

SUSTAINABLE COASTAL & DELTA ZONE DEVELOPMENT

Integrated Coast & Delta Policy via Building with Nature[®] & Aquapuncture[©]



$(\alpha+\beta+\gamma)$ knowledge
+ action \rightarrow Δ sustainable



Delft University of Technology
Civil Engineering & Applied GeoScience



2021

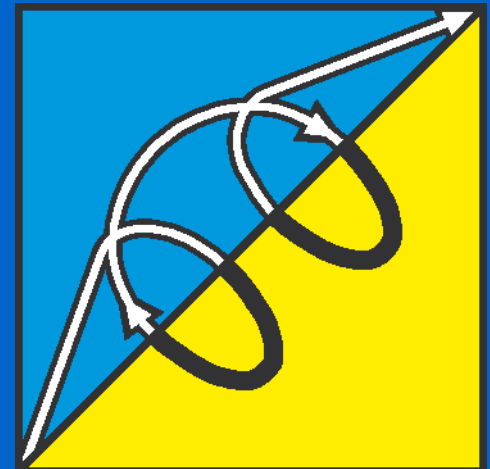
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SUSTAINABLE COASTAL ZONE DEVELOPMENT

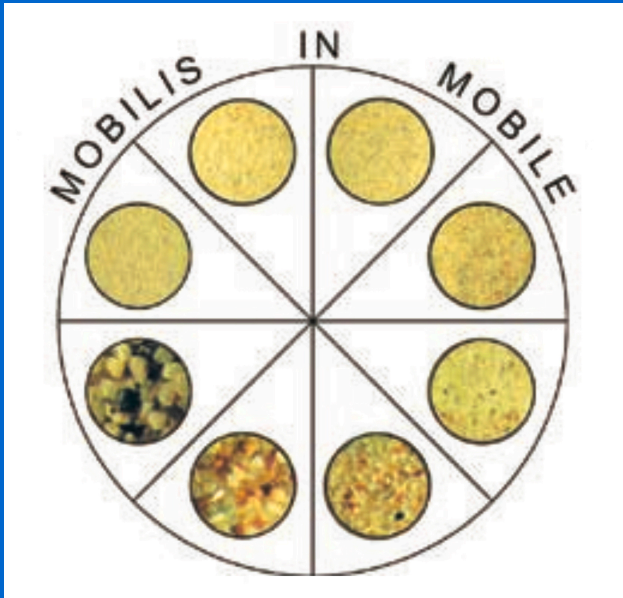


Flexible integration
of land in water
and of water in land

Making use of materials
and forces & interactions
present in nature



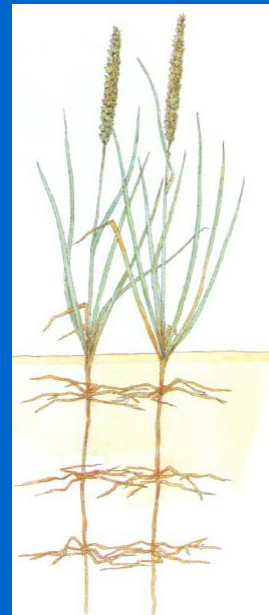
BUILDING WITH NATURE



INORGANIC MATERIALS

gravel/sand
silt/clay

Loose mobile material sand & silt from coarse to fine and the forces & interactions to which they are exposed



ORGANIC MATERIALS flora & fauna

-
-
- **FORCES & INTERACTIONS:**

01. Tidal action (ebb & flood)

02. Wave action (specifically in the breaking zone) and swell action

03. Sea currents other than tidal currents

04. River outflow (as force and as supplier of freshwater and sediment)

05. Gravity

06. Wind

07. Rain

08. Solar radiation

09. Interaction dunes - vegetation (root system vegetation keeps together sand/silt)

10. Complex interaction marine organisms - sand/silt.

BIOGEOMORPHOLOGY & GEOHYDROLOGY OF COAST AND SEABED

3 types of coast:

- Wadden coast
- Closed, segmented coast
Hoek of Holland – Den Helder
- Estuarine coast in transition
between Hoek of Holland and
Belgium



The Netherlands

Plan 5

Plan 3_{a+b}

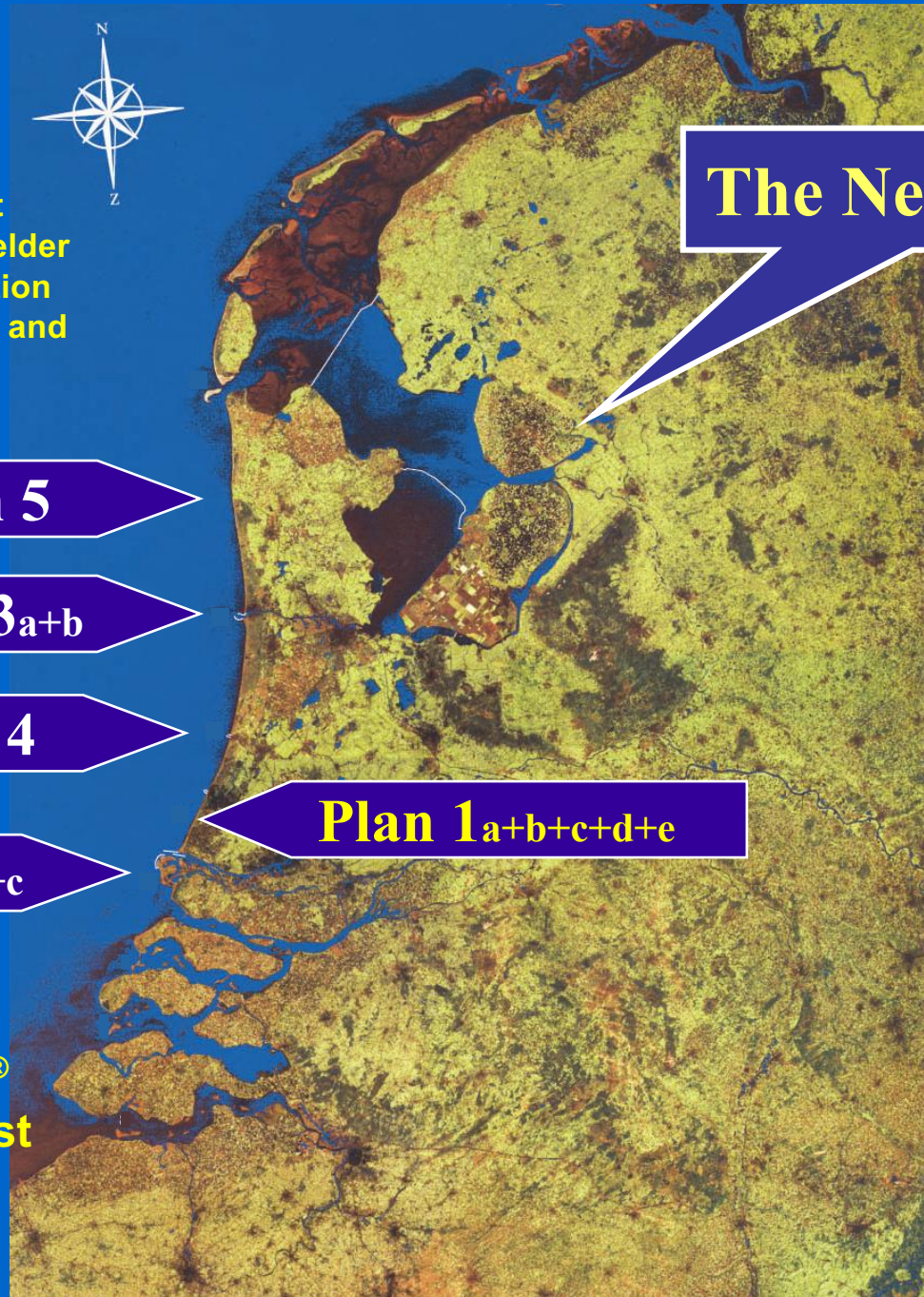
Plan 4

Plan 2_{a+b+c}

Plan 1_{a+b+c+d+e}

**Integrated
Coastal
Policy via
Building
with Nature®**

**Land reclamation via
Building with Nature®
along North Sea Coast**



Geological Young Dune Wedges



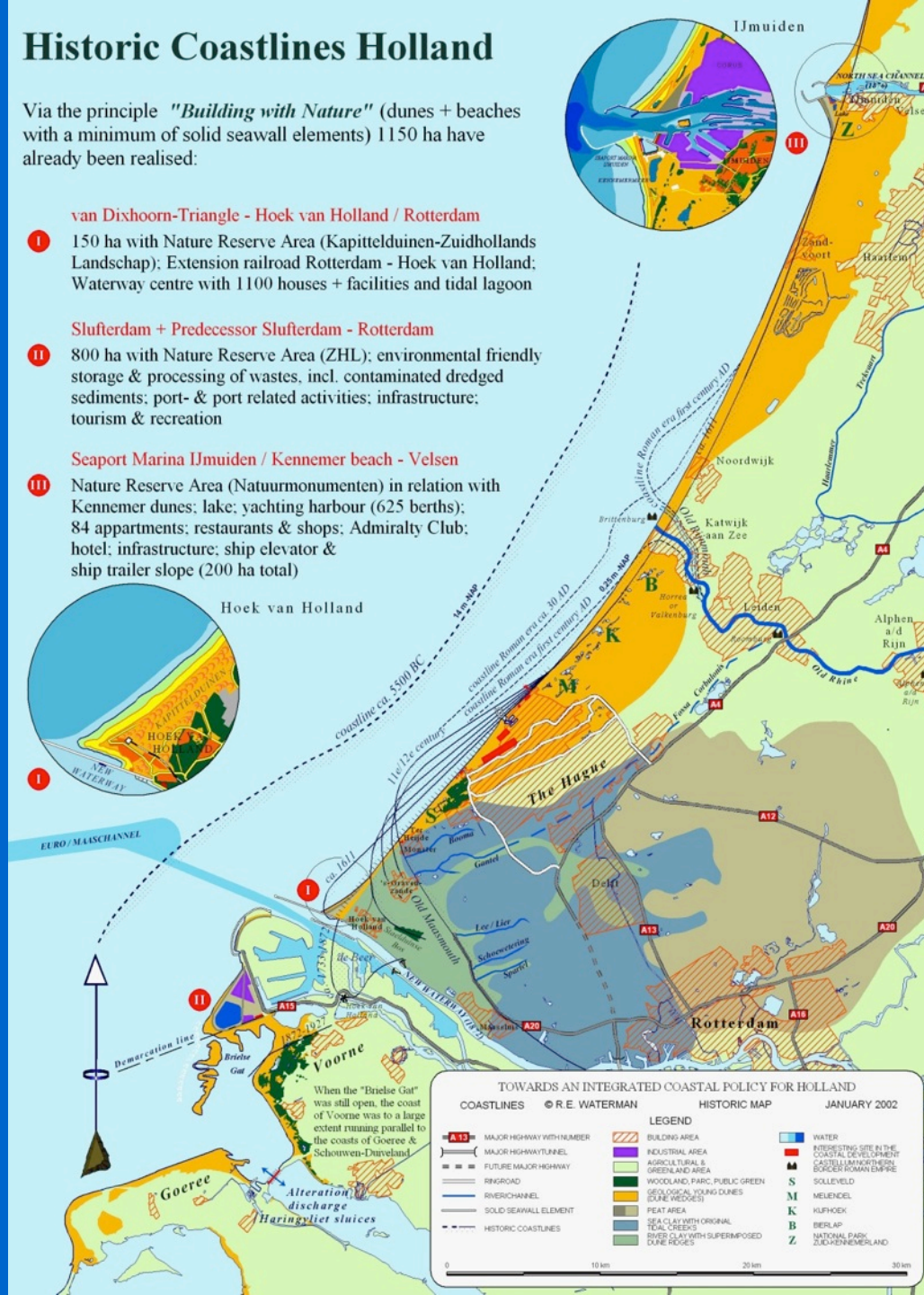
Historical Coastline Delfland



Historic Coastlines Holland

Via the principle *"Building with Nature"* (dunes + beaches with a minimum of solid seawall elements) 1150 ha have already been realised:

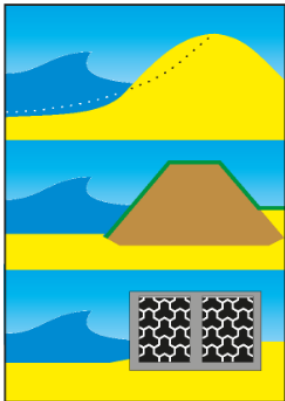
- I** van Dixhoorn-Triangle - Hoek van Holland / Rotterdam
150 ha with Nature Reserve Area (Kapittelduinen-Zuidhollands Landschap); Extension railroad Rotterdam - Hoek van Holland; Waterway centre with 1100 houses + facilities and tidal lagoon
- II** Slufterdam + Predecessor Slufterdam - Rotterdam
800 ha with Nature Reserve Area (ZHL); environmental friendly storage & processing of wastes, incl. contaminated dredged sediments; port- & port related activities; infrastructure; tourism & recreation
- III** Seaport Marina IJmuiden / Kennemer beach - Velsen
Nature Reserve Area (Natuurmonumenten) in relation with Kennemer dunes; lake; yachting harbour (625 berths); 84 apartments; restaurants & shops; Admiralty Club; hotel; infrastructure; ship elevator & ship trailer slope (200 ha total)



TOWARDS AN INTEGRATED COASTAL POLICY FOR HOLLAND
 COASTLINES © R.E. WATERMAN HISTORIC MAP JANUARY 2002

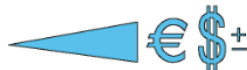
COASTLINES		LEGEND	
	MAJOR HIGHWAY WITH NUMBER		BUILDING AREA
	MAJOR HIGHWAY TUNNEL		INDUSTRIAL AREA
	FUTURE MAJOR HIGHWAY		AGRICULTURAL & GREENLAND AREA
	RINGROAD		WOODLAND, PARK, PUBLIC GREEN
	RIVER/CHANNEL		GEOLOGICAL YOUNG DUNES (DUNE WEDGES)
	SOLID SEAWALL ELEMENT		PEAT AREA
	HISTORIC COASTLINES		SEA CLAY WITH ORIGINAL TIDAL CREEKS
			RIVER CLAY WITH SUPERIMPOSED DUNE RIDGES
			WATER
			INTERESTING SITE IN THE COASTAL DEVELOPMENT
			CASTLE/MONUMENTS/BORDER ROMAN EMPIRE
			S SOLLEVELD
			M MELIHOEFL
			K KUIPHOEK
			B BIERLAP
			Z NATIONAL PARK ZUID-KENNERMERLAND

0 10 km 20 km 30 km



SAFETY with regard to:

- flooding
(including effects:
sea level & river level rise)
- drought
- coastal erosion
- land subsidence
- salt water intrusion
- natural disasters
- human activities



01



ENVIRONMENT
(IN GENERAL)

environmental
compartments:

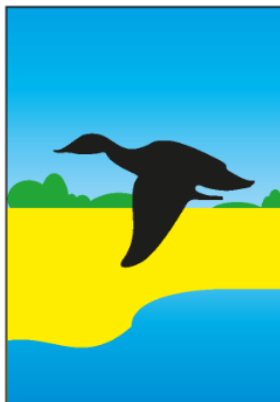
- air
- water
- land



02

NATURE

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



LANDSCAPE

- landscape conservation
- landscape development

SEASCAPE



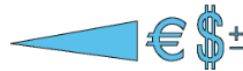
03

04

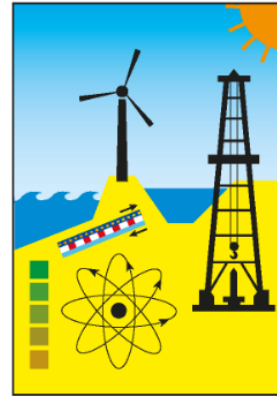


WATER RESOURCES MANAGEMENT

- water quantity
- water quality
- groundwater
- surface water
- dune infiltrated water
- (desalinated) sea-water
- sewer systems
- waste water purification



05



ENERGY

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

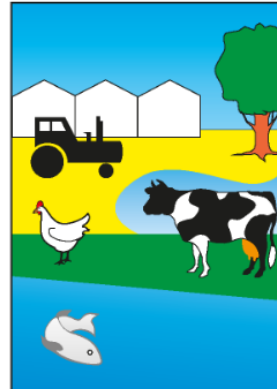


06

AGRICULTURE
horticulture, forestry,
cattle & poultry breeding

FISHERY

AQUACULTURE



MINING / EXTRACTION & STORAGE

in / on

Land / Sea-bed / Sea / Air



07

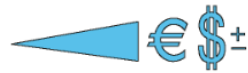


08



**BUILDING SITES FOR
LIVING & WORKING**

- houses & apartments
+ facilities
- industries & offices
+ facilities
- urban development



09



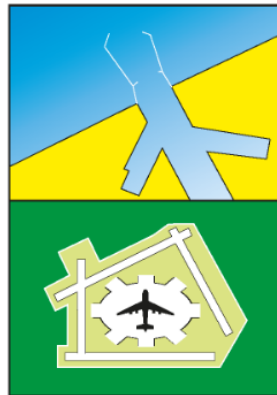
**RECREATION
&
TOURISM**



10

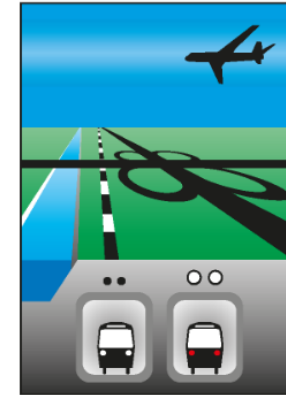
**TRANSFER /
DISTRIBUTION
CENTRES &
RELATED ACTIVITIES**

- seaport
- riverport,
- lake port
- airport,
- landport



INFRASTRUCTURE

- roads
- railroads
- waterways
- underground systems
- airplanes
- electronic highway



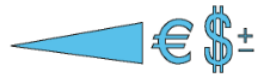
11

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TRANSPORT MODULES

- bicycle, motor-car, bus, tram, train, maglev (magnetic levitation train),
- metro
- ship,
- container
- drone, airplane, rocket, satellite



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INFORMATION COMMUNICATION TECHNOLOGY

- DATA ACQUISITION
- DATA STORAGE
- DATA TRANSMISSION
- DATA PROCESSING

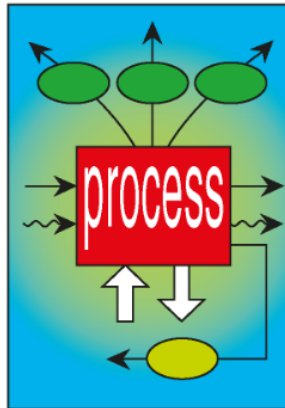
A.I.



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ENVIRONMENT (IN PARTICULAR)

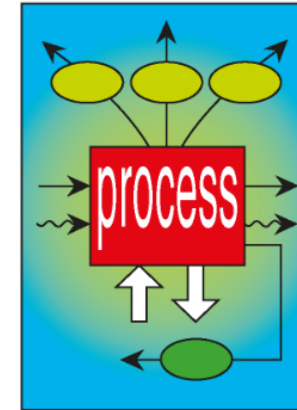
Air- / Water- / Soil-quality by improvement of conversion processes and by end of pipe purification



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ENVIRONMENT (IN PARTICULAR)

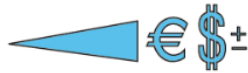
solid waste reduction by improvement of conversion processes and by environmental friendly collection - transport - storage - processing - recycling - usage



16



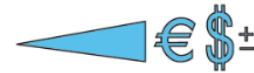
GOVERNMENTAL
INSTITUTIONS
NON-GOVERNMENTAL
INSTITUTIONS
CITIZEN GROUPS
INDIVIDUAL CITIZENS
PEOPLE'S
PARTICIPATION
LAW - JUSTICE - ORDER



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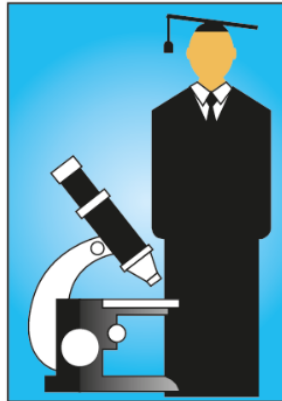


HEALTH & WELFARE
SPORT / PLAYGROUND
HISTORY & CULTURE
RELIGION
PHILOSOPHY OF LIFE
VALUES & STANDARDS
SOCIOSPHERE



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EDUCATION
&
RESEARCH



19

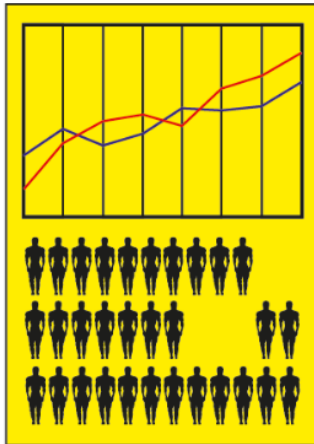
DEFENCE
&
RISK MANAGEMENT

SAFETY & SECURITY



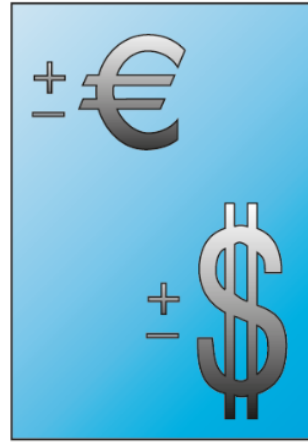
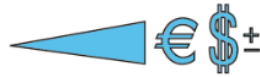
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ECONOMY
&
EMPLOYMENT

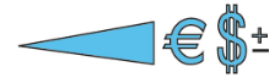


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FINANCE

FINANCIAL
ENGINEERING

OTHER FUNCTIONS



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3 types of coast:

- Wadden coast
- Closed, segmented coast
Hoek of Holland – Den Helder
- Estuarine coast in transition
between Hoek of Holland and
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The Netherlands

Plan 5

Plan 3_{a+b}

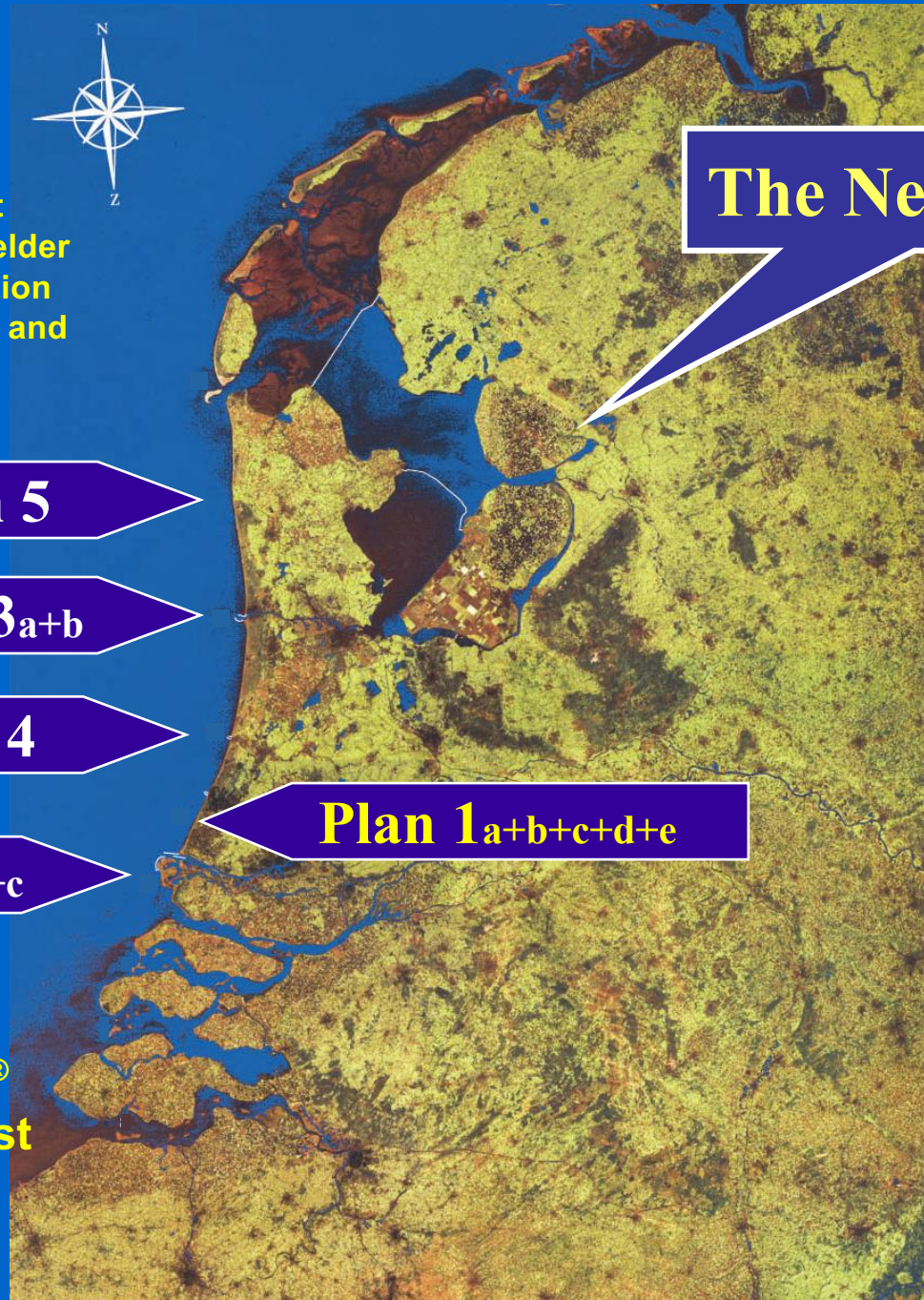
Plan 4

Plan 2_{a+b+c}

Plan 1_{a+b+c+d+e}

**Integrated
Coastal
Policy via
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with Nature®**

**Land reclamation via
Building with Nature®
along North Sea Coast**



SUSTAINABLE COASTAL ZONE DEVELOPMENT

About 80% of
the major cities
can be found in
coast and delta areas

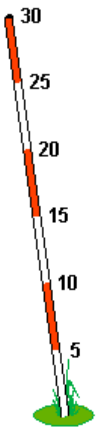
Building with Nature[®]
Aquapuncture

A large part of
the remaining 20%
can be found upstream
along rivers, lakes & canals

Aquapuncture[©]
Building with Nature

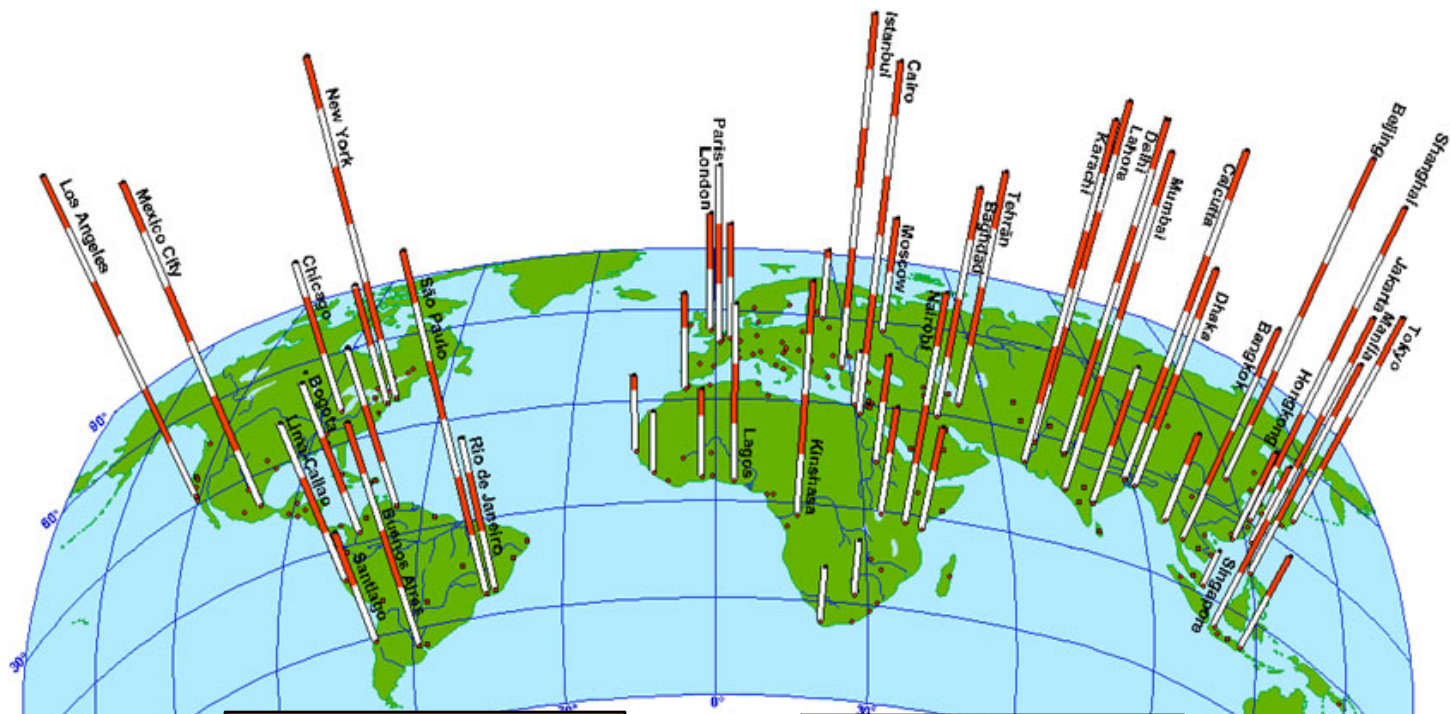
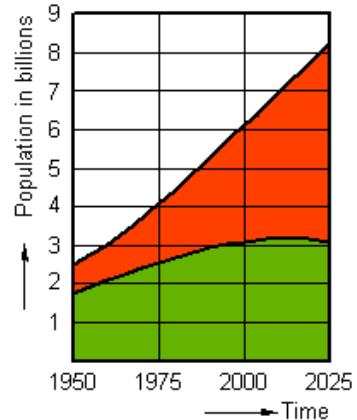
In these densely populated areas there is little space available for living, working, infrastructure, recreation & tourism, and at the same time there is the need to preserve or expand valuable environment, nature and landscape.

Number of inhabitants in millions



major city (more than 1 million inhabitants)

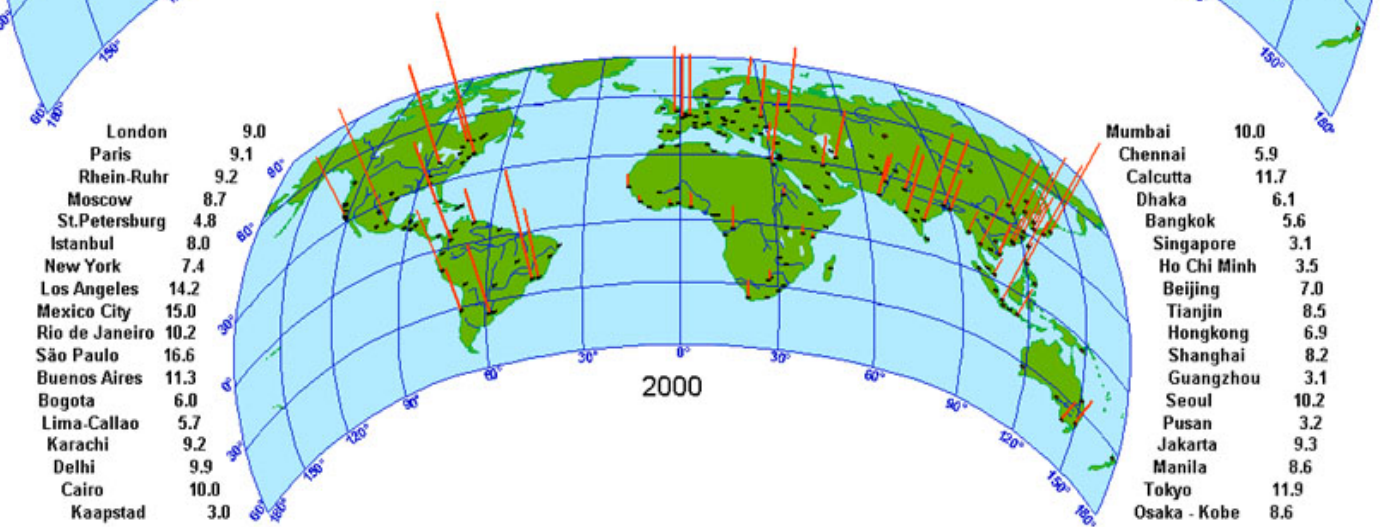
Growth of World Population in urban (red) and rural (green) areas in billions



About 80 % of the major cities can be found in coastal and deltaic areas

2025

A large part of the remaining 20% can be found upstream along rivers, lakes & canals



2000

London	9.0
Paris	9.1
Rhein-Ruhr	9.2
Moscow	8.7
St.Petersburg	4.8
Istanbul	8.0
New York	7.4
Los Angeles	14.2
Mexico City	15.0
Rio de Janeiro	10.2
São Paulo	16.6
Buenos Aires	11.3
Bogota	6.0
Lima-Callao	5.7
Karachi	9.2
Delhi	9.9
Cairo	10.0
Kaapstad	3.0

Mumbai	10.0
Chennai	5.9
Calcutta	11.7
Dhaka	6.1
Bangkok	5.6
Singapore	3.1
Ho Chi Minh	3.5
Beijing	7.0
Tianjin	8.5
Hongkong	6.9
Shanghai	8.2
Guangzhou	3.1
Seoul	10.2
Pusan	3.2
Jakarta	9.3
Manila	8.6
Tokyo	11.9
Osaka - Kobe	8.6

The Netherlands



Space for the Coast Living
Coasts

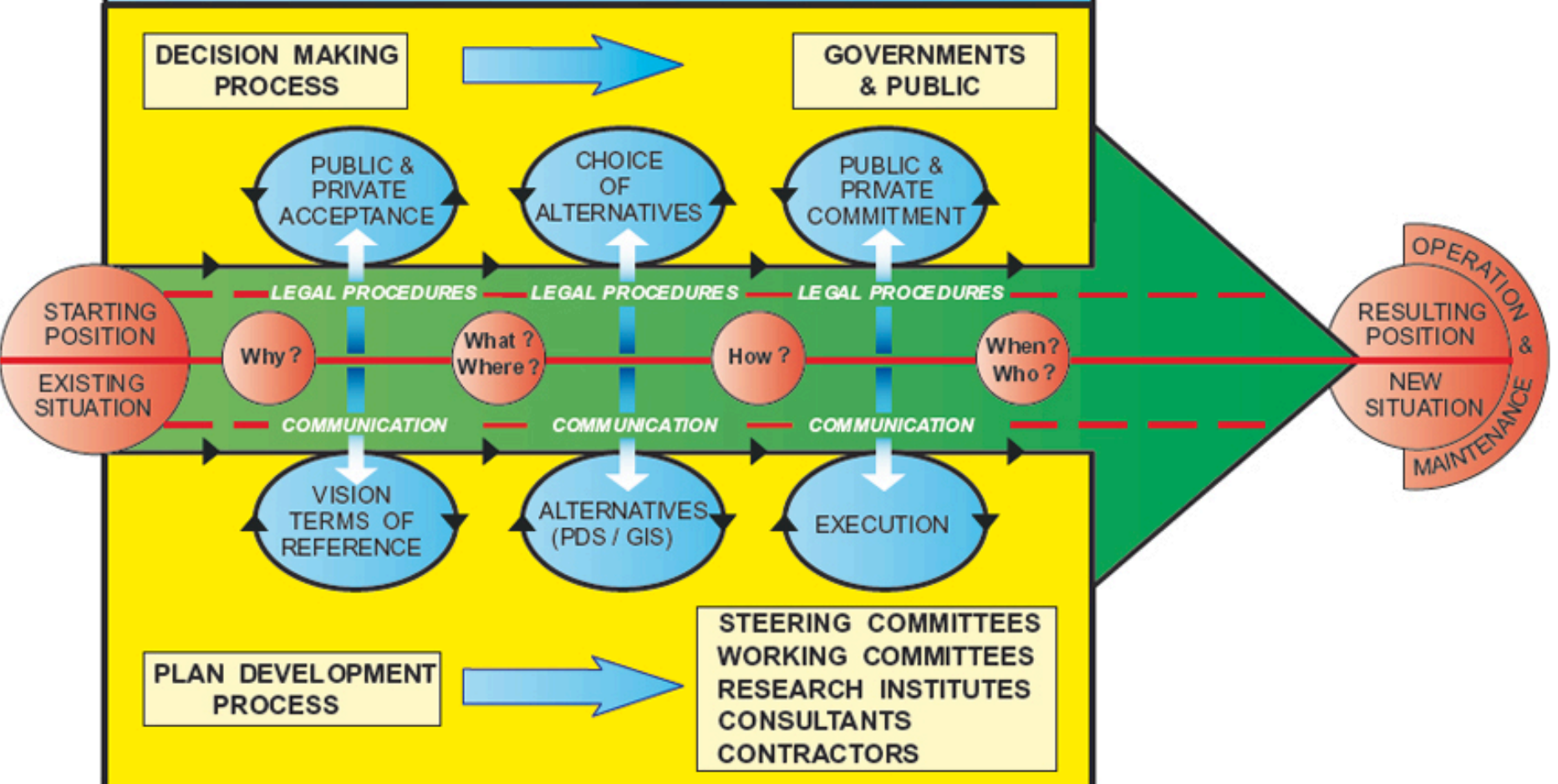
Space for the River Living
Rivers

Space in & around
the Lakes
Living Lakes

Space in & around
the Estuaries
Living Estuaries

Space for the Delta's
Living Delta's

INTERACTIVE PLAN DEVELOPMENT



$$P_R = F(Q \times A)$$

Probability of Realisation =
Function of Quality & Acceptance

- The interactive plan development must be:
- in accordance with legal procedures & standards;
 - fully equipped for vice-versa communication;
 - feasible from a financial - economical - social - cultural - environmental point of view;
 - striving for sustainability.