



## Comparative assessment of the vulnerability and resilience of 10 deltas

Tom Bucx, Marcel Marchand, Cees van de Guchte (*Deltares*)

Bart Makaske (*Alterra, Wageningen UR*)

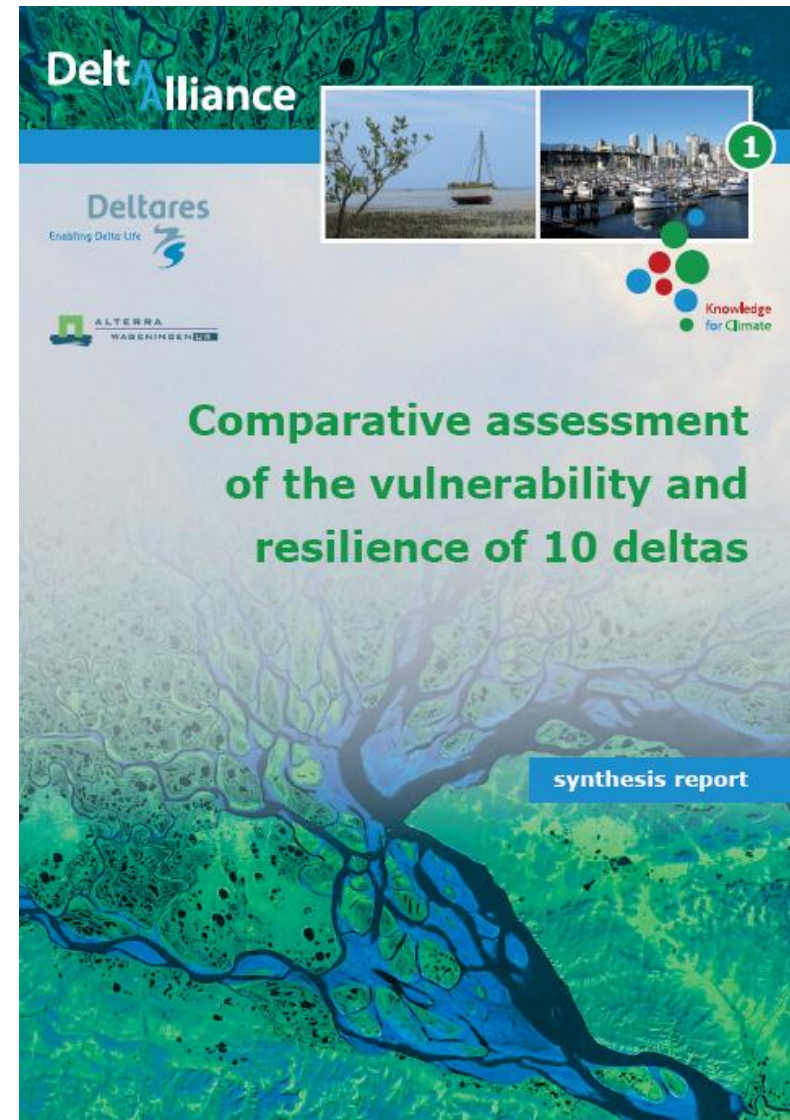
**+ many experts from the 10 deltas**

Wim van Driel, Program manager, Delta Alliance

DeltaNet Conference, Ebro delta, 8 June 2011

# Objectives

- Provide a first step towards a comprehensive overview of the current and future state of deltas
- Integrate scientific, social and management knowledge
- Provide framework for future data collection



# Deltas studied





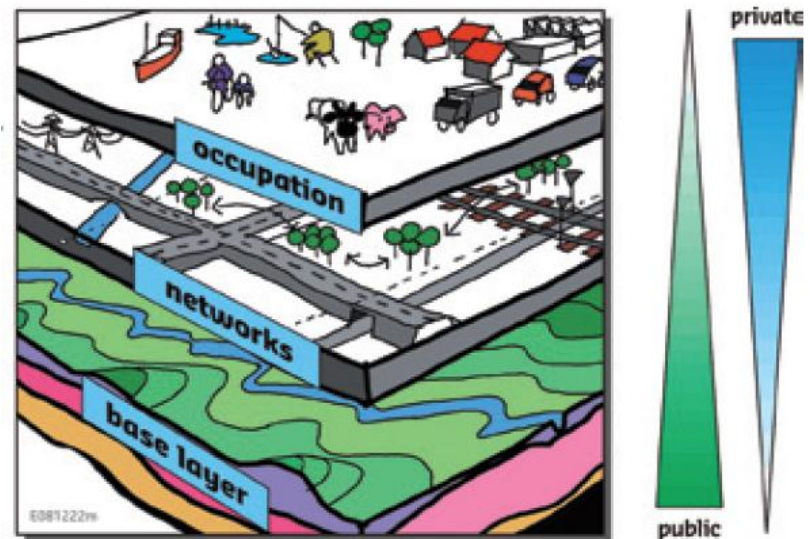
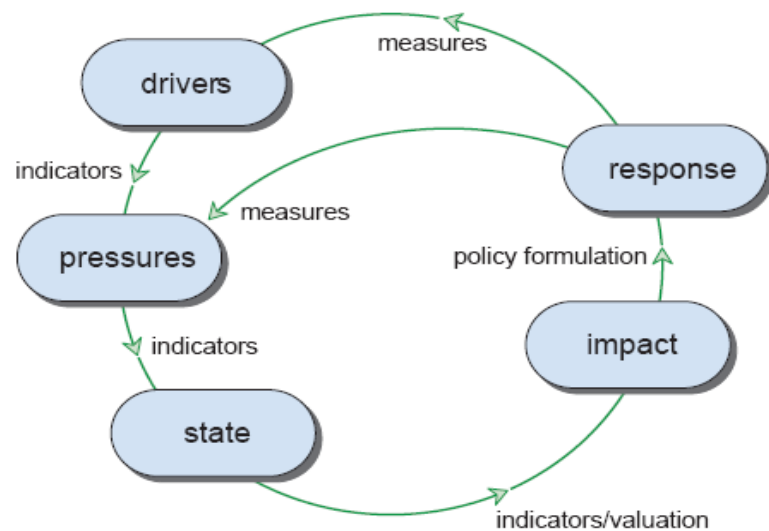
# Many local experts involved

## Main authors of delta descriptions

<b>Nile:</b>	Shaden Abdel-Gawad, <a href="#">National Water Research Center, Egypt</a>
<b>Incomati:</b>	Antonio Hogueane, <a href="#">Eduardo Mondlane University, Mozambique</a> Frank van der Meulen, <a href="#">Deltares, the Netherlands</a>
<b>Ganges-Brahmaputra-Meghna:</b>	Emaduddin Ahmad, Asif Mohammed Zaman, Zahir Haque Khan, S.M. Mahbubur Rahman, <a href="#">Institute of Water Modelling, Bangladesh</a>
<b>Yangtze:</b>	Wenwei Ren, Yi Yong, Xinghua Fu, <a href="#">World Wide Fund for Nature, China</a>
<b>Ciliwung:</b>	Jan Sopaheluwakan, Heru Santoso, <a href="#">Indonesian Institute of Sciences, Indonesia</a>
<b>Mekong:</b>	Le Quang Minh, <a href="#">Vietnam National University Ho Chi Minh City, Vietnam</a>
<b>Rhine Meuse:</b>	Bart Makaske, <a href="#">Alterra-Wageningen UR, the Netherlands</a> Arjan Berkhuisen, <a href="#">World Wide Fund for Nature, the Netherlands</a>
<b>Danube:</b>	Adrian Stanica, Nicolae Panin, <a href="#">National Institute for Research and Development of Marine Geology and Geoecology, Romania</a>
<b>California Bay-Delta:</b>	Peter Wijsman, <a href="#">Arcadis, USA</a>
<b>Mississippi:</b>	Anthony Fontenot, <a href="#">Princeton University, USA</a> Richard Campanella, <a href="#">Tulane University, USA</a>

In addition the World Wide Fund for Nature contributed to the delta descriptions of the Ganges-Brahmaputra-Meghna, Ciliwung and Mekong

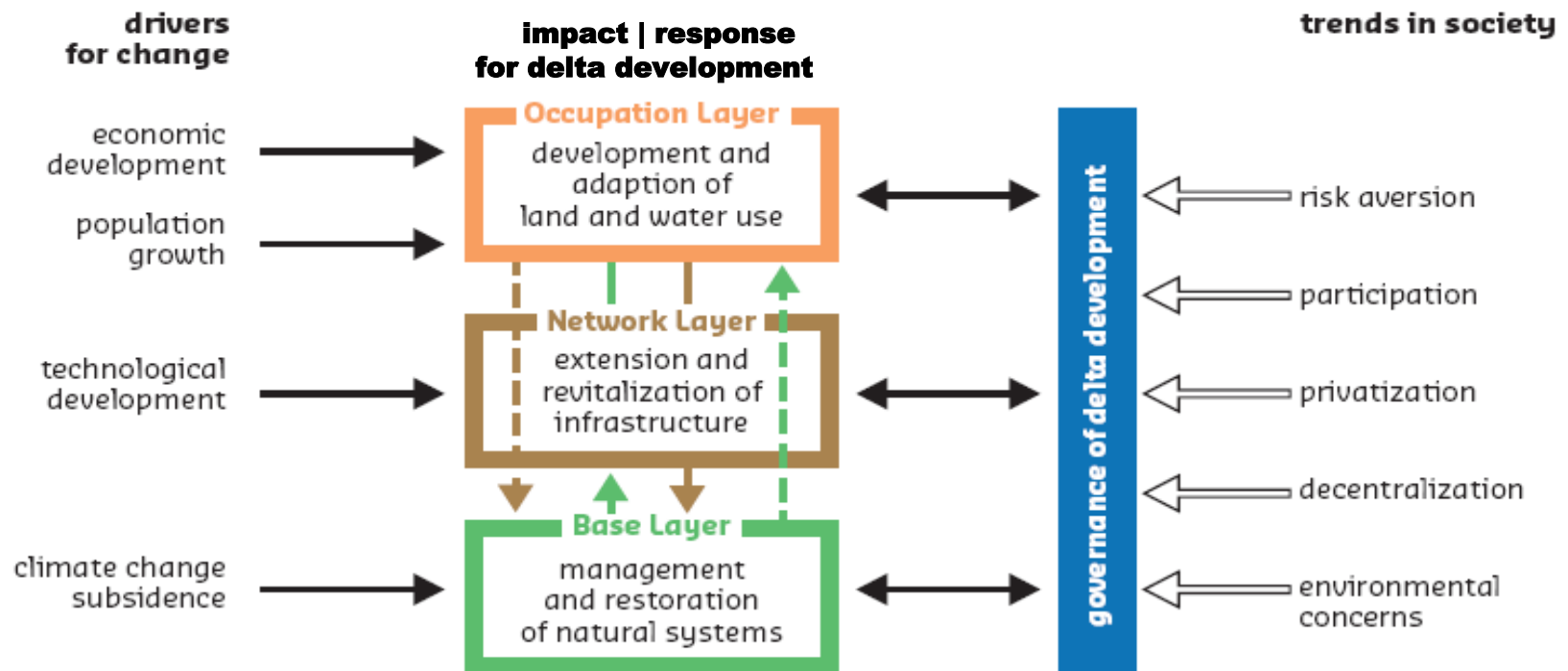
# Approach: models



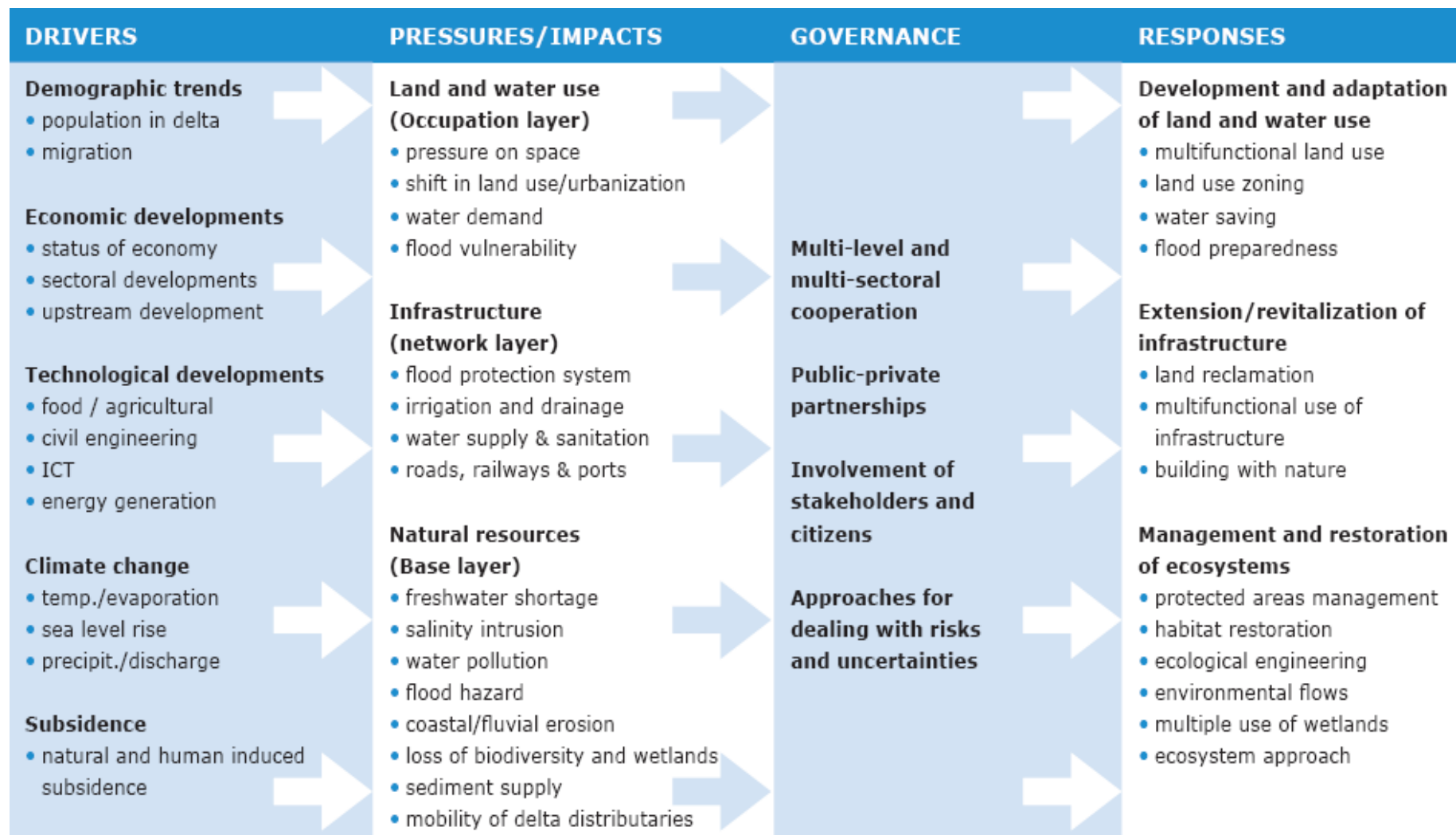
**DPSIR approach (OECD, 1993)**

**Layer model**

# Approach: framework



# Approach: towards indicators of change





# Approach: from indicators to scorecards

Land and water use (occupation layer)	Infra-structure (network layer)	Natural Resources (base layer)	Governance	Resilience & Sustainability Indicator		
				Current	Moderate Scenario	Extreme scenario
+	++	0	+	+	0	-

++ very good    + good  
 0 medium    - low    -- very low

## Performance criteria (Occupation Layer)

Pressure on space

Water demand

Flood vulnerability

••

•

••

- no pressure
- some pressure
- moderate pressure
- severe pressure

## Main indicators: Pressures

### Land and water use (occupation layer)

- Population density
- Urbanization

- 500/km<sup>2</sup>
- High



# Approach: Scorecard

Assessment of the current and future state of the delta

Delta	Land and water use (occupation layer)	Infrastructure (network layer)	Natural resources (base layer)	Governance	Overall Resilience & Sustainability index
Current situation 2010	+	++	+	+	+
Scenario 1 moderate 2050	0	++	0	+	0
Scenario 2 extreme 2050	-	++	-	+	0

*resilience/sustainability: ++(very good), +(good), 0 (medium),- (low), -- (very low)*

# Scorecard for the Rhine-Meuse delta

Rhine-Meuse delta	Land and water use (occupation layer)	Infrastructure (network layer)	Natural resources (base layer)	Governance	Overall resilience & sustainability indicator
Current situation 2010	+	++	0	+	+
Scenario 1 moderate 2050	0	++	0	+	0
Scenario 2 extreme 2050	-	++	-	+	-

**resilience/sustainability:** ++ (very good), + (good), 0 (medium), - (low), -- (very low)

Current situation seems sustainable but this will lessen in the future

Pressures on the occupation layer and the base layer will increase due to economic development and climate change (sea level rise)

Most critical issues will be related to drought and salinisation



# Scorecard Ganges Bhramaputra Meghna delta

## Scorecard

Ganges-Brahmaputra-Meghna delta	Land and water use (occupation layer)	Infrastructure (network layer)	Natural resources (base layer)	Governance	Overall resilience & sustainability indicator
Current situation 2010	--	--	--	0	--
Scenario 1 moderate 2050	--	-	-	-	-
Scenario 2 extreme 2050	--	--	--	-	--

**resilience/sustainability:** ++ (very good), + (good), 0 (medium), - (low), -- (very low)

**Current situation is unsustainable and this will worsen in the future**

**Pressures on the occupation layer and the base layer will increase due to population growth and economic development**

**Climate change and sea level rise will make the situation worse**

**Most critical issues will be related to increased river and coastal flooding, salinisation in coastal areas, and droughts in northwest region**



# Summary of delta scorecards

	Land and water use (occupation layer)	Infra-structure (network layer)	Natural Resources (base layer)	Governance	Resilience & Sustainability Indicator		
					Current	Moderate Scenario	Extreme scenario
Nile delta	--	0	-	0	-	-	--
Incomati delta	0	-	-	-	-	-	--
Ganges-Brahmaputra-Meghna delta	--	--	--	0	--	-	--
Yangtze delta	-	+	-	0	0	0	--
Ciliwung delta	--	--	--	-	--	--	-
Mekong delta	0	0	-	0	0	+	0
Rhine-Meuse delta	+	++	0	+	+	0	-
Danube delta	+	+	+	0	+	0	0
California Bay-Delta	0	-	-	0	-	0	-
Mississippi River Delta	0	0	-	0	-	0	-

resilience/sustainability: ++ (very good), + (good), 0 (medium), - (low), -- (very low)

## Delta description - format

- Drivers of change
  - Pressures / potential problems
    - Land and water use (occupation layer)
    - Infrastructure (network layer)
    - Natural resources (base layer)
  - Governance (institutional and organisation aspects)
- Score card
- Adaptive measures
  - Technical methods and tools
  - Needs for knowledge exchange and research gaps
  - Lessons learned

## Conclusions

**For most deltas current resilience and sustainability is not satisfactory**

Reasons differ per delta, but some general mechanisms are:

- an imbalance between demand and supply with regard to land and water use
- an inadequate or ageing infrastructure in the delta
- disruption of the natural delta processes
- inadequate governance to address problems and implement solutions

**The combined DPSIR-layer approach has proven to be useful**



# Comparative overview of research gaps

(Only most important ones shown here)

	Nile	Incomati	Ganges- Brahmaputra- Meghna	Yangtze	Ciliwung	Mekong	Rhine- Meuse	Danube	California Bay-delta	Mississippi River delta
<b>Occupation layer</b>										
Socio-economic scenarios (6)	•	•		•	•			•		•
Water use and treatment (5)	•	•	•		•		•			
<b>Network layer</b>										
Freshwater management (7)	•	•	•		•	•	•		•	
Dikes and dams (5)	•		•		•		•		•	
<b>Base layer</b>										
Effects of changes/ eco-system functioning (9)	•	•	•	•	•		•	•	•	•
Building with nature and natural safety (8)	•		•	•	•	•	•	•		•
<b>Governance</b>										
Governmental roles and arrangements (6)	•				•	•	•		•	•
Integrated delta management (6)	•	•	•	•	•			•		

# Comparative overview of adaptive measures

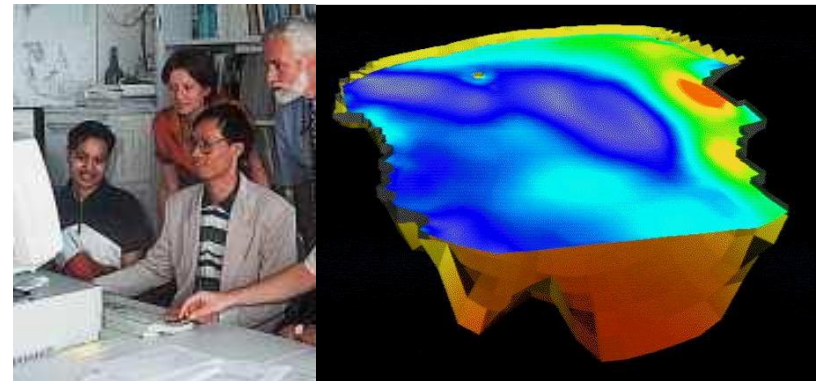
	Technical	Ecological	Economic	Institutional
Nile	••	•	•	•
Incomati	•	••	•	••
Ganges-Brahmaputra-Meghna delta	•••	•	•	•
Yangtze	•	•••	•	•
Ciliwung	••	••	•	••
Mekong	••	••	•	••
Rhine-Meuse	•••	••	••	••
Danube	•	•	•	•
California Bay-Delta	•	•••	•	•
Mississippi River Delta	••	••	•	•

- *none or few*
- *some*
- *many*



# Comparative overview of tools and methods

- Many advanced delta process models, decision support systems and integrated assessment and management tools
- Especially for base layer
- Rather generic



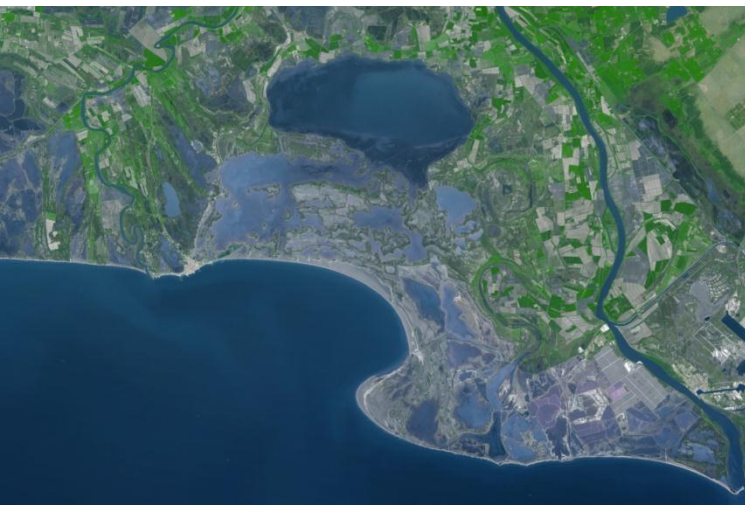
## Recommendations:

- adapt existing tools for new situations rather than develop completely new ones for each delta
- working with common tools will facilitate research collaboration and inter-delta data exchange



## What's next?

- Develop set of key (quantitative) indicators
- Optimize scoring and ranking method
- Work out scenarios in more detail
- Include more deltas (Rhône, Po, Red?)
- Work out concrete collaborative research ideas/proposals across deltas



## Website - downloads

➤ **[www.delta-alliance.org](http://www.delta-alliance.org)**

➤ **Background information**

➤ **Documents to download:**

- **Synthesis report**
- **Working document (with full delta descriptions)**





World Delta Summit: the pulse of deltas and the fate of our civilisation. Jakarta, November 21- 24, 2011, [www.deltasummit.org](http://www.deltasummit.org)

Call for abstracts is open now!

The banner features a blue and green geometric logo on the left. The main title 'WORLD DELTA SUMMIT' is in large blue letters, followed by the subtitle 'The Pulse of Deltas and the Fate of our Civilization' in green. Below this, the location 'Jakarta - INDONESIA' and dates '21 - 24 November 2011' are listed, along with the venue 'Balai Sidang Jakarta Convention Center'. A green navigation bar contains links: HOME, ABOUT, FAQ's, DOWNLOADS, and CONTACT. The main content area shows a night cityscape with the text 'WELCOME TO WORLD DELTA SUMMIT 2011'. A sidebar on the left lists: PROGRAMS, ABSTRACTS, GENERAL INFORMATION, REGISTRATION, COMMITTEE, and SECRETARIAT. A paragraph of text describes the importance of deltas, and a small image of a slum is on the right.

**WORLD DELTA SUMMIT**  
*The Pulse of Deltas and the Fate of our Civilization*  
Jakarta - INDONESIA  
21 - 24 November 2011  
Balai Sidang Jakarta Convention Center

HOME ABOUT FAQ's DOWNLOADS CONTACT

**WELCOME TO WORLD DELTA SUMMIT 2011**

DELTA SUMMIT  
Jakarta  
INDONESIA 2011

PROGRAMS  
ABSTRACTS  
GENERAL INFORMATION  
REGISTRATION  
COMMITTEE  
SECRETARIAT

Deltas and coastal lowlands are the most prolific regions because of their rich environmental resources and strong economic potentials; they are hubs of innovation, biodiversity, industrial and agricultural productivity, and home to the fastest growing cities in the world. Great ancient and present life and the emerging civilizations begin in deltas. A lot of people live in delta regions, which provide many resources and functions for human life. Deltas have provided not only the basic needs for human being like water, fertile land, food, pleasant climate and weather, but they also provide energy (oil and gas), wood, fish and many others for human living like the rivers for the transportation.