NETHERLANDS MARITIME UNIVERSITY ROTTERDAM
MASTER SHIPPING AND TRANSPORT

Dr. R.E. Waterman MSc

September 2016
Rotterdam

SUSTAINABLE COASTAL ZONE DEVELOPMENT

Integrated Coastal & Deltaic Policy via Building with Nature®

Building with Nature

$(\alpha+\beta+\gamma)_{\text{knowledge + action}} \rightarrow \Delta_{\text{sustainable}}$

Netherlands Maritime University Rotterdam

September 2016

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- Advisor MINISTRY OF INFRASTRUCTURE & ENVIRONMENT
- Advisor MINISTRY OF ECONOMY
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SUSTAINABLE COASTAL ZONE DEVELOPMENT

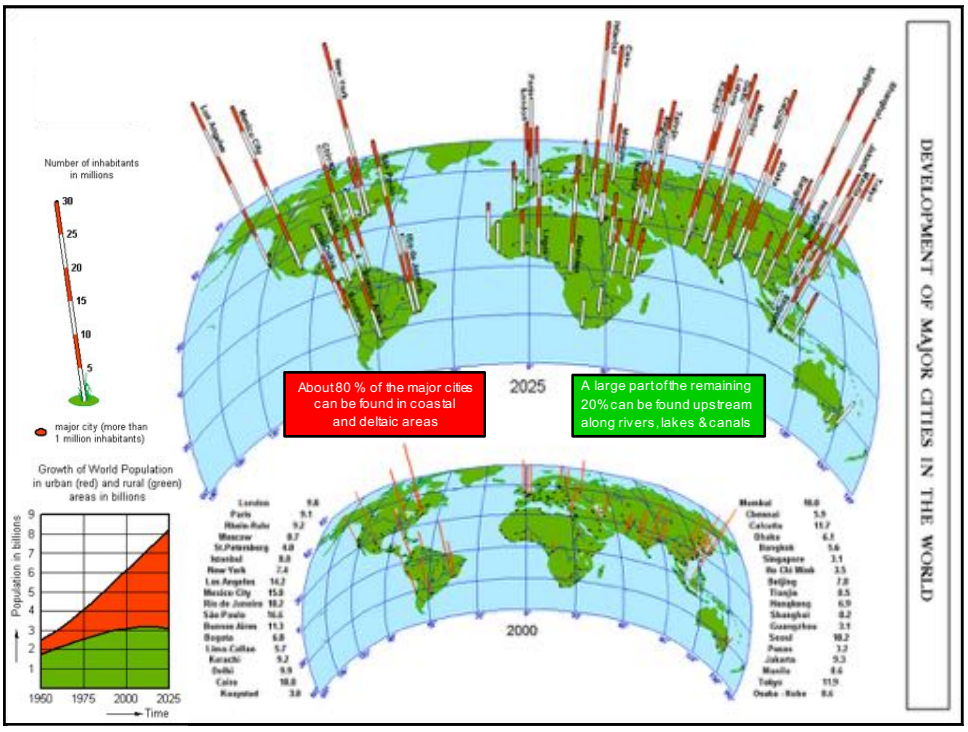
Flexible integration of land in water and of water in land

Making use of materials and forces & interactions present in nature

SUSTAINABLE COASTAL ZONE DEVELOPMENT

Civilisations were often developed in the border zone land-water, in coastal and deltaic regions. These border-zones are very attractive for living, working, tourism & recreation, transport, water resources, food supply. They are also important for nature values, because of the presence of gradients from wet to dry, from high to low salt & chalk content, differences in height & micro-climate. Gradients are often guarantees for a large variety of species.

Therefore it is not a surprise that in the 21st century, ~ 80% of the largest population centres are found in coastal areas.



SUSTAINABLE COASTAL ZONE DEVELOPMENT

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.

SUSTAINABLE COASTAL ZONE DEVELOPMENT

For the scarcity of space there are 3 solutions:

- ★ Making better use of the 3d and 4th dimension
- ★ Using space in the existing hinterland
- ★ Seaward option or combinations

SUSTAINABLE COASTAL ZONE DEVELOPMENT

As an answer to this scarcity of space:

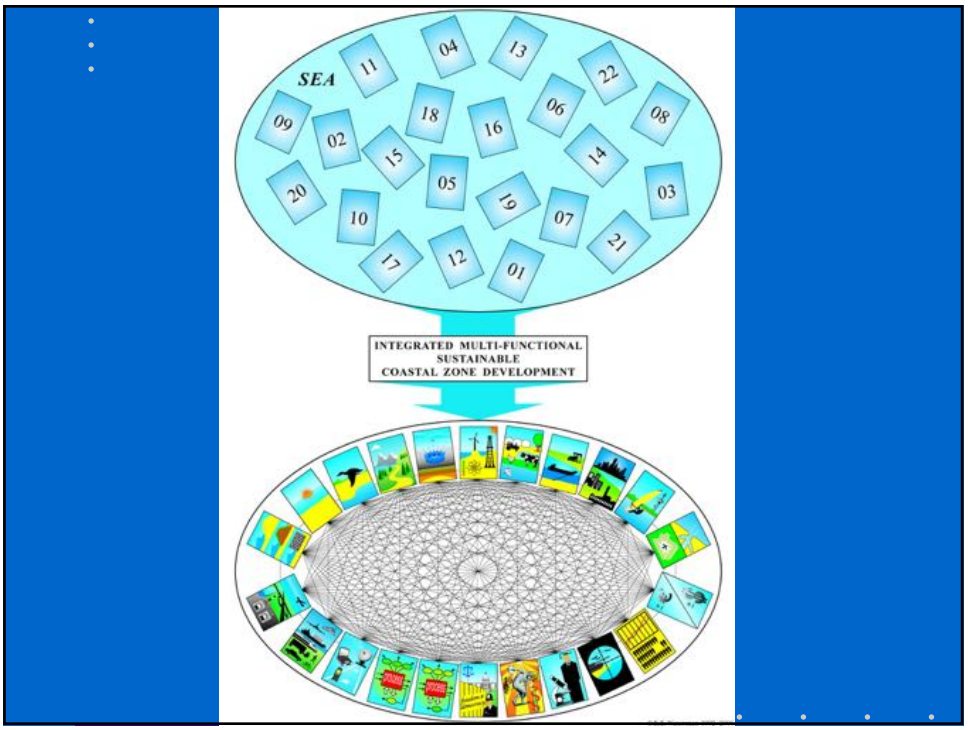
Reclaiming Land in Sea
and
Water in the new Land !

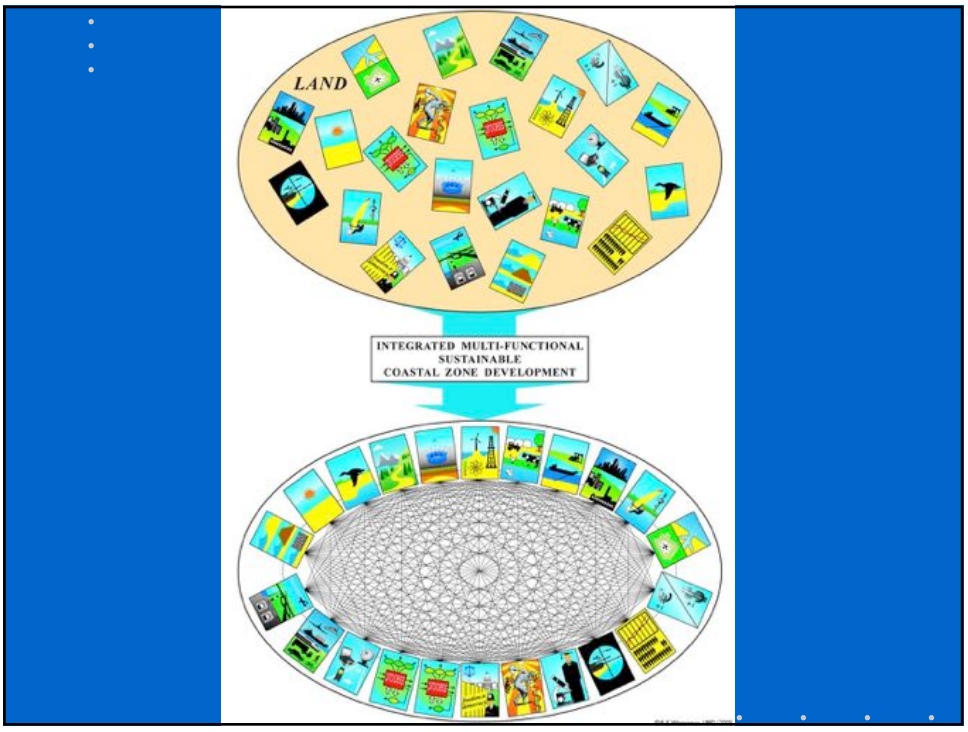
BUILDING WITH NATURE

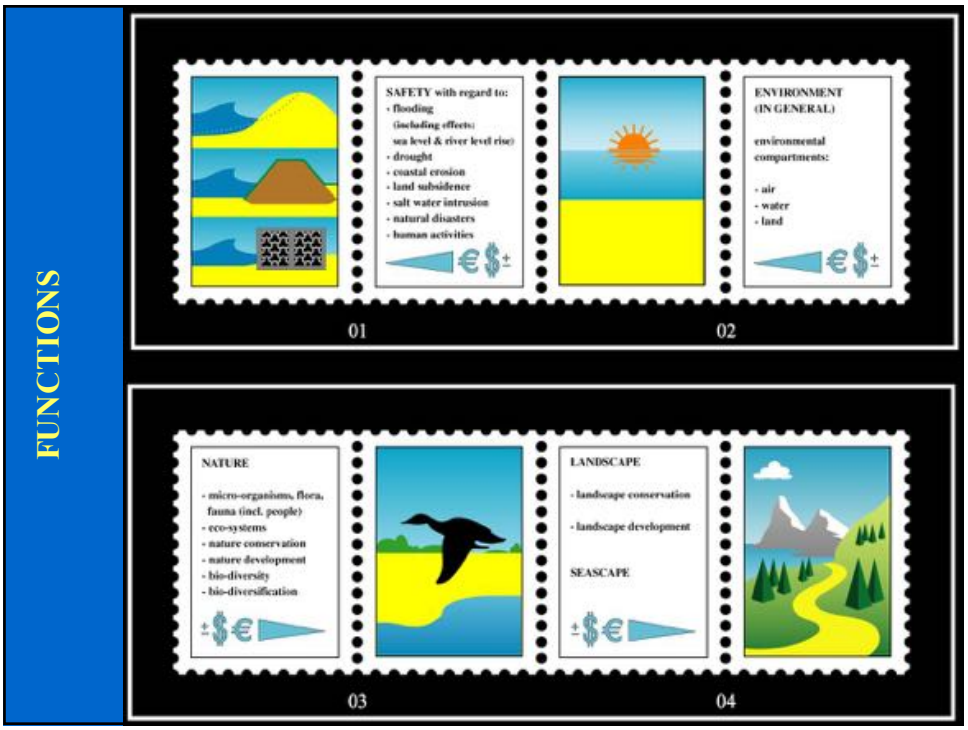
Integrated Approach to the coastal zone, including new and old land & sea.

Many functions have to be considered, while using many different disciplines.

Integrating land in sea and water in new and old land, thereby solving many existing and future problems in relation to the hinterland and the bordering sea, while creating added value.

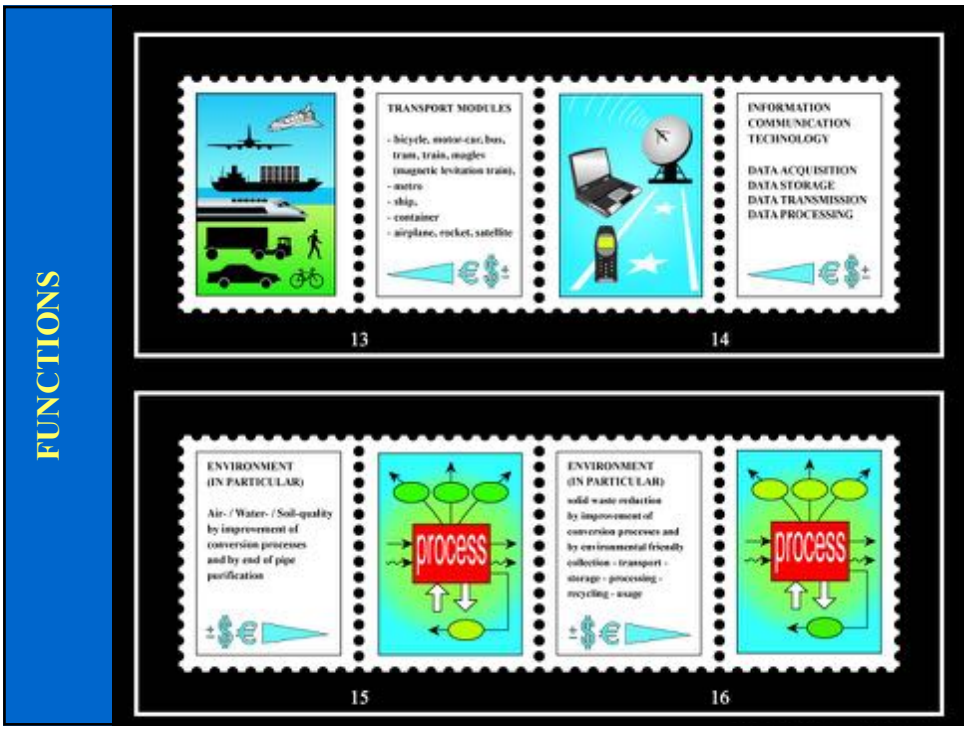

SEA
04
13
22
11
08
09
18
06
02
16
15
14
20
05
03
19
10
07
21
17
12
01
INTEGRATED MULTI-FUNCTIONAL
SUSTAINABLE
COASTAL ZONE DEVELOPMENT

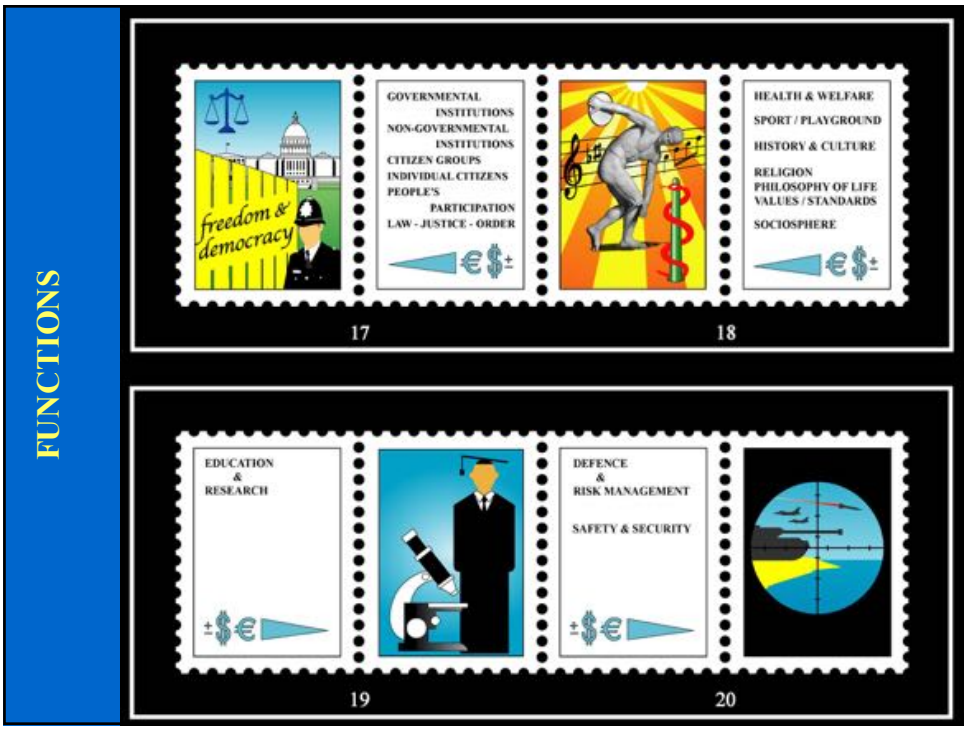

LAND
INTEGRATED MULTI-FUNCTIONAL
SUSTAINABLE
COASTAL ZONE DEVELOPMENT


FUNCTIONS
SAFETY with regard to:
- flooding
(including effects:
sea level & river level rise)
- drought
- coastal erosion
- land subsidence
- salt water intrusion
- natural disasters
- human activities
ENVIRONMENT
(IN GENERAL)
environmental
compartments:
- air
- water
- land
01
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


FUNCTIONS
WATER RESOURCES
MANAGEMENT
- water quantity
- water quality
- groundwater
- surface water
- dune infiltrated water
- (desalinated) sea-water
- sewer systems
- waste water purification
ENERGY
- natural gas, oil, coal, etc.
- biomass (wood, etc.);
orgasic wastes
- nuclear energy
- solar-, wind-,
water-, geo-energy
- combined cycle,
isolation, etc.
05
06
AGRICULTURE
horticulture, forestry,
cattle & poultry breeding
FISHERY
AQUACULTURE
MINING / EXTRACTION
& STORAGE
in / on
Land / Sea-bed / Sea /
Air
07
08


FUNCTIONS
BUILDING SITES FOR LIVING & WORKING
- houses & apartments + facilities
- industries & offices + facilities
- urban development
RECREATION & TOURISM
09
10
TRANSFER / DISTRIBUTION CENTRES & RELATED ACTIVITIES
- seaport
- riverport,
- lake port
- airport,
- landport
INFRASTRUCTURE
- roads
- railroads
- waterways
- underground systems
- airlanes
- electronic highway
11
12


FUNCTIONS
TRANSPORT MODULES
- bicycle, motor-car, bus, tram, train, maglev (magnetic levitation train),
- metro
- ship,
- container
- airplane, rocket, satellite
INFORMATION COMMUNICATION TECHNOLOGY
DATA ACQUISITION
DATA STORAGE
DATA TRANSMISSION
DATA PROCESSING
13
14
ENVIRONMENT (IN PARTICULAR)
Air- / Water- / Soil-quality by improvement of conversion processes and by end of pipe purification
process
ENVIRONMENT (IN PARTICULAR)
solid waste reduction by improvement of conversion processes and by environmental friendly collection - transport - storage - processing - recycling - usage
process
15
16


FUNCTIONS
freedom & democracy
GOVERNMENTAL INSTITUTIONS
NON-GOVERNMENTAL INSTITUTIONS
CITIZEN GROUPS
INDIVIDUAL CITIZENS
PEOPLE'S PARTICIPATION
LAW - JUSTICE - ORDER
HEALTH & WELFARE
SPORT / PLAYGROUND
HISTORY & CULTURE
RELIGION
PHILOSOPHY OF LIFE
VALUES / STANDARDS
SOCIOSPHERE
17
18
EDUCATION & RESEARCH
DEFENCE & RISK MANAGEMENT
SAFETY & SECURITY
19
20


FUNCTIONS
ECONOMY & EMPLOYMENT
FINANCE
FINANCIAL ENGINEERING
OTHER FUNCTIONS
21
22
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BUILDING WITH NATURE

Realisation of new land, where nature allows us to do so, using 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/interactions, present in nature, taking into account existing and potential nature values, and the biogeomorphology & geohydrology of coast and seabed.

BUILDING WITH NATURE

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

INORGANIC MATERIALS
gravel/sand
silt/clay

ORGANIC MATERIALS

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

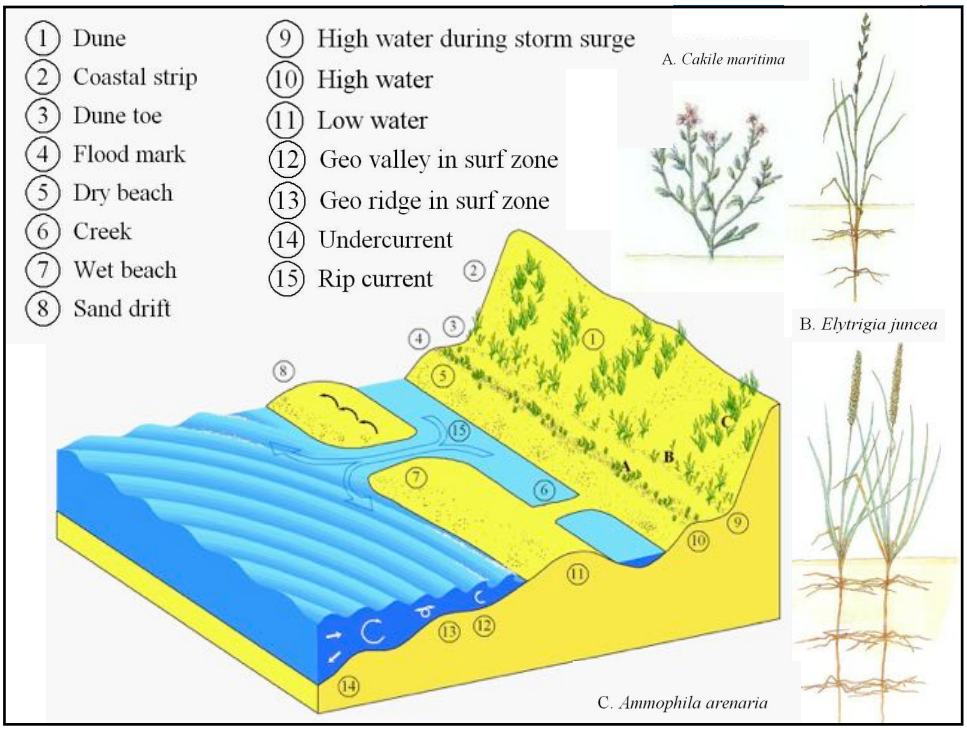
07. Rain

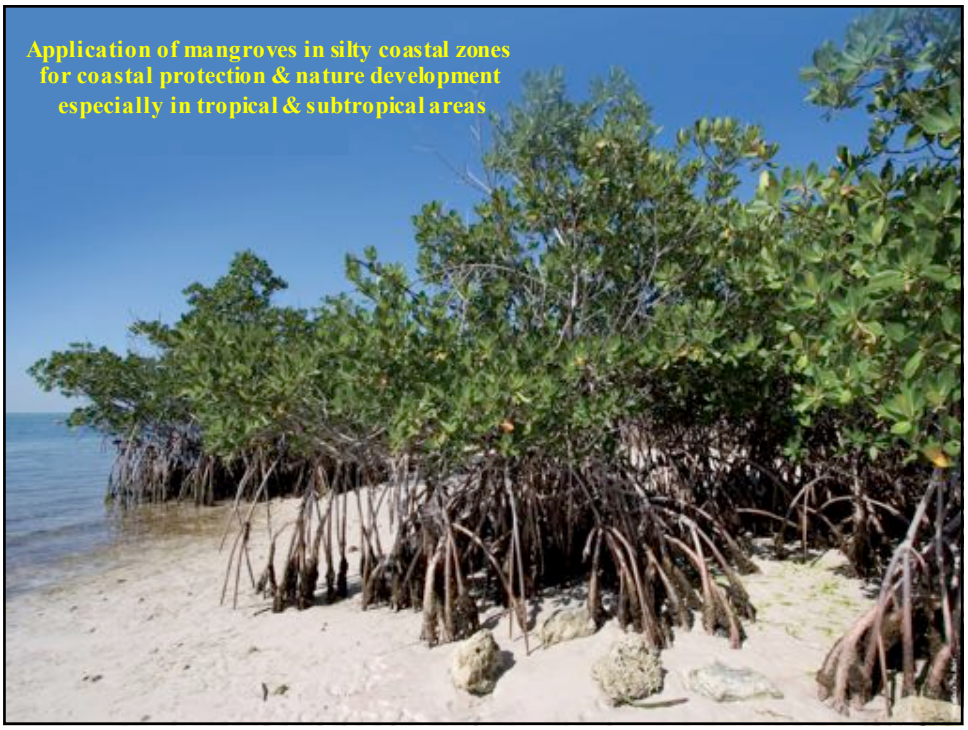
08. Solar radiation

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

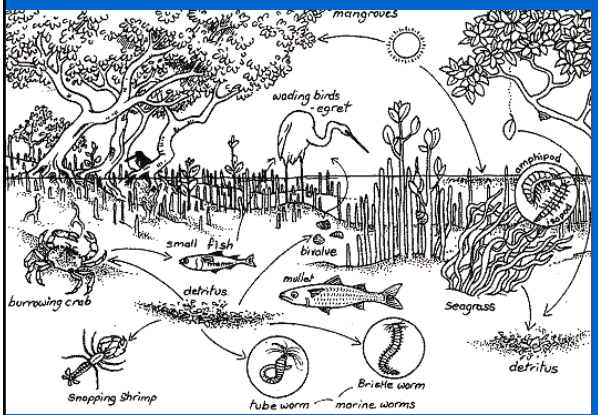
10. Complex interaction marine organisms - sand/silt.

BIOGEOMORPHOLOGY & GEOHYDROLOGY OF COAST AND SEABED

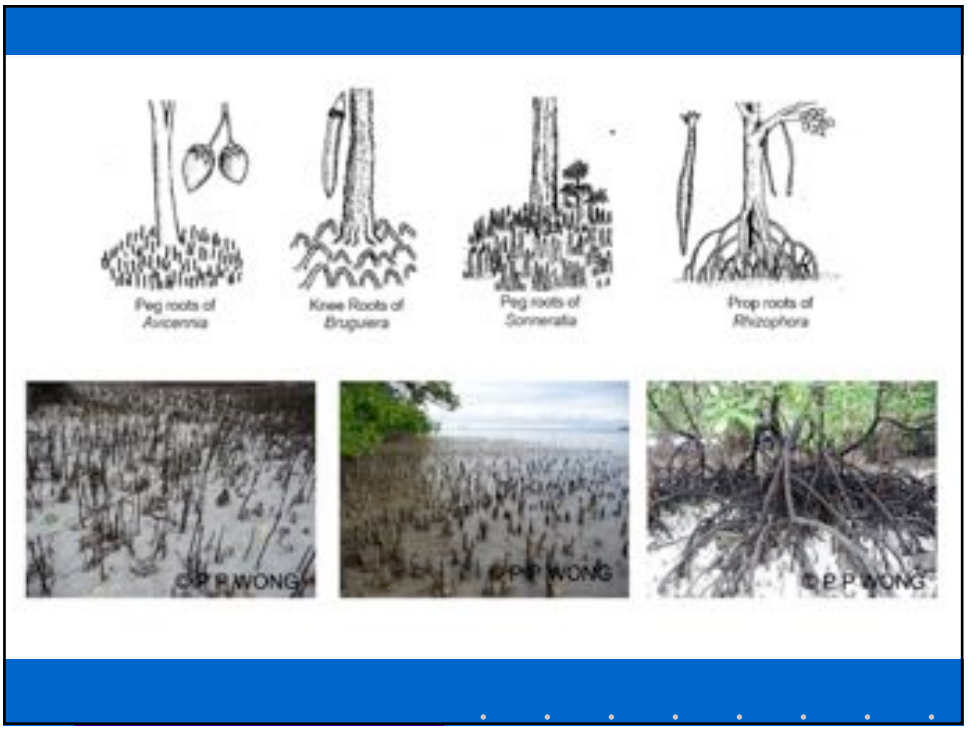




Mangroves

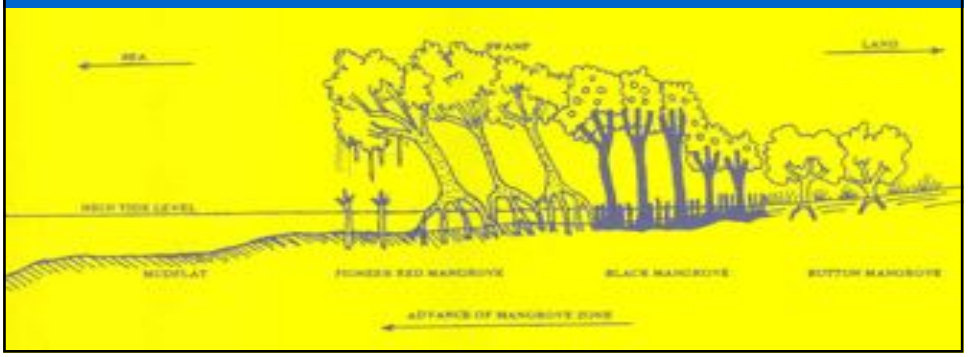


- Shoreline protection from erosion
- Basis for the complex marine food chain
- Creation of breeding habitats
- Protection for maturing offspring
- Filtering and assimilation of pollutants from upland runoffs
- Stabilisation of bottom sediment
- Improvement of water quality



MANGROVES **Dr. Bob Ursem TU Delft**

Mangroves characteristics & types
Mangroves for coastal protection
Mangroves as a basis for a rich eco-system

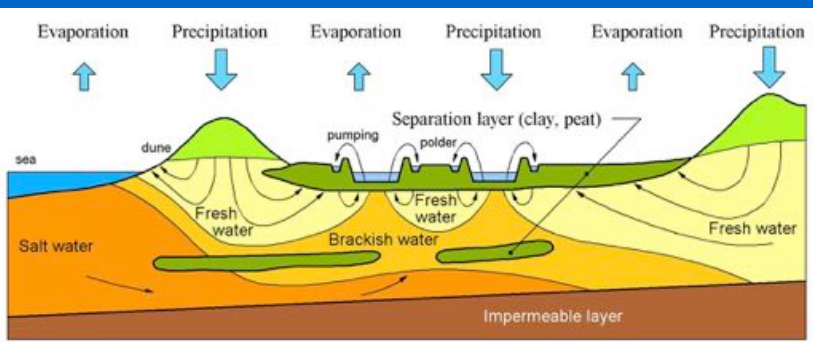


Category 1
First boundary layer of coastal defense, rough salt rich turbulent environment is an excellent growth area for mangroves with stilt pneumatophore root systems: tall trees, robust root systems, well anchored in mud, no settling of silt. Especially good for blocking storms and strong wave impact.

Category 2 and 3
A more inland, relative dynamic up to non turbulent, low saline level environment is an excellent growth area for mangroves with erect pneumatophore root systems: middle to tall tree sizes, sometimes shrubs, root system just reaching the high tide level, relative open to dense root cover, only anchored in mud at the base, creating a perfect alluvial environment.

Semi Permeable Dam
To initiate intertidal silt sedimentation for natural mangrove formation

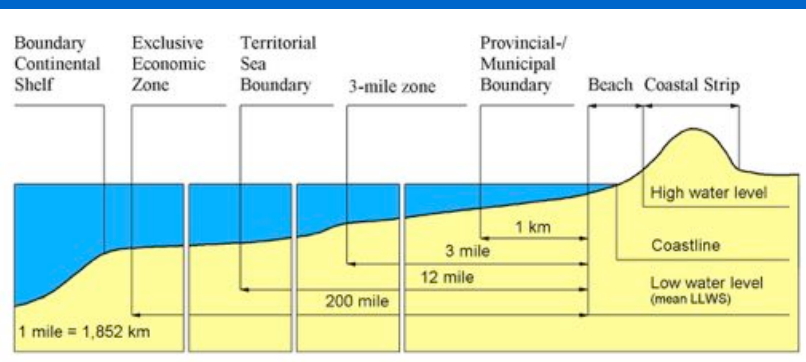
BUILDING WITH NATURE



CROSS SECTION SUBSOIL OF WEST-HOLLAND

Data: Rijks Geologische Dienst - S. Jelgersma

BUILDING WITH NATURE

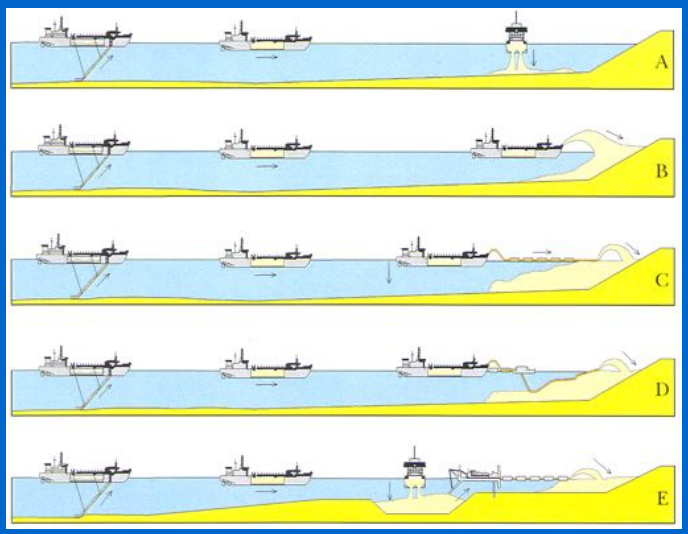


CROSS SECTION COASTAL ZONE
with national & international boundaries

Data: Chef der Hydrografie W.A. van Gein

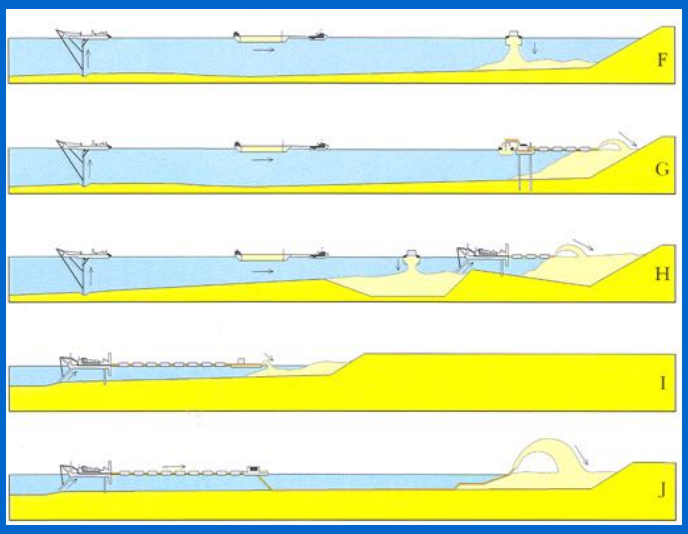
BUILDING WITH NATURE

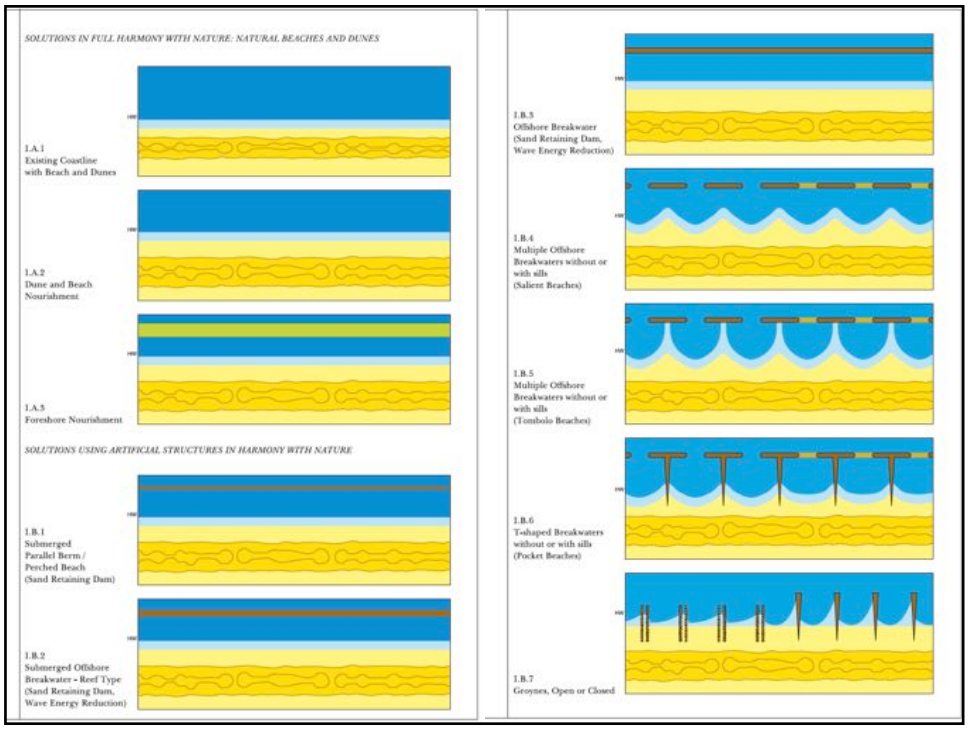
Dredging for Land Reclamation & Beach Nourishment

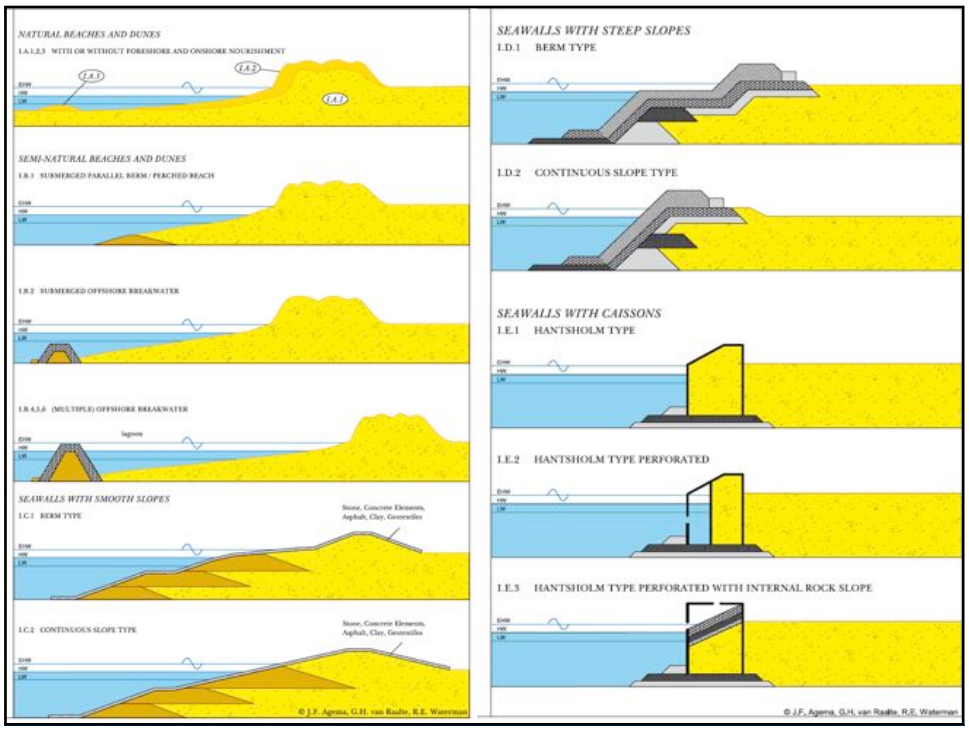


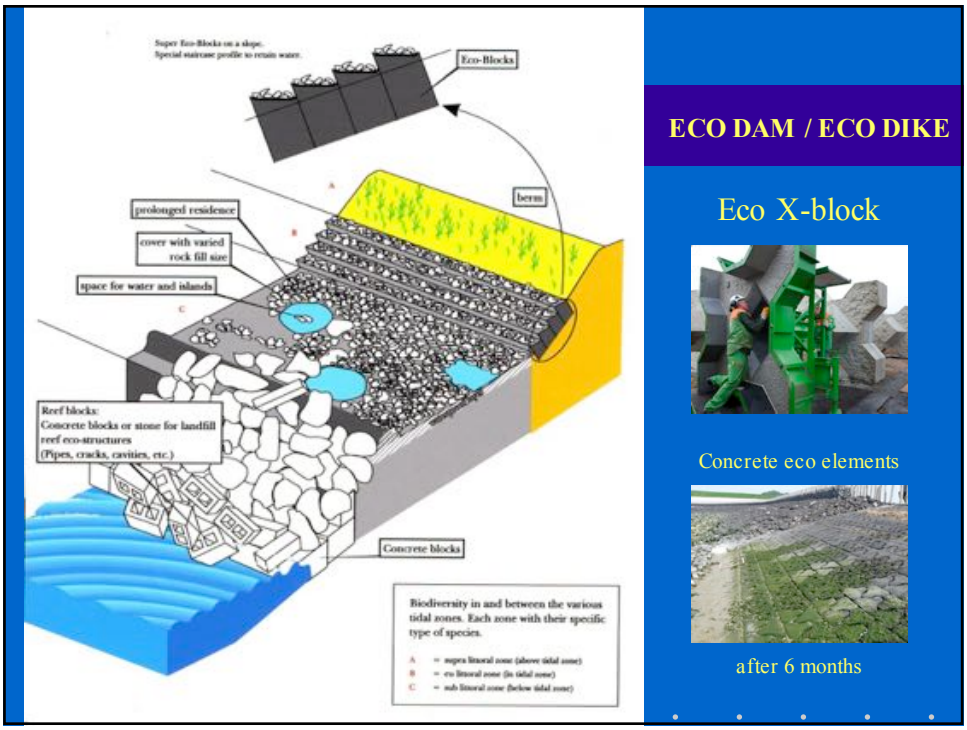
BUILDING WITH NATURE

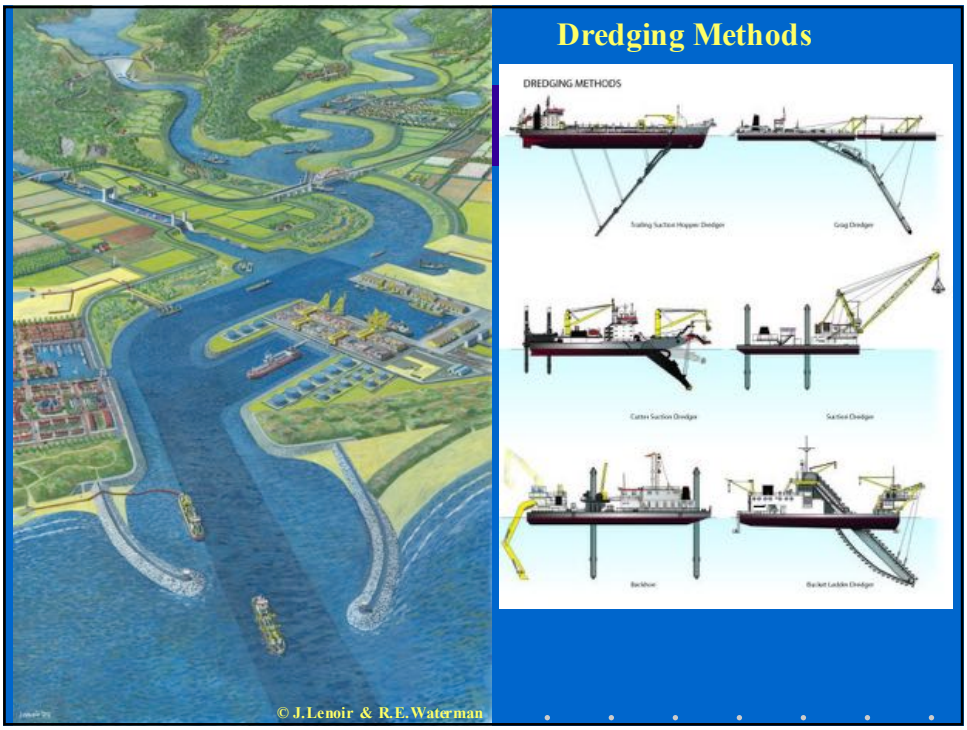
Dredging for Land Reclamation & Beach Nourishment




SOLUTIONS IN FULL HARMONY WITH NATURE: NATURAL BEACHES AND DUNES
I.A.1 Existing Coastline with Beach and Dunes
I.A.2 Dune and Beach Nourishment
I.A.3 Foreshore Nourishment
SOLUTIONS USING ARTIFICIAL STRUCTURES IN HARMONY WITH NATURE
I.B.1 Submerged Parallel Berm / Perched Beach (Sand Retaining Dam)
I.B.2 Submerged Offshore Breakwater - Reef Type (Sand Retaining Dam, Wave Energy Reduction)
I.B.3 Offshore Breakwater (Sand Retaining Dam, Wave Energy Reduction)
I.B.4 Multiple Offshore Breakwaters without or with sills (Salient Beaches)
I.B.5 Multiple Offshore Breakwaters without or with sills (Tombolo Beaches)
I.B.6 T-shaped Breakwaters without or with sills (Pocket Beaches)
I.B.7 Groynes, Open or Closed


NATURAL BEACHES AND DUNES
I.A.1,2,3 WITH OR WITHOUT FORESHORE AND ONSHORE NOURISHMENT
SEMI-NATURAL BEACHES AND DUNES
I.B.1 SUBMERGED PARALLEL BERM / PERCHED BEACH
I.B.2 SUBMERGED OFFSHORE BREAKWATER
I.B.4,5,6 (MULTIPLE) OFFSHORE BREAKWATER
lagoon
SEAWALLS WITH SMOOTH SLOPES
I.C.1 BERM TYPE
I.C.2 CONTINUOUS SLOPE TYPE
Stone, Concrete Elements, Asphalt, Clay, Geotextiles
SEAWALLS WITH STEEP SLOPES
I.D.1 BERM TYPE
I.D.2 CONTINUOUS SLOPE TYPE
SEAWALLS WITH CAISSONS
I.E.1 HANTSHOLM TYPE
I.E.2 HANTSHOLM TYPE PERFORATED
I.E.3 HANTSHOLM TYPE PERFORATED WITH INTERNAL ROCK SLOPE
© J.F. Agema, G.H. van Raalte, R.E. Waterman


Eco-Blocks
berm
prolonged residence
cover with varied rock fill size
space for water and islands
Reef blocks:
Concrete blocks or stone for landfill
reef eco-structures
(Pipes, cracks, cavities, etc.)
Concrete blocks
Biodiversity in and between the various tidal zones. Each zone with their specific type of species.
ECO DAM / ECO DIKE
Eco X-block
Concrete eco elements
after 6 months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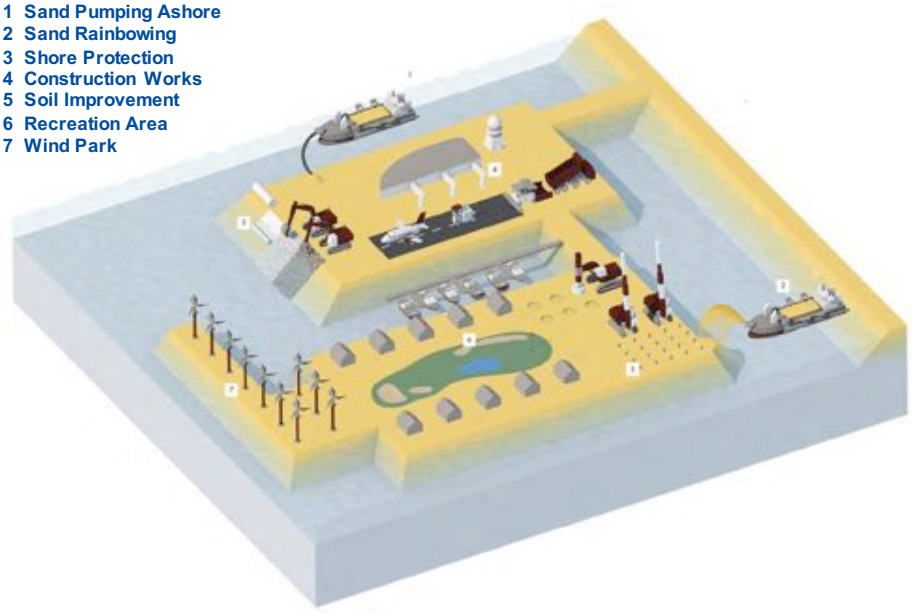
Dredging Methods
DREDGING METHODS

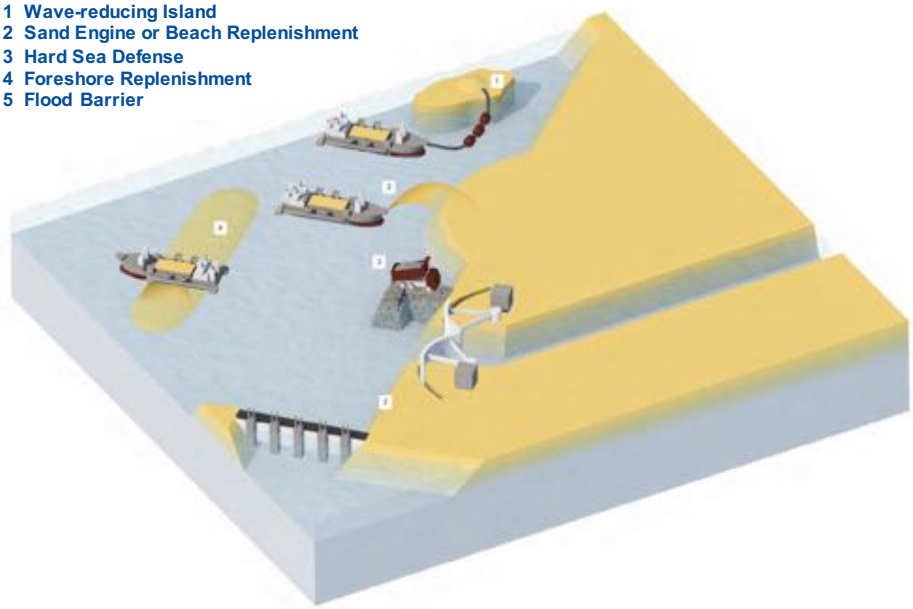
Land Reclamation

1 Sand Pumping Ashore
2 Sand Rainbowing
3 Shore Protection
4 Construction Works
5 Soil Improvement
6 Recreation Area
7 Wind Park



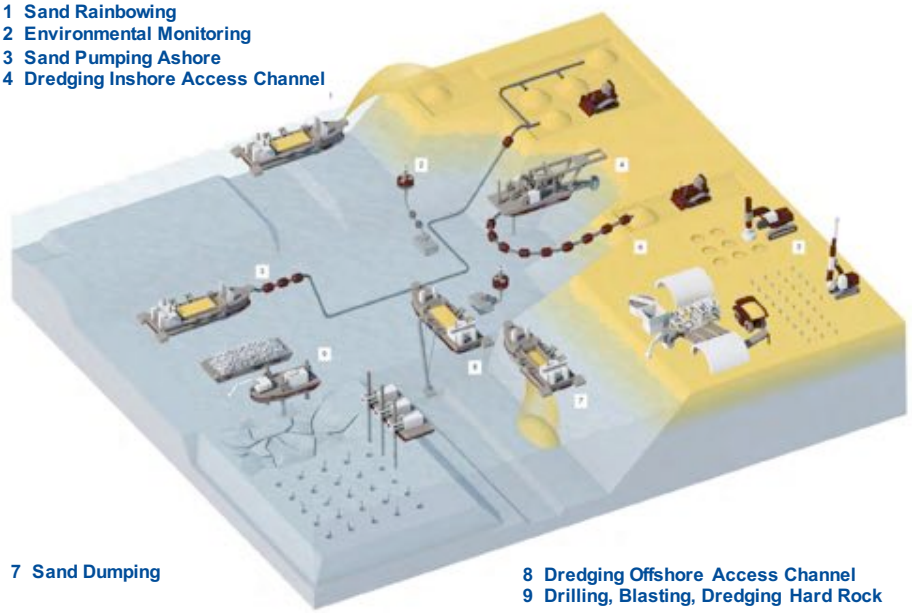
Coastal Protection

1 Wave-reducing Island
2 Sand Engine or Beach Replenishment
3 Hard Sea Defense
4 Foreshore Replenishment
5 Flood Barrier



Port Development

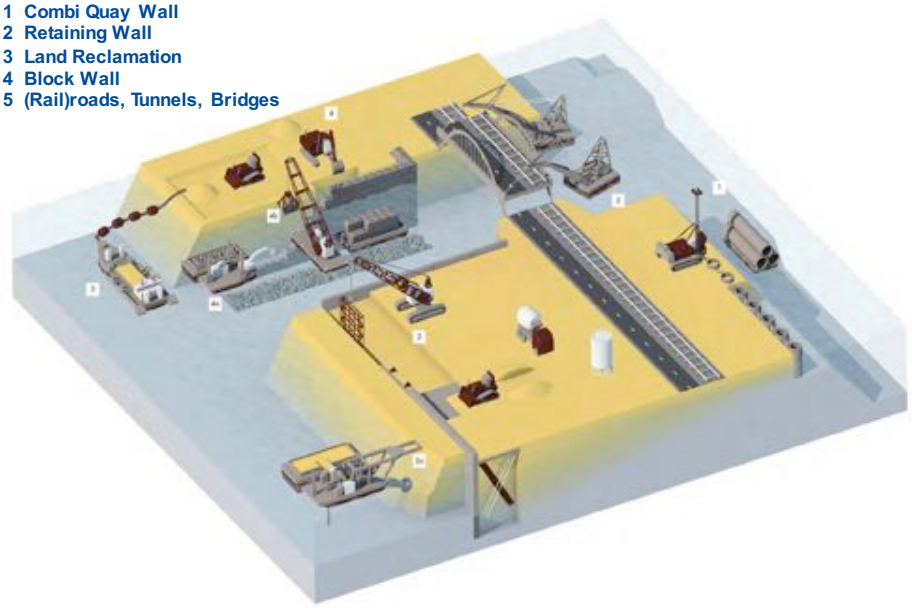
1 Sand Rainbowing
2 Environmental Monitoring
3 Sand Pumping Ashore
4 Dredging Inshore Access Channel
5 Soil Improvement Techniques
6 Soil Remediation



7 Sand Dumping
8 Dredging Offshore Access Channel
9 Drilling, Blasting, Dredging Hard Rock

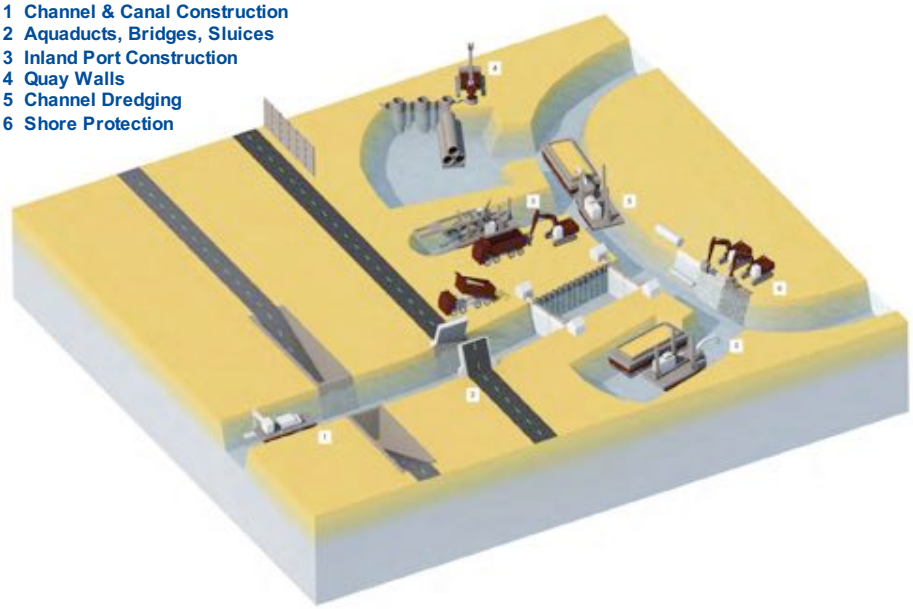
Port Infrastructure

1 Combi Quay Wall
2 Retaining Wall
3 Land Reclamation
4 Block Wall
5 (Rail)roads, Tunnels, Bridges



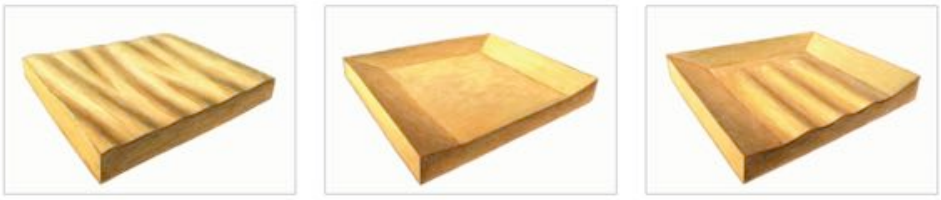
Inland Ports & Waterways

1 Channel & Canal Construction
2 Aquaducts, Bridges, Sluices
3 Inland Port Construction
4 Quay Walls
5 Channel Dredging
6 Shore Protection



ENVIRONMENT-FRIENDLY DREDGING METHODS

1 Dredging in alternate zones
2 Sub-surface dredging
3 Application of silt screens
4 Specially designed suction heads & pumping systems
5 Eco-efficient dredging: instead of shallow dredging over large areas, deep dredging over small areas, combined with seabed landscaping

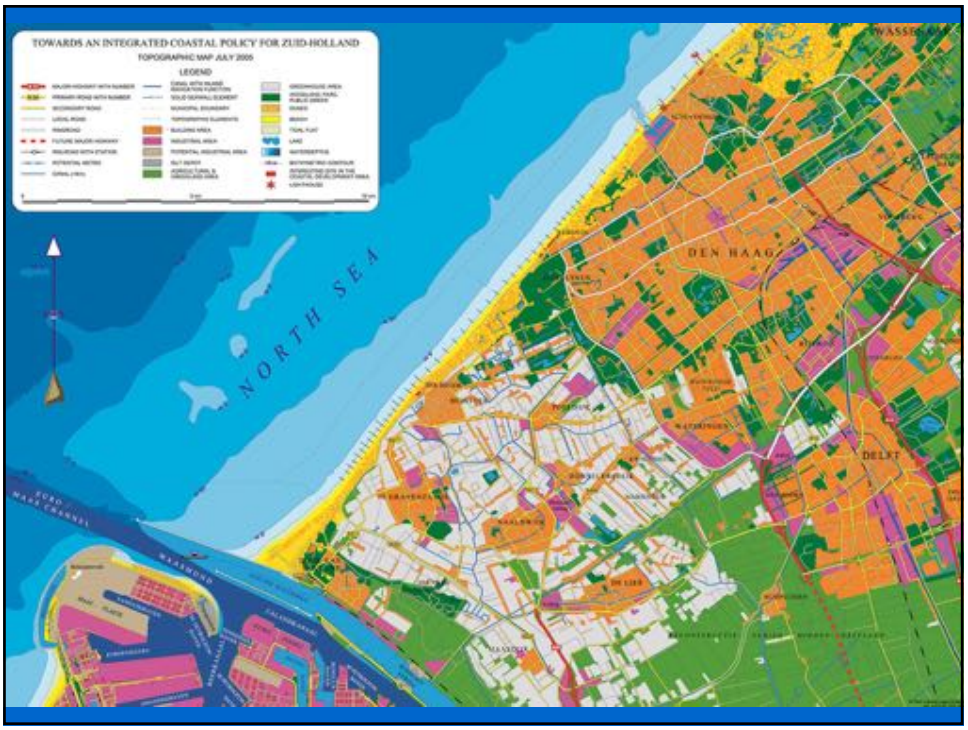



EUROPE


EUROPE
Arctic Ocean
Barentsz Sea
Atlantic Ocean
North Sea
Baltic Sea
Gulf of Biscay
Mediterranean Sea
Norge
Sverige
Suomi
Eesti
Latvija
Lietuva
Belarus
Rossija
Danmark
Polska
Deutschland
Ukraina
Ceska
Slovenska
Magyarorszag
România
France
Portugal
España
Srbija i Crna Gora
Shqipëria
Ellas
Türkiye
Kypros
Al Maghrib
Al Jaza'ir
Tunis
Libiyan

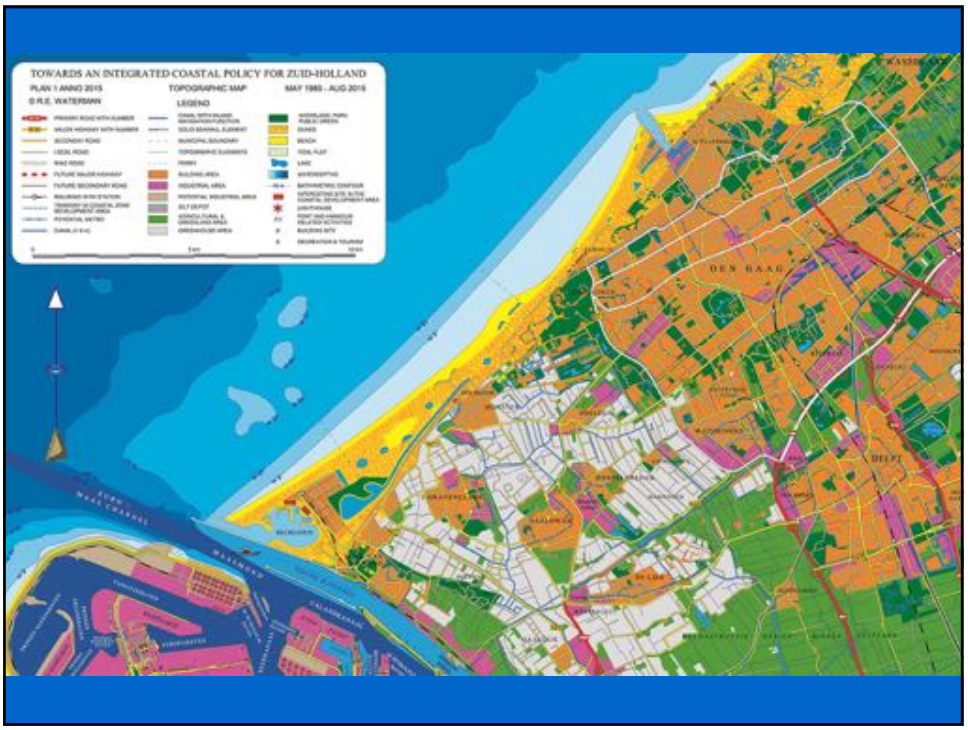

Plan A
Land reclamation via Building with Nature®
along North Sea Coast
The Netherlands
Plan 4
Plan 3
Plan 6
Plan 1
Plan 2
Integrated Coastal Policy via Building with Nature®


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
LEGEND
Plan 1
NORTH SEA
DEN HAAG


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
TOPOGRAPHIC MAP JULY 2005
LEGEND
NORTH SEA
DEN HAAG
DELFT


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
2015 current situation
MAY 1960 - AUG 2015
D.R.E. WATERMAN
LEGEND
TOPOGRAPHIC MAP
NORTH SEA
DEN HAAG
DELFT


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
PLAN 1 ANNO 2015 with current Kijkduin & Scheveningen
MAY 1980 - AUG 2015
© R.E. WATERMAN
LEGEND
TOPOGRAPHIC MAP
DEN HAAG
DELFT
EURO MAAS CHANNEL
MAASVLAKTE


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
PLAN 1 ANNO 2015
TOPOGRAPHIC MAP
MAY 1980 - AUG 2015
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LEGEND
DEN HAAG
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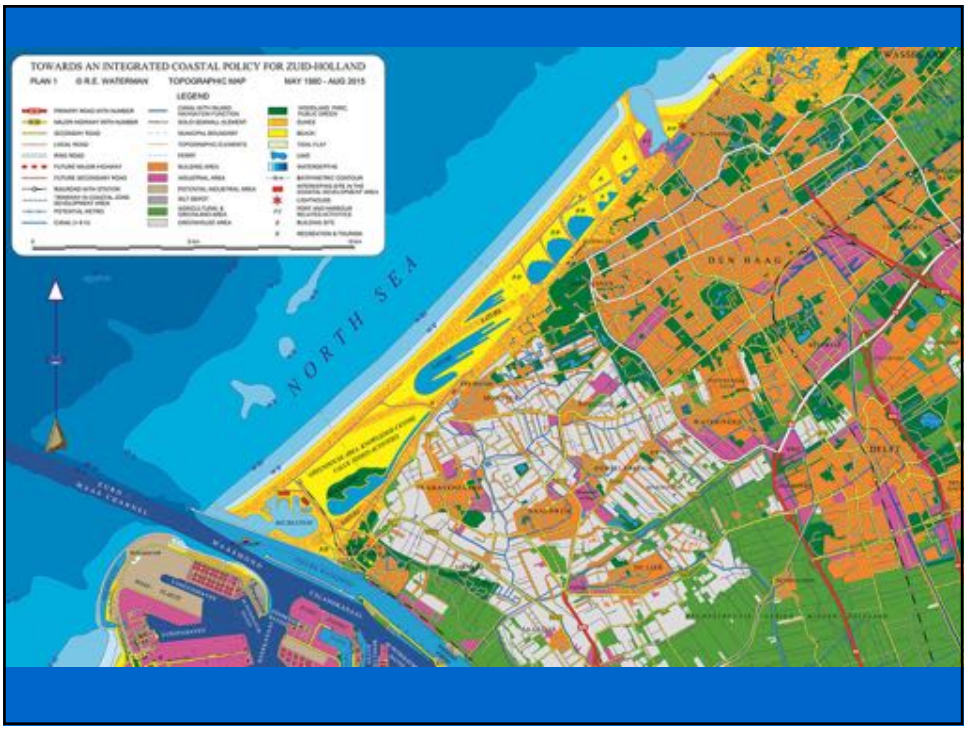
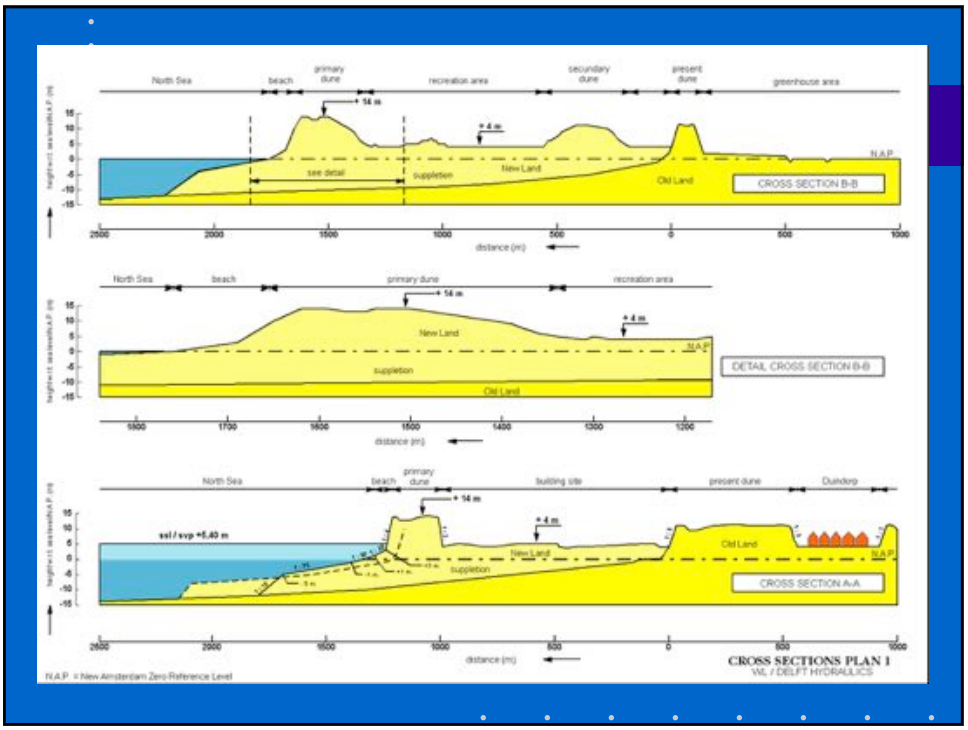
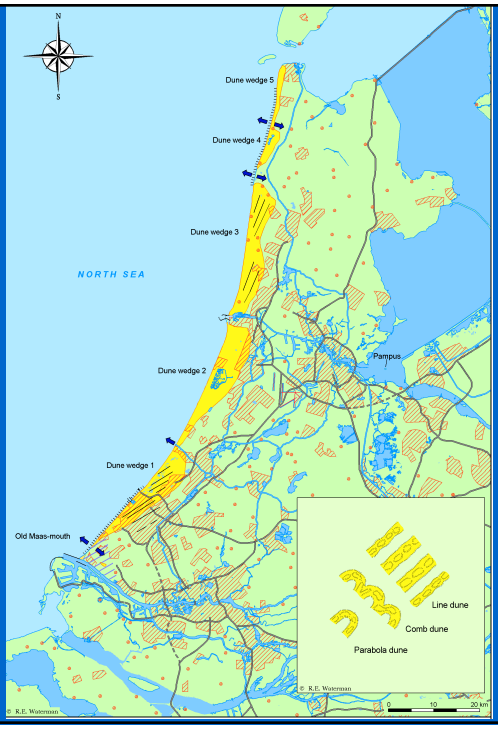
EURO MAAS CHANNEL
MAASVLAKTE


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
PLAN 1 G.R.E. WATERMAN TOPOGRAPHIC MAP MAY 1980 - AUG 2015
LEGEND
NORTH SEA
DEN HAAG
DELFT


North Sea
beach
primary dune
recreation area
secondary dune
present dune
greenhouse area
+ 14 m
+ 4 m
see detail
suppletion
New Land
Old Land
N.A.P.
CROSS SECTION B-B
distance (m)
DETAIL CROSS SECTION B-B
building site
present dune
Duindorp
CROSS SECTION A-A
CROSS SECTIONS PLAN 1
N.A.P. = New Amsterdam Zero-Reference Level

Geological Young Dune Wedges



Historical Coastline Delfland

Historical Coastlines Holland

BUILDING WITH NATURE PLAN 1

Rip currents alongside groynes causing sand transport towards the North Sea

1985

COAST OF DELFLAND WITH 69 GROYNES

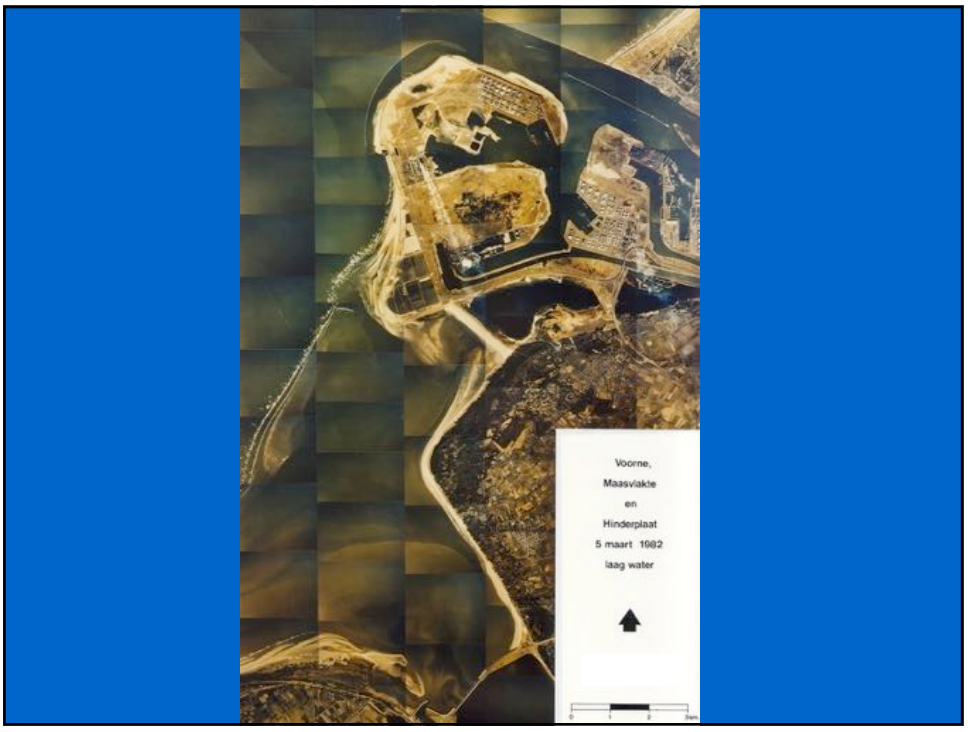
BUILDING WITH NATURE PLAN 1

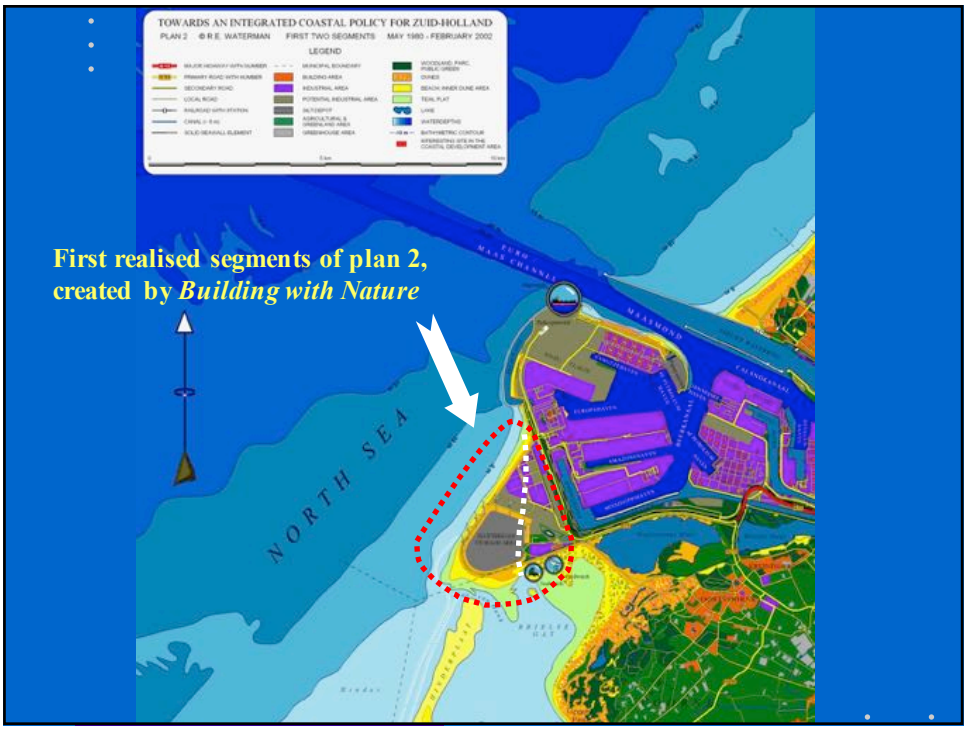
March 16 - 1981

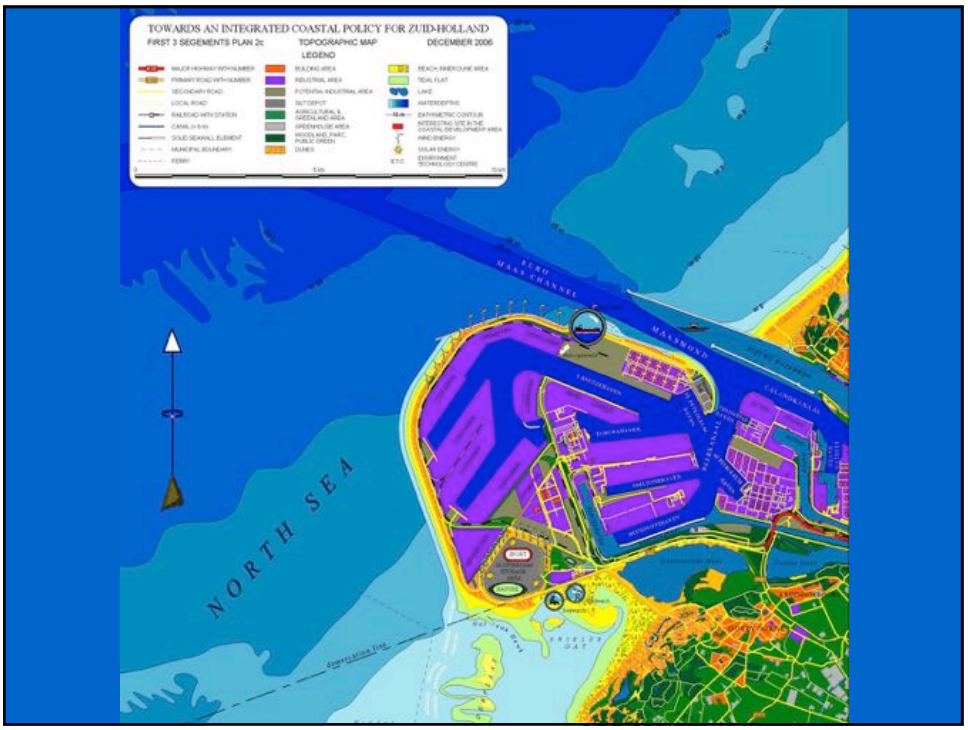
FIRST REALISED SEGMENT OF PLAN 1, NEAR HOEK VAN HOLLAND

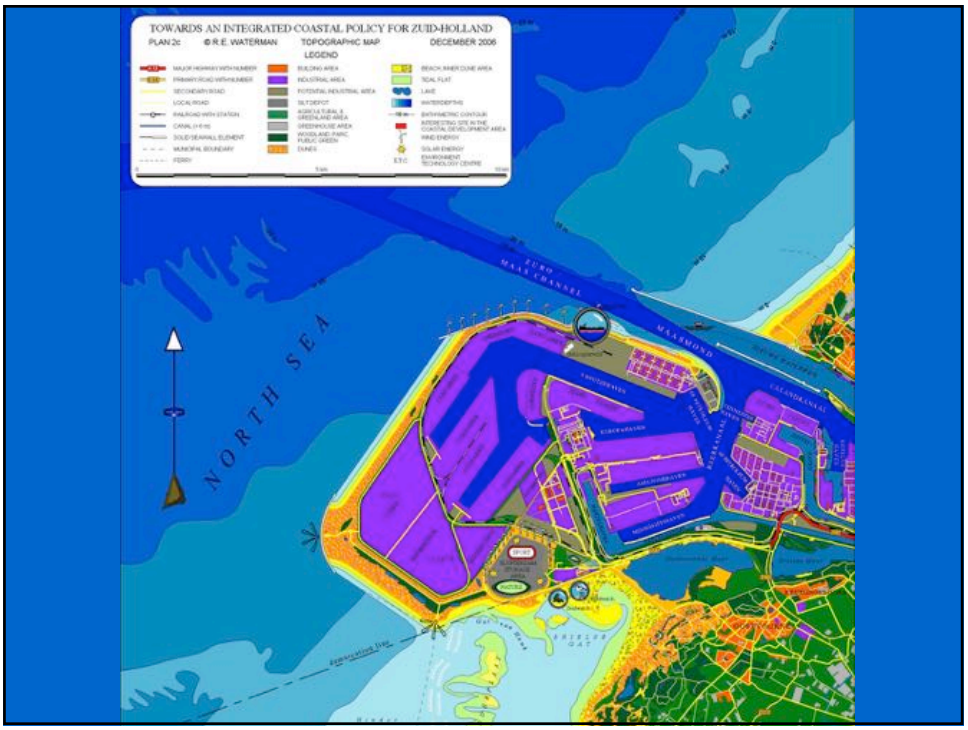
Narrow endangered coast of South-Holland near Ter Heijde 16-3-1981


Plan A
Land reclamation via Building with Nature® along North Sea Coast
The Netherlands
Plan 4
Plan 3
Plan 6
Plan 1
Plan 2
Integrated Coastal Policy via Building with Nature®


Voorne,
Maasvlakte
en
Hinderplaat
5 maart 1982
laag water

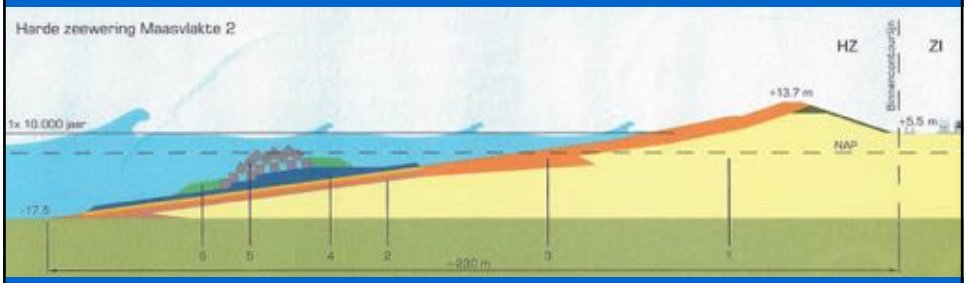

TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
LEGEND
First realised segments of plan 2,
created by *Building with Nature*
NORTH SEA


TOWARDS AN INTEGRATED COASTAL POLICY FOR ZUID-HOLLAND
LEGEND
NORTH SEA

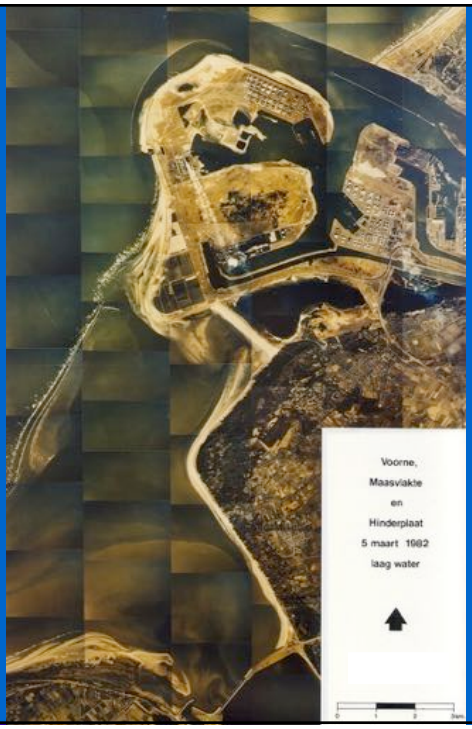


COASTAL DEFENSE MAASPLAIN 2 (RHINEPLAIN)

3,5 km hard construction; 7,5 km soft dune-beach construction



1 Sand base layer approx. 150 µm; top layer min. 370 µm
2 Filter layer gravel under concrete block dam 0,3 - 35 mm
3 Cobble layer 1 m thickness under concrete block dam up to 4 m thickness on top of gravel dune, diameter cobbles 20 – 135 mm
4 Quarry stones 150 – 800 kg on top of quarry stones 5 – 70 kg
5 Concrete blocks (17.000 blocks - 2,5 x 2,5 x 2,5 m - 40 à 43 ton) across 3,5 km coastal length
6 Toe construction with stones from 1 – 10 ton to prevent sliding of concrete blocks



BUILDING WITH NATURE PLAN 2

March 22 - 1991

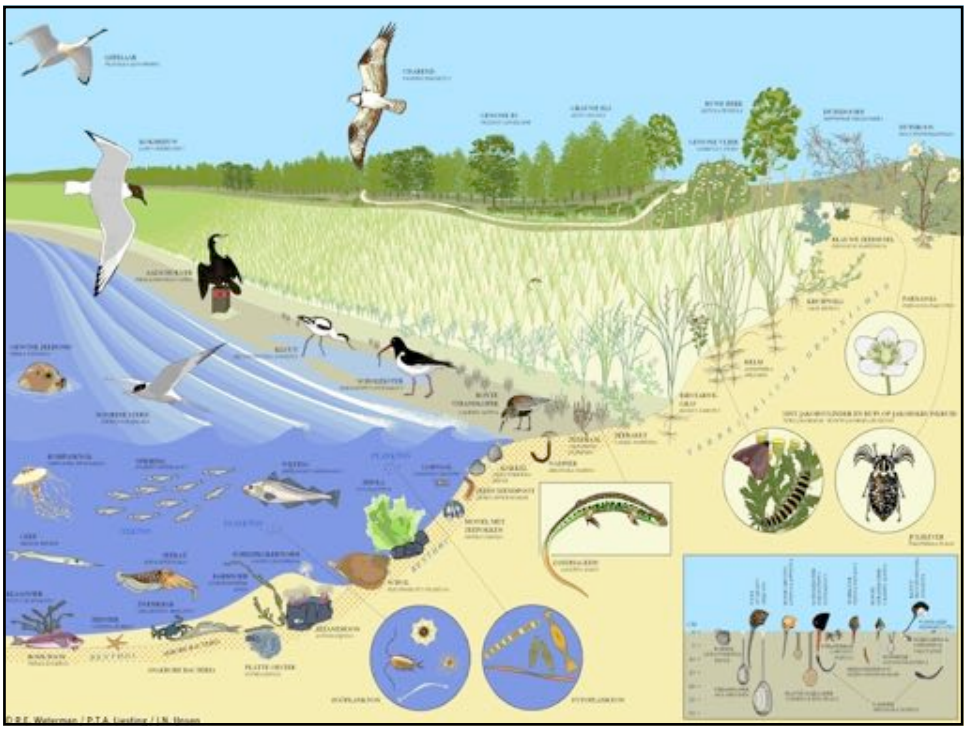
FIRST REALISED SEGMENTS OF PLAN 2

BUILDING WITH NATURE PLAN 2

August 17 - 2000

FIRST REALISED SEGMENTS OF PLAN 2


Euroklei-bakstenen uit havenslib
Vliegas van kolengestookte elektriciteitscentrale
Vliegas en vuilverbrandingsinstallatie
Aardelite©, kunstgrind
Eco-grind©, kunstgrind
Aardelite©, kunstgrind in betonprodukten



BUILDING WITH NATURE Plan 2

Parnassia

Euphorbia Maritima

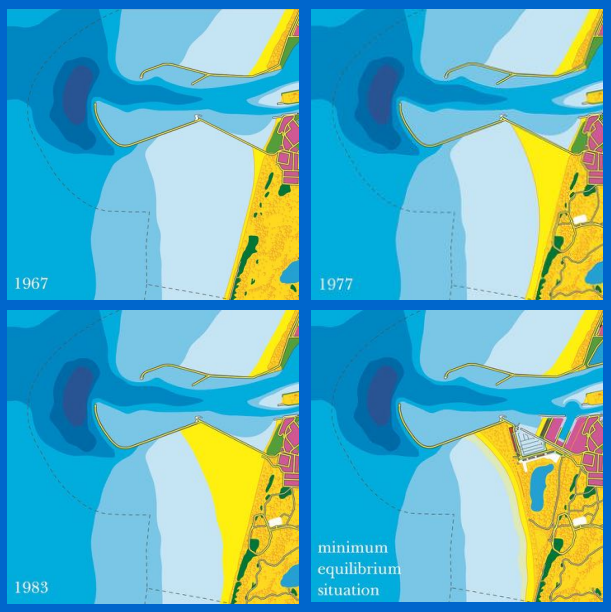

Sand Engine
August 2011
Cakile
Maritima


BUILDING WITH NATURE
Plan 2
Lacerta Agilis


Plan A
Land reclamation via Building with Nature® along North Sea Coast
The Netherlands
Plan 4
Plan 3
Plan 6
Plan 1
Plan 2
Integrated Coastal Policy via Building with Nature®

SEAPORT MARINA IJMUIDEN
KENNEMER BEACH

BUILDING WITH NATURE — PLAN 3a

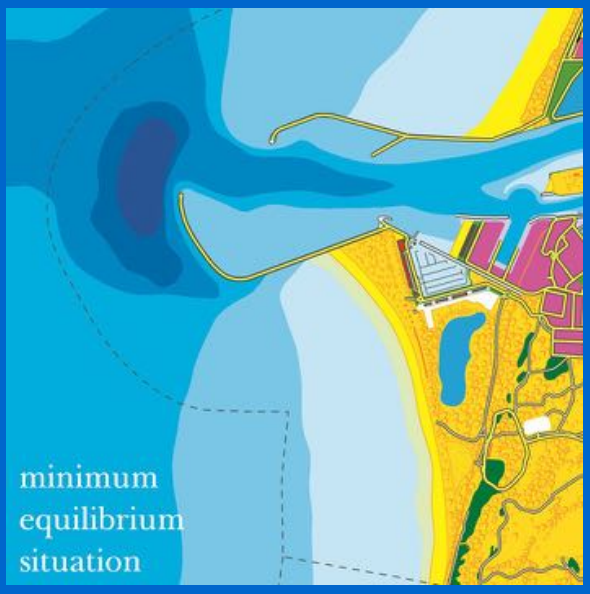


Nature is already developing the new area south of the existing Southern Harbour Mole IJmuiden, owing to littoral sand transport from Province South-Holland to Province North-Holland.

This process is quickened by external and internal dredging operations.

SEAPORT MARINA IJMUIDEN
KENNEMER BEACH

BUILDING WITH NATURE — PLAN 3a



Plan 3a is triangle-shaped and consists of a primary range of dunes with a marina, double boulevard, apartments, restaurants & shops, hotel, infrastructure, recreation & tourism; transition zone with lake; nature reserve area linked to an existing nature reserve area (Kennemer Dunes).

BUILDING WITH NATURE PLAN 3a

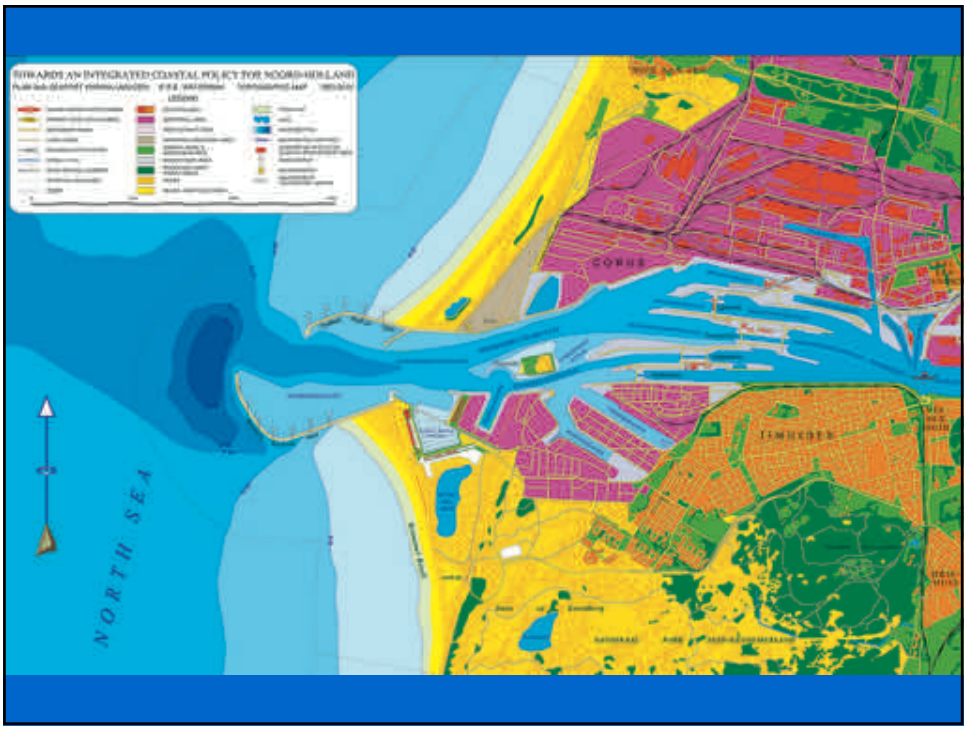
July 10 - 1997

PLAN 3a. Complete with primary range of dunes, beaches, marina, boulevard, apartments, restaurants & shops, hotel, infrastructure, lake & nature reserve area.

BUILDING WITH NATURE PLAN 3a

June 2000

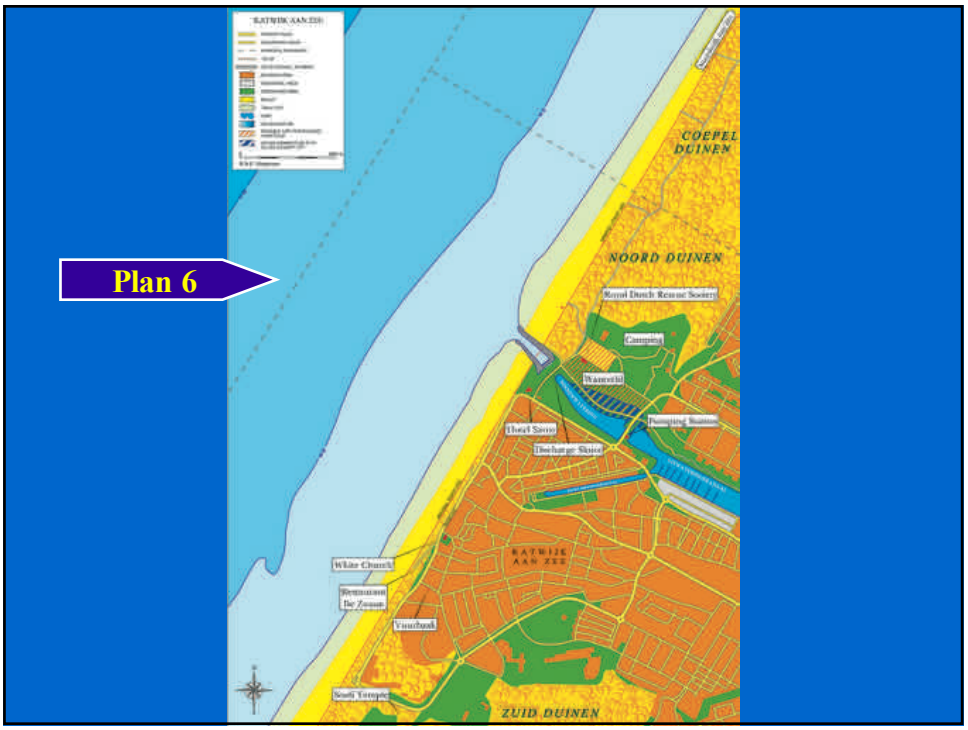
PLAN 3a. Complete with primary range of dunes, beaches, marina, boulevard, apartments, restaurants & shops, hotel, infrastructure, lake & nature reserve area.


NORTH SEA


BUILDING WITH NATURE
PLAN 3a
North Sea
2012


Plan A
Land reclamation via Building with Nature® along North Sea Coast
The Netherlands
Plan 4
Plan 3
Plan 6
Plan 1
Plan 2
Integrated Coastal Policy via Building with Nature®


Plan 6.
Katwijk aan Zee
NORTH SEA
COEPEL DUINEN
NOORD DUINEN
ZUID DUINEN
KATWIJK AAN ZEE
Seaport Marina with dune widening on each side for Katwijk & Noordwijk
Future connection with Old Rhine River with sluice or boat conveyor


Plan 6
COEPEL DUINEN
NOORD DUINEN
Royal Dutch Rescue Society
Campsite
Waterstop
Pumping Station
Hotel Savoy
Discharge Sluice
KATWIJK AAN ZEE
White Church
Restaurant De Zwaan
Vuurduin
South Tempel
ZUID DUINEN


Plan 6
NORTH SEA
COEPEL DUINEN
NOORD DUINEN
Royal Dutch Rescue Society
Campsite
Waterstop
Pumping Station
Hotel Savoy
Discharge Sluice
KATWIJK AAN ZEE
White Church
Restaurant De Zwaan
Vuurduin
South Tempel
ZUID DUINEN

Plan 6. Katwijk aan Zee 2008

Plan 6. Katwijk aan Zee 2015

Dune with underground park incorporated

Plan 6.
Katwijk aan Zee

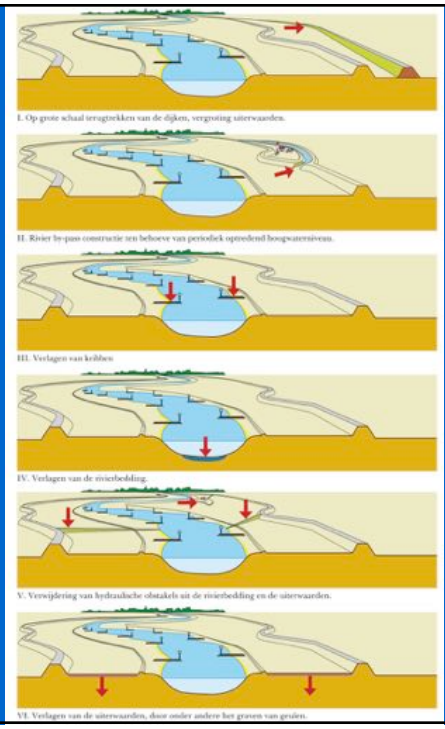
Space for the Coast Living Coasts

Space for the River Living Rivers

Space in & around the Lakes Living Lakes

Space in & around the Estuaries Living Estuaries

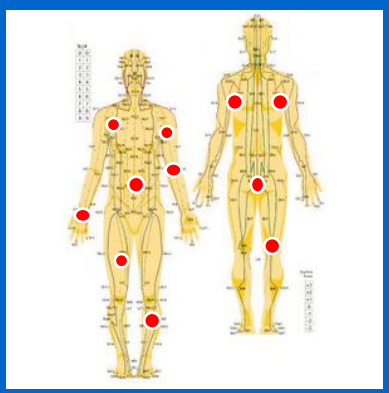
Space for the Delta's Living Delta's



Space for the River / Living Rivers

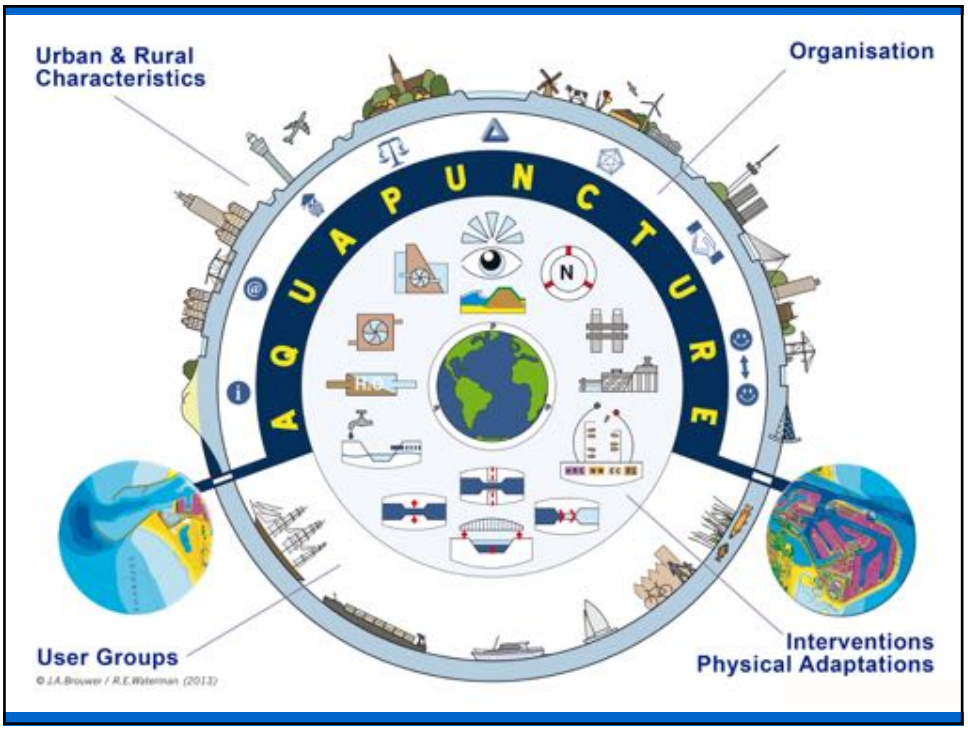
ACUPUNCTURE

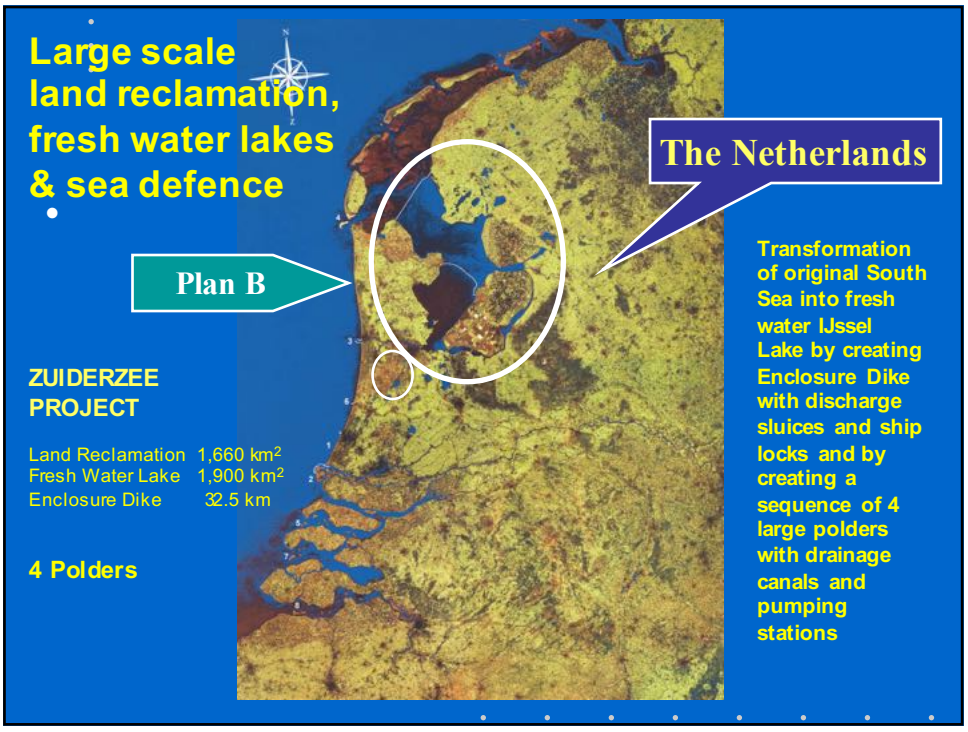
to revitalize
the Nervous System
& Human Organs



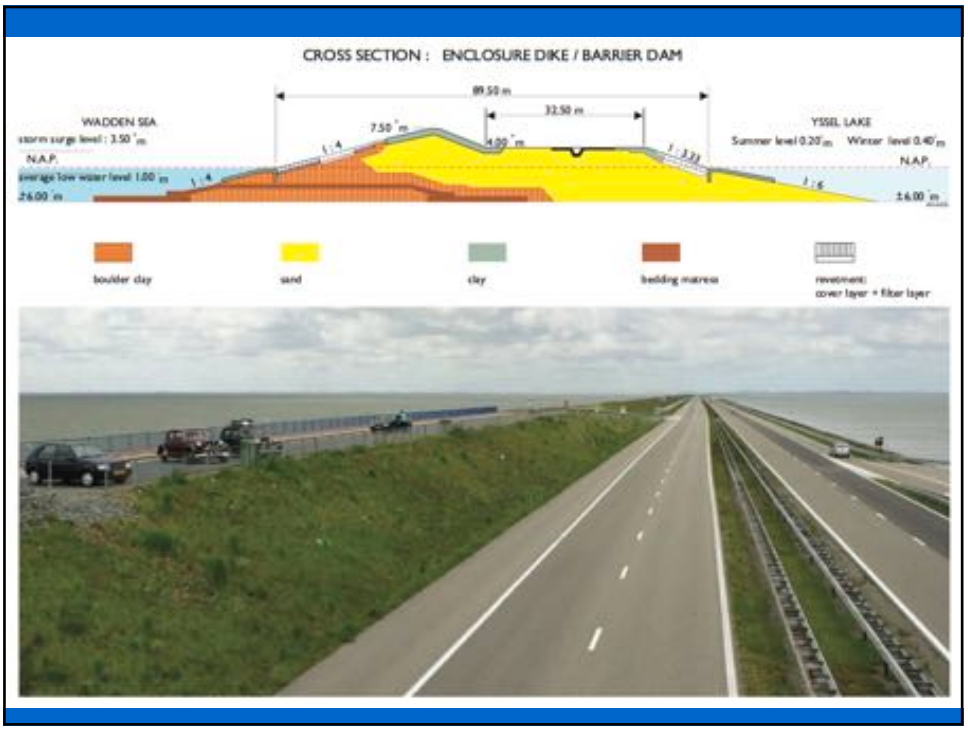
AQUAPUNCTURE

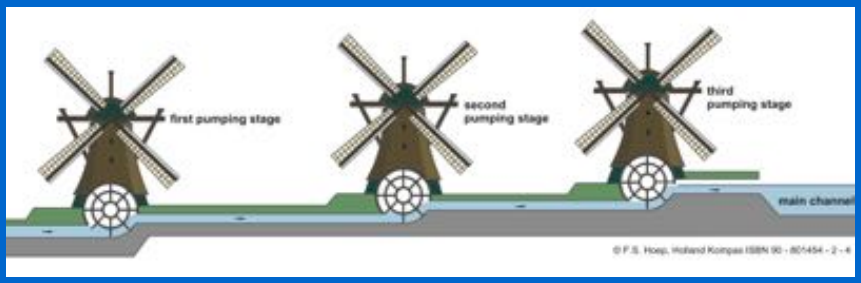
to revitalize
the Waterways & their
Water Fronts


Urban & Rural Characteristics
Organisation
AQUAPUNCTURE
User Groups
Interventions Physical Adaptations


Large scale land reclamation, fresh water lakes & sea defence
The Netherlands
Plan B
ZUIDERZEE PROJECT
Land Reclamation 1,660 km²
Fresh Water Lake 1,900 km²
Enclosure Dike 32.5 km
4 Polders
Transformation of original South Sea into fresh water IJssel Lake by creating Enclosure Dike with discharge sluices and ship locks and by creating a sequence of 4 large polders with drainage canals and pumping stations


WADDEN SEA
A Living Nation
is
Building it's Future


CROSS SECTION : ENCLOSURE DIKE / BARRIER DAM
WADDEN SEA
YSSEL LAKE
N.A.P.
boulder clay
sand
clay
bedding matress

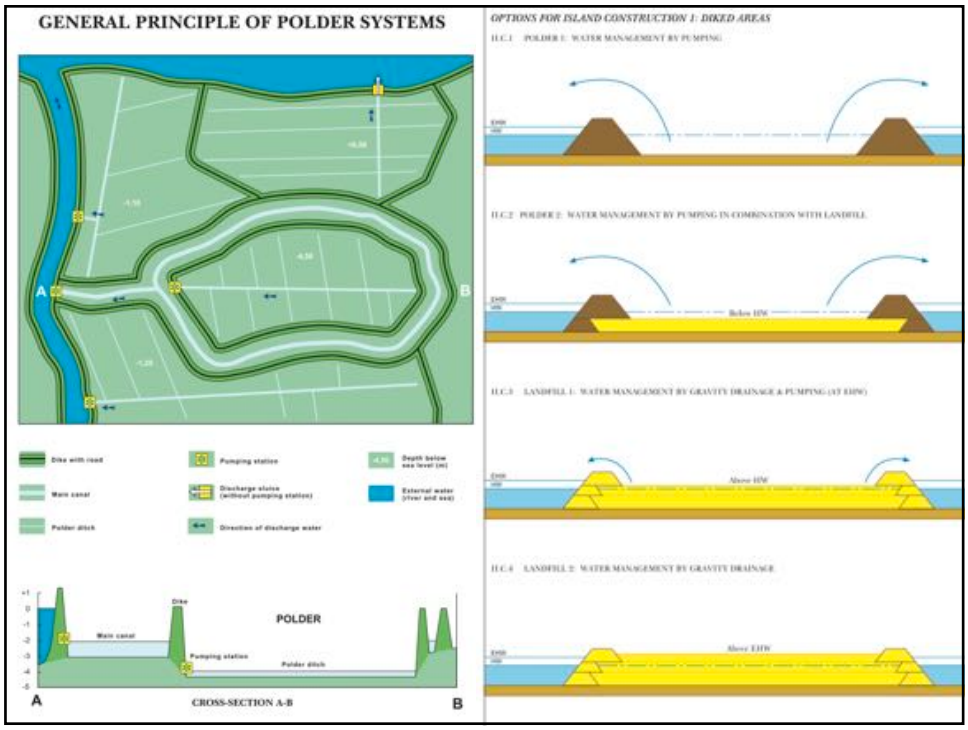


Period of creation	Name of Polder	Area	Pumping Stations		Initially pumped out	Maintenance pumping
			number	power		
		hectares	x	MW	10^6 m³	10^6 m³/yr
1927-1932	Wieringermeer Polder	20,000	2	3.28	700	160
1937-1942	North East Polder	48,000	3	6.10	1500	400
1950-1957	East Flevoland	54,000	3	5.94	1600	800
1959-1968	South Flevoland	43,000	1	3.53	1400	

Land-Use in %	Wieringermeer Polder	North East Polder	East Flevoland	South Flevoland
Agriculture	87	87	75	50
Nature (incl. woodland & marshland)	3	5	11	18
Cities	1	1	8	25
Dikes, roads, water	9	7	6	7





Europe
Netherlands
United Kingdom
Denmark
Belgium

Africa
South Africa
Tunesia
Egypt

Middle East
Israel
Jordan
UAE
Qatar

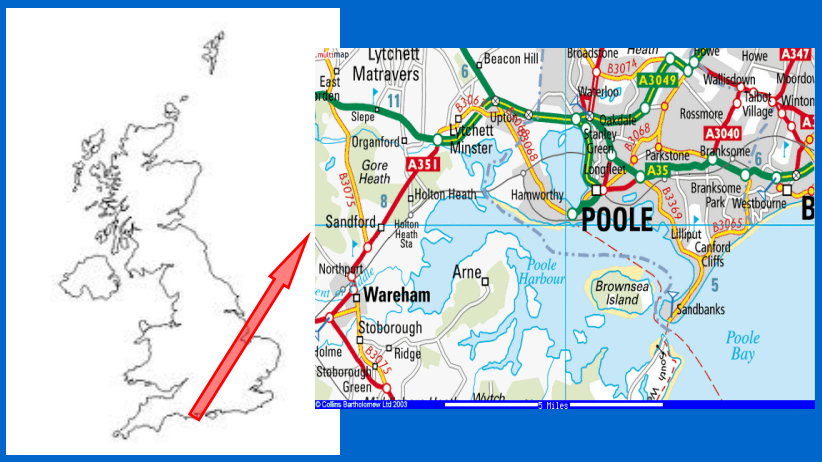
Asia
India
Bangladesh
Singapore
Indonesia
Brunei
Philippines
Vietnam
China
Korea
Japan

Americas
USA
Mexico
Curacao
Colombia
Argentine
Chile

Australia

Building with Nature ®

BUILDING WITH NATURE



UK, Poole

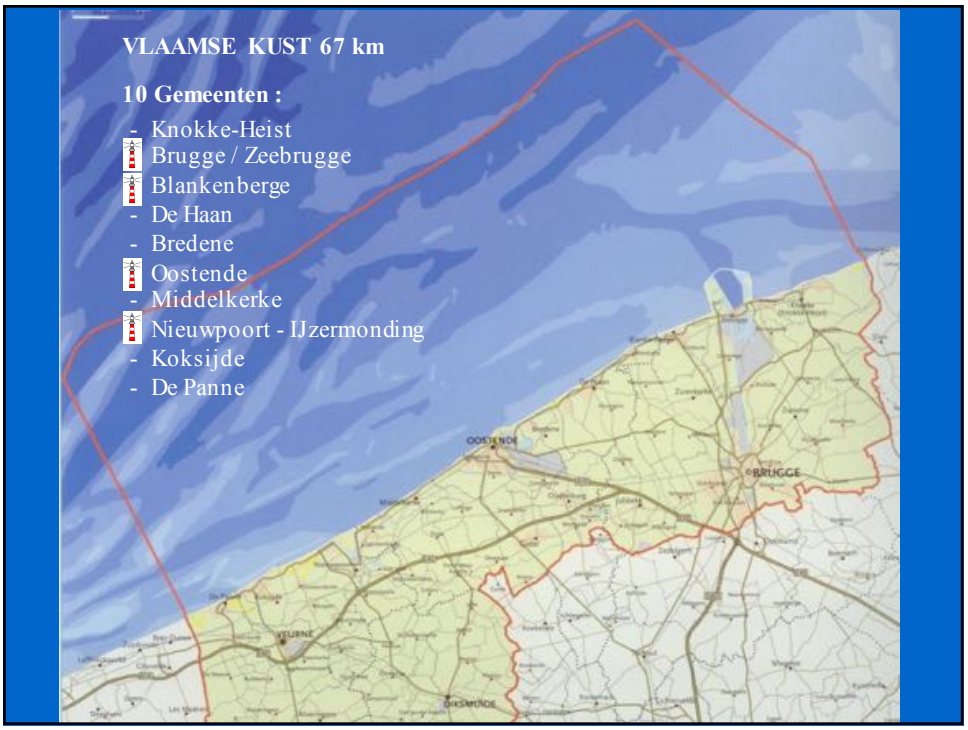
UK, Poole Before the land reclamation

UK, Poole During the land reclamation

UK, Poole After the land reclamation


Amager Beach Park - Copenhagen - Denmark
3 – COASTLINE PROJECT WITH ISLAND & LAGOON
WATERFRONT DEVELOPMENTS IN HARMONY WITH NATURE


BOUWEN MET DE NATUUR
Vlaamse Baaien
Veilig, natuurlijk, aantrekkelijk, duurzaam, ontwikkelend
Van een smalle, harde naar een brede, zachte kust


VLAAMSE KUST 67 km
10 Gemeenten :
- Knokke-Heist
Brugge / Zeebrugge
Blankenberge
- De Haan
- Bredene
Oostende
- Middelkerke
Nieuwpoort - IJzermonding
- Koksijde
- De Panne
OOSTENDE
BRUGGE
VEURNE
DIKSMUIDE


Blankenberge - Zeebrugge
Heist / Knokke - 't Zwin
Blankenberge – Zeebrugge
Aanleg Blankenberge havendammen
Marina & strandverbreding
Heist
Natuurreservaat Baai van Heist
& Marina Heist


Blankenberge - Zeebrugge
Heist / Knokke - 't Zwin
Blankenberge – Zeebrugge
Aanleg Blankenberge havendammen
Marina & strandverbreding
Blankenberge – Zeebrugge
Marina Residentie & Lagune
met stranden in aansluiting
op Zeebrugge II

Oostende
Verlenging havenhoofden
Buitenhaven met Marina
Duin-strand verbreding met Resorts & voorzieningen
Nieuwe Pier met Casino

Nieuwpoort
Bestaande Jachthaven met 1800 ligplaatsen

BUILDING WITH NATURE

AFRICA

BUILDING WITH NATURE

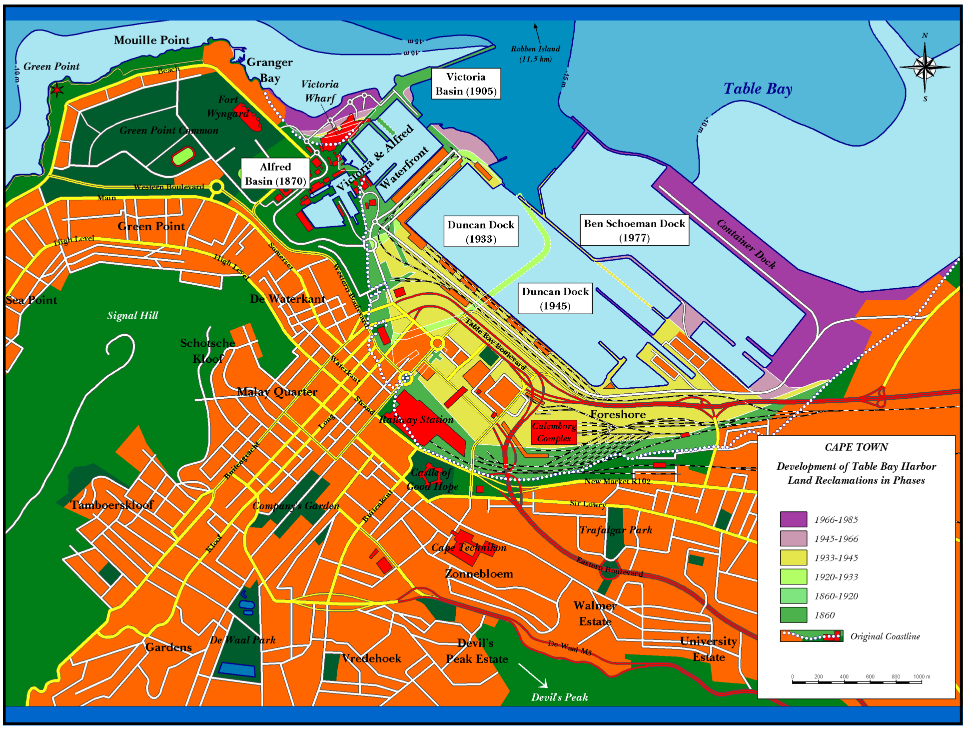
SOUTH AFRICA

BUILDING WITH NATURE

CAPE TOWN

BUILDING WITH NATURE

CAPE TOWN

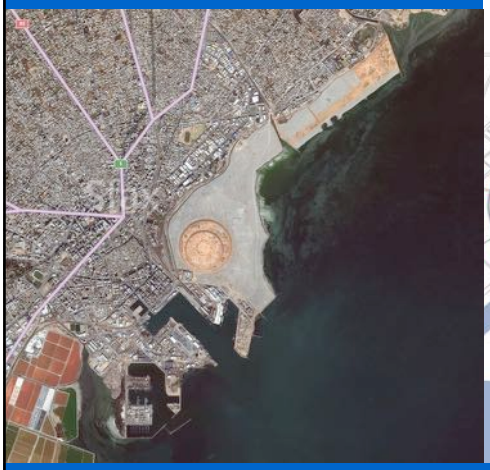


Mouille Point
Green Point
Granger Bay
Victoria Wharf
Fort Wyngard
Green Point Common
Victoria Basin (1905)
Table Bay
Alfred Basin (1870)
Victoria & Alfred Waterfront
Duncan Dock (1933)
Ben Schoeman Dock (1977)
Container Dock
Duncan Dock (1945)
Green Point
Sea Point
Signal Hill
De Waterkant
Schotsche Kloof
Malay Quarter
Railway Station
Foreshore
Castle of Good Hope
Tamboerskloof
Company's Garden
Trafalgar Park
Cape Technikon
Zonnebloem
Walmer Estate
Gardens
De Waal Park
Vredehoek
Devil's Peak Estate
University Estate
Devil's Peak
CAPE TOWN
Development of Table Bay Harbor
Land Reclamations in Phases
1966-1985
1945-1966
1933-1945
1920-1933
1860-1920
1860
Original Coastline

BUILDING WITH NATURE

CAPE TOWN, SOUTH - AFRICA

TUNESIA - SFAX



LAND RECLAMATION DESIGN

SUSTAINABLE COASTAL ZONE DEVELOPMENT

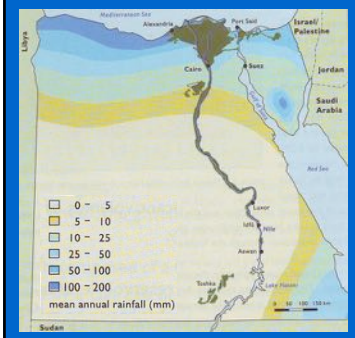
Integrated Coastal Policy via Building with Nature

Dr. R. E. Waterman MSc

ALEXANDRIA - EGYPT
CoRI March 2010

THE HAGUE – THE NETHERLANDS
June 2012

ARAB REPUBLIC OF EGYPT
جمهورية مصر العربية

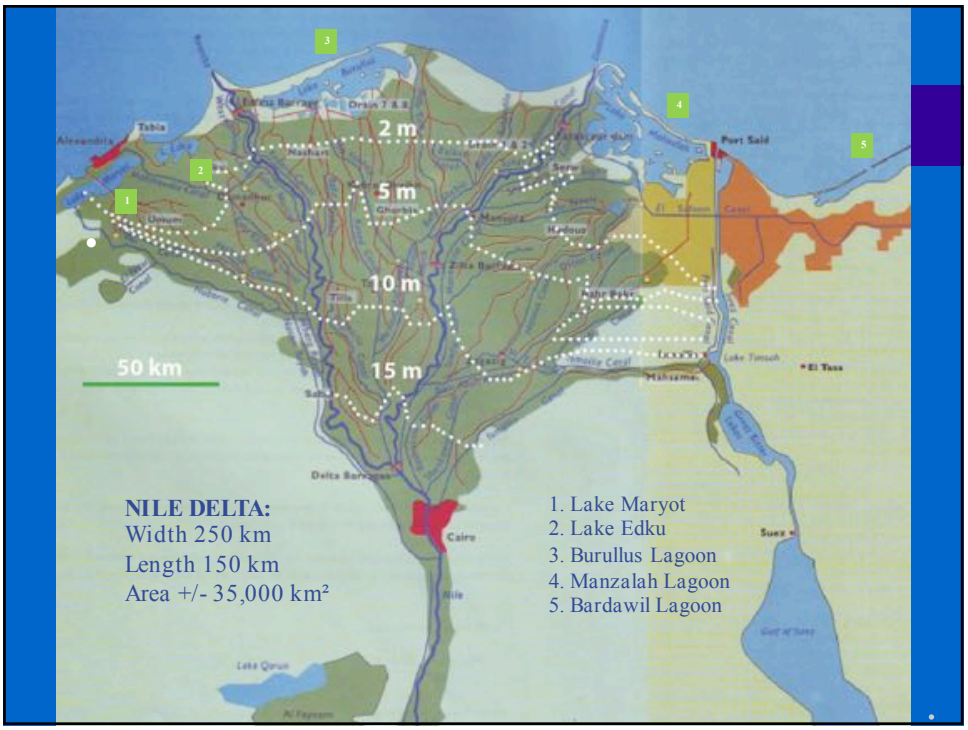


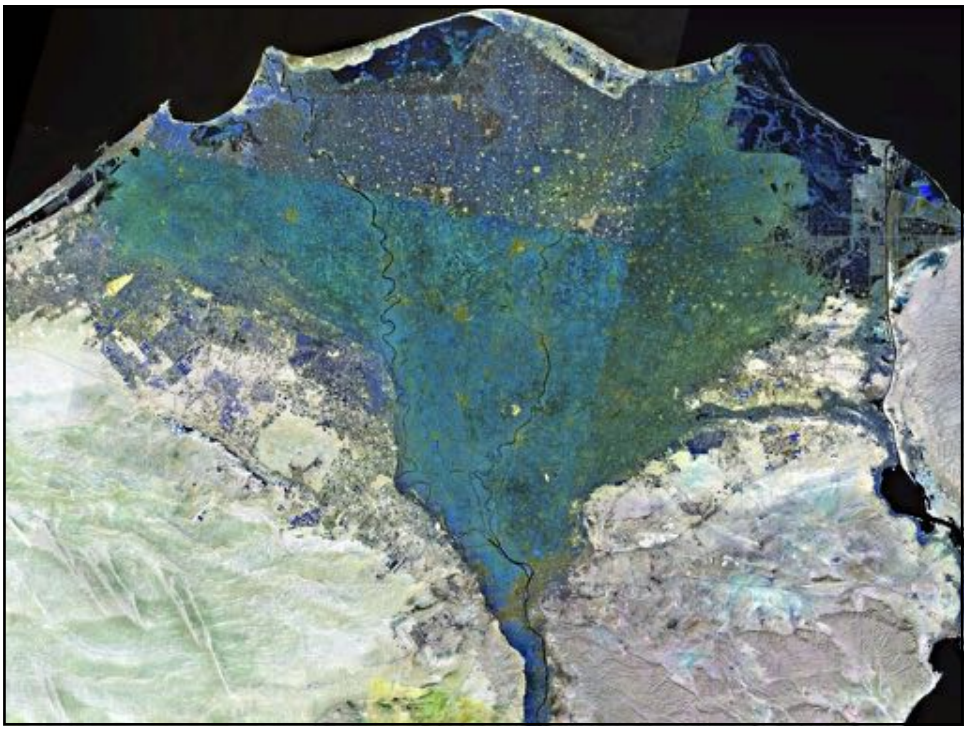
SURFACE AREA	
1,010,000 km²	41,500 km²
INHABITANTS	
82 million	16.7 million
COASTAL LENGTH	
1,200 km M. Coast	353 km
2,300 km R.S. Coast	
MAIN RIVER	
Nile	Rhine
6,650 km	1,320 km
5,100 m³/s	2,330 m³/s

1.Cairo	8,5 million	1. Amsterdam	0,8 million
1.Cairo m.a.	20 million	2. Rotterdam	0,6 million
2. Alexandria	4,5 million	3. The Hague	0,5 million
6. Port Said	0,6 million	4. Utrecht	0,3 million
7. Suez	0,5 million	5. Rim City Holland	8,0 million

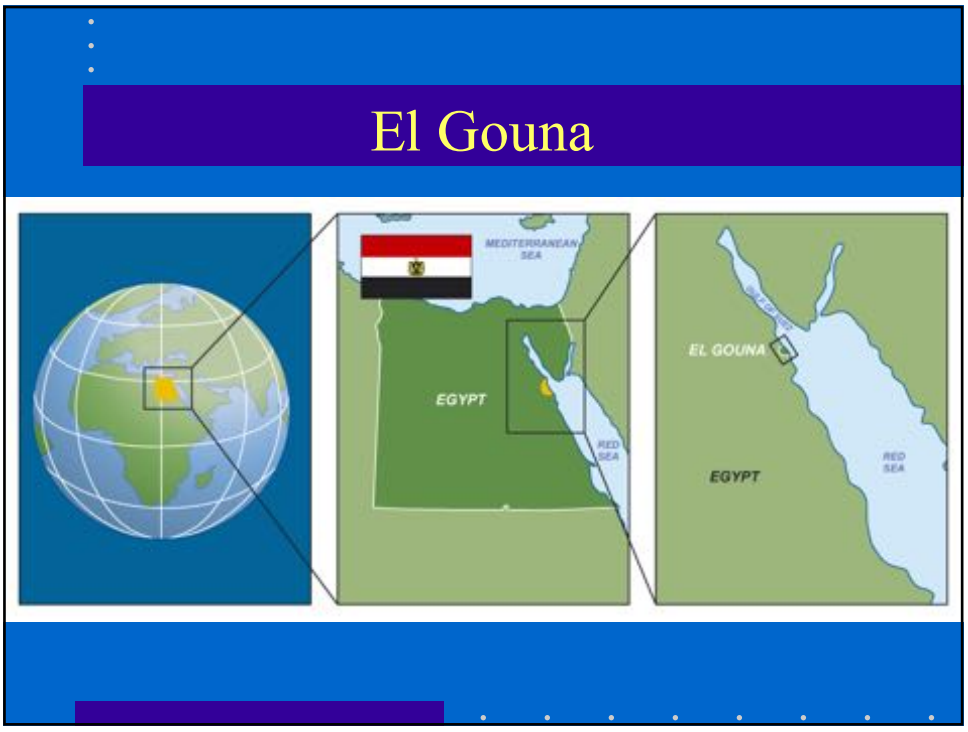
LARGEST CITIES

THE NETHERLANDS


2 m
5 m
10 m
15 m
50 km
NILE DELTA:
Width 250 km
Length 150 km
Area +/- 35,000 km²
1. Lake Maryot
2. Lake Edku
3. Burullus Lagoon
4. Manzalah Lagoon
5. Bardawil Lagoon
Cairo
Suez
Port Said
El Tasa




Alexandria
Tabia


El Gouna
MEDITERRANEAN SEA
EGYPT
RED SEA
EL GOUNA
EGYPT
RED SEA


Red Sea
New Nubia
Nubia
Kafr El Gouna
Thebes II
Golf course
Avaris I
Buto III
Memphis IV
EL GOUNA
Land reclamations

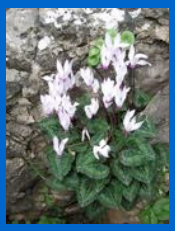
El Gouna

SUSTAINABLE COASTAL ZONE DEVELOPMENT

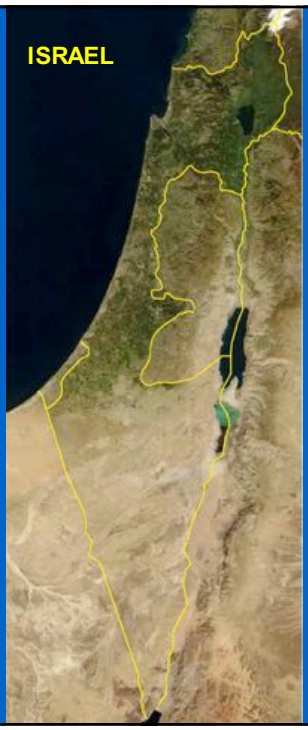
Integrated Coastal Policy via Building with Nature®

Prof. Dr. R.E. Waterman MSc

ISRAEL - Tel Aviv



Coastal Extentions & Airport



ISRAEL

SURFACE AREA

22,145 km² 33,883 km²

INHABITANTS

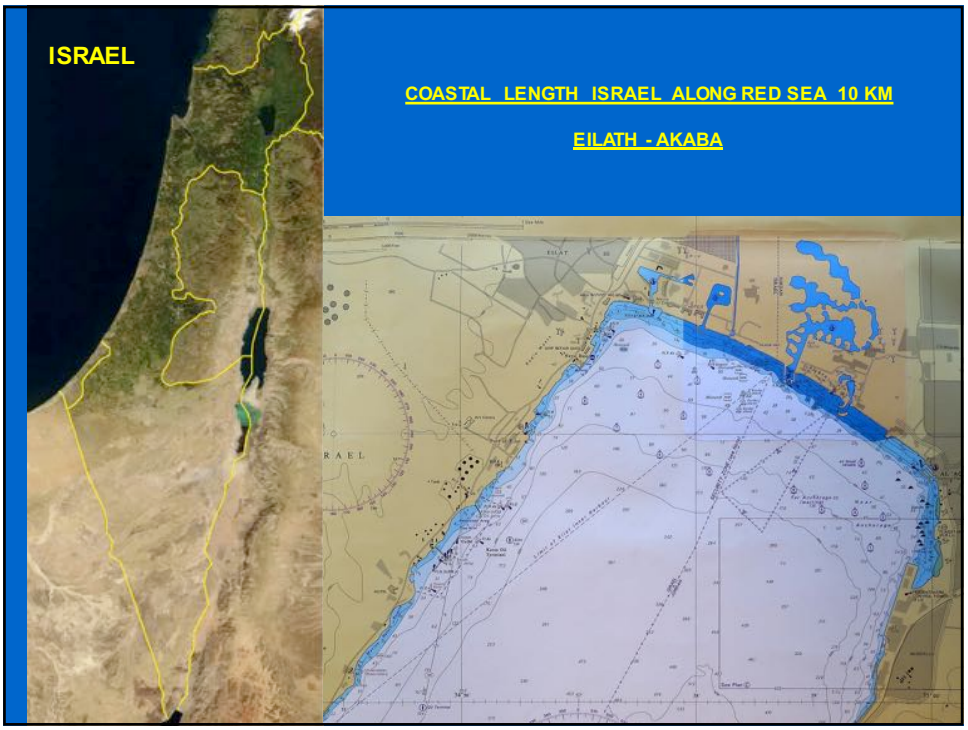
7.7 million 16.7 million

COASTAL LENGTH

188 + 10 km 353 km

THE NETHERLANDS


ISRAEL
COASTAL LENGTH
188 km
Rosh Hanikra
Nahariya
Ako
Haifa
Atlit
Caesarea
Hadera
Netanya
Herzliyah
Tel Aviv
Jaffa
Bat Yam
Rishon Letsion
Palmachim
Ashdod
Ashkelon
Zikim

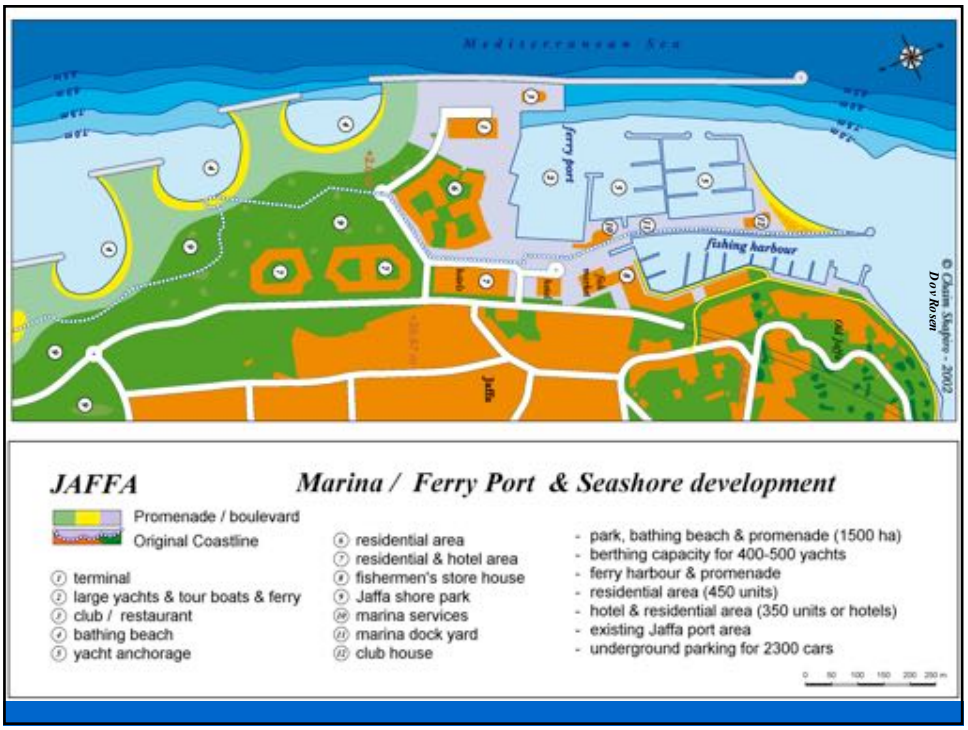

ISRAEL
COASTAL LENGTH ISRAEL ALONG RED SEA 10 KM
EILATH - AKABA

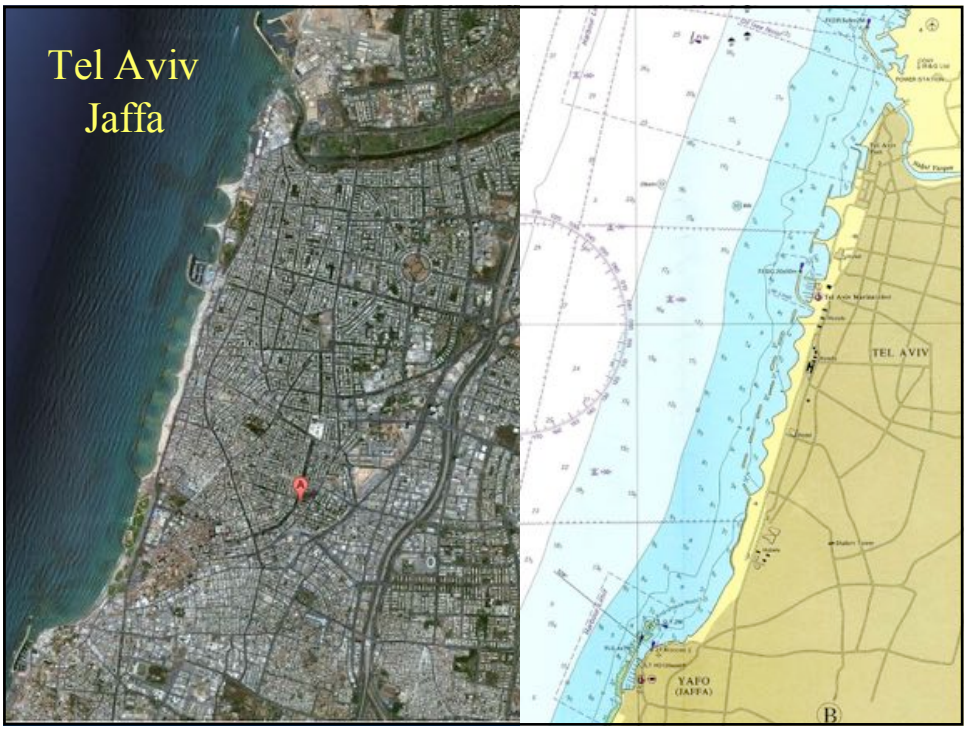

COASTAL LENGTH ISRAEL ALONG RED SEA 10 KM
EILATH - AKABA


A
HADERA
SCALE 1 : 25000
B
TEL AVIV AND YAFO
C
ASHDOD
D
ASHQELON

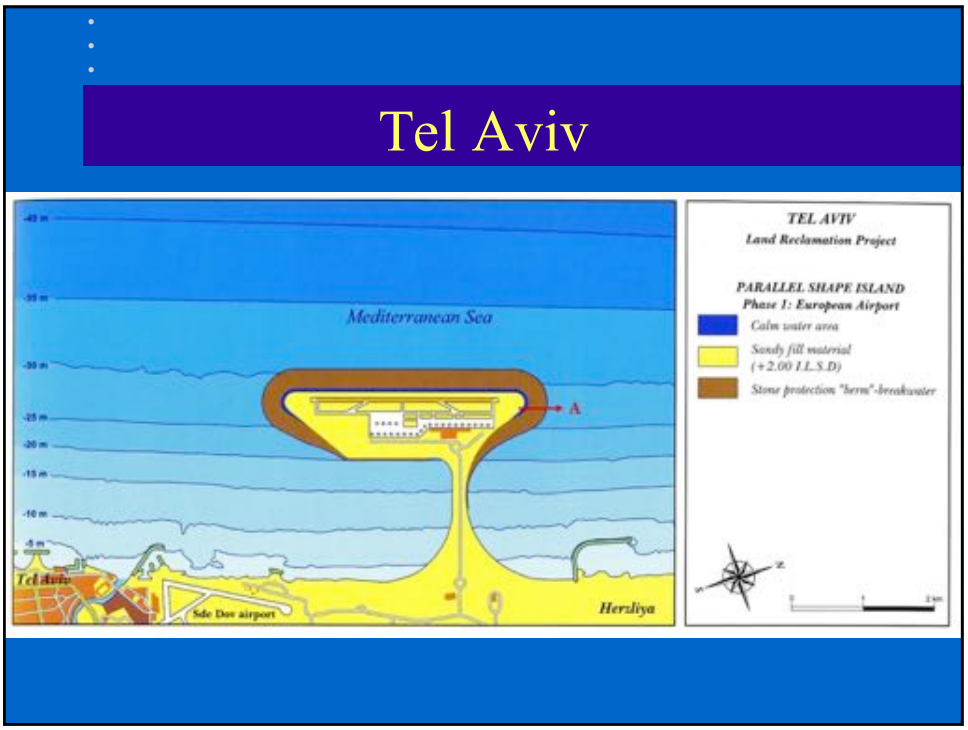
Tel Aviv - Jaffa

Jaffa

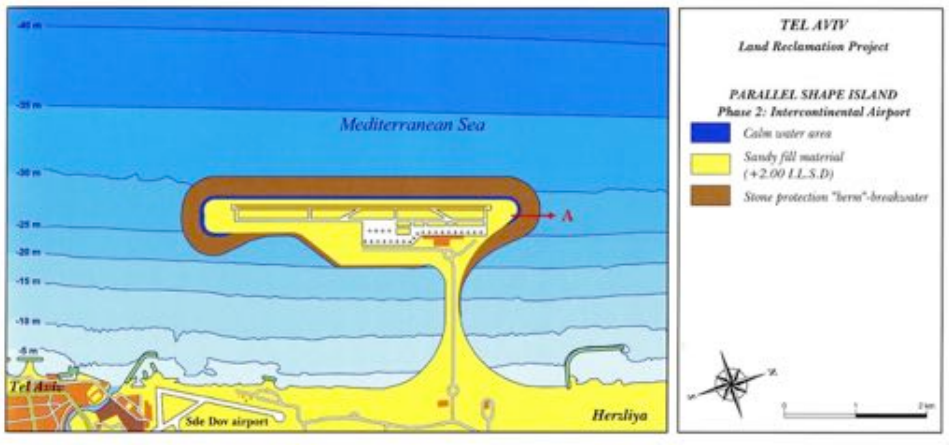

Mediterranean Sea
ferry port
fishing harbour
Jaffa
© Oren Shafiro - 2002
Dov Rosen
JAFFA
Marina / Ferry Port & Seashore development
Promenade / boulevard
Original Coastline
terminal
large yachts & tour boats & ferry
club / restaurant
bathing beach
yacht anchorage
residential area
residential & hotel area
fishermen's store house
Jaffa shore park
marina services
marina dock yard
club house
- park, bathing beach & promenade (1500 ha)
- berthing capacity for 400-500 yachts
- ferry harbour & promenade
- residential area (450 units)
- hotel & residential area (350 units or hotels)
- existing Jaffa port area
- underground parking for 2300 cars


Tel Aviv
Jaffa
TEL AVIV
YAFO
(JAFFA)

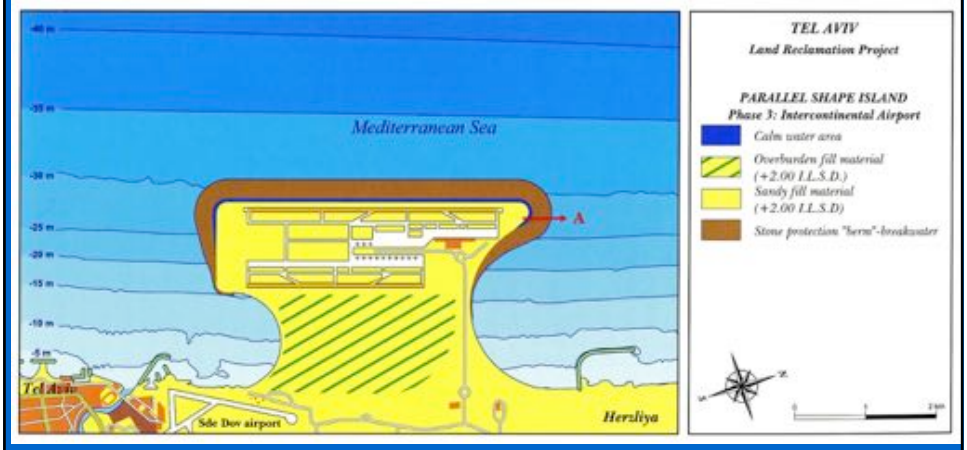

Tel Aviv
Jaffa
Sde Dov
Herzlia


Tel Aviv
Mediterranean Sea
Tel Aviv
Sde Dov airport
Herzliya
TEL AVIV
Land Reclamation Project
PARALLEL SHAPE ISLAND
Phase 1: European Airport
Calm water area
Sandy fill material
(+2.00 I.L.S.D)
Stone protection "berm"-breakwater

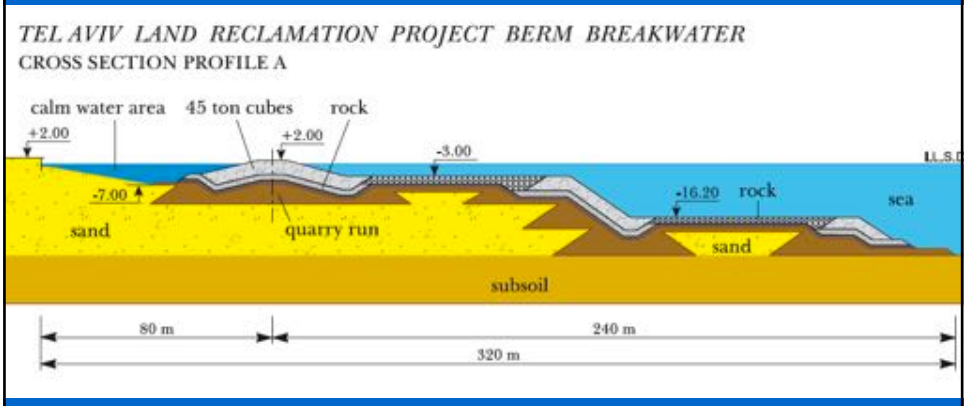
Tel Aviv



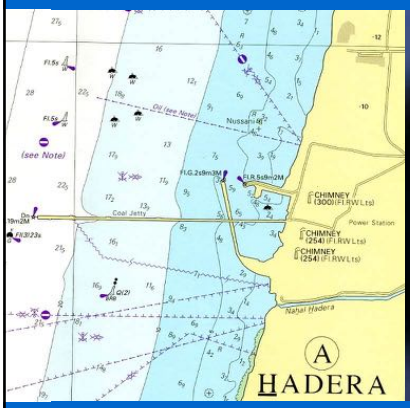
Tel Aviv

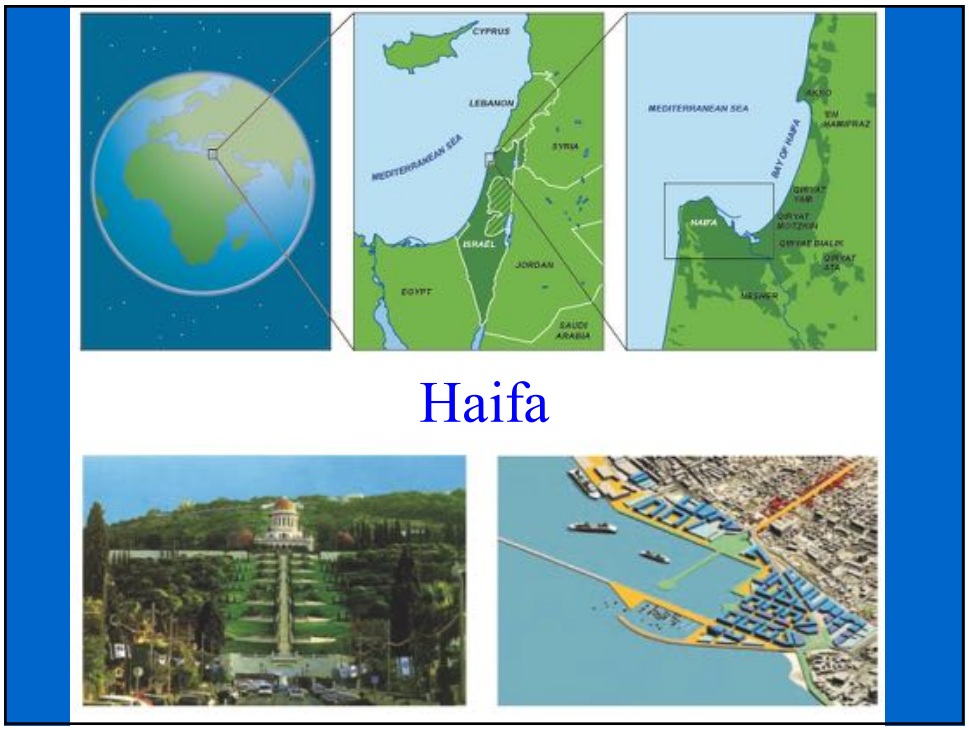


Tel Aviv

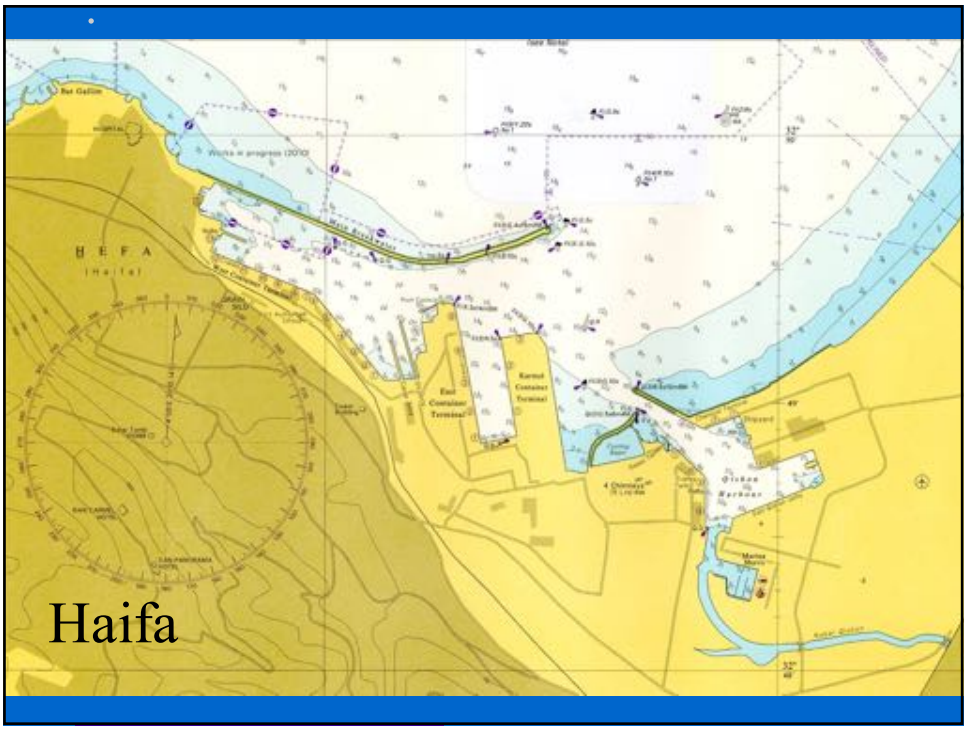


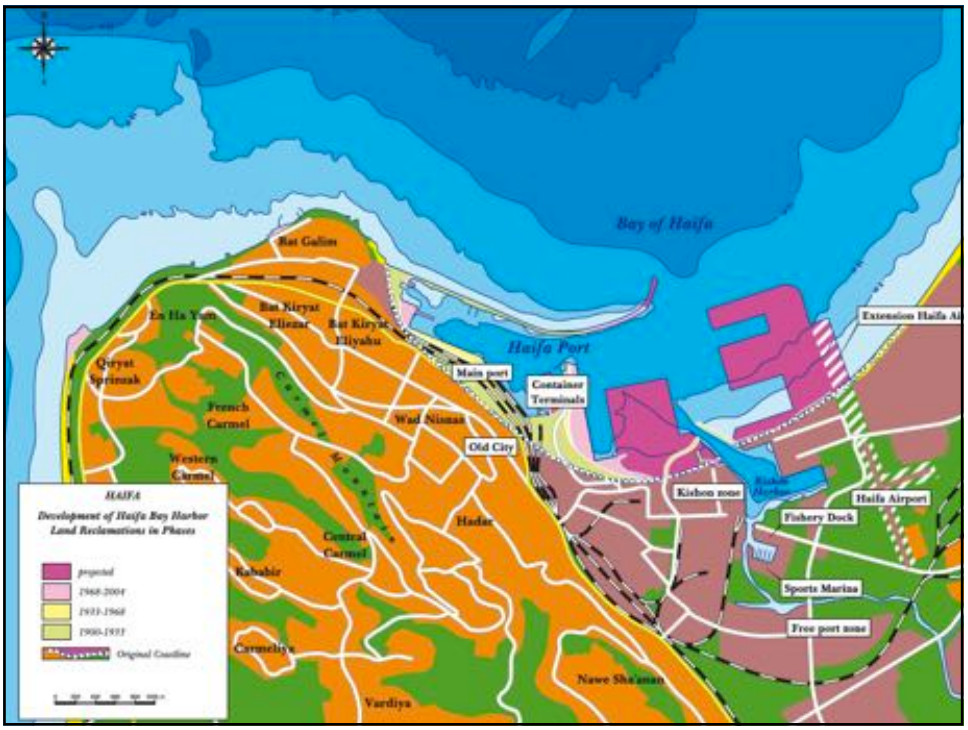
Hadera



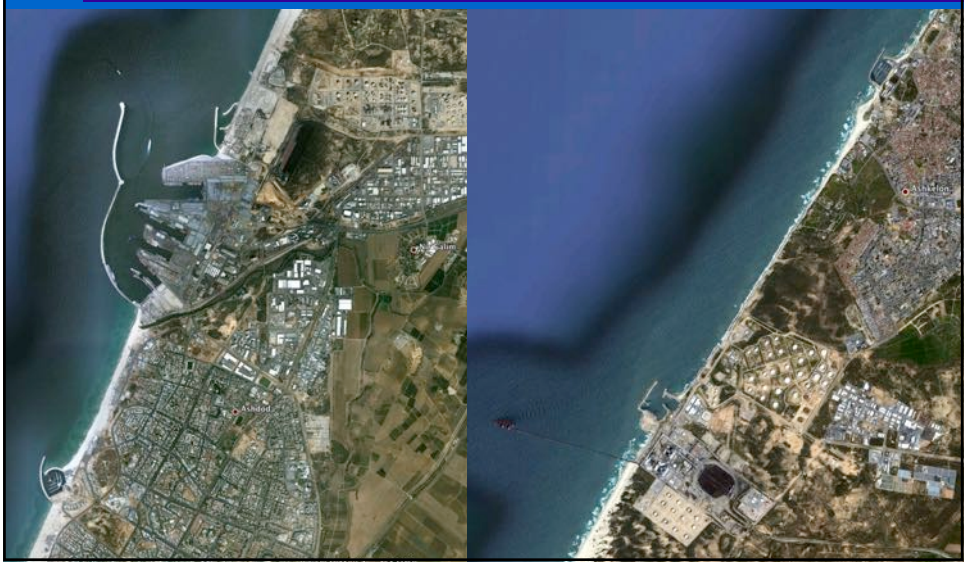

CYPRUS
LEBANON
SYRIA
MEDITERRANEAN SEA
ISRAEL
JORDAN
EGYPT
SAUDI ARABIA
MEDITERRANEAN SEA
BAY OF HAIFA
AKKO
HAIFA
Haifa


Haifa

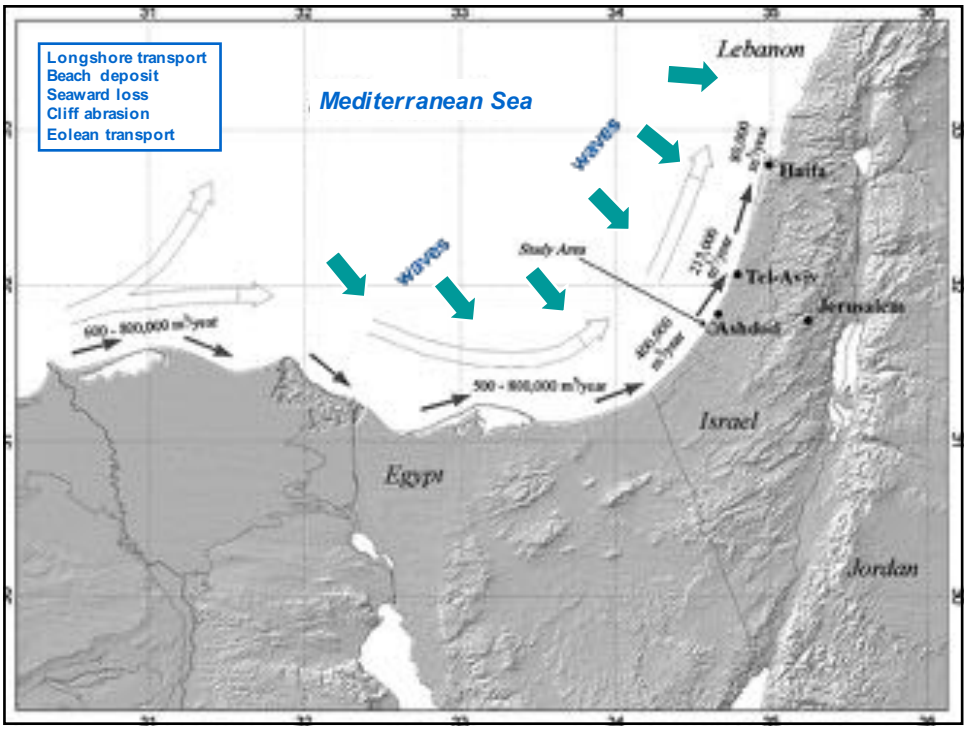

HEFA
Haifa


Bay of Haifa
Haifa Port
Bat Galim
En Ha Yam
Bat Kiryat Eliezar
Bat Kiryat Eliyahu
Qeryat Shprinzak
French Carmel
Western Carmel
Central Carmel
Wad Nisnas
Hadar
Old City
Main port
Container Terminals
Kishon zone
Fishery Dock
Haifa Airport
Sports Marina
Free port zone
Rahabir
Carmeliya
Vardiya
Neve Sha'anan
HAIFA
Development of Haifa Bay Harbor Land Reclamations in Phases
projected
1968-2004
1933-1968
1900-1933
Original Coastline

Ashdod - Ashkelon



Ashdod - Ashkelon


Longshore transport
Beach deposit
Seaward loss
Cliff abrasion
Eolean transport
Mediterranean Sea
Lebanon
Haifa
Tel-Aviv
Jerusalem
Ashdod
Israel
Egypt
Jordan
Study Area
WAVES
WAVES
600 - 800,000 m³/year
500 - 800,000 m³/year


ENVIRONMENTAL RISK ALONG THE SHARON ESCARPMENT
G. Almagor - D. Gill - I. Perath
D. Rosen

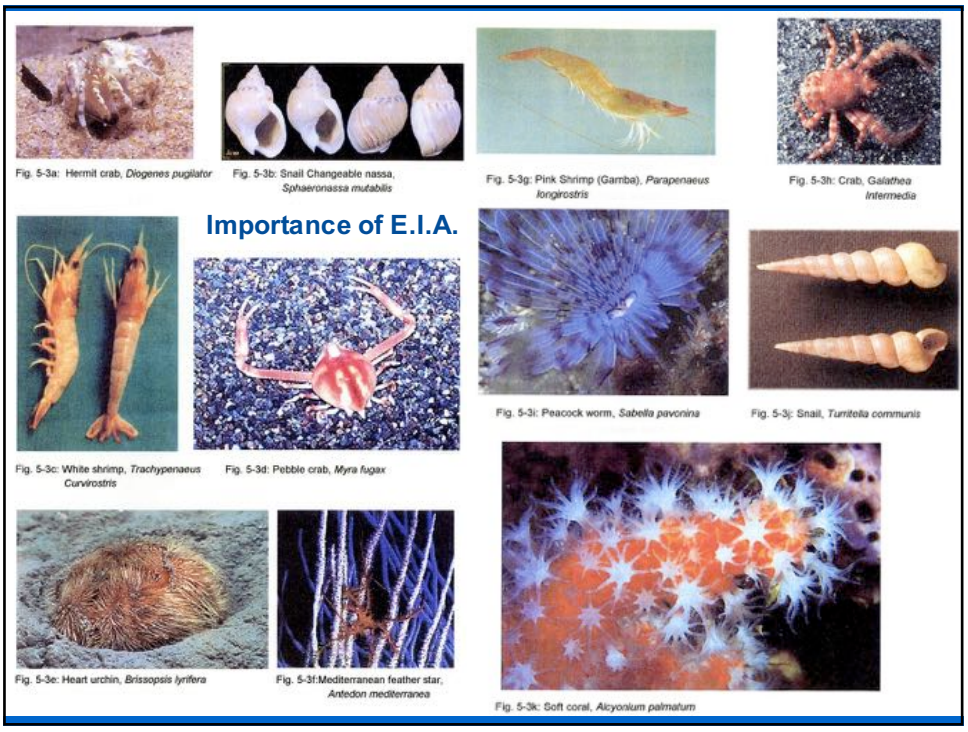


Fig. 5-3a: Hermit crab, *Diogenes pugilator*

Fig. 5-3b: Snail Changeable nassa, *Sphaeronassa mutabilis*

Fig. 5-3g: Pink Shrimp (Gamba), *Parapenaeus longirostris*

Fig. 5-3h: Crab, *Galathea Intermedia*

Fig. 5-3c: White shrimp, *Trachypenaeus Curvirostris*

Fig. 5-3d: Pebble crab, *Myra fugax*

Fig. 5-3i: Peacock worm, *Sabella pavonina*

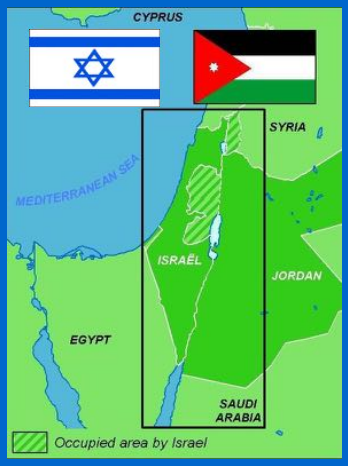
Fig. 5-3j: Snail, *Turritella communis*

Fig. 5-3e: Heart urchin, *Brissopsis lyrifera*

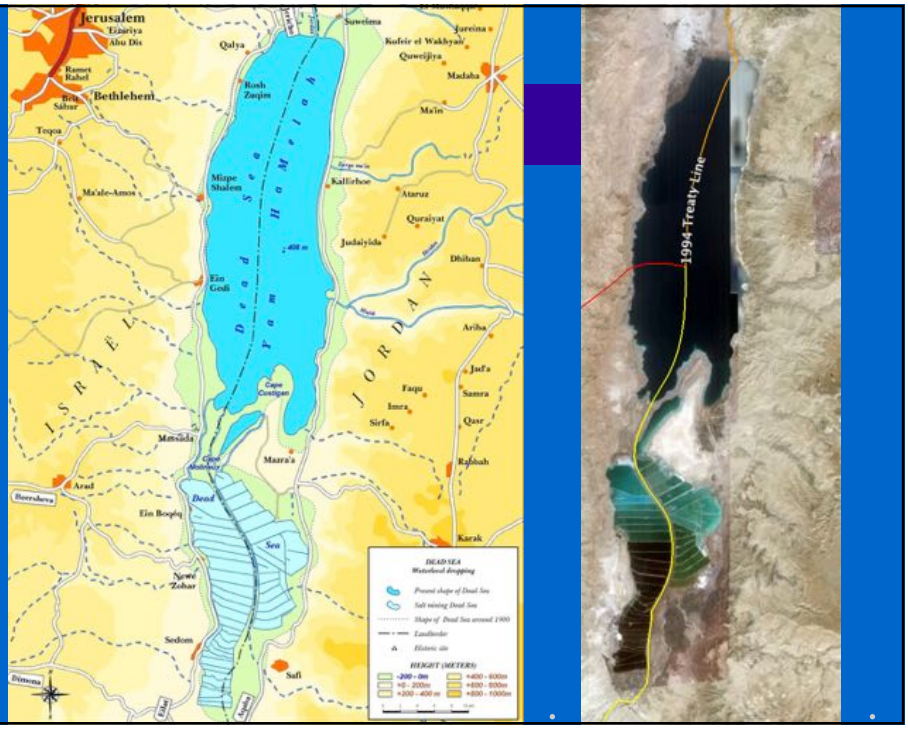
Fig. 5-3f:Mediterranean feather star, *Antedon mediterranea*

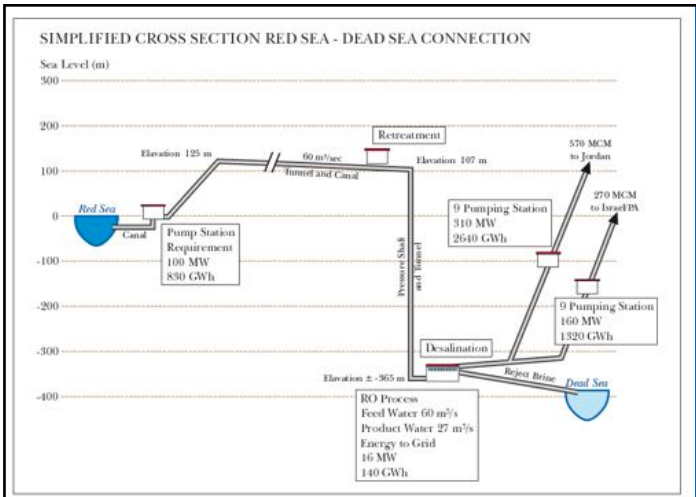
Fig. 5-3k: Soft coral, *Alcyonium palmatum*

BUILDING WITH NATURE



Israël, Jordan





Pipeline approx. 180 km length
Volume 200 million m³ / year from Red Sea
of which:
approx. 100 million m³ / year desalinated water
approx. 100 million m³ / year residual water into Dead Sea
Environmental concerns

Eilat - Aqaba

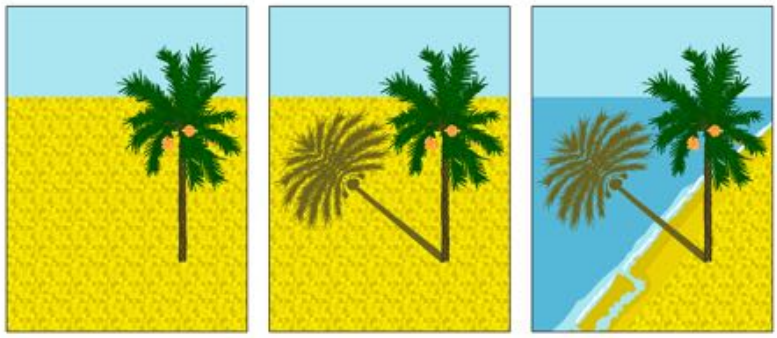
BUILDING WITH NATURE

Middle East U.A.E.

BUILDING WITH NATURE

U.A.E.
Dubai

BUILDING WITH NATURE

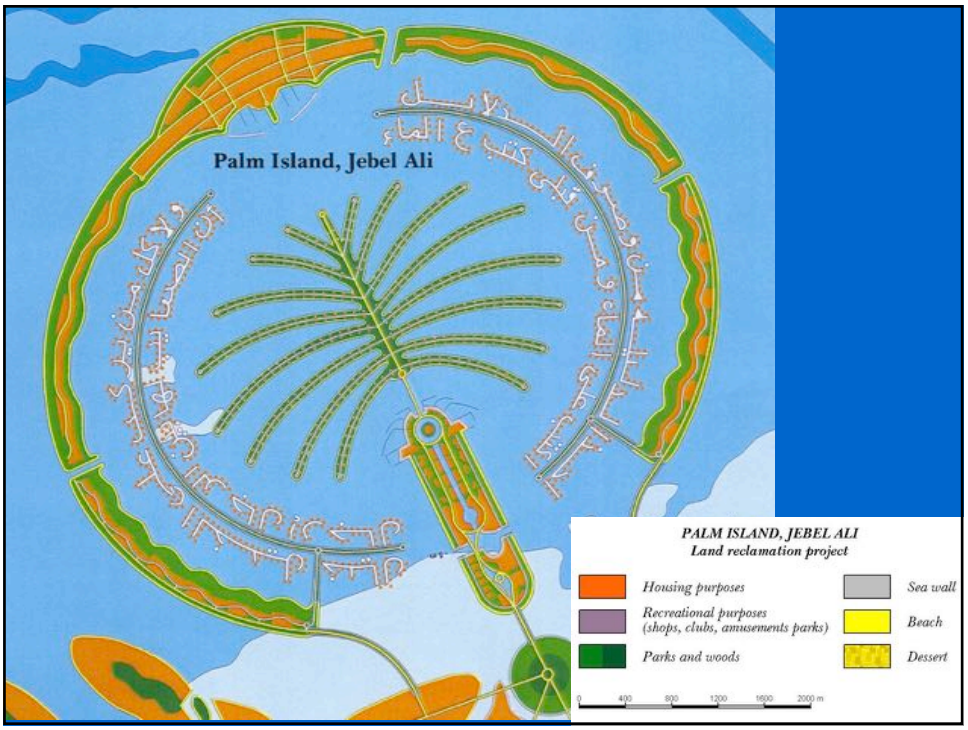


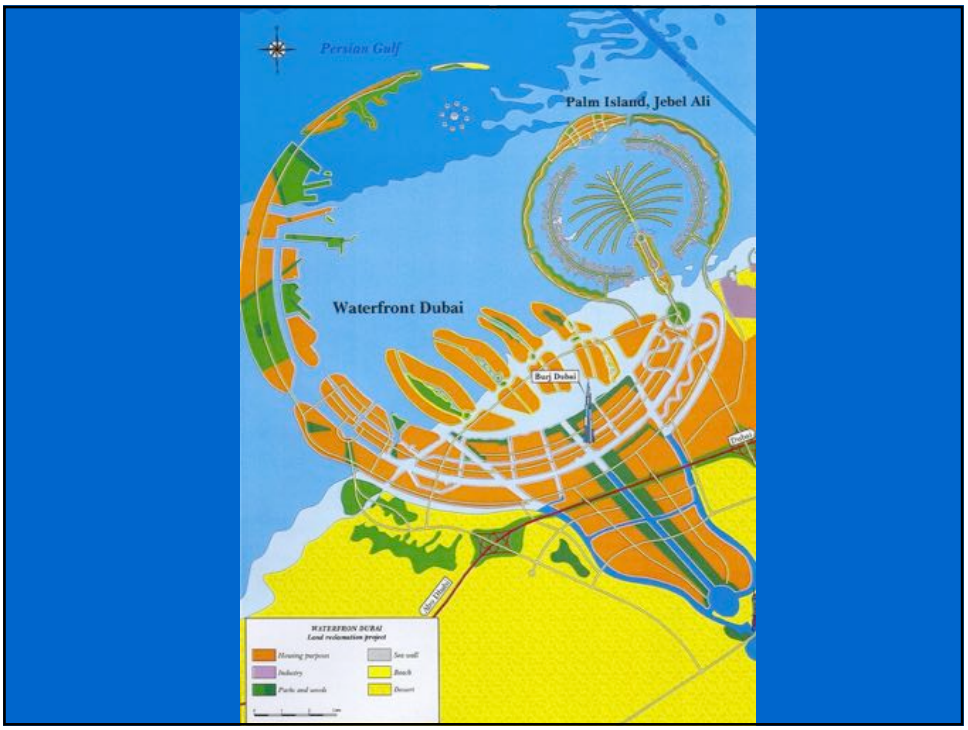
U.A.E.
Dubai

Palm Island Jumeirah - Dubai

april 2002 september 2002 mei 2003

2012


Palm Island, Jebel Ali
PALM ISLAND, JEBEL ALI
Land reclamation project
Housing purposes
Recreational purposes
(shops, clubs, amusements parks)
Parks and woods
Sea wall
Beach
Dessert
0
400
800
1200
1600
2000 m


Persian Gulf
Palm Island, Jebel Ali
Waterfront Dubai
Burj Dubai
Dubai
Abu Dhabi

The World

approx. 9 km x 6 km
5 km off the coast
of Dubai

ca. 300 Islands

325 million m³ sand

32 million ton stones

The Palm, Deira

approx. 14.3 km x 8.5 km

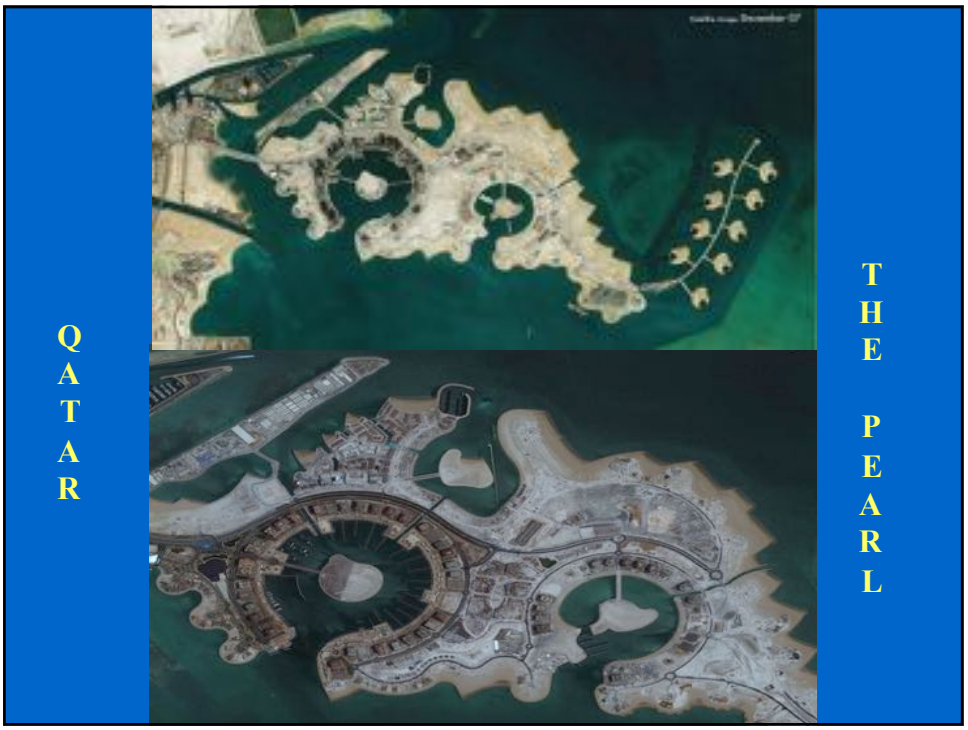
surface area 80 km²

41 palm leaves

1.3 billion m³ sand

length of outher rim
berm break water
ca. 21 km


RECLAMATION PROJECTS OVERVIEW
Land reclamation project
Housing purpose
Harbor, industry
Parks and woods
Sea wall
Beach
Tenant
Persian Gulf
The Palm, Deira
The World
Dubay
East Dubay
Jumeirah
Palm Island, Jumeirah
Umm Al Sheif
Dubai Waterfront
Palm Island, Jebel Ali
United Arab Emirates
1 Jumeirah Lake Towers
2 Jumeirah Islands
3 The Gardens
4 Gardens Shopping Mall
5 Burj Al Arab Hotel
6 Jebel Ali Harbor
7 Burj Arab
8 Jebel Ali International Airport


QATAR
THE PEARL

SUSTAINABLE COASTAL ZONE DEVELOPMENT

Integrated Coastal & Deltaic Policy via Building with Nature®

Dr. R.E. Waterman MSc

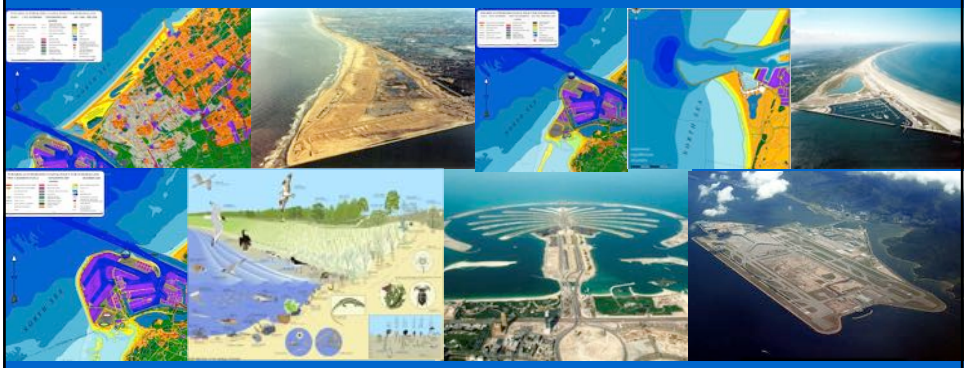
April 2014

India
The Netherlands

173

DUTCH EXPERTISE

Building with Nature, Land Reclamation, Transportation & Infrastructure



DUTCH PLATFORM OF COMPANIES

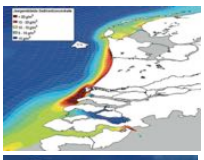
Boskalis Deltares Royal HaskoningDHV FUGRO Van Oord

RECLAMATION USING 'BUILDING WITH NATURE'

Land / Seabed Survey

FUGRO

Impact Assessment Modelling



Deltares
Enabling Delta Life

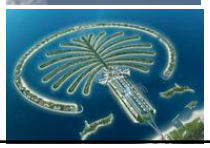
Concept Planning Engineering

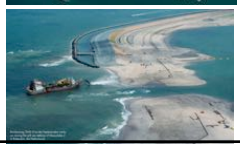
Royal HaskoningDHV
Enhancing Society Together

Dredging Marine Experts

Boskalis
Dredging & Marine Experts

Dredging Marine Experts



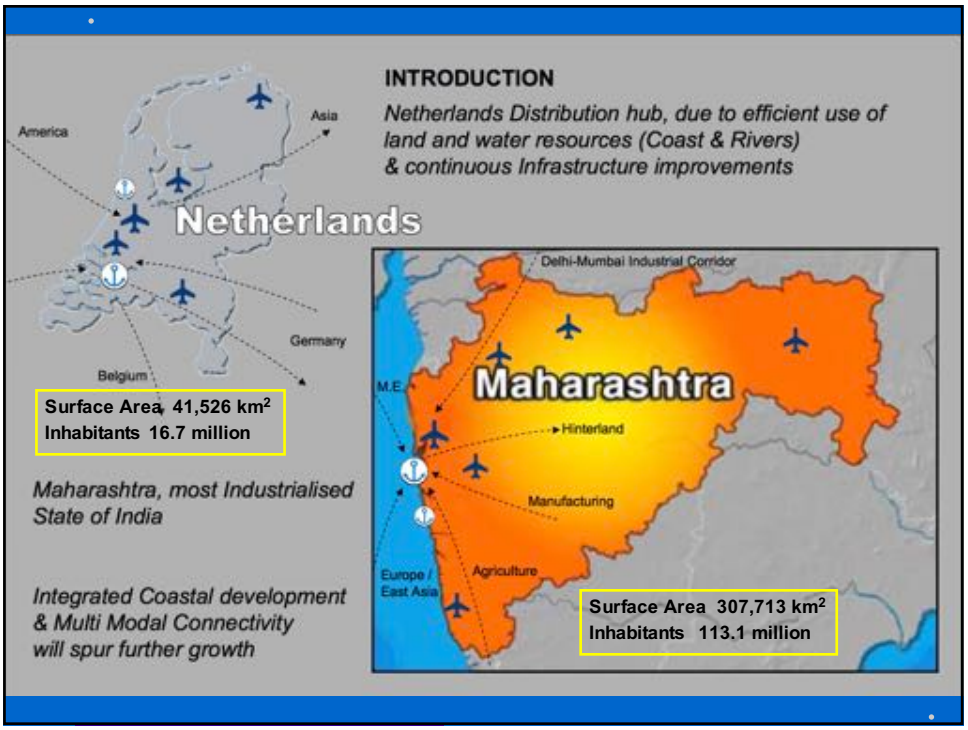


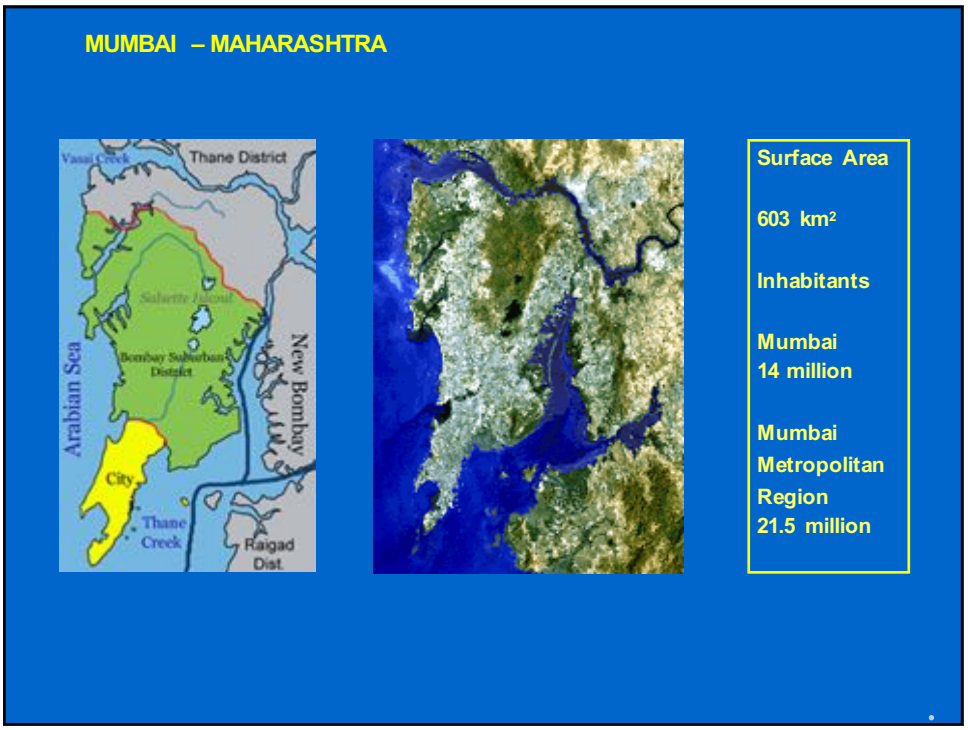
Van Oord
Marine ingenuity

BUILDING WITH NATURE®

- Natural system dynamics basis for design & realisation of maritime infrastructure
- Proactive approach for optimizing full economic & environmental potential
- Integration of disciplines: Engineering, Ecology & Governance

Eco-dynamic Development & Design


INTRODUCTION
Netherlands Distribution hub, due to efficient use of land and water resources (Coast & Rivers) & continuous Infrastructure improvements
America
Asia
Germany
Belgium
Netherlands
Surface Area 41,526 km²
Inhabitants 16.7 million
Maharashtra, most Industrialised State of India
Integrated Coastal development & Multi Modal Connectivity will spur further growth
Delhi-Mumbai Industrial Corridor
M.E.
Maharashtra
Hinterland
Manufacturing
Agriculture
Europe / East Asia
Surface Area 307,713 km²
Inhabitants 113.1 million


MUMBAI – MAHARASHTRA
Vasai Creek
Thane District
Salsette Island
Bombay Suburban District
Arabian Sea
New Bombay
City
Thane Creek
Raigad Dist.
Surface Area
603 km²
Inhabitants
Mumbai
14 million
Mumbai
Metropolitan
Region
21.5 million

MUMBAI – MAHARASHTRA

Proposed developments

MUMBAI'S HISTORY

The Metamorphosis of an 'Island City'

When Portugese sailors first sailed east to a number of islands off the Indian mainland, seeking respite from the treacherous Arabian Sea, little did they know that these 7 islands and the 'Bom Baya' (or 'good bay') would some day give rise to the great city of Mumbai.

This is why they did not hesitate to part with their claim on these islands as part of a wedding gift to the king of England.

The Koli fishermen inhabiting these islands knew the value of a well-sheltered bay in these turbulent waters…

17th Century

60km of coastline

(publicly accessible)

In Holland at around the same time, the city of Amsterdam, located on a similarly sheltered bay called the 'Southern Sea', grew to prominence.

And so did the English:

By the 19th century the city they had founded on the biggest of the seven islands had grown so fast due to its sheltered harbour. The requirement for more land had compelled the Royal Engineers to embark on a furious reclamation program that turned the original seven islands into one continuous landmass.

The Koli fishermen communities thus lost large tracts of their precious shoreline, previously used for mooring their vessels and drying their fish.

Another disadvantage was that the Royal Engineers applied a method of merely blocking the inlets in between the islands. This way indeed the inner area stopped getting flooded at high tide, but during monsoon, it was heavily prone to flooding

19th Century

40km of coastline

(publicly accessible)

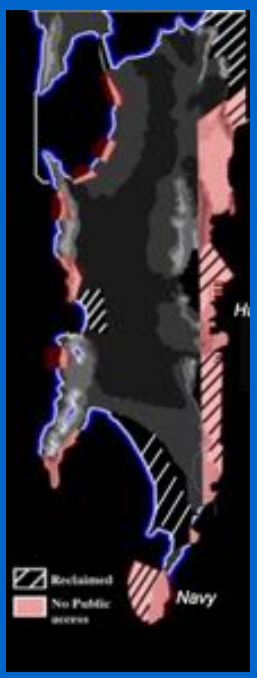
In Holland at around the same time, different water bodies were reclaimed by pumping water out with permanent wind-powered pumping-stations which maintained the low water level for the long term, up till the present-day.

In the 20th century the problem of flooding was understood and the Brimstowad study recommended to apply the Dutch method:

a series of strategic pumping stations to control the water-level and pump out stormwater even during high tide.

Unfortunately this study was commissioned after the 1950's and 1970's which both saw yet more reclamation with the same faults at respectively Marine Drive and Cuff Parade.

Worse still; the study's recommendations were not implemented till 20 years after the study was completed and in 2005 the city had experienced its worst flood ever, leading to massive economic damage and loss of lives.

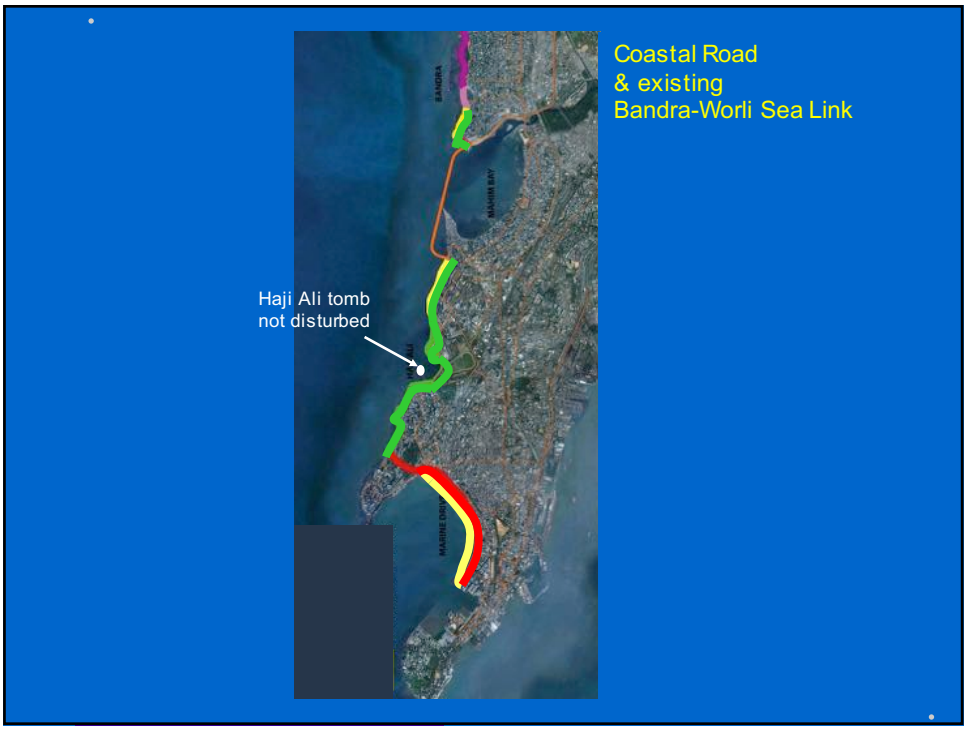


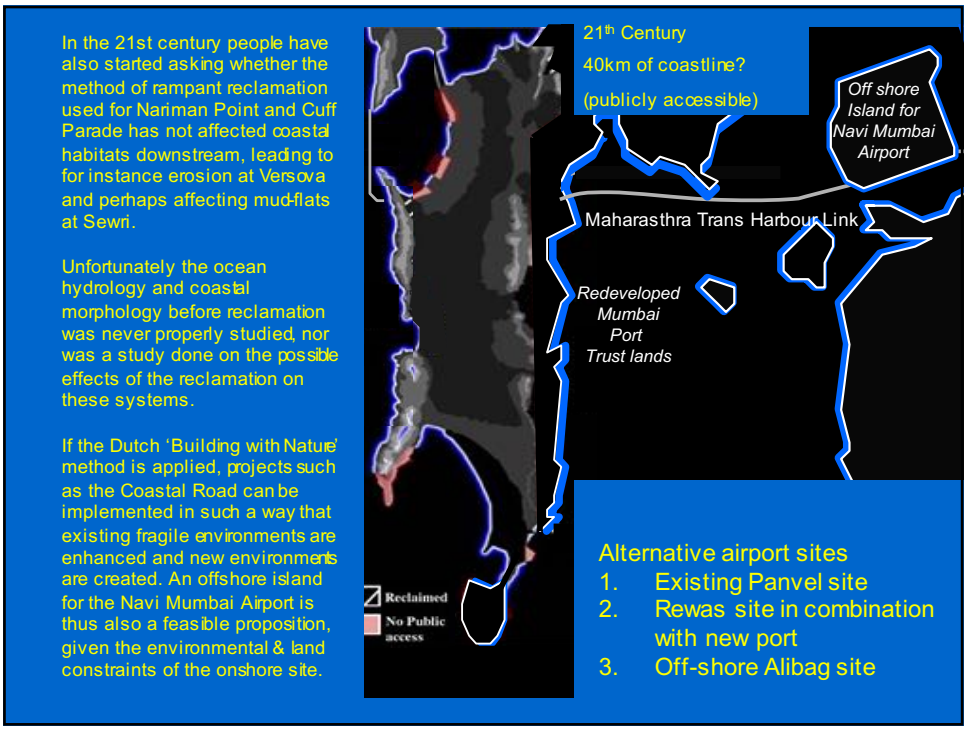
20th Century

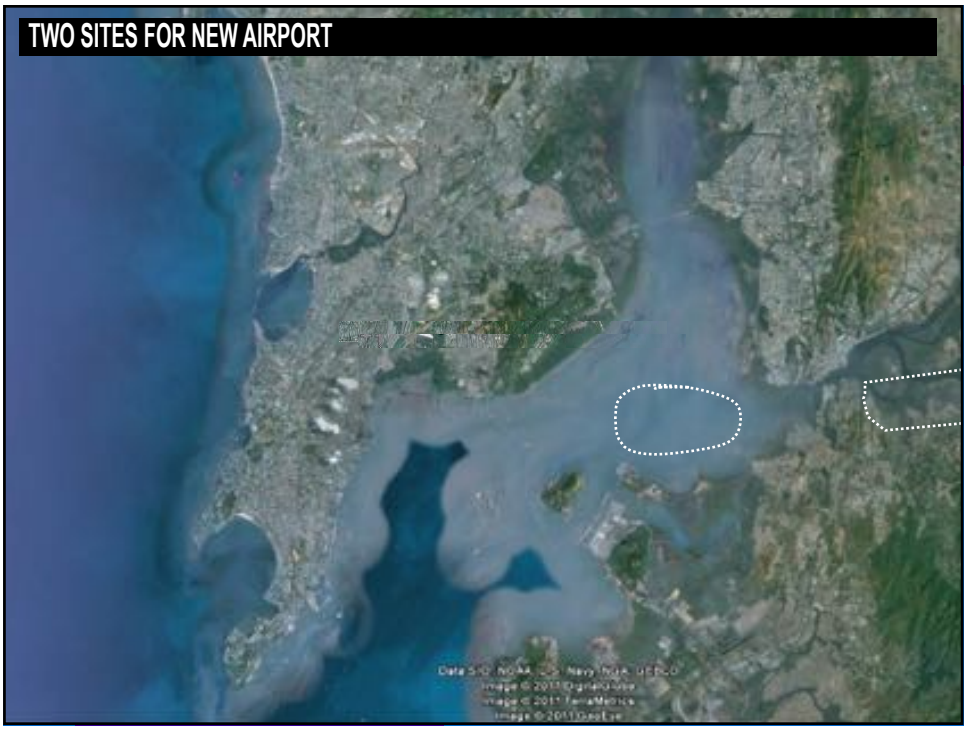
15km of coastline

(publicly accessible)

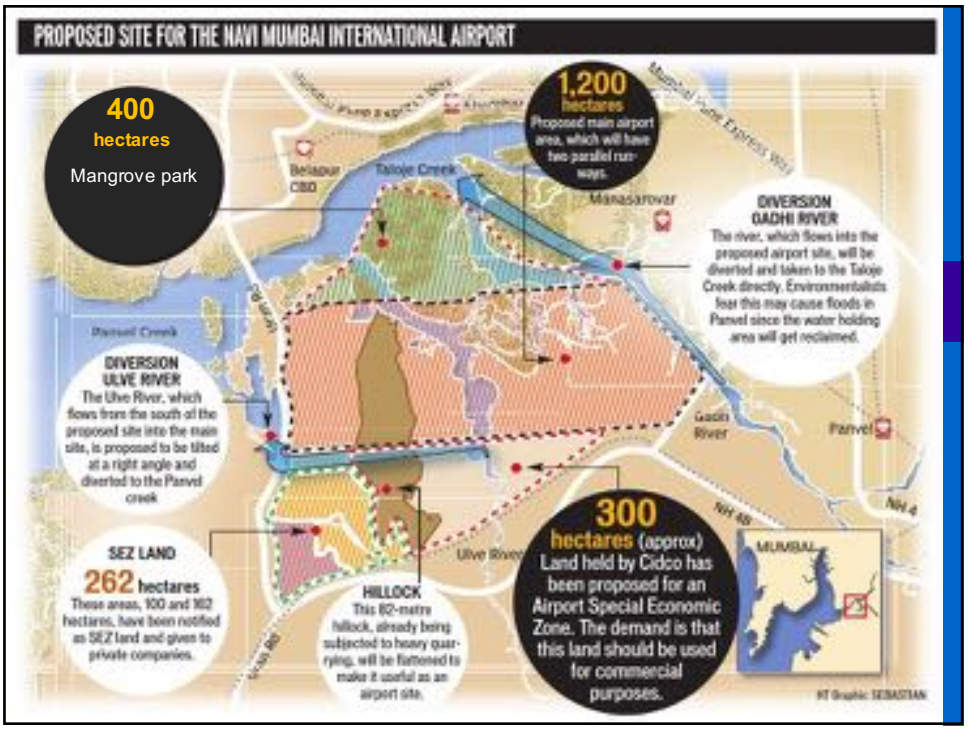
In Holland the greatest reclamations yet happened after construction of a barrier-cum-road which effectively made the 'Southern Sea' into a fresh water reservoir with a series of new islands for food-production & new cities.

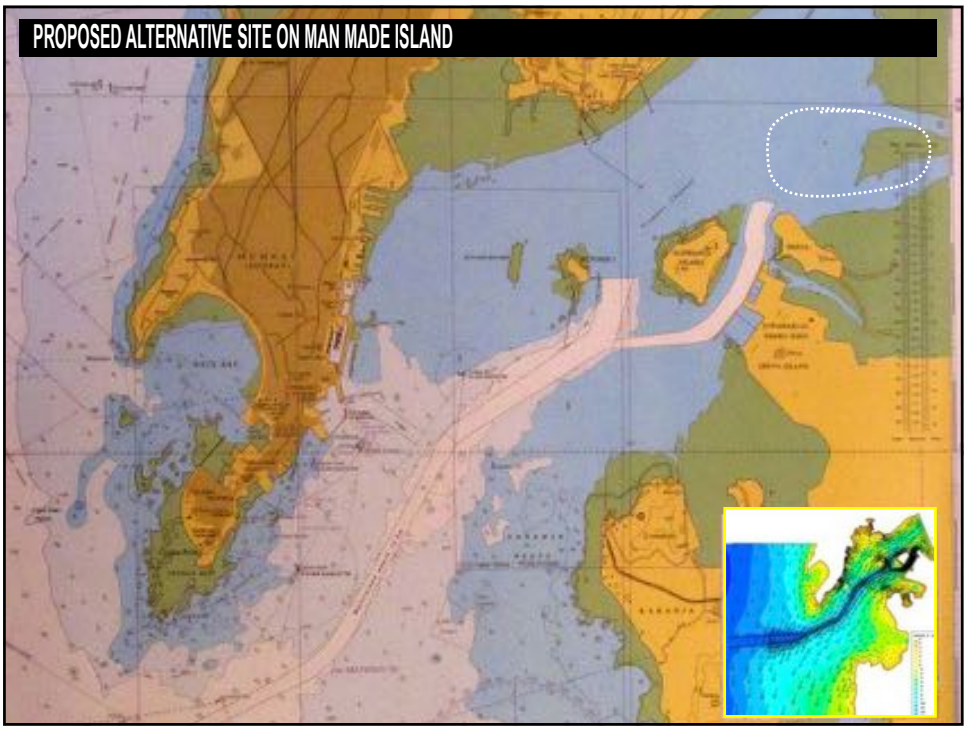

Coastal Road
& existing
Bandra-Worli Sea Link
Haji Ali tomb
not disturbed


In the 21st century people have also started asking whether the method of rampant reclamation used for Nariman Point and Cuff Parade has not affected coastal habitats downstream, leading to for instance erosion at Versova and perhaps affecting mud-flats at Sewri.
Unfortunately the ocean hydrology and coastal morphology before reclamation was never properly studied, nor was a study done on the possible effects of the reclamation on these systems.
If the Dutch 'Building with Nature' method is applied, projects such as the Coastal Road can be implemented in such a way that existing fragile environments are enhanced and new environments are created. An offshore island for the Navi Mumbai Airport is thus also a feasible proposition, given the environmental & land constraints of the onshore site.
21th Century
40km of coastline?
(publicly accessible)
Off shore Island for Navi Mumbai Airport
Maharasthra Trans Harbour Link
Redeveloped Mumbai Port Trust lands
Reclaimed
No Public access
Alternative airport sites
1. Existing Panvel site
2. Rewas site in combination with new port
3. Off-shore Alibag site


TWO SITES FOR NEW AIRPORT


Vashi toll post
Trombay
700 Ha logistics area
500 Ha Residential area
New Flamingo Island
MTHL
MTHL in tunnel
150 Ha Commercial area
100 Ha logistics area
Elephanta Is.
Nhava
Butcher Is.
JNPT
Sheva Creek
Panvel Creek
old site
Vahal
to Panvel
Kopar


PROPOSED SITE FOR THE NAVI MUMBAI INTERNATIONAL AIRPORT
400
hectares
Mangrove park
1,200
hectares
Proposed main airport area, which will have two parallel runways.
DIVERSION
DADHI RIVER
The river, which flows into the proposed airport site, will be diverted and taken to the Taloje Creek directly. Environmentalists fear this may cause floods in Panvel since the water holding area will get reclaimed.
DIVERSION
ULVE RIVER
The Ulve River, which flows from the south of the proposed site into the main site, is proposed to be tilted at a right angle and diverted to the Panvel creek
SEZ LAND
262 hectares
These areas, 100 and 162 hectares, have been notified as SEZ land and given to private companies.
HILLOCK
This 82-metre hillock, already being subjected to heavy quarrying, will be flattened to make it useful as an airport site.
300
hectares (approx)
Land held by Cidco has been proposed for an Airport Special Economic Zone. The demand is that this land should be used for commercial purposes.
Belapur CBD
Taloje Creek
Manasarovar
Panvel Creek
Gadhi River
Panvel
Ulve River
NH 48
NH 4
MUMBAI


PROPOSED ALTERNATIVE SITE ON MAN MADE ISLAND

New coastal developments, using 'Building with Nature', coupled with important transportation-linkages will thus help Mumbai achieve its ambition of becoming a truly world-class city ... for its People, its Commerce and for Environmental values.

CASE STUDIES

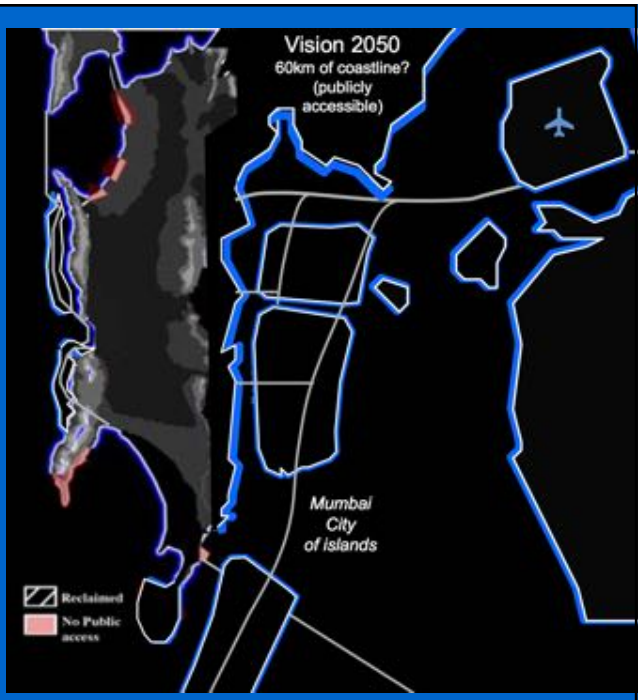
1. Coastal Road vs Sea Link

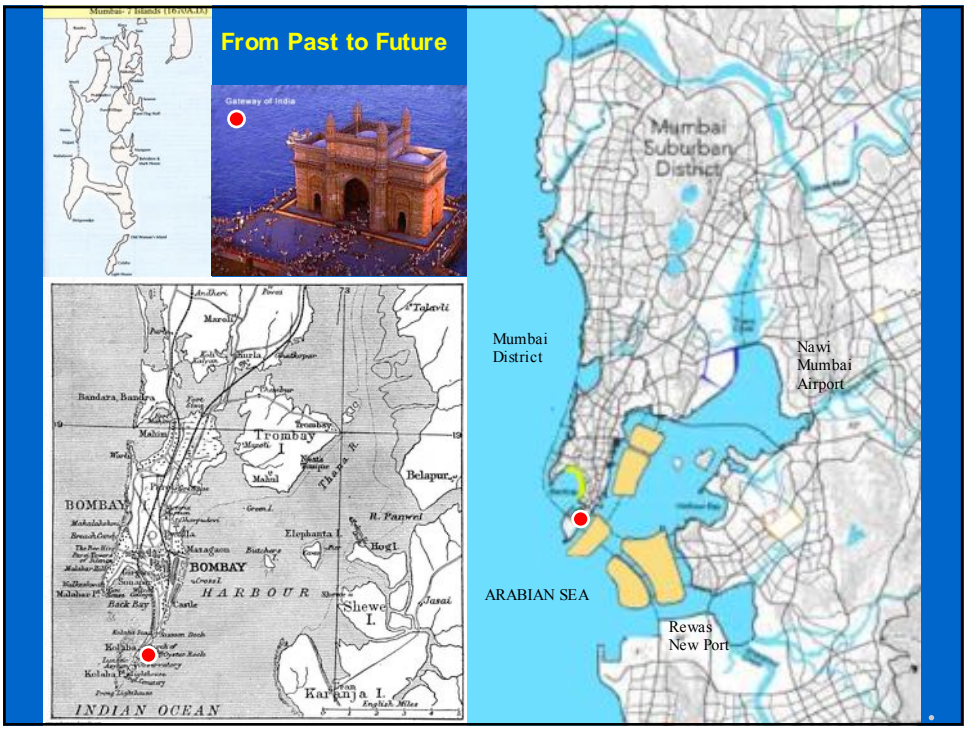
Opportunity for more linkages to existing city road networks;
Value of reclaimed land makes for a viable PPP case.

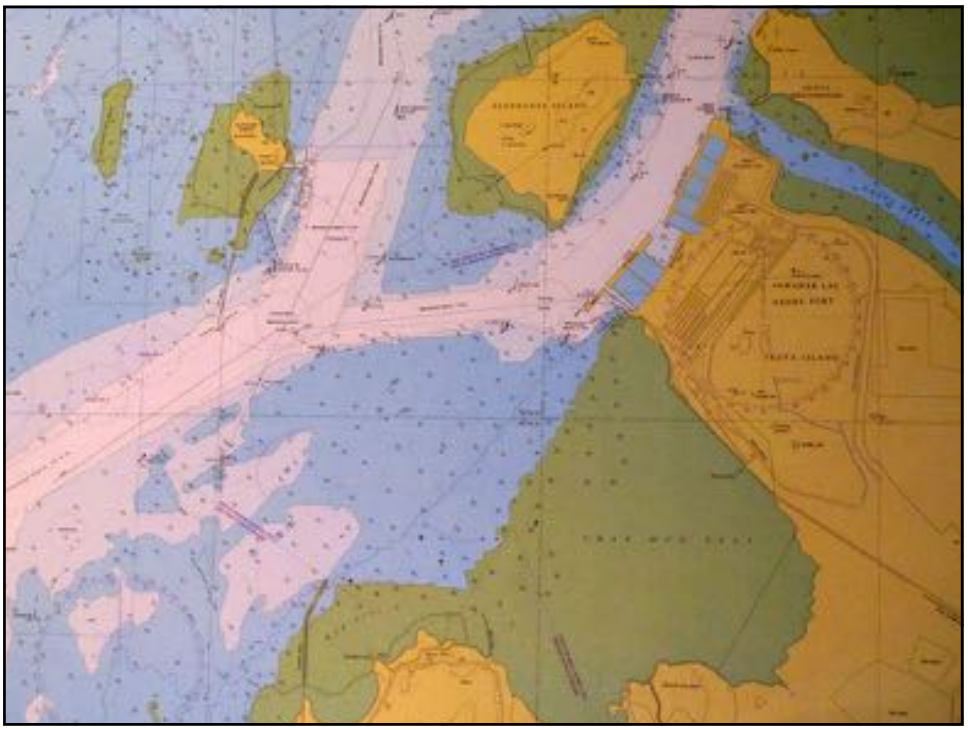
2. Island Airport vs Navi Mumbai site

Island Airport can have unconstrained capacity as opposed to proposed site;

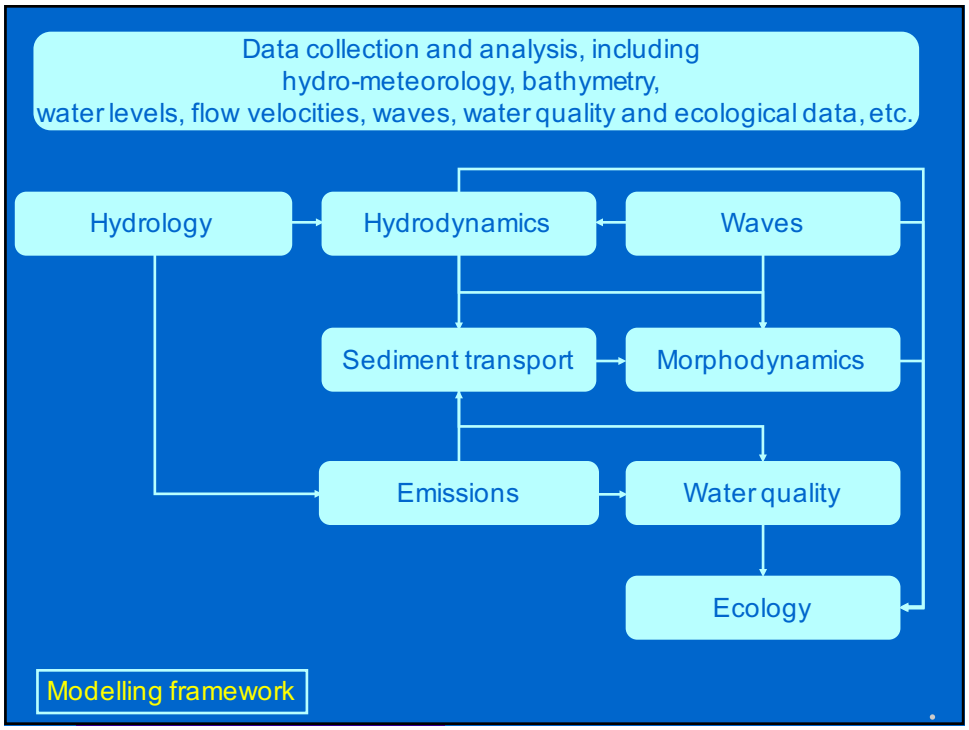
Cost of creek-diversion, hill-demolition and remaining land acquisition for Navi Mumbai site are similar to reclamation!








Gateway of India


Data collection and analysis, including
hydro-meteorology, bathymetry,
water levels, flow velocities, waves, water quality and ecological data, etc.
Hydrology
Hydrodynamics
Waves
Sediment transport
Morphodynamics
Emissions
Water quality
Ecology
Modelling framework

MISSION FINDINGS

In September 2011, a platform of Dutch Companies presented best practices in Planning, Design and Construction of Coastal Developments and Land Reclamation applying the 'Building with Nature' method.

Based on the response to the conference in Mumbai, the platform came to the following conclusions:

1.Need for a flexible Masterplan that allows for stepwise, phased development

2.Key Priority Projects

- The Coastal Road
- Navi Mumbai Airport
- MTHL Bay-crossing
- Port Expansion
- Integration of sea defences & recreation
- Fresh water reservoirs
- Islands in the bay

3. Priority Studies

For a safe and sustainable approach and full utilization of the 'Building with Nature' concept

•Integrated modeling framework on hydrology, hydrodynamics, waves, sendiment transport, morpho-dynamics, emissions, water quality and ecology

•Design conditions for infrastructural and land reclamation works (currents, waves, etc.)

Identification & analysis of mitigation & compensation measures

Forecast impact of future scenarios such as climate change, economic sector development, population increase on the system

Environmental Impact Assessment

Study of stakeholder concerns / Social Impact Assessment (Koli fishermen communities)

Feedback monitor system

Findings High Level Round Table Conference

1. Flexible masterplan that allows for a stepwise approach (phase after phase, segment after segment) for economic, environmental and financial reasons
2. Improvement of Jawarhal Nehru Port and New Deep Sea Port in Rewas district
3. Site for new Mumbai International Airport with adequate environmental compensation measures
4. Widening / heigthening / extending Beach along Marine Drive (between Malabar Hill and Nariman Point)
5. Land reclamations through the execution of a series of islands parallel to and east of Indira Dock, Victoria Dock and Prince's Dock in the Bay
6. Safeguarding the interests of the local Koli fishermen
7. Infrastructure connections between islands and mainland Mumbai
8. Overall improvement of infrastructure in and around Mumbai Metropolitan area, including the possibility of a coastal road along the west coast
9. Freshwater reservoir through barrage in Mahim Bay. This is only possible if an adequate sewer system and waste water treatment in upstream catchment area are provided for.

Requirements

- **Integrated Study**, taking into account a whole series of functions, covering the entire wider Mumbai area, including:
  - Set-up of an integrated modelling framework addressing the hydrodynamics, waves, morphodynamics / sediment transport, water quality and ecology
    - Design conditions for infrastructural and land reclamation works (currents, waves, siltation, etc.)
    - Effects on ecosystem (terrestrial and aquatic flora and fauna with special emphasis on the mangroves)
    - Identification and analysis of mitigating and compensating measures
    - Taking into account future scenarios such as climate change, sector development, population increase, etc.
  - Environmental impact assessment
  - Respecting the cultural heritage values (Mumbai can become an island city again:
    "Good plans have their roots in the past and are pointing to the future"
- **Development of a (feedback) monitoring program**
    - Including a description of the reference situation
- **Application of best practices** in a local context
- **Introducing Building with Nature® concepts**

SUSTAINABLE COASTAL ZONE DEVELOPMENT

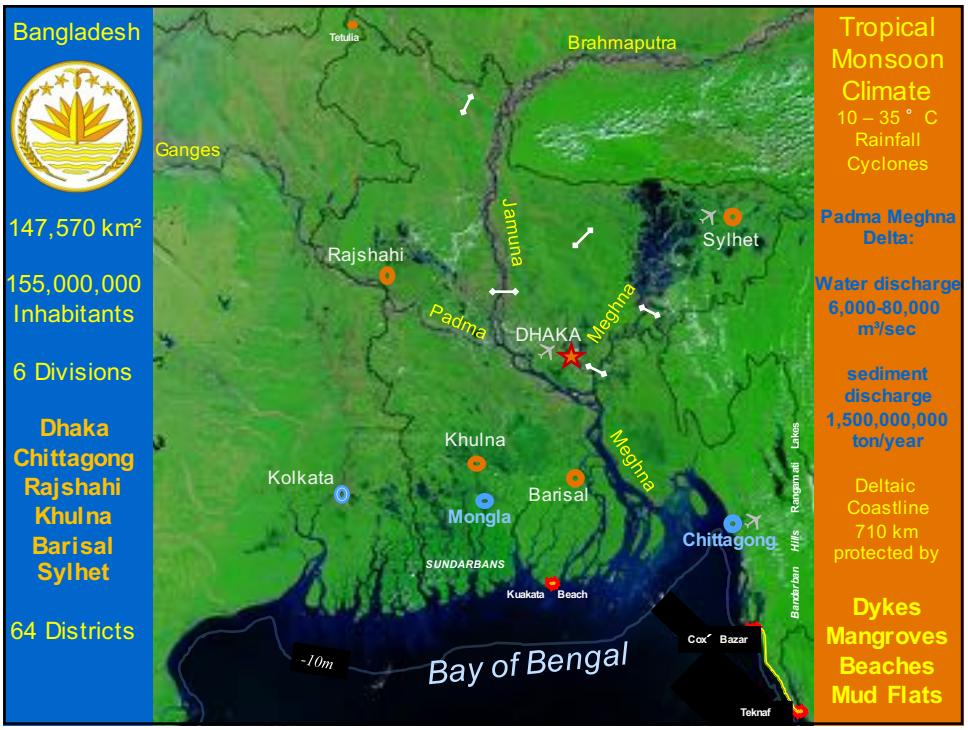
Integrated Coastal Policy via Building with Nature

BANGLADESH

-

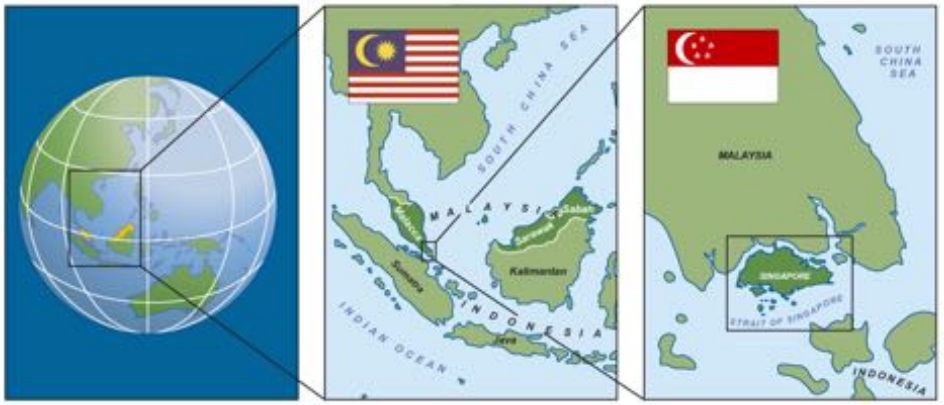
THE NETHERLANDS

March, 2009

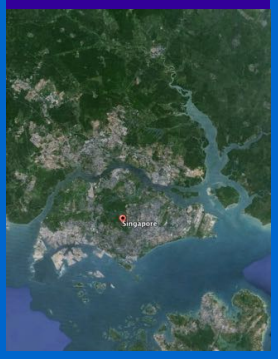

Bangladesh
147,570 km²
155,000,000 Inhabitants
6 Divisions
Dhaka
Chittagong
Rajshahi
Khulna
Barisal
Sylhet
64 Districts
Tetulia
Brahmaputra
Ganges
Jamuna
Rajshahi
Sylhet
Padma
DHAKA
Meghna
Khulna
Meghna
Kolkata
Barisal
Mongla
Chittagong
SUNDARBANS
Kuakata Beach
Cox Bazar
Teknaf
-10m
Bay of Bengal
Rangamati Lakes Hills
Barisan
Tropical Monsoon Climate
10 – 35 ° C
Rainfall
Cyclones
Padma Meghna Delta:
Water discharge 6,000-80,000 m³/sec
sediment discharge 1,500,000,000 ton/year
Deltaic Coastline 710 km protected by
Dykes
Mangroves
Beaches
Mud Flats

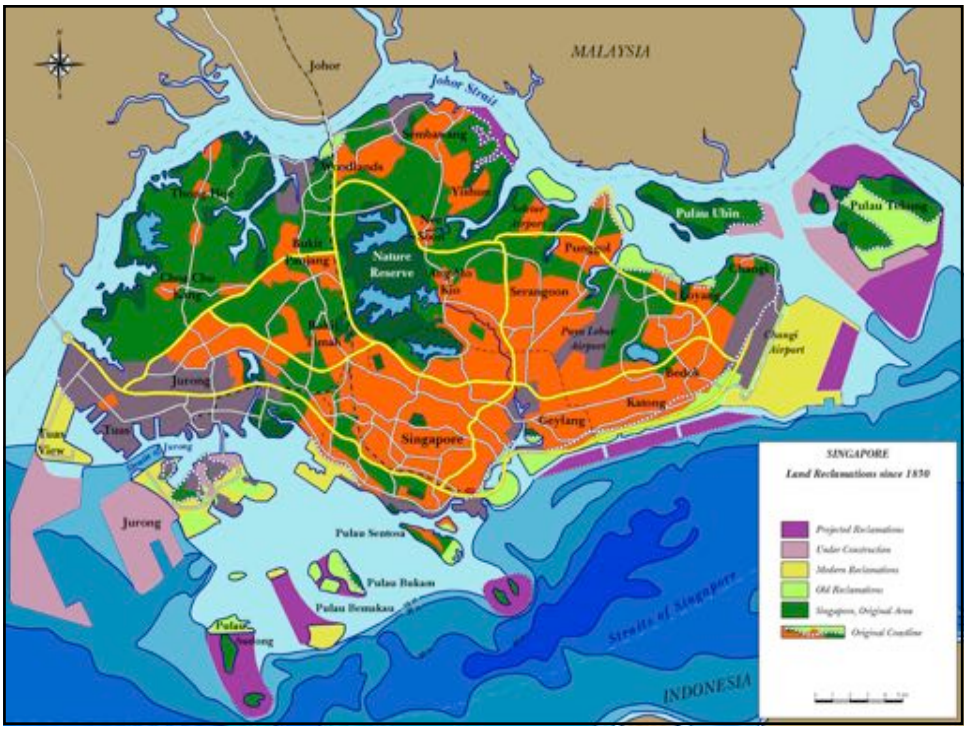

SUSTAINABLE COASTAL ZONE DEVELOPMENT
Integrated Coastal Policy via Building with Nature
SINGAPORE
-
THE NETHERLANDS
2015

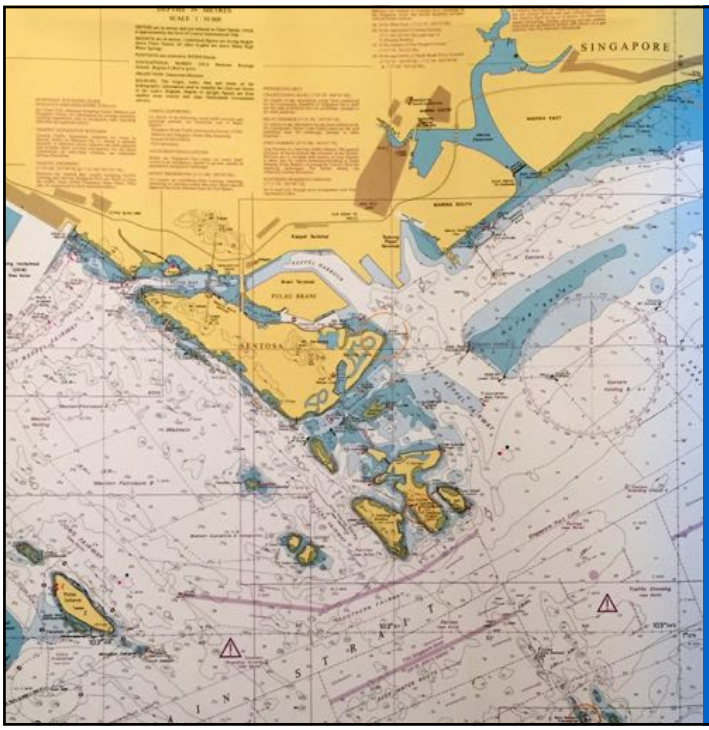
Singapore



ASIA

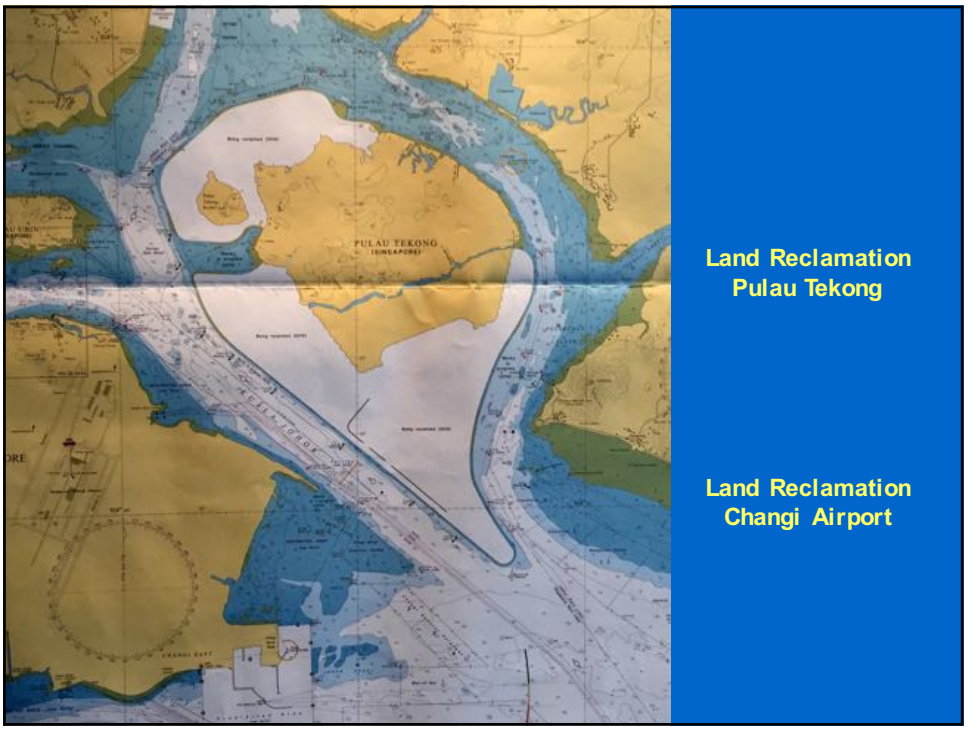
SINGAPORE		THE NETHERLANDS
	**LAND AREA**	
	699 km² 33,883 km²	
	EXCL. ECONOMIC ZONE	
	823 km² 63,912 km²	
	MARITIME SPATIAL PLAN Functional E.E.Z. Atlas	
	INHABITANTS	
	5.4 million 16.9 million	
	COASTAL LENGTH	
	193 km 353 km	
AV. ANNUAL RAINFALL	**MAIN PORT**	**AV. ANNUAL RAINFALL**
2,400 mm	Singapore Rotterdam 558 mln ton 450 32 mln TEU 12 mln 134,868 vessels 30,000 inland vessels 80,000	850 mm
IRREGULAR RAINFALL		





Land Reclamation Around Singapore River & Marina Reservoir

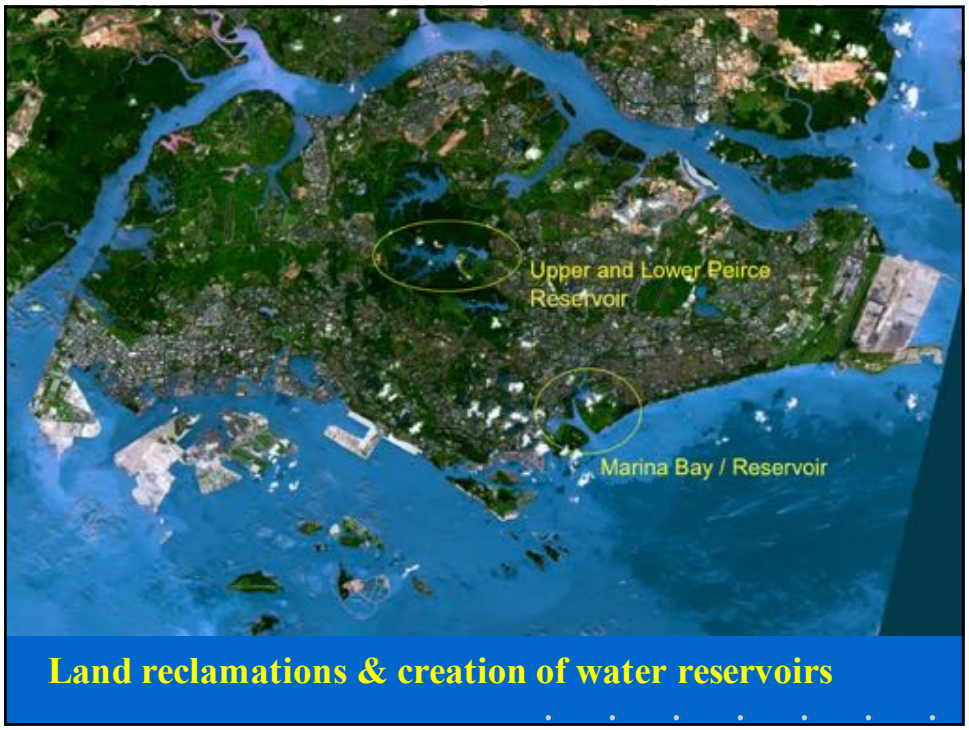

Land Reclamation
around
Singapore River
Marina Reservoir
Singapore Port
Sentosa


PULAU TEKONG
(SINGAPORE)
Land Reclamation
Pulau Tekong
Land Reclamation
Changi Airport

Northern Singapore & Bridge Connection Johor Bahru

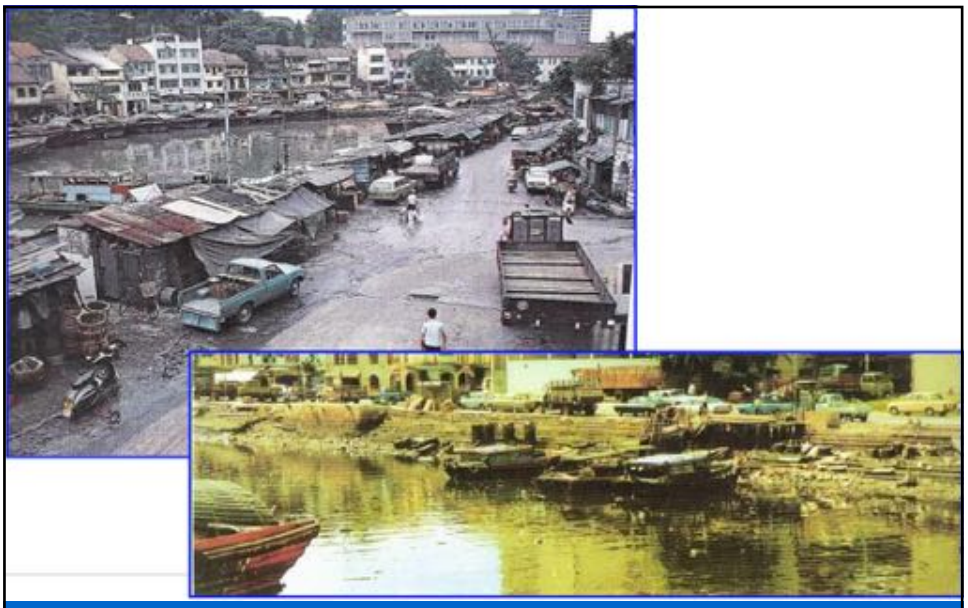
Land Reclamation Tuas & Jurong Island


Land Reclamation Tuas & Jurong Island


Upper and Lower Peirce Reservoir
Marina Bay / Reservoir
Land reclamations & creation of water reservoirs

The LEE KUAN YEW WATER PRIZE is a platform for solving global water problems by outstanding technologies & implementing innovative policies and programmes which benefit humanity

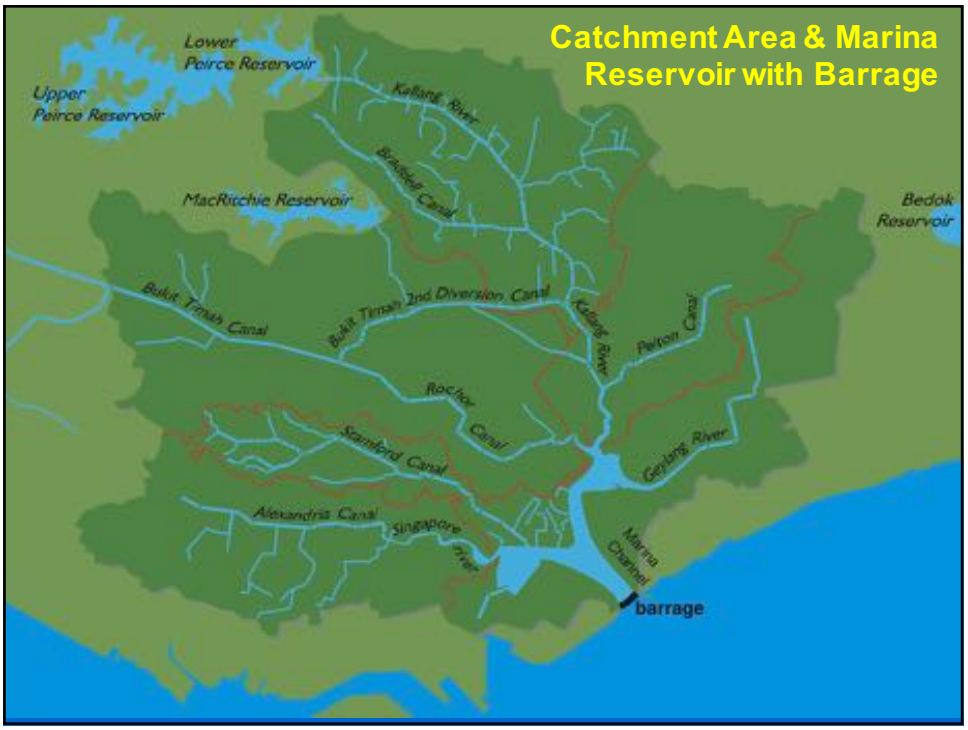
The importance of Water Quantity & Water Quality



Singapore history – 50 years ago


Floods were common occurrences...
Singapore history – 50 years ago


1970s
1990s
Singapore history – solutions found



SUSTAINABLE FUTURE OF INLAND WATERWAYS

Stimulating the Blue Green Economy for Regional, Socio-Economic & Spatial Development, while safeguarding Environmental Values & Nature, Navigability as well as Safety

218

AQUAPUNCTURE©

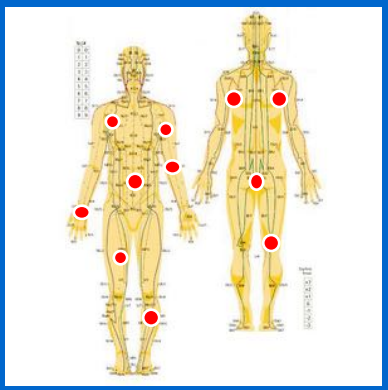
Introduction of AQUAPUNCTURE©
for the optimal use, adaptation & management
of inland waterways and their waterfronts

For economy, employment, spatial quality,
navigability, safety & environmental values

219

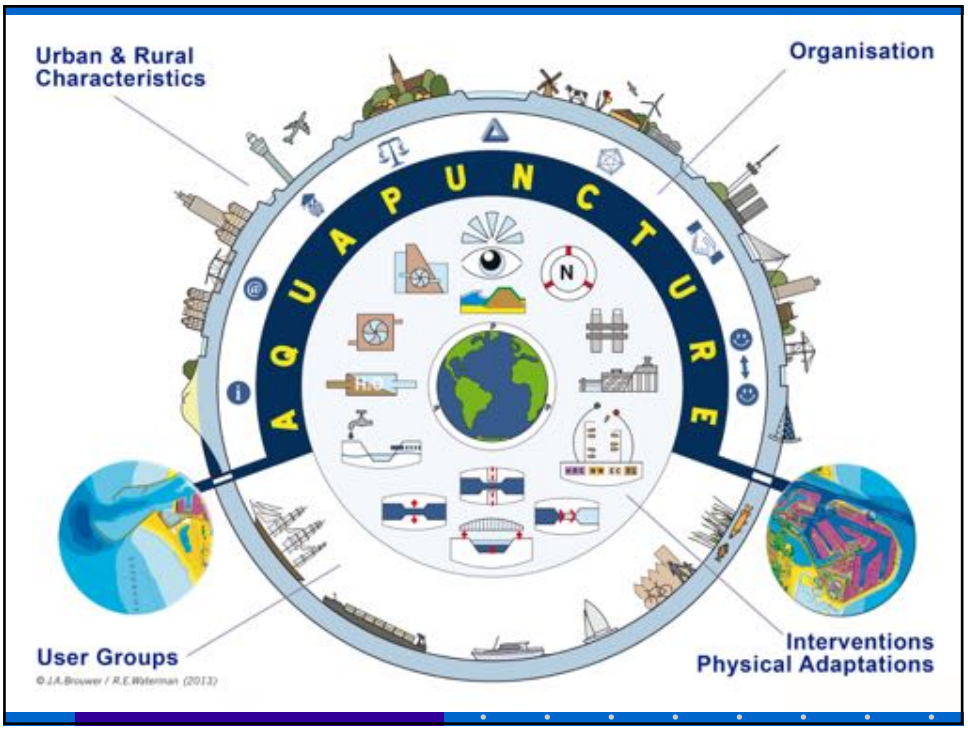
ACUPUNCTURE

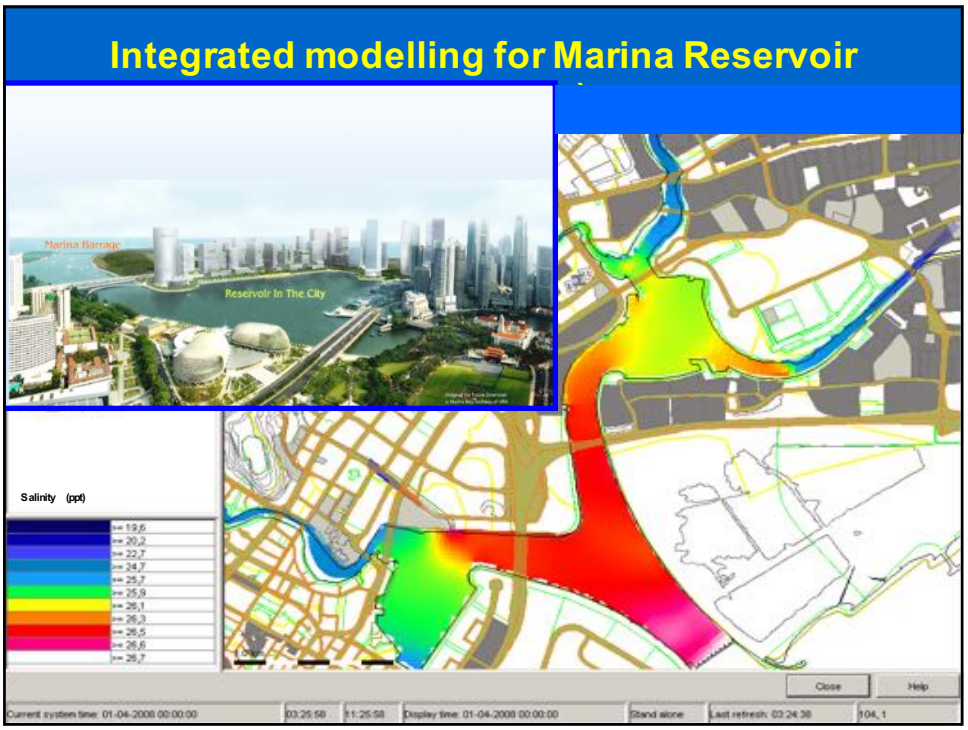
to revitalize
the Nervous System
& Human Organs



AQUAPUNCTURE

to revitalize
the Waterways & their
Water Fronts


Urban & Rural Characteristics
Organisation
AQUAPUNCTURE
User Groups
Interventions Physical Adaptations
© J.A.Brouwer / R.E.Waterman (2013)


Integrated modelling for Marina Reservoir
Marina Barrage
Reservoir In The City
Salinity (ppt)
Close
Help

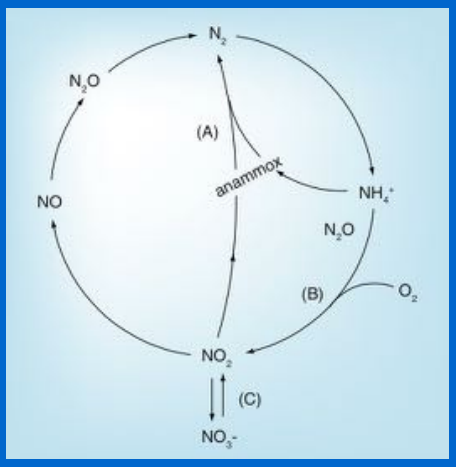
WATER QUANTITY	PARAMETER
Supply	Watervolume
Level	Water level
WATER QUALITY	
Physical-chemical	Salinity
	DO Surface
	DO Bottom
	Turbidity
	TOC
Nutrients	TN
	NH_4-NO_X
	TP
	PO_4-P
Algea	Micro algea Cyanobacteria
Bacteria	Enterococcus Faecal coliforms Escherichia coli
Ecosystem Health	NH_3-N
	pH
	Temperature

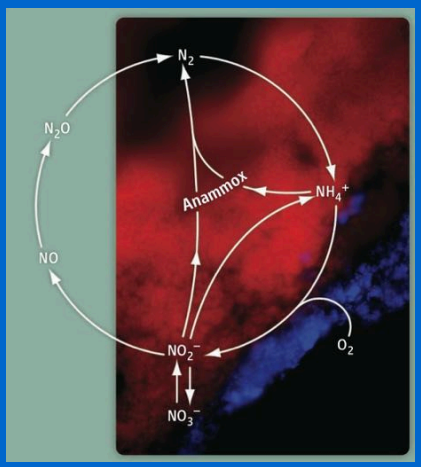
Catchment Area & Marina Reservoir with Barrage

Improving Water Quantity & Water Quality

Introducing new Waste Water Purification Method

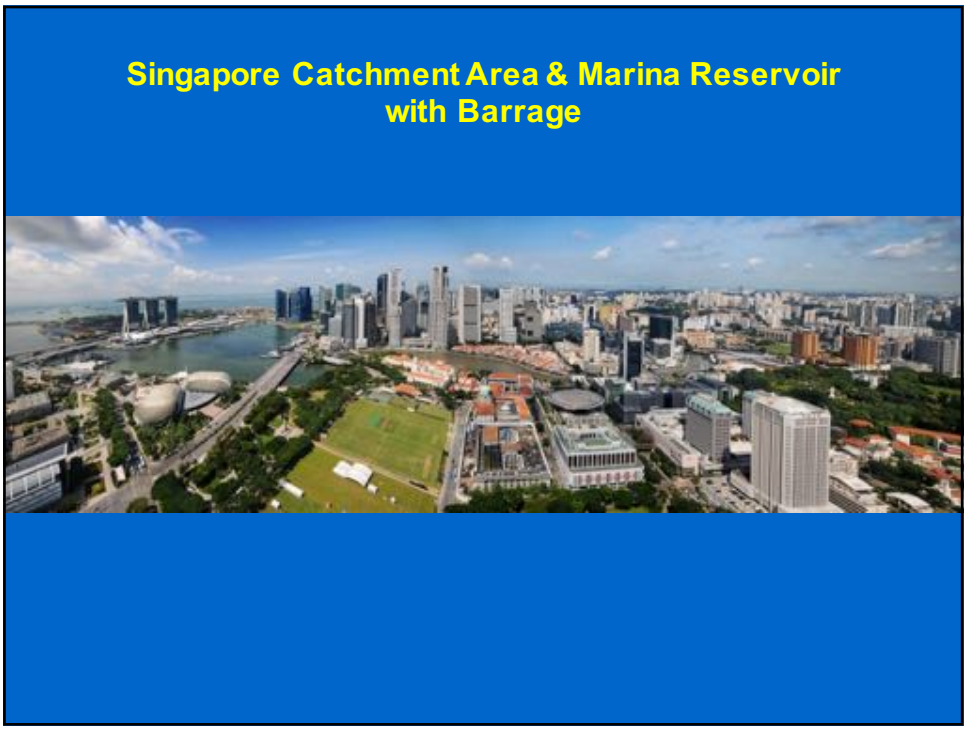
ANAMMOX – NEREDA Project $NH_4^+ + NO_2^- \rightarrow N_2 + 2H_2O$





Granulated anammox bacteria covered with a skin of nitrite producing bacteria are able to produce nitrogen


Creating a Reservoir in the City –
Marina Reservoir
Marina Barrage
Reservoir In The City

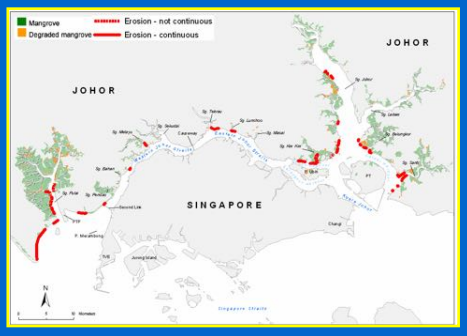

Singapore Catchment Area & Marina Reservoir
with Barrage


Aquapuncture©
CLEANSING BIOTOPE
WATER PLAYGROUND
LOTUS GARDEN
PLAYGROUND
POND
ACTIVITY LAWN
PLAYGROUND
DOG RUN
LAWN II
FOOT REFLEXOLOGY
RIVERSIDE GALLERY
LAWN I
SCULPTURE
Kallang River at Ang Mo Kio-Bishan Park
Section of the Kallang River at Ang Mo Kio-Bishan Park (image from Singapore's national water agency, by Atelier Dreiseitl)


Aquapuncture©


Aquapuncture©

External impacts on mangroves



Erosion of mangroves observed during boat survey along the coastline

Rhizophora type mangrove tree

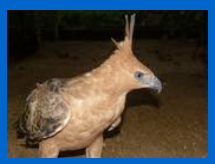
SUSTAINABLE COASTAL ZONE DEVELOPMENT

Integrated Coastal & Delta Policy via Building with Nature®

Prof. Dr. R.E. Waterman MSc

INDONESIA – THE NETHERLANDS

2015


BHINNEKA TUNGGAL IKA
PANCASILA
KETUHANAN YANG MAHA ESA
KEMANUSIAAN YANG ADIL DAN BERADAB
PERSATUAN INDONESIA
KERAKYATAN YANG DIPIMPIN OLEH HIKMAT KEBIJAKSANAAN DALAM PERMUSYAWARATAN / PERWAKILAN
KEADILAN SOSIAL BAGI SELURUH RAKYAT INDONESIA
JE MAINTIENDRAI


Indonesia Jakarta
SOUTH CHINA SEA
PACIFIC OCEAN
INDIAN OCEAN
Australia
JAVA SEA
JAKARTA
JAVA
INDIAN OCEAN
Indonesia 17,500 islands - 81,000 km coast lines

Jakarta

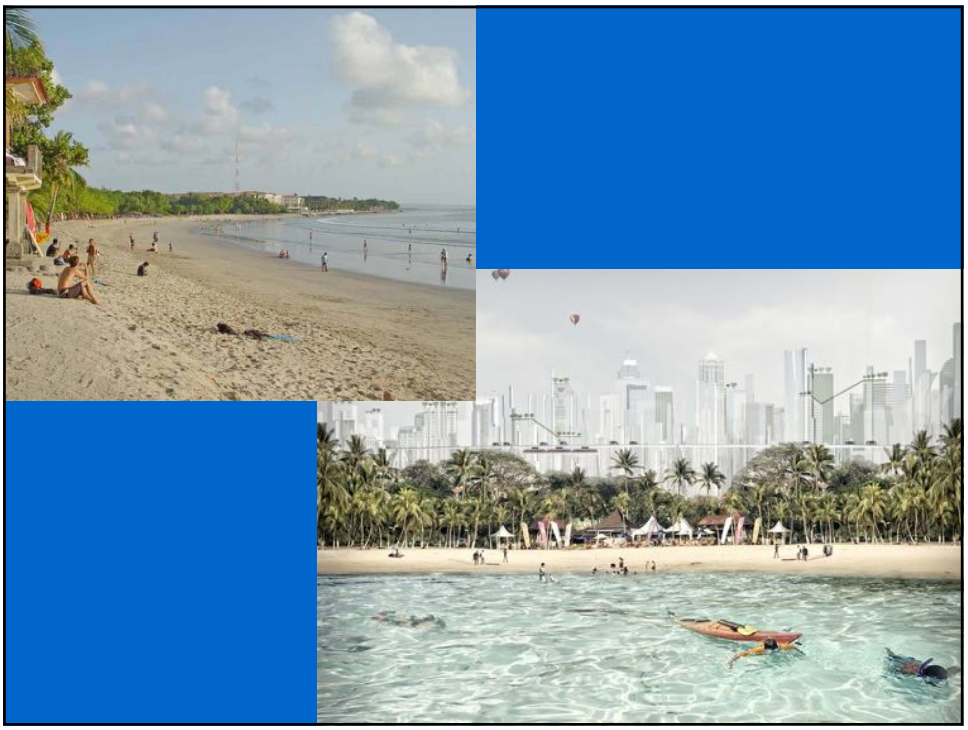
740.28 km²

10,200,000 Inhabitants

Jabotabek

28,000,000 Inhabitants

30 km Coastline



Rapid Urbanisation

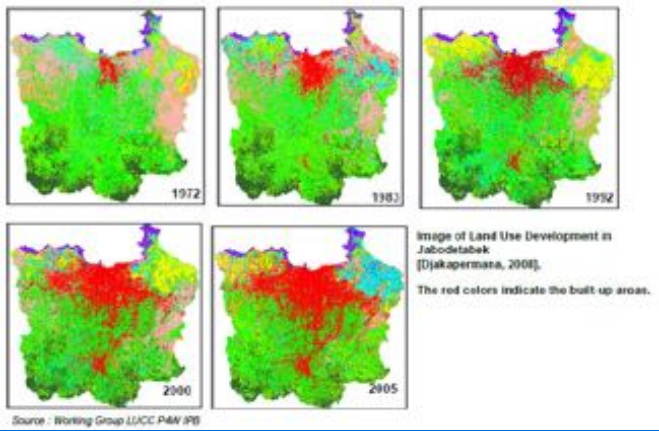


Image of Land Use Development in Jabodetabek
[Djakapermana, 2008].

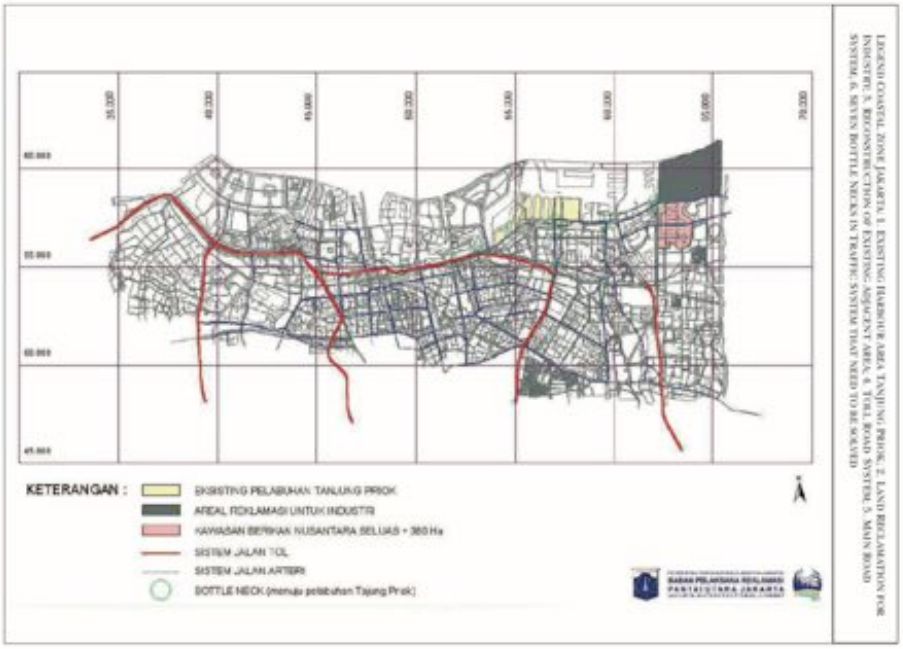
The red colors indicate the built up areas.

INHABITANTS

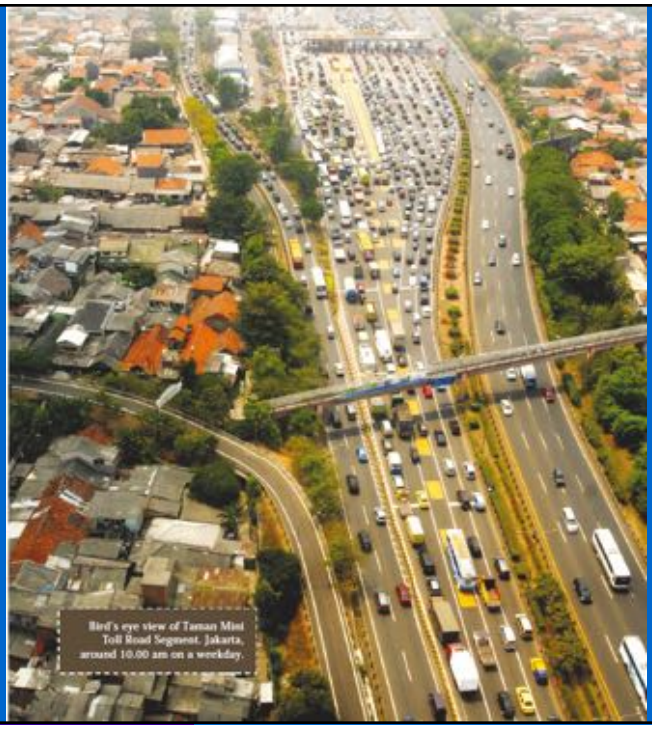
2000: 20 million

2010: 30 million

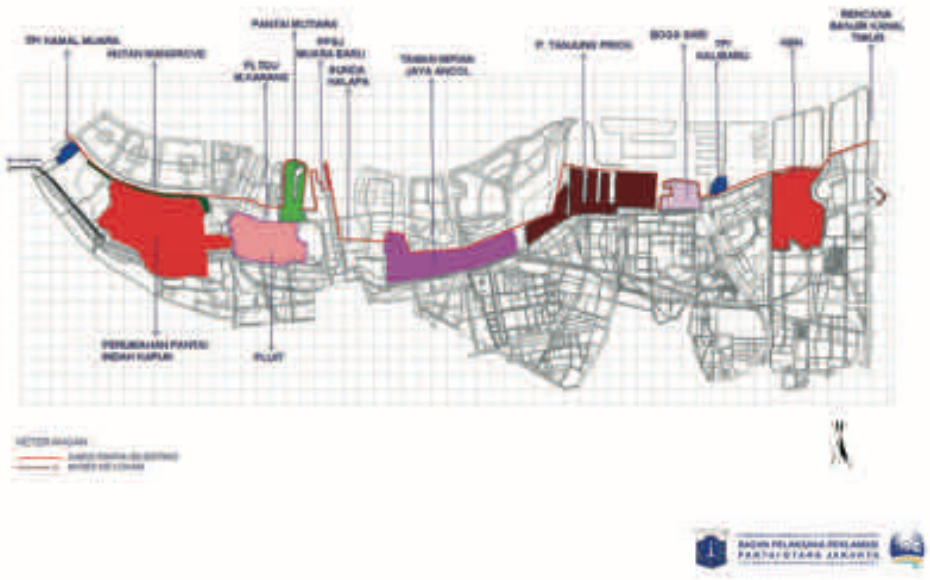
COASTAL ZONE DEVELOPMENT & MAIN INFRASTRUCTURE OF JAKARTA UTARA

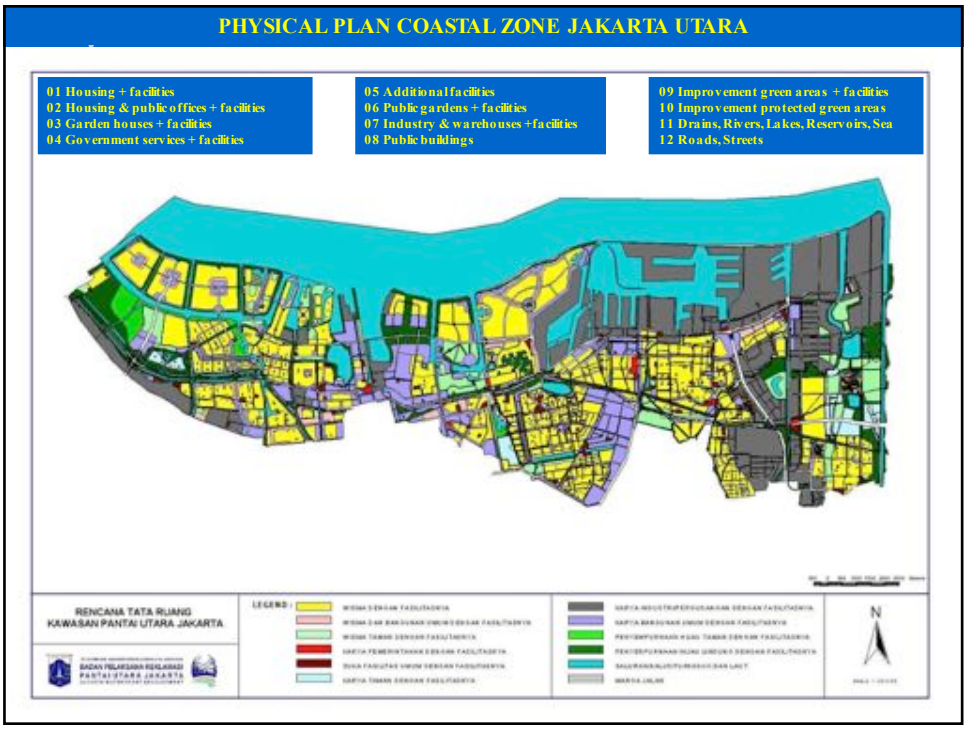


Taman Mini
Toll Road
Jakarta

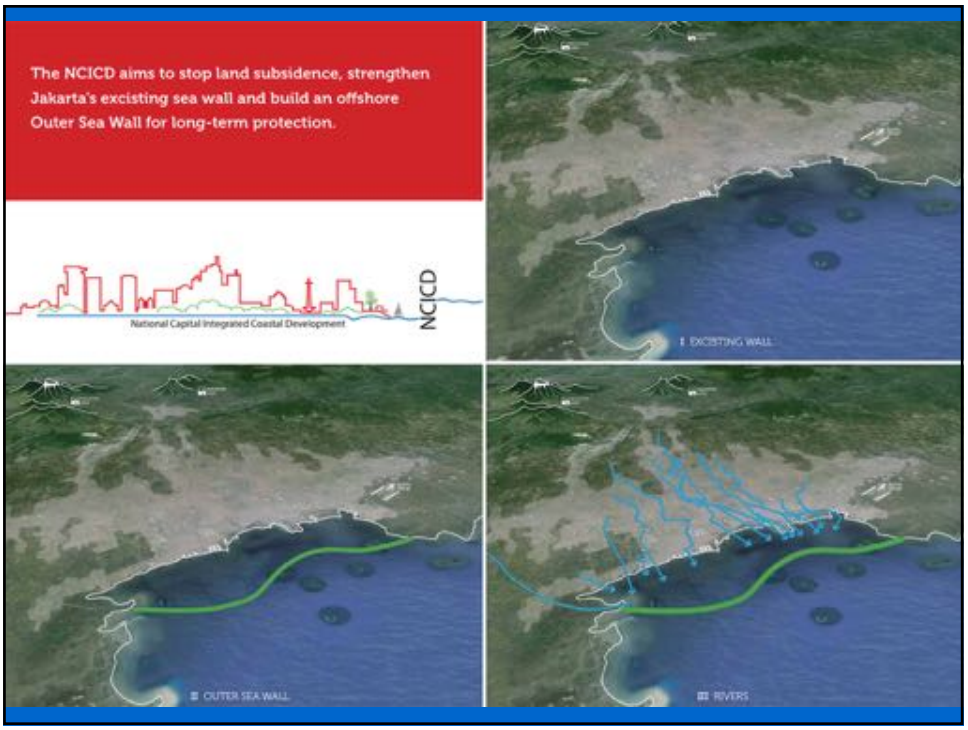


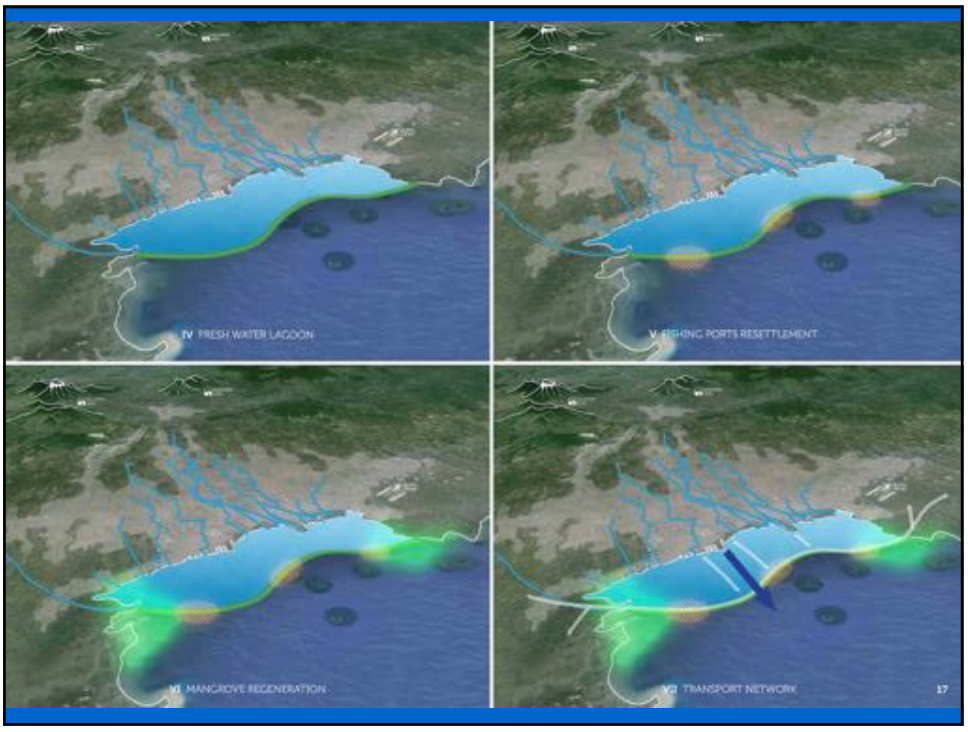
LOCATIONS ADJACENT TO THE PROJECTED LAND RECLAMATIONS



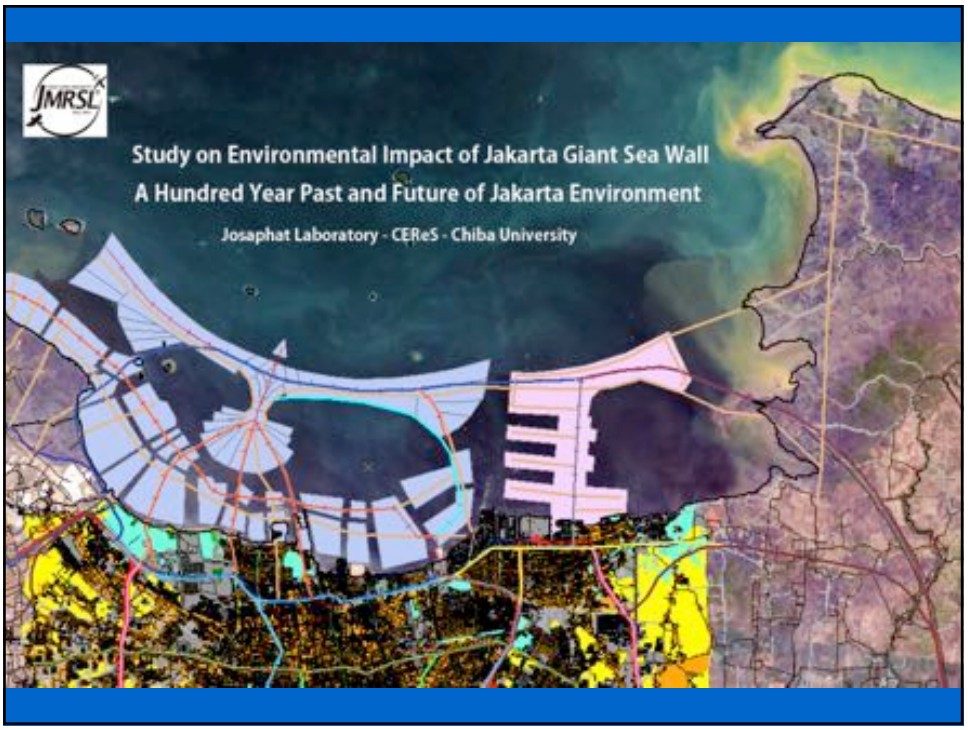

PHYSICAL PLAN COASTAL ZONE JAKARTA UTARA
01 Housing + facilities
02 Housing & public offices + facilities
03 Garden houses + facilities
04 Government services + facilities
05 Additional facilities
06 Public gardens + facilities
07 Industry & warehouses + facilities
08 Public buildings
09 Improvement green areas + facilities
10 Improvement protected green areas
11 Drains, Rivers, Lakes, Reservoirs, Sea
12 Roads, Streets
RENCANA TATA RUANG
KAWASAN PANTAI UTARA JAKARTA
LEGEND :
N

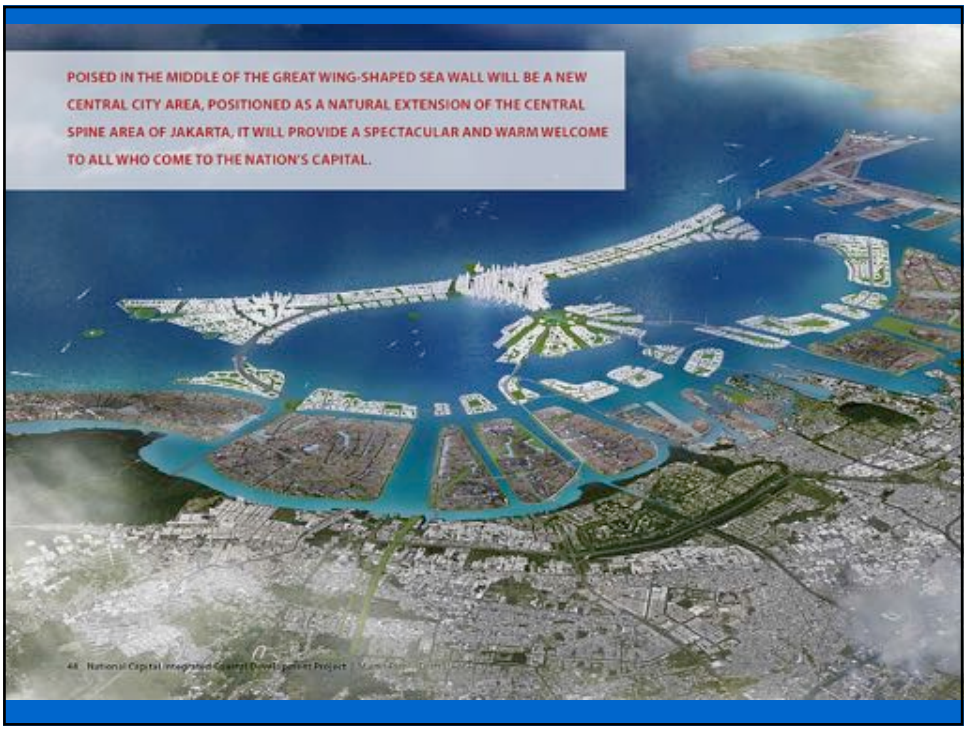

Waduk Air Baku
Waduk Air Baku
Pelabuhan Laut Dalam
FRESH WATER RESERVOIR 1
FRESH WATER RESERVOIR 2


The NCICD aims to stop land subsidence, strengthen Jakarta's excisting sea wall and build an offshore Outer Sea Wall for long-term protection.
National Capital Integrated Coastal Development
NCICD
I EXCISTING WALL
II OUTER SEA WALL
III RIVERS

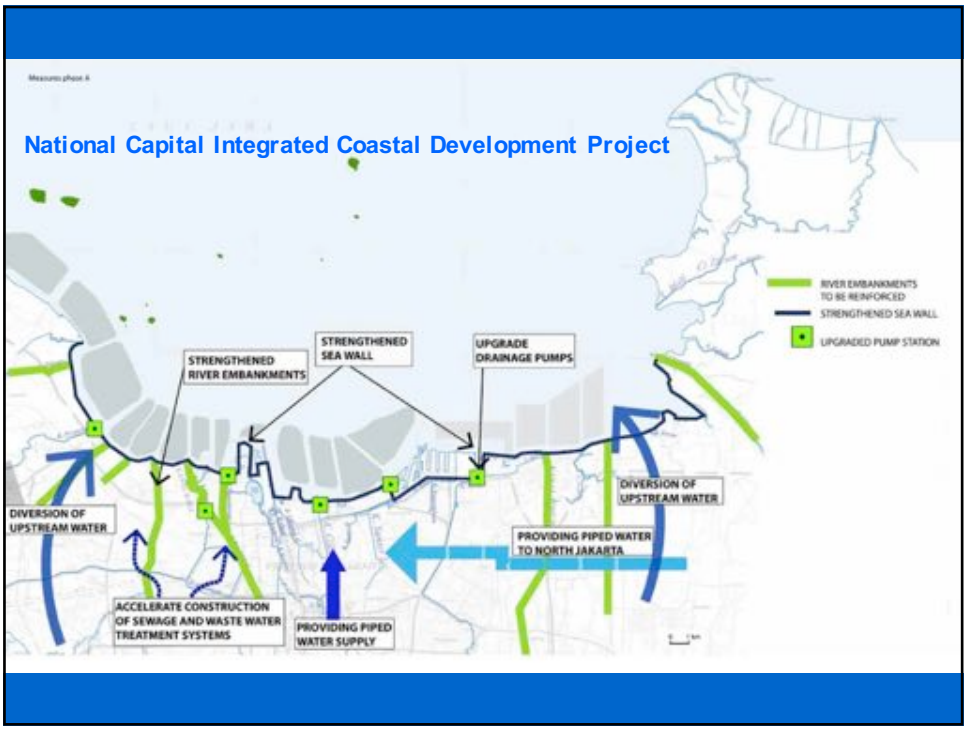

IV FRESH WATER LAGOON
V FISHING PORTS RESETTLEMENT
VI MANGROVE REGENERATION
VII TRANSPORT NETWORK
17

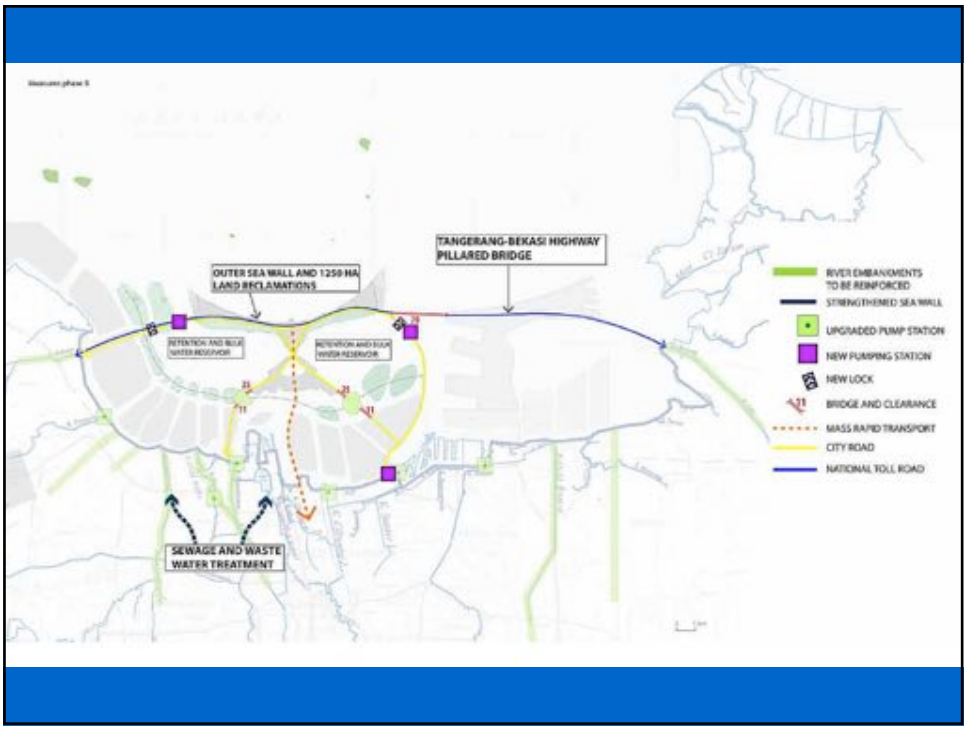

MANGROVE REGENERATION
Other objectives for the NCICD are to secure the future of Jakarta's fishing communities and continue the Mangrove Regeneration Program.


JMRSL
Study on Environmental Impact of Jakarta Giant Sea Wall
A Hundred Year Past and Future of Jakarta Environment
Josaphat Laboratory - CEReS - Chiba University

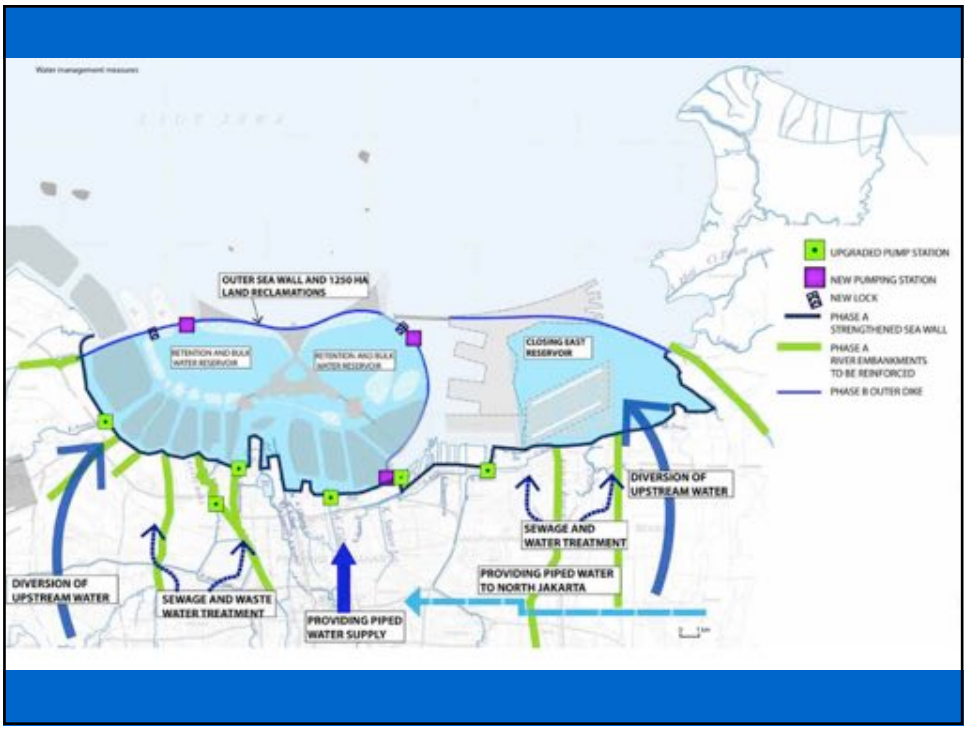

POISED IN THE MIDDLE OF THE GREAT WING-SHAPED SEA WALL WILL BE A NEW CENTRAL CITY AREA, POSITIONED AS A NATURAL EXTENSION OF THE CENTRAL SPINE AREA OF JAKARTA, IT WILL PROVIDE A SPECTACULAR AND WARM WELCOME TO ALL WHO COME TO THE NATION'S CAPITAL.

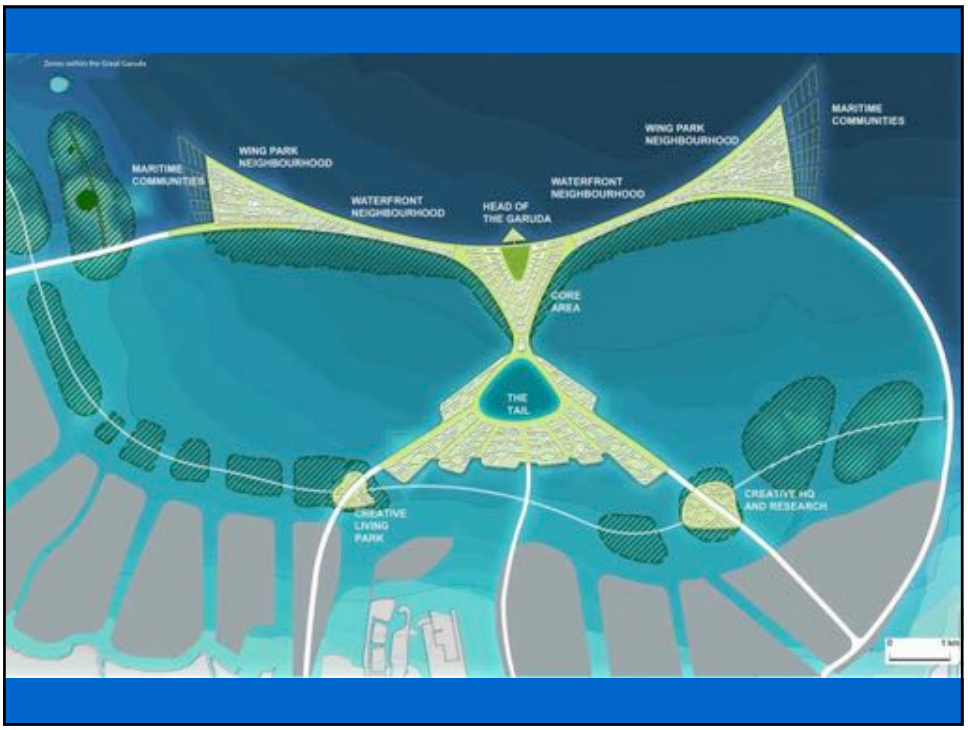

FORMED BY THE LAWS OF NATURE, FLOW AND EFFICIENCY, THIS ELEGANT FOIL-SHAPED WATERFRONT CITY RESEMBLES A GREAT BIRD, AN EAGLE SPREADING ITS GREAT WINGS TO PROTECT THE PEOPLE OF JAKARTA, THE NATIONAL CAPITAL.

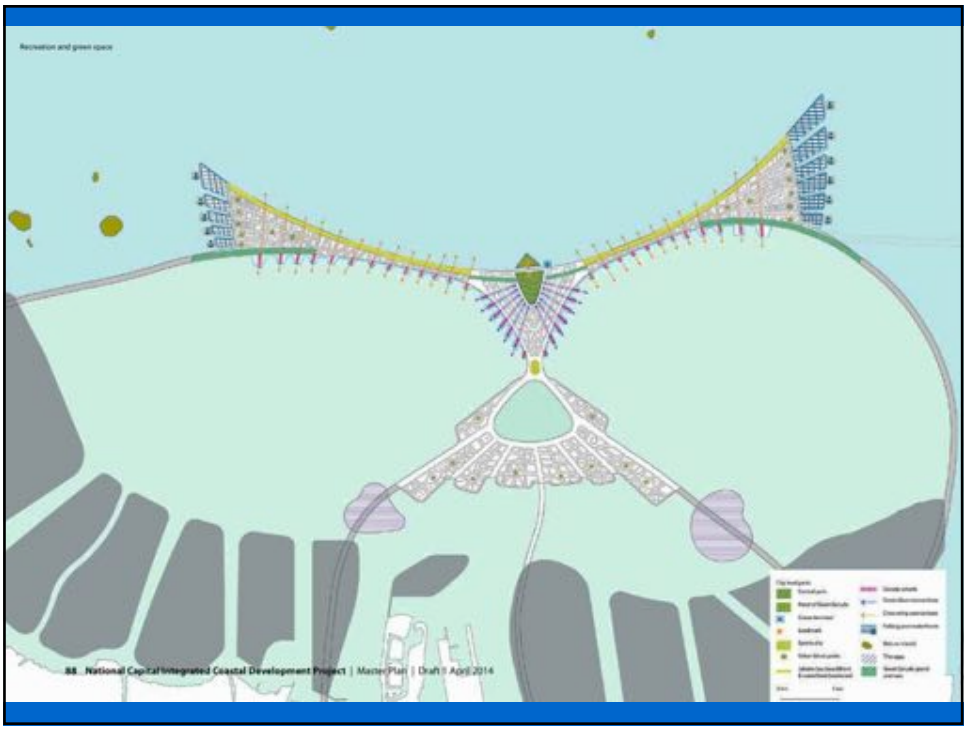

National Capital Integrated Coastal Development Project
RIVER EMBANKMENTS TO BE REINFORCED
STRENGTHENED SEA WALL
UPGRADED PUMP STATION
STRENGTHENED RIVER EMBANKMENTS
STRENGTHENED SEA WALL
UPGRADE DRAINAGE PUMPS
DIVERSION OF UPSTREAM WATER
DIVERSION OF UPSTREAM WATER
PROVIDING PIPED WATER TO NORTH JAKARTA
ACCELERATE CONSTRUCTION OF SEWAGE AND WASTE WATER TREATMENT SYSTEMS
PROVIDING PIPED WATER SUPPLY

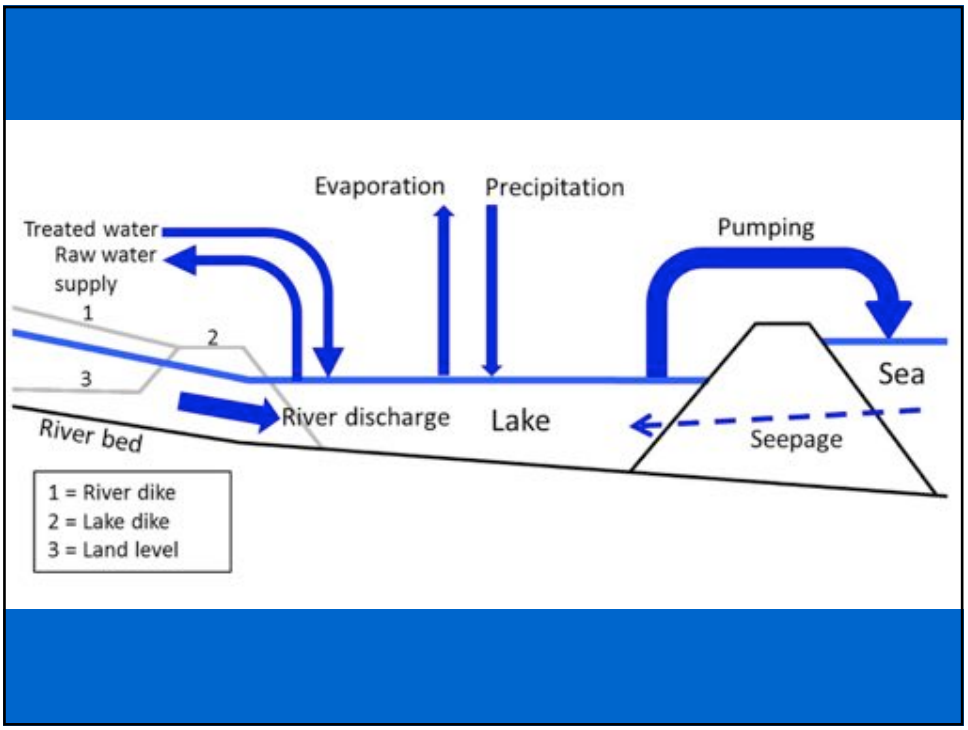

TANGERANG-BEKASI HIGHWAY
PILLARED BRIDGE
OUTER SEA WALL AND 1250 HA
LAND RECLAMATIONS
SEWAGE AND WASTE
WATER TREATMENT
RIVER EMBANKMENTS
TO BE REINFORCED
STRENGTHENED SEA WALL
UPGRADED PUMP STATION
NEW PUMPING STATION
NEW LOCK
BRIDGE AND CLEARANCE
MASS RAPID TRANSPORT
CITY ROAD
NATIONAL TOLL ROAD

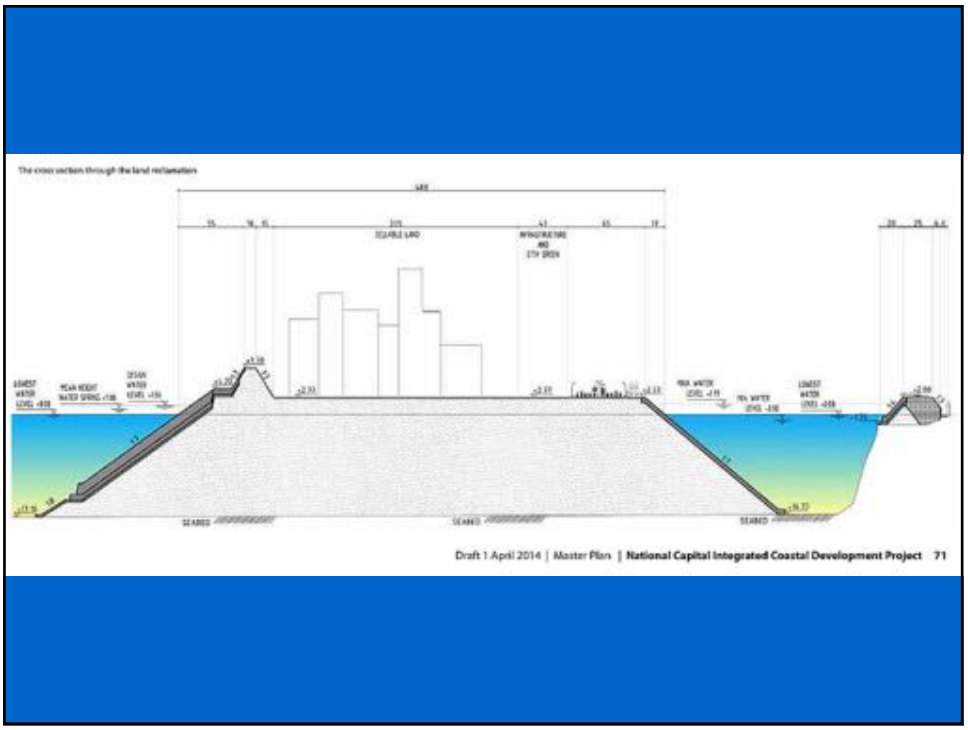

PORT EXTENSION
400 HA
CLOSING EAST
RESERVOIR
SPACE FOR
FUTURE
AIRPORT
SEWAGE AND
WATER TREATMENT
RIVER EMBANKMENTS
TO BE REINFORCED
STRENGTHENED SEA WALL
UPGRADED PUMP STATION
NEW PUMPING STATION
NEW LOCK
BRIDGE AND CLEARANCE
MASS RAPID TRANSPORT
CITY ROAD
NATIONAL TOLL ROAD

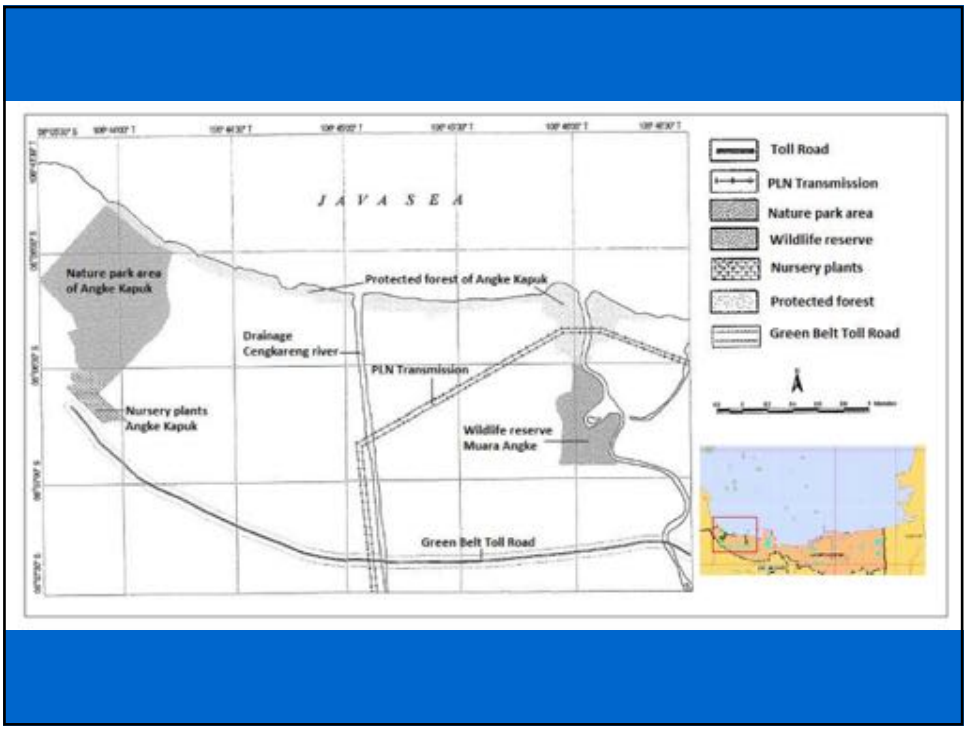

Water management measures
OUTER SEA WALL AND 1250 HA LAND RECLAMATIONS
RETENTION AND BULK WATER RESERVOIR
RETENTION AND BULK WATER RESERVOIR
CLOSING EAST RESERVOIR
UPGRADED PUMP STATION
NEW PUMPING STATION
NEW LOCK
PHASE A STRENGTHENED SEA WALL
PHASE A RIVER EMBANKMENTS TO BE REINFORCED
PHASE B OUTER DIKE
DIVERSION OF UPSTREAM WATER
SEWAGE AND WATER TREATMENT
PROVIDING PIPED WATER TO NORTH JAKARTA
DIVERSION OF UPSTREAM WATER
SEWAGE AND WASTE WATER TREATMENT
PROVIDING PIPED WATER SUPPLY


Zones within the Great Garuda
MARITIME COMMUNITIES
WING PARK NEIGHBOURHOOD
WATERFRONT NEIGHBOURHOOD
HEAD OF THE GARUDA
WING PARK NEIGHBOURHOOD
WATERFRONT NEIGHBOURHOOD
MARITIME COMMUNITIES
CORE AREA
THE TAIL
CREATIVE LIVING PARK
CREATIVE HQ AND RESEARCH




Evaporation
Precipitation
Treated water
Raw water supply
Pumping
1
2
3
Sea
River discharge
Lake
River bed
Seepage
1 = River dike
2 = Lake dike
3 = Land level


Draft 1 April 2014 | Master Plan | National Capital Integrated Coastal Development Project 71

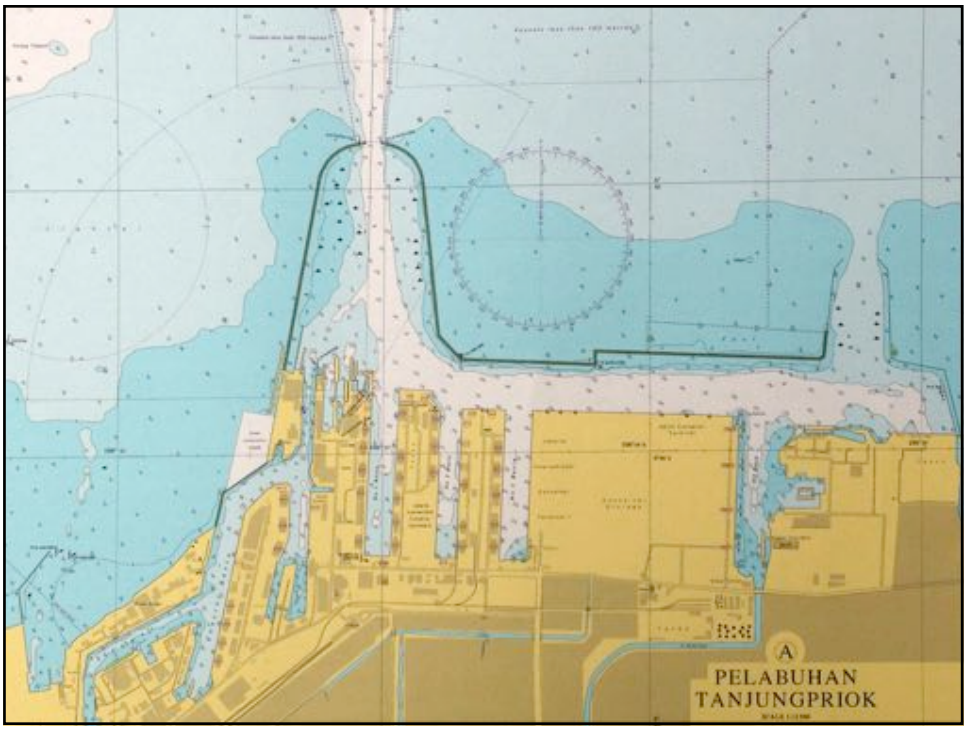

J A V A S E A
Nature park area of Angke Kapuk
Protected forest of Angke Kapuk
Drainage Cengkareng river
PLN Transmission
Nursery plants Angke Kapuk
Wildlife reserve Muara Angke
Green Belt Toll Road
Toll Road
PLN Transmission
Nature park area
Wildlife reserve
Nursery plants
Protected forest
Green Belt Toll Road

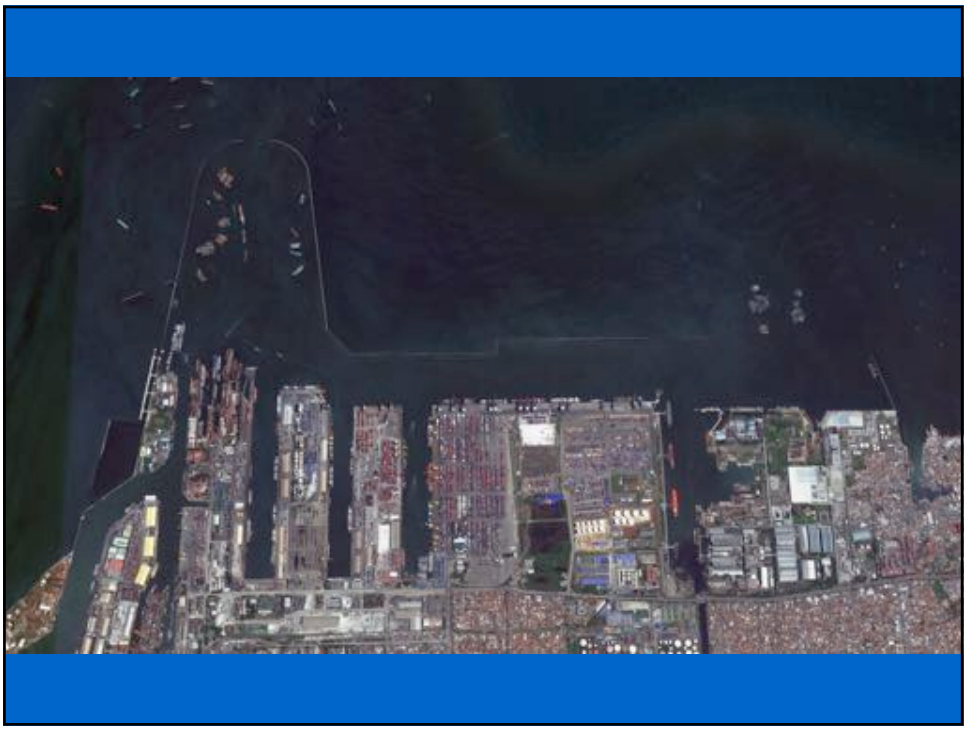
GEODESY

In planning & design Geodesy plays an essential role.

Historical and actual data with regard to land & sea surfaces and sub surfaces are needed for planning & map making.

Measurements are required through land- and sea survey, including Remote Sensing.


A
PELABUHAN
TANJUNGPRIOK



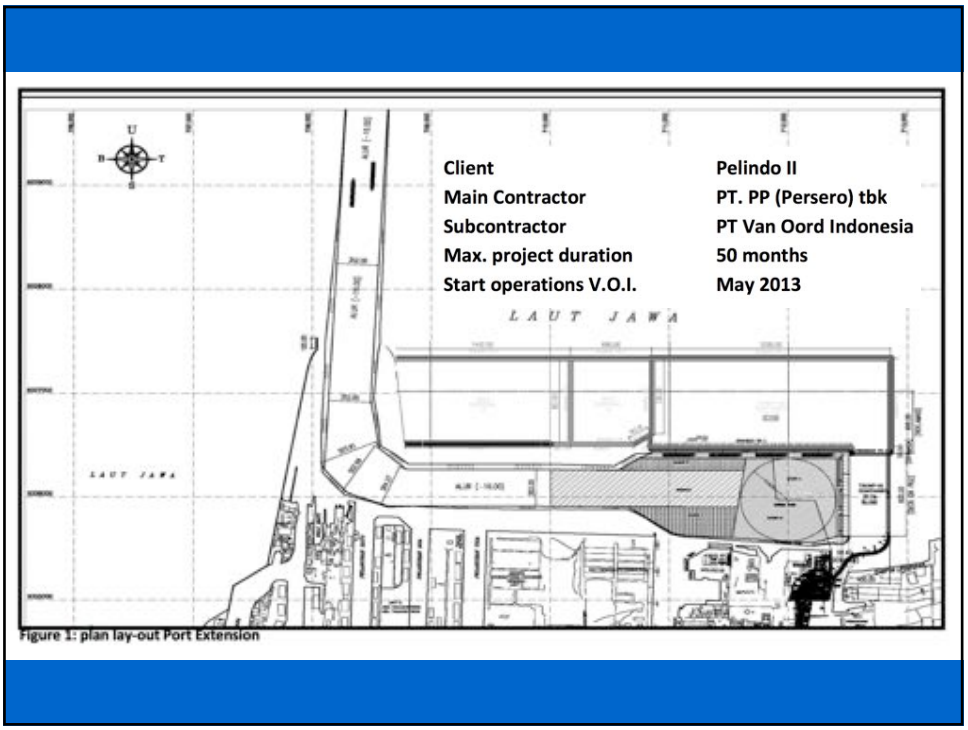
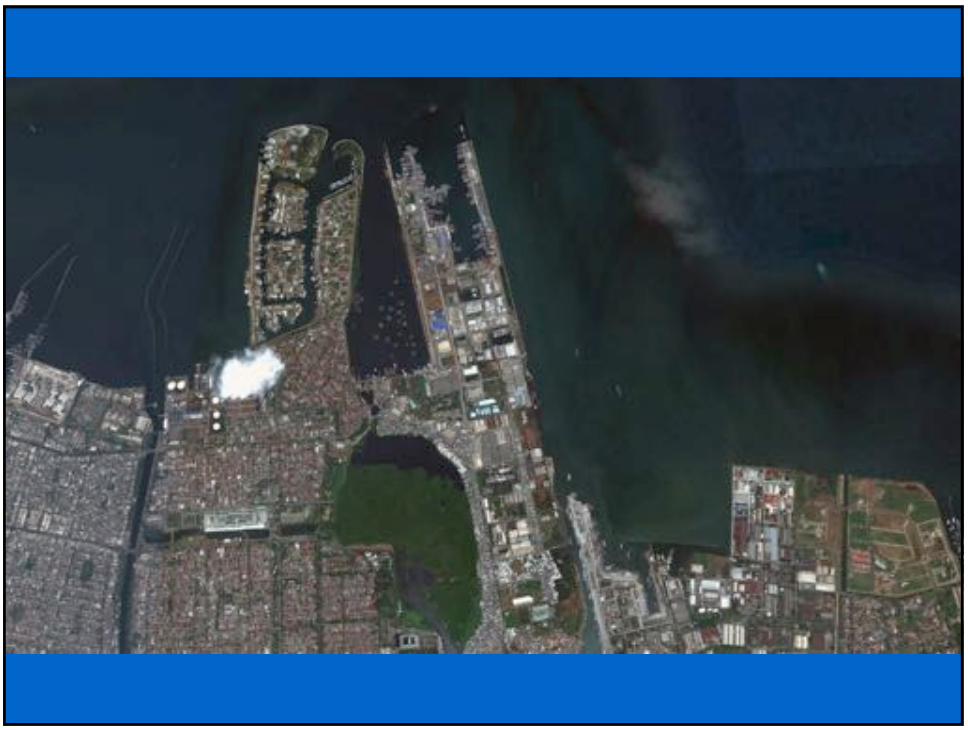
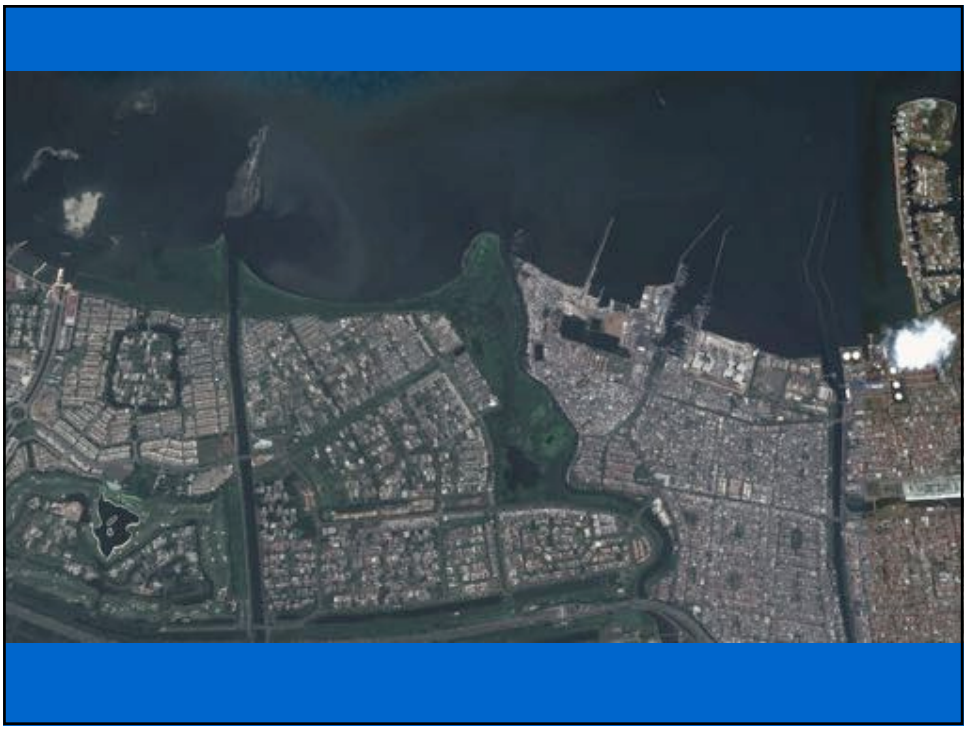


Figure 1: plan lay-out Port Extension





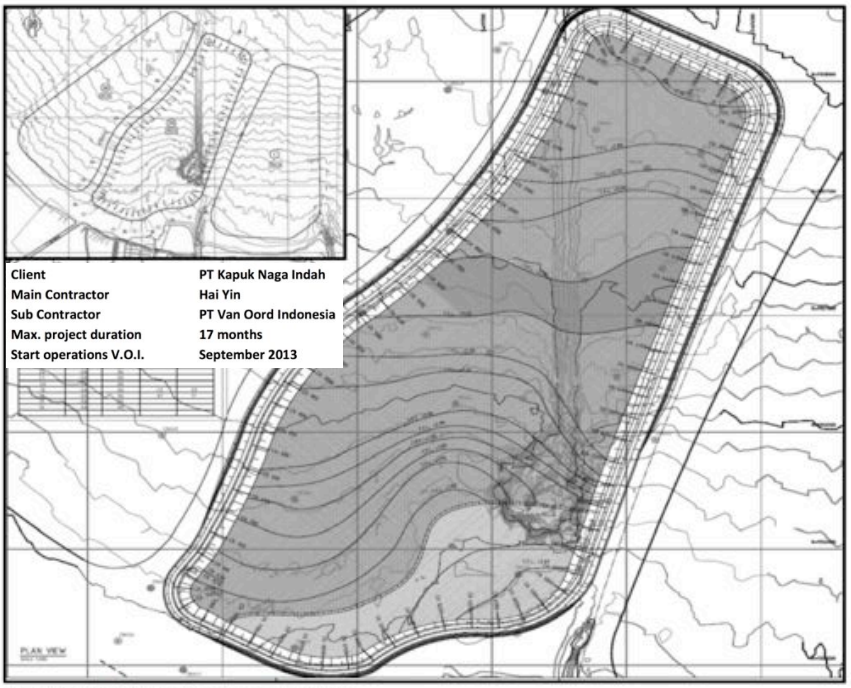
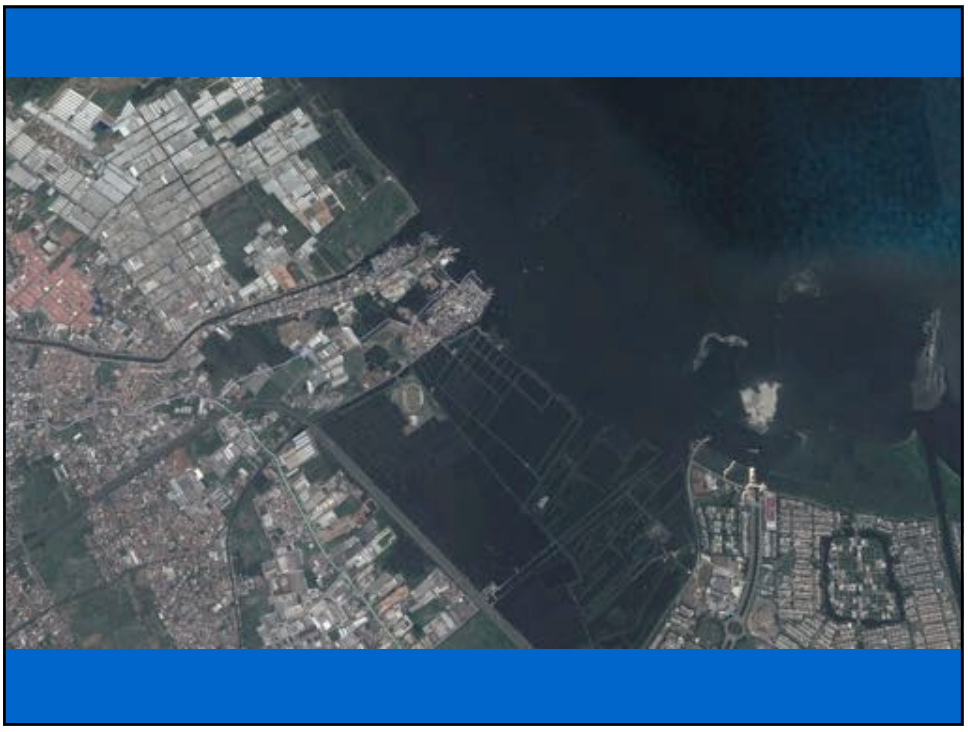


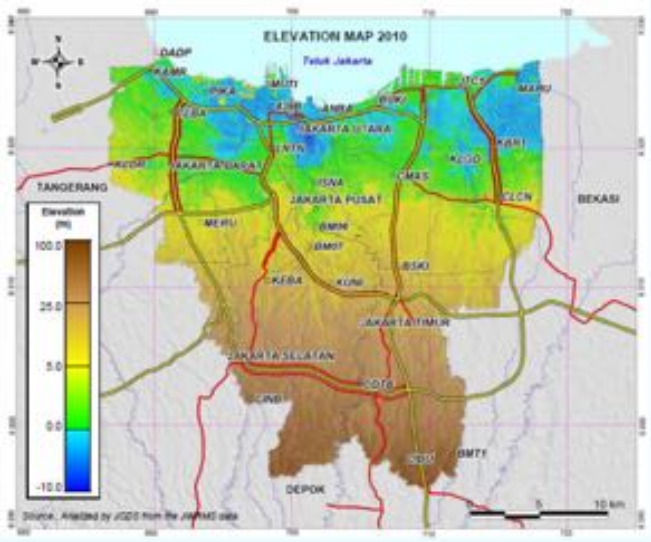
Figure 1: KNI Island 2 A drawing and bathymetry



Weak Local Coastal Defense to be improved

Sea level rise, higher frequency & intensity of stormsurges & rainfall

Land Subsidence up to 10-20 cm / year



Necessity of adequate sewer & drainage systems

Insufficient pumping capacity

Too much drinking water extraction from groundwater

Contaminated surface water

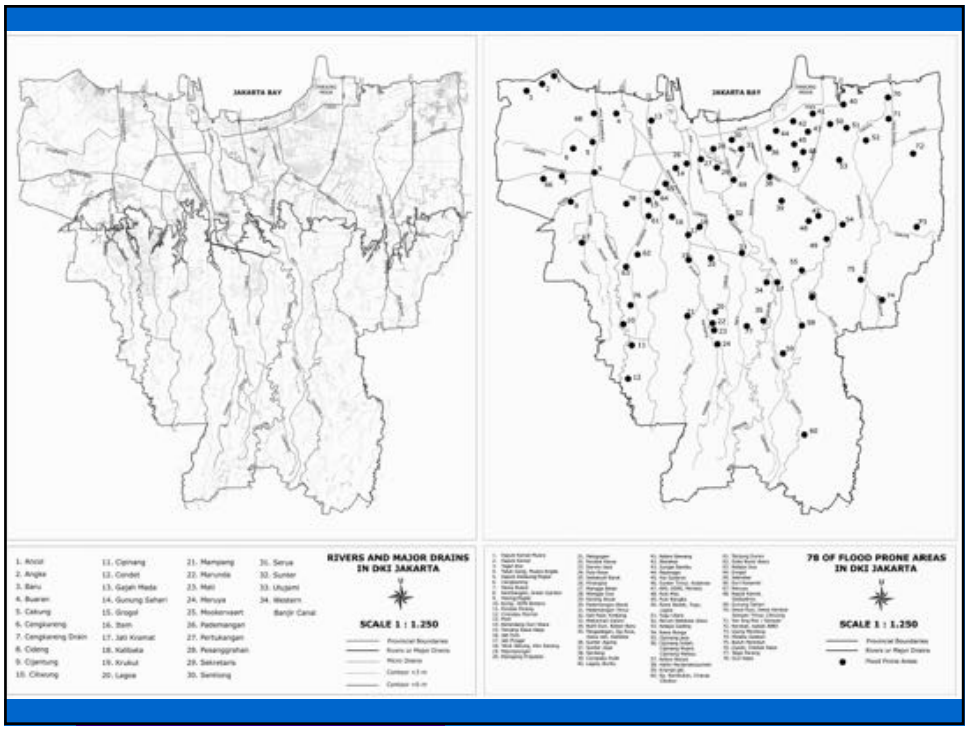
Illegal encroachment into rivers & drains

Necessity collection & treatment of wastes

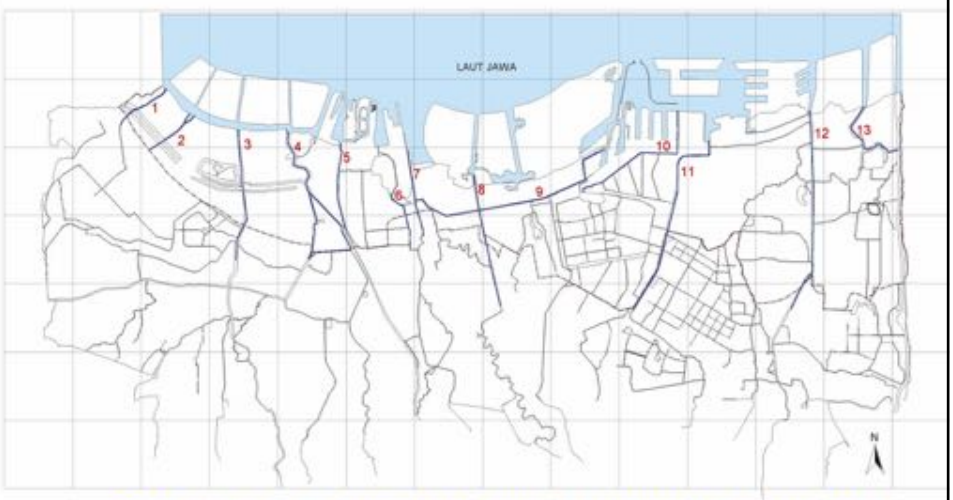
Outdated infrastructures along rivers & canals
(pipelines, cables, bridges, roads)

Flood retaining walls, ring dykes, shore protection

Siltation of rivers & canals



LOCATION OF 11 RIVERS & 2 DRAINAGE CANALS IN PANTURA ZONE OF JAKARTA



PETA LOKASI 13 SUNGAI DI KAWASAN PANTURA JAKARTA

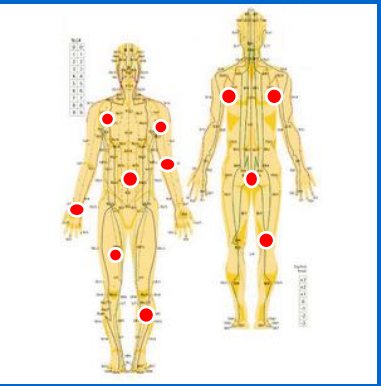
KETERANGAN :

1. KALI KAMAL
2. KALI TUNJUNGAN
3. CENGKARENG DRAIN
4. KALI MUARA ANGKE
5. KALI DURI LEDENG
6. KALI OPAK
7. KALI ANAK CILIWUNG I
8. KALI CILIWUNG/MARINA
9. KALI ANCOL
10. KALI LAGOA
11. KALI SUNTER
12. CAKUNG DRAIN
13. KALI BLENCONG

BADAN PELAKSANA REKLAMASI PANTAI UTARA JAKARTA

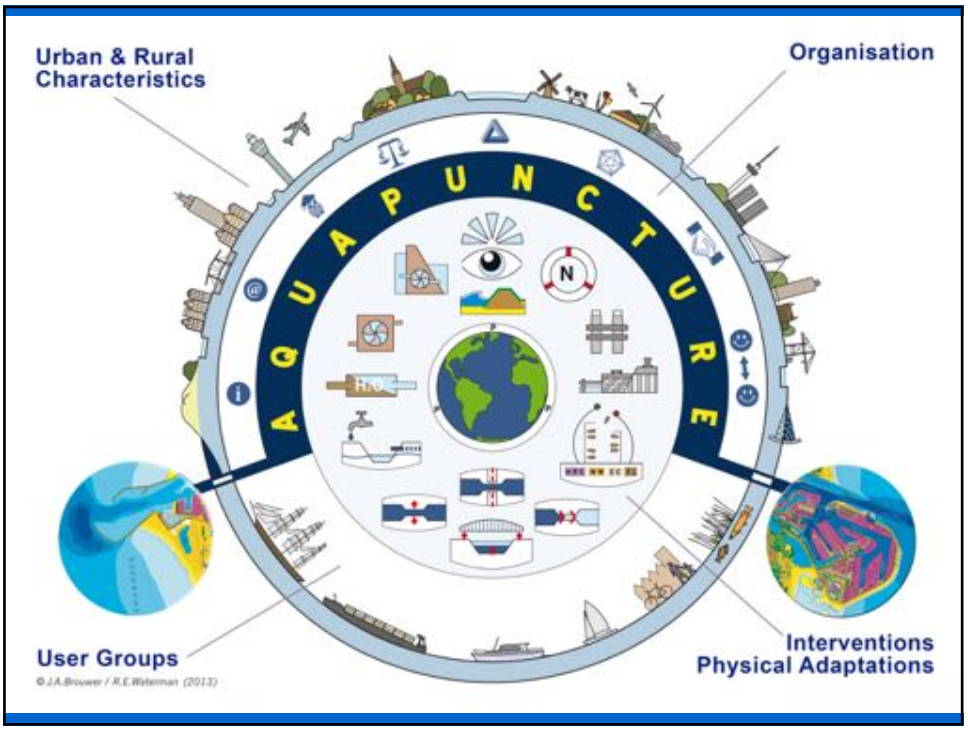
ACUPUNCTURE

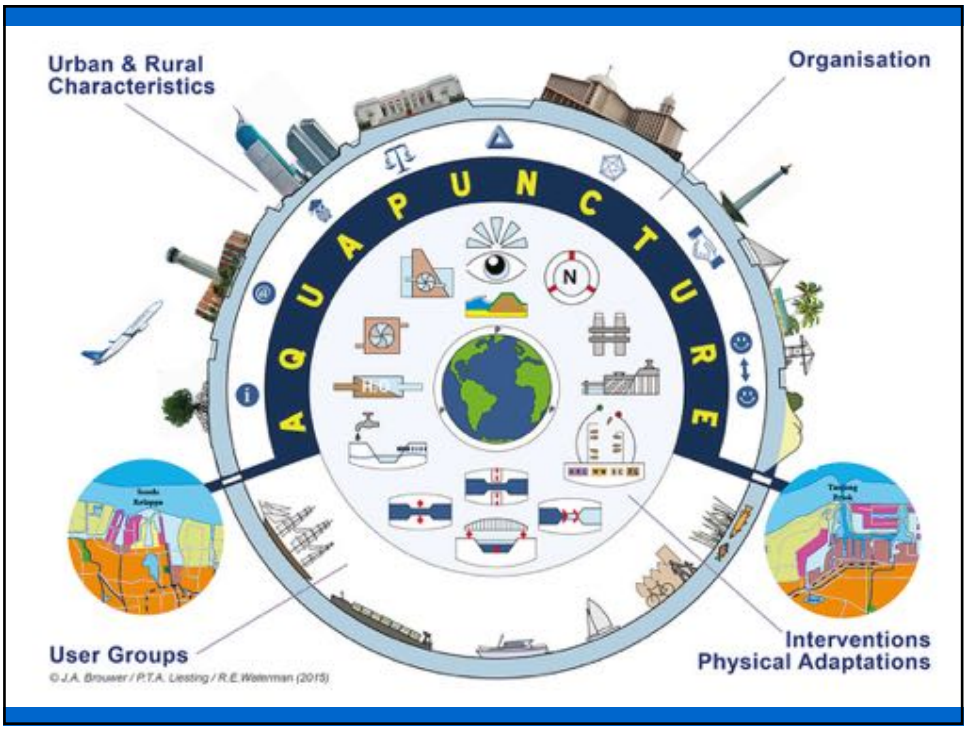
to revitalize
the Nervous System
& Human Organs

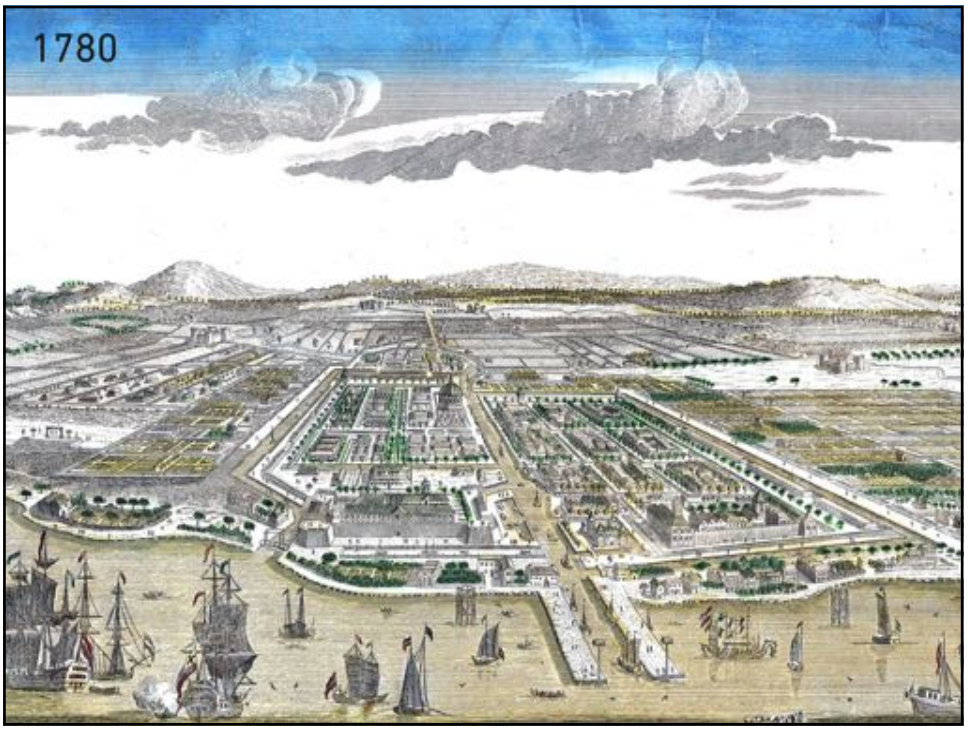


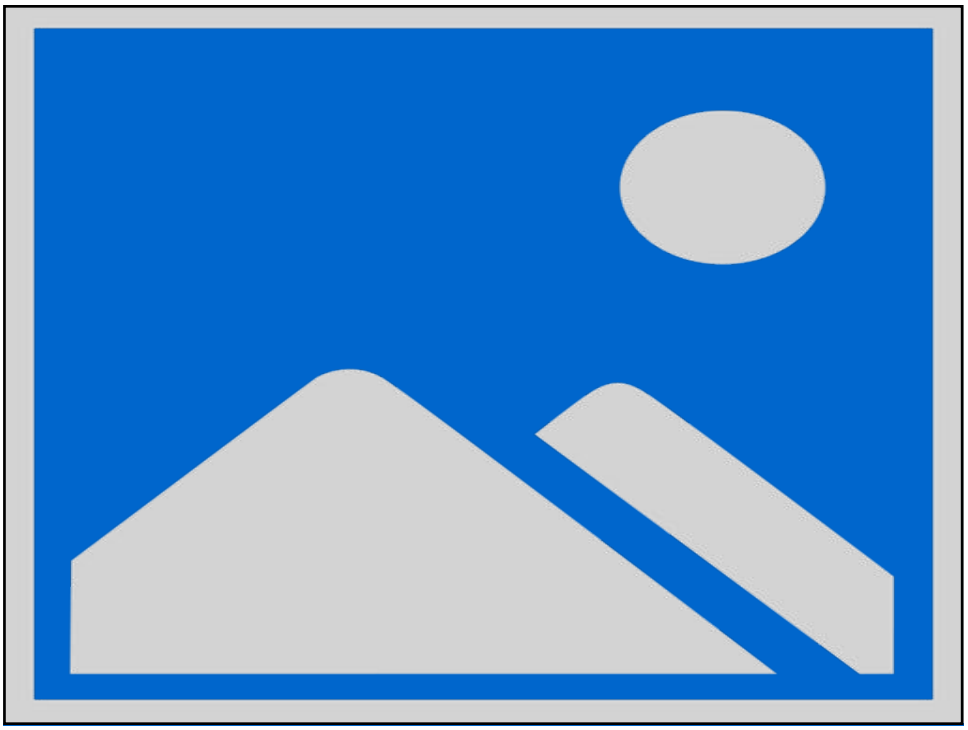
AQUAPUNCTURE

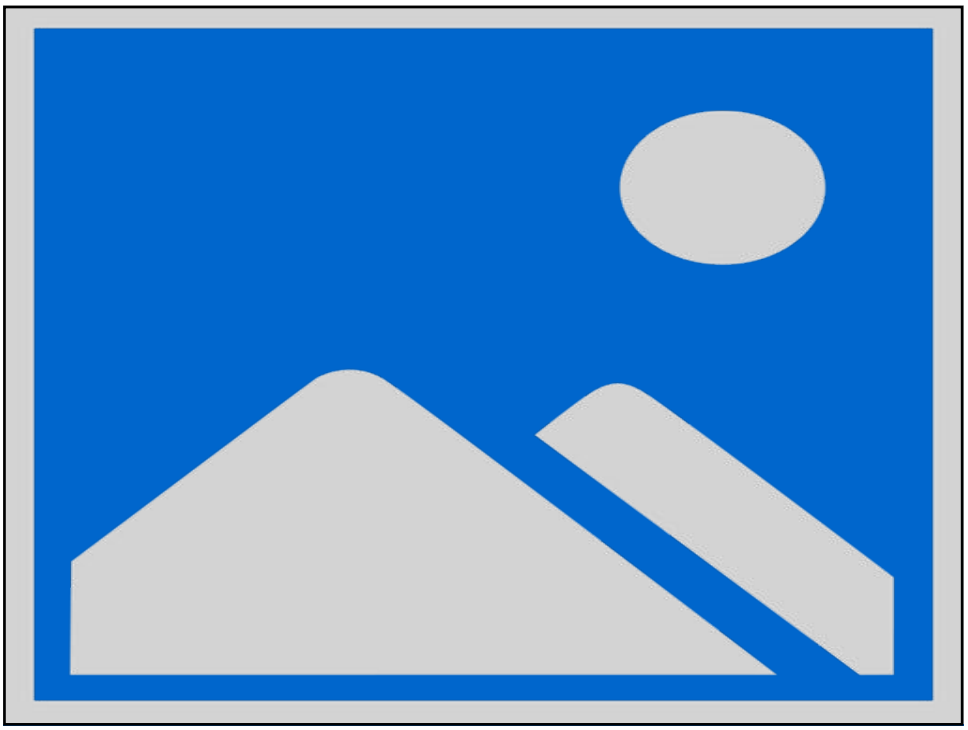
to revitalize
the Waterways & their
Water Fronts

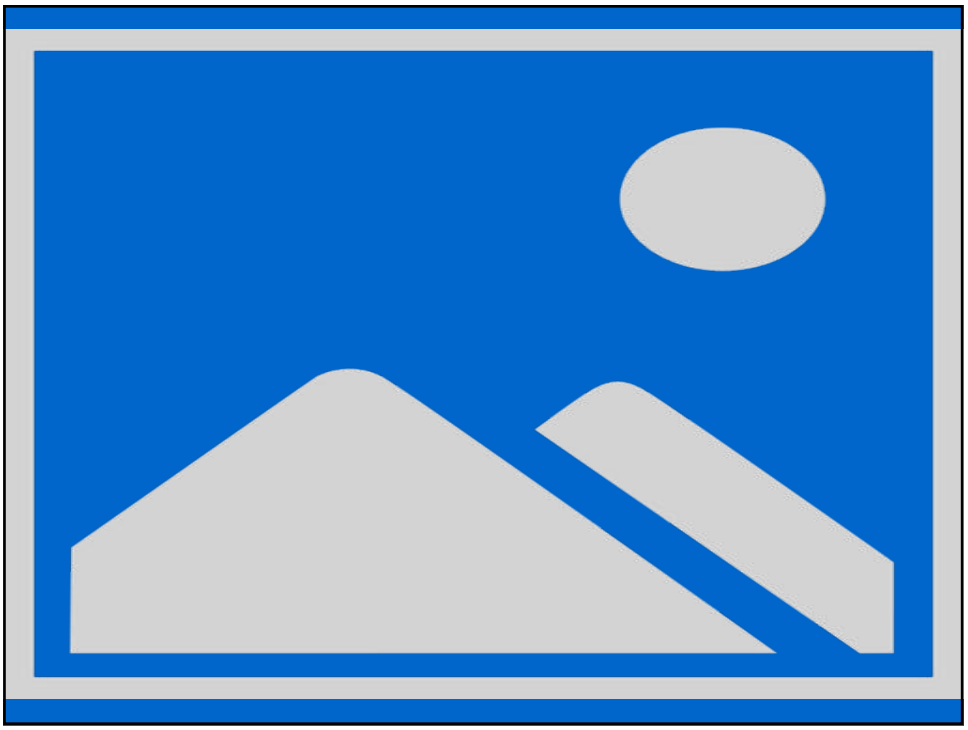



Urban & Rural Characteristics
Organisation
AQUAPUNCTURE
User Groups
Interventions Physical Adaptations
© J.A. Brouwer / P.T.A. Liesting / R.E.Waterman (2015)


1780







SUSTAINABLE COASTAL ZONE DEVELOPMENT

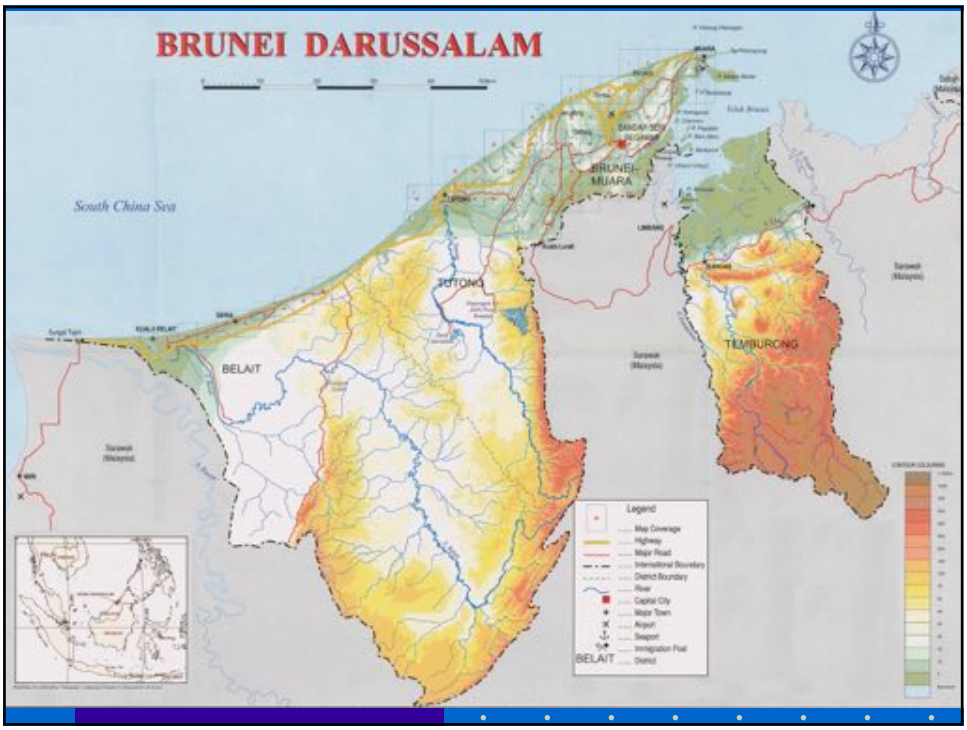
Integrated Coastal & Deltaic Policy via Building with Nature®

Prof. Dr. R.E. Waterman MSc

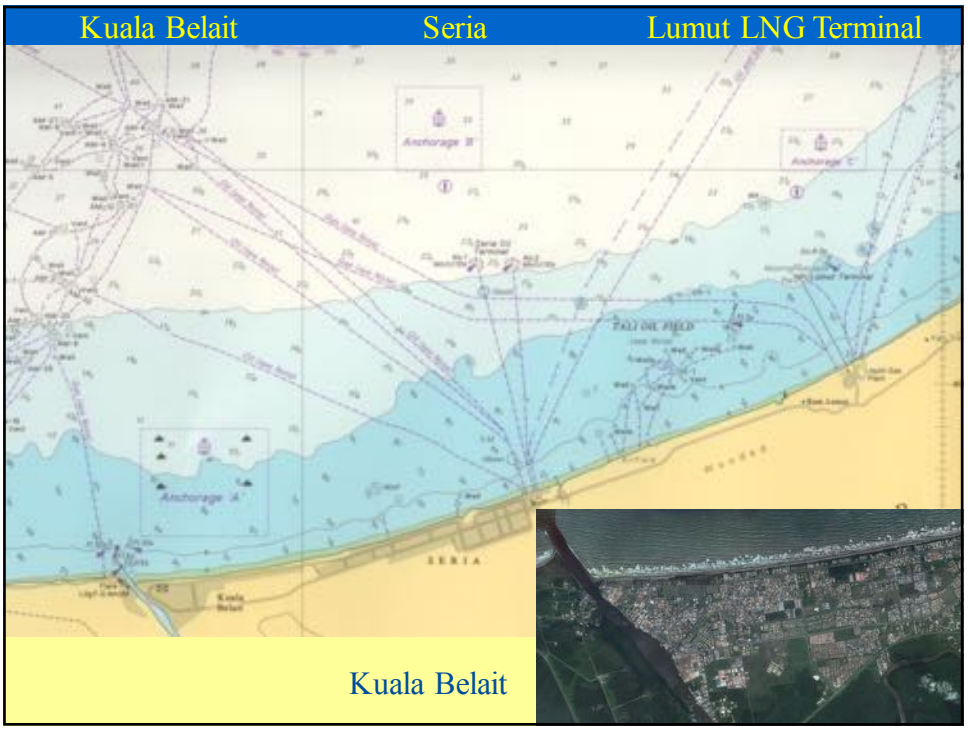
Negara Brunei Darussalam

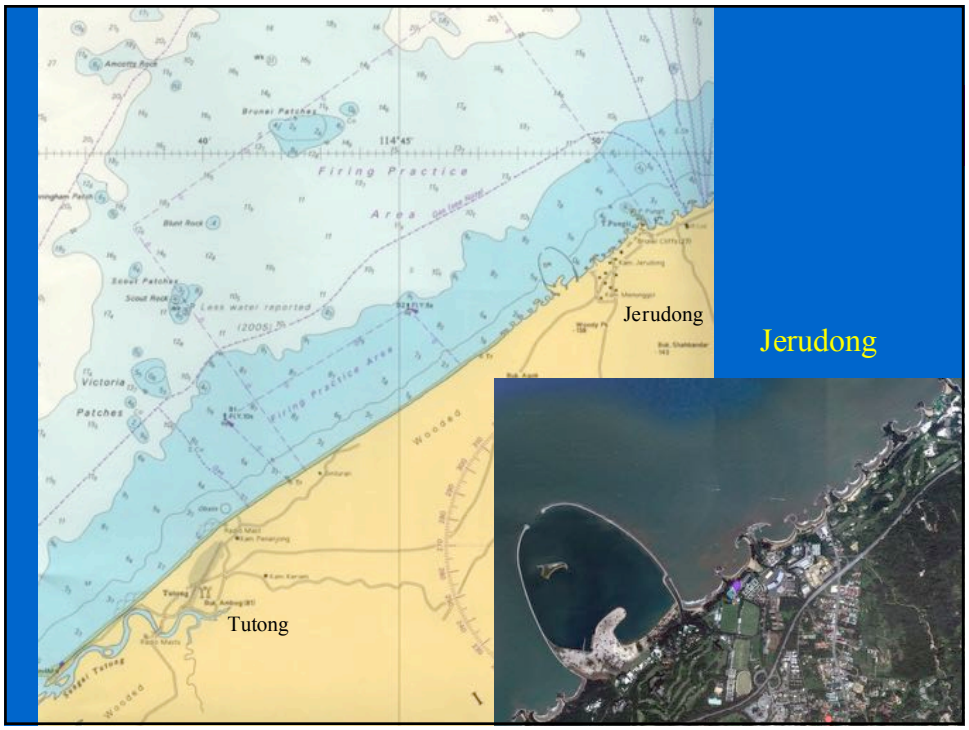
Bandar Seri Begawan
2013

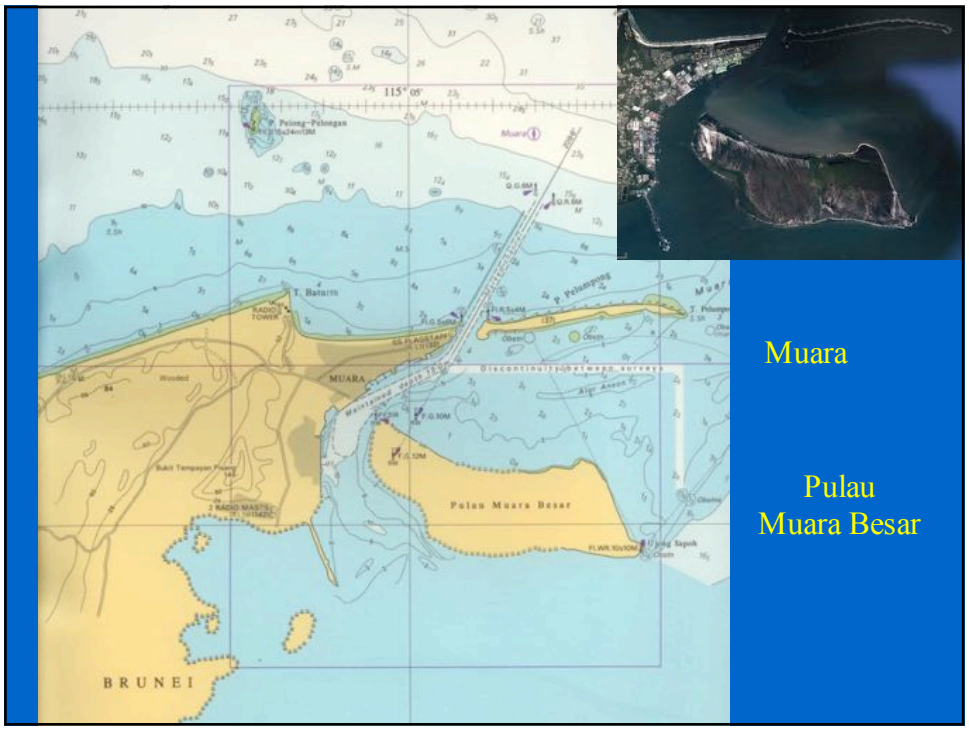
BRUNEI		THE NETHERLANDS
	SURFACE AREA	
	5,765 km²	33,883 km²
	INHABITANTS	
	0.422 million	16.7 million
	COASTAL LENGTH	
	161 km	353 km
	MAIN RIVERS	
	Sungai Belait	Rhine
	Sungai Brunei	Maas
	Sungai Liang	Scheldt
	Sungai Tutong	Eems
	Sungai Temburong	




Bandar Seri Begawan
Muara Port
BRUNEI
Kuala Belait
Seria
MALAYSIA
Sarawak
MALAYSIA
Sarawak


Kuala Belait
Seria
Lumut LNG Terminal
Kuala Belait


Firing Practice
Area
Victoria
Patches
Tutong
Jerudong
Jerudong


MUARA
Pulau Muara Besar
BRUNEI
Muara
Pulau
Muara Besar


Pulau
Pelumpong
Muara
Pulau
Muara Besar


Western Channel
-13 m
Pulau
Muara Besar
260 ha
Refinery & Aromatics Complex
Gas-based power plant
Desalination plant
Marine supply base
Logistics
Eastern Channel
0
500
1000
1500m

SUSTAINABLE COASTAL ZONE DEVELOPMENT

In all cases of coastal zone & port development it is profitable to make use of the principle of

Building with Nature®

taking into account existing and new nature reserve areas.

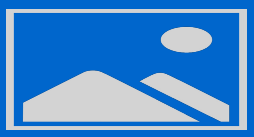
Special attention thereby for the introduction of :

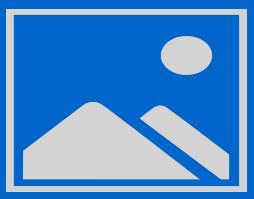
- Renewable Energy
- Production of Aquatic & Terrestrial (halal) Food
- Pharmaceuticals
- Necessary Logistics

SUSTAINABLE COASTAL ZONE DEVELOPMENT

Integrated Coastal & Deltaic Policy via Building with Nature®

Dr. R.E. Waterman MSc





Philippines

2014

PHILIPPINES		THE NETHERLANDS
	SURFACE AREA	
300,000 km²		33,883 km²
	**INHABITANTS**	
100 million		16.7 million
	COASTAL LENGTH	
36,289 km		353 km
	MAIN RIVERS	
Cagayan River		Rhine Maas Scheldt Eems
	ISLANDS	
7,107 islands		10 small islands

PHILIPPINES

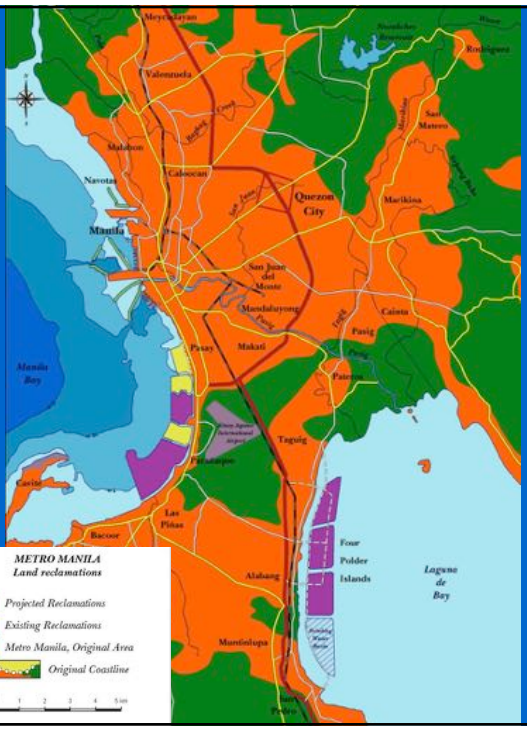
Philippines Manila *Laguna de Bay*

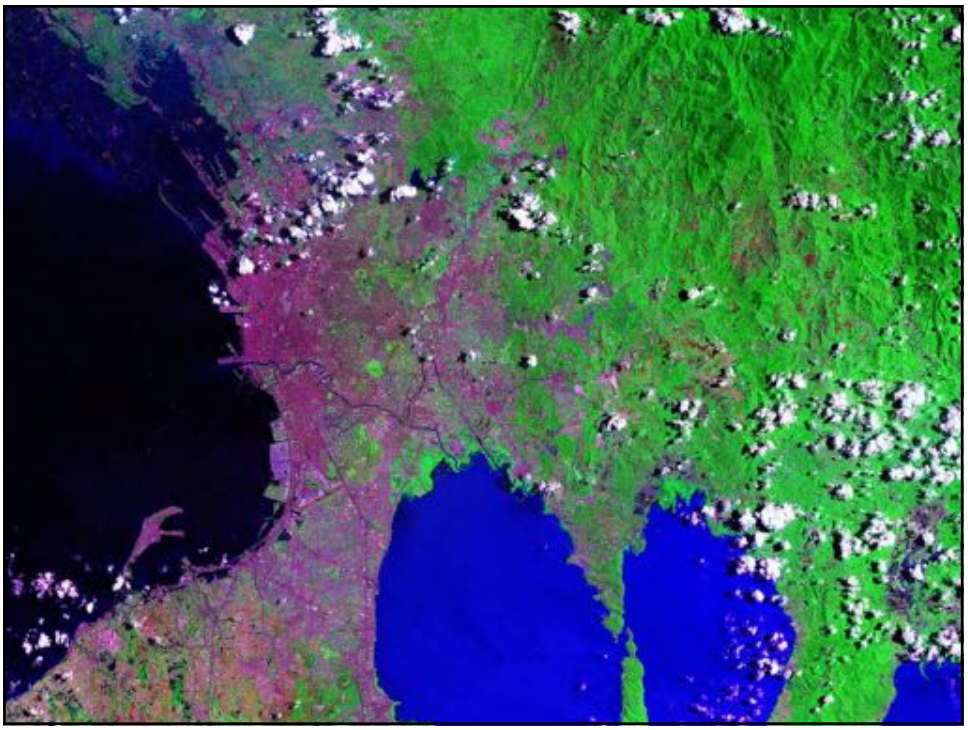
Metro Manilla

Inhabitants: 12 million

Land reclamations along Manilla Bay & Laguna de Bay

Pasig River between Manilla Bay & Laguna de Bay





Metro Manilla

Land reclamations
along Manilla Bay
& Manilla Port

Metro Manila

Laguna de Bay

SUSTAINABLE COASTAL ZONE DEVELOPMENT

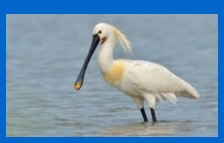
Integrated Coastal & Delta Policy via Building with Nature®

Prof. Dr. R.E. Waterman MSc

Vietnam - Ho Chi Minh City

Mekong Delta & Ho Chi Minh City







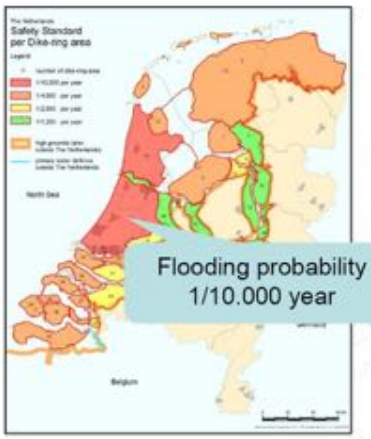
VIETNAM
THE NETHERLANDS
SURFACE AREA
330,957 km²
33,883 km²
INHABITANTS
90 million
16.7 million
COASTAL LENGTH
3444 km
353 km
MAIN DELTAS
Mekong Delta 40,000 km²
Red River Delta 14,700 km²
Rhine - Maas - Scheldt Delta
33,000 km²
VIETNAM
CAMBODIA
LAND
LAOS
Hanoi
Phnom Penh

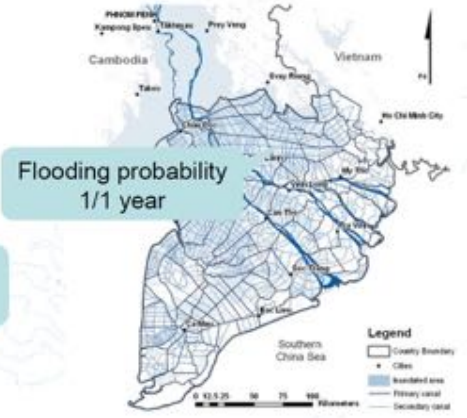

MEKONG DELTA
THE NETHERLANDS
SURFACE AREA
40,000 km²
33,883 km²
INHABITANTS
18 million
16.7 million
CAMBODJA
HO CHI MINH CITY
SOUTH CHINA SEA
INHABITANTS
HO CHI MINH CITY
8 million

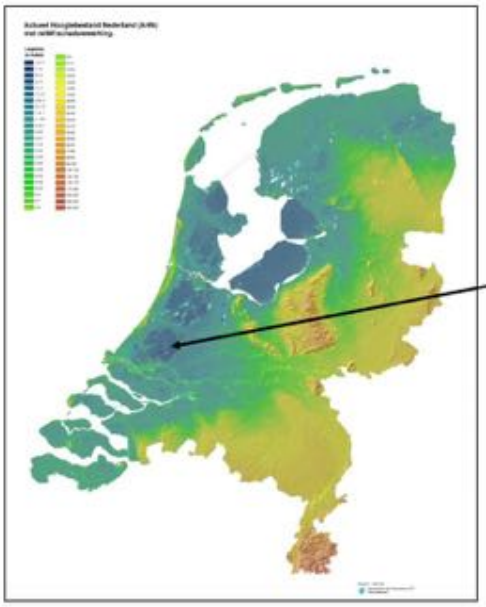
The Dutch Delta in NW Europe and the Mekong Delta in Vietnam

The Netherlands is shaped by the alluvial deposits of Rhine, Meuse, Scheldt and Eems rivers. Approximately the size of the Mekong Delta, which is shaped by the alluvial deposits of the Mekong (and Sai Gon and Dong Nai) river(s). Similar population size ~17 million.

Comparable geography, demography and vulnerability issues, but also marked differences







- 10 million people in floodprone areas
- Deepest location Zuidplaspolder around Nieuwerkerk aan den IJssel: MSL – 6,76 m.

Safety standard for 53 dike-ring areas

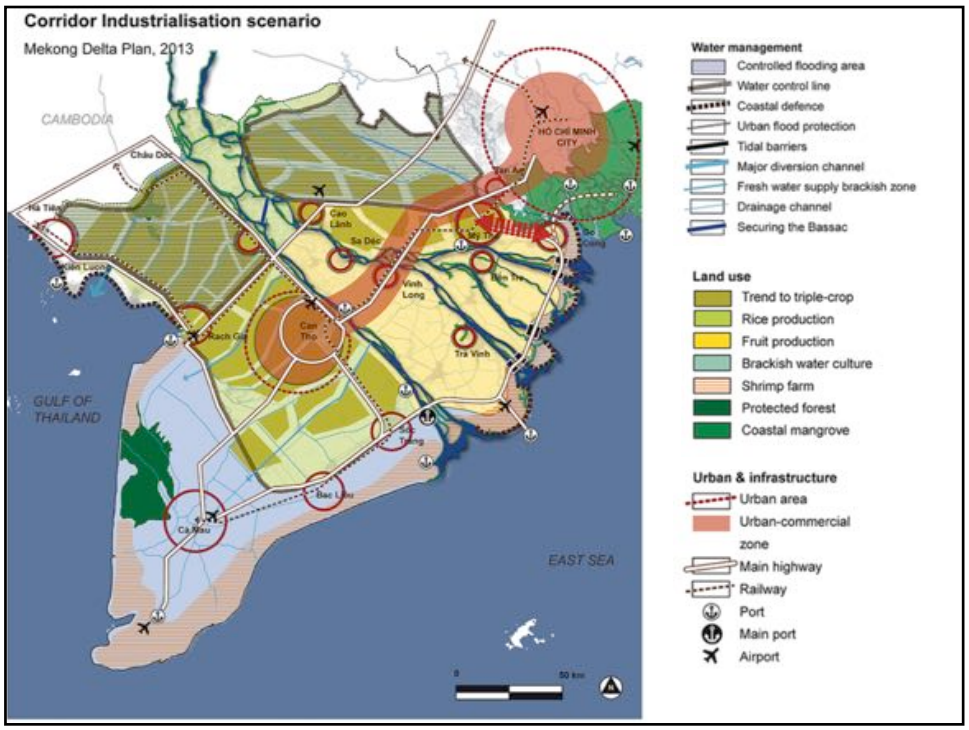
De facto a varying safety:

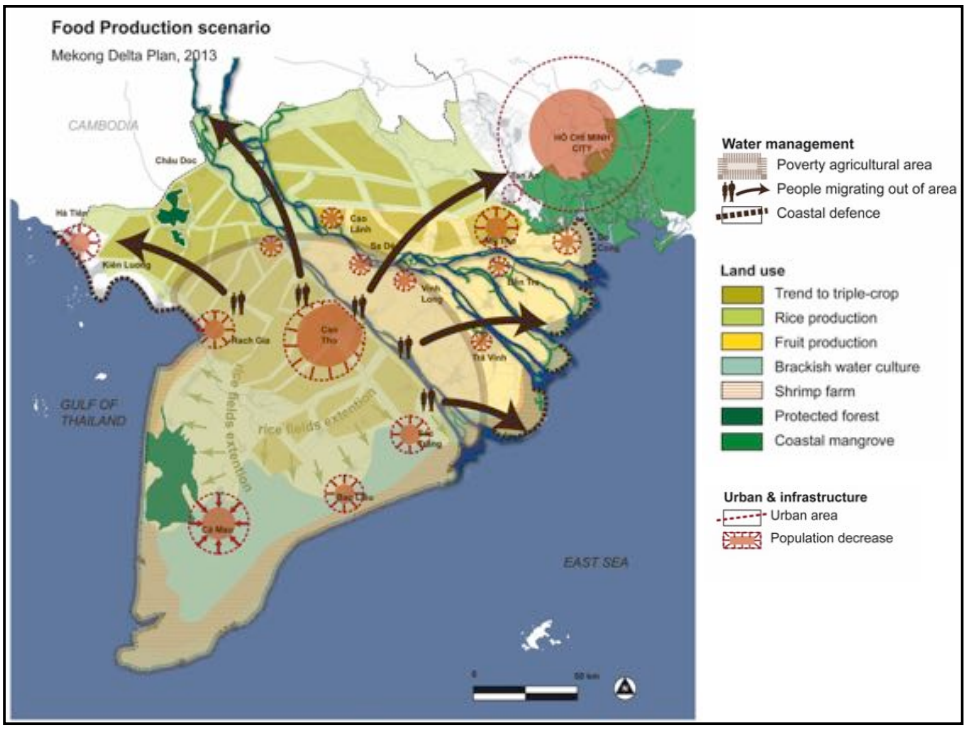
- NH and ZH 1/10.000 per year
- North and South 1/4.000 per year
- Yellow 1/2.000 per year
- Green: 1/1.250 per year

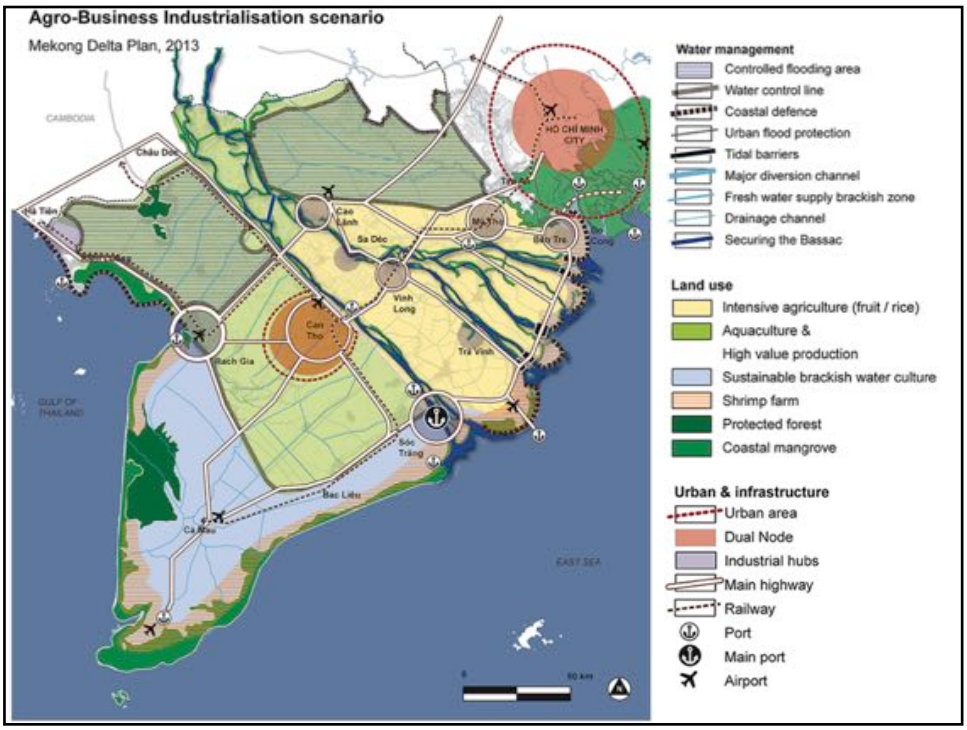
NB:

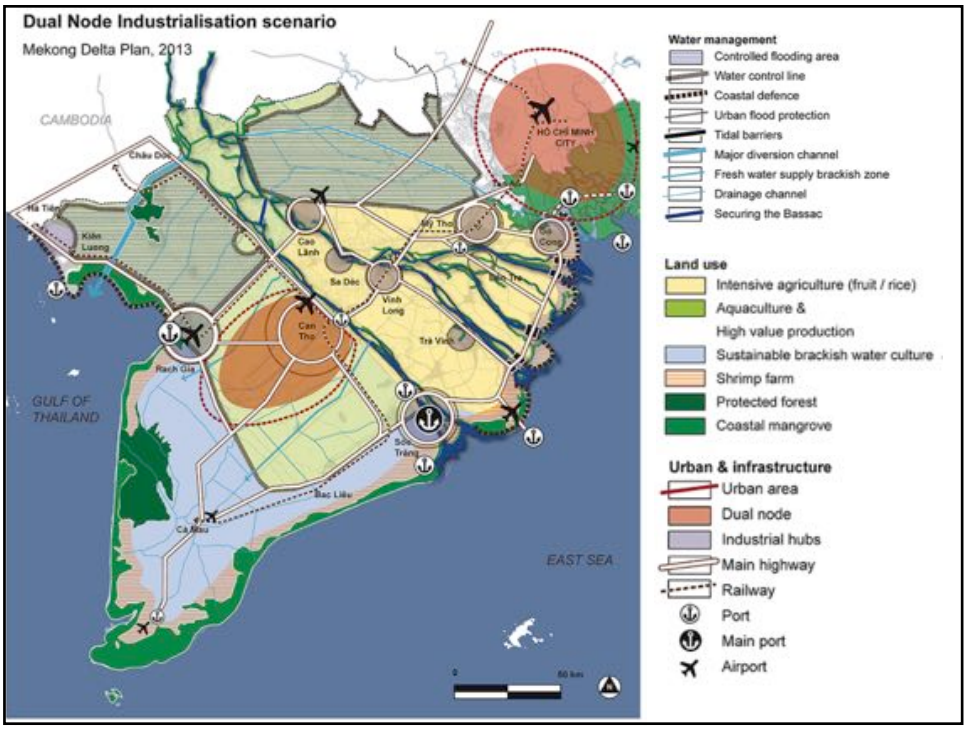
- Probability individual loss of life in a flooding is 1%, so that the probability due to flooding in the green areas is 1 in 125.000 per year!

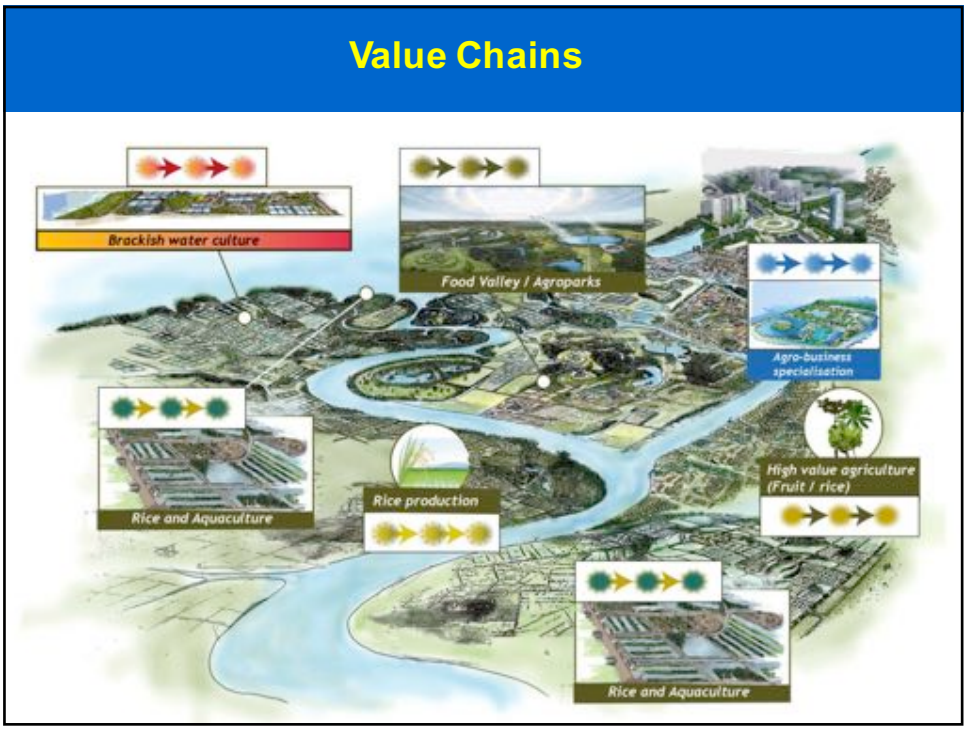

Cambodia
Vietnam
Gulf of Thailand
East Sea
Tan Chau
Chau Doc
Moc Hoa
High Terrace
Plain of Reeds
Vam Co Tay
Vam Co Dong
Ho Chi Minh City
Bien Hoa
Dong Nai
Tien River
Hau River
Cao Lanh
Tan An
My Tho
Vung Tau
Ha Tien
Long Xuyen
Long Xuyen Quadrangle
Central Delta
Ben Tre
Vinh Long
Tieu
Dai
Rach Gia
Can Tho
Ba Lai
Hom Luong
West Bassac
Cai Lon
Tra Vinh
Co Chien
Cung Hau
Vi Than
Eastern Coastal Zone
Soc Trang
Dinh An
Tranh De
Ca Mau Peninsula
Bac Lieu
Ca Mau
Cua Lon
0
50 km

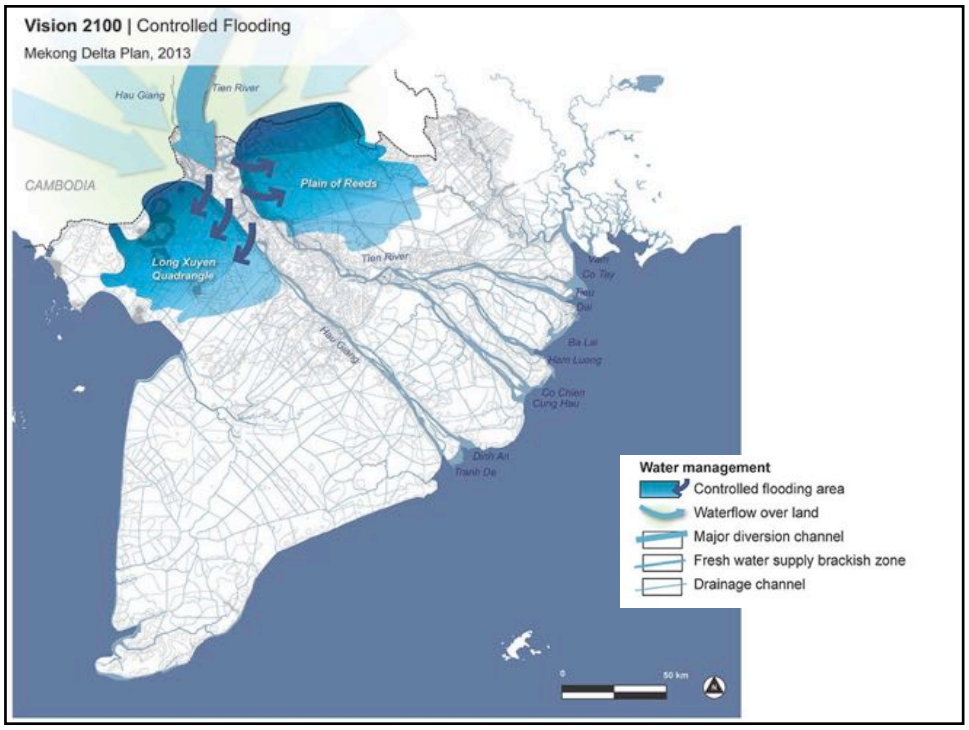

Corridor Industrialisation scenario
Mekong Delta Plan, 2013
CAMBODIA
GULF OF THAILAND
EAST SEA
HO CHI MINH CITY
Water management
Controlled flooding area
Water control line
Coastal defence
Urban flood protection
Tidal barriers
Major diversion channel
Fresh water supply brackish zone
Drainage channel
Securing the Bassac
Land use
Trend to triple-crop
Rice production
Fruit production
Brackish water culture
Shrimp farm
Protected forest
Coastal mangrove
Urban & infrastructure
Urban area
Urban-commercial zone
Main highway
Railway
Port
Main port
Airport


Food Production scenario
Mekong Delta Plan, 2013
CAMBODIA
Châu Đốc
HỒ CHÍ MINH CITY
Hà Tiên
Kiên Lương
Cao Lãnh
Sa Đéc
Vĩnh Long
Bến Tre
Rạch Giá
Cần Thơ
Trà Vinh
GULF OF THAILAND
rice fields extention
rice fields extention
Sóc Trăng
Bạc Liêu
Cà Mau
EAST SEA
Water management
Poverty agricultural area
People migrating out of area
Coastal defence
Land use
Trend to triple-crop
Rice production
Fruit production
Brackish water culture
Shrimp farm
Protected forest
Coastal mangrove
Urban & infrastructure
Urban area
Population decrease

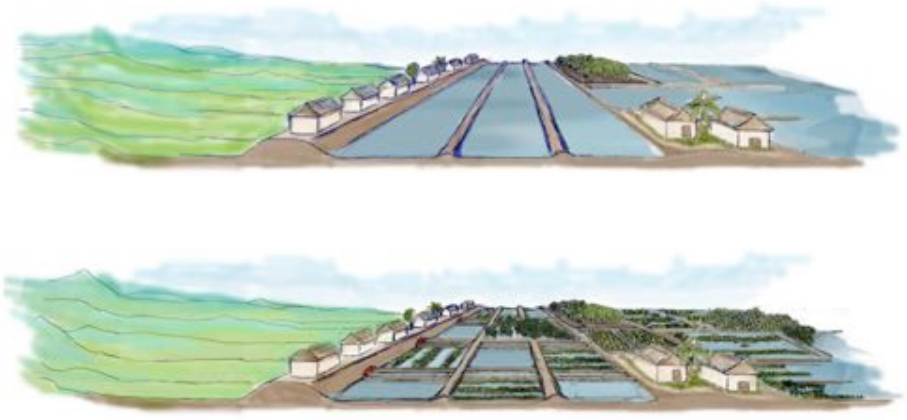

Agro-Business Industrialisation scenario
Mekong Delta Plan, 2013
CAMBODIA
Châu Đốc
HỒ CHÍ MINH CITY
Hà Tiên
Cao Lãnh
Sa Đéc
Mỹ Tho
Bến Tre
Vĩnh Long
Cần Thơ
Trà Vinh
Rạch Giá
GULF OF THAILAND
Sóc Trăng
Bạc Liêu
Cà Mau
EAST SEA
Water management
Controlled flooding area
Water control line
Coastal defence
Urban flood protection
Tidal barriers
Major diversion channel
Fresh water supply brackish zone
Drainage channel
Securing the Bassac
Land use
Intensive agriculture (fruit / rice)
Aquaculture &
High value production
Sustainable brackish water culture
Shrimp farm
Protected forest
Coastal mangrove
Urban & infrastructure
Urban area
Dual Node
Industrial hubs
Main highway
Railway
Port
Main port
Airport


Dual Node Industrialisation scenario
Mekong Delta Plan, 2013
CAMBODIA
GULF OF THAILAND
EAST SEA
HỒ CHÍ MINH CITY
Cao Lãnh
Sa Đéc
Vĩnh Long
Cần Thơ
Trà Vinh
Rạch Giá
Sóc Trăng
Bạc Liêu
Cà Mau
Water management
Controlled flooding area
Water control line
Coastal defence
Urban flood protection
Tidal barriers
Major diversion channel
Fresh water supply brackish zone
Drainage channel
Securing the Bassac
Land use
Intensive agriculture (fruit / rice)
Aquaculture &
High value production
Sustainable brackish water culture
Shrimp farm
Protected forest
Coastal mangrove
Urban & infrastructure
Urban area
Dual node
Industrial hubs
Main highway
Railway
Port
Main port
Airport

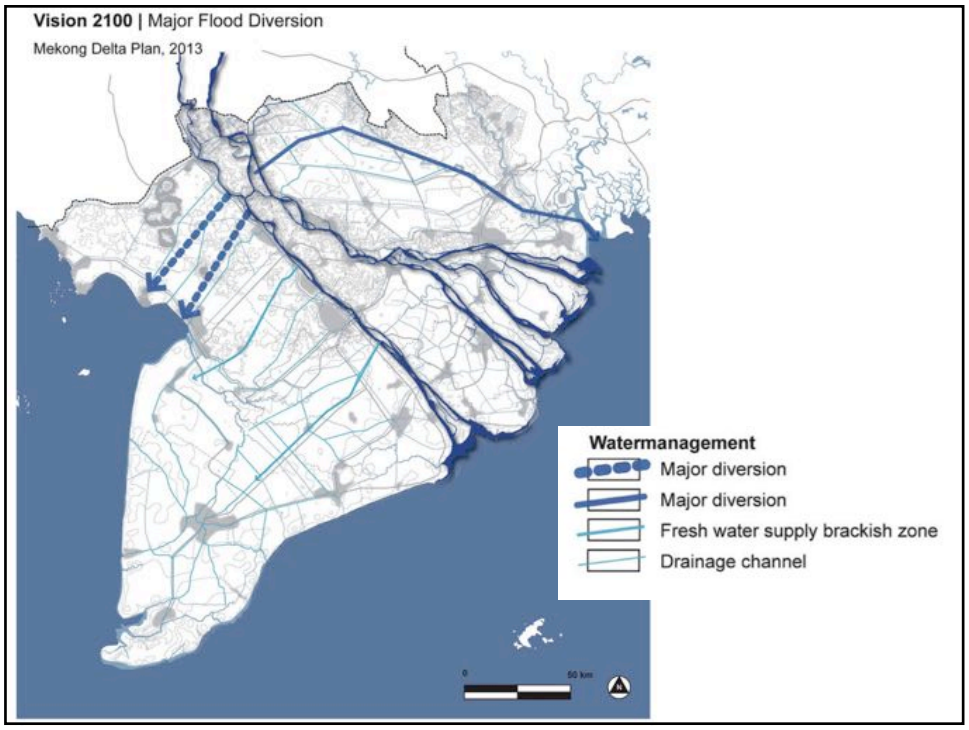

Value Chains
Brackish water culture
Food Valley / Agroparks
Agro-business specialisation
Rice and Aquaculture
Rice production
High value agriculture (Fruit / rice)
Rice and Aquaculture

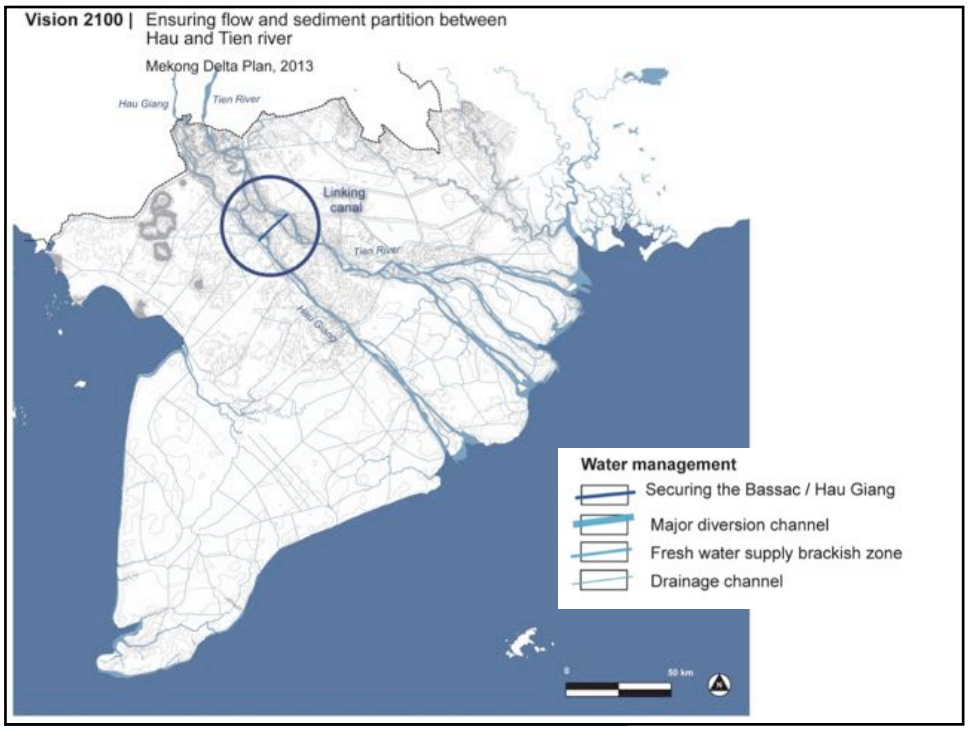


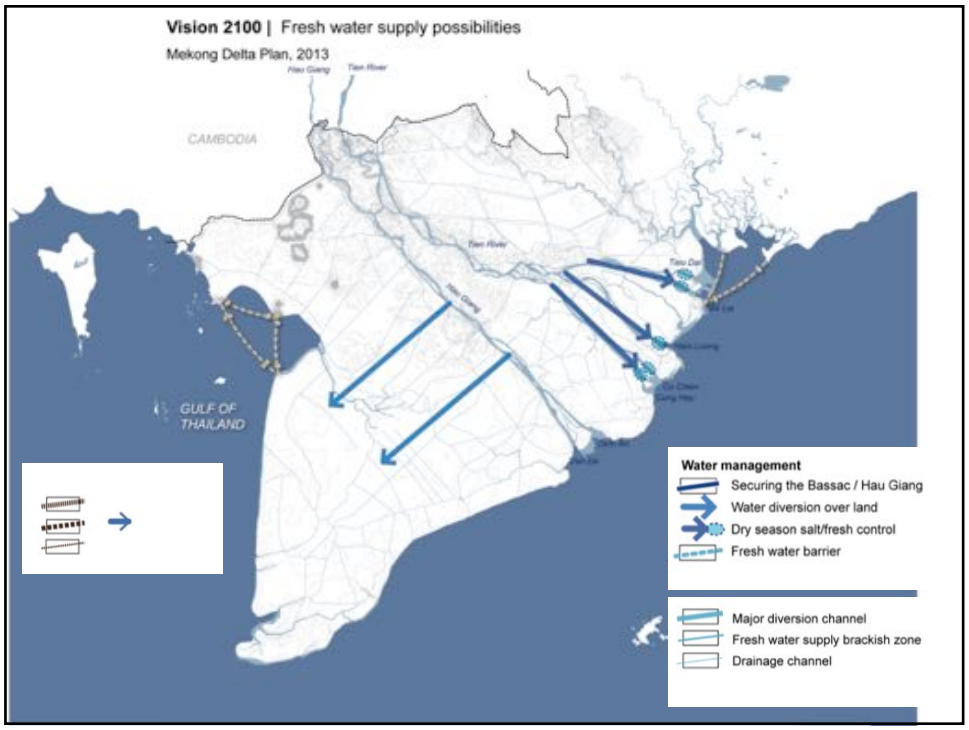
Inundated rice paddies in the wet season (Upper Delta) offer controlled retention of river floods after two crops

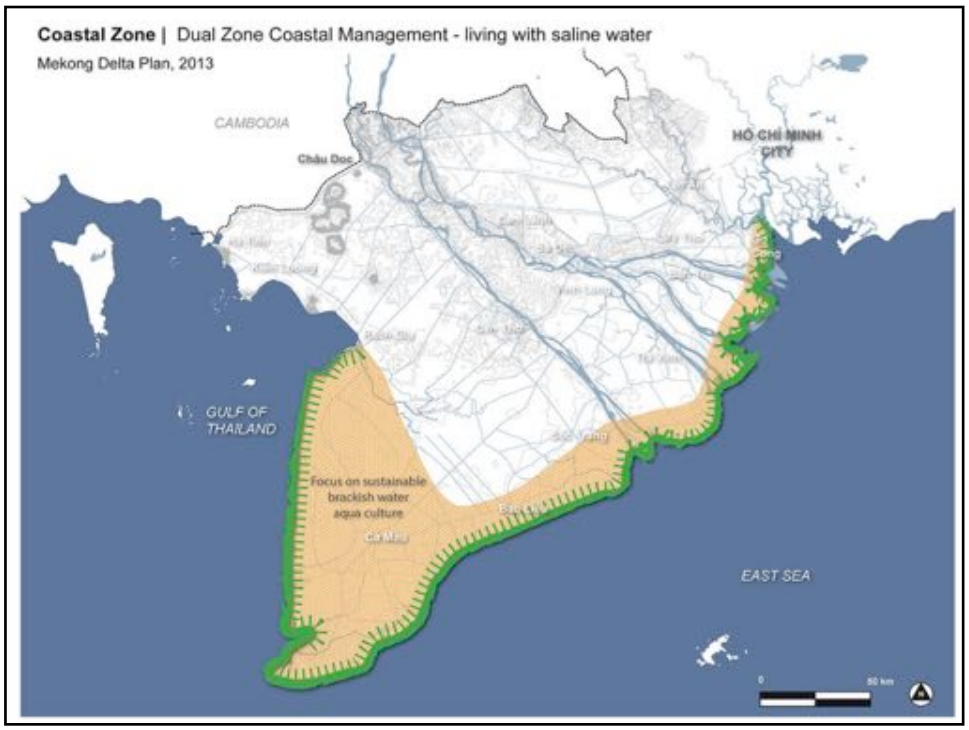


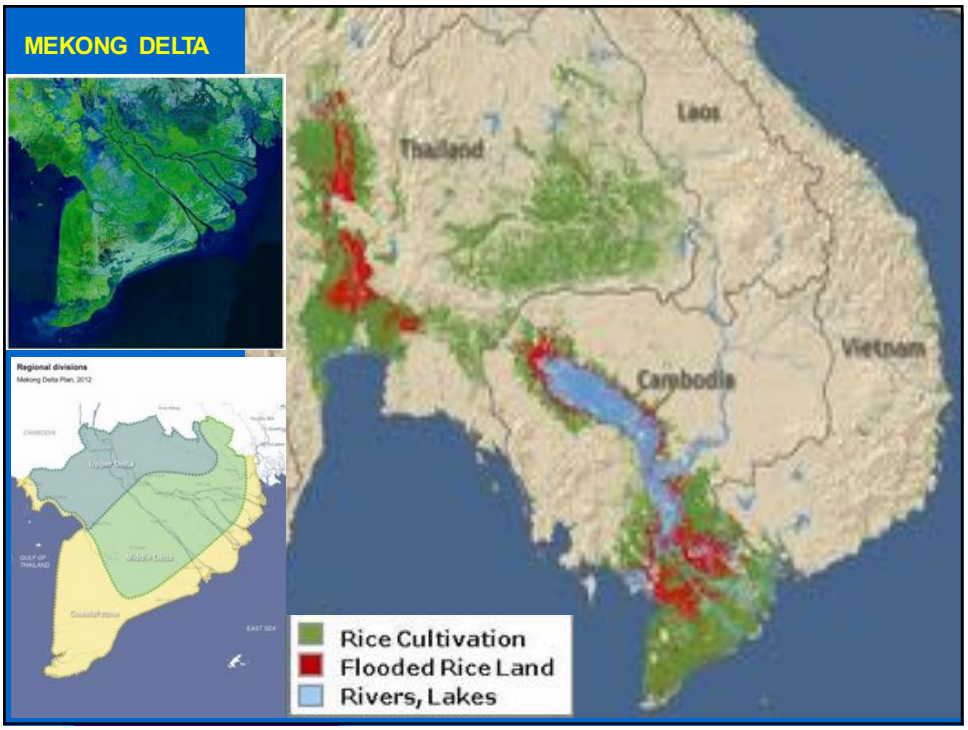
Controlled flooding in the Upper Delta, using the inundated paddies for fish farming in the wet season or 'floating vegetables', offering an attractive economic proposition

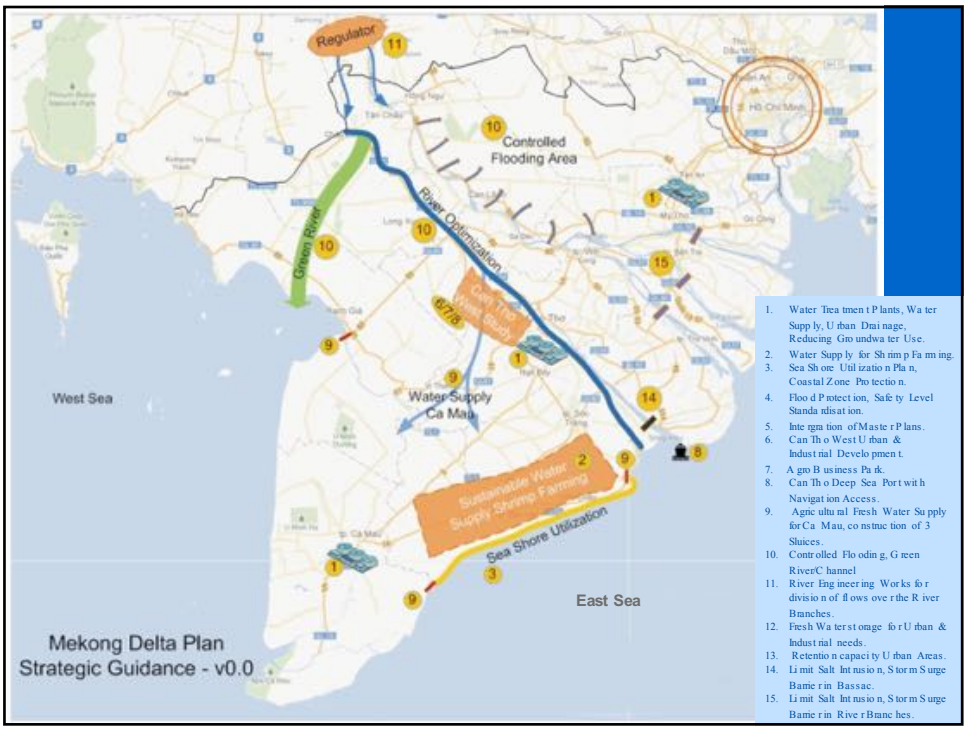

Vision 2100 | Major Flood Diversion
Mekong Delta Plan, 2013
Watermanagement
Major diversion
Major diversion
Fresh water supply brackish zone
Drainage channel
0
50 km


Vision 2100 | Ensuring flow and sediment partition between Hau and Tien river
Mekong Delta Plan, 2013
Hau Giang
Tien River
Linking canal
Tien River
Hau Giang
Water management
Securing the Bassac / Hau Giang
Major diversion channel
Fresh water supply brackish zone
Drainage channel
0
50 km

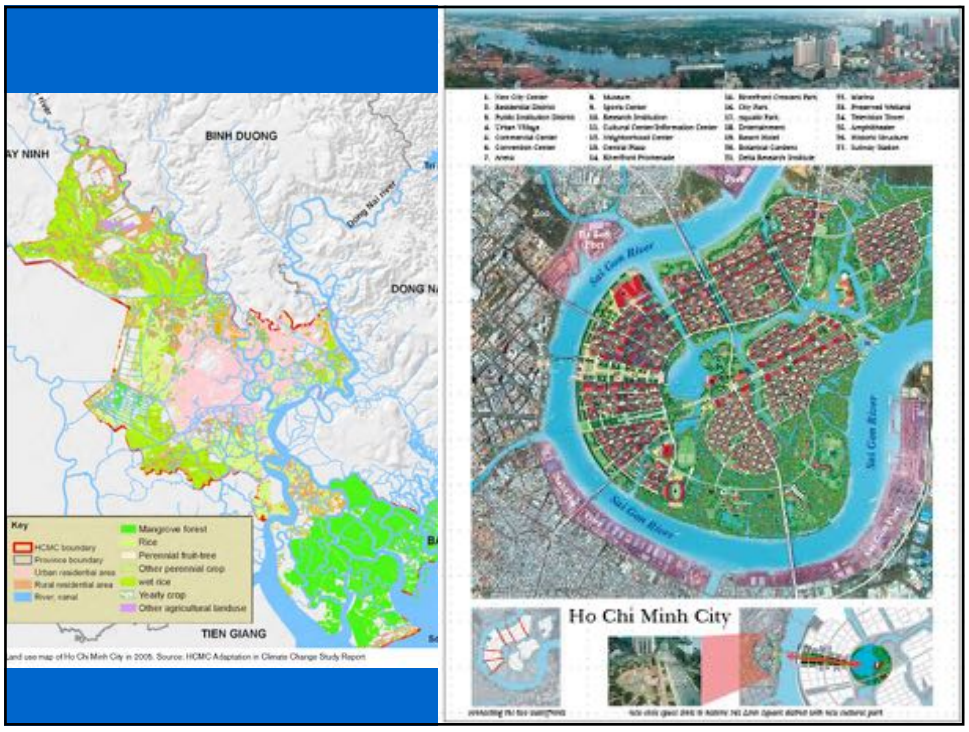

Vision 2100 | Fresh water supply possibilities
Mekong Delta Plan, 2013
CAMBODIA
GULF OF THAILAND
Water management
Securing the Bassac / Hau Giang
Water diversion over land
Dry season salt/fresh control
Fresh water barrier
Major diversion channel
Fresh water supply brackish zone
Drainage channel

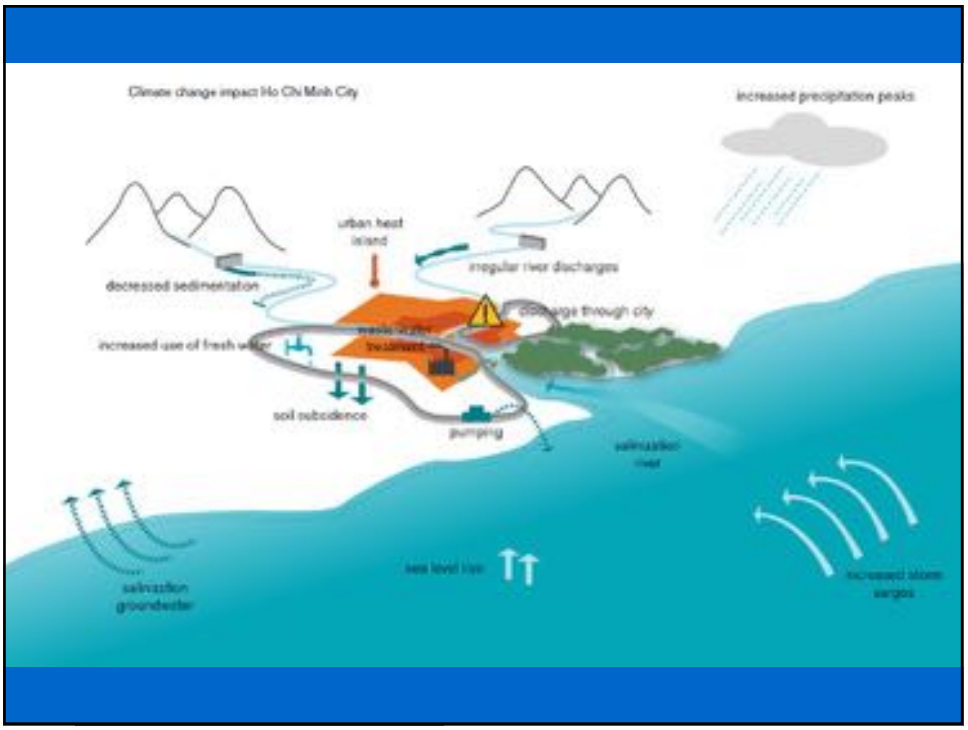

Coastal Zone | Dual Zone Coastal Management - living with saline water
Mekong Delta Plan, 2013
CAMBODIA
Châu Đốc
HỒ CHÍ MINH CITY
GULF OF THAILAND
Focus on sustainable brackish water aqua culture
Cà Mau
EAST SEA

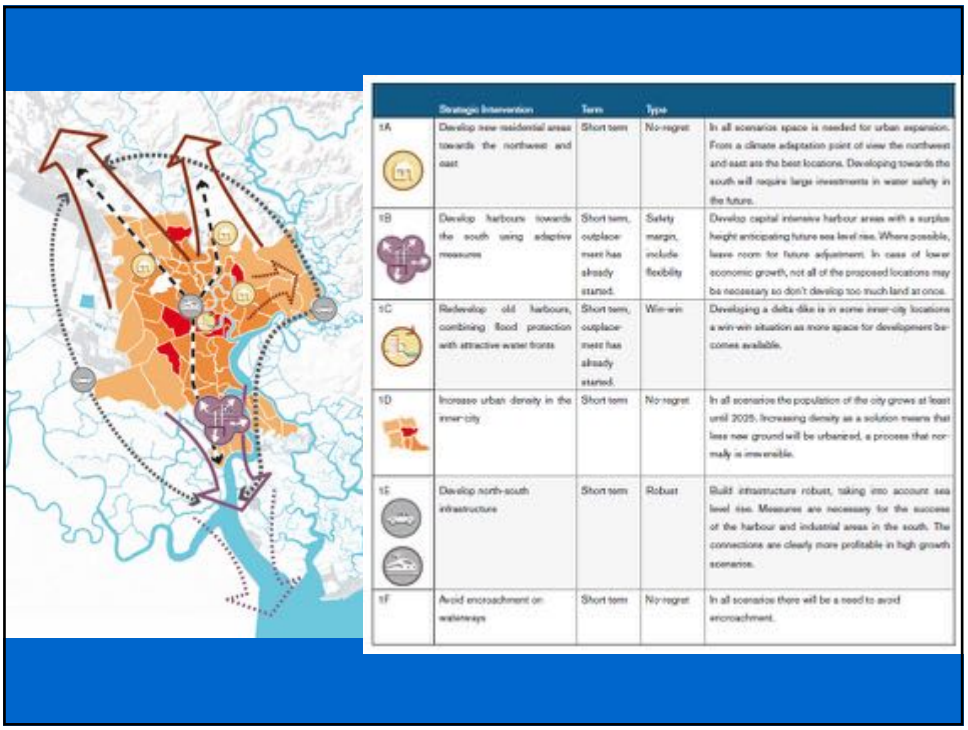

MEKONG DELTA
Thailand
Laos
Vietnam
Cambodia
Regional divisions
Mekong Delta Plan, 2012
Rice Cultivation
Flooded Rice Land
Rivers, Lakes


Regulator
Controlled Flooding Area
River Optimization
Green River
West Sea
Water Supply Ca Mau
Sustainable Water Supply Shrimp Farming
Sea Shore Utilization
East Sea
Mekong Delta Plan
Strategic Guidance - v0.0
1. Water Treatment Plants, Water Supply, Urban Drainage, Reducing Groundwater Use.
2. Water Supply for Shrimp Farming.
3. Sea Shore Utilization Plan, Coastal Zone Protection.
4. Flood Protection, Safety Level Standardisation.
5. Integration of Master Plans.
6. Can Tho West Urban & Industrial Development.
7. Agro Business Park.
8. Can Tho Deep Sea Port with Navigation Access.
9. Agricultural Fresh Water Supply for Ca Mau, construction of 3 Sluices.
10. Controlled Flooding, Green River/Channel
11. River Engineering Works for division of flows over the River Branches.
12. Fresh Water storage for Urban & Industrial needs.
13. Retention capacity Urban Areas.
14. Limit Salt Intrusion, Storm Surge Barrier in Bassac.
15. Limit Salt Intrusion, Storm Surge Barrier in River Branches.

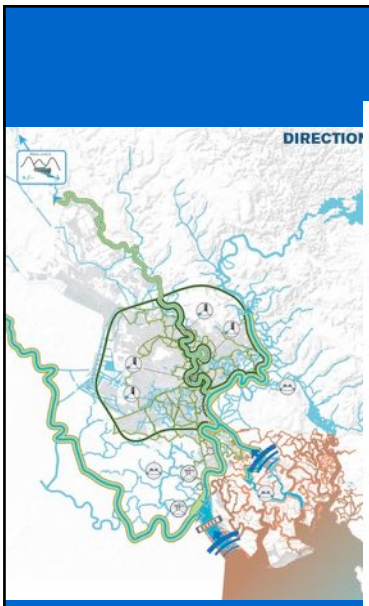

Climate Adaptation Strategy
Ho Chi Minh City
moving towards the sea with climate change adaptation


BINH DUONG
TIEN GIANG
Key
HCMC boundary
Province boundary
Urban residential area
Rural residential area
River, canal
Mangrove forest
Rice
Perennial fruit-tree
Other perennial crop
wet rice
Yearly crop
Other agricultural landuse
Ho Chi Minh City

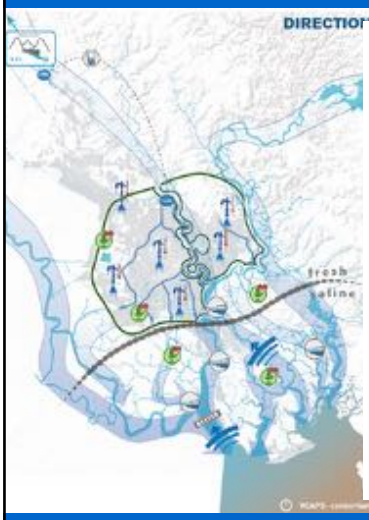




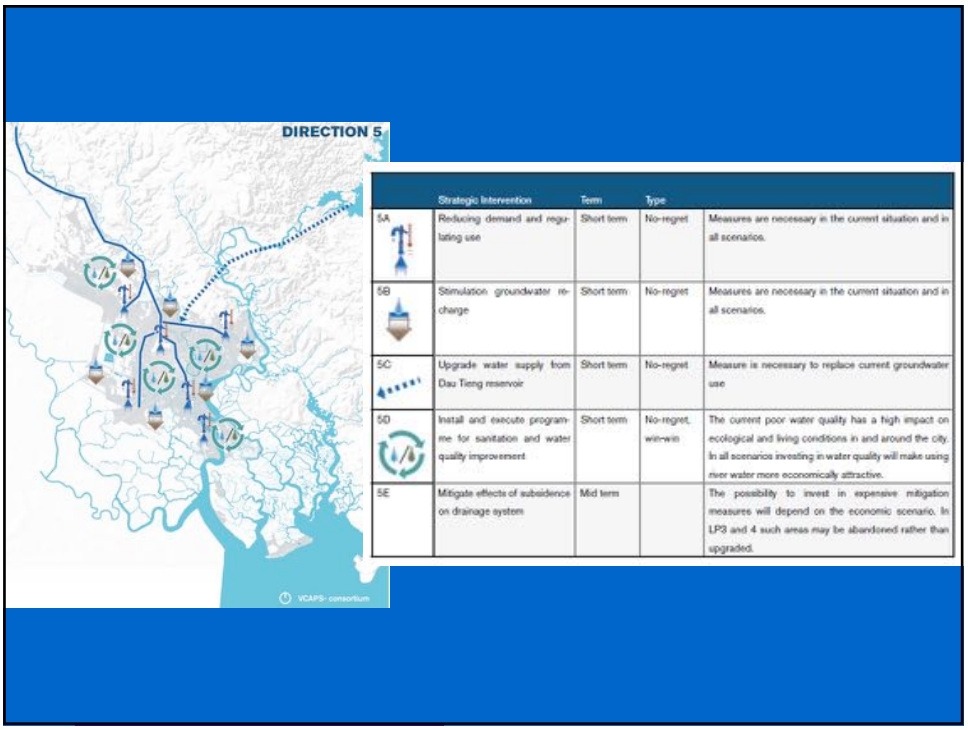
	Strategic Intervention	Term	Type	
1A	Develop new residential areas towards the northwest and east	Short term	No-regret	In all scenarios space is needed for urban expansion. From a climate adaptation point of view the northwest and east are the best locations. Developing towards the south will require large investments in water safety in the future.
1B	Develop harbours towards the south using adaptive measures	Short term, outplacement has already started.	Safety margin, include flexibility	Develop capital intensive harbour areas with a surplus height anticipating future sea level rise. Where possible, leave room for future adjustment. In case of lower economic growth, not all of the proposed locations may be necessary so don't develop too much land at once.
1C	Redevelop old harbours, combining flood protection with attractive water fronts	Short term, outplacement has already started.	Win-win	Developing a delta dike is in some inner-city locations a win-win situation as more space for development becomes available.
1D	Increase urban density in the inner-city	Short term	No-regret	In all scenarios the population of the city grows at least until 2025. Increasing density as a solution means that less new ground will be urbanized, a process that normally is irreversible.
1E	Develop north-south infrastructure	Short term	Robust	Build infrastructure robust, taking into account sea level rise. Measures are necessary for the success of the harbour and industrial areas in the south. The connections are clearly more profitable in high growth scenarios.
1F	Avoid encroachment on waterways	Short term	No-regret	In all scenarios there will be a need to avoid encroachment.



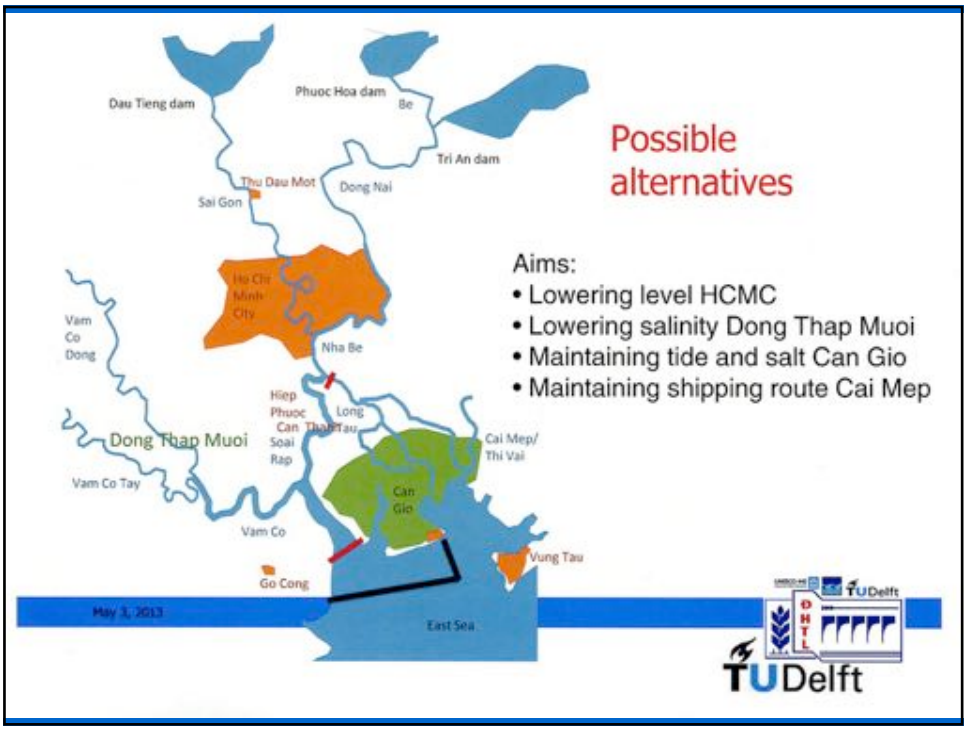
	Strategic Intervention	Term	Type	
2A	Develop flood risk maps and flood risk standards	Short term		Flood risk maps form the basis for standards
2B	Protect the inner city with ring dike	Short term	Win-win	Combination with the development of ring road 3 saves costs.
2C	Optimize reservoir management for flood protection	Short term	No-regret	Optimizing reservoir operation from a floods perspective will reduce the risks of inundation north of HCMC.
2D	Tidal barrier	Long term		Measure only necessary in case of extreme sea level rise.
2E	Develop district adaptation pathways	Short term	No-regret	A bottom-up approach is expected to contribute to resilience at the district level.
2F	Adaptive building towards the south	Short term	Flexible	Building in smaller quantities and on mounds leaving space for future adaptation makes it possible to grow with sea level rise.
2G	Identify and protect the vital and the vulnerable areas in HCMC	Short term	No-regret, robust	Create extra robust solutions for vital and vulnerable functions.
2H	Protect the riparian zones along the rivers	Short term	No-regret	In all scenarios, safeguarding riparian zones leads to the reduction of flood risks.
2I	Strengthen emergency management	Short term	No-regret	Helps to reduce victims and economic damage also in the existing situation.



	Strategic Intervention	Term	Type	
4A	Large scale measures against flooding reduce salt intrusion	Mid-term	Win-win	A ring dike with tidal gates will also reduce the amount of brackish water entering the city's water system. If these measures are taken this will be justified from a floods perspective. Their effect on salt intrusion is a positive side-effect.
4B	Smart dredging to reduce impact	Short term	Delaying action	Coupled to development of harbours. Smart dredging reduces the impact of dredging on salt intrusion compared to normal dredging.
4C	Flush the city's water system	Short term		Measure to reduce impacts.
4D	Evaluate relocation of drinking water intakes and wells	Mid term	No-regret	Locations for water supply station should be reserved on the short term to relocate intakes on the mid-term.
4E	Decrease groundwater extraction to a sustainable level	Short term	No-regret	If groundwater extraction is not reduced to a sustainable level, groundwater resources will be depleted in all scenarios.
4F	Use salt resistant vegetation in flood prone areas	Short term	No-regret	Take midterm changes in salt levels into account when designing public space.

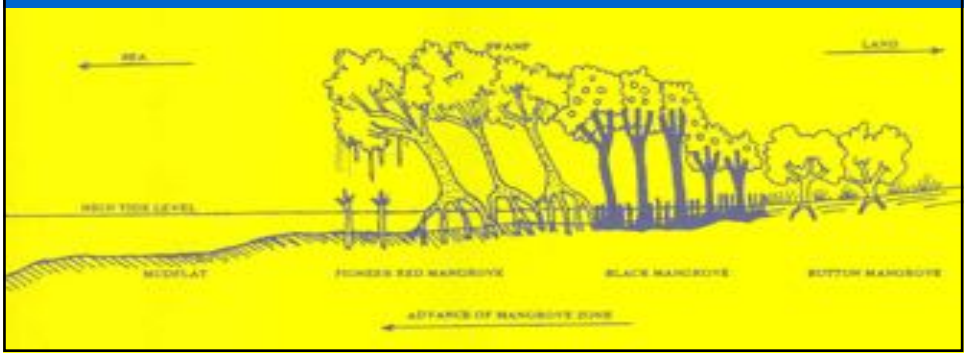


	Strategic Intervention	Term	Type	
5A	Reducing demand and regulating use	Short term	No-regret	Measures are necessary in the current situation and in all scenarios.
5B	Stimulation groundwater recharge	Short term	No-regret	Measures are necessary in the current situation and in all scenarios.
5C	Upgrade water supply from Dau Tieng reservoir	Short term	No-regret	Measure is necessary to replace current groundwater use
5D	Install and execute programme for sanitation and water quality improvement	Short term	No-regret, win-win	The current poor water quality has a high impact on ecological and living conditions in and around the city. In all scenarios investing in water quality will make using river water more economically attractive.
5E	Mitigate effects of subsidence on drainage system	Mid term		The possibility to invest in expensive mitigation measures will depend on the economic scenario. In LP3 and 4 such areas may be abandoned rather than upgraded.



MANGROVES Dr. Bob Ursem TU Delft

Mangroves characteristics & types
Mangroves for coastal protection
Mangroves as a basis for a rich eco-system



Category 1
First boundary layer of coastal defense, rough salt rich turbulent environment is an excellent growth area for mangroves with stilt pneumatophore root systems: tall trees, robust root systems, well anchored in mud, no settling of silt. Especially good for blocking storms and strong wave impact.

Category 2 and 3
A more inland, relative dynamic up to non turbulent, low saline level environment is an excellent growth area for mangroves with erect pneumatophore root systems: middle to tall tree sizes, sometimes shrubs, root system just reaching the high tide level, relative open to dense root cover, only anchored in mud at the base, creating a perfect alluvial environment.

Mangroves suitable for coastal defense in Vietnam (from open sea to the ecological succession of mangrove forests)

Category 1 Rhizophora apiculata

Rhizophora apiculata can handle rough turbulent, high saline conditions and soils of sand flats with slimy mud up to heavy clay/mud conditions. Needs high saline water all year around!

Sonneratia caseolaris

Sonneratia caseolaris prefer sand and mud conditions, most common in estuaries, having high saline up to brackish water (5 up to 10‰).

Red mangroves exclude salt by having significantly impermeable roots which are highly buttressed, acting as an ultra-filtration mechanism to exclude sodium salts from the rest of the plant.
Analysis of water inside mangroves has shown that 90% to 97% of salt has been excluded at the roots. Salt which does accumulate in the shoot concentrates in old leaves which the plant then sheds.
Red mangroves can also store salt in cell vacuoles.
White (or grey) mangroves can secrete salts directly; they have two salt glands at each leaf base (hence their name white mangrove - they are covered in white salt crystals as shown below).

Avicennia marina var. intermedia
(grey mangrove, guava mangrove)

Natural conditions. The islands form a barrier to create sheltered conditions with alluvial accumulation of soil settling and to prevent large wave impacts.

What do mangroves need?

- Preferable a muddy (clay or silt rich/rich silt-sandy soil) with a low gradient.
- An suitable tide range, not extreme, as bottom line a near lacking tide.
- A dynamic environment where soil increase can occur due to alluvial accumulation by mangroves.
- A low water current.
- The saline conditions may be variable, high to low content and never totally fresh water.
- Support in the pioneer growth phase to prevent large impact of waves.

Placing bamboo sticks
- in rows parallel to the coast
- at certain distances from each other
- at a considerable distance from the coast (at least 500 m or more).

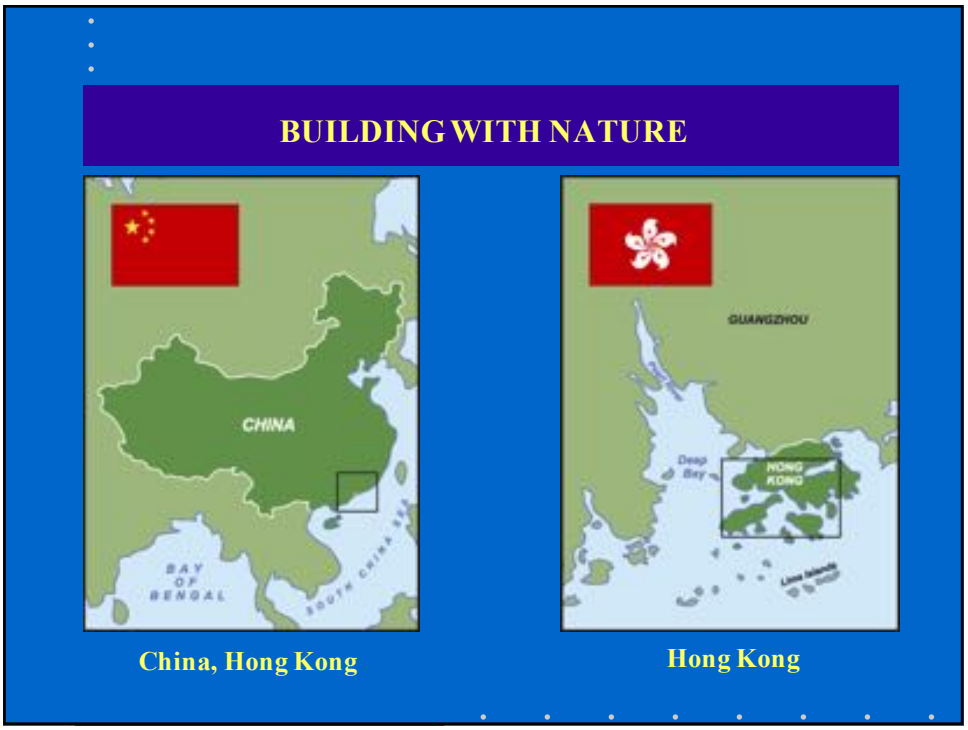
Siltation occurs. When the silt layer has a certain thickness planting of mangroves can start in a certain sequence.

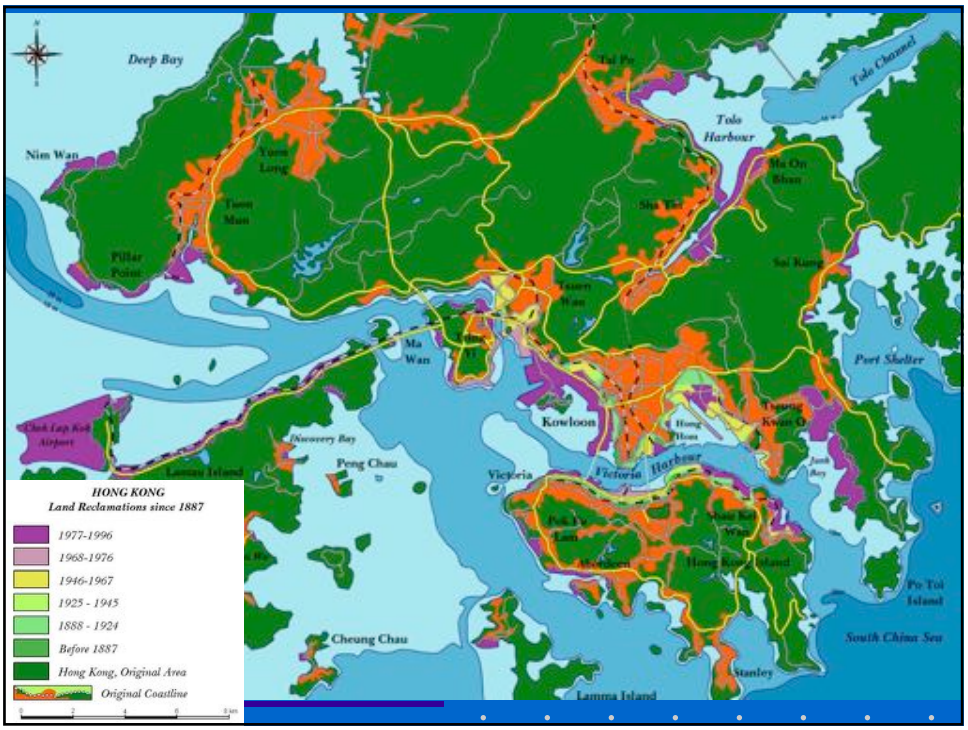
SUSTAINABLE COASTAL ZONE DEVELOPMENT

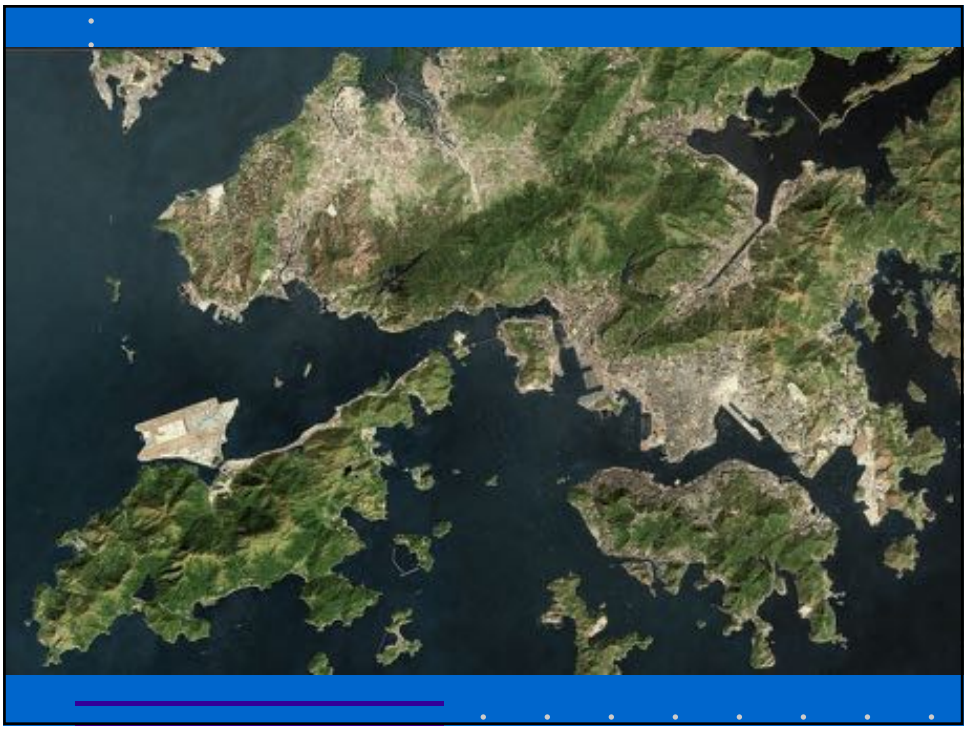
Integrated Coastal & Deltaic Policy
via Building with Nature®

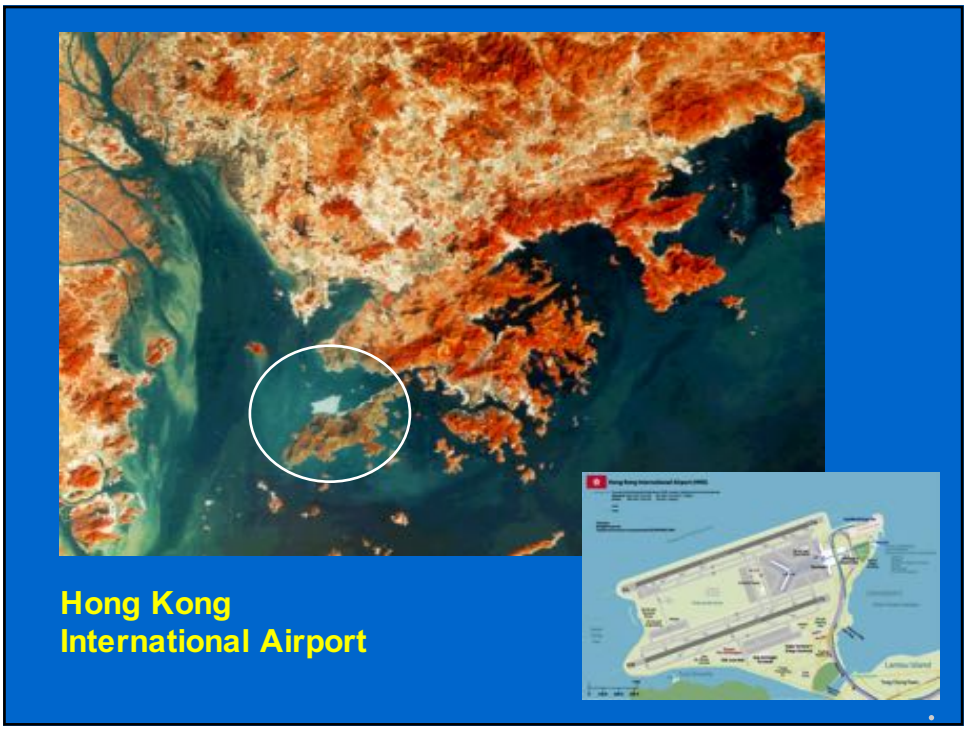
Dr. R.E. Waterman MSc
January 2013

Peoples Republic of China
The Netherlands


BUILDING WITH NATURE
CHINA
BAY OF BENGAL
SOUTH CHINA SEA
GUANGZHOU
Deep Bay
HONG KONG
China, Hong Kong
Hong Kong


Deep Bay
Nim Wan
Yung Long
Tuen Mun
Pillar Point
Tolo Channel
Tolo Harbour
Ma On Shan
Sha Tin
Sai Kung
Tsuen Wan
Ma Wan
Port Shelter
Kowloon
Hong Kong Kwun Tong
Chek Lap Kok Airport
Discovery Bay
Lantau Island
Peng Chau
Victoria
Victoria Harbour
Aberdeen
Hong Kong Island
Po Toi Island
South China Sea
Cheung Chau
Stanley
Lamma Island
HONG KONG
Land Reclamations since 1887
1977-1996
1968-1976
1946-1967
1925 - 1945
1888 - 1924
Before 1887
Hong Kong, Original Area
Original Coastline




Hong Kong
International Airport

SUSTAINABLE COASTAL ZONE DEVELOPMENT

Integrated Coastal & Deltaic Policy via Building with Nature®

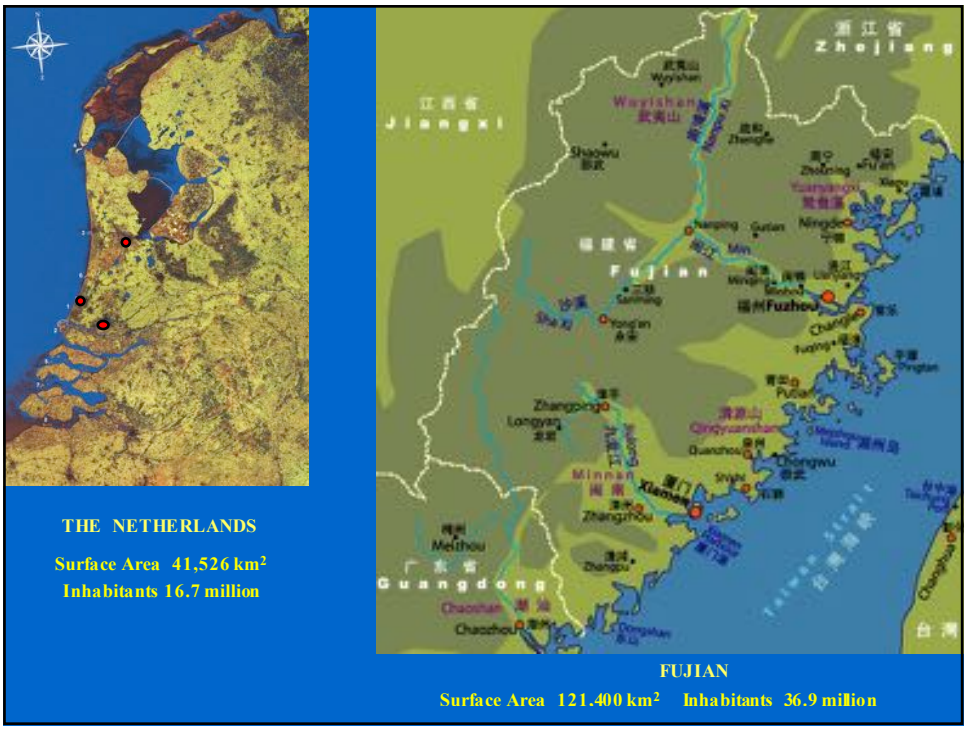
Dr. R.E. Waterman MSc

FUJIAN

March 2012

Peoples Republic of China
The Netherlands

354


THE NETHERLANDS
Surface Area 41,526 km²
Inhabitants 16.7 million
FUJIAN
Surface Area 121.400 km² Inhabitants 36.9 million


Jinjiang Weitou Bay
XIAMEN DAO
XIAMEN
JINMEN DAO
WEITOU WAN


Jinjiang Weitou Bay Reclamation
ca.15 x 3 km : land 34 km² water 10.7 km²
Jinjiang
Xiamen
Jinjiang
晋江市
Xiamen
3.5 million inhabitants
Jinjiang
1 million inhabitants
13 neighbourhoods
a. Residential Area
b. Ocean park
c. Business & sports
a
b
c


YUNXIAO
Development Zone
LED Technology Centre
& Fishing Harbour
with Residential Area
GULEI PENINSULA
Harbour Development
Zone
DONGSHAN
High Tech Industry
Industry & Logistics
Green Axis
Ecological Farmland
Residential Area
Marine Industry Area
Tourism Area
DONGSHAN DAO & DONGSHAN WAN

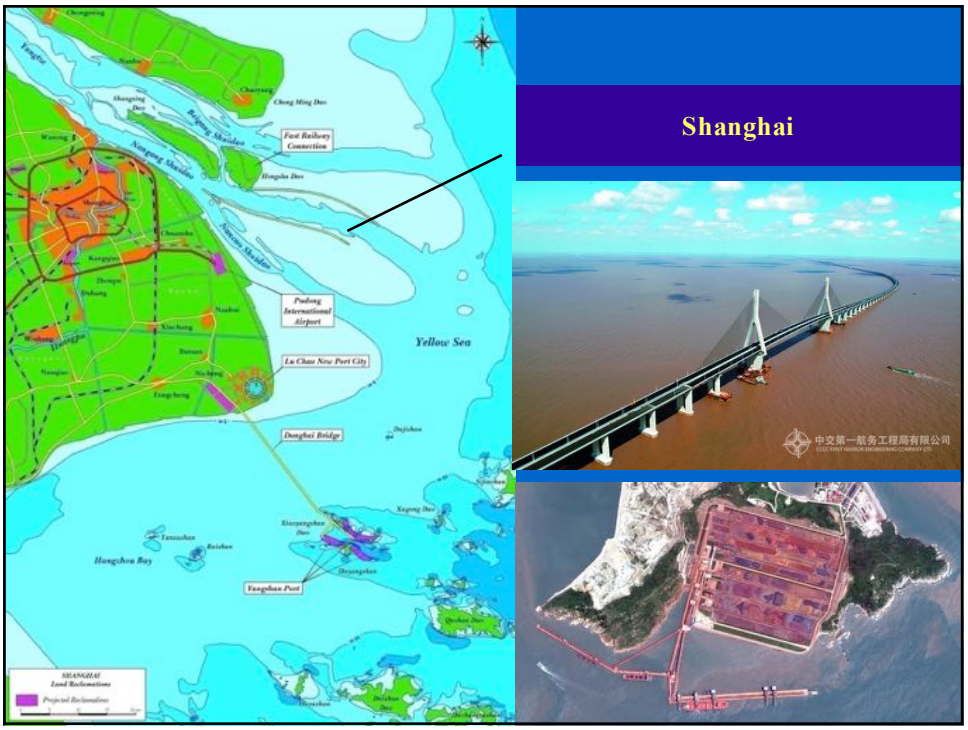
BUILDING WITH NATURE

China, Shanghai

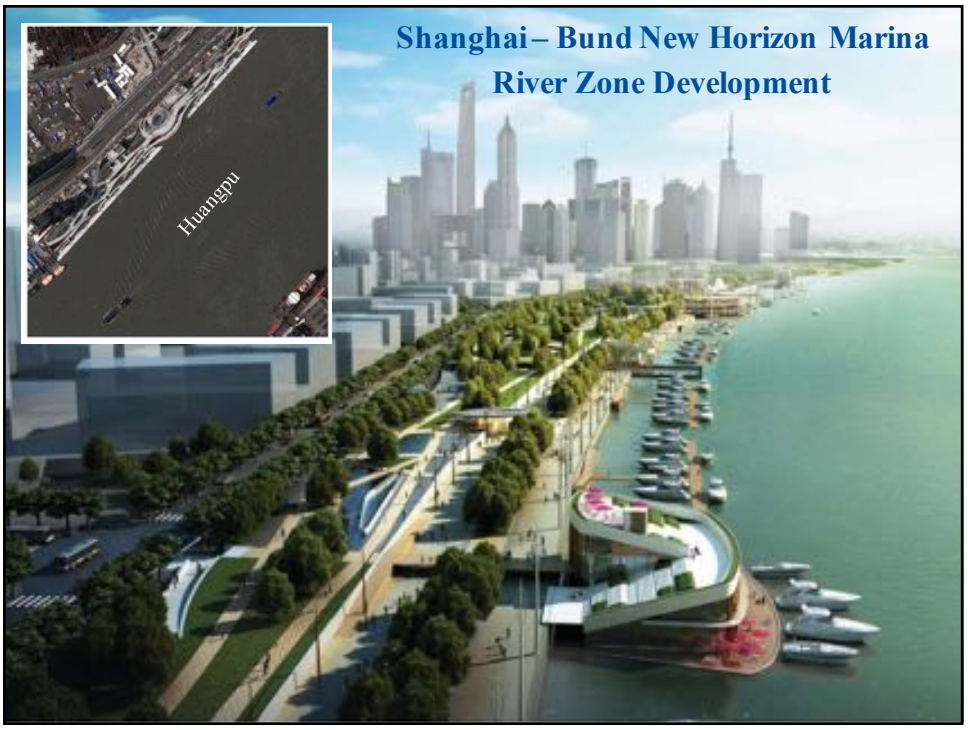
Shanghai

BUILDING WITH NATURE

Shanghai


Shanghai
Yellow Sea
Hangzhou Bay
Fast Railway Connection
Pudong International Airport
Lu Chao New Port City
Donghai Bridge
Yangshan Port


Shanghai


Shanghai – Bund New Horizon Marina
River Zone Development
Huangpu


Shanghai – New Horizon Marina
River Zone Development

SUSTAINABLE COASTAL ZONE DEVELOPMENT

Dr. R. E. Waterman MSc

KOREA
THE NETHERLANDS

JUNE 2012

SOUTH KOREA		THE NETHERLANDS
	SURFACE AREA	
99,538 km²		33,883 km²
	INHABITANTS	
48.8 million		16.7 million
	COASTAL LENGTH	
14,800 km		353 km
	MAIN RIVERS	
Han Gang		Rhine
Nak Dong Gang		Maas
Geum Gang		Scheldt
Yeong San Gang		Eems
	4 RIVERS RENAISSANCE	
Han Gang, Nak Dong Gang, Geum Gang, Yeong San Gang		

Background

As part of the Four Major Rivers Restoration Project:

- 16 weirs
- 4 river basins

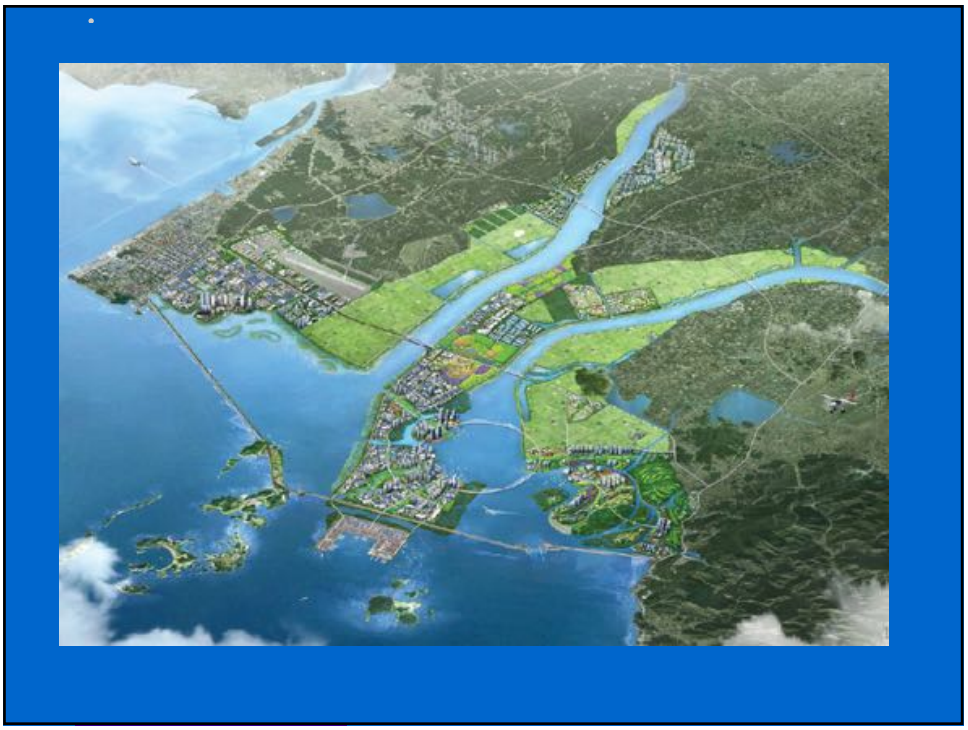
Five core challenges of the Four Major Rivers Restoration Project

- Securing abundant water resources to mitigate water scarcity.

Seamangeum Tideland Reclamation

Total Land Development	283 km²
Large Fresh Water Lake	
Sea Dike Length	33.9 km

Use	Total(km²)
Total Area	283.00
Multifunctional City (Industry / Global Business / Tourism & Leisure / Eco Environment)	67.30
Agriculture	85.70
Industry	18.70
Scientific & Research	23.00
New & Renewable Energy	20.30
City(Agriculture, Hinterland)	14.60
Eco & Environment	42.40
Waterproof Facilities, etc.	11.00

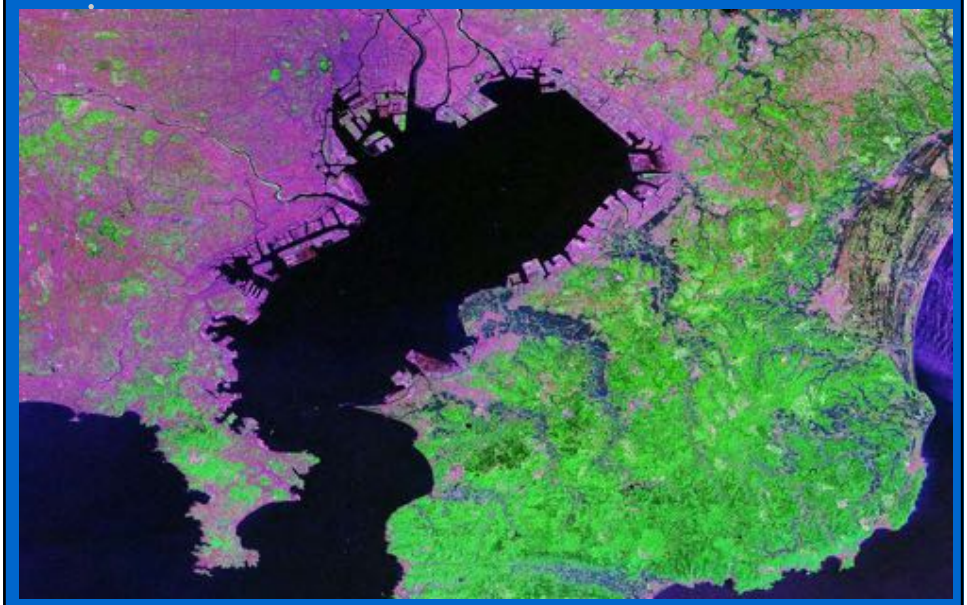



Gunsan, Seoul
Seoul
E-W road #1
Iksan
N-S road #3
Saemangem-Gunsan Railroad
Seohaean Expressway
N-S road #1
E-W road #2
N-S road #2
Saemangeum-Jeonju Expressway
Jeonju, Pohang
Internal Circulation Ring
Namwon, Sunchang
E-W road #3
Gwangju
Mokpo

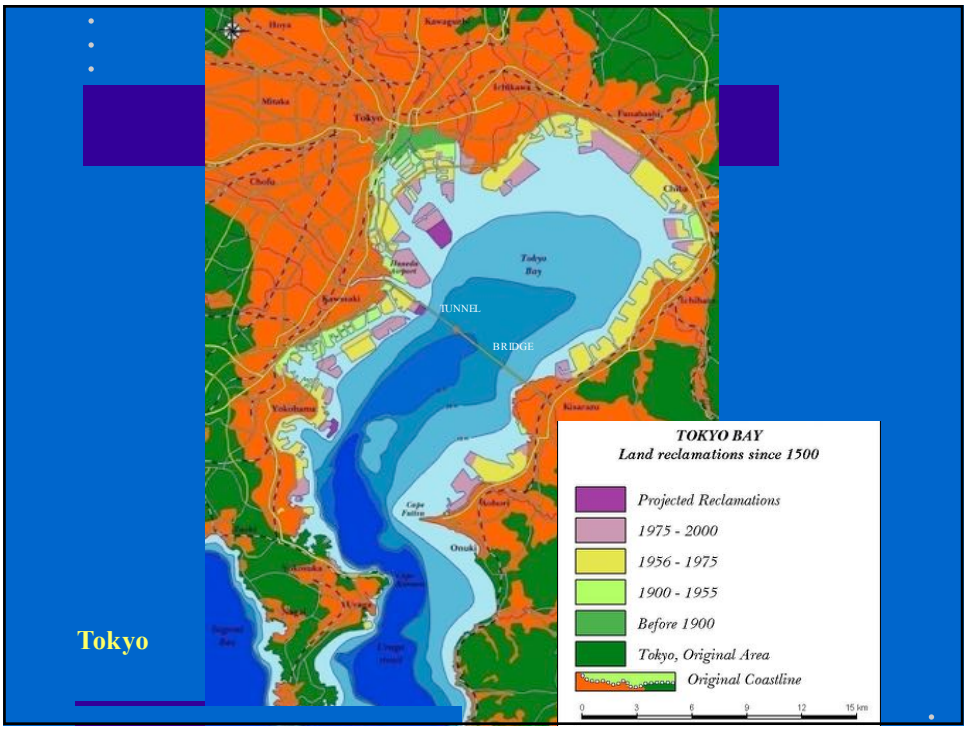
BUILDING WITH NATURE

Japan, Tokyo

Tokyo

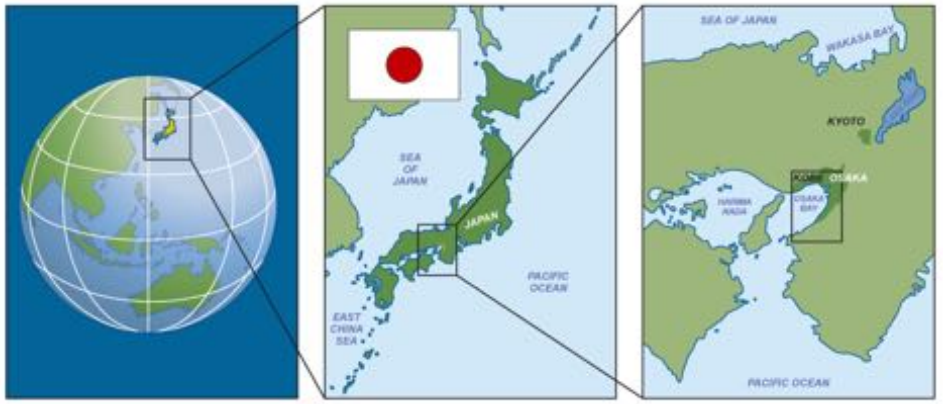


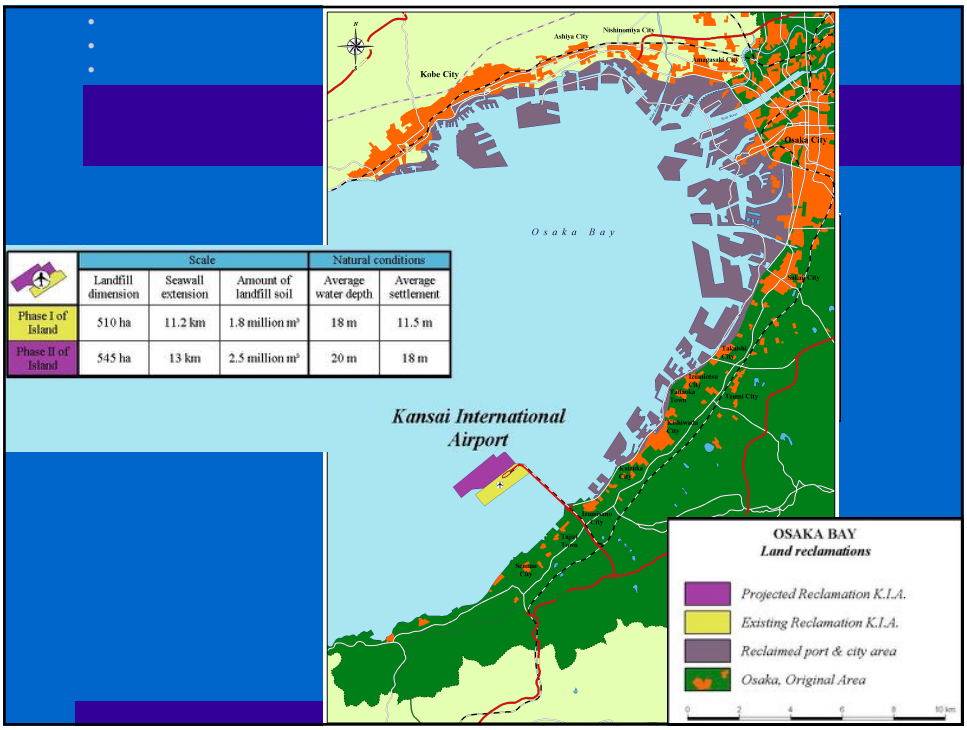
Tokyo


Tokyo
TUNNEL
BRIDGE
TOKYO BAY
Land reclamations since 1500
Projected Reclamations
1975 - 2000
1956 - 1975
1900 - 1955
Before 1900
Tokyo, Original Area
Original Coastline


Outline of Tokyo Bay

Osaka - Kobe

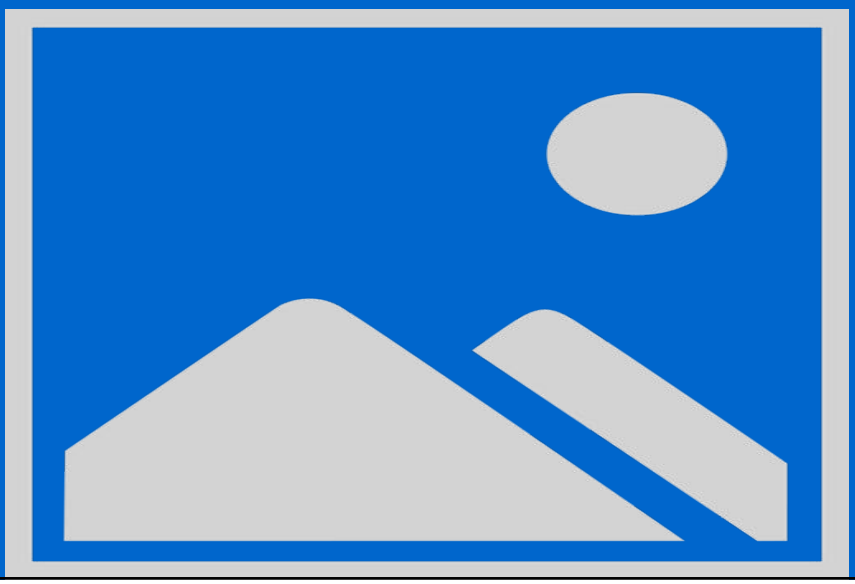




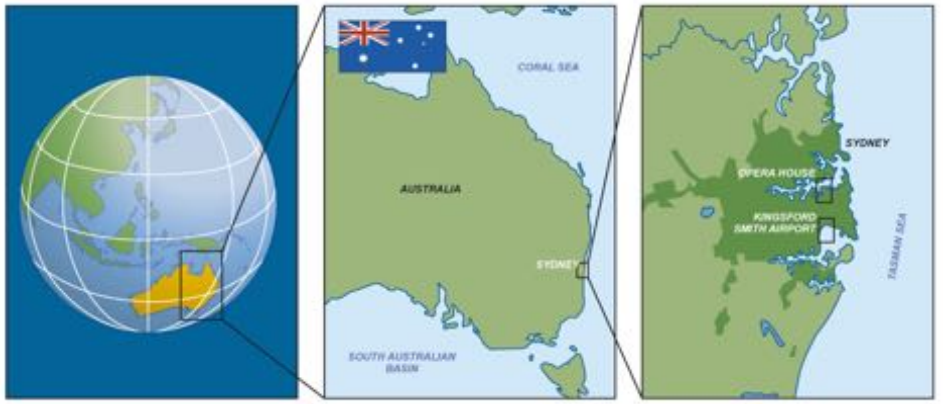
	Scale			Natural conditions	
	Landfill dimension	Seawall extension	Amount of landfill soil	Average water depth	Average settlement
Phase I of Island	510 ha	11.2 km	1.8 million m³	18 m	11.5 m
Phase II of Island	545 ha	13 km	2.5 million m³	20 m	18 m

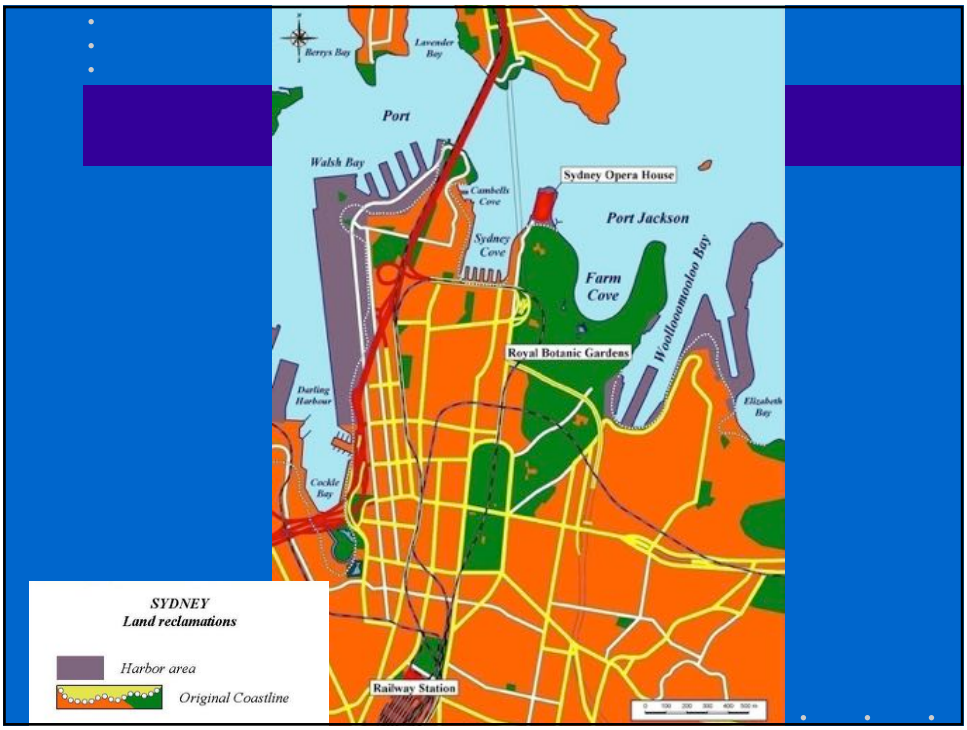
Osaka – Kobe *Kansai Int. Airport 1*

Osaka – Kobe *Kansai Int. Airport 2*

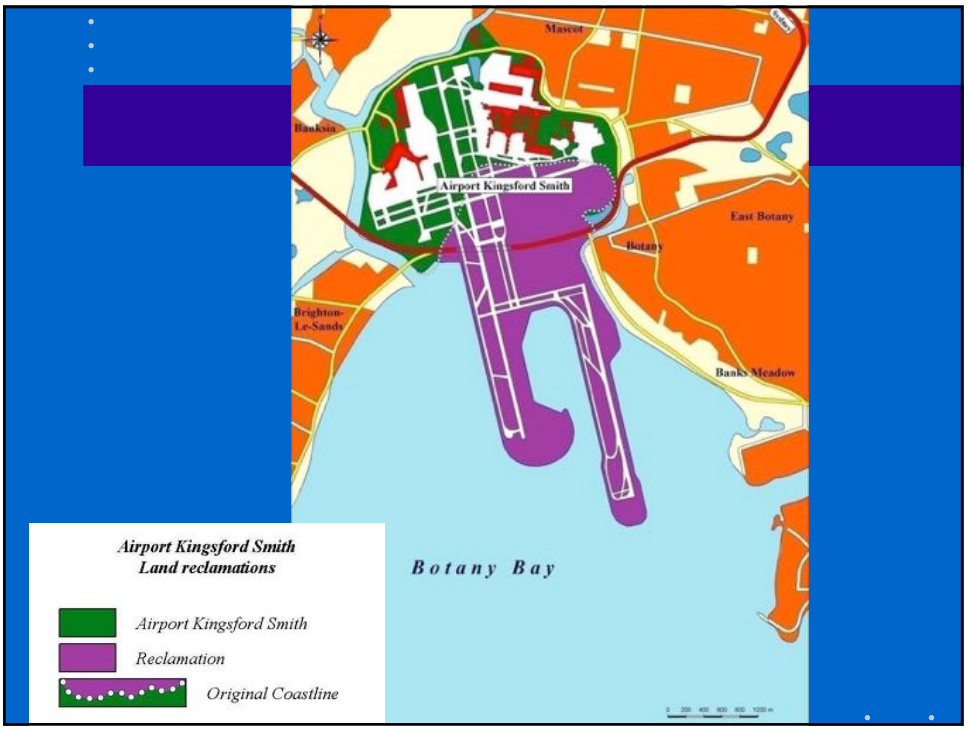


Australia - Sydney






Sydney Opera House


Mascot
Banksia
Airport Kingsford Smith
East Botany
Botany
Brighton-Le-Sands
Banks Meadow
Botany Bay
Airport Kingsford Smith
Land reclamations
Airport Kingsford Smith
Reclamation
Original Coastline

Sydney *Kingsford Smith Airport*

Sydney

SUSTAINABLE COASTAL ZONE DEVELOPMENT

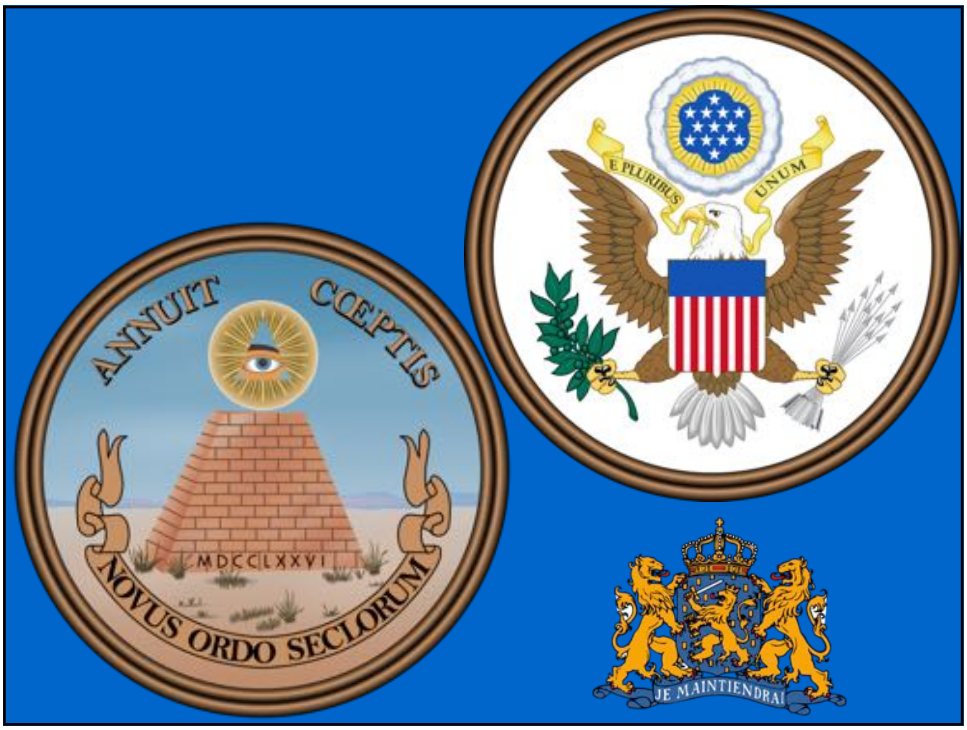
Integrated Coastal & Delta Policy via Building with Nature®

Prof. Dr. R.E. Waterman MSc

USA – THE NETHERLANDS

2013



HURRICANE SANDY

HURRICANE SANDY
impact on
New Jersey shore

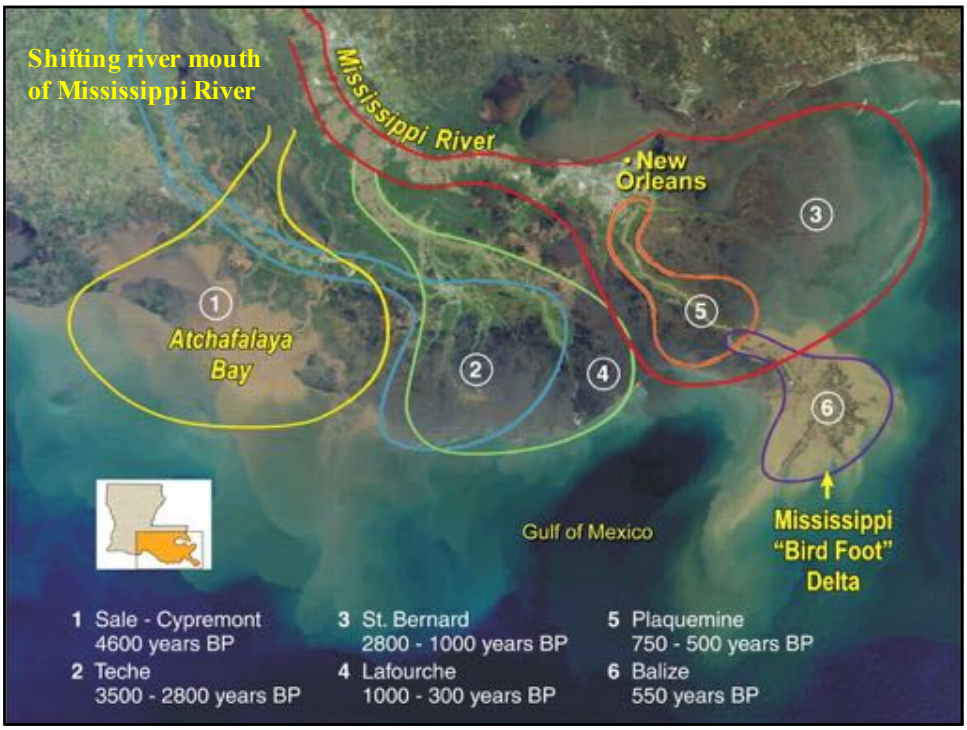
Remedy:

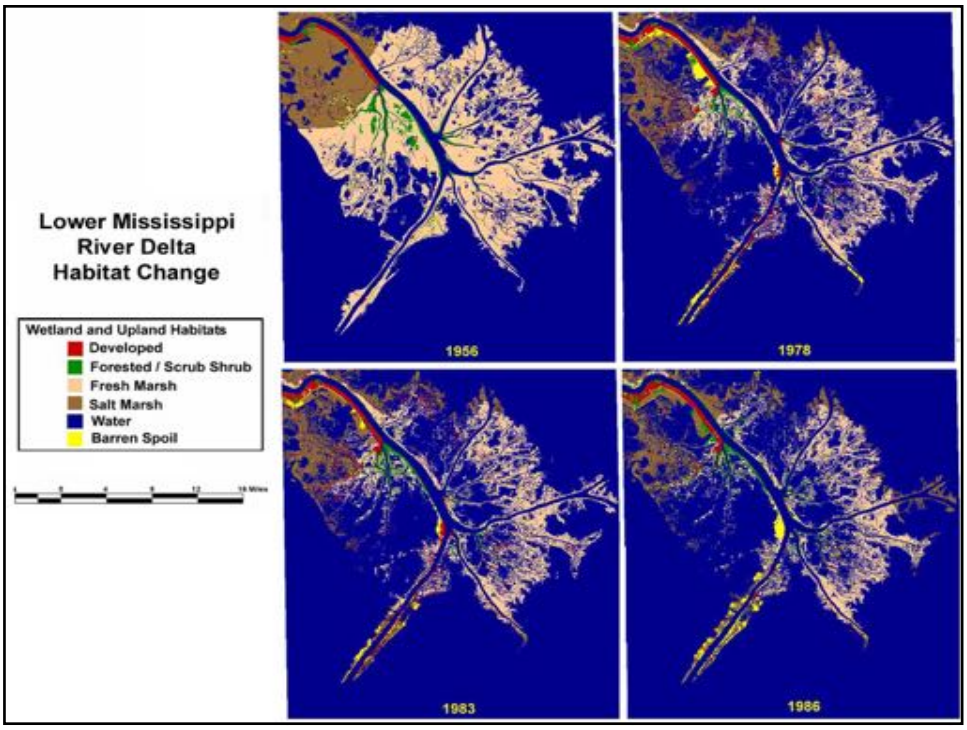
Dune - Beach Widening & Heightening

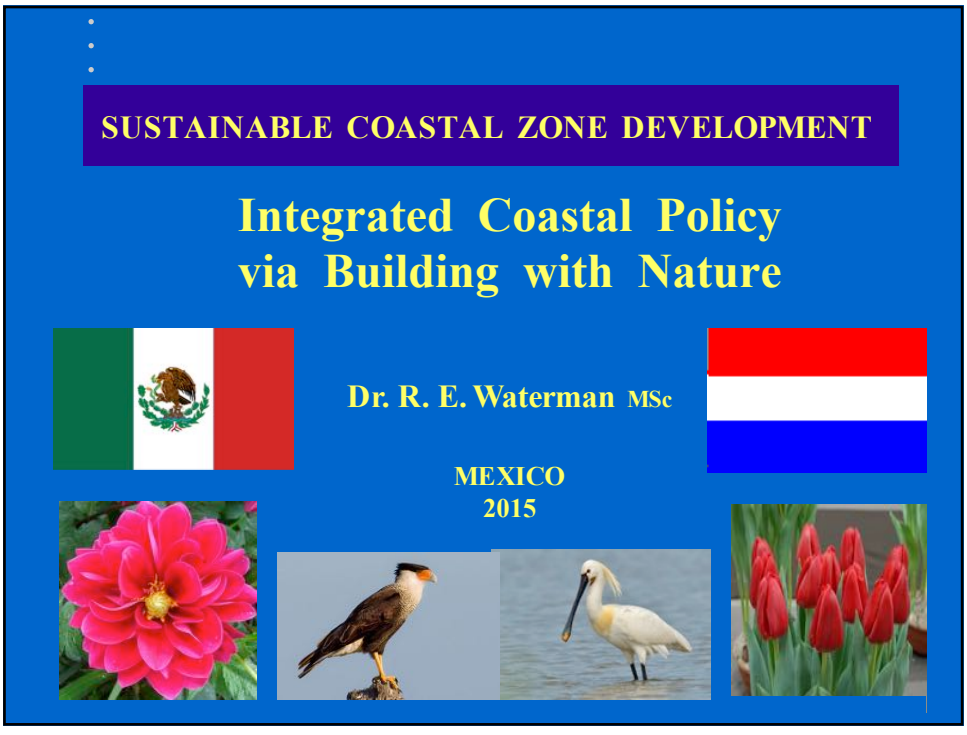
No constructions on the 1st range of protecting dunes

New Orleans in Mississippi Delta

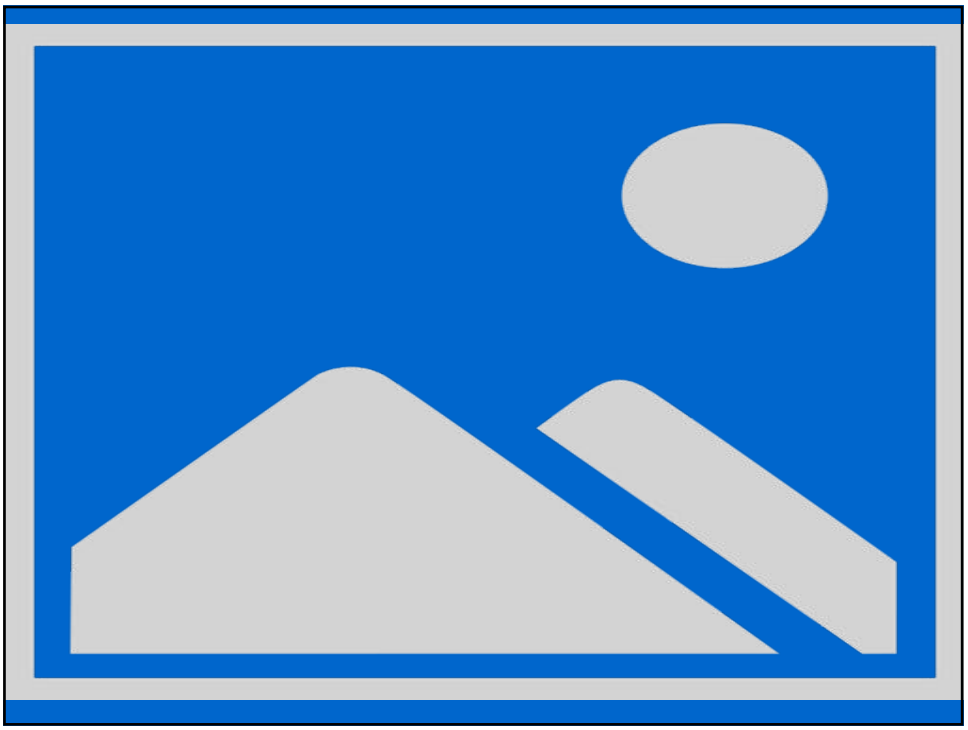
- Improving levees
- Improving drainage & pumping systems
- Introducing storm surge barriers
- Wetlands extension for safety & nature development



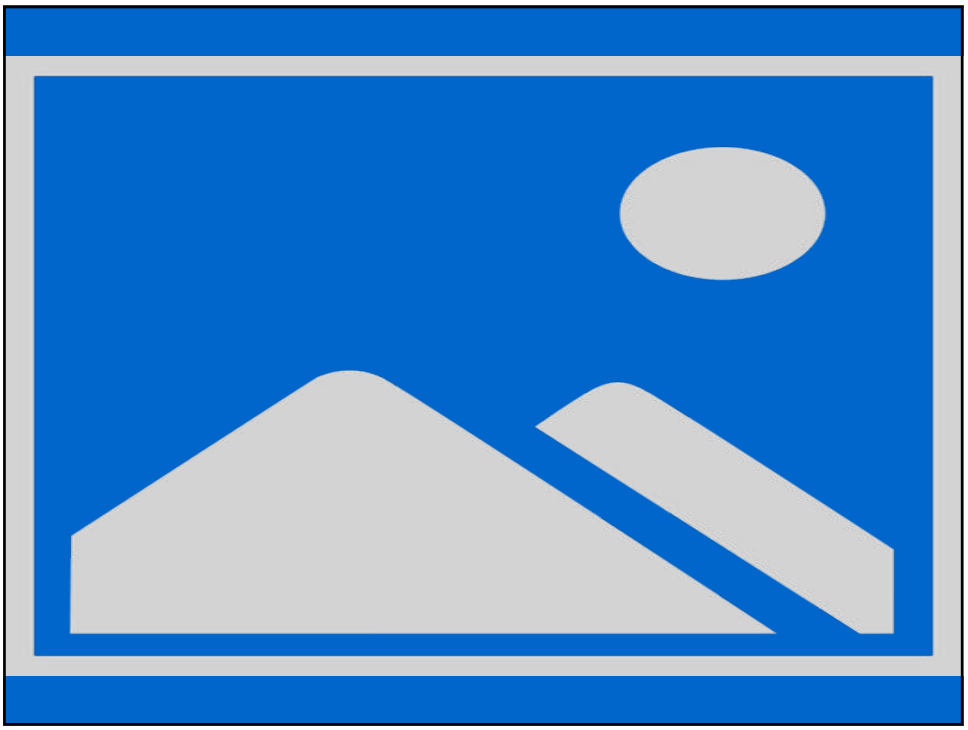

Lower Mississippi
River Delta
Habitat Change
Wetland and Upland Habitats
Developed
Forested / Scrub Shrub
Fresh Marsh
Salt Marsh
Water
Barren Spoil
1956
1978
1983
1986


SUSTAINABLE COASTAL ZONE DEVELOPMENT
Integrated Coastal Policy
via Building with Nature
Dr. R. E. Waterman MSc
MEXICO
2015

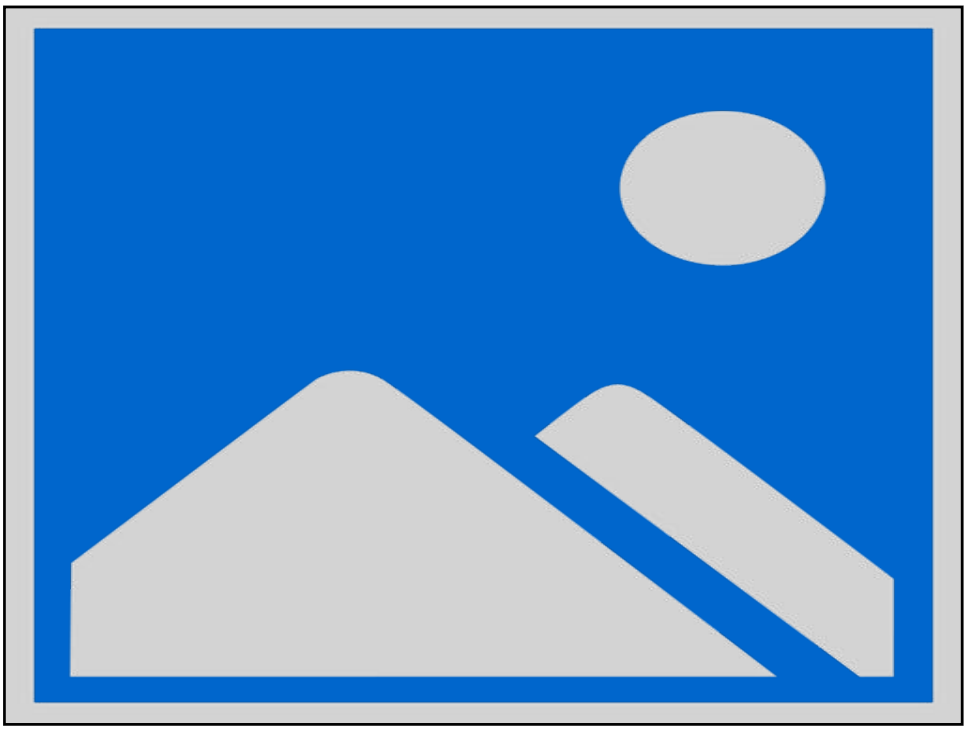

MEXICO.




Xochimilco – Chinampas – World Heritage




MEXICO
THE NETHERLANDS
SURFACE AREA
1,964,375 km²
33,883 km²
INHABITANTS
116.2 million
16.7 million
COASTAL LENGTH
2,805 km Gulf of Mexico
7,338 km Océano Pacifico
353 km North Sea
SEA PORTS
Veracruz
Altamira
Tampico
Dos Bocas
Acapulco
Rotterdam
Amsterdam
FOTOGRAFÍA TOMADA ANTES DE 2003.
DOS BOCAS
PARAÍSO

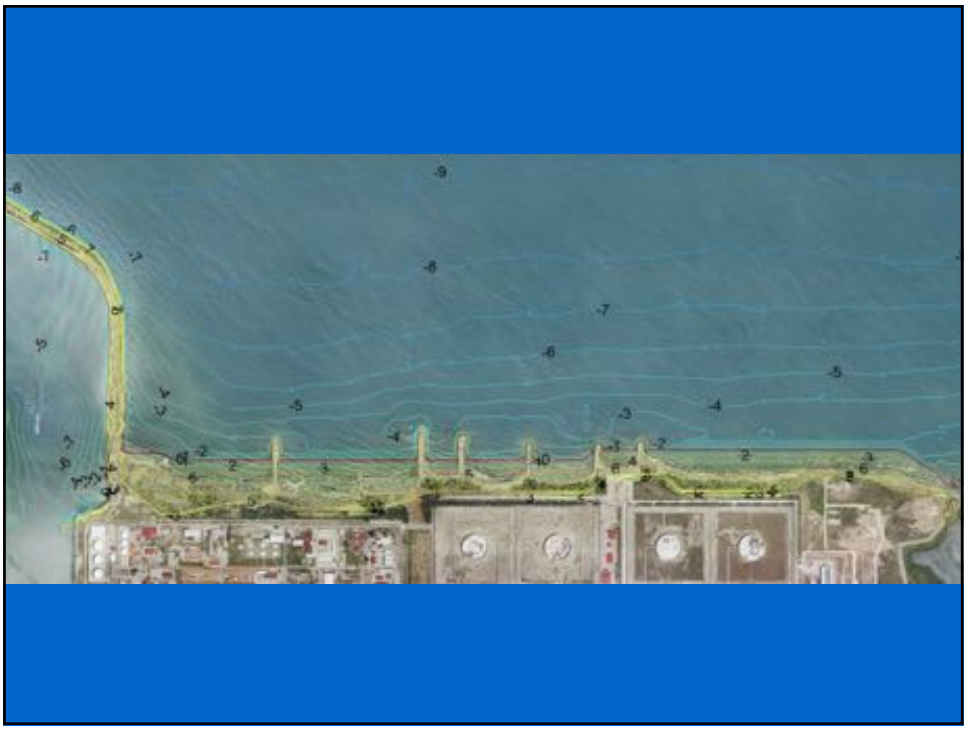


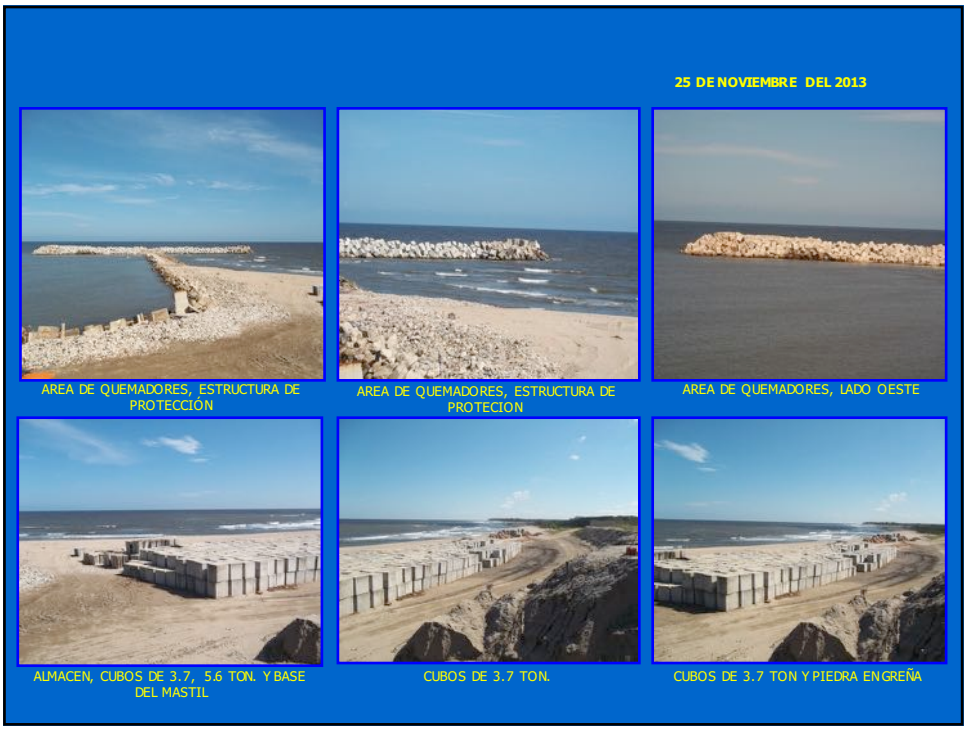

VERA CRUZ


DOS BOCAS
TABASCO
TERMINAL MARITIMA
PEMEX
Estado: TABASCO
Municipio: PARAISO
Altitud: 1msnm
Puerto de DOS BOCAS:
Depths 7-10 meter
Turning bassin 300 m diameter
Multipurpose & Specialised Terminals
Petroleum, fruit, meat, machinery, cruise passengers
TABASCO

Espigones que se han construido frente TMPDB
Breakwaters (groynes) in front of TMPDB


ZONAS DE INTERVENCION
TUBERIAS DE SALIDA
TUBERIAS DE LLEGADA
DOS BOCAS, TABASCO
TERMINAL MARITIMA PEMEX




25 DE NOVIEMBRE DEL 2013
AREA DE QUEMADORES, ESTRUCTURA DE PROTECCIÓN
AREA DE QUEMADORES, ESTRUCTURA DE PROTECION
AREA DE QUEMADORES, LADO OESTE
ALMACEN, CUBOS DE 3.7, 5.6 TON. Y BASE DEL MASTIL
CUBOS DE 3.7 TON.
CUBOS DE 3.7 TON Y PIEDRA ENGREÑA

25 DE NOVIEMBRE DEL 2013

BASE DEL MASTIL, CUBOS DE 5.6 Y 3.7 TON

CAMINO AL MORRO

CAMINO AL MORRO

CENTRO DE ESTRUCTURA DE PROTECCION

ESTRUCTURA DE PROTECCION, LADO OESTE

ESTRUCTURA DE PROTECCION, LADO ESTE

25 DE NOVIEMBRE DEL 2013

ESTRUCTURA DE PROTECCION, LADO ESTE

ESTRUCTURA DE PROTECCION, LADO

CENRO DE LA ESTRUCTURA DE

ESTRUCTURA DE PROTECCION LADO ESTE

CENTRO DE LA ESTRUCTURA DE PROTECCION

ESTRUCTURA DE PROTECCION, LADO OESTE

25 DE NOVIEMBRE DEL 2013

ALMACEN DE MATERIALES EN AREA DE QUEMADORES

BARDA PERIMETRAL TDN.

BARDA PERIMETRAL TDN.

BARDA PERIMETRAL, TDN.

BARDA PERIMETRAL, TDN.

BARDA PERIMETRAL TDN, 1er, TRAMO

25 DE NOVIEMBRE DEL 2013

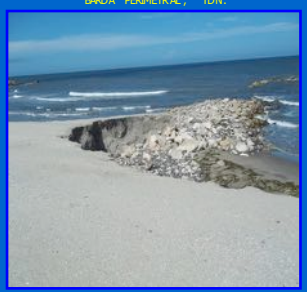
BARDA PERIMETRAL, TDN.

BARDA PERIMETRAL, TDN.

BARDA PERIMETRAL, TDN.

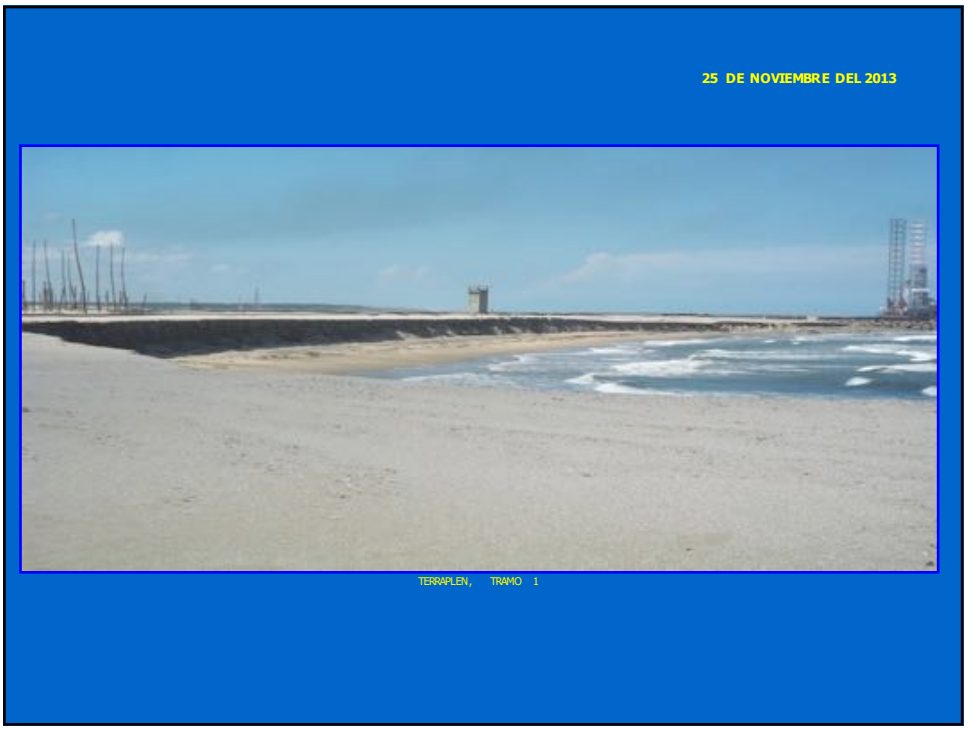
TERRAPLEN, TRAMO 7

TERRAPLEN, TRAMO 6



TERRAPLEN, TRAMO 7


25 DE NOVIEMBRE DEL 2013
TERRAPLEN, TRAMO 5
TERRAPLEN, TRAMO 4
TERRAPLEN, TRAMO 4
TERRAPLEN, TRAMO 3
TERRAPLEN, TRAMO 3
TERRAPLEN, TRAMO 2


25 DE NOVIEMBRE DEL 2013
TERRAPLEN, TRAMO 1

Recuperacion y proteccion de la linea de costa de las instalaciones PEMEX Dos Bocas, Tabasco, Mexico

Dr. Ronald Waterman

Equipo

- Ronald Waterman
- Paul Geerders
- David Ortega Grillasca
- Alejandro Gomez Ponce

Antecedentes

- Historia de la problematica
  - Proteccion tuberia marina
  - Proteccion y reduccion de la vulnerabilidad de las instalaciones (incl. quemadores, bateria de separacion y conversion)
  - Recuperacion zona de playa
- Salida de campo
- Sobrevuelo helicoptero

Conclusiones, observaciones

- Hasta ahora: acciones puntuales
- Acciones no han tenido efecto deseado
- Acciones han tenido efectos adversos (ej. eliminacion de las dunas)
- Oportunidad para PEMEX promover su conciencia ambiental
- Potencial de beneficios sociales, economicos para la region

Objetivos

- Plan Maestro: solucion holistica, integral, multifuncional, sostenible
- Recuperacion dunas (incl. vegetacion) y playas
- Implementacion en fases y segmentos

Concepto: Construir con la Naturaleza

- Usar mas que antes los materiales, las fuerzas e interacciones de la Naturaleza
- Creacion de una nueva linea de costa dinamica y flexible, consistiendo de dunas (con vegetacion) y playas
- Equilibrio entre erosion y acrecion
- Minimo de elementos duros
- Arena requerida a traves de dragado amigable al ambiente y en profundidad mas de 20 m
- Minimo de mantenimiento (alimentacion)
- Monitoreo: antes (linea de base), durante y despues (seguimiento)

Prioridad

- Base de datos e informacion: actualizados, completos, confiables
- Todos aspectos relevantes

Actividades

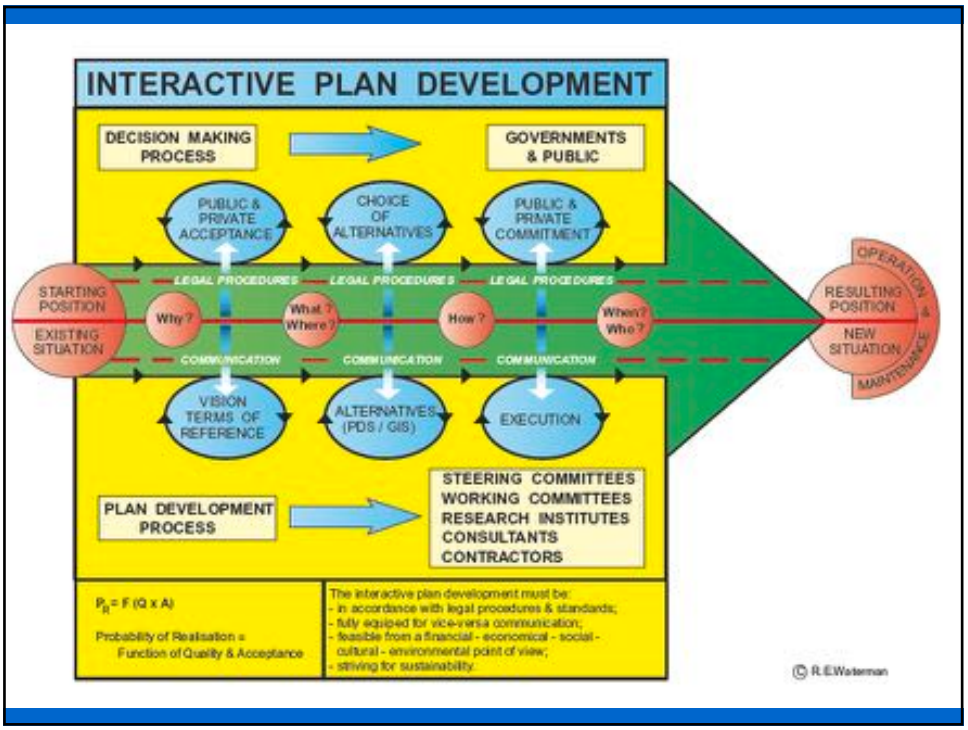
- Establecimiento de una base de datos e informacion:
  - Evaluacion de datos e informacion historicos
  - Identificacion de posibles vacios en el conjunto de datos e informacion
  - Llenar vacios a traves de mediciones en campo
- Confirmar la factibilidad del Construir con la Naturaleza
- Identificacion de obras prioritarias
- Desarrollo del proyecto definitivo apuntando a una solucion holistica, integral, multifuncional y sostenible

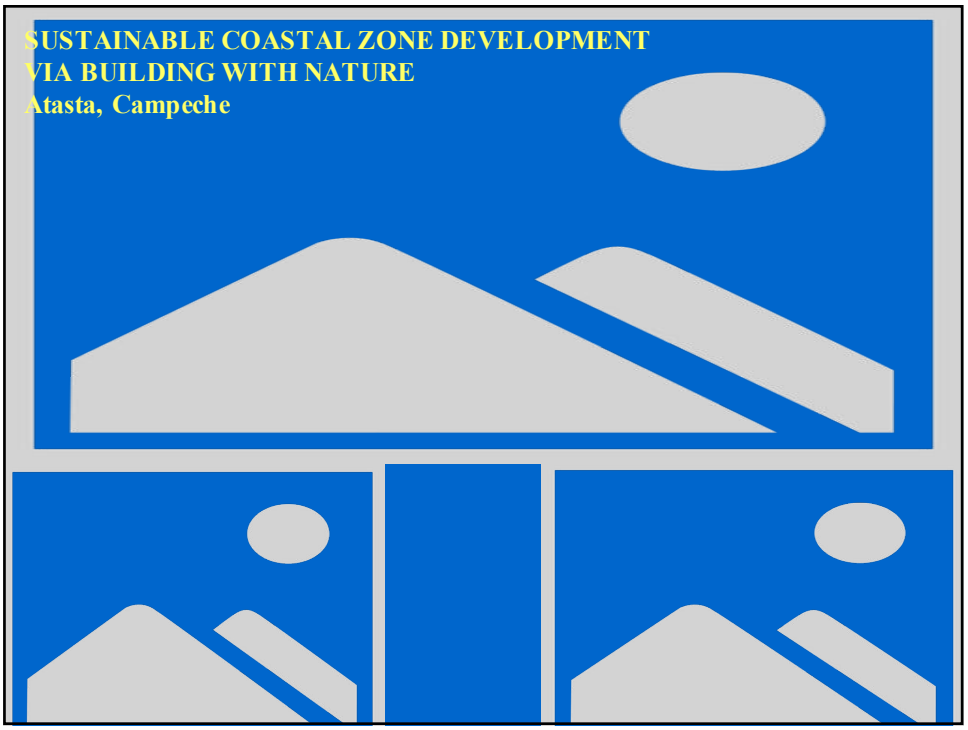
Cronograma

- Hasta finales del 2015
  - Propuesta proyecto datos e informacion
  - Establecimiento base de datos e informacion
  - Desarrollo e implementacion en fases
  - Propuesta proyecto Plan Maestro definitivo (Octubre 2015)
- 2016 - ….
  - Implementacion proyecto definitivo en fases y segmentos

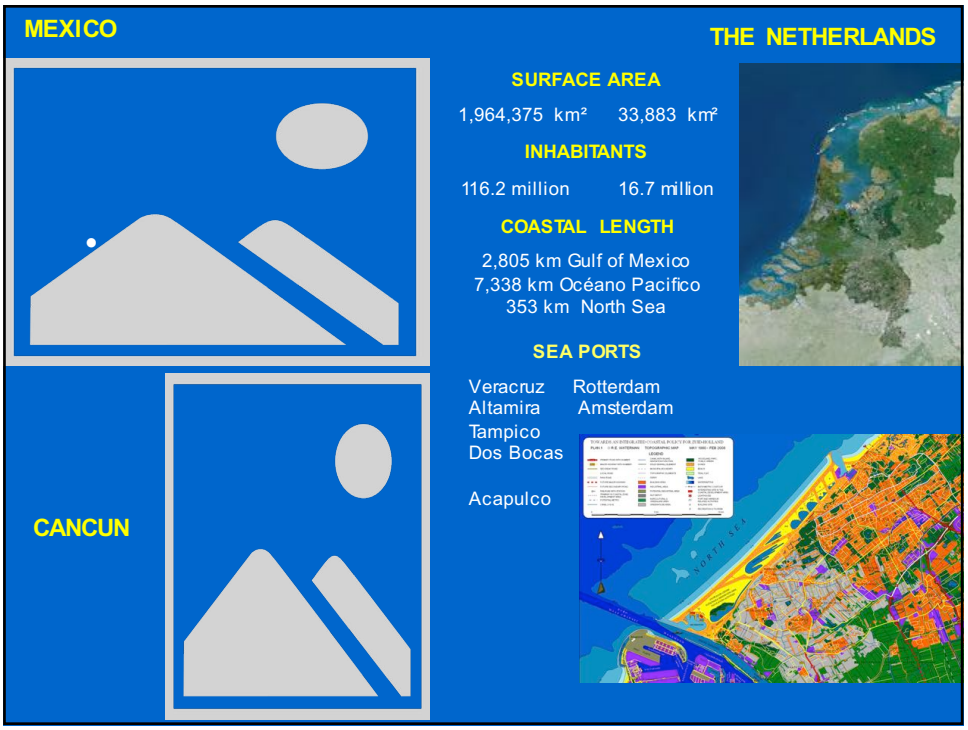
Planificacion

MesX	1	2	3	4	5	6
Evaluacion datos e informacion historicos						
Identificacion vacios en el conjunto de datos e informacion						
Llenar vacios a traves de estudios y trabajo de campo						
Confirmar factibilidad Construir con la Naturaleza						
Identificacion obras prioritarias						
Desarrollo proyecto definitivo						




SUSTAINABLE COASTAL ZONE DEVELOPMENT
VIA BUILDING WITH NATURE
Atasta, Campeche


SUSTAINABLE FUTURE OF INLAND WATERWAYS
Stimulating the Blue Green Economy
for
Regional, Socio-Economic &
Spatial Development,
while safeguarding
Environmental Values & Nature
as well as Safety
430


MEXICO
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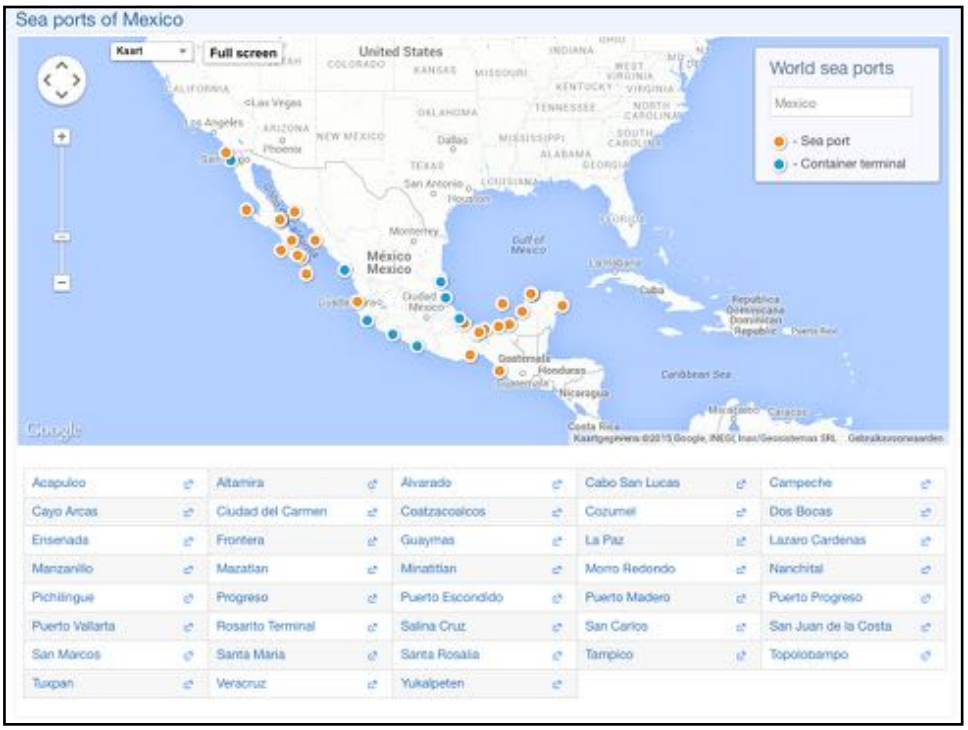
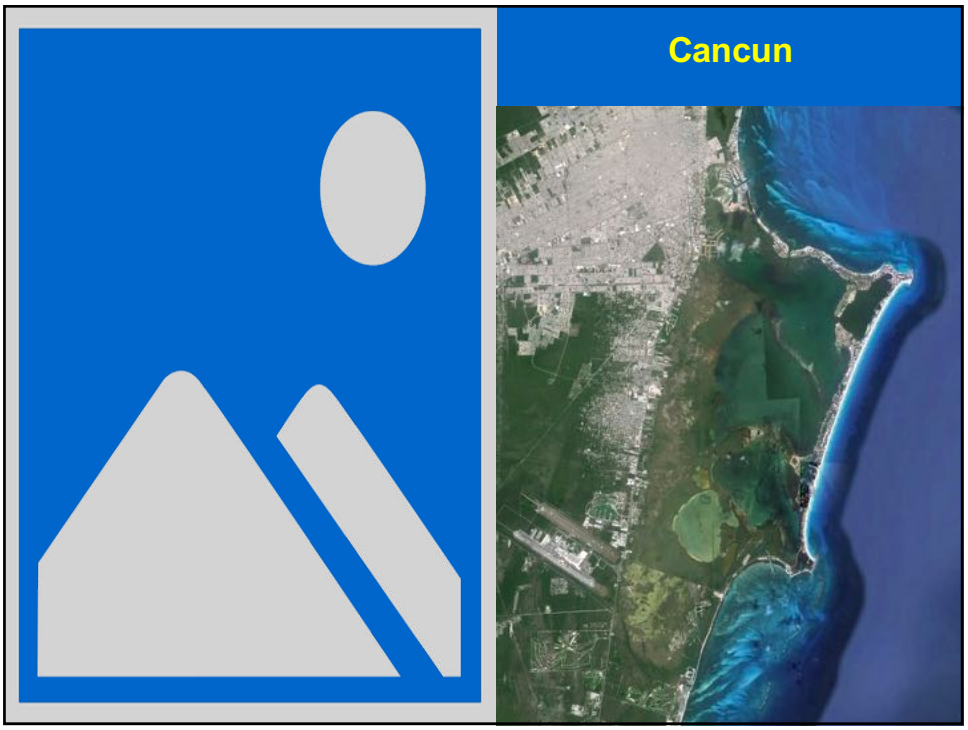
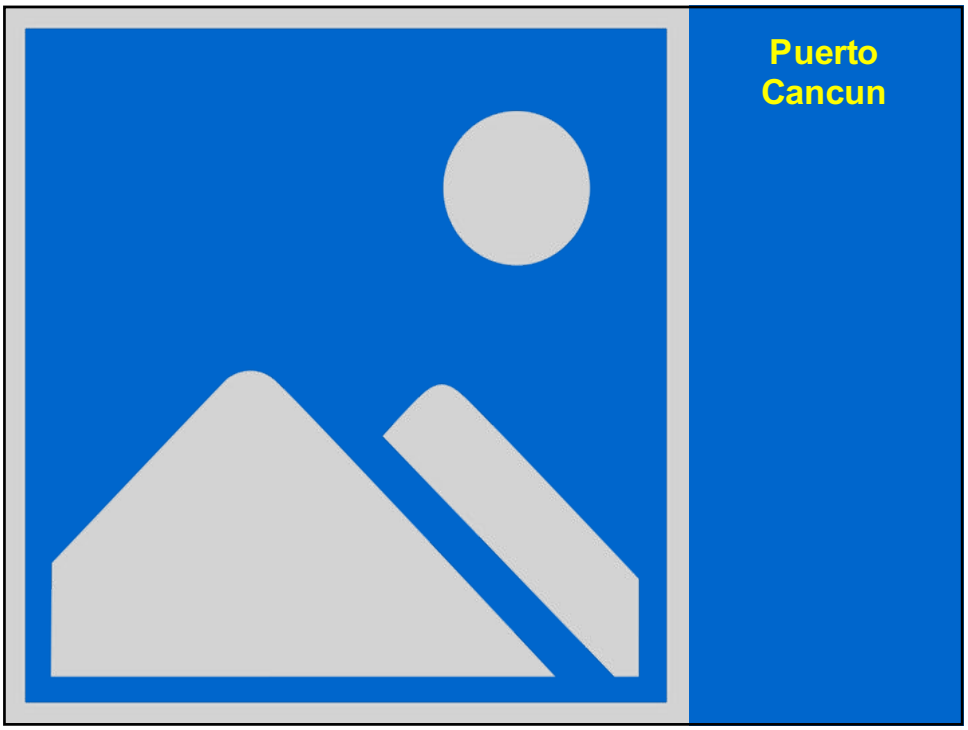
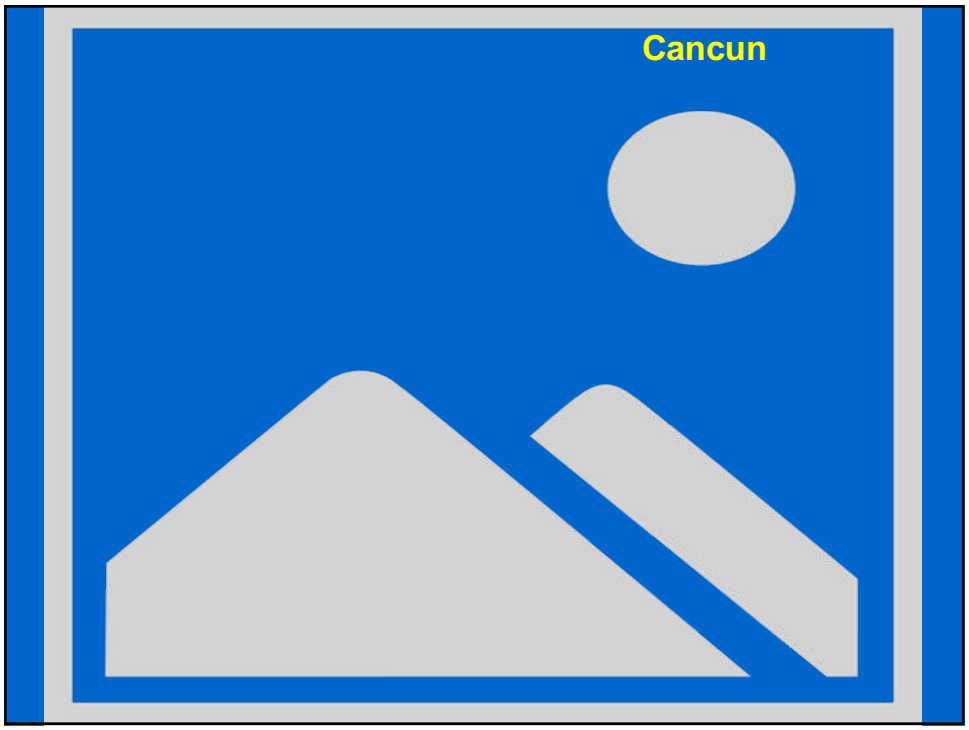
Amsterdam
CANCUN


Sea ports of Mexico
Kaart
Full screen
United States
World sea ports
Mexico
- Sea port
- Container terminal
México
Mexico
Gulf of Mexico
Caribbean Sea
Acapulco
Altamira
Alvarado
Cabo San Lucas
Campeche
Cayo Arcas
Ciudad del Carmen
Coatzacoalcos
Cozumel
Dos Bocas
Ensenada
Frontera
Guaymas
La Paz
Lazaro Cardenas
Manzanillo
Mazatlan
Minatitlan
Morro Redondo
Nanchital
Pichilingue
Progreso
Puerto Escondido
Puerto Madero
Puerto Progreso
Puerto Vallarta
Rosarito Terminal
Salina Cruz
San Carlos
San Juan de la Costa
San Marcos
Santa Maria
Santa Rosalia
Tampico
Topolobampo
Tuxpan
Veracruz
Yukalpeten


Cancun


Puerto
Cancun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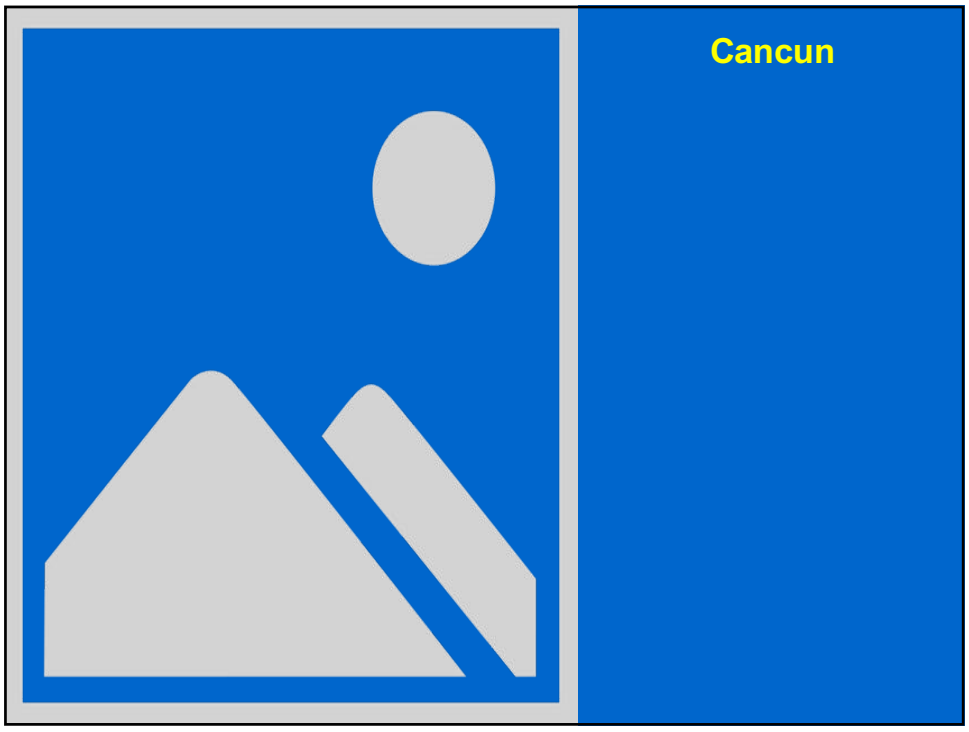
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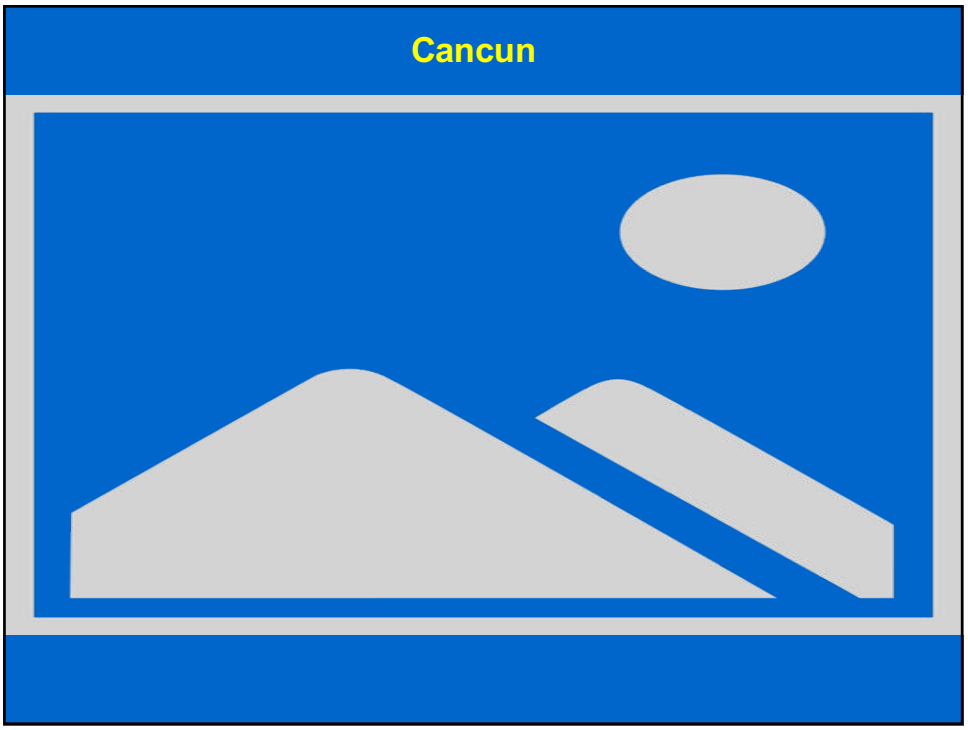
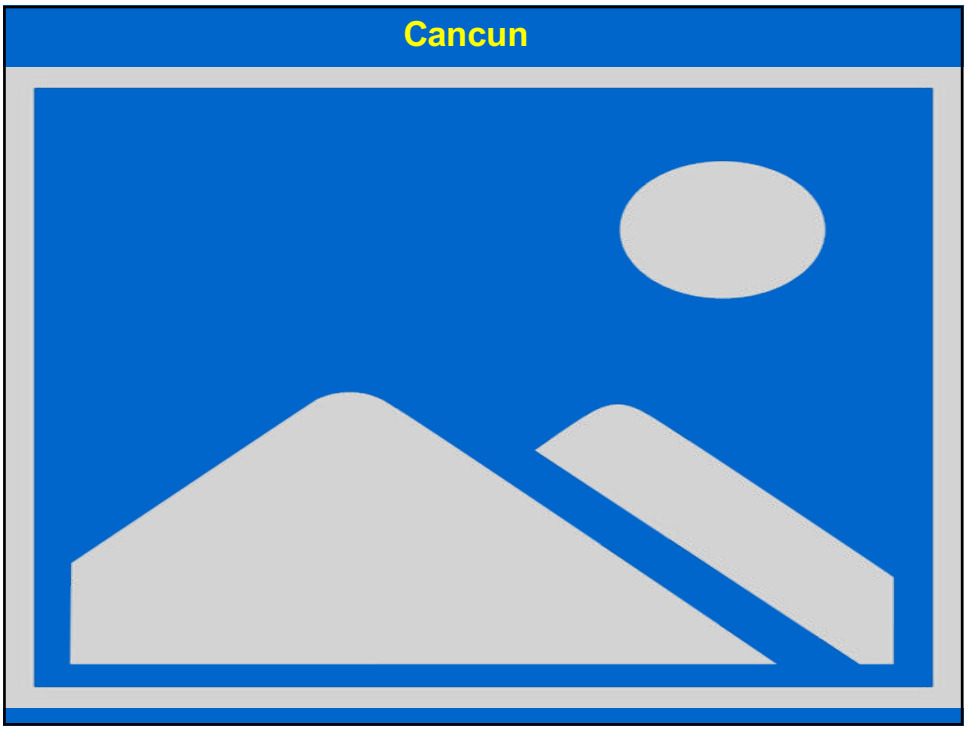

Cancun


Cancun

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  - Proteccion y reduccion de la vulnerabilidad de dunas y playas
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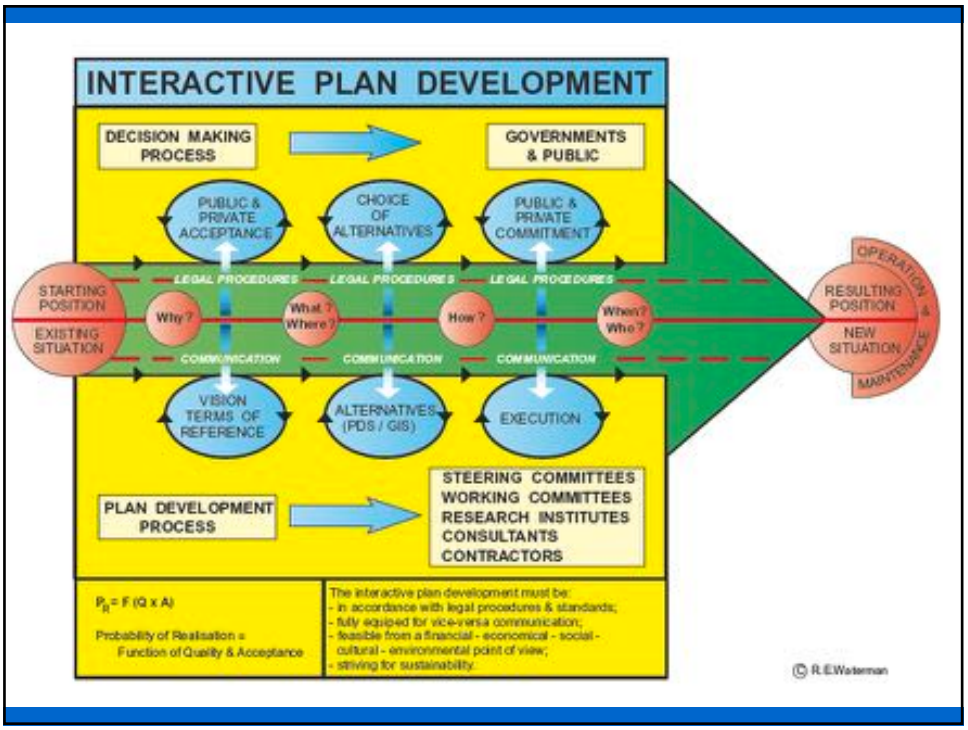


AQUAPUNCTURE©

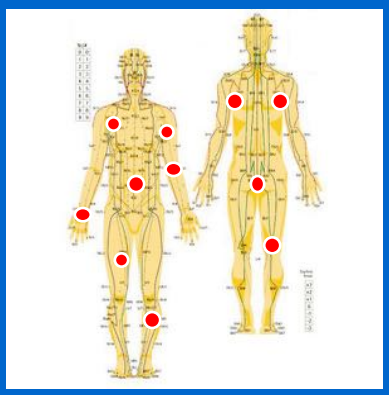
Introduction of AQUAPUNCTURE©
for the optimal use, adaptation & management
of inland waterways and their waterfronts

For economy, employment, spatial quality,
safety & environmental values

448

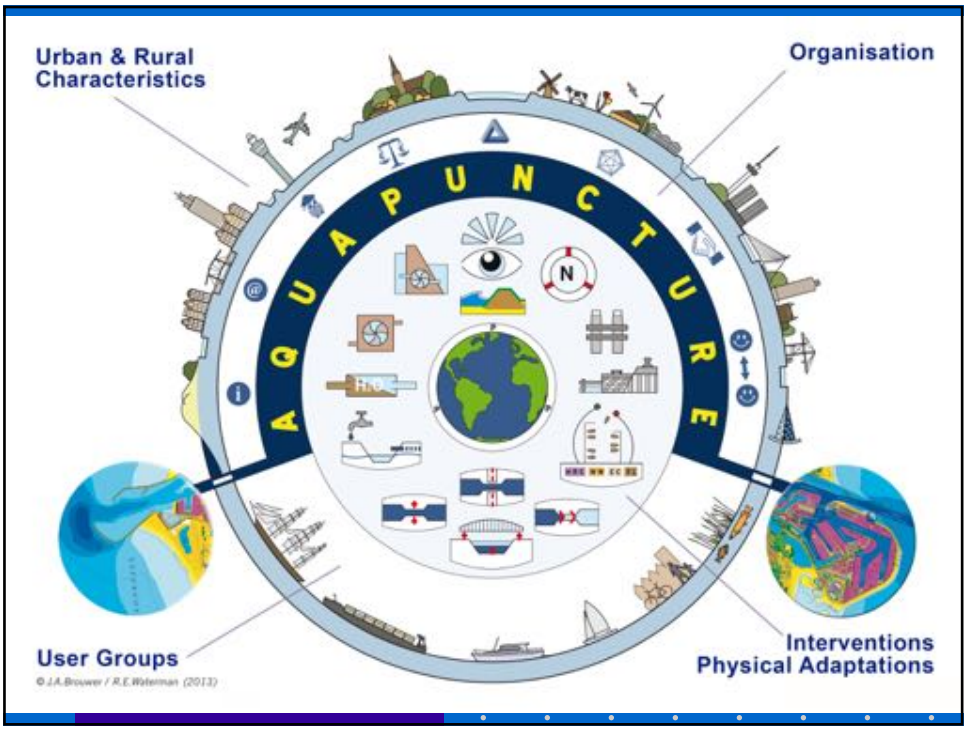
ACUPUNCTURE

to revitalize
the Nervous System
& Human Organs



AQUAPUNCTURE

to revitalize
the Waterways & their
Water Fronts



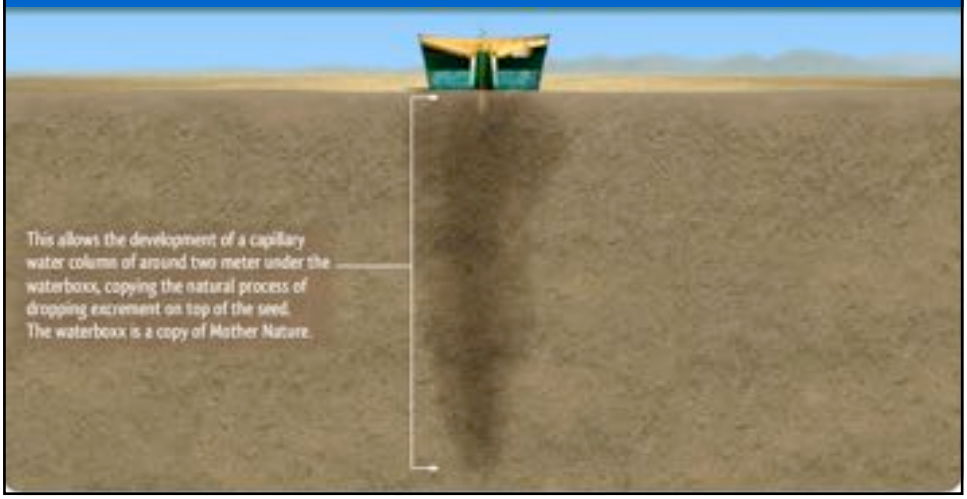
The GROASIS® TREE TECHNOLOGY is an integrated solution to solve food, soil erosion and climate problems by introducing the WATERBOXX

Groasis Greenboxx

Successful planting in Los Monegros Desert – Zaragosa – Spain

The GROASIS® TREE TECHNOLOGY is an integrated solution to solve food, soil erosion and climate problems by introducing the WATERBOXX

The GROASIS® TREE TECHNOLOGY is an integrated solution to solve food, soil erosion and climate problems by introducing the WATERBOXX



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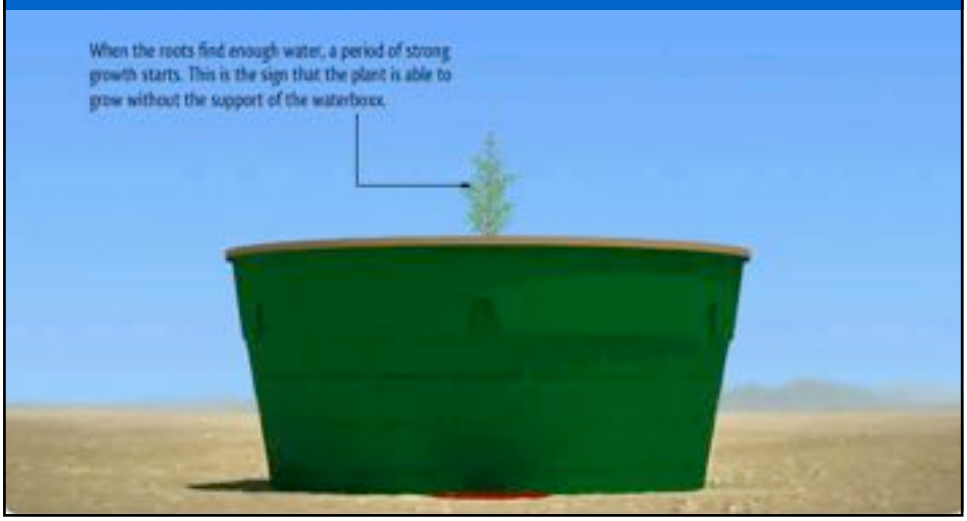


SUSTAINABLE COASTAL ZONE DEVELOPMENT

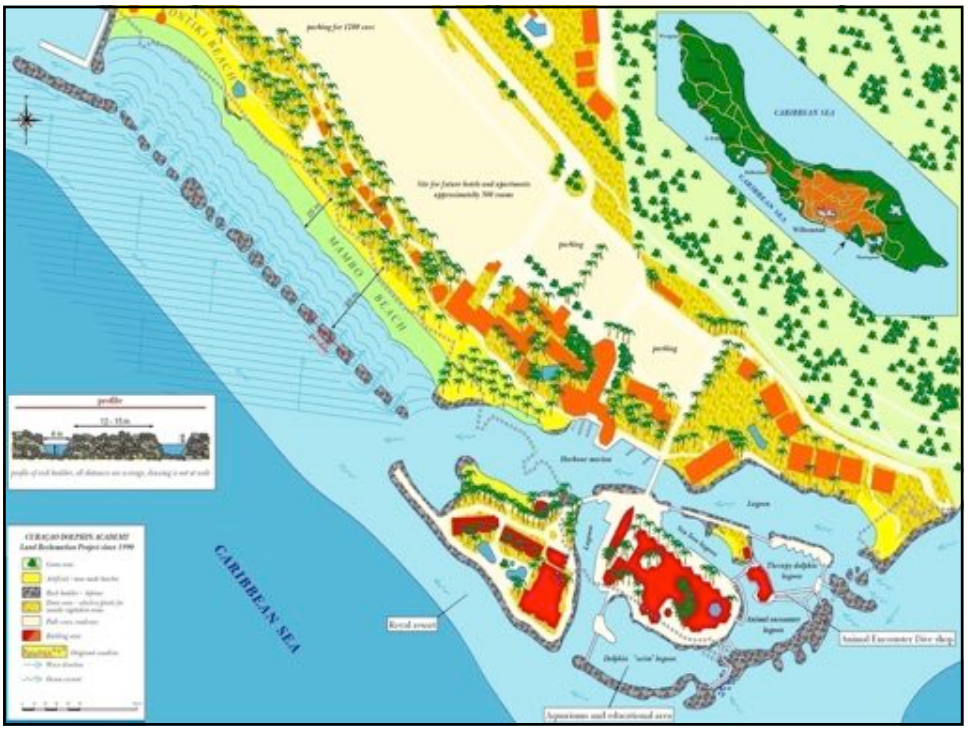
Integrated Coastal Policy via Building with Nature

Dr. R. E. Waterman MSc

CURAÇAO
2013

Curaçao


Curaçao
Westpunt
Barber
Caribbean Sea
Bullen Bay
Julianadorp
Santa Catharina
St Anna Bay
St Joris Bay
Willemstad
Caracas Bay
Fuik Bay
10 km
10 miles
Underwater Marine Park
Little Curaçao
Inhabitants 150,000
Surface Area 444 km²
Length 61 km
Width 5 – 14 km
Coastal Length 364 km
Highest Point Christoffel Berg 375 m


CARIBBEAN SEA

SUSTAINABLE COASTAL ZONE DEVELOPMENT

Integrated Coastal & Delta Policy via Building with Nature®

Prof. Dr. R.E. Waterman MSc

COLOMBIA – THE NETHERLANDS

2015


LIBERTAD Y ORDEN
JE MAINTIENDRAI


COLOMBIA
THE NETHERLANDS
SURFACE AREA
1,141,748 km²
33,883 km²
INHABITANTS
45.8 million
16.7 million
COASTAL LENGTH
1760 km Mar Caribe
1448 km Océano Pacifico
353 km North Sea
MAIN RIVER BASINS
Magdalena-Cauca
Orinoquia
Amazonia
Caribe
Pacifico
Rhine - Maas - Scheldt
SEA PORTS
Cartagena de Indias
Barranquilla
Santa Marta
Buenaventura
Tumaco
Rotterdam - Amsterdam
COLOMBIA
PANAMA

PACIFIC COAST

Mostly rocky with steep rocky slope

Tidal difference up to 7 m

Currents more random and coastline is prone to tsunamis

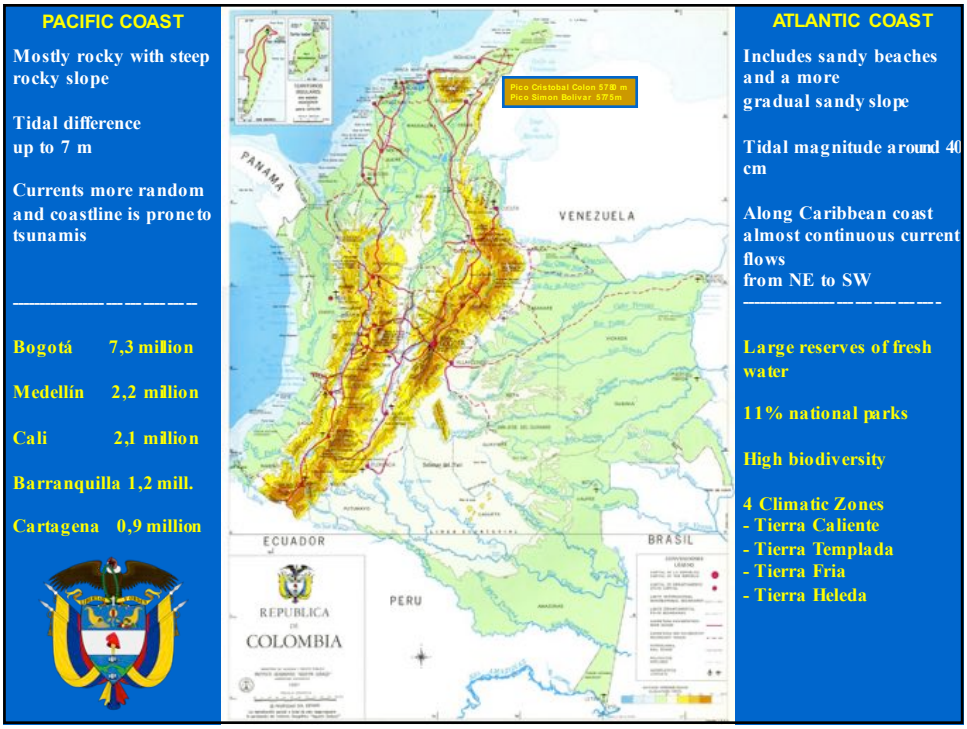
Bogotá 7,3 million

Medellín 2,2 million

Cali 2,1 million

Barranquilla 1,2 mill.

Cartagena 0,9 million



ATLANTIC COAST

Includes sandy beaches and a more gradual sandy slope

Tidal magnitude around 40 cm

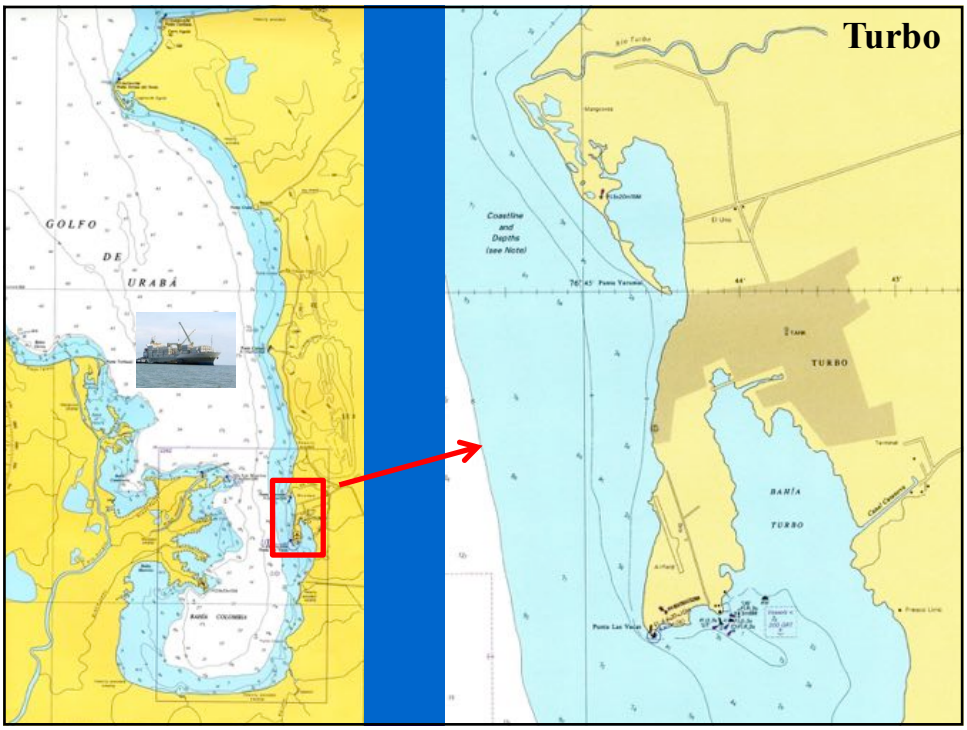
Along Caribbean coast almost continuous current flows from NE to SW

Large reserves of fresh water

11% national parks

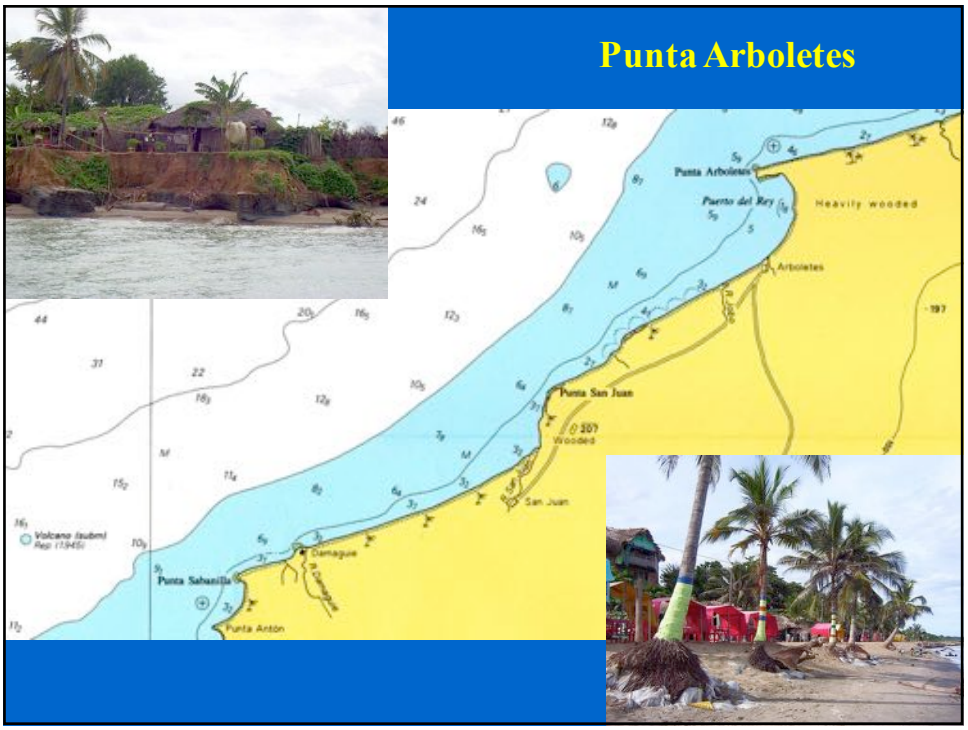
High biodiversity

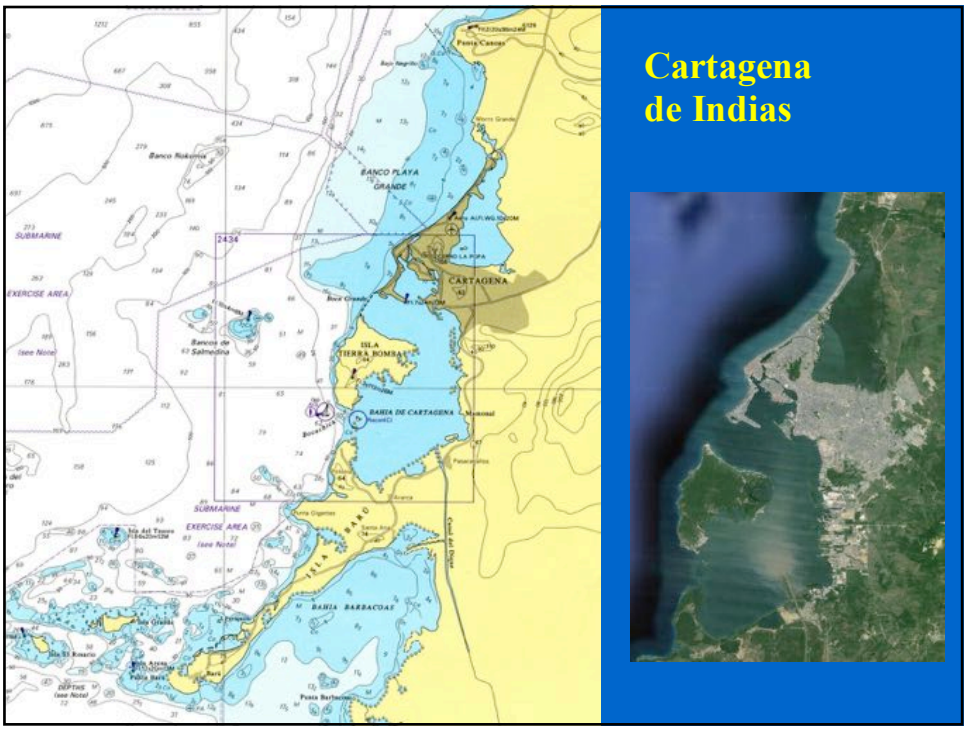
4 Climatic Zones
- Tierra Caliente
- Tierra Templada
- Tierra Fria
- Tierra Heleda




Golfo
de
Urabá
&
Turbo


Golfo
de
Urabá
&
Turbo


Punta Arboletes
Punta Arboletes
Puerto del Rey
Heavily wooded
Arboletes
Punta San Juan
Wooded
San Juan
Damague
Punta Sabanilla
Punta Anton
Volcano (subm)


Cartagena
de Indias
BANCO PLAYA GRANDE
CARTAGENA
ISLA TIERRA BOMBA
BAHIA DE CARTAGENA
ISLA BARU
BAHIA BARBACOAS
SUBMARINE
EXERCISE AREA


Cartagena de Indias


BANCO PLAYA GRANDE
CARTAGENA
ISLA TIERRA BOMBA
BAHIA DE CARTAGENA
Cartagena de Indias


Cartagena
de Indias


Barranquilla
&
Rio Magdalena

GEODESY

In planning & design Geodesy plays an essential role.

Historical and actual data with regard to land & sea surfaces and sub surfaces are needed for planning & map making.

Measurements are required through land- and sea survey, including Remote Sensing.

SUSTAINABLE MULTI-FUNCTIONAL COASTAL ZONE DEVELOPMENT

General approach

A. ***Integrated Coastal Policy*** to give an answer to the question: How can we solve many existing and future problems in relation to each other, in relation to the existing hinterland on the one hand and in relation to the bordering sea on the other, while creating added value

B. Application of the method ***Building with Nature***® using more than before the materials and forces/interactions present in nature, creating a new flexible dynamic equilibrium coast in which accretion and erosion are more or less balancing each other with a minimum of solid seawall elements. Taking into account the bio-geomorphology & geohydroloy of coast & seabed.

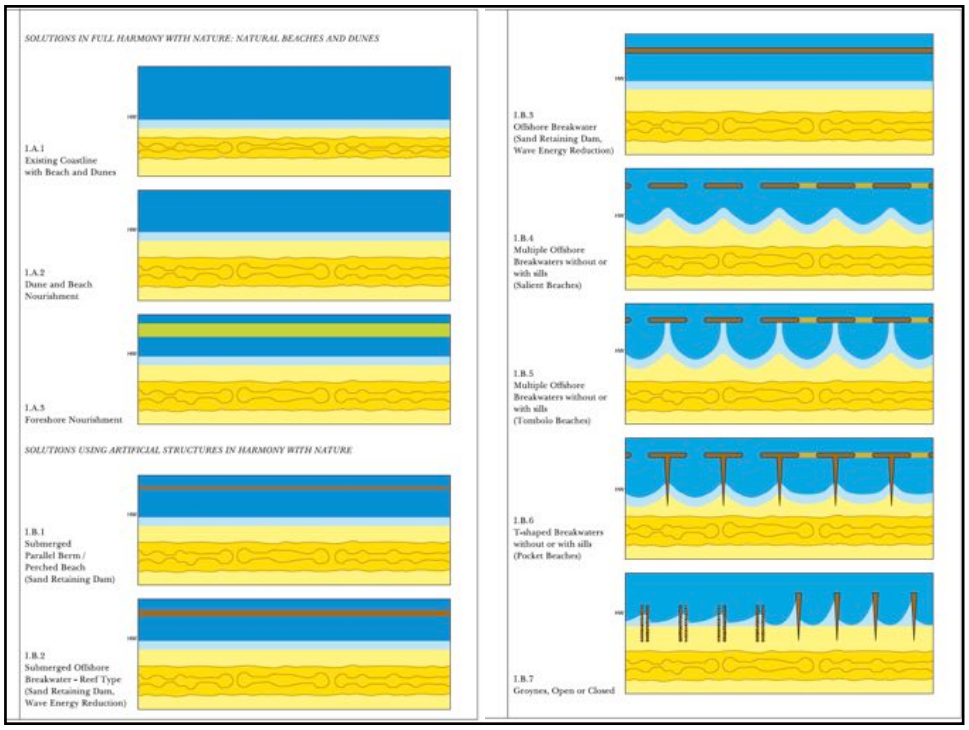
SUSTAINABLE MULTI-FUNCTIONAL COASTAL ZONE DEVELOPMENT

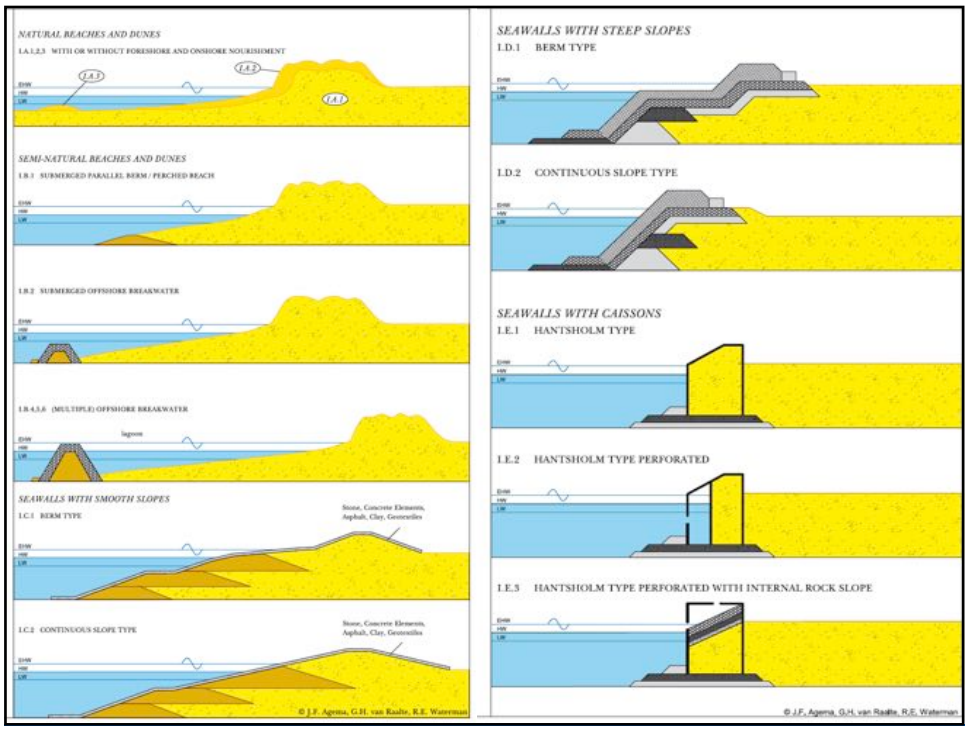
Local Measures

1. Dune & Beach & Foreshore nourishment
2. Restoration of natural sediment transport
3. Sand Engine for long term maintenance
4. Making work with work: reuse of dredged material
5. Mangrove rehabilitation
6. Application of sand packed geotextiles, poles & sticks
7. Reshaping cliffs with adequate slope combined with vegetation
8. Preservation & restoration of Coral Reefs; artificial reefs
9. Use of existing Barrier Islands
10. Introduction of a minimum of Coast Parallel Breakwaters
11. Spatial Planning

PRINCIPALES MEDIDAS PARA MITIGAR LA EROSION

1. La restauración del transporte natural de sedimentos
2. La reutilización de material dragado
3. La regeneración de arena
4. La rehabilitación de manglares
5. La remodelación de acantilados
6. El desarrollo de arrecifes de coral
7. El uso inteligente de estructuras duras
8. Medidas de protección a pequeña escala
9. La planificación espacial


SOLUTIONS IN FULL HARMONY WITH NATURE: NATURAL BEACHES AND DUNES
I.A.1 Existing Coastline with Beach and Dunes
I.A.2 Dune and Beach Nourishment
I.A.3 Foreshore Nourishment
SOLUTIONS USING ARTIFICIAL STRUCTURES IN HARMONY WITH NATURE
I.B.1 Submerged Parallel Berm / Perched Beach (Sand Retaining Dam)
I.B.2 Submerged Offshore Breakwater - Reef Type (Sand Retaining Dam, Wave Energy Reduction)
I.B.3 Offshore Breakwater (Sand Retaining Dam, Wave Energy Reduction)
I.B.4 Multiple Offshore Breakwaters without or with sills (Salient Beaches)
I.B.5 Multiple Offshore Breakwaters without or with sills (Tombolo Beaches)
I.B.6 T-shaped Breakwaters without or with sills (Pocket Beaches)
I.B.7 Groynes, Open or Closed


NATURAL BEACHES AND DUNES
I.A.1,2,3 WITH OR WITHOUT FORESHORE AND ONSHORE NOURISHMENT
SEMI-NATURAL BEACHES AND DUNES
I.B.1 SUBMERGED PARALLEL BERM / PERCHED BEACH
I.B.2 SUBMERGED OFFSHORE BREAKWATER
I.B.4,5,6 (MULTIPLE) OFFSHORE BREAKWATER
lagoon
SEAWALLS WITH SMOOTH SLOPES
I.C.1 BERM TYPE
I.C.2 CONTINUOUS SLOPE TYPE
Stone, Concrete Elements, Asphalt, Clay, Geotextiles
SEAWALLS WITH STEEP SLOPES
I.D.1 BERM TYPE
I.D.2 CONTINUOUS SLOPE TYPE
SEAWALLS WITH CAISSONS
I.E.1 HANTSHOLM TYPE
I.E.2 HANTSHOLM TYPE PERFORATED
I.E.3 HANTSHOLM TYPE PERFORATED WITH INTERNAL ROCK SLOPE
© J.F. Agema, G.H. van Raalte, R.E. Waterman

PACIFIC COAST

Mostly rocky with steep rocky slope

Tidal difference up to 7 m

Currents more random and coastline is prone to tsunamis

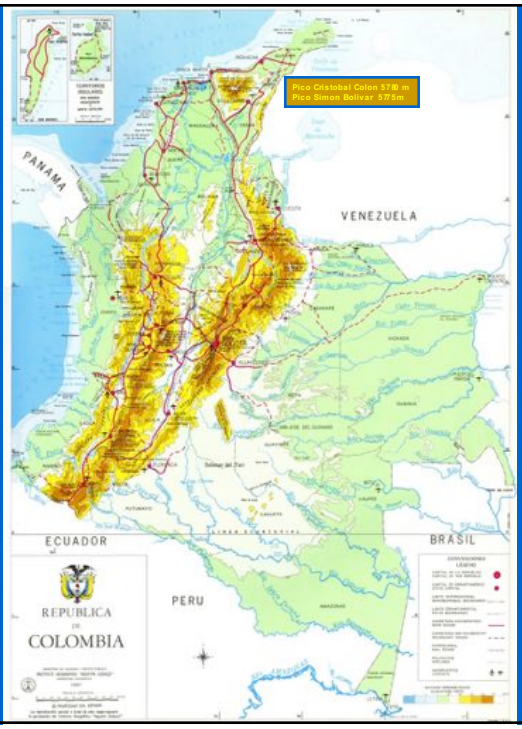
Bogotá 6,9 million

Medellín 2,2 million

Cali 2,1 million

Barranquilla 1,2 mill.

Cartagena 0,9 million



ATLANTIC COAST

Includes sandy beaches and a more gradual sandy slope

Tidal magnitude around 40 cm

Along Caribbean coast almost continuous current flows from NE to SW

MAIN RIVER BASINS

Magdalena-Cauca

Orinoquia

Amazonia

Caribe

Pacifico

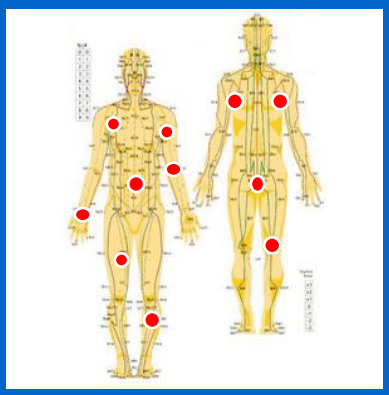
MAIN RIVER BASINS

Magdalena-Cauca
Orinoquia
Amazonia
Caribe
Pacifico

Flood Areas

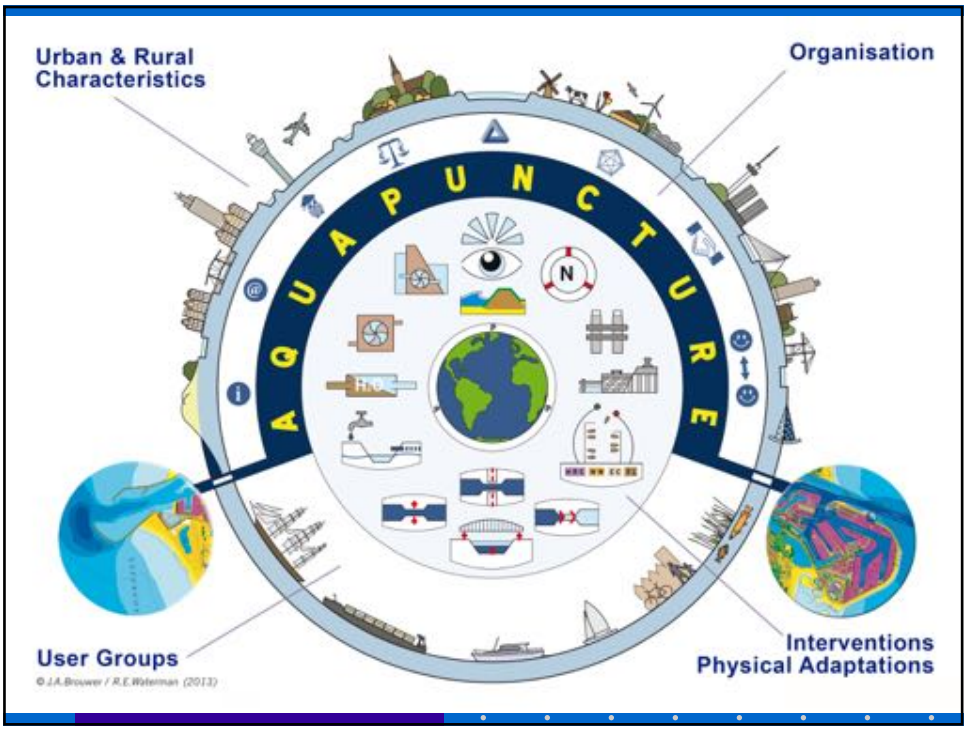
ACUPUNCTURE

to revitalize
the Nervous System
& Human Organs



AQUAPUNCTURE

to revitalize
the Waterways & their
Water Fronts



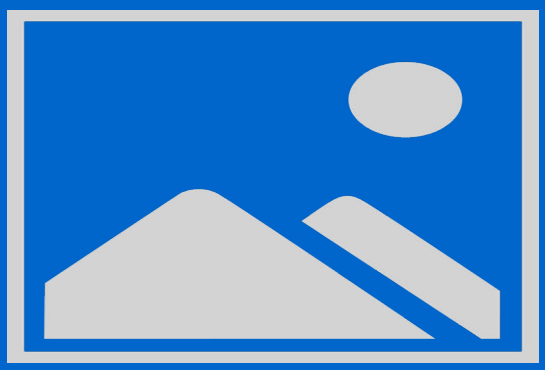
Recuperación del Canal del Dique

Length 120 km, from Catagena to Rio Magdalena & Calamar

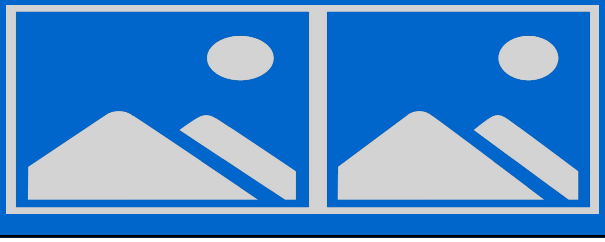
Recuperation complete with dikes, new locks & marsh improvements

AGUAPUNTURA©
for the optimal use & adaptation of the waterway
and the waterfronts for economy, employment, environment, nature & landscape

Rio Magdalena



Rio Magdalena –
Length 1540 km



AGUAPUNTURA©
for the optimal use & adaptation of the waterway and the waterfronts for economy, employment, environment, nature & landscape

Rio Bogotá

The relation between Bogotá and the Rio Bogotá should be improved through AGUAPUNTURA©

AGUAPUNTURA©
for the optimal use & adaptation of the waterway
and the waterfronts for economy, employment, environment, nature & landscape

Bogotá

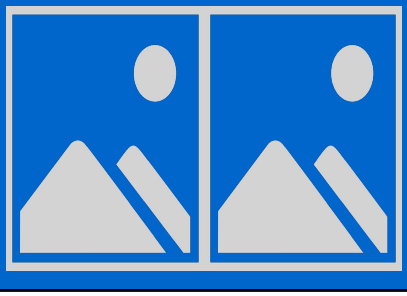
7.3 million inhabitants

Rio Medellin

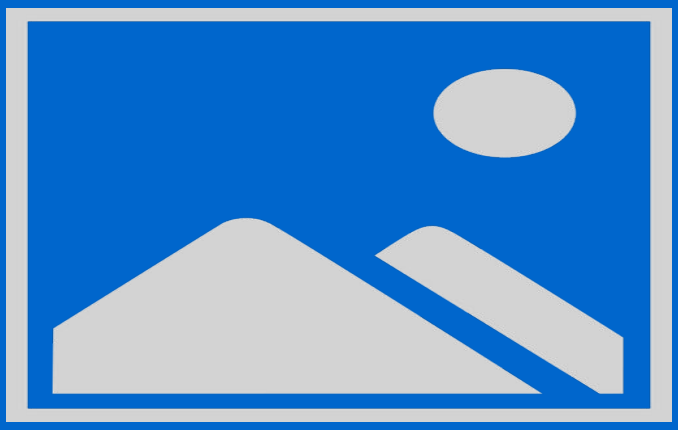
Medellin - 2.2 million inhabitants

Rio Medellin - Length 100 km
(60 km Medellin & 40 km Porce)

AGUAPUNTURA©
for the optimal use & adaptation of the waterway and the waterfronts for economy, employment, environment, nature & landscape

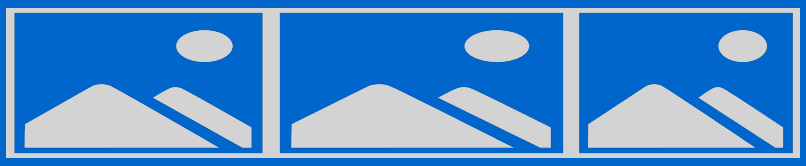


Rio Cauca

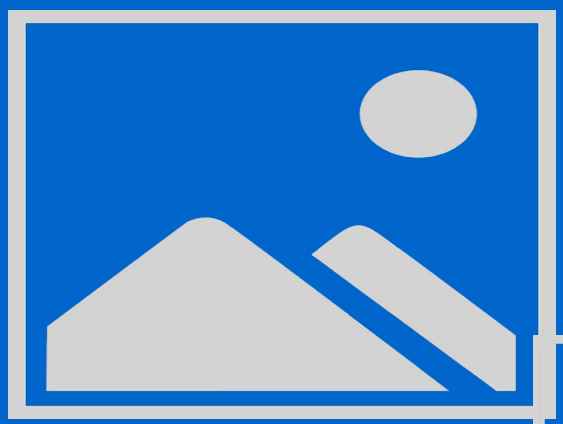


Rio Cauca –
Length 965 km

AGUAPUNTURA©
for the optimal use & adaptation of the waterway
and the waterfronts for economy, employment, environment, nature & landscape



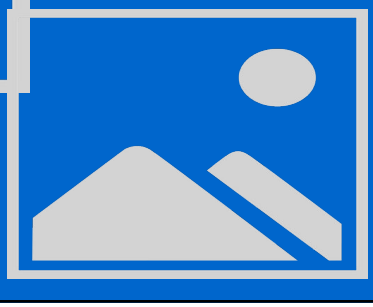
Rio Cali



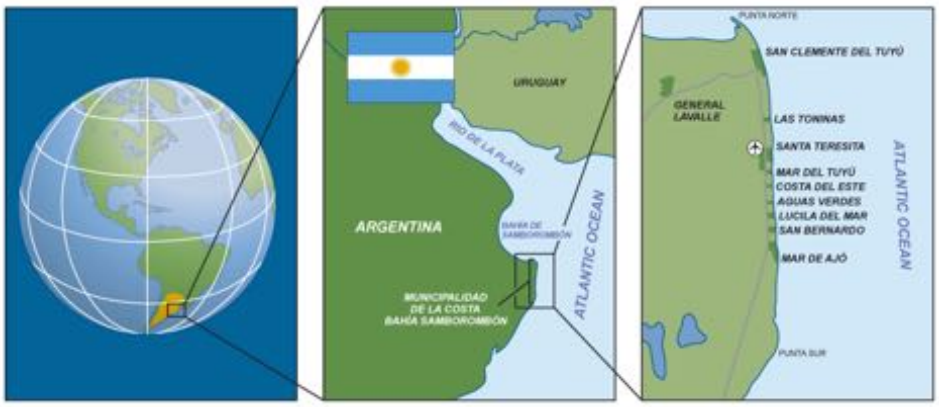
Santiago de Cali –
2.0 million inhabitants

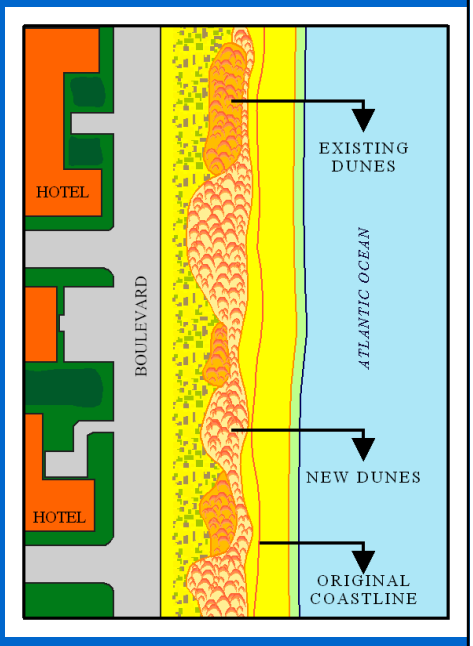
Rio Cali

AGUAPUNTURA©
for the optimal use & adaptation of the waterway and their waterfronts for economy, employment, environment,
nature & landscape

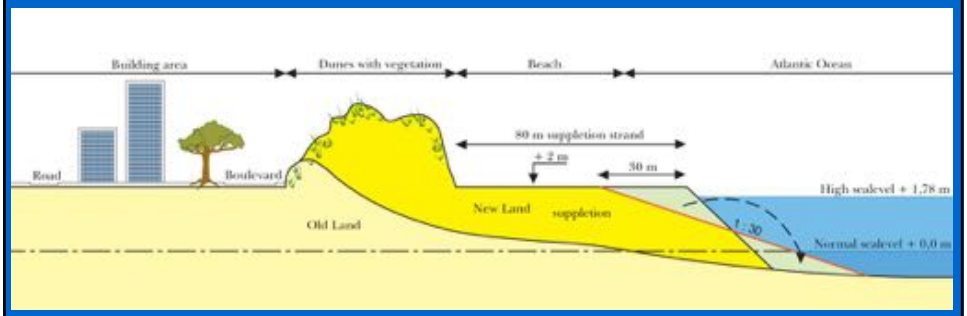


Argentina – *Municipalidad de la Costa*





Argentina – *Municipalidad de la Costa*

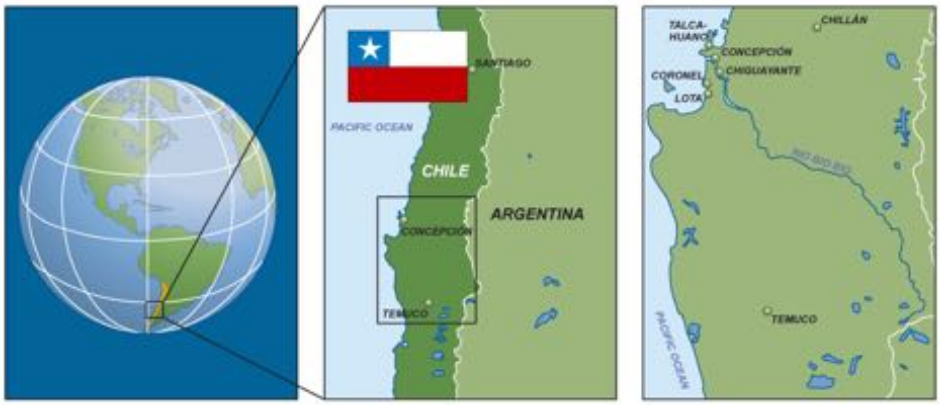


Argentina

Mar del Tuyu

San Clemente del Tuyu

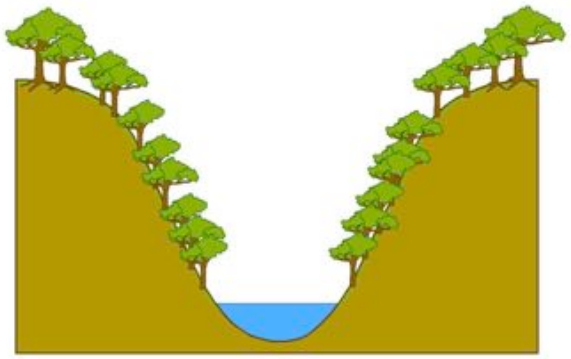
Chile



Chile *Rio Bio Bio*

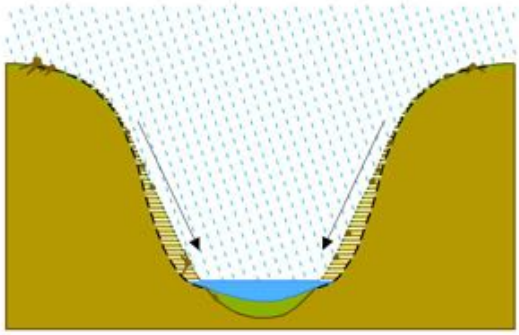
RIO BIO BIO IN CHILE

Cross section in original situation of riverbanks with trees, shrubs and a navigable river.



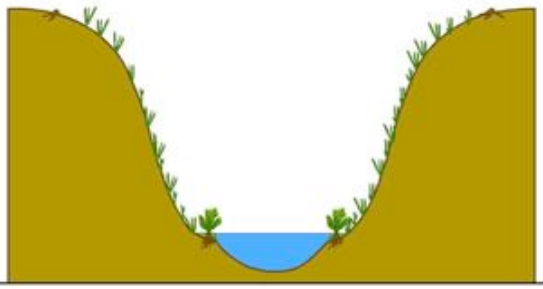
Chile *Rio Bio Bio*

Cross section with man-induced erosion by tree logging leading to a wider but less deep riverbed which in turn causes reduced navigatebility and reduction of fertile land.



Chile *Rio Bio Bio*

Cross section with river bank restoration by tree planting and planting of tree saplings in the river causing local sedimentation and land reclamation, which in turn forces the river in a narrower and deeper riverbed, thereby restoring the original river depth.



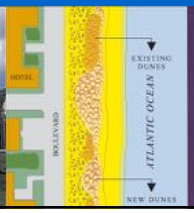
Chile *Rio Bio Bio*

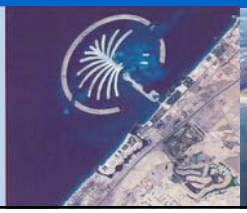
BUILDING WITH NATURE

Building with Nature®

$(\alpha+\beta+\gamma)_{\text{knowledge + action}} \longrightarrow \Delta_{\text{sustainable}}$

Question Time





GEODESY

In planning & design Geodesy plays an essential role.

Historical and actual data with regard to land & sea surfaces and sub surfaces are needed for planning & map making.

Measurements are required through land- and sea survey, including Remote Sensing.

Spatial plan based on a six layer system

SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE

1. Underground Layer (Soil / Hydrosphere)

The underground layer with its composition and structure and all its natural resources serves a whole series of natural functions. In addition to these natural functions, it fulfils and can fulfil a series of human-initiated and humanmade functions in and on the underground layer, which are and have to be based on its soil, sub-soil and hydrosphere characteristics.
This underground layer serves as a basis for:

- landscape & seascape
- agriculture, fishery, aquaculture
- exploitation of composite minerals, ores
- foundation for building sites and infrastructure
- storage for waste products, energy, water and CO2
- terrestrial & aquatic nature values
- extraction groundwater & surface water
- geothermal energy, water energy, fossil energy
- tunnels, cables, pipelines, geodetic domes
- preservation historic and archaeological sites.

The composition and structure of the underground layer are of vital importance for the following layers.

SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE

2. Green-Blue Layer

This layer contains all valuable terrestrial & aquatic nature values, including landscape and seascape, rivers, lakes, ponds and waterways that are in constant need of conservation.

3. Agriculture – Fishery – Aquaculture Layer

This production layer contains all forms of agriculture (greenhouse horticulture, forestry, cattle & poultry breeding, dairy farming); fishery & aquaculture (including mariculture); the production of microorganisms and their metabolic products.

This layer has a clear overlap and interaction with the green-blue layer, especially since production and nature protection are increasingly combined.

SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE

4. Occupation Layer

The occupation layer contains all building sites for living, working and recreation with all additional facilities amongst others related to education, health care & welfare, religion, shopping, sports and culture.

5. Infrastructure Layer

This layer contains all forms of infrastructure: waterways, roads (including motorways, cycle paths, and footpaths), railroads, pipe / tube / cable, air lanes, electronic highway. In this infrastructure layer, are also present all construction / engineering / structural works such as bridges, tunnels, viaducts, aqueducts, sluices, weirs, railroad stations, metro stations and bus stations, airports, pumping stations, transformers, transceiver stations, sensors, electronic signalling and control equipment. This infrastructure layer serves to link cities, ports and urban, rural & sea areas.

SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE

6. Atmosphere Layer

This umbrella layer is essential for the climate cycle, hydrological cycle as well as other cycles. It is also an important medium for transportation of electromagnetic waves, sound waves and matter in all its diversity.

Although these six layers are separately defined, which in itself is very useful, clearly the six layers are strongly interrelated and partly overlapping each other.

In the spatial planning process with regard to the separate and interrelated layers, special attention must be given to the composition of the underground layer and thereby in general to the third dimension.

SUSTAINABLE COASTAL & DELTAIC ZONE
DEVELOPMENT VIA BUILDING WITH NATURE

Relation
Environment – Economy – Space

SIGNIFICANCE OF THE ANTHROPOCENE

Dr. R.E. Waterman Msc

Estimated age of the universe: approx. 13.5 billion / year

Estimated age of the earth: approx. 4.5 billion / year

Geological periods:

Precambrium
Cambrium
Ordovicium
Silurian
Devonian
Carboniferous
Perm
Triassic
Jurassic
Cretaceous
Tertiair
Quartair: Pleistocene – Holocene – Anthropocene

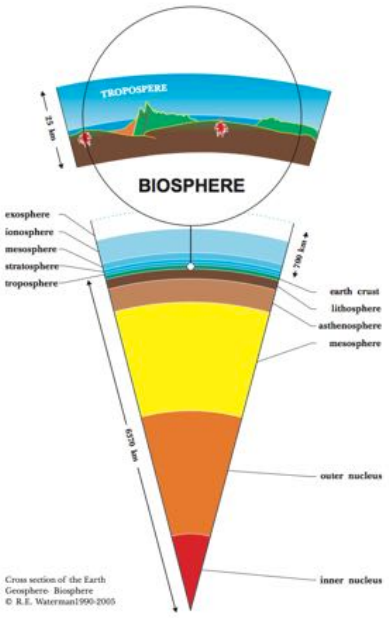
ANTHROPOCENE

For the first time in the geological history MANKIND has become a geological factor by numbers and lifestyle

Global footprint =

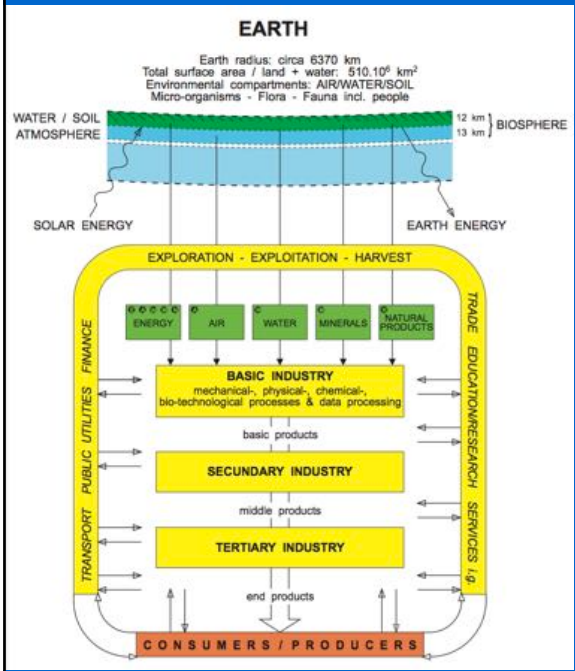
F (size of population, lifestyle, technology)

Necessity: stabilizing world population, lifestyle modification and introduction of technologies focused on sustainability



Apart from space travel all human activities take place in a thin shell around the earth: the geosphere - biosphere – sociosphere system

There we find the environmental compartments Air – Water – Soil, flora, fauna, micro-organisms and people and all the material expressions of human activities



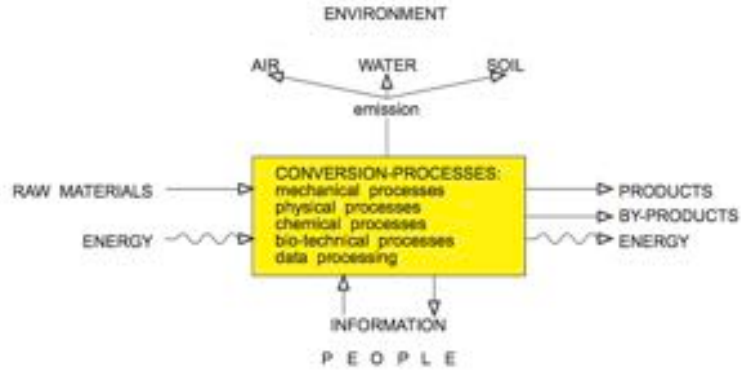
MANKIND extracts from / in the geosphere raw materials and energy

Every human being is at the same time

PRODUCER & CONSUMER

1804: 1 billion people
1927: 2 billion people
2000: 6 billion people
2012: 7 billion people
2050: 9 billion people

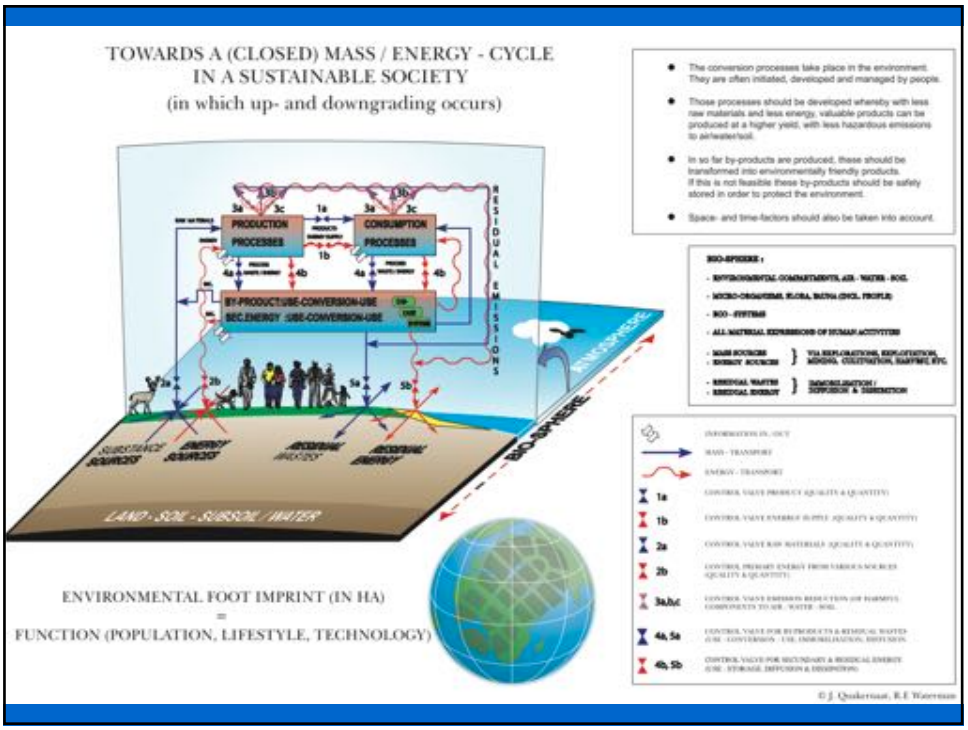
Process innovations take place in the environment and are initiated, developed and managed by people

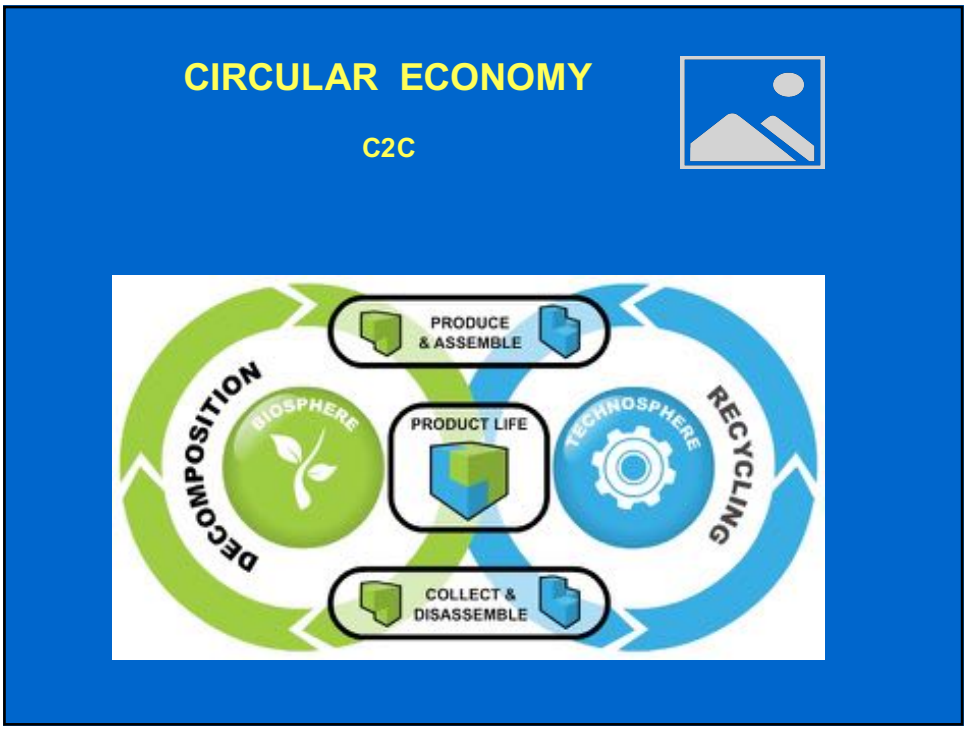


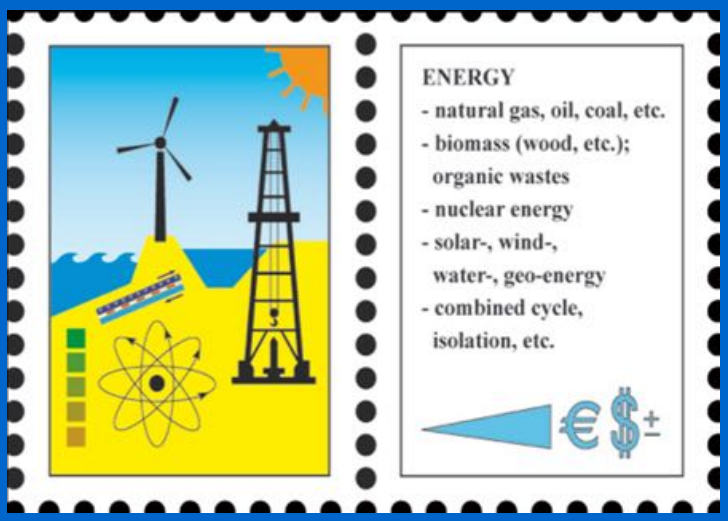
The great challenge of the 21st century is to develop and implement conversion processes in such a way that at the same time the economy is strengthened and the environment improved

Environmental Technology

Triple - C approach


TOWARDS A (CLOSED) MASS / ENERGY - CYCLE
IN A SUSTAINABLE SOCIETY
(in which up- and downgrading occurs)
PRODUCTION PROCESSES
CONSUMPTION PROCESSES
RESIDUAL EMISSIONS
BIO-SPHERE
LAND - SOIL - SUBSOIL / WATER
ENVIRONMENTAL FOOT IMPRINT (IN HA)
=
FUNCTION (POPULATION, LIFESTYLE, TECHNOLOGY)


CIRCULAR ECONOMY
C2C
PRODUCE & ASSEMBLE
BIOSPHERE
PRODUCT LIFE
TECHNOSPHERE
DECOMPOSITION
RECYCLING
COLLECT & DISASSEMBLE

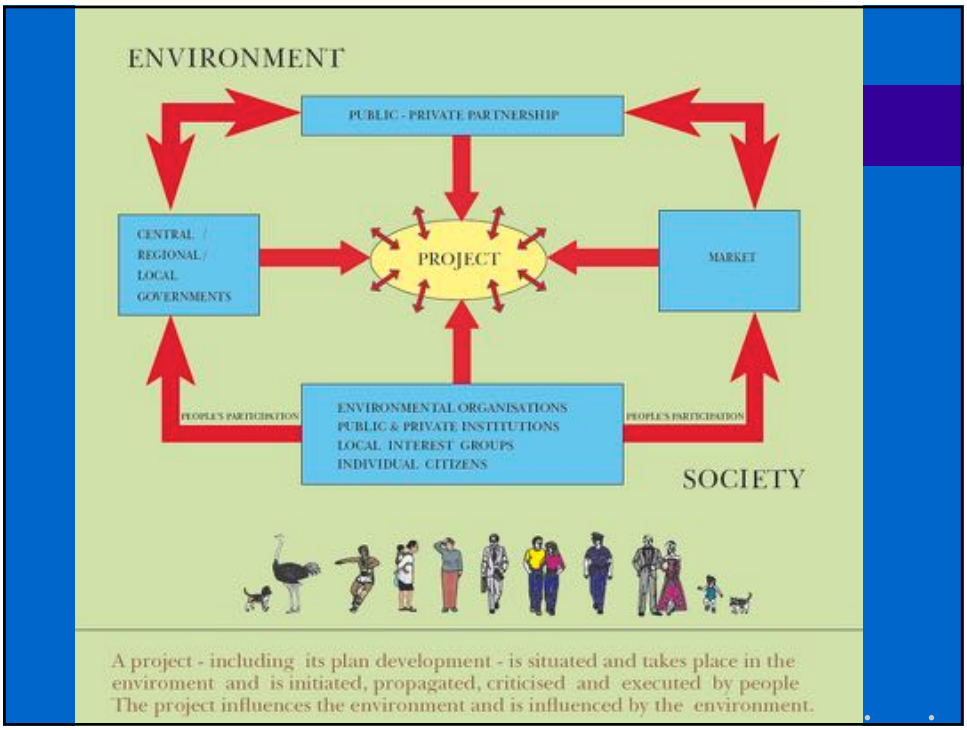


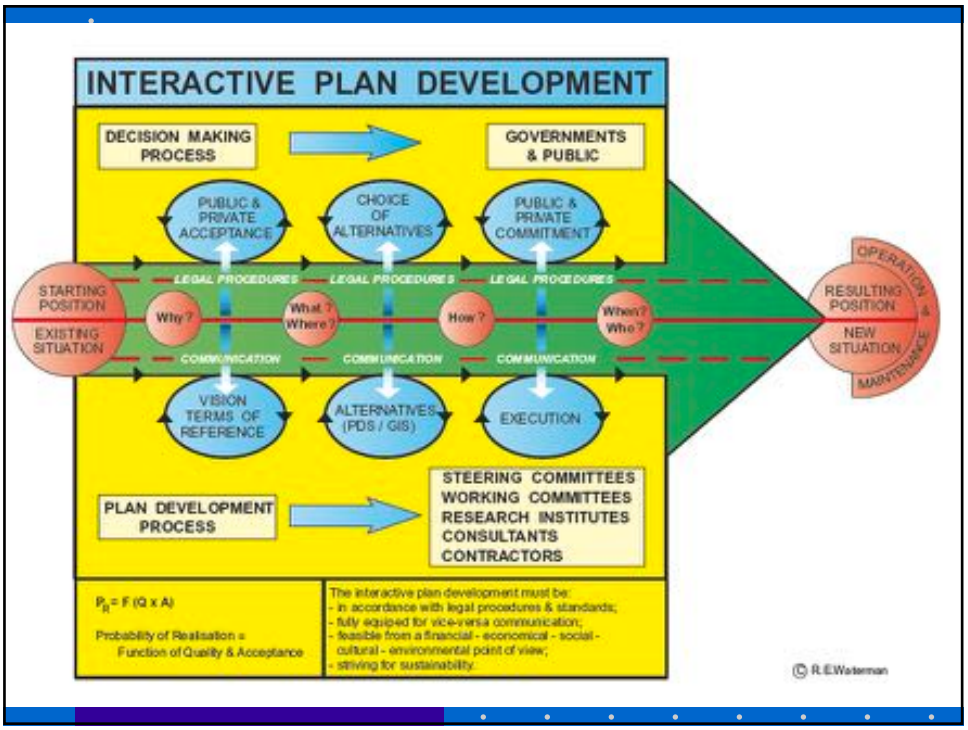
Special attention for the Energy Conversion – Storage – Transport and for the application of Photovoltaic Cells, Concentrated Solar Power & Biomass

SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE

Interactive Plan Development

SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE





SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE

Vision

Vision plays a crucial and essential role from start to finish in any interactive plan development process. Without vision neither an excellent plan design, nor its development can be achieved.

Every plan development is or should be based on a well-founded vision.

Ideally, this vision, placed in time and space, should be based on knowledge, insight, sensory perception, analytical skill, sound rational reasoning and intuition, inspiration and creativity.

1.1 *"Creative Thinking – Thoughtful Acting."*
Motto Royal Dutch Institute of Engineers

1.2 *"A Living Nation is Building its Future."*
Dr. Ir. C. Lely (1854 – 1929), the Netherlands

1.3 *"Luctor et Emergo." ("I struggle and emerge")*
Motto Province of Zeeland, the Netherlands

SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE

Vision

2.1 *"Nature is a brilliant source of inspiration and an excellent teacher for the development of well-designed plans."*
R.E. Waterman

2.2 *"Well-designed plans have their roots in the past and are pointing to the future."*
R.E. Waterman

2.3 *"The great challenge in this era is to develop methods that simultaneously improve the environment and strengthen the economy"*
R.E. Waterman

2.4 *"The most valuable resource available to us is our brain. Therefore let us together use these brains for the benefit of the environment, the economy and our fellow human beings."*
R.E. Waterman

2.5 *"Sharing knowledge is multiplying knowledge."*
Anonymous

2.6 *"Think Long-Term – Act Short-Term."*
P.J.A. van Hessen

3.1 *"If you will, it is no fairy-tale."*
Th. Herzl (1860-1904), "Altneuland" (1899-1902)

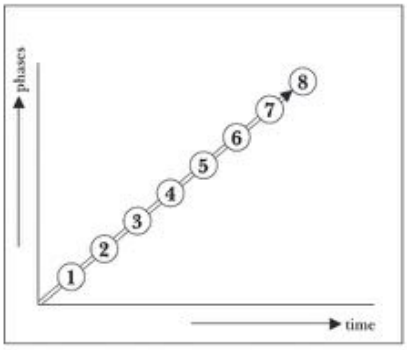
3.2 *"Who doesn't believe in dreams, is not a realist."*
D. Ben Goerion (1886-1973)

3.3 *"Dream great dreams and take practical steps to turn them into reality."*
Henrietta Szold (1860-1945)

3.4 *"Dreams are not to soothe us asleep, but to shake us awake."*
R. Magritte (1898-1967), 1929

SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE

1. PLAN DEVELOPMENT & EXECUTION



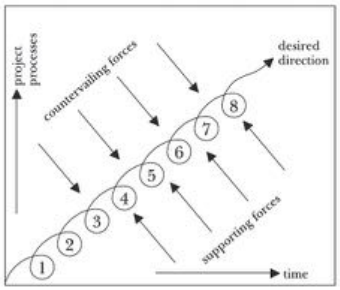
In the development and execution of a plan many phases can be distinguished. All other interacting processes, although of extreme importance, have been left out.

1. Existing situation.
2. Vision for a future situation.
3. Conceptual plan based on acquired data, trends, careful analysis and additional research.
4. From conceptual plan towards a number of concrete plans.
5. Fine tuning and final choice of selected plan.
6. Execution of chosen plan.
7. Wished for resulting situation.
8. Operation and maintenance of executed plan.

Additional Instruments

SUSTAINABLE COASTAL & DELTAIC ZONE DEVELOPMENT VIA BUILDING WITH NATURE

2. SERIES OF CYCLIC PROCESSES IN "FORCES FIELD"



- Mapping of Field Forces
- Field Force Analysis
- Weighing forces for and against a project

  Weighing factor = *f* (availability & power to influence change)

3. SWOT ANALYSIS

Strengths	Weaknesses
Opportunities	Threats

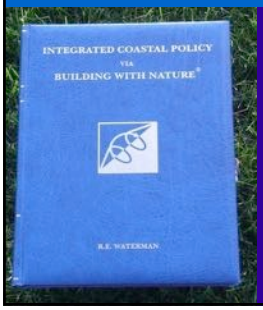
4. MULTI-CRITERIA ANALYSIS

Multi-criteria Analysis which weighs factors for comparative model research, whereby each relevant function from a to z is weighed qualitatively and quantitatively. This is an additional instrument to compare and evaluate a series of plans.

Additional Instruments

Thank you for your attention

Integrated Coastal Policy via Building with Nature ®



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Cartography