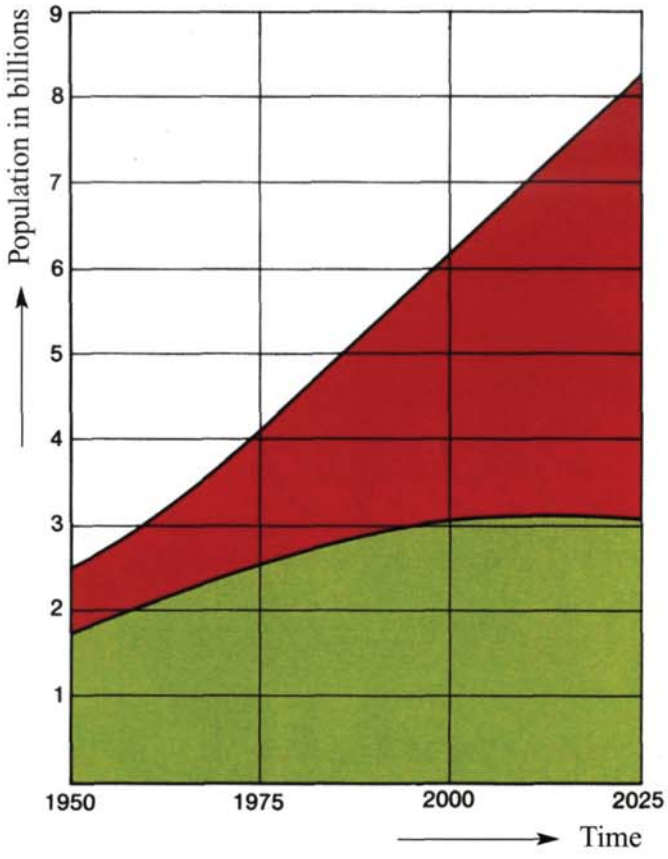
C

CONTINENTS & OCEANS

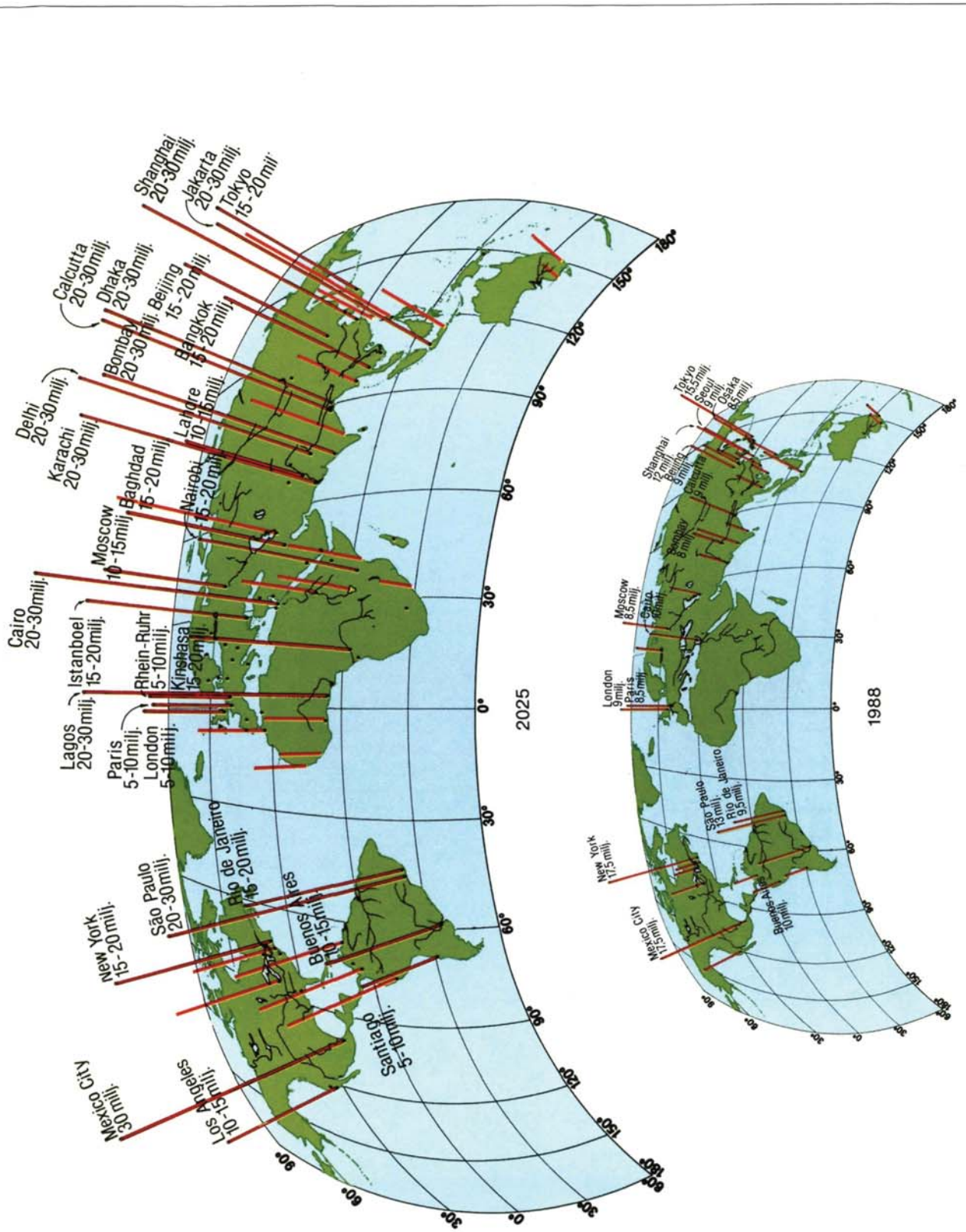
Deltaic and Coastal Regions between Sea and Land







Growth of World Population in urban (red) and rural (green) areas in billions.
Densely populated areas are dominant in coastal- and deltaic regions



DEVELOPMENT OF THE BIG CITIES IN THE WORLD

3. PLAN DEVELOPMENT MANAGING SYSTEM

3.1 SPATIAL PLANNING PROJECT

When a spatial plan is being considered on existing land or on a land reclamation or on a combination of both, it should be based on valid data with regard to the existing situation and on wishes, possibilities and terms of reference.

To obtain a relatively quick insight in the financial feasibility of such a plan in all its varieties it is useful to use a Plan Development Management System.
It should be noted that the larger the space under consideration, the more functions can be accommodated, the more complex the plan will be and the larger the number of possible layouts will be.

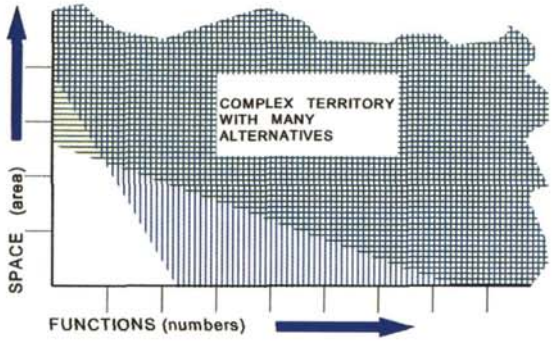


Figure: Complexity Plan Development

Because of the public & private interest and involvement it is necessary that a good choice is made between various alternative plans, while taking into account all interests and all the functions in the space under consideration, including environment, nature and landscape.

3.2 WHAT IS A PLAN DEVELOPMENT MANAGEMENT SYSTEM (PDMS)

PDMS is a decision support system, which can be used as an instrument for achieving an optimum spatial plan. It is a computer program that enables us to analyse & compare a number of alternative plans in a relatively short time.
PDMS has to be coupled to Geographic Information Systems (GIS)

3.3 PDMS AND RECENT DEVELOPMENTS

In the past governments and the private sector generally determined in a simple way the destiny and development of a territorial plan. See Figure A: "Factors of Influence, situation 1".

However tremendous changes have taken place in our society. The society has become more complex and the involvement of environmental organisations, public & private institutions, citizen groups and individual citizens has grown considerably, and rightly so.

A project- including its plan development - is situated and takes place in the environment and is initiated, propagated, criticised and executed by people. Furthermore we have to be aware that a project influences the environment and vice versa is influenced by the environment. Moreover, we have to realise that development and financing of certain projects are increasingly being executed through public-private participation. All these changes can be considered as improvements and result in a new setting, characterised in Figure B ("Factors of Influence, siuation 2").

It is clear that the afore mentioned changes are leading to a more complex situation and that it has become more difficult to choose between a series of alternative plans in order to obtain a publicly and privately endorsed plan, that takes into account all relevant functions and effects - both qualitatively and quantitativaly - doing justice in a balanced way to all parties involved.

PDMS offers the possibility to calculate and evaluate each and every plan, in a relatively short period of time. Through the careful weighing of interests of all the parties involved, the ultimate choice of the various plans can thus be well founded.

The final goal of PDMS is therefore to accelerate the plan development process, which makes it possible to evaluate within a limited time frame a variety of plans, thereby including a careful weighing - both qualitatively and quantitatively - of relevant functions, taking into account the interests of the various parties involved.

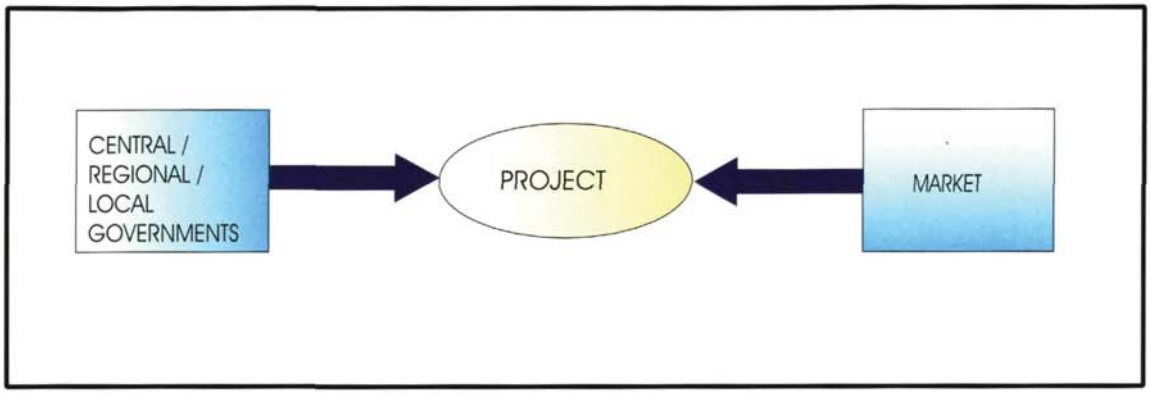


Figure A: Factors of Influence, situation 1

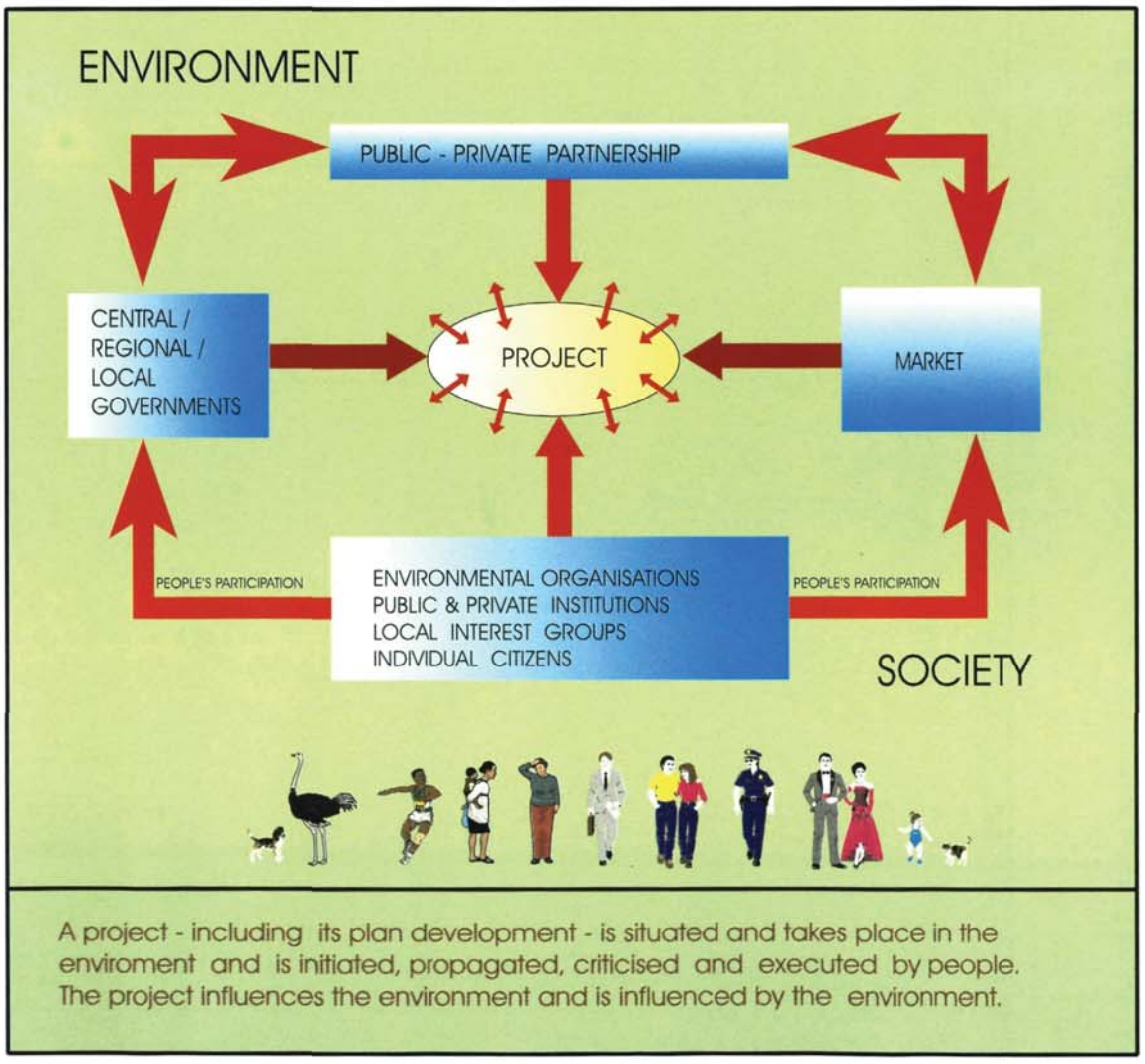


Figure B: Factors of Influence, situation 2

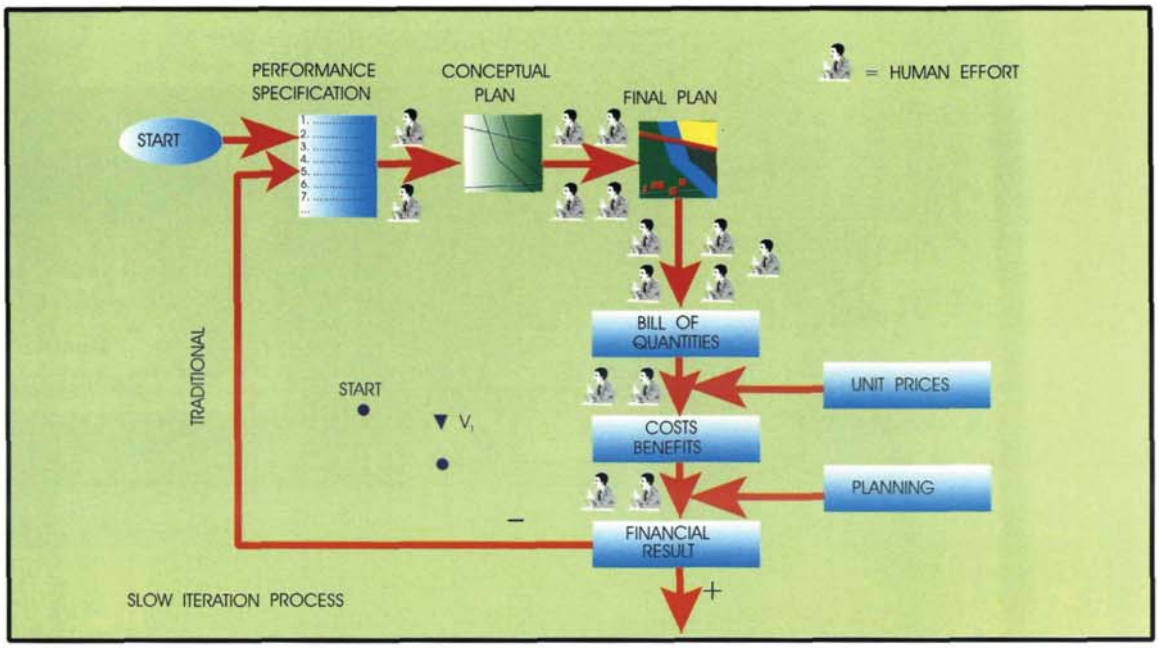


Figure C: Traditional Plan Development

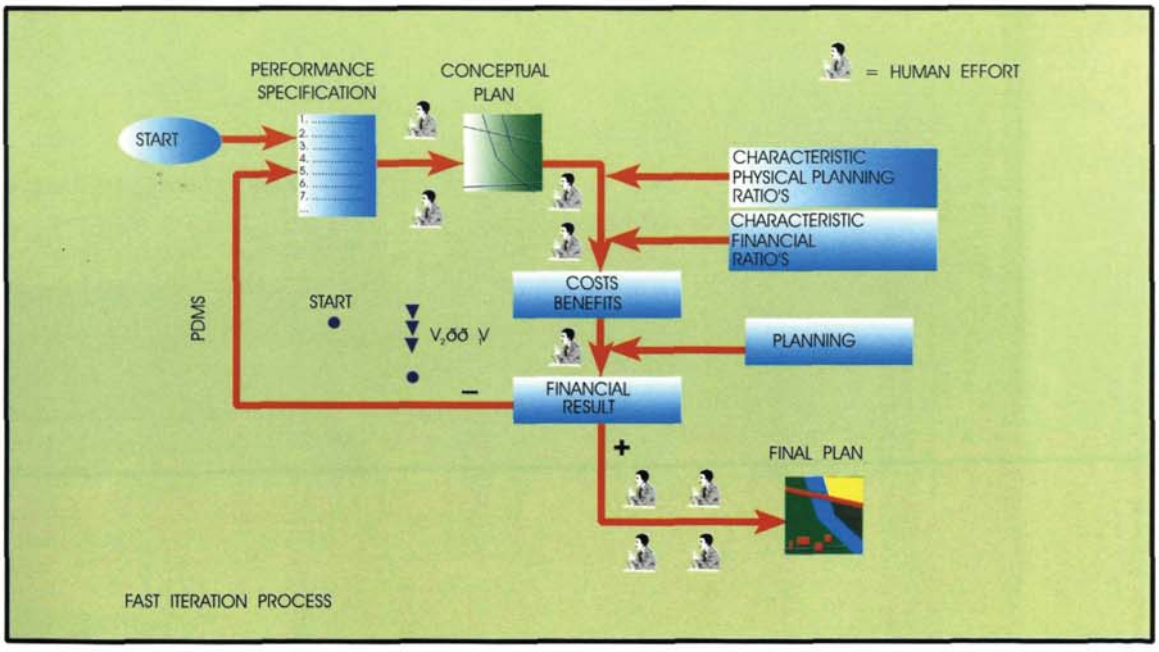


Figure D: Use of a Plan Development Management System

3.4 PDMS AND RISK / SENSITIVITY ANALYSIS

An important aspect of plan development projects are the uncertainties and risks. In addition to accelerate the plan development process, PDMS offers the possibility to execute systematically a risk and/or sensitivity analysis.

After identification and quantification of these uncertainties it is possible to introduce these in an integrated way in the calculations within the PDMS. This produces the uncertainty in the final financial results and the distribution of this uncertainty with regard to the separate risk sources. This deepens the insight in the risks and uncertainties of the project and offers a basis for the strategy necessary to forward the project to its ultimate destination.

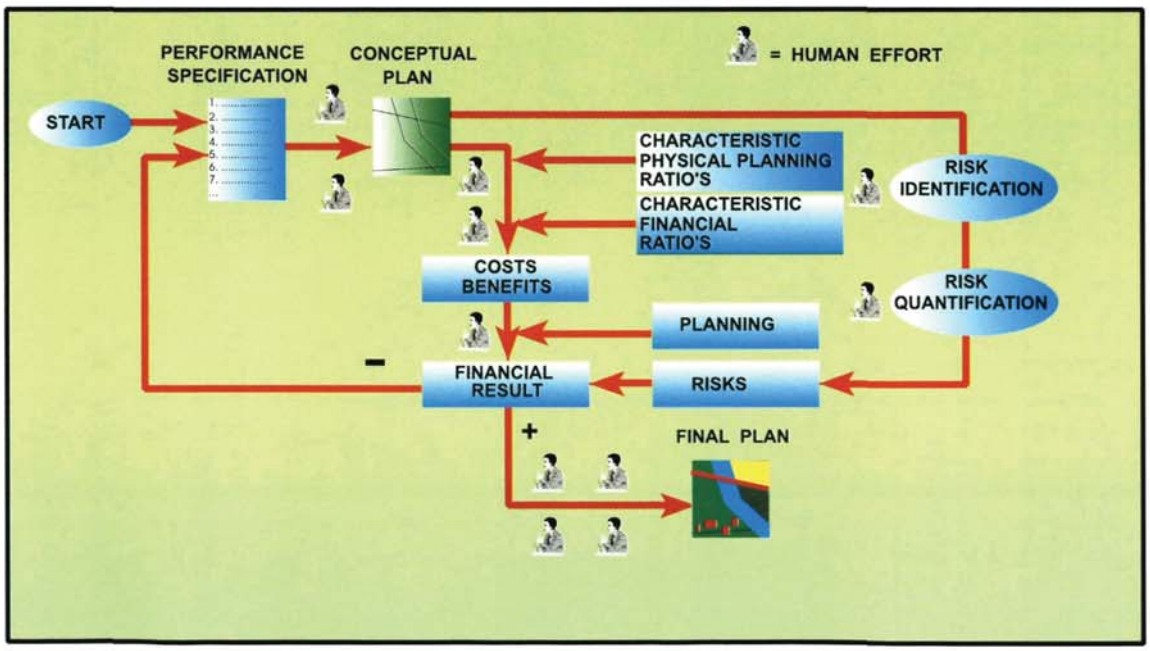
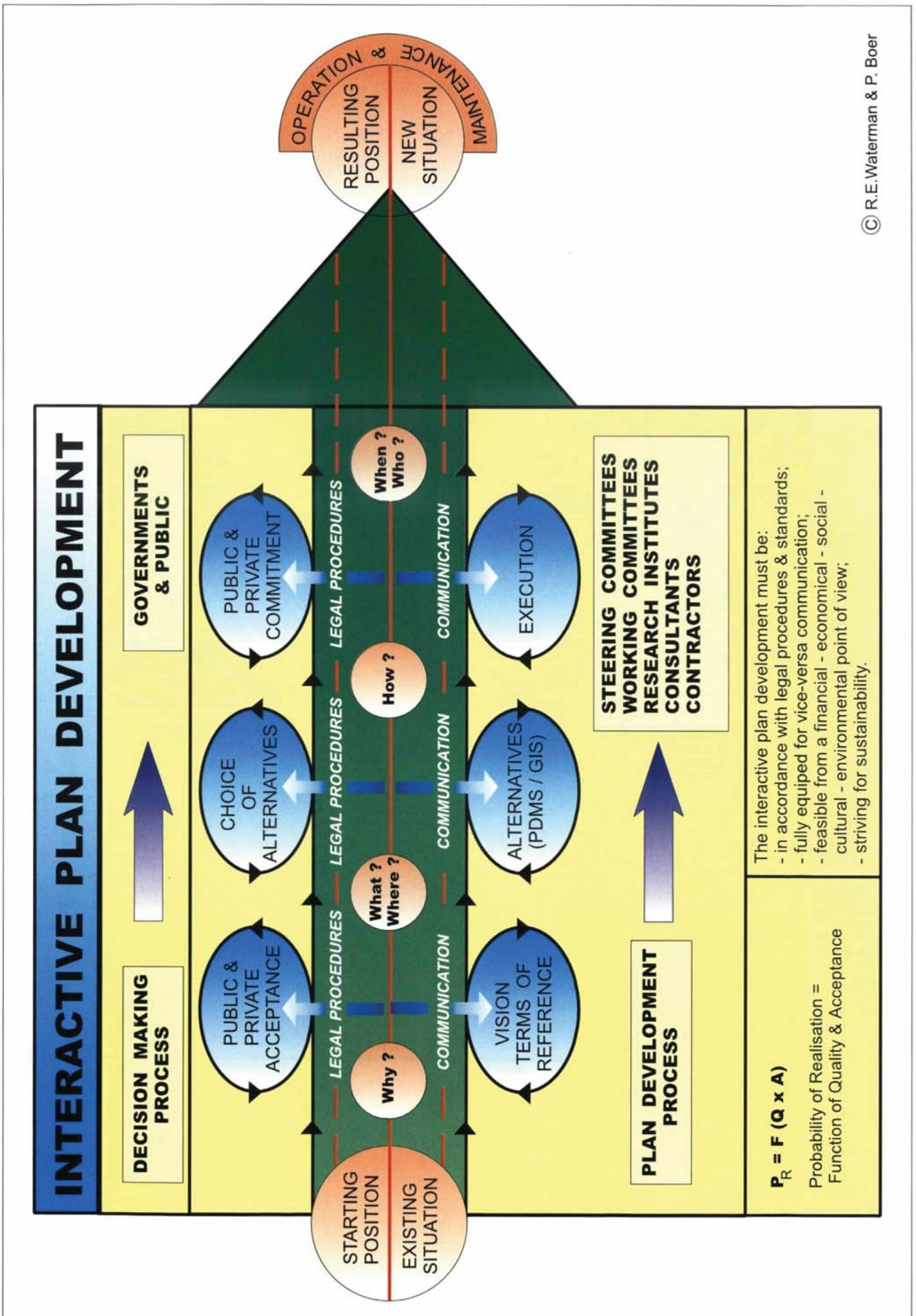


Figure E: PDMS / GIS and Risk / Sensitivity - Analysis


INTERACTIVE PLAN DEVELOPMENT
DECISION MAKING PROCESS
GOVERNMENTS & PUBLIC
PLAN DEVELOPMENT PROCESS
STEERING COMMITTEES
WORKING COMMITTEES
RESEARCH INSTITUTES
CONSULTANTS
CONTRACTORS
STARTING POSITION
EXISTING SITUATION
Why ?
What ?
Where ?
How ?
When ?
Who ?
LEGAL PROCEDURES
COMMUNICATION
PUBLIC & PRIVATE ACCEPTANCE
VISION TERMS OF REFERENCE
CHOICE OF ALTERNATIVES
ALTERNATIVES (PDMS / GIS)
PUBLIC & PRIVATE COMMITMENT
EXECUTION
OPERATION & MAINTENANCE
RESULTING POSITION
NEW SITUATION
$P_R = F (Q \times A)$
Probability of Realisation = Function of Quality & Acceptance
The interactive plan development must be:
- in accordance with legal procedures & standards;
- fully equiped for vice-versa communication;
- feasible from a financial - economical - social - cultural - environmental point of view;
- striving for sustainability.
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3.5 INTERACTIVE PLAN DEVELOPMENT

PDMS should be embedded in an interactive plan development as illustrated in the picture ("Interactive Plan Development").

Within an *Interactive Plan Development* it is essential:

a. To know and analyse exactly the existing situation / starting position.

b. To formulate precisely the task ahead which has to be based on a well founded vision.

c. To recognise, to acknowledge and to bring together the interests of all people involved. To strive for a "mutual gains approach" including joint fact finding, joint problem solving, building long term mutual beneficial relationships, increasing knowledge, participation in the decision making process, enlarging public & private acceptance, coordination.

d. To provide for accurate data acquisition, data transmission, data processing during the whole process from the existing stituation to the resulting situation, and monitoring afterwards.

e. To execute the necessary integrated multi-functional planning, using many different disciplines.

f. To make choices during the decision making process in a well balanced way.

g. To provide for quality assurance during and after the integrated plan development and execution, seeing to it that in the end added value is created.

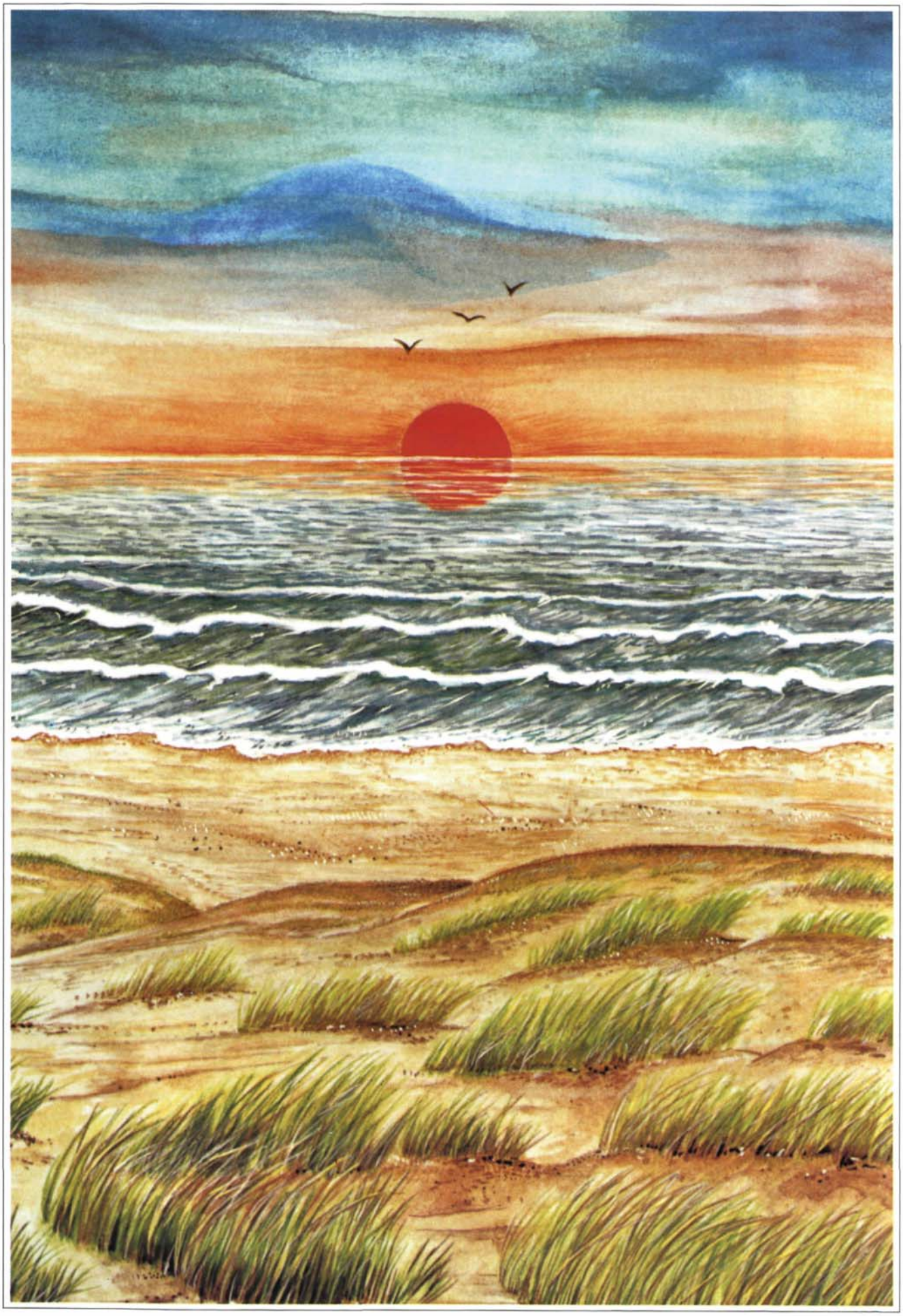
h. To strive for sustainability.

i. To study and to take fully into account cultural, historical and innovative aspects. The final plan should have roots in the past and it should point to the future as well.

j. To take fully into account all relevant legal procedures and standards.

k. To provide for excellent vice versa communication with regard to every aspect and phase of the process.

l. To realise that the personal contact is still one of the most efficient ways of communication, apart from all other necessary ways of communication.



4. BUILDING WITH NATURE

4.1 BUILDING WITH NATURE

When coastal extensions and/or artificial islands are considered, it is essential to apply as much as possible the principle of building with nature. This means using more than before the materials and forces present in nature. The material being the loose mobile material sand, silt and gravel which can be present in the beaches, the dunes and/or the seabed. The forces acting on this material, being the action of tides (ebb & flood), waves (specifically in the breaker zone), swell, estuarine, bay and sea currents, river outflow (referring to both sediment and water), gravity & wind & rain and the interaction vegetation-sand (the root-system of grasses, herbs, shrubs, trees, keeping the sand together). Another factor which can be considered is the (complex) interaction between marine organisms (such as sea-grasses, algae, diatoms) and sand/silt/clay particles in beach and nearshore.

On the basis of careful studying the interaction of these materials and the forces acting on them, it is in many cases possible to create new flexible dynamic equilibrium coastlines, in which accretion and erosion are more or less balancing each other, be it that often a maintenance factor has to be taken into account, in the form of a beach nourishment to compensate for losses caused by longshore and/or offshore sand-transport. So, it is often possible to use sand from the sea-bed in order to integrate land in sea. Nature has to be helped in this process using certain dredging methods. Often a 2-way process is preferred in the sense that land is integrated in the sea, but also water in the new land (creating salt & fresh water ports, lagoons & lakes & waterways, and fresh water lenses under the newly acquired dunes). This approach has a number of advantages, it is attractive to live, work and recreate near waterfronts, it can be very attractive for creating new nature reserve areas, and fresh water lenses can increase the fresh water supply under the dunes and can be an instrument fighting salt water intrusion at the same time.

Very important is the interaction vegetation-sand. The vegetation has to be carefully chosen and applied and has to be in harmony with the geomorphology, the soil characteristics and the climate of the region.

The sand needed for the coastal extensions or offshore islands should in most cases be obtained from the sea-bed. This should be done in such a way that the disturbance of the marine environment is minimised (and as far as possible causing only temporarily disturbance). Analysis & monitoring of Plankton-Nekton-Benthos and of life in the adjacent terrestrial part of the coastal zone is necessary, before and after the dredging operation. Special attention for food chains and food webs within the ecosystem.

Various types of sea-beds should be taken into account. The presence of corals can be a reason for the imposition of strict conditions on the extraction of sand in certain areas. Living corals can be very sensitive to the deposition of overflowing solid particles.

Effects of fishing and especially overfishing should be considered, since their effects can be very serious. Mitigating measures such as the construction of artificial reefs, - if well designed and carefully executed -, can create an interesting environment for marine organisms as has been proven in many cases over many years.

It is also possible to use dredged material in order to create a variety of wildlife habitats, especially aquatic habitats for benthic organisms and fish, bird habitats (upland habitat and nesting islands) and wetlands. Fishery resource improvement can take many forms. For example, bottom relief created by mounds of dredged material may provide refuge habitat for fish. In shallow or inter-tidal waters, subject to erosion, mounds composed of fine grain sediments can be stabilised by planting sea grasses or capping with shell or other coarse material. These can also enhance the habitat.

4.2 SEA-BED SURVEY

With regard to the sea-bed survey it can be stated that before obtaining the sand the presence and position of the borrow areas for this material should be found through bathymetric and & seismic reflection survey, grid positioning, gravity cores, vibrocores, cone penetration tests, boreholes & sampling (preferably undisturbed samples), etc. Through laboratory tests the characteristics of the sand to be used must be determined, a.o. average grain size, grain size distribution, mineralogical type, specific density. Attention should also be paid to silt- and clay particles.

4.3 ASPECTS OF DREDGING

The various dredging techniques should be compared and the right one should be chosen. In some cases adaptation is necessary in order to achieve environmental friendly dredging. Deep dredging in restricted areas or the use of larger but thinner subsurface layers and limited depths, dredging in alternate zones, specially designed suction heads and pumping systems, silt screens, etc., are aspects which can be considered. In some cases deep dredging for sand can be followed by environmental friendly storage of contaminated sediments and certain wastes in the created sand borrow pits. In some cases prior to extraction of

suitable sand, layers of marine mud and clay have to be removed.
Of importance is the distance between the marine borrow areas and the land reclamation under consideration. When the distance is too short the new flexible dynamic equilibrium coast can not be obtained, because the slope towards the sea-bed of the new coast is influenced; when the distance is too large the costs become too high; environmental factors and geological uncertainties can also play a role. Generally there is an optimum range, provided suitable borrow areas can be found within that range.

Even if a new flexible dynamic equilibrium coast cannot be achieved, because erosion is clearly dominating accretion, and solid seawall elements therefore have to be chosen for coastal protection, sand from the sea-bed still has to be used for the land reclamation, which means that dredging remains in all cases of vital importance.
In those cases that erosion is clearly dominating accretion and dune/beach solutions cannot be achieved, solid seawall elements should be applied for shore protection. However, even then it is possible to introduce some aspects of building with nature, by creating special niches within and in between the solid seawall elements, which niches are attractive to marine and/or terrestrial organisms.

Very important, also from a viewpoint of nature, planning and cost effectiveness, is that a coastal extension or offshore island of certain dimensions can be created segment after segment, phase after phase.

4.4 SOIL COMPACTION/ REINFORCEMENT/IMPROVEMENT

In the case of land reclamation it is practically always necessary that shortly after the completion the soil can be used for various purposes. Therefore natural or stimulated soil consolidation, maturation, compaction are of vital importance.

Soil compaction can be achieved by using various methods, like vibro-flotation, dynamic compaction methods by using shock waves (Ménard method in which high-energy impacts are given onto the surface of compressible ground following a special grid pattern), as well as certain drainage methods.
The type of soil, e.g. sand with its characteristics (type, grain size, grain size distribution, regular rounded off grains, irregular grains with more or less edges and corners) should be known, as well as the initial porosity and the ground water levels.

- The presence of layers of sand, silt, clay, peat, - their depths and thickness -, should be known or determined.
- Methods of penetration by vibro-instruments, the use of generators, of air and/or water jets, of pumps and compressors should be chosen.
- The penetration sites within a certain triangular grid pattern; penetration depth, penetration velocity are other factors to be considered.
- Special attention for drainage methods, including the use of geo-synthetic vertical strips up to certain depths, installed at suitable spacings in a regular pattern.

Various geo-synthetic fabrics (sometimes in combination with natural materials) can also be used in soil reinforcement (base and slope) for a wide range of applications, such as reinforced slopes, retaining walls, landslide repairs, noise barriers, visual walls, compartment dams, road/railroad/airport foundations, industrial sites, port and port related areas, residential areas. All together geo-synthetic fabrics are used for three main functions: filter constructions, separation constructions, reinforcement constructions.

Soil improvement methods in the case of soft soils (soft clay, organic silt, etc.) in order to increase the bearing capacity and to reduce settlement are generally classified as:

Geometrical Methods
- Floating foundations
- Light weight fills
- Pressure berms

Mechanical Methods
- Preloading (often combined with vertical drains consisting of sand piles or geo-synthetic vertical strips)
- Lime piles (generally unslaked lime - CaO)

Physical and Chemical Methods
- Lime (CaO) and cement columns, including also chemical mixing
- Electro-osmosis (phenomenon of movement of soil water under an electric field) and vacuum compaction

Structural Methods
- Geo-fabrics and geo-membranes
- Excavation and replacement
- Soil displacement
- Dynamic consolidation, dynamic replacement and mixing
- Jet grouting
- Sand compaction piles, stone, gravel and sand columns
- Embankment piles.

All these soil improvement methods can be applied to existing areas and newly reclaimed areas.

4.5 ENVIRONMENTAL ASPECTS

With regard to the urban and regional planning of the newly acquired area, landscaping and the introduction of parks and even of new nature reserve areas - provided that the new area is not too small - offer excellent possibilities. For a relative high value of a nature reserve area it is important to obtain an abundance of different species. This can be achieved by applying differences in height, in gradients from salt to fresh water, differences in chalk content, variations in micro-climate, etc.
Of great importance in the terrestrial coastal zone is water resources management and linked to that the reduction of waste loads in the adjacent sea, bay, estuary or lagoon. Therefore special attention is necessary for sewer systems; waste water purification; the collection - transport - temporary disposal - processing - recycling & final environmental friendly storage of solid wastes.
In the coastal zone we always have to deal with existing and new man-induced conversion processes in the field of industry, power stations for energy-supply, agriculture and acquaculture, transport and distribution, and also in the domestic sector.
In the direct future those processes should be developed and implemented that with less raw materials and with less energy, produce products at a higher yield, with less hazardous emissions to air, water and soil, and with less waste products. In case waste products are formed, they should be converted to environmental friendly products, or safely stored.

Clean Technology (process-integrated clean technology), Clean Products (products that during their lifetime and thereafter are relatively environmental friendly) and Cleaning-up Technology are useful instruments to almost achieve - in due time - sustainable development.

It is clear that the quality of all three environmental compartments air-water-soil should be maintained or improved. Within the environment special regard for all the terrestrial and marine organisms in the ecosystems. It is vitally important to take always into account that the environment, including nature has:

1. Carrier Functions, providing space and substrate for all living organisms and other organic as well as inorganic matter, landscape & seascape, energy systems and all man and non-man induced processes.

2. Production Functions, providing materials and energy for production- and consumption processes.

3. Regulation Functions, maintaining essential ecological as well as other systems and processes.

4. Information Functions, providing information in many forms for many different known and unknown purposes.

The diversity of species, their intricate relationships and the range of pressures acting on them in the coastal system make it a very complex system to assess.
On-going monitoring programs producing relevant data are necessary in order to achieve insight how different factors relate to each other and how their combined effects influence the eco-systems under consideration.
AMOEBA (A general Method Of Ecological and Biological Assessment) is one of several interesting tools to meet this need.
The basic idea underlying AMOEBA is that an impression of the relative health of an aquatic or terrestrial environment can be obtained by counting individuals of a selected number of key species and comparing the current figures with corresponding data in the past and future in relation to human activities in that period. Ideally the reference situation needs to be one which guarantees the fundamental values of production and harvest, diversity within the species community and self-regulating ecosystems: in short a sustainable situation.

AMOEBA makes it possible to present the data in a visual form (diagram) revealing almost at a glance the actual state of an aquatic or terrestrial ecosystem and the biological diversity within it.
AMOEBA can also encompass physical and chemical factors.

As a final remark we want to state the following. In order to come closer to the ideal of sustainability in the third millenium learning lessons from nature and working in harmony with nature is an absolute prerequisite.

5. FOUR REALMS OF LIVING ORGANISMS

5.0 VIRUSES

5.1 KINGDOM MONERA

a. Phylum SCHIZOPHYTA (BACTERIA)

b. Phylum CYANOPHYTA (BLUE-GREEN ALGAE)

5.2 KINGDOM PROTISTA

a. Phylum MASTIGOPHORA (FLAGELLATES)

b. Phylum SPOROZOA (SPOROZOANS)

c. Phylum RHIZOPODA (AMOEBAS)

d. Phylum CILIOPHORA (CILIATES)

e. Phylum MYXOMYCETES (SLIME MOLDS)

f. Phylum RHODOPHYTA (RED ALGAE)

g. Phylum PHAEOPHYTA (BROWN ALGAE)

h. Phylum PYRROPHYTA (FIRE ALGAE)

i. Phylum CHRYSOPHYTA (GOLDEN-BROWN ALGAE, DIATOMS, YELLOW-GREEN ALGAE)

j. Phylum EUGLENOPHYTA

k. Phylum CHAROPHYTA (STONEWORTS)

l. Phylum CHLOROPHYTA (GREEN ALGAE)

m. ———— LICHENS (ALGAL-FUNGAL PARTNERSHIPS)

n. PHYLUM MYCOPHYTA (FUNGI, e.g. fungi, mushrooms, yeasts)

5.3 KINGDOM PLANTAE

Sub-Realm BRYOPHYTA **(NON-VASCULAR PLANTS)**

a. Phylum BRIOPHYTA (MOSSES, LIVERWORTS, HORNWORTS)

Sub-Realm TRACHEOPHYTA **(VASCULAR PLANTS**, possessing **roots, stems, leaves)**

b. Phylum PSILOTOPHYTA (PSILOPSIDS - WHISK FERNS)
c. Phylum LYCOPODIOPHYTA (CLUB MOSSES & QUILL WORTS)
d. Phylum EQUISETOPHYTA (HORSETAILS)
e. Phylum POLYPODIOPHYTA (FERNS)

f. Phylum ***PINOPHYTA*** **(GYMNOSPERMAE = NAKED SEED BEARING PLANTS)**

Order GINKGOALES (e.g. ginkgo biloba)
Order GNETALES
Order CONIFERALES (e.g. pines, cedars, firs, spruces, redwood)
Order CYCADALES (PALMLIKE CYCADS, e.g. sago palm)

g. Phylum ***MAGNOLIOPHYTA*** **(ANGIOSPERMAE = FLOWERING PLANTS)**

Class ***MONOCOTYLEDONOUS PLANTS*** **(PLANTS WITH ONE SEED-LEAF)**[1]

Family LILIACEAE (LILY FAMILY, e.g. asparagus, tulip, yucca)
Family PALMAE (PALM FAMILY, e.g. date palm, cocos palm)
Family GRAMINEAE (GRASS FAMILY, incl. all cereals, bamboo, sugar cane, ammophila arenaria)
Family IRIDACEAE (IRIS FAMILY, e.g. gladiolus, crocus)
Family ORCHIDACEAE (ORCHID FAMILY)
Family MUSACEAE (BANANA FAMILY)

Class ***DICOTYLEDONOUS PLANTS*** **(PLANTS WITH TWO SEED-LEAVES)**[1]

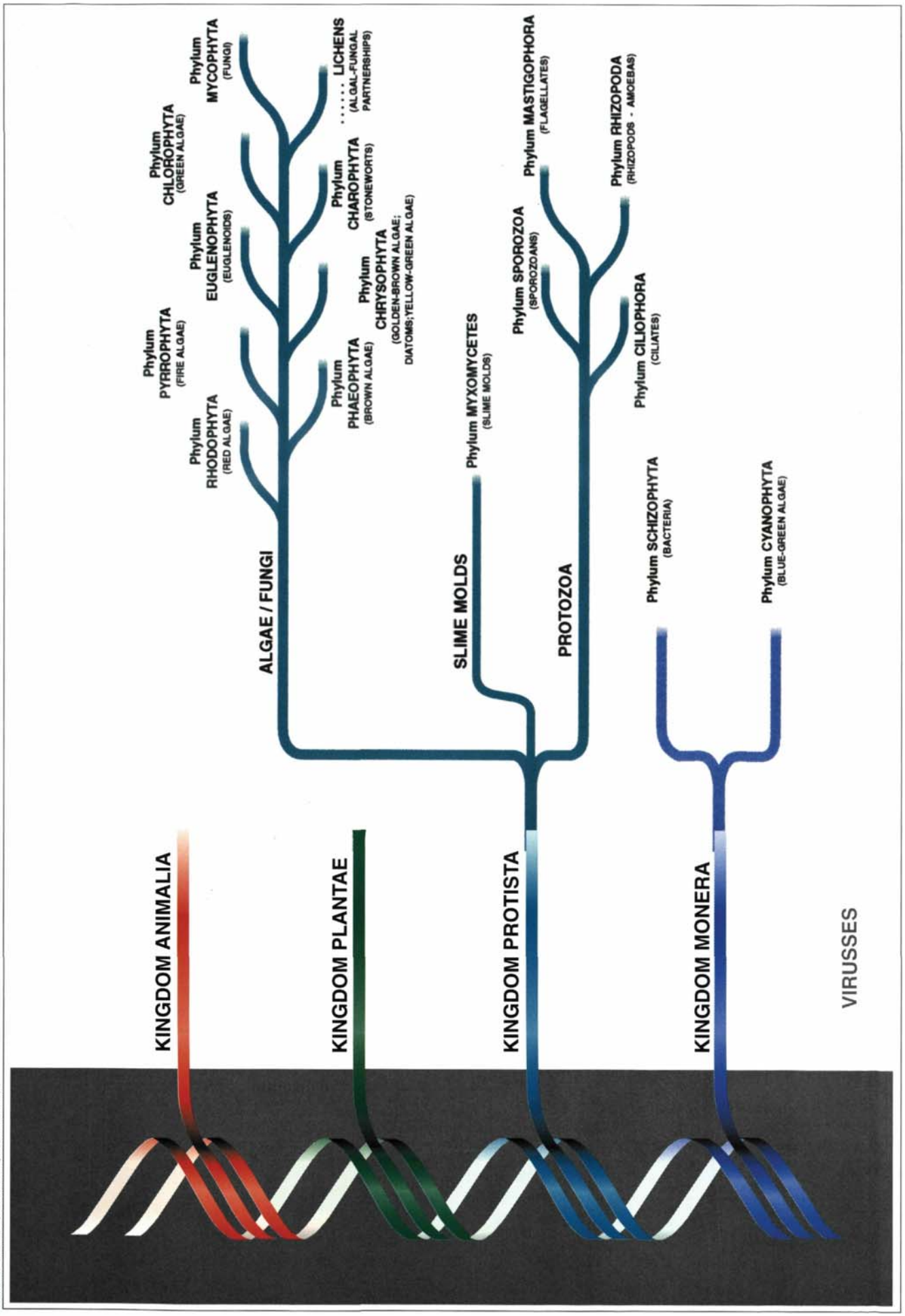
Includes most trees (Aceraceae, e.g. maple; **Ulmaceae,** e.g. elm; **Betulaceae,** e.g. birch, hazelnut; **Oleaceae,** e.g. fraxinus, jasminum, forsythia; **Platanaceae; Magnoliaceae; Tamaricaceae; Bignoniaceae,** e.g. catalpa; **Fagaceae,** e.g. beech, oak, chestnut; **Salisaceae,** e.g. willow, poplar; **Juglandaceae,** e.g. walnut; **Rhizophoraceae,** e.g. mangroves).

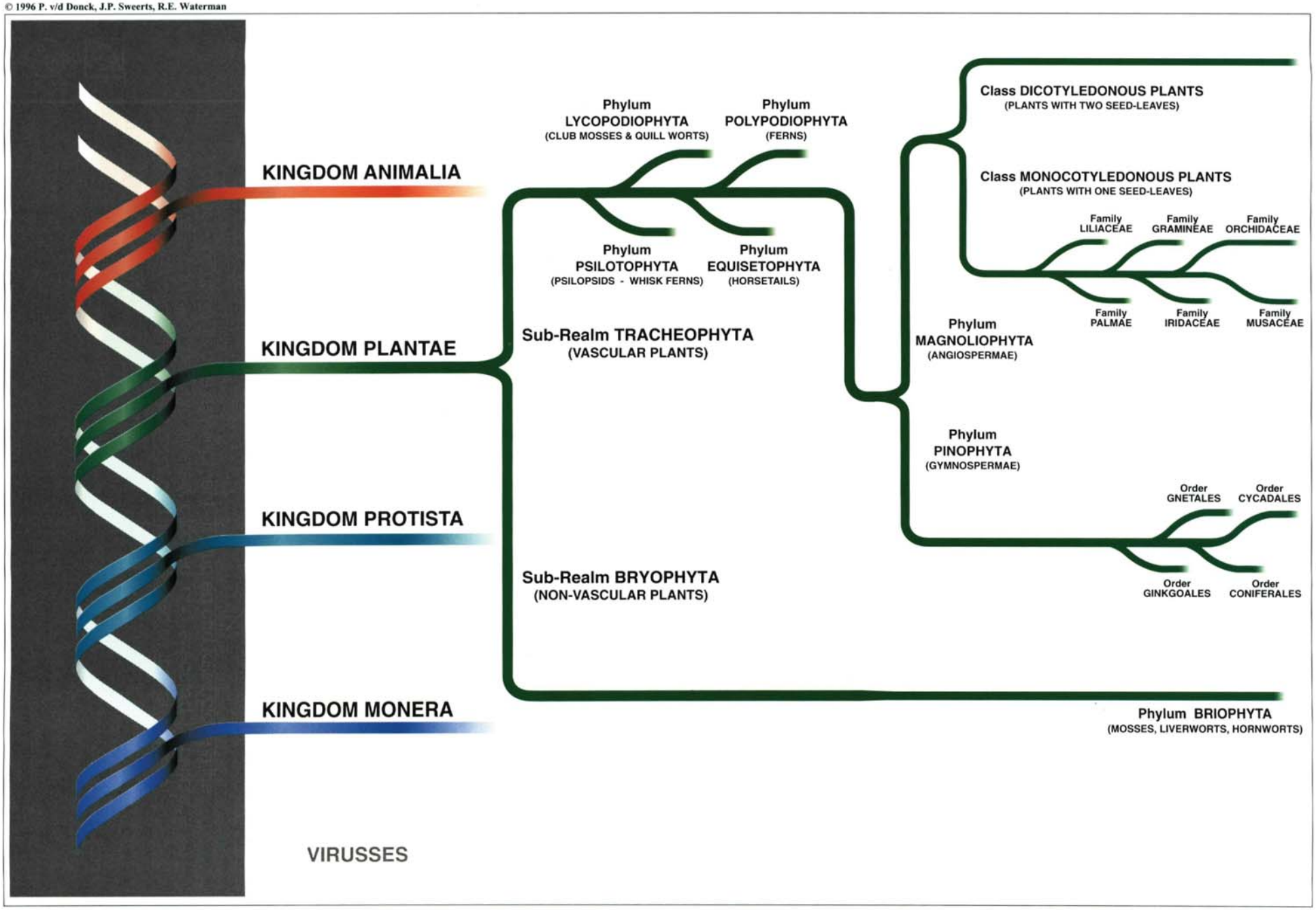
Ranunculaceae (e.g. anemone, buttercup, clematis), **Rosaceae** (Rose Family, e.g. rose, pear, apple, strawberry), **Umbelliferae** (Parsley Family, e.g. parsley, dill, carrot, eryngium), **Cucurbitaceae** (e.g. cucumber, melon, pumpkin), **Cactaceae** (Cactus Family), **Leguminosae** (Mimosacea & Papilionacea, e.g. pea, peanut, clover, wisteria, bean), **Compositae** (e.g. dandelion, sun flower, thistles), **Cruciferae** (Mustard Family e.g. cabbage, cauliflower, broccoli, radish), **Solanaceae** (Nightshade Family, e.g. potato, belladonna, tobacco, tomato), **Euphorbiaceae** (e.g. poinsettia, rubber), **Rutaceae** (Citrus Family), **Labiatae** (e.g. mint, melissa, oregan, lavender); **Scrophulariaceae** (Figwort Family, e.g. digitalis), **Ericaceae** (e.g. heather, azalea, rhododendron), etc.

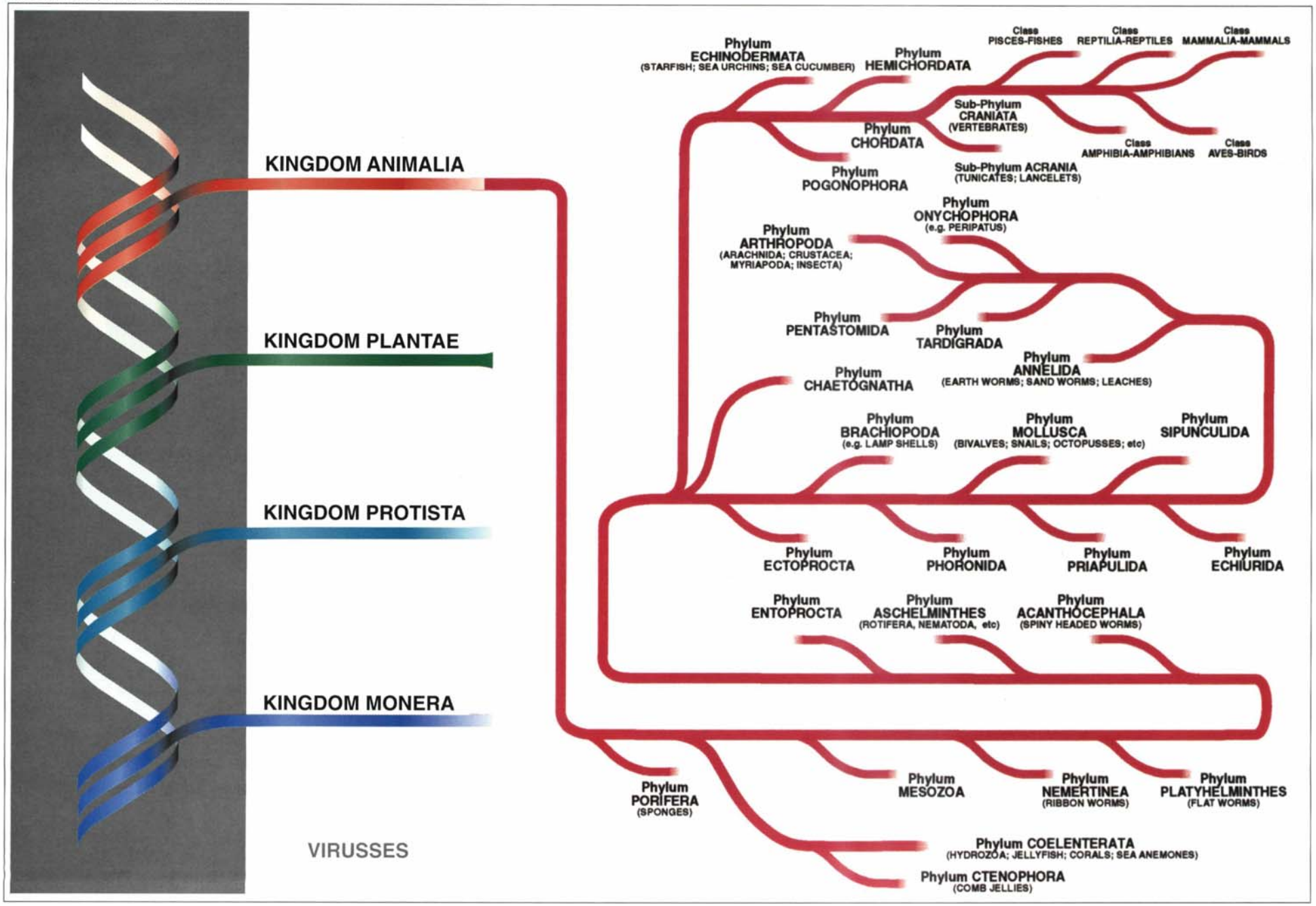
[1]) with regard to the monocotyledonous and dicotyledonous plants only a very limited number of families are presented.

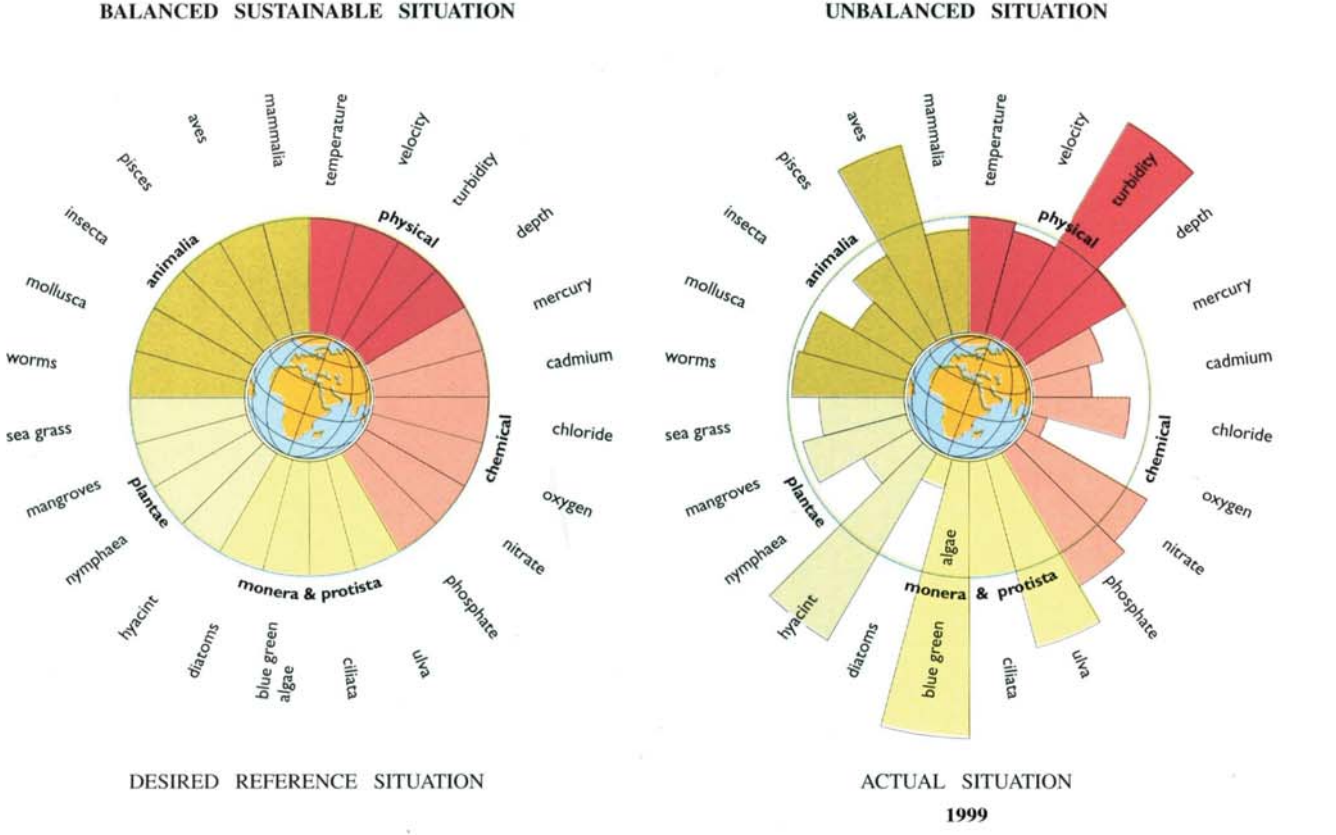
5.4 KINGDOM ANIMALIA

Phylum *PORIFERA*	**(SPONGES)**
Phylum *COELENTERATA*	**(HYDRAZOA; JELLY FISH; SEA ANEMONES & CORALS)**
Phylum CTENOPHORA	(COMB JELLIES)
Phylum *PLATYHELMINTHES*	**(FLATWORMS**, e.g. sheep liver fluke, tapeworms)
Phylum MESOZOA	
Phylum NEMERTINEA	(RIBBON WORMS)
Phylum *ASCHELMINTHES*	**(ROTIFERA; GASTROTRICHA; KINORHYNCHA; NEMATODA; NEMATOMORPHA)**
Phylum ENTOPROCTA	
Phylum ACANTHOCEPHALA	(SPINY HEADED WORMS)
Phylum PRIAPULIDA	
Phylum CHAETOGNATHA	(ARROW WORMS)
Phylum ECHIURIDA	
Phylum SIPUNCULIDA	(e.g. peanut worms)
Phylum *MOLLUSCA*	**(MUSSELS, CLAMS, OYSTERS, SCALLOPS; SNAILS, CONCHES, SEA SLUGS; TUSK SHELLS; SQUIDS, OCTOPUS, NAUTILUS; CHITONS)**
Phylum *ANNELIDA*	**(EARTH WORMS; SAND WORMS; LEACHES)**
Phylum *ARTHROPODA*	**(ARACHNIDA - spiders, scorpions, mites, horseshoe crabs); (CRUSTACEA - crabs, lobsters, shrimps, water fleas, cyclops, barnacles); (MYRIAPODA - centipedes, millipedes); (INSECTA)**
Phylum TARDIGRADA	
Phylum ONYCHOPHORA	(e.g. peripatus)
Phylum PENTASTOMIDA	
Phylum BRACHIOPODA	(e.g. lamp shells)
Phylum *ECTOPROCTA*	
Phylum PHORONIDA	
Phylum HEMICHORDATA	(e.g. acorn worm)
Phylum POGONOPHORA	
Phylum *ECHINODERMATA*	***(STARFISH; SEA URCHINS; BRITTLE STARS; SEA CUCUMBER)***
Phylum *CHORDATA*	**(TUNICATES; LANCELETS; VERTEBRATA)**
Sub-Phylum ACRANIA	(TUNICATES; LANCELETS)
Sub-Phylum CRANIATA	**(VERTEBRATA)**
Class* PISCES - FISHES	**Class AGNATHA,** JAWLESS FISHES, e.g. lamprey, hagfish **Class CHONDRICHTHYES,** CARTILAGINOUS FISHES, e.g. sharks, rays, chimaeras **Class OSTEICHTHYES,** e.g. lungfish, coelacanth, sturgeon, herring, salmon, bass
Class AMPHIBIA - AMPHIBIANS	**(APODA; TRACHYSTOMATA; CAUDATA,** e.g. salamander; **ANURA**, e.g. frog, toad)
Class REPTILIA - REPTILES	**(CROCODILES; TURTLES; LIZARDS & SNAKES)**
Class AVES - BIRDS	
Class MAMMALIA - MAMMALS	

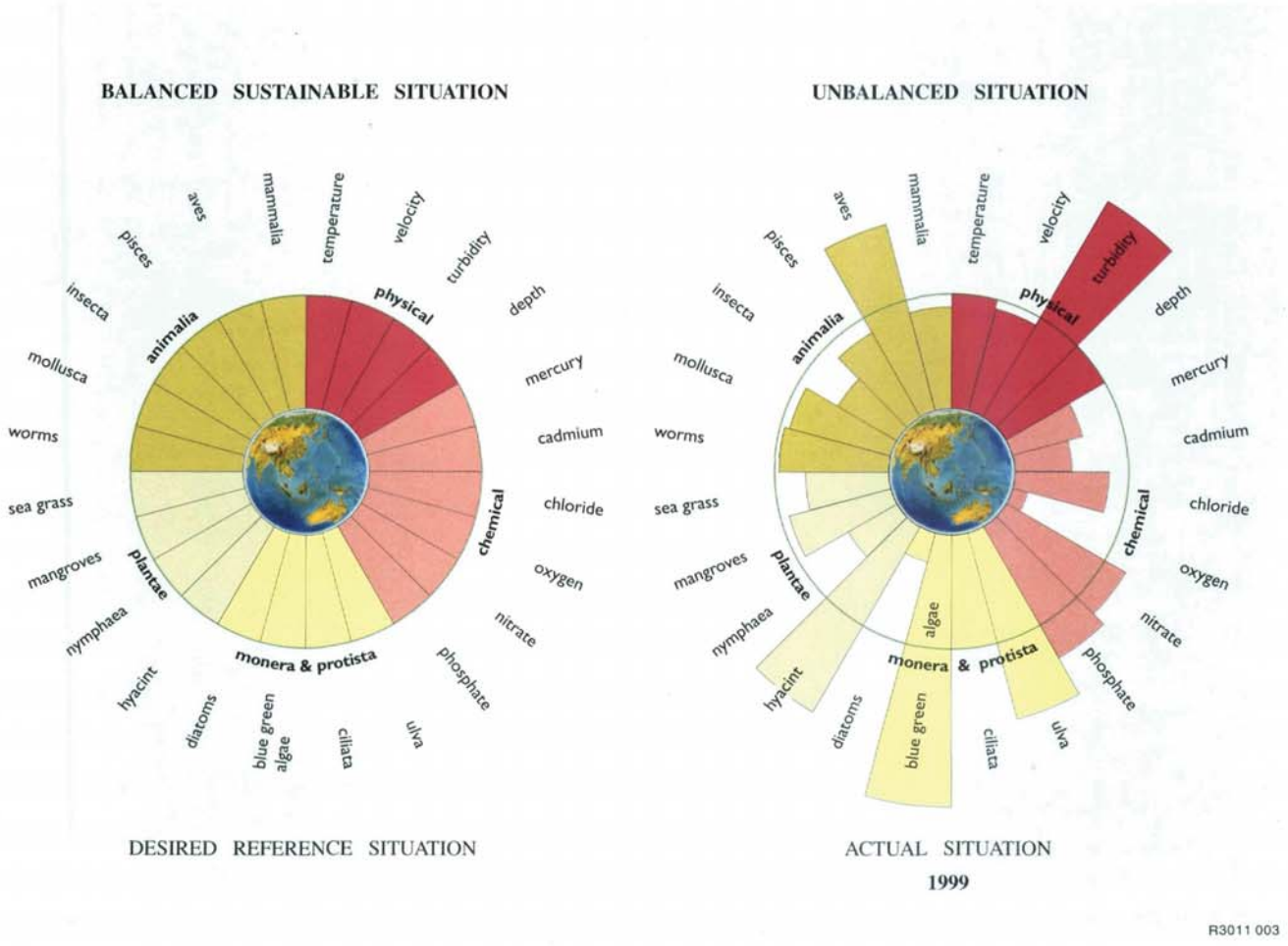




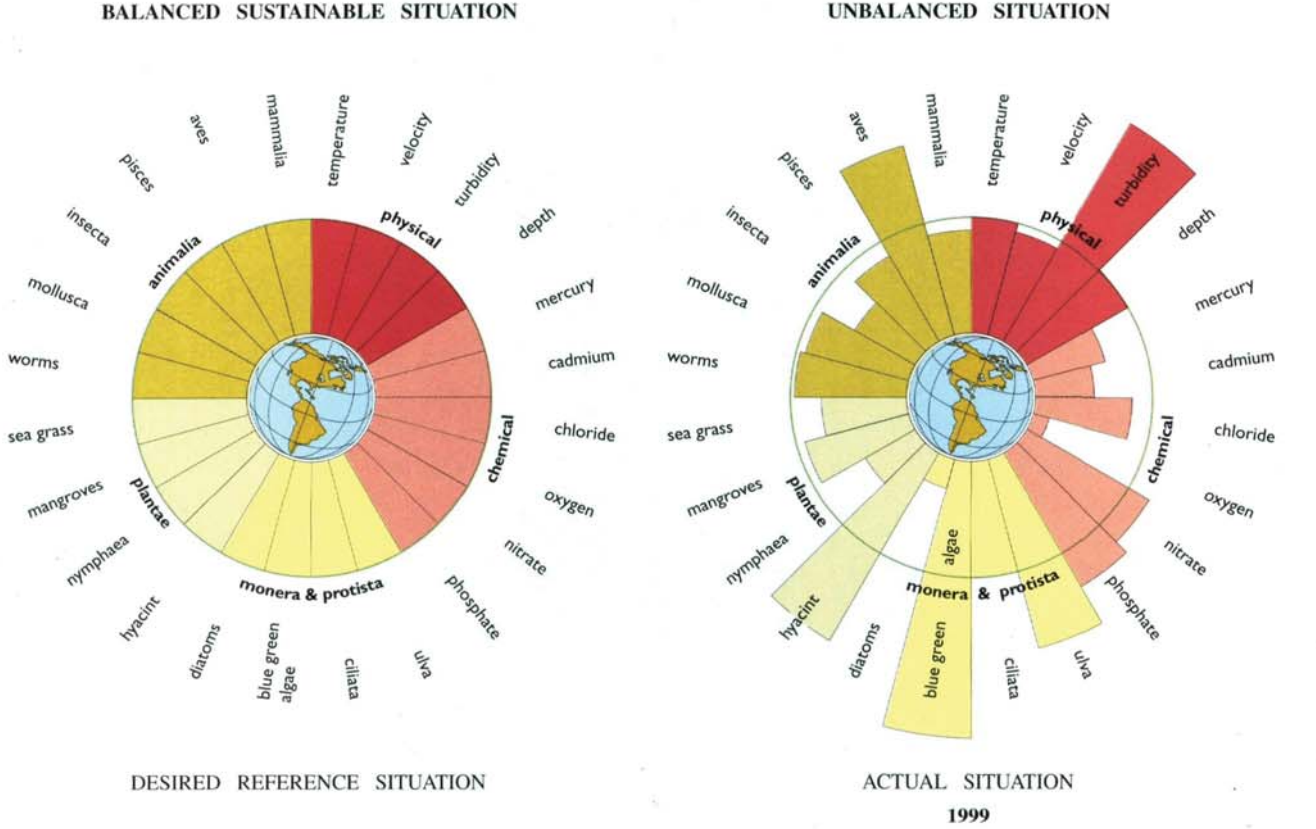




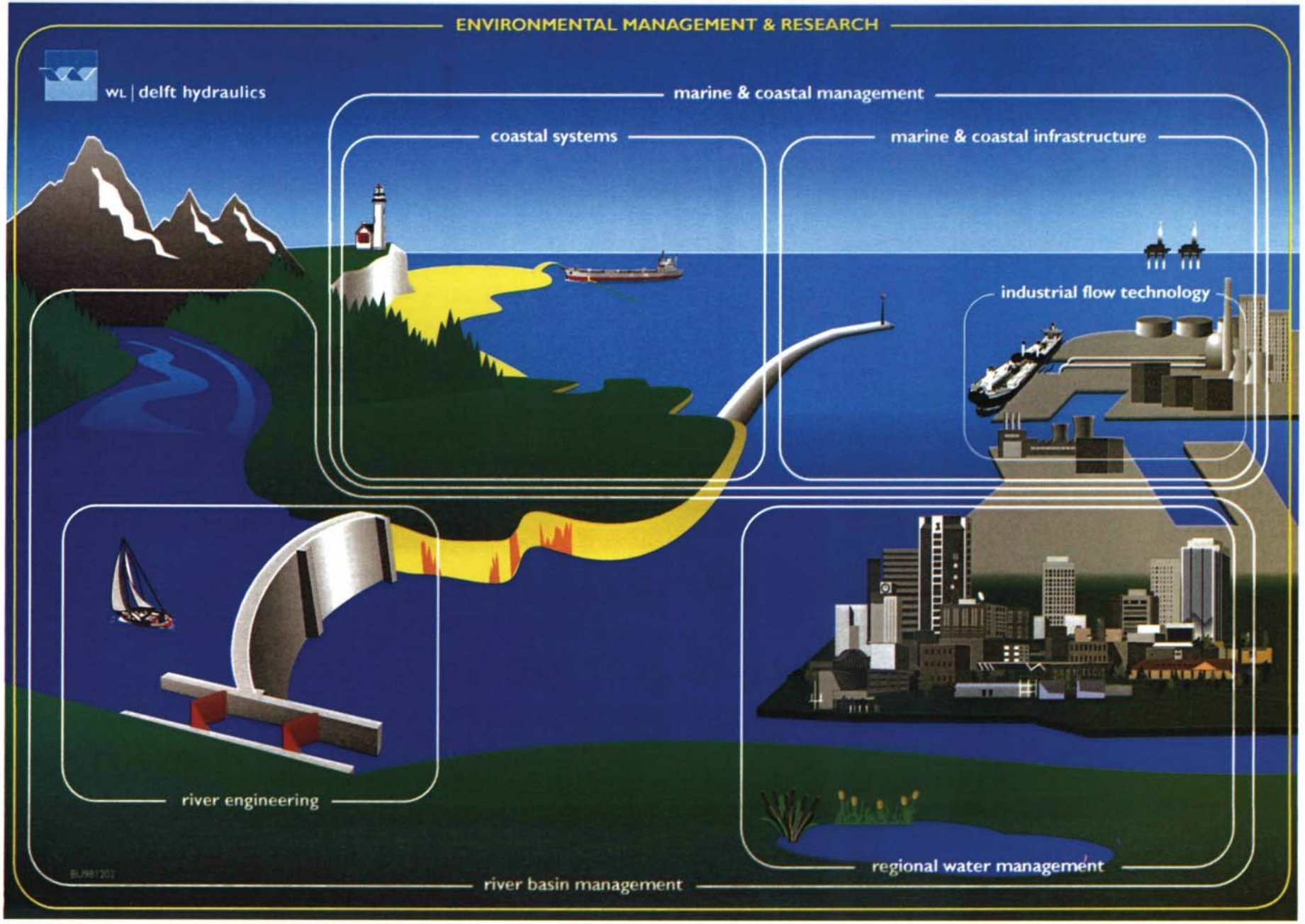
Each circle sector represents a certain biological, physical or chemical parameter. The length of each circle sector is a quantitative indication of the parameter under consideration. The combination of circle sectors gives information concerning the situation with regard to the eco-system.



Each circle sector represents a certain biological, physical or chemical parameter. The length of each circle sector is a quantitative indication of the parameter under consideration. The combination of circle sectors gives information concerning the situation with regard to the eco-system.

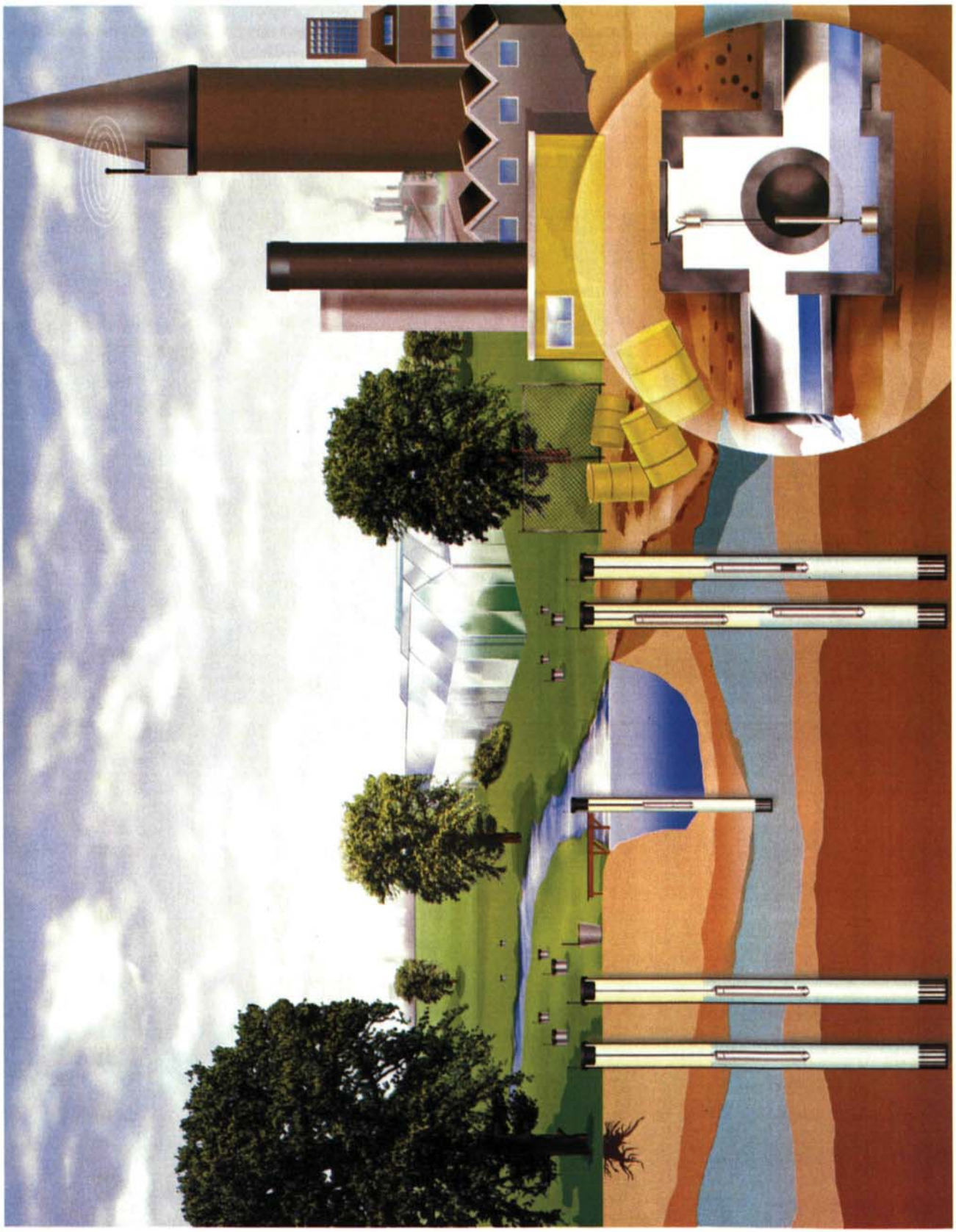


Each circle sector represents a certain biological, physical or chemical parameter. The length of each circle sector is a quantitative indication of the parameter under consideration. The combination of circle sectors gives information concerning the situation with regard to the eco-system.

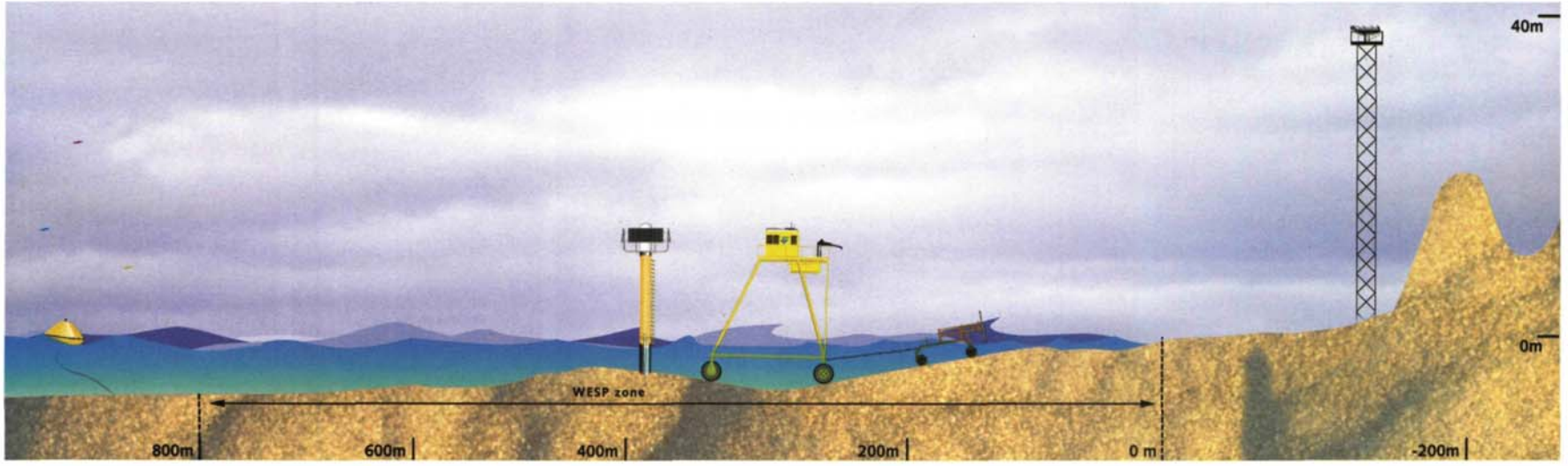

ENVIRONMENTAL MANAGEMENT & RESEARCH
WL | delft hydraulics
marine & coastal management
coastal systems
marine & coastal infrastructure
industrial flow technology
river engineering
regional water management
river basin management

MULTI-PARAMETER RADIO-TELEMETIC MONITORING FOR WATER MANAGEMENT

USING BOREHOLE DATA LOGGERS WITH SENSOR TECHNOLOGY



OBSERVATIONS OF NATURAL FORCES SHAPING THE COAST



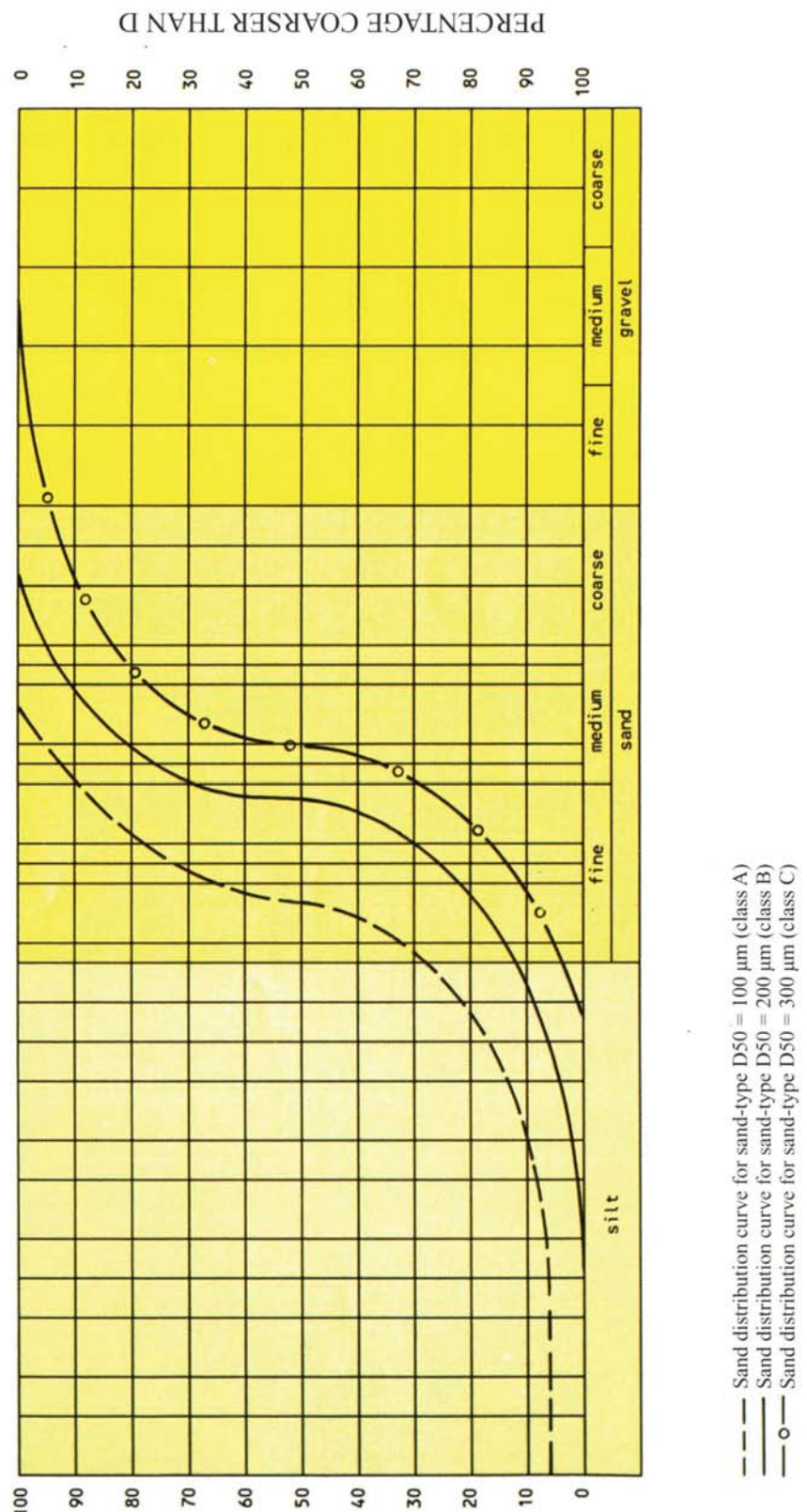
Instrument:	*Buoy*	*Frames*	*Post*	*WASP*	*Sledge*	*Video-camera*
Measures:	*Waves*	*Currents, Waves, Sand-transport*	*Wind and Water-level*	*Bottom-level*	*Currents, Waves & Sand-transport*	*Surf-zone*

The WASP (Water and Strand/Beach Profiler) survey vehicle has been developed to help clarify the causes of underwater coastal erosion. The WASP measures the position of the seabed currents and sand transport down to a depth of eight meters.

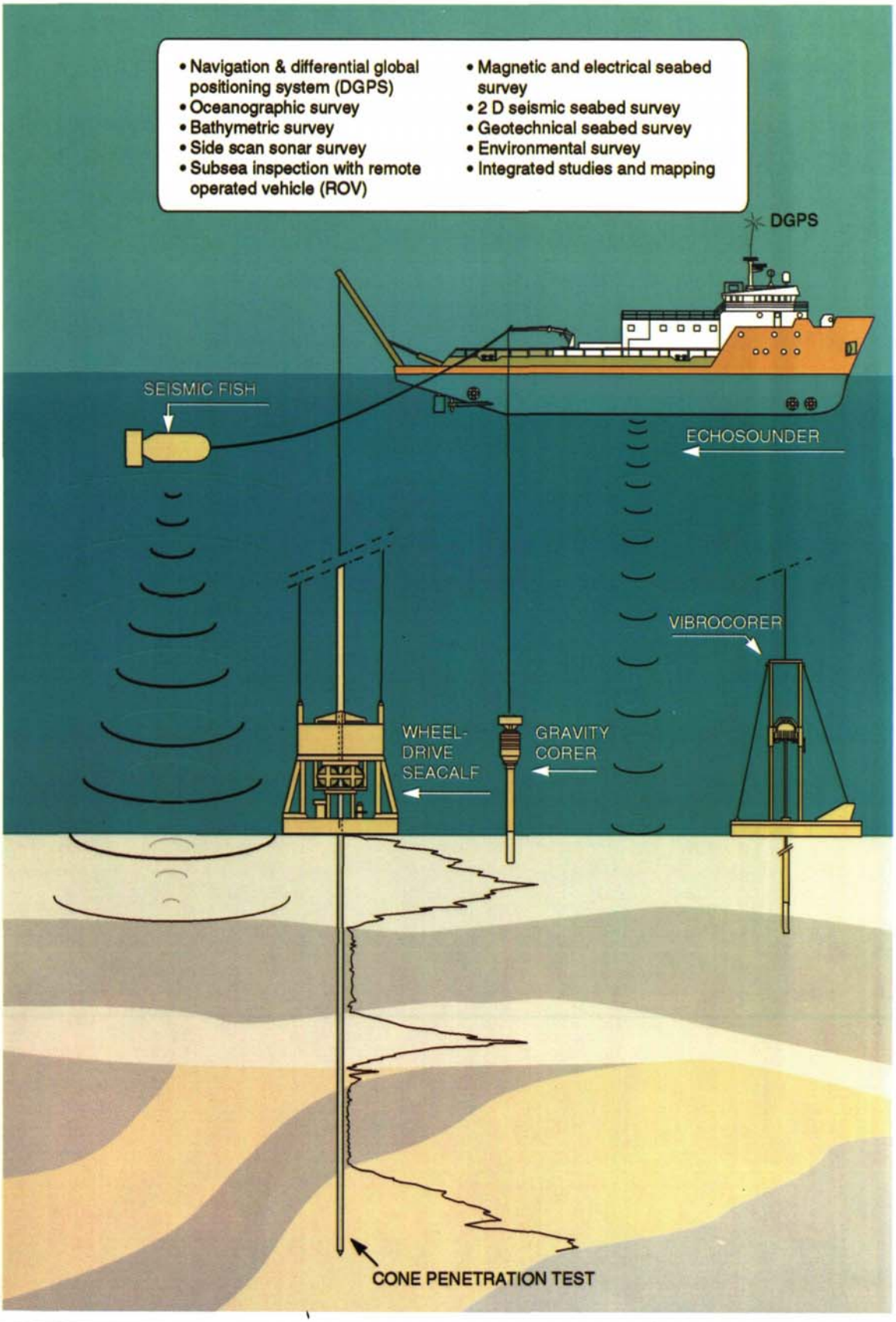
Even in rough weather, the WASP can operate quickly and accurately, considerably reducing the costs of the annual coastal survey.

Survey data gathered by the WASP provide an insight into the natural forces shaping and eroding the coast. Information about the behaviour of underwater sand-banks produces a firmer grasp of the best way to preserve the coastline.

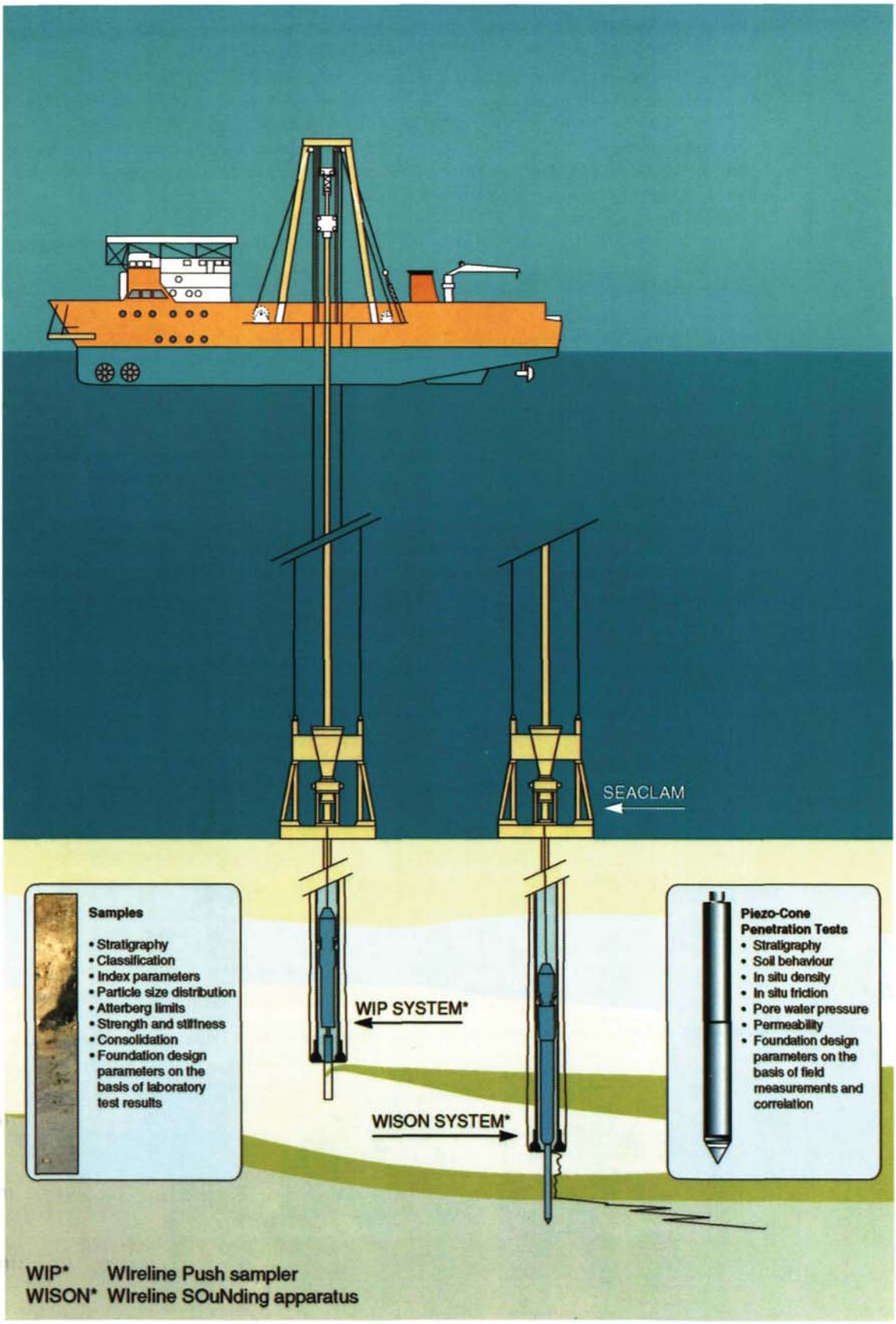
SAND CHARACTERISTICS



MARINE AND SEABED SURVEY SYSTEMS



SAMPLING AND TESTING SYSTEMS



8. BEACH NOURISHMENT AND LAND RECLAMATION

Examples of available dredging methods:

A. Trailer suction hopper dredge borrowing offshore, followed and dumping in nearshore zone

B. Trailer suction hopper dredge borrowing offshore, followed by sailing and directly pumping to the beach zone through a pipeline.

C. Trailer suction hopper dredge borrowing offshore, followed by sailing and, moored at a nearshore location, pumping through a sinkerline to the beach zone.

D. Trailer suction hopper dredge borrowing offshore, followed by sailing and rainbowing onto the beach.

E. Trailer suction hopper dredge borrowing offshore, followed by sailing and dumping in rehandle pit with suction dredge re-borrowing and dumping to the beach through a pipeline.

F. (Cutter) suction dredge borrowing in offshore area, barge loading, followed by sailing of the barge and by dumping in nearshore zone.

G. (Cutter) suction dredge borrowing in offshore area, barge loading, followed by sailing of the barge which is unloaded by a barge unloading dredge, pumpimg material though a pipeline directly to the beach.

H. (Cutter) suction dredge borrowing in offshore area, barge loading, followed by sailing of the barge which dumps in rehandle pit, where another (cutter) suction dredge re-borrows the material and pumps it to the beach through a pipeline.

I. (Cutter) suction dredge borrowing and direct pumping to the beach through a pipeline.

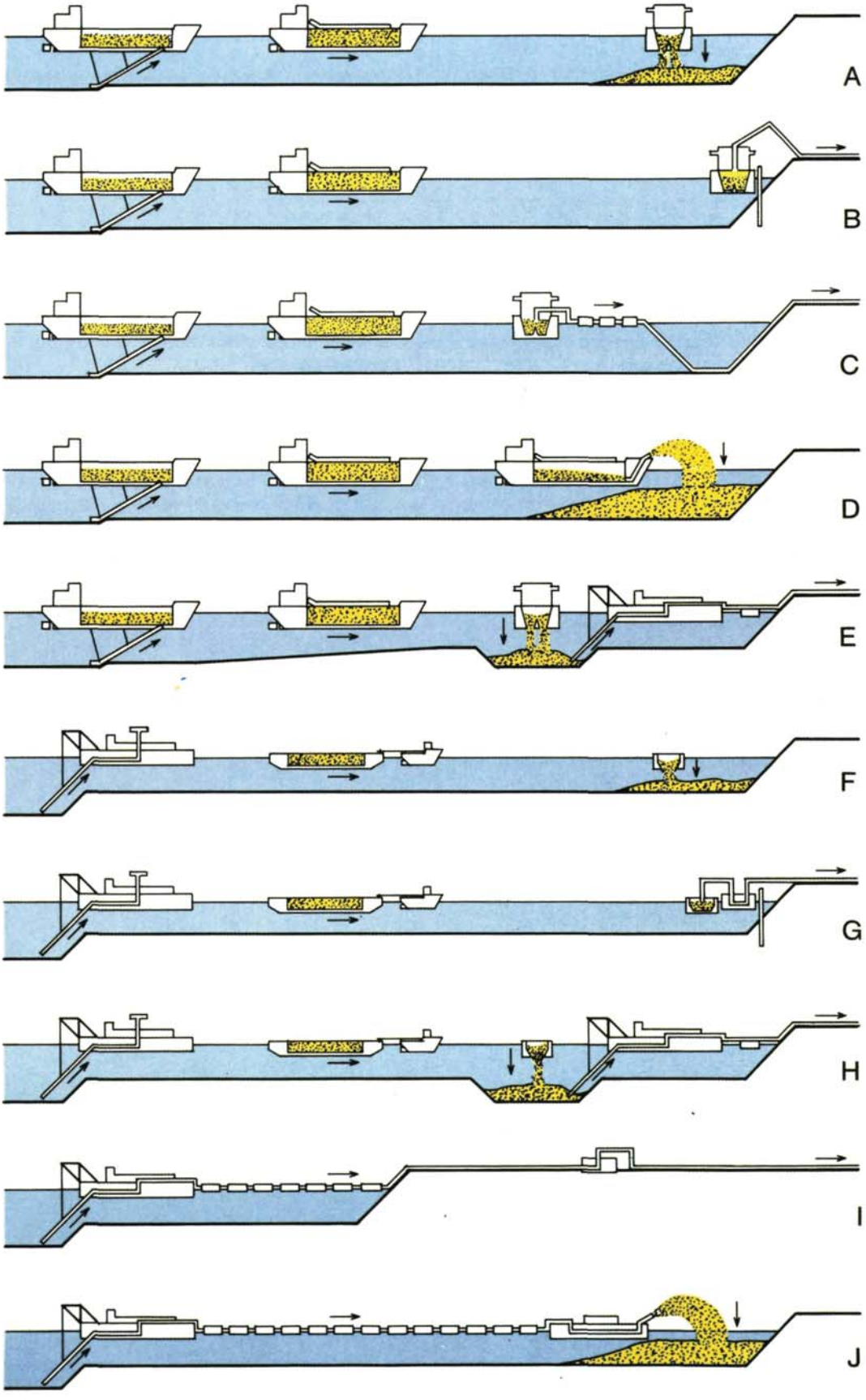
J. (Cutter) suction dredge borrowing and pumping to spray pontoon for rainbowing onto the beach.

Depending on pumping distances one or more booster stations might be incorporated in the system lay-out.

Besides these options various other schemes can be constructed to optimally fit the local conditions. It shall be noted that some auxiliary equipment will be involved in beach nourishment and land reclamation projects for beach and dune profiling and for pipeline handling.

Recent state of the art concerning dredging equipment and techniques can provide an environmentally acceptable dredging and nourishment operation. Possible negative ecological effects can in this way be minimized.

BEACH NOURISHMENT AND LAND RECLAMATION



G. H. van Raalte, J. H. van Oorschot, R. E. Waterman

9. SHORE PROTECTION

I.A. SOLUTIONS IN FULL HARMONY WITH NATURE: NATURAL BEACHES AND DUNES

I.A.1. Existing Coastline with Beaches and Dunes
I.A.2. Dune & Beach Nourishment
I.A.3. Foreshore Nourishment

I.B. SOLUTIONS USING ARTIFICAL STRUCTURES IN HARMONY WITH NATURE

I.B.1. Submerged Parallel Berm / Perched Beach
I.B.2. Submerged Offshore Breakwaters (Reef type)
I.B.3. Offshore Breakwaters
I.B.4. Multiple Offshore Breakwaters, without or with Sills
I.B.5. Multiple Offshore Breakwaters, without or with Sills
I.B.6. T - shaped Breakwaters, without or with Sills
I.B.7. Groynes, open or closed

I.C. SEAWALLS WITH SMOOTH SLOPES

I.C.1. Berm type
I.C.2. Continuous Slope Type

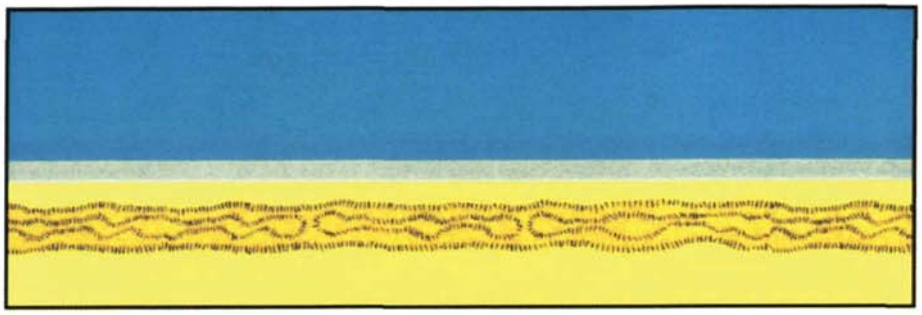
I.D. SEAWALLS WITH STEEP SLOPES

I.D.1. Berm type
I.D.2. Continuous Slope Type

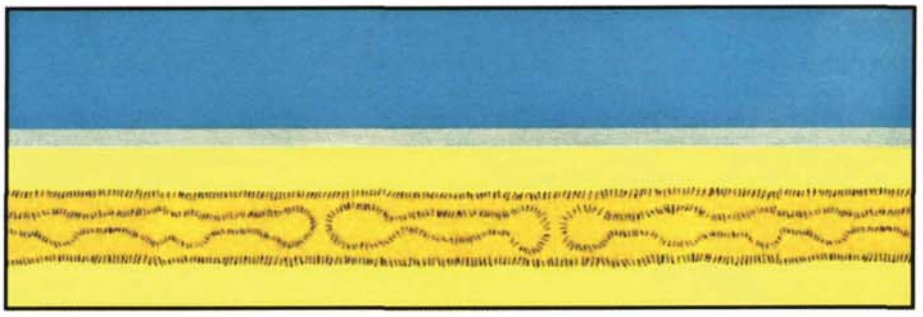
I.E. SEAWALLS WITH CAISSONS

I.E.1 Hantsholm Type
I.E.1 Hantsholm Type, perforated
I.E.1 Hantsholm Type, perforated, with internal Rock Slope

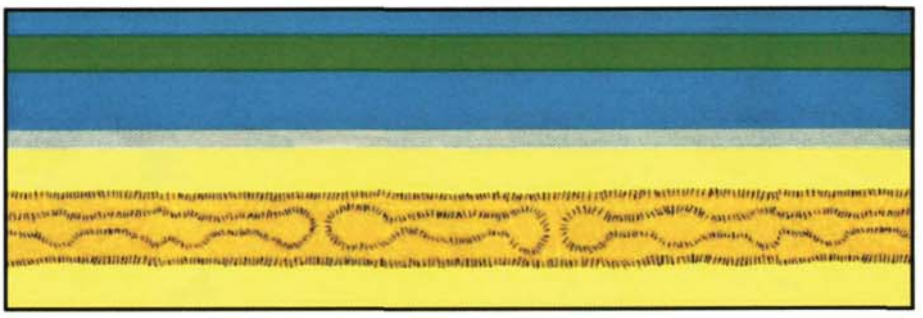
1.A. Solutions in full harmony with Nature: Natural Beaches and Dunes



1.A.1.
Existing Coastline
with Beach and Dunes

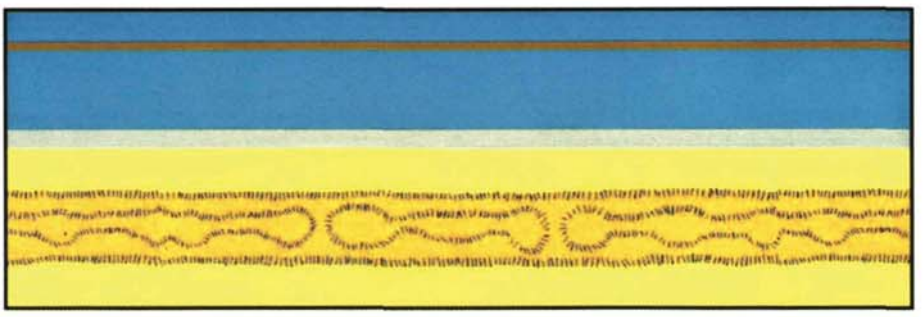


1.A.2.
Dune and Beach
Nourishment

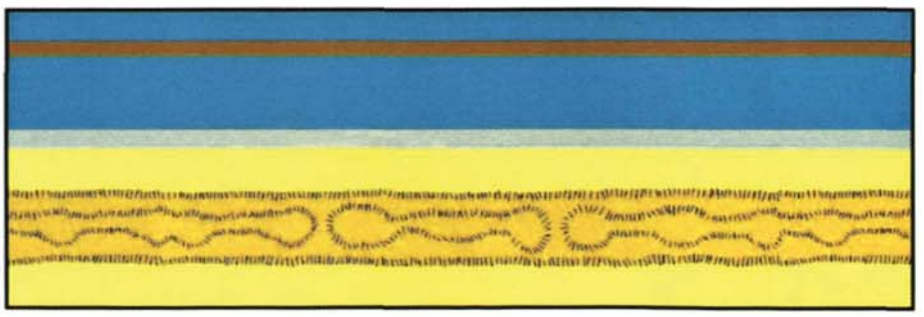


1.A.3.
Foreshore Nourishment

1.B. Solutions using Artificial Structures in harmony with Nature



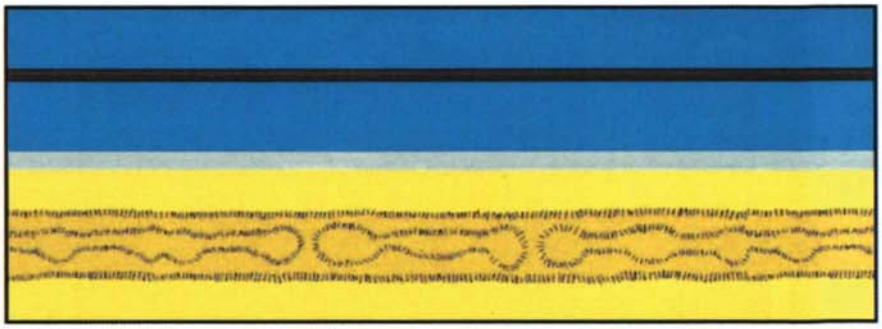
1.B.1.
Submerged
Parallel Berm /
Perched Beach
(Sand Retaining Dam)



1.B.2.
Submerged Offshore
Breakwater - Reef Type
(Sand Retaining Dam,
Wave Energy Reduction)

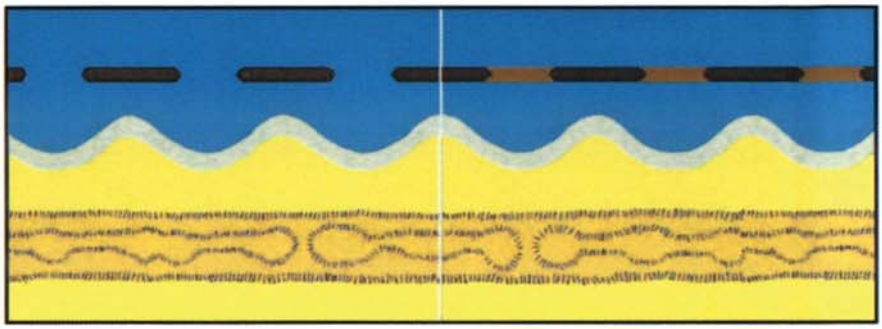
HW

1.B.3.
Offshore Breakwaters
(Sand Retaining Dam,
Wave Energy Reduction)



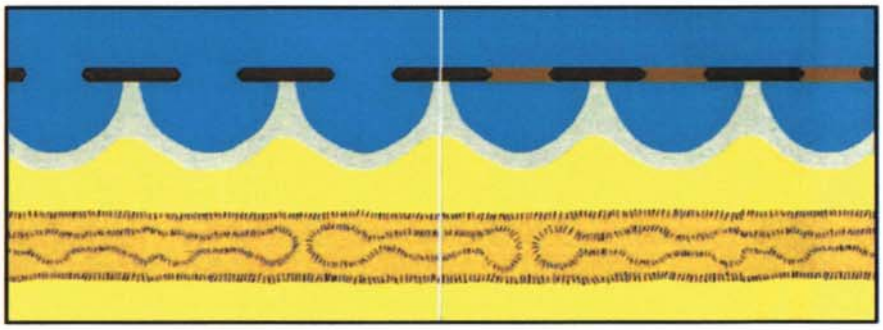
HW

1.B.4.
Multiple Offshore
Breakwaters without or
with Sills
(Salient Beaches)



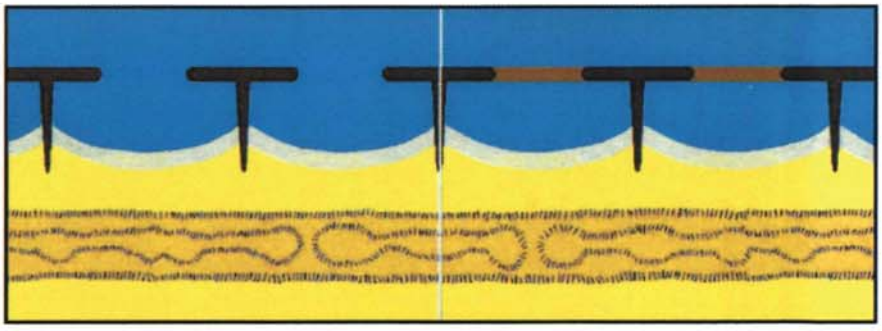
HW

1.B.5.
Multiple Offshore
Breakwaters without or
with Sills
(Tombolo Beaches)



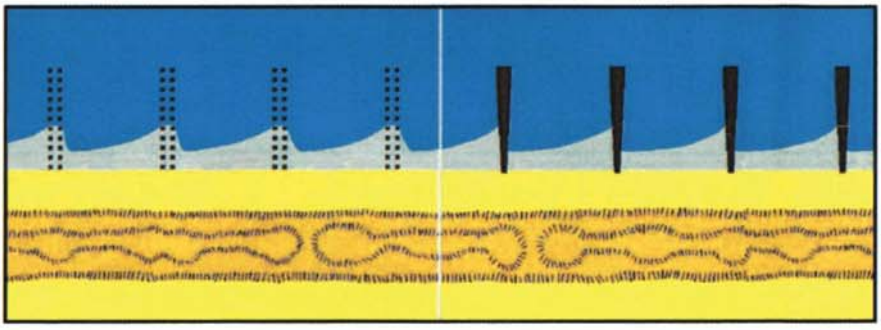
HW

1.B.6.
T-Shaped Breakwaters
without or with Sills
(Pocket Beaches)



HW

1.B.7.
Groynes, Open or Closed

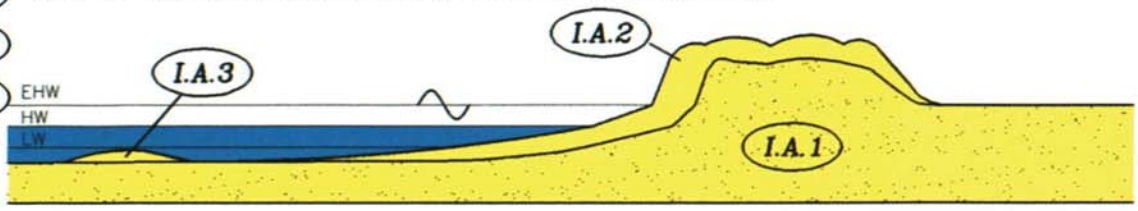


I.A NATURAL BEACHES AND DUNES

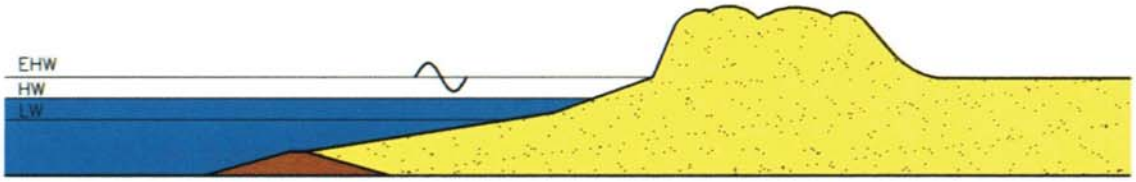
I.A.1 WITH OR WITHOUT FORESHORE AND ONSHORE NOURISHMENT

I.A.2

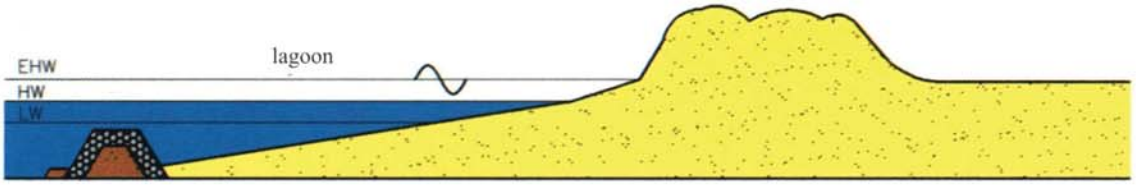
I.A.3



I.B.1 SUBMERGED PARALLEL BERM / PERCHED BEACH



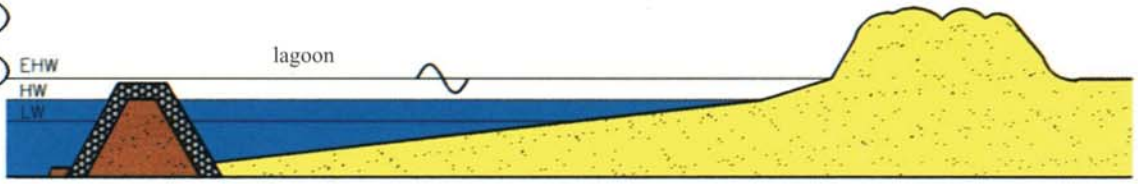
I.B.2 SUBMERGED OFFSHORE BREAKWATER



I.B.4 (MULTIPLE) OFFSHORE BREAKWATER

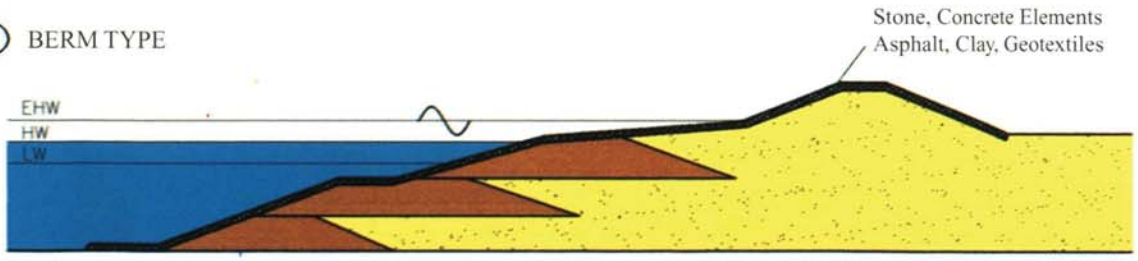
I.B.5

I.B.6

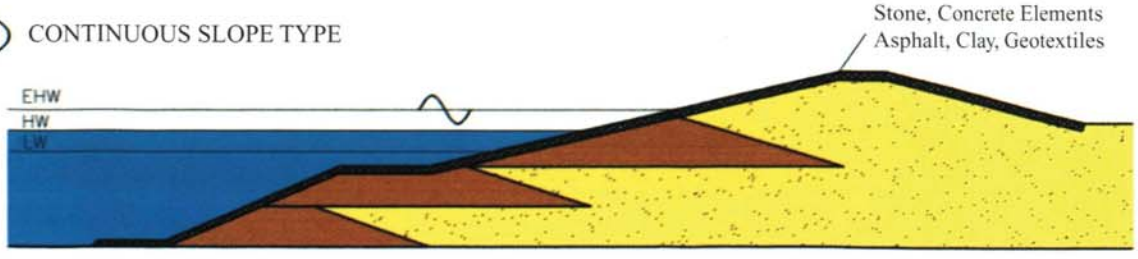


I.C SEAWALLS WITH SMOOTH SLOPES

I.C.1 BERM TYPE

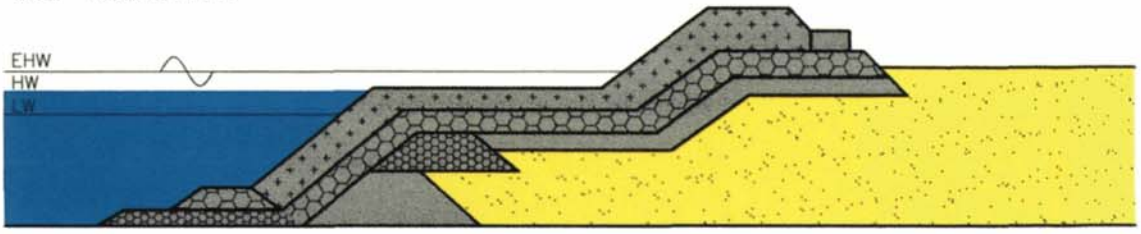


I.C.2 CONTINUOUS SLOPE TYPE

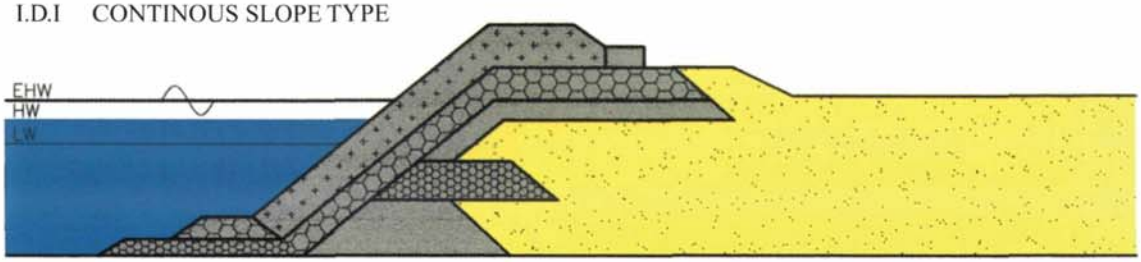


I.D SEAWALLS WITH STEEP SLOPES

I.D.I BERM TYPE

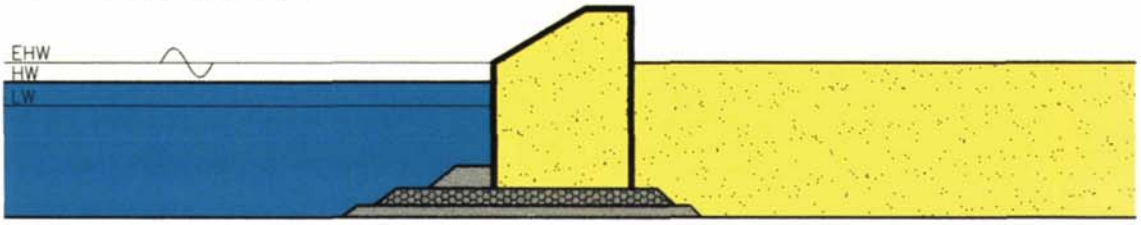


I.D.I CONTINOUS SLOPE TYPE

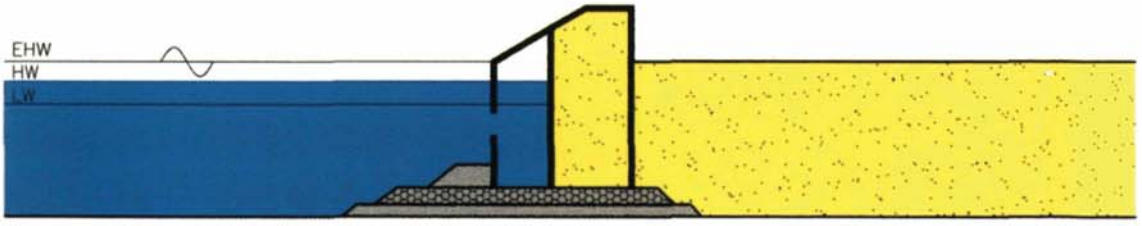


I.E SEAWALLS WITH CAISSONS

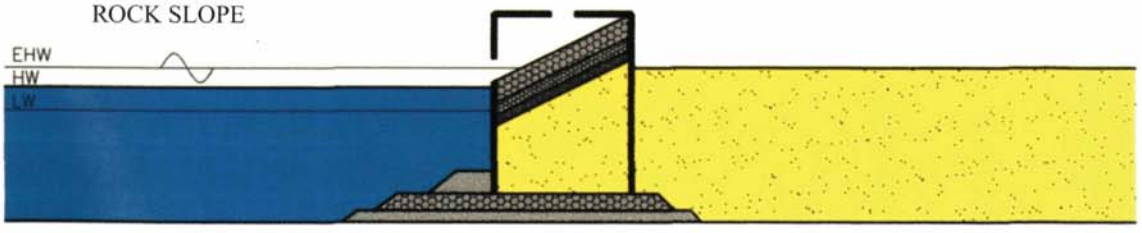
I.E.I. HANTSHOLM TYPE



I.E.2 HANTSHOLM TYPE PERFORATED



I.E.3 HANTSHOLM TYPE
PERFORATEDWITH INTERNAL
ROCK SLOPE



10. LAND RECLAMATION

II.A POLDERS: DIKE AROUND A SILTATED AREA OF TIDAL FLATS (MARSHLANDS)

II.A.1. Stage 1
II.A.1. Stage 2
II.A.1. Stage 3
II.A.1. Stage 4: Water Management by Gravity Drainage

II.B. POLDERS: DIKE AROUND AN AREA OF SEA BED OR LAKE BED

II.B.1. Stage 1
II.B.2. Stage 2: Water Management by Pumping

II.C. OPTIONS FOR ISLAND CONSTRUCTION I: DIKED AREAS

II.C.1. Polder 1: Water Management by Pumping
II.C.2. Polder 2: in combination with Landfill: Water Management by Pumping
II.C.3. Landfill 1: Water Management by Gravity Drainage

II.D. OPTIONS FOR ISLAND CONSTRUCTION 2: SANDFILL BASE

II.D.1. Protection by Dunes or Dykes
II.D.2. Protection by Caisson Walls

II.E. OPTIONS FOR ISLAND CONSTRUCTION 3: CONCRETE BASE

II.E.1. Caissons
II.E.2. Pile Based Platform
II.E.3. Pile Based Platform

II.F. PHASES OF URBAN DEVELOPMENT ON ARTIFICIAL ISLANDS 1: POLDER TYPE

II.F.1. Stage 1: Polder
II.F. 2. Stage 2: Concrete Slab Base (with Underground Space)
II.F.3. Urban Construction

II.G. PHASES OF URBAN DEVELOPMENT ON ARTIFICIAL ISLANDS 2: LANDFILL TYPE

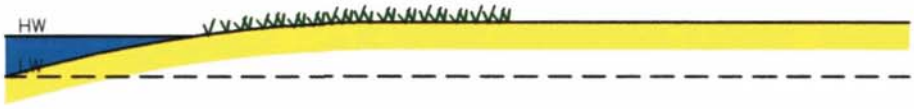
II.G.1. Stage 1: 'Pancake Fill'
II.G.2. Stage 2: Caisson Base (with Underground Space)
II.G.3. Stage 3: Urban Construction

II.A POLDERS : DIKE AROUND AN ABOVE HW LEVEL SILTATED AREA OF TIDAL FLATS (MARSHLAND)

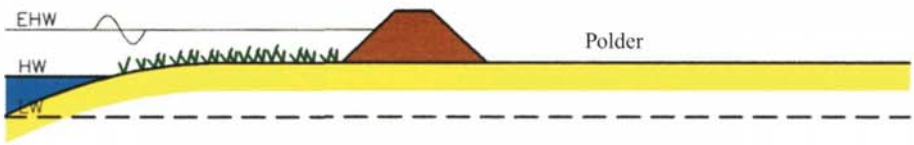
II.A.1 STAGE 1

II.A.2 STAGE 2

II.A.3 STAGE 3



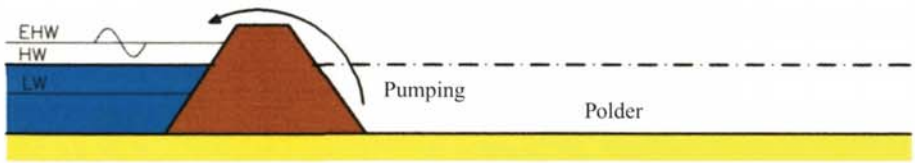
II.A.4 STAGE 4 : WATER MANAGEMENT BY GRAVITY DRAINAGE



II.B DIKE AROUND AN AREA OF SEA BED OR LAKE BED

II.B.1 STAGE 1

II.B.2 STAGE 2 : WATER MANAGEMENT BY PUMPING



GENERAL PRINCIPLE OF POLDER SYSTEMS

H 2126 040

Dike with road

Main canal

-4,50 Depth below sea level (m)

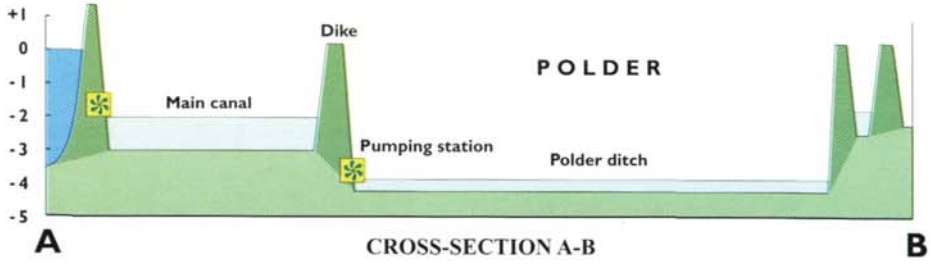
Pumping station

Polder ditch

External water (river and sea)

Discharge sluice (without pumping station)

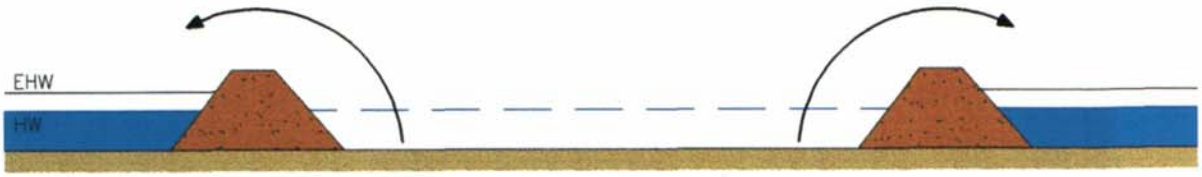
Direction of discharge of water



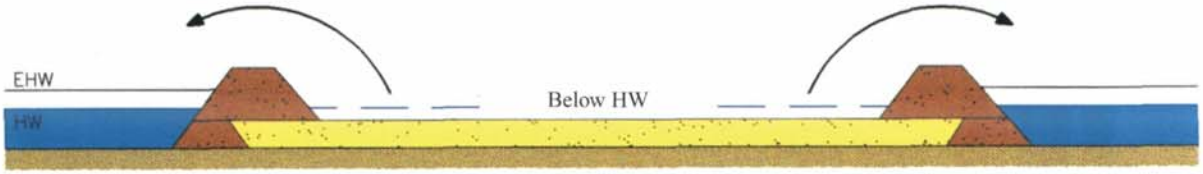
CROSS-SECTION A-B

II.C OPTIONS FOR ISLAND CONSTRUCTION 1 : DIKED AREAS

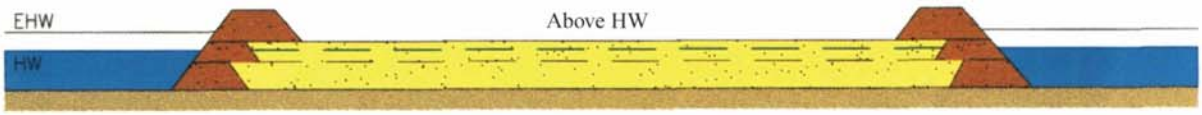
II.C.1 POLDER 1 : WATER MANAGEMENT BY PUMPING



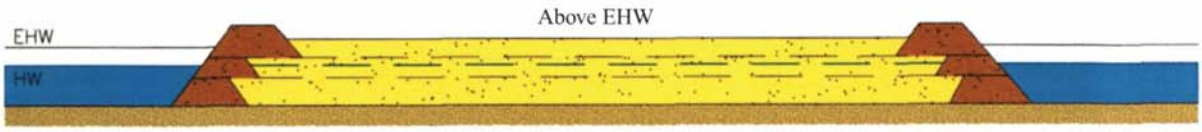
II.C.2 POLDER 2 : WATER MANAGEMENT BY PUMPING IN COMBINATION WITH LANDFILL



II.C.3 LANDFILL 1 : WATER MANAGEMENT BY GRAVITY DRAINAGE

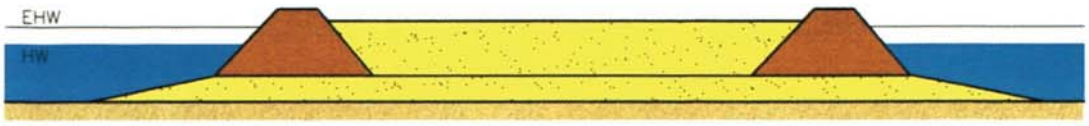


II.C.4 LANDFILL 2 : WATER MANAGEMENT BY GRAVITY DRAINAGE

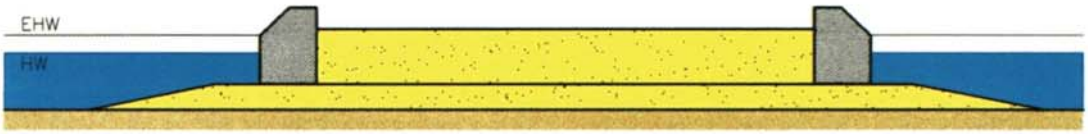


II.D OPTIONS FOR ISLAND CONSTRUCTION 2 : SANDFILL BASE

II.D.1 PROTECTION BY DUNES OR DIKES

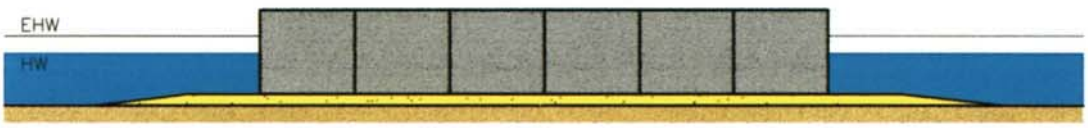


II.D.2 PROTECTION BY CAISSON WALLS

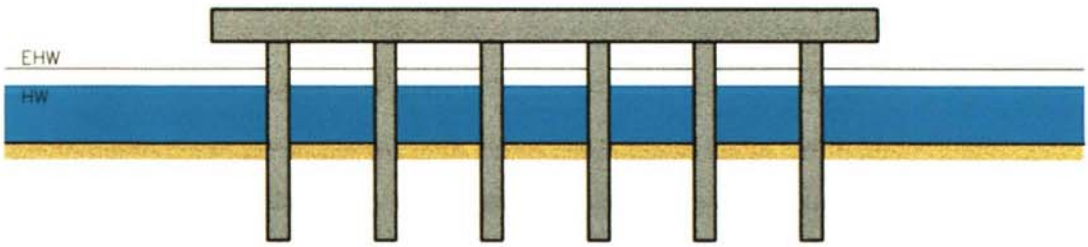


II.E OPTIONS FOR ISLAND CONSTRUCTION 3 : CONCRETE BASE :

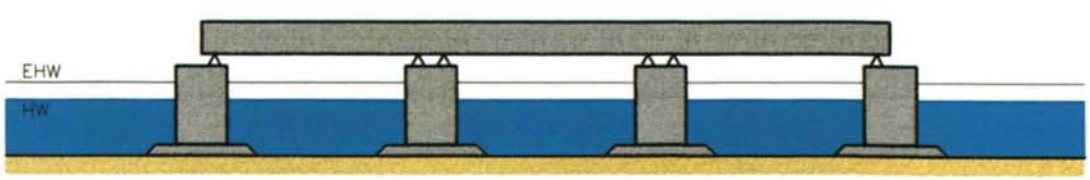
II.E.1 CAISSONS



II.E.2 PILE BASED PLATFORM



II.E.3 PIER BASED PLATFORM

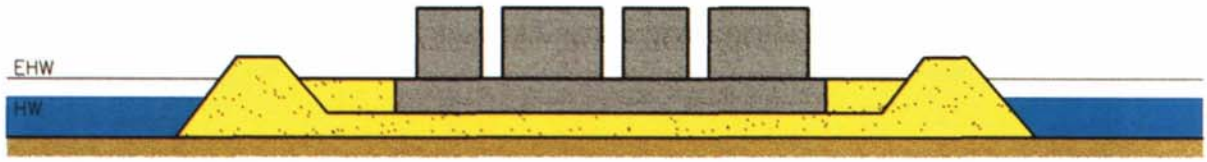


II.F PHASES OF URBAN DEVELOPMENT ON ARTIFICIAL ISLANDS 1 : POLDER TYPE

II.F.1 STAGE 1 : POLDER

II.F.2 STAGE 2 : CONCRETE SLAB BASE (WITH UNDERGROUND SPACE)

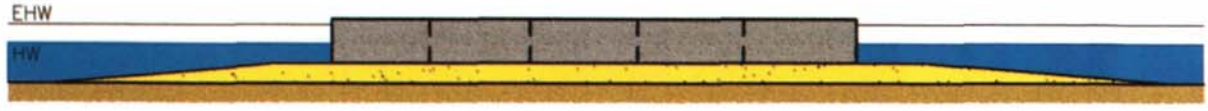
II.F.3 STAGE 3 : URBAN CONSTRUCTION



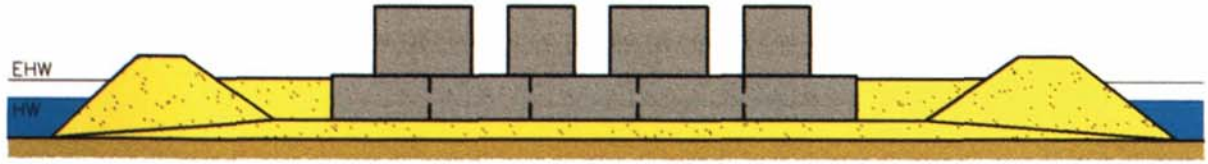
II.G PHASES OF URBAN DEVELOPMENT ON ARTIFICIAL ISLANDS 2 : LANDFILL TYPE

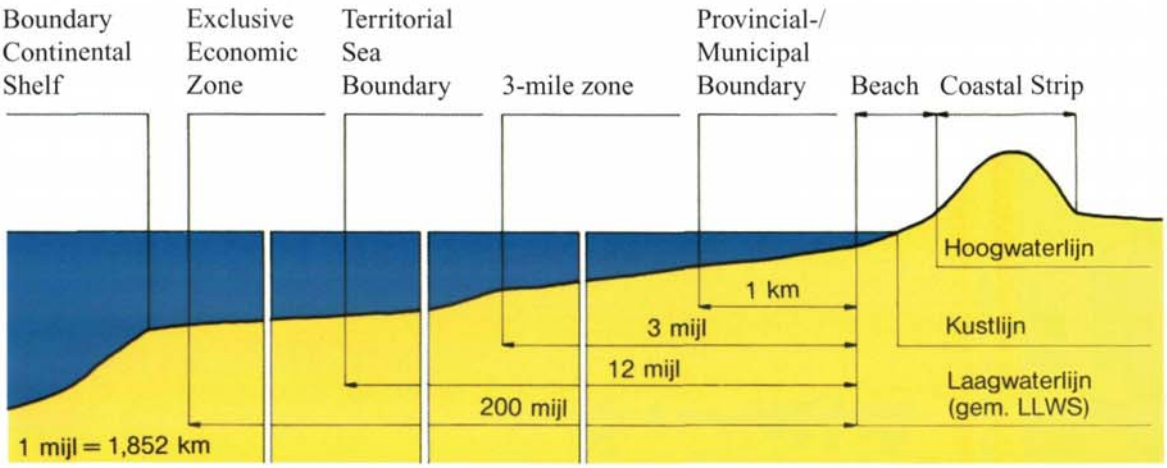
II.G.1 STAGE 1 : 'PANCAKE' FILL

II.G.2 STAGE 2 : CAISSON BASE (WITH UNDERGROUND SPACE)



II.G.3 STAGE 3 : URBAN CONSTRUCTION

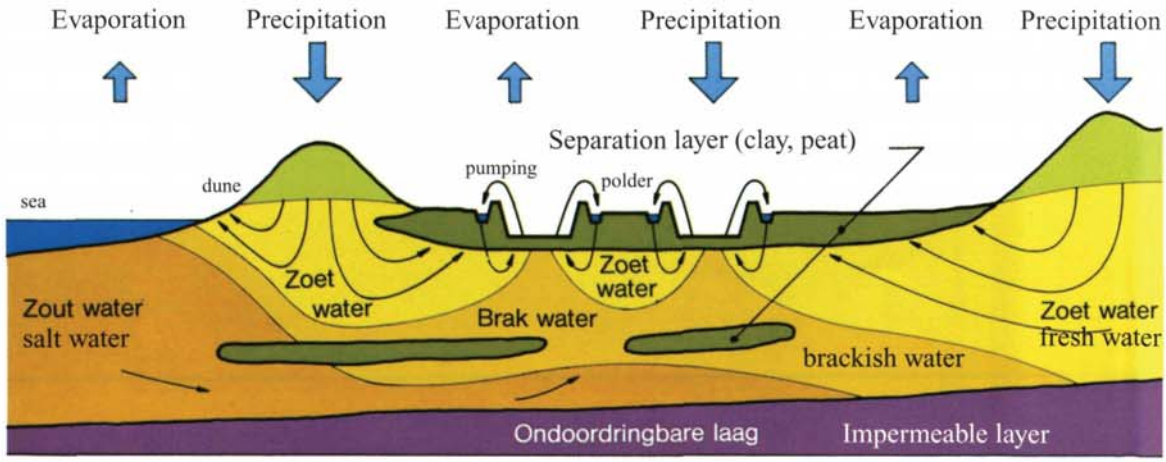




CROSS SECTION COASTAL ZONE

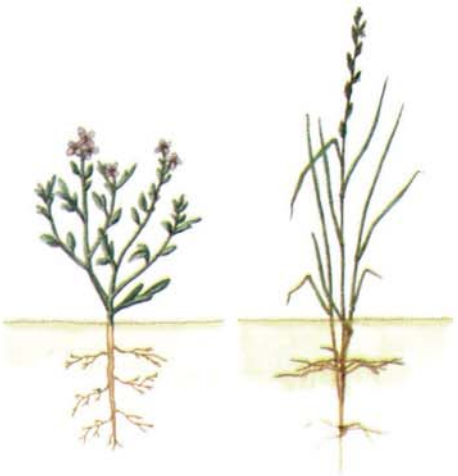
with national & international boundaries

Data : Chef der Hydrografie W.A. van Gein



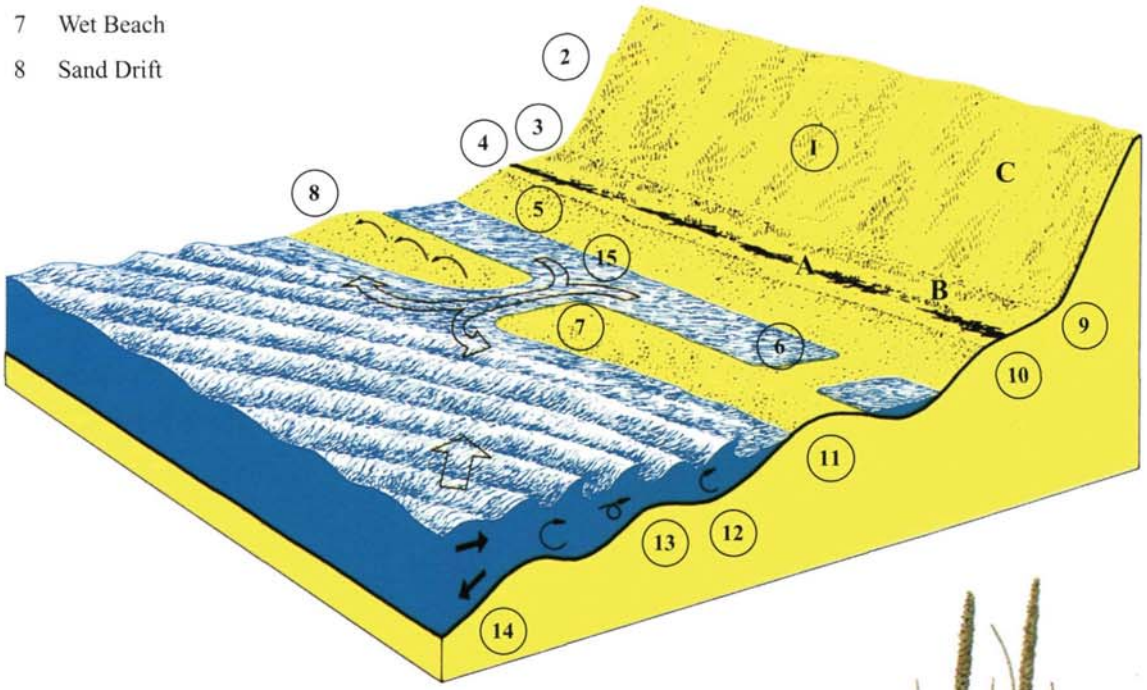
CROSS SECTION SUBSOIL OF WEST-HOLLAND

Data : Rijks Geologische Dienst - S. Jelgersma

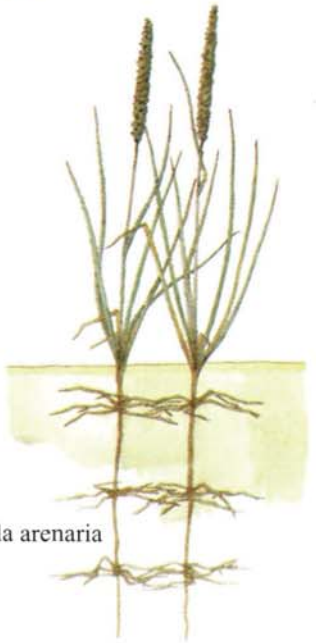


A. Elytrigia juncea B. Cakile maritima

1 Dune
2 Coastal Strip
3 Dune Toe
4 Flood Mark
5 Dry Beach
6 Creek
7 Wet Beach
8 Sand Drift



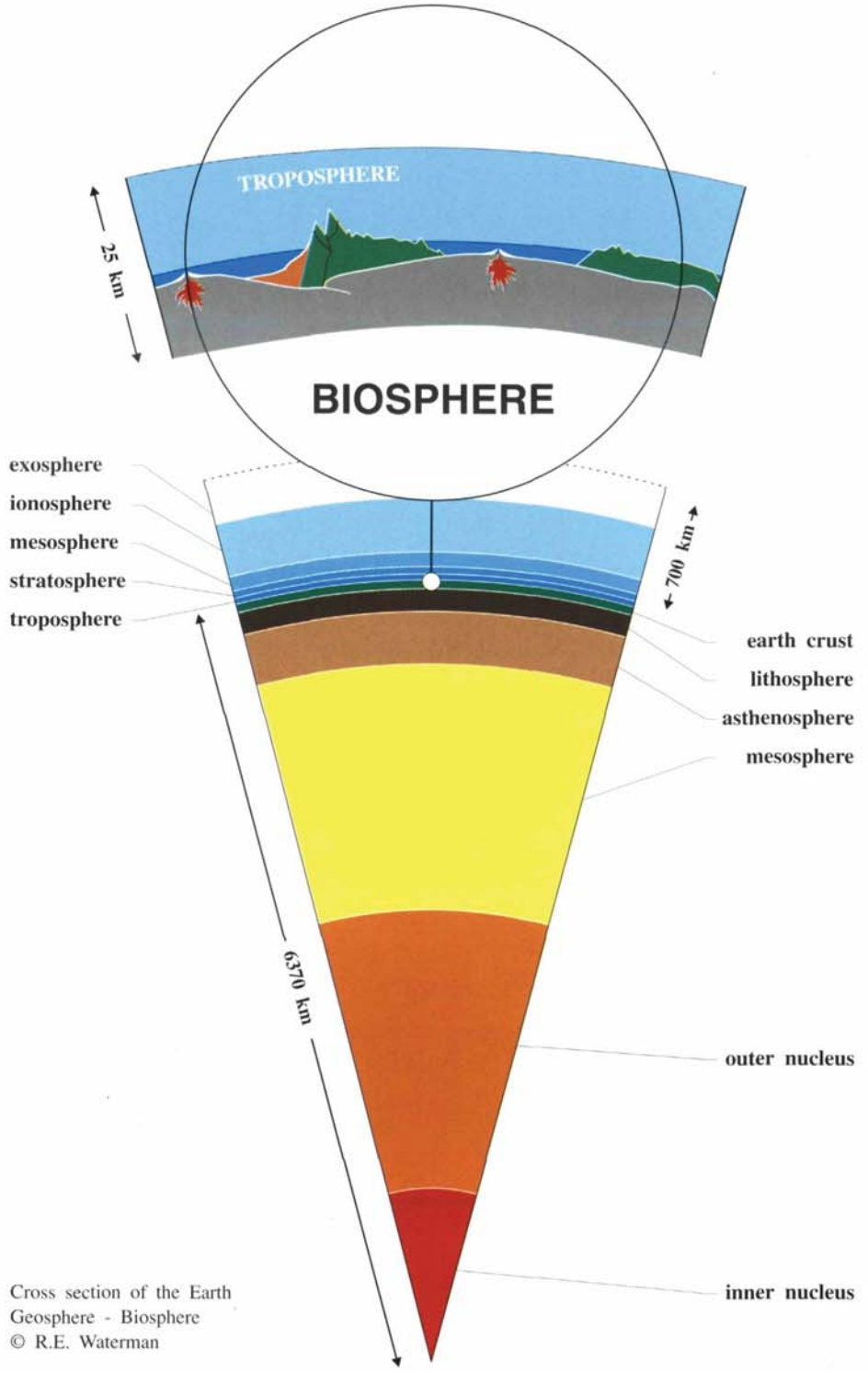
9 High water during storm surge
10 High water
11 Low water
12 Geo valley in surfzone
13 Geo ridge in surfzone
14 Undercurrent
15 Rip current



C. Ammophila arenaria

COASTAL ZONE WITH DUNES & VEGETATION

Lit: L.P. Louwe Kooijmans, Sporen in het Land, de Nederlandse Delta in de Prehistorie,
W.H. van der Putten, Establishment, Growth and Degeneration of Ammophila Arenaria in Coastal Sand Dunes, dissertatie, Wageningen, 1989.



Cross section of the Earth
Geosphere - Biosphere
© R.E. Waterman

11. RELATIONSHIP ENVIRONMENT - ECONOMY

1. ENVIRONMENT - CONVERSION PROCESSES - ECONOMY

In the coastal zone under consideration, as in any other terrestrial zone, it is of vital importance to pay close attention to the relationship between environment and economy and to the actions of men in this zone. Therefore it is necessary to describe briefly but thoroughly the environment in general and to investigate in more detail conversion processes initiated, propagated, terminated or influenced by men in this environment.

Apart from space travel practically all direct and indirect human activities take place in the biosphere. This is a very thin layer around the earth of which the thickness is determined by the height of the lower layers of the atmosphere (troposphere) and the maximum depth of the sea, including a thin upper layer of the sea bed *), all together not exceeding 25 km.

The land and sea surface within this biosphere is very large, totalling 510,000,000 km^2, and the radius of the earth is approximately 6370 km. However the thickness of the biosphere of only 25 km remains, relative to the other dimensions, very limited.

In the biosphere of the earth there are three environmental compartments present: AIR - WATER - SOIL and furthermore, in close relationship with these compartments: MICRO-ORGANISMS - FLORA - FAUNA, (including mankind, totalling at least 6 billion in the year 2000; a number which will still rise in the future, with all the inherent -often negative- consequences). To this list we have to add BUILDINGS in the widest sense, meaning all material expressions of human activities like cities, villages, factories, dikes, roads, railroads, airports.

The earth, including the biosphere, receives from the outside, through radiation, electromagnetic energy from the sun. The earth itself also radiates energy. Other outside influences in the biosphere are the various rotation and translation movements in which the earth is participating, the force of gravity and electromagnetic fields within our solar system.
The upper layers of the atmosphere above the troposphere and the various shells of the earth below the troposphere (crust, mantle, molten zone and solid nucleus) express their influence in various ways, amongst others coupled with transport of impulse, mass and energy between and within the various layers, often also accompanied by chemical reactions.

In short it is crystal clear that within our solar system, we have to deal with a very complex geosphere - biosphere - sociosphere**).

In the biosphere there are eco-systems present. An eco-system can be defined as a total of living organisms, in continuous relationship with each other and with their environment. More specific, these organisms are fully dependent on the biotic, chemical and physical factors and information.
When we consider information, we are referring to all forms of information, varying from information in the human brain, in libraries, computer-stored information; information in DNA to, generally speaking, information in the earth itself and in the universe.

Furthermore we have to take into account a whole series of mass/energy-cycles, such as the hydrological cycle, the carbon-cycle, the nitrogen-cycle, the sulfur cycle. We must realise that in this geosphere - biosphere - sociosphere we have to deal with a complex (so far !) self-regulating dynamic system. But that could change in the future, primarily due to the activities of men.

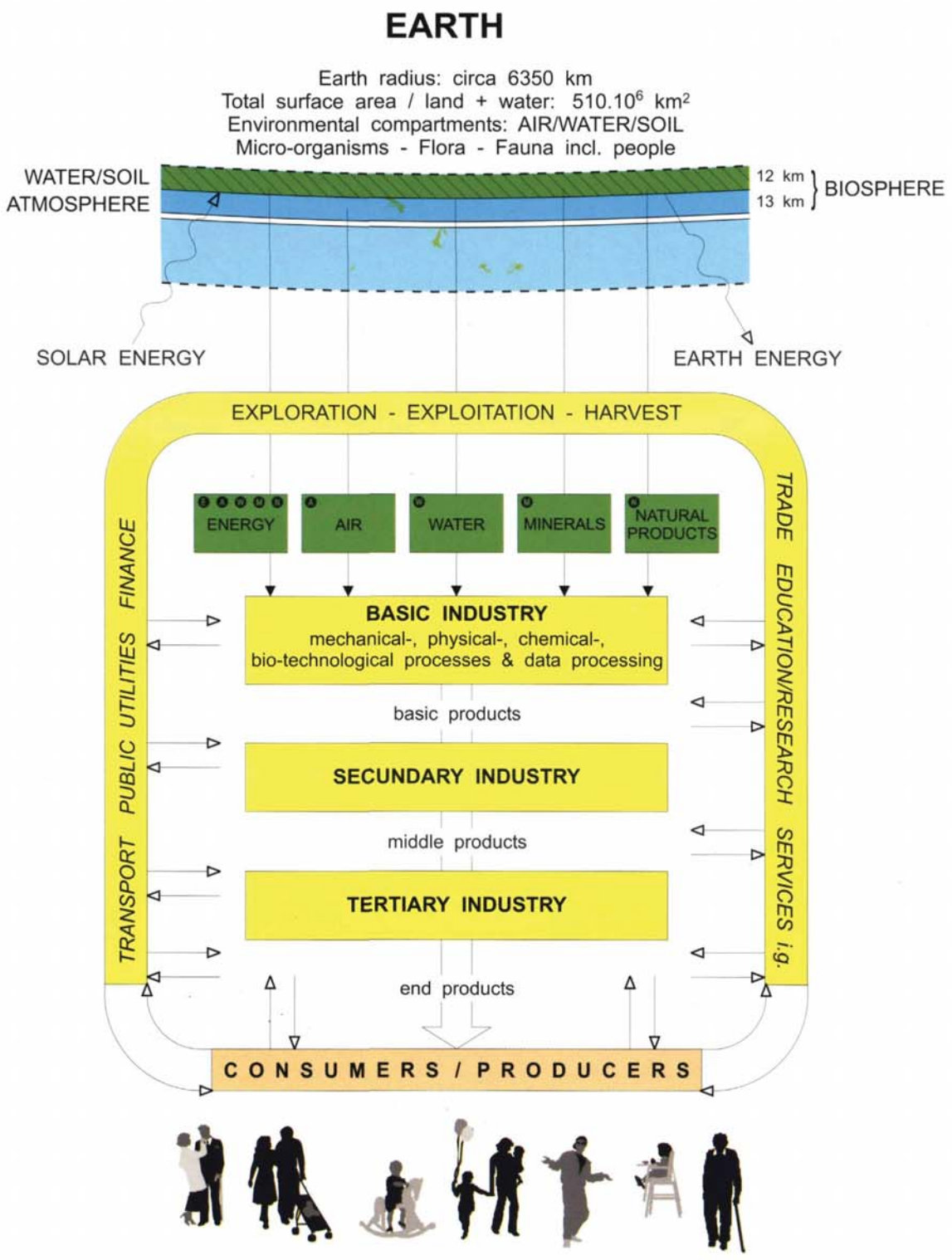
Year after year men are extracting thousands of types of raw materials from this biosphere and in this biosphere, to be used in man-initiated and man-managed conversion processes. These thousands can be reduced to five elementary types (groups) of raw materials:

1. Energy, in various forms, from various sources;
2. Air (N_2, O_2, A, CO_2, CH_4, ...);
3. Water;
4. Minerals;
5. Nature products, which can be gained or harvested through forestry, horticulture and other types of agriculture, aquaculture, mariculture, fishery, and through various types of bio-technological processes.

These five elementary groups of raw materials are brought, together with information, to the primary industry. Using mechanical-, physical-, chemical- and/or bio-technological conversion processes and data-processing, these raw materials are transformed into

*) *or maximum depth of boreholes*

**) *the sociosphere, as part of the biosphere, takes into account all the intricate interactive human relationships in society*



Process-industry as core-activity within the economic situation in the environment

primary products. From there they are transported to the secondary industry, where again conversion processes take place. Etcetera. In fact we have often to deal with a whole industrial chain, starting with raw materials and ending with end-products. Not only with industrial chains, but also with clusters consisting of production units in the industrial sector, the energy sector, the transport sector, the agricultural sector and/or the domestic sector, in which raw materials, certain primary and secundary products & by-products, 'degraded' and/or excess energy and so on are interactively used.

Exploration and exploitation (mining, agriculture including forestry and horticulture, cattle-breeding, aqua-culture & mari-culture, fishery, biological/biotechnological processes in general) of the five elementary groups of raw materials (Energy/Air/Water/Minerals/Nature Products), are followed by a producing industrial chain with as important links and cross-links Transport - Trade - Public Utilities- Finance - Education - Research - Development - Services in general (public & private). At the end of the chain the end-products reach the consumers, which are always also producers.

Each person, each human being is producing waste, and many consumers are in one way or another involved in the production processes. So each consumer is at the same time a producer.

In industry, but also in exploration and exploitation, in power stations, in municipal waste incinerators, in transport, in agriculture, aquaculture & mariculture, in the domestic sector one has to deal with conversion processes, including the afore mentioned conversion processes.

When we focus on the conversion-processes and give them a central position in industry and related categories, we have to state that generally speaking these industries and related categories are not working with closed systems. There are almost always emissions to air, water and soil. Some of these emissions are not harmful to the environment, others are. And the same applies to products and by- products.

2. VIA PROCESS-INNOVATION TOWARDS A STRONGER ECONOMY AND A BETTER ENVIRONMENT

When we want to improve the environment, it is essential that the hazardous emissions to air, water and soil are drastically reduced. That in itself is however not sufficient.

The industry and other related categories in which conversion-processes take place should develop their processes in such a way that these processes or new processes should be so developed and executed, that with less raw materials and less energy and with a higher yield, with less hazardous emissions to air, water and soil, useful products are made with less by-products. The product specification must be chosen in such a way that these products during their lifetime and thereafter are relatively environmentally friendly. The by-products must be processed and applicated or - if that is not possible- safely stored.

In many cases such an innovation not only leads to better products and a better environment, but also - after a shorter or longer period- to an overall improved economy.

Important instruments for an environmental policy are clean process-integrated technology, clean products and in addition a cleaning-up and isolation technology to remove or improve existing situations that are harmful to the environment.

Closely related with the development of new environmentally friendly production-processes and products, is the analysis of existing processes and products. Therefore an integrated environmental care system is necessary; a system that can be defined as a whole constellation of technical, administrative and organization provisions and measures in a company, institute or entity, aiming at obtaining insight, at an improved management and where possible leading to a reduction or prevention of harm to the environment by the activities of the company, institute or entity.

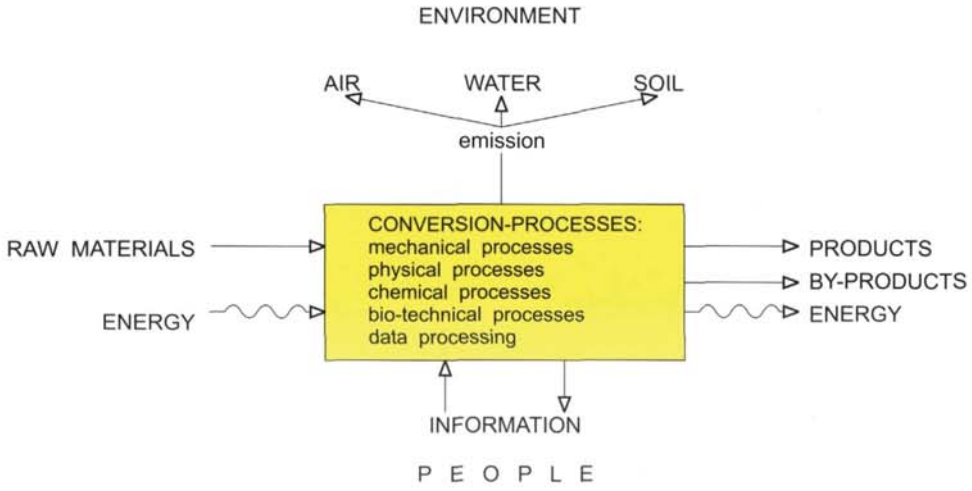
The present situation is such that many industries and related categories produce waste products and hazardous emissions to air, water and soil, creating environmental problems.

A good solution for these problems would be if the existing knowledge and experience present in the various companies, institutes, consultants, local and central government, is used to make a systematic qualitative and quantitative inventory of emissions and waste products as a basis for the absolute environmental friendly processing, application and storage of the various types of wastes, coupled with preventive measures at the sources.

An environmental policy - a raw materials policy - an energy policy - an urban & rural planning policy - ecology policy - and an economic policy, should go hand in hand. Development of methods that at the same time improve the environment and strengthen the economy. The government should stimulate these developments. Process- and Product Innovation are perhaps the most important instruments to achieve a better environment. A constructive diligent approach by both consumers & producers is vital.

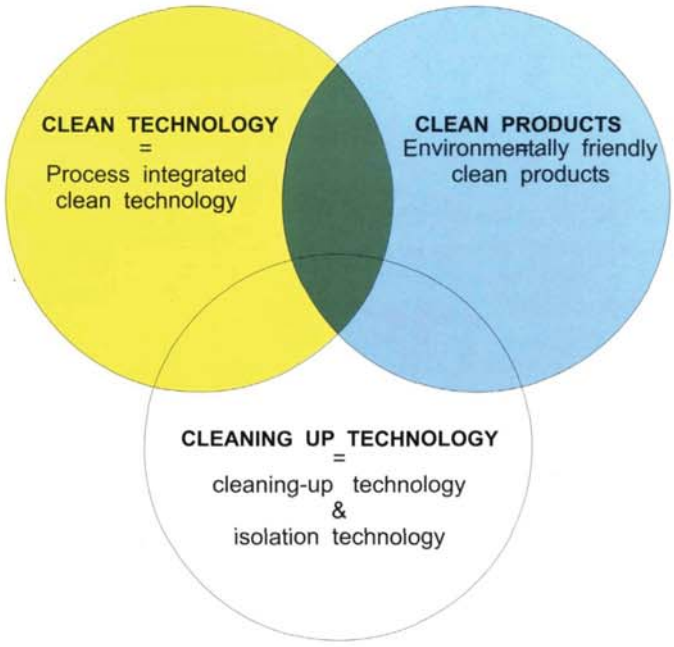
The government has to provide for environmental laws, correct standards and adequate control. Central goal of environmental and nature policies is to achieve a new

Process innovations take place in the environment and are initiated, developed and managed by people



Those processes should be developed whereby with less raw materials and less energy, valuable products can be produced with less hazardous emmissions to AIR / WATER / SOIL.
In so far by-products are produced, these should be transformed into environmentally friendly products.
If this is not feasible these by-products should be safely stored in order to protect the environment.

Environmental Technology



Triple - C approach

dynamic equilibrium, aiming at a sustainable development, in which human activities are embedded in natural cycles with special attention to eco-systems. Conditions should be such that within these eco-systems a large variety of species can be maintained.

3. INTEGRATED COASTAL POLICY AND THE RELATION ENVIRONMENT - ECONOMY

Integrated coastal policy is a matter of local, regional, national and international interest. Coastal Zone Management & Development are only possible if environmental aspects, including nature aspects are taken seriously into account.

Human activities have the tendency to be concentrated in coastal and deltaic regions and can thus be a threat to the vulnerable dynamic equilibrium in several of these regions. In these densily populated areas, there is only limited space available for living, working, tourism & recreation and infrastructure. At the same time there is the need to preserve or expand valuable environment - nature - landscape. There are several solutions to these spatial problems:

1. In due time stabilization of the world population;
2. Making better use of the third dimension (sky-scraping, underground development & multifunctional use of the available space);
3. Using possibilities in the existing hinterland;
4. Flexible integration of land in sea and of water in land, making use of materials and forces present in nature, with special attention to the intensive relation water - land.

It is clear that the relation environment - economy is an essential part of integrated coastal policy. When the creation of coastal locations, through gaining new land from the sea, is decided upon, - using dominantly the method of building with nature -, then one has to take into consideration:

- Thorough knowledge of the coastal zone in past and present, including the coastal zone morphology, the climate, the river systems, the soil and subsoil characteristics, the terrestrial and marine environment, present functions and activities.

- The extent of integration of land in sea and of water in the new land, based on safety, on what nature allows us to do so, on the area needed for various functions, and on the quality of environment, nature and landscape.

- The internal planning of the new area, taking into account the various functions in relation to each other and in relation to the existing hinterland on one hand and the bordering sea on the other.

- Anticipation and adaptation or complete renewal of the conversion-processes which shall take place in the new territories.

- Awareness of the fact that the environment is the basis for the economy. Furthermore, it is vitaly important to take into account that the environment, including nature, has:

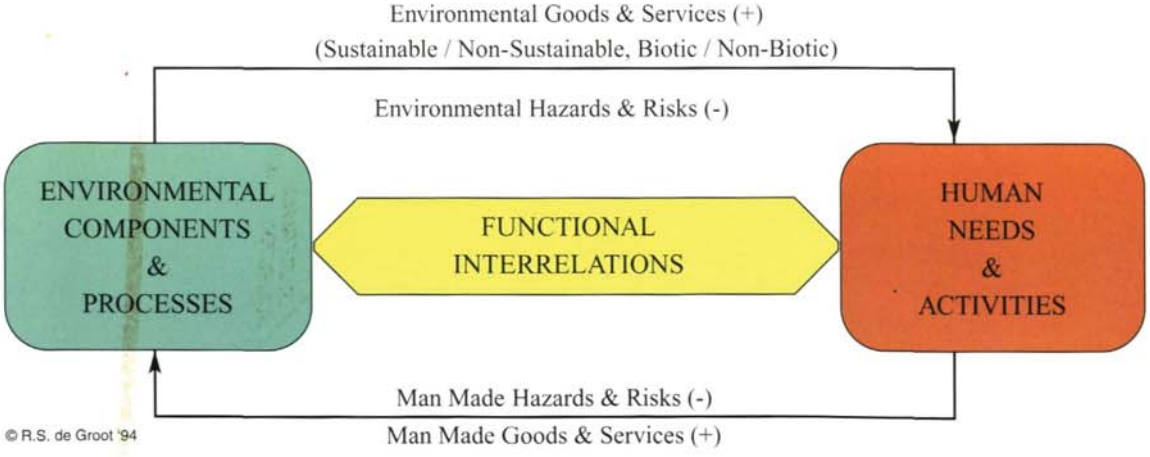
1. Carrier Functions, providing space and substrate for all living organisms and other organic as well as inorganic matter, landscape & seascape, energy systems and all man and non-man induced processes.

2. Production Functions, providing materials and energy for production - and consumption processes.

3. Regulation Functions, maintaining essential eco-systems as well as other systems and processes.

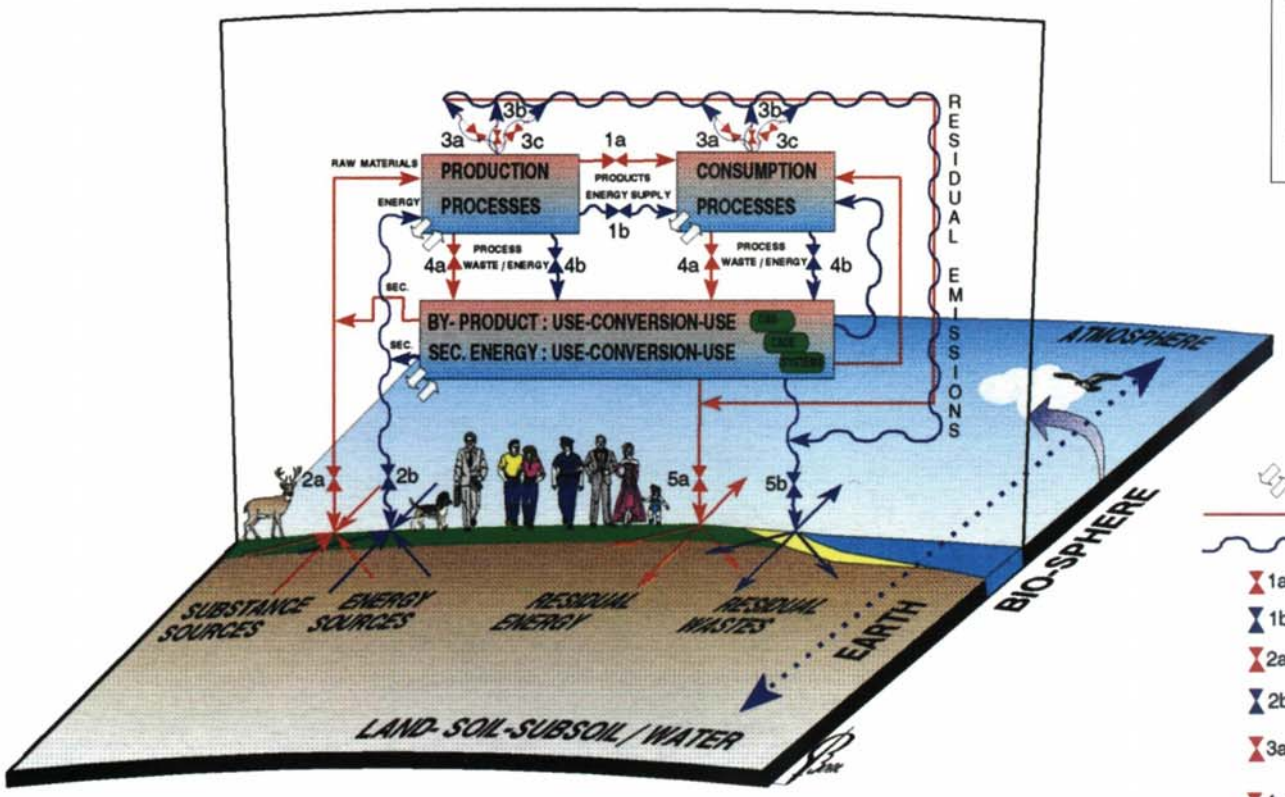
4. Information Functions, providing information in many forms for many different known and unknown purposes.

FUNCTIONAL INTERACTIONS BETWEEN MAN AND ENVIRONMENT



TOWARDS A (CLOSED) SUBSTANCE/ENERGY - CYCLE IN A SUSTAINABLE SOCIETY (IN WICH UP- AND DOWNGRADING OCCURS)

- The conversion processes take place in the environment. They are often, developed and managed by people.
- Those processes should be developed whereby with less raw materials and less energy, valuable products can be produced at a higher yield, with less hazardous emissions to air/water/soil.
- In so far by-products are produced, these should be transformed into environmentally friendly products. If this is not feasible these by-products should be safely stored in order to protect the environment.
- Space- and time-factors should also be taken into account.



BIO-SPHERE:

- ENVIRONMENTAL COMPARTMENTS : AIR - WATER - SOIL
- MICRO-ORGANISMS, FLORA, FAUNA (INCL. PEOPLE)
- ECO - SYSTEMS
- ALL MATERIAL EXPRESSIONS OF HUMAN ACTIVITIES

- SUBSTANCE SOURCES
- ENERGY SOURCES

} VIA EXPLORATION, MINING, CULTIVATION, HARVEST. ETC

- RESIDUAL WASTES
- RESIDUAL ENERGY

} IMMOBILISATION / DIFFUSION & DISSIPATION

INFORMATION IN / OUT

MASS - TRANSPORT

ENERGY - TRANSPORT

1a CONTROL VALVE **PRODUCT** (QUALITY & QUANTITY)

1b CONTROL VALVE **ENERGY SUPPLY** (QUALITY & QUANTITY)

2a CONTROL VALVE **RAW MATERIALS** (QUALITY & QUANTITY)

2b CONTROL VALVE **PRIMARY** FROM VARIOUS SOURCES (QUALITY & QUANTITY)

3a,b,c. CONTROL VALVE **EMISSION REDUCTION** (OF HARMFUL COMPONENTS TO AIR - WATER - SOIL)

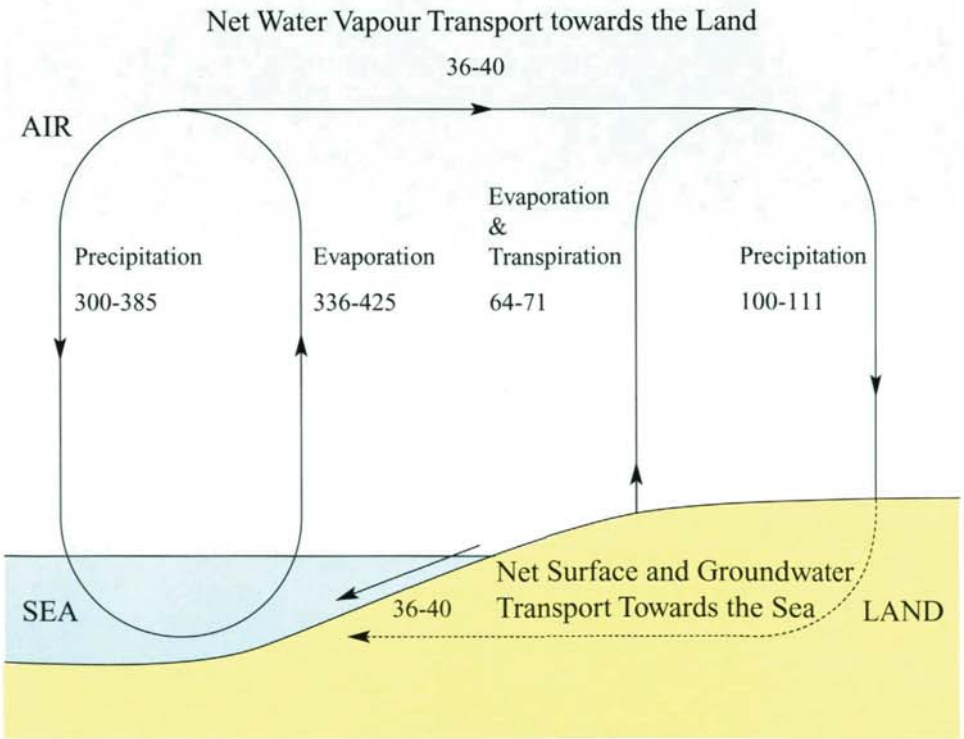
4a,b,c. CONTROL VALVE FOR **BY-PRODUCT & SECUNDARY ENERGY** (USE - CONVERSERSION - USE)

5a,b,c. CONTROL VALVE FOR **RESIDUAL WASTES & ENERGY** (IMMOBILISATION / DIFFUSION & DISSIPATION)

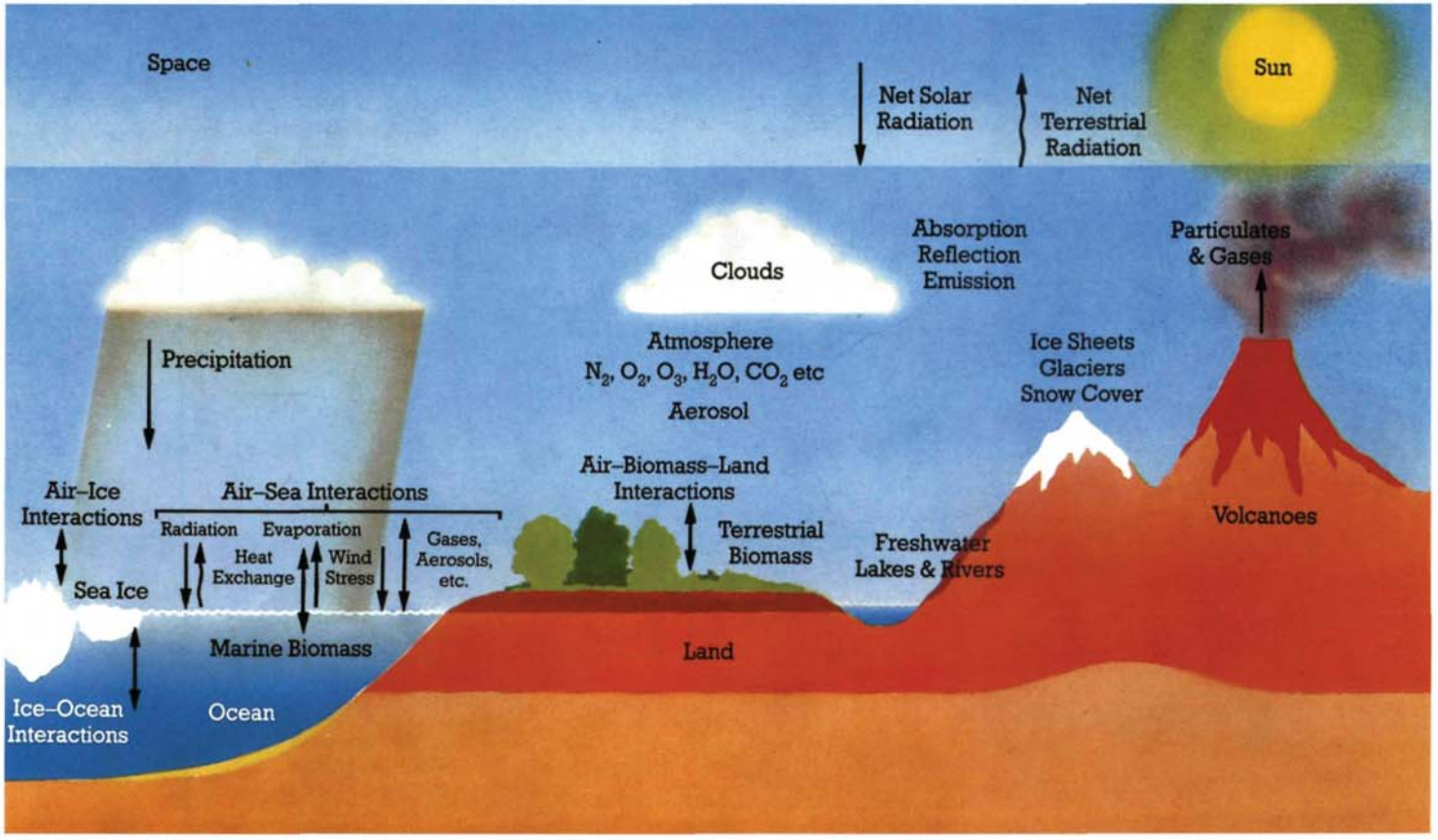
12. SEVERAL CYCLES & INTERACTIONS IN THE ENVIRONMENT

AMOUNT OF WATER IN THE GEOSPHERE

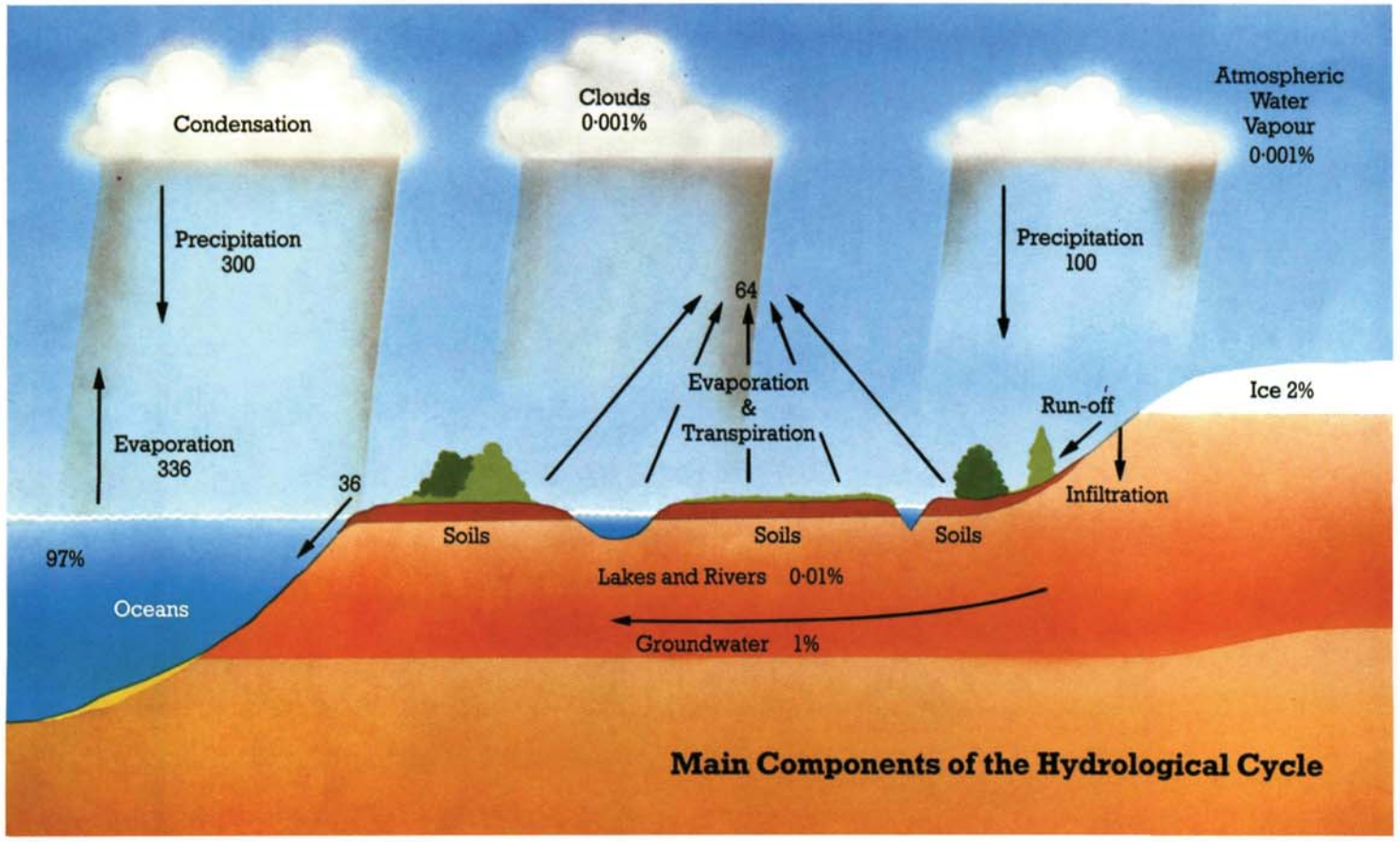
97.3	%	=	1348.	$.10^6$	km^3	sea
2.1	%	=	29.	$.10^6$	km^3	ice, snow
0.6	%	=	8.	$.10^6$	km^3	groundwater
0.015	%	=	0.2	$.10^6$	km^3	lakes, rivers
0.001	%	=	0.013	$.10^6$	km^3	atmosphere
100	%	=	1385.	$.10^6$	km^3	total amount H_2O



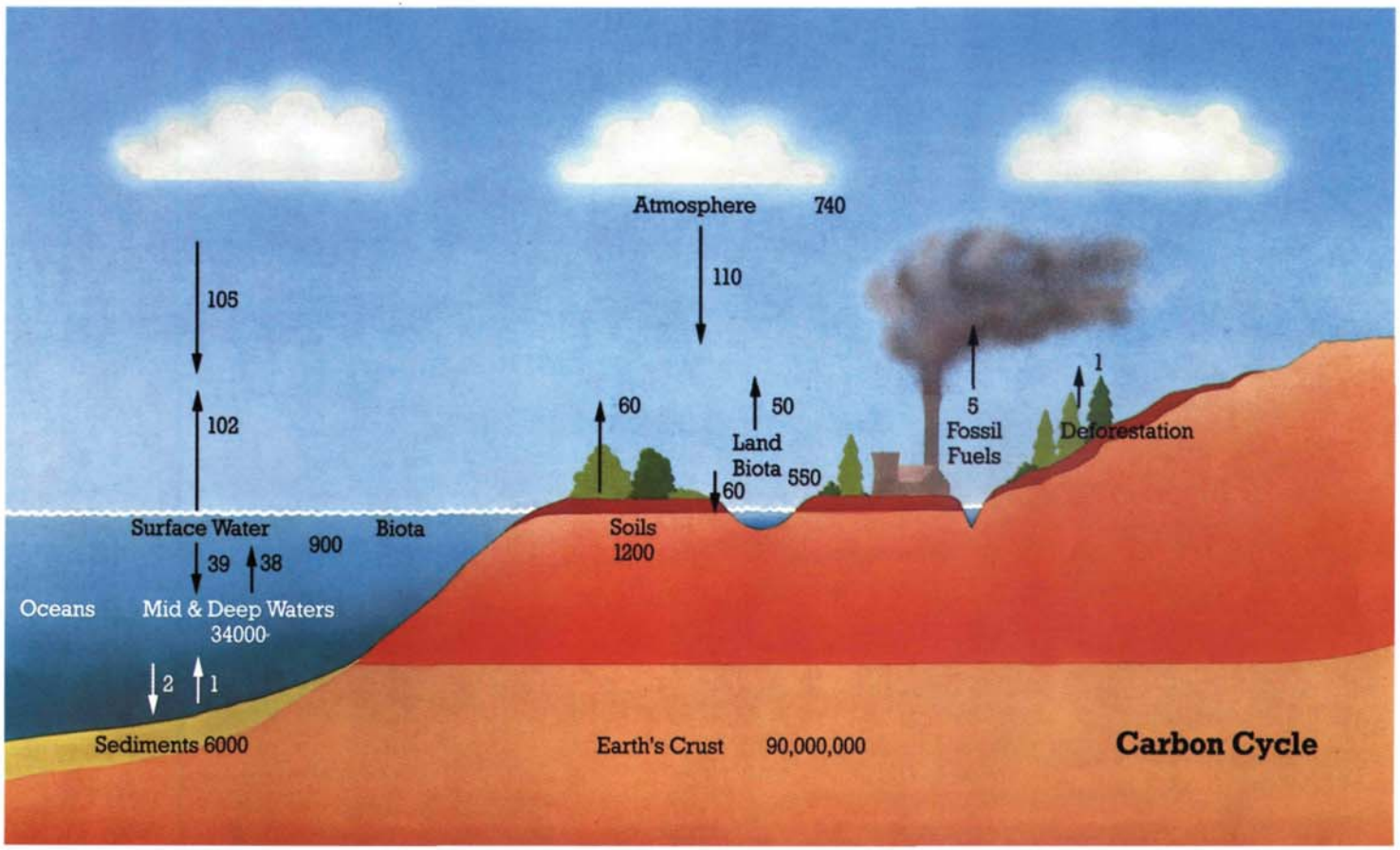
SCHEMATIC DIAGRAM OF HYDROLOGICAL CYCLE.
Fluxes are given in 10^3 km^3.



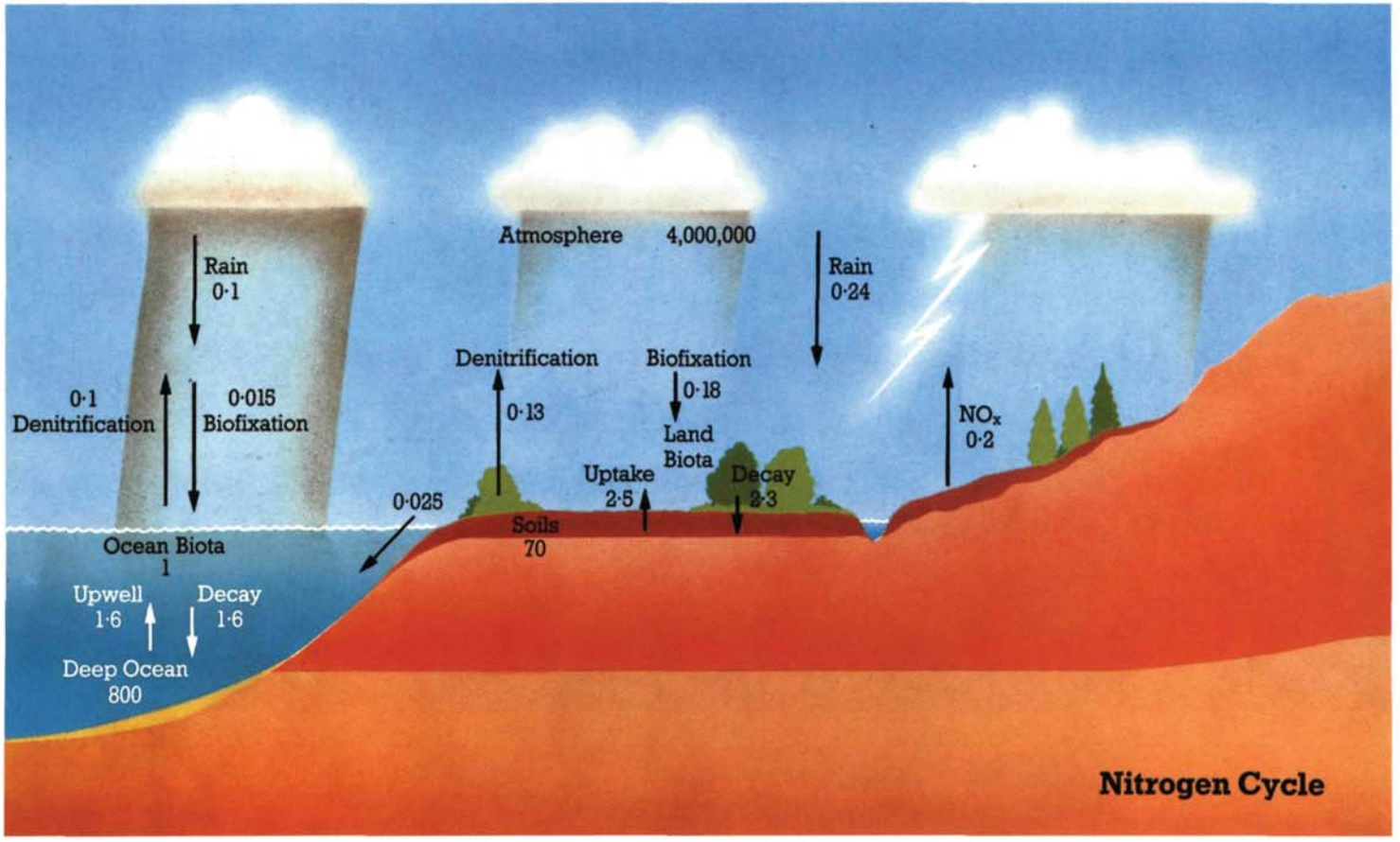
The generalised climate cycle showing the principal interacting land, air and sea components



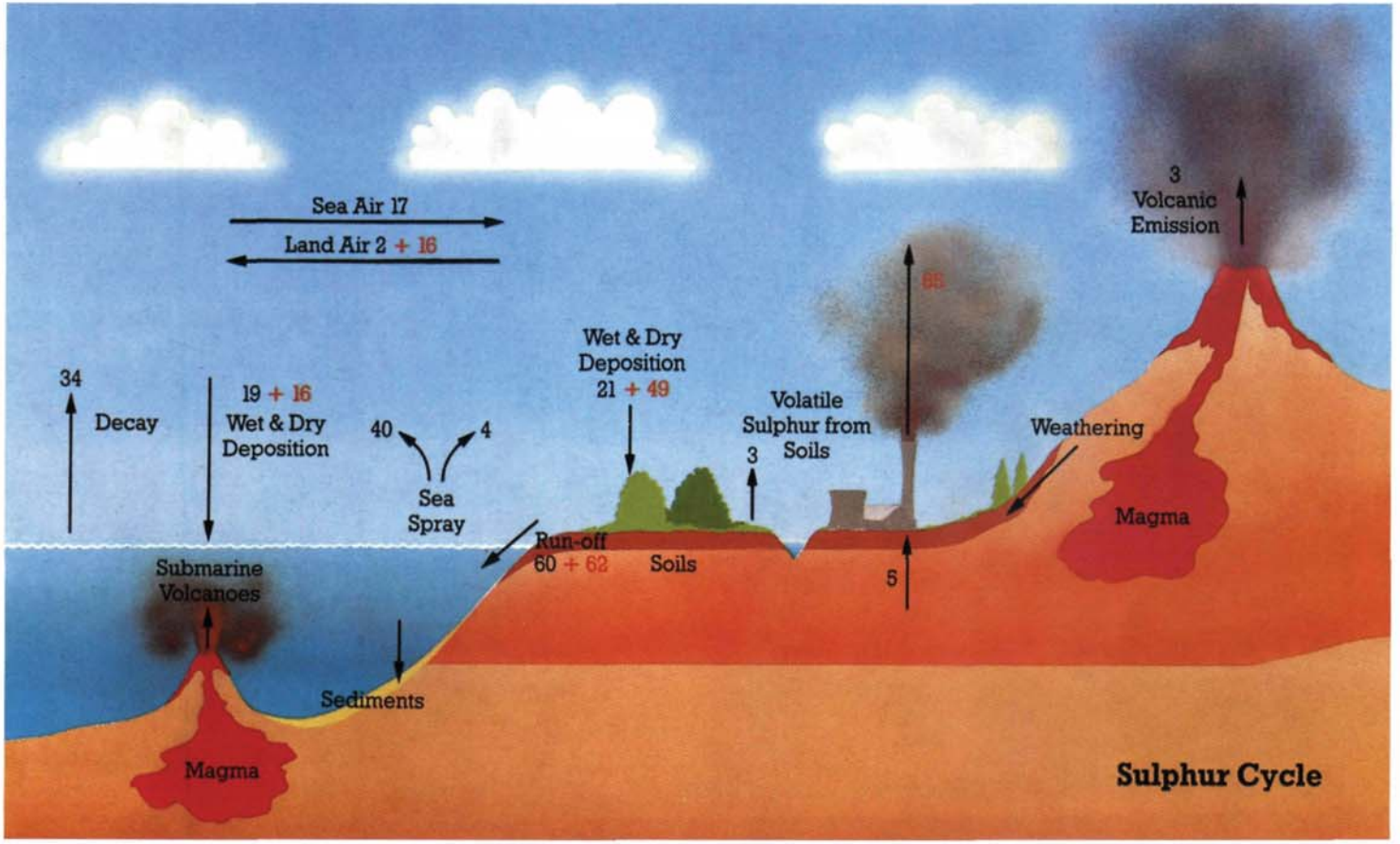
The Hydrological Cycle. Fluxes are given in units of 10^{15} kilograms per year.
The percentage of total water in the cycle is also shown.



The Carbon Cycle showing the estimated carbon content of the principal reservoirs and the annual fluxes between them in units of 10^{12} kilograms



The Nitrogen Cycle showing its principal reservoirs and fluxes in units of 10^{12} kilograms. Fluxes represent the annual rate of transfer



The Sulphur Cycle showing fluxes between the components of the system (in units of 10^9 kilograms per year). Figures in black represent natural fluxes and those in red represent Man-made sources of sulphur.

13. SURVEY SUMMARY & CHECKLIST ENVIRONMENTAL AFFAIRS

ENVIRONMENT

01. ENVIRONMENT IN GENERAL
- Geosphere - Biosphere
- Environmental Compartment: Air
- Environmental Compartment: Water
- Environmental Compartment: Soil
- Surface Area Land - Water
- Third Dimension above the surface concerning various Layers of the Geosphere and Layer Composition
- Third Dimension under the surface concerning various Layers of the Geosphere and Layer Composition
- Outside Influence from the Solar System and Inside Influence from the Earth on the Geosphere - Biosphere System
- Transport of Impulse, Energy & Mass and occurrence of Chemical Reactions within and in between the various layers of the Geosphere - Biosphere System
- Biosphere & Eco-systems: definition and inventarisation
- Micro-organisms
- Flora
- Fauna, including People
- Cycles, a.o. Hydrological cycle, Carbon-cycle, Nitrogen-cycle, Sulfur-cycle, etc.; Food Chains.
- All Material Expressions of Human Activities: cities & villages, harbours, airports, dikes, roads, railroads, canals, etc.
- Human Activities within the Biosphere
- Chemical Conversion Processes within the Biosphere
- Interactions within the dynamic Biosphere - Geosphere System
- Characteristic Environmental Numbers and Standards

02. ENVIRONMENTAL COMPARTMENT: AIR
Composition; Emissions in the Air; Upgrading Air Quality

03. ENVIRONMENTAL COMPARTMENT: WATER
Composition; Emissions in Water; Upgrading Water Quality; Water Quantity
Surface Water & Water Beds
Ground Water & Soil
Drinking Water
Sewer Systems
Waste Water Purification

04. ENVIRONMENTAL COMPARTMENT: SOIL
Composition; Soil Characteristics
Soil Protection
Soil Sanitation/Purification

05. FOOD
Inventarisation
Quality & Quantity
Food Selection and Quality Improvement

06. WASTE PRODUCTS (SOLID / liquid)
- Qualitative & Quantitative Analysis (type and amounts of waste products)
- Source-oriented Waste Reduction
- Environmental friendly Collection (separate) - Transport - Transfer - Storage - Processing - Recycling - Application & Usage

Categories: domestic wastes, industrial wastes, office waste, hospital waste, contaminated soil, building & demolition waste, chemical wastes, waste water purification residue, contaminated dredged material, agricultural waste, manure, motor-car wrecks, tyres, oil- & chemical slobs, old paper, glass, plastics, textile, metals; fly-ash, slags, bottom-ash; waste products in general

07. SOUND / STENCH / DUST and other forms of NUISANCE
Industry, Power Stations, Agriculture, Domestic Sector, Road-traffic, Railroad-traffic, Water-traffic, Air-traffic.
See also: AIR
Sound-Reduction, Zoning;
Creation and Preservation of Low Sound Level Areas

08. RADIATION

09. EXTERNAL and INTERNAL SAFETY

10. ENVIRONMENTAL ISSUES
Population growth - Endangered World Peace - Waste of Raw Materials & Energy - Global Climate Change - Erosion - Deforestation - Acid rain - Water Shortage - Desiccation - Siltation - Excess Manure - Diffusion of Harmful Components - Internal Climate Deterioration - Environmental Disturbance - Habitat Destruction - Extinction of Species & Varieties -

11. ENVIRONMENT - LANDSCAPE - NATURE
Landscape Conservation - Landscape Development
Nature Conservation - Nature Development
Bio-Diversity - Bio-Diversification

12. COUPLING an ENVIRONMENTAL POLICY - RAW MATERIALS POLICY -ENERGY POLICY - SPATIAL POLICY - ECOLOGY POLICY to an ECONOMIC POLICY
Developments of Methods that at the same time Improve the Environment and Strengthen the Economy

13. TRIPLE C-APPROACH: CLEAN TECHNOLOGY - CLEAN PRODUCTS - CLEANING-UP TECHNOLOGY
Polution Prevention
Stimulation of Environmental Technology
Environmental Engineering Centre's (E.E.C.'s)
Improvement of all Elements of the Environmental Chains

14. SUSTAINABLE DEVELOPMENT

15. ENVIRONMENTAL IMPACT ASSESSMENT

16. GOVERNMENTS & ENVIRONMENT
United Nations (UNEP, etc.)
International Institutes and Organisations (World Bank, etc.)
Large Regions (Europe, Middle East, Far East, Asia, N.-America, S.-America, M.-America, Africa, Australia & New-Zealand, Polynesia)
National Government & Parliament
Provinces
Local Regions
Municipalities
Waterboards
Governmental Institutes and Organisations
Laws, By-Laws, Regulations, Standards, Licenses

17. RELATION PEOPLE - ENVIRONMENT
Citizen-Groups and Individuals, People's Participation
Non-Governmental Organisations in general
Environmental Organisations
Institutes, Universities

18. ENVIRONMENTAL POLICY PLANS & E.P.P.-EXECUTION

19. ORGANISATIONS (related to tasks)
Personnel (tasks and quality guarantee)
Laboratory and Facilities for Field Measurements and Monitoring

20. FINANCE
Incoming and Outflowing Money

21. STANDARDS

22. LICENCES
Related to Laws, By-Laws, Regulations and Standards

23. ENVIRONMENTAL POLICY aiming at VARIOUS SECTORS of SOCIETY
Amongst others by Internal Environmental Care in the Various Sectors of Society:
a. Industry
b. Power Stations
c. Transport
d. Agriculture & Aquaculture
e. Domestic Sector

24. LAW-ENFORCEMENT, CONTINUOUS AUDIT, INSPECTION, CONTROL

25. ENVIRONMENTAL INFORMATION & EDUCATION

26. ENVIRONMENTAL RESEARCH

27. ENVIRONMENTAL INDICATIVE NUMBERS, ENVIRONMENTAL MONITORING NETWORK

28. SYSTEMATIC APPROACH, EFFICIENCY & EFFECTIVITY

R.E. Waterman, 1990 - 1995

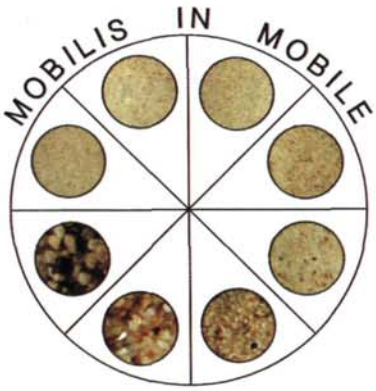
14. ENVIRONMENTAL CARE FOR MARINE ORGANISMS

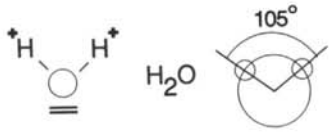
courtesy R.I.K.Z.

PLATESSA FLESUS

14. ENVIRONMENTAL CARE FOR TERRESTRIAL ORGANISMS

ERYNGIUM MARITIMUM





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