

# Climate change and coastal zones in Africa

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PlanCoast, Berlin, 21 november  
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# Our vulnerable coasts

- Coastal erosion
- Inundation of low lying coasts
- Degradation of coastal ecosystems: mangroves, coral reefs (El Nino 1998 coral bleaching)
- Overexploitation of natural resources
- Salinisation of land, surface and ground waters
- Tropical cyclones

# Sandy coast of Mauritania



Photo Hellio Van Ingen/FIBA

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# Erosion naturelle/humaine



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Oui est responsable de quoi?



# Highly variable coastal evolution rates (Sénégal case)

Saint-Louis	- 3,3 à + 0,6 m / an
Yoff	- 3,7 à + 0,9 m / an
Falaises de Dakar	- 0,4 à - 1,4 m / an
Rufisque	- 3,8 à + 1,3 m / an
Joal	- 9,1 à + 8,5 m / an
Sangomar	- 137 m /an

# Slow but destructive erosion



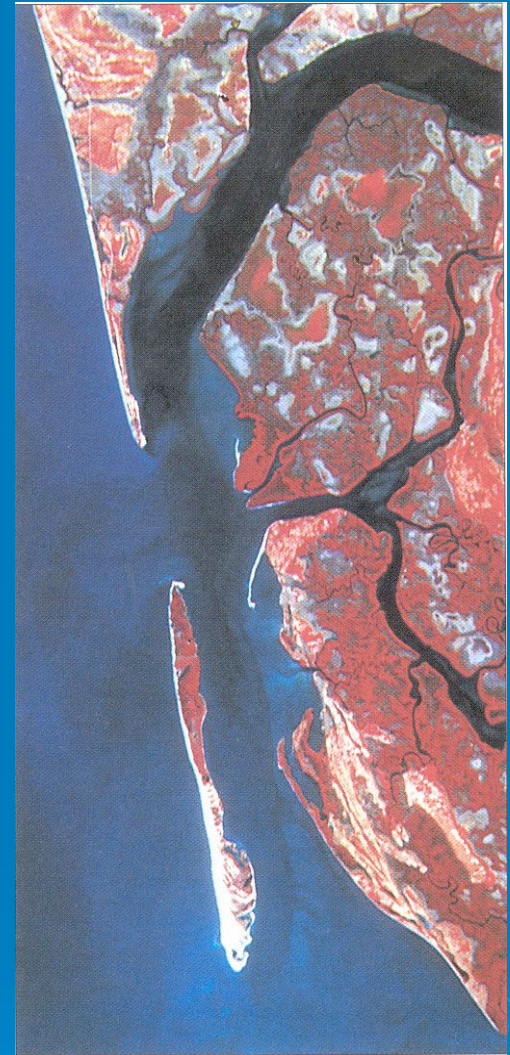
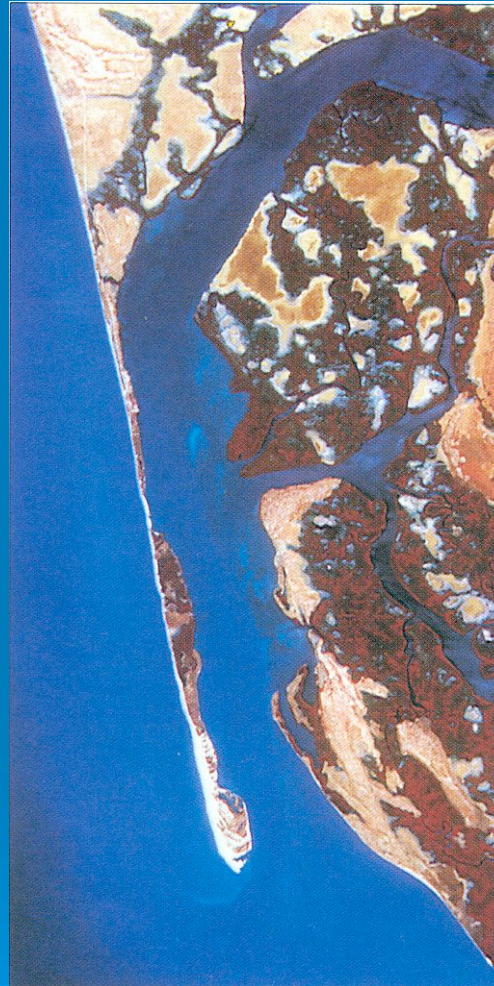
**Mbao**



**Rufisque**



# Djiffere and the Lagoba breach



An exceptional and natural phenomenon!  
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Senegal river

The  
breach

Lingue de  
Barbarie

North

Saint Louis island

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## Man induced erosion : the « breach » in the langue de Barbarie sand spit



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Photo Hellio et Van Ingen



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## Le cas du port de Nouakchott (Mauritanie)



Photo: Ould Elmoustapha, 2000

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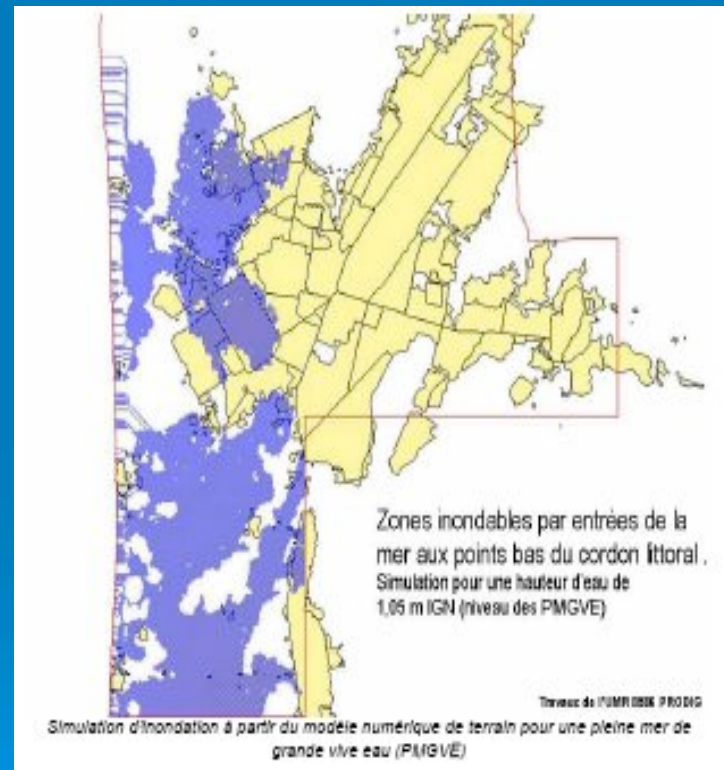
Entre 1980 et 1998, recul de 25 m par an (Ould Elmoustapha, 2000)

# Risks of inundation

## Nouakchott: Mauritania

From the Rapport sur  
les risques d'inondation  
de la zone littorale de  
Nouakchott

SenHoury et al., 2003





Saint-Louis quays closed to be overflooded  
(photo Diop I.)



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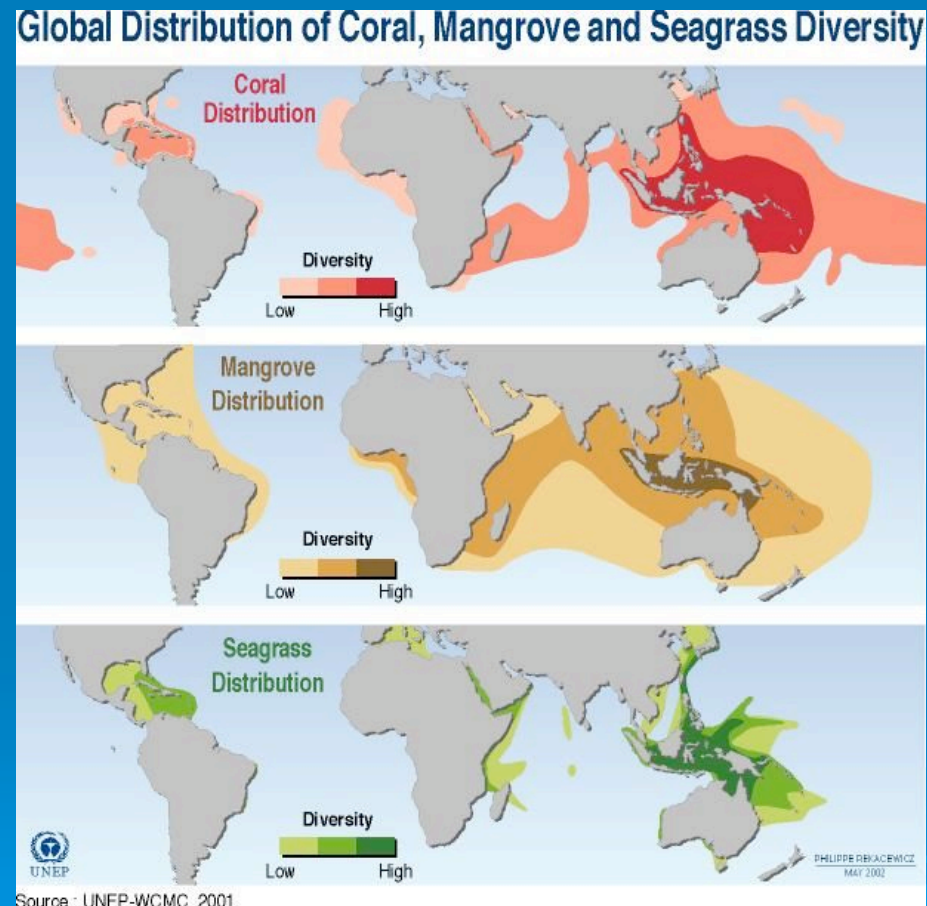
Cimetary of Guet Ndar  
(photo Diop, I.)



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# Coastal ecosystems



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# MANGROVE ESTUARIES



A special ecosystem playing a number of functions

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# MANGROVE ESTUARIES



But a degraded ecosystem transformed in tans

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## Overexploitation of natural resources



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Hellio, Van Ingen, 2005

# The importance of our coastal zones and seas

- The place of a number of very productive ecosystems (mangroves, coral reefs, etc.)
- In some cases, presence of important non renewable materials (sand, oil and gas, )
- Concentration of populations
- A number of economic activities or infrastructures strictly dependent on this environment (fisheries, tourism, harbour, etc.)



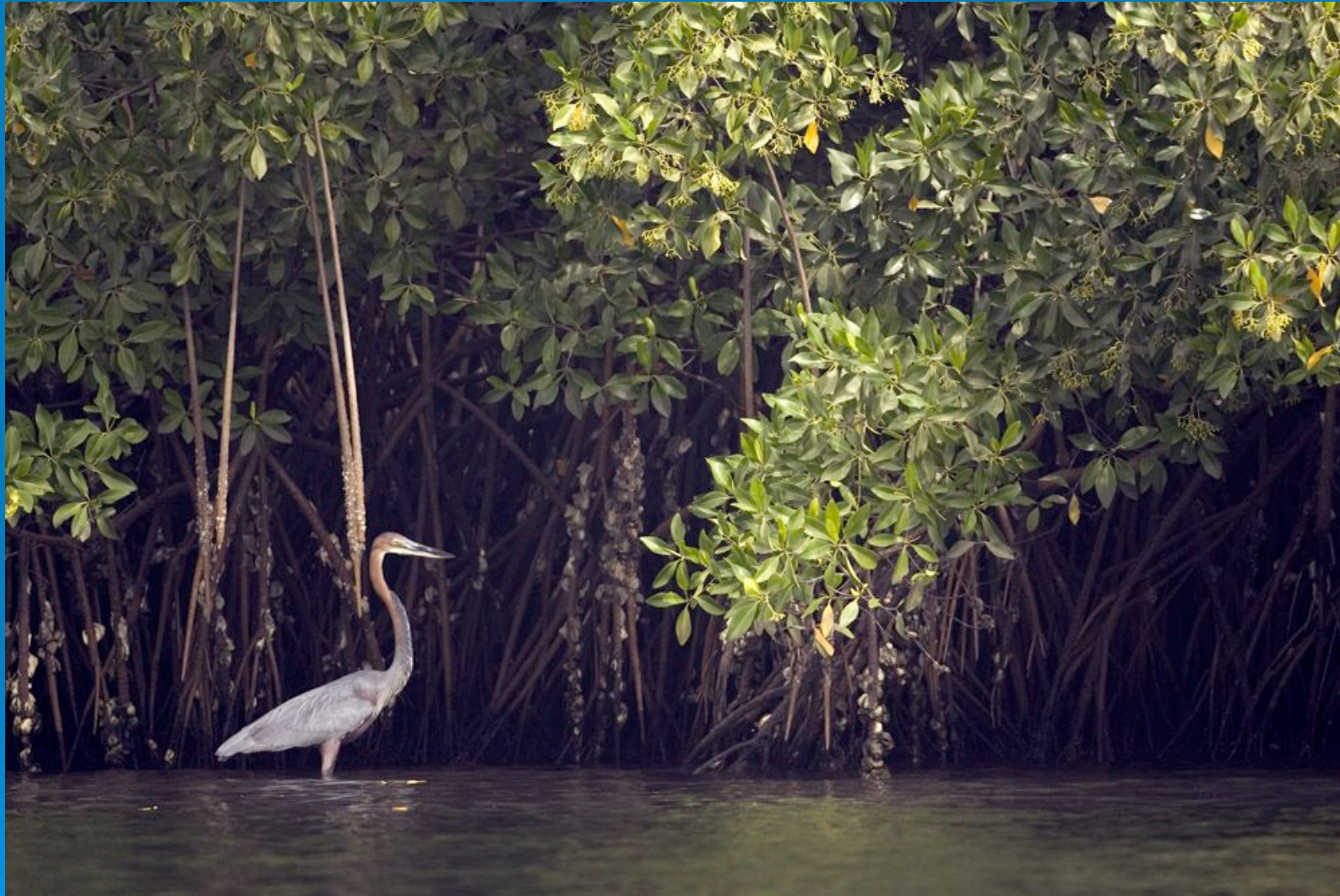


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Hellio, Van Ingen, 2005



## Mangroves: a key habitat for numerous species



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## Salt exploitation



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## Oyster exploitation

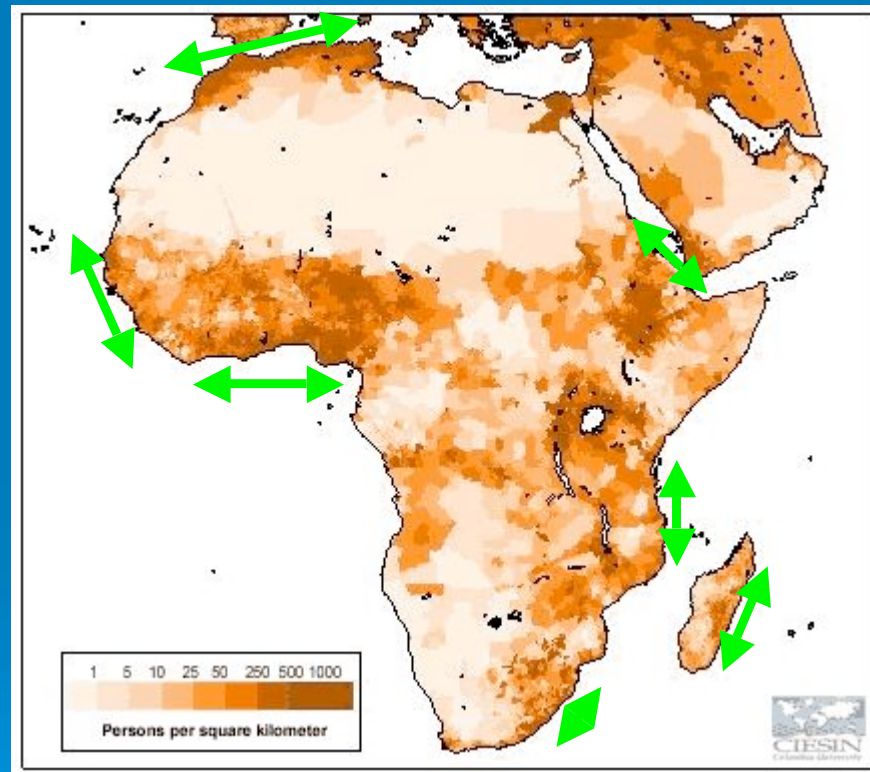


Hellio, Van Ingen, 2005

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# Population density



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## Benefits from Marine and Coastal Ecosystems and Activities

### Coastal tourism



The volume of global tourist arrivals increased more than 20 times between 1950 and 1995, making tourism the world's fastest-growing industry. The present number of tourists is expected to double by 2010 – particularly in the Caribbean and Asia-Pacific regions, where much of the industry is concentrated in coastal areas.

**\$ 161 billion**

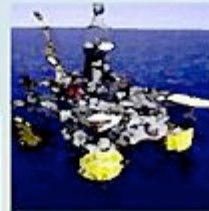
### Trade and shipping



Since the 1950s, the annual volume of shipping and seaborne trade has risen sixfold, to more than 5 billion tonnes of oil, dry bulk goods and other cargo. In 1995, there were 27,000 freighters over 1,000 tonnes in operation. Industrial countries account for 50% of the cargo loaded – and 75% of that unloaded.

**\$ 155 billion**

### Offshore oil and gas



Since gasoline was first used in California a century ago, the oil and natural gas industry has skyrocketed to meet soaring energy demands. Today, about 20% of the world's oil and natural gas comes from offshore drilling installations in the Middle East, the United States, Latin America, and the North Sea.

**\$ 132 billion**

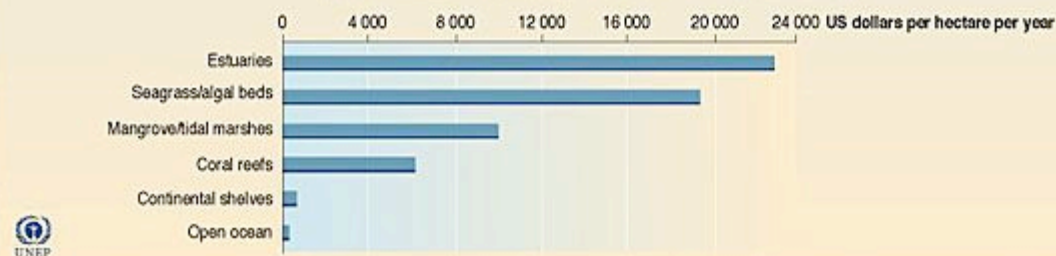
### Fisheries



Between 1950 and 1997, global fish production from capture and culture fisheries grew from 20 million tonnes to 122 million tonnes, with the per capita supply doubling from 8 kg to 15 kg. Over 200 million people rely on fishing for their livelihoods, with more than 80% of all fish (by value) sold in industrial countries.

**\$ 80 billion**

## Estimated Mean Value of Marine Biomes



Source: Anne Platt McGinn, *The Health of Oceans*, Worldwatch paper 145, Worldwatch Institute, 1999, Washington DC ([www.worldwatch.org](http://www.worldwatch.org)); Costanza, R., et al., *The Value of the World's Ecosystem Services and Natural Capital*, Ecological Economics, 1998.

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## Fisheries: an important economic activity



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Hellio, Van Ingen, 2005



# The Joal quay

**June 2002**



**April 2005**

PlanC







# Tourism Saly



Photo CSE, 2003

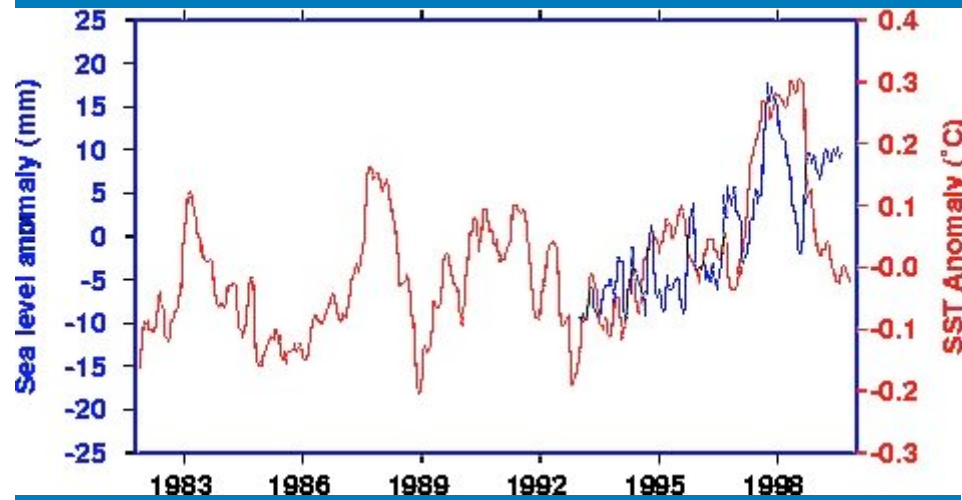
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# Climate change and sea level rise

- Tide gauges have registered a 1 to 2 mm sea level rise per year during the 20<sup>th</sup> century
- Recent satellite data indicate a slight acceleration of this rate (3 mm per year) 
- The last IPCC report predict a sea level rise (only due to climate change) comprised between 9 and 88 cm by 2100 (5 to 32 cm by 2050), that's mean a 0.09 to 8.8 mm/yr and a mean value of 48 cm 



## Global sea level rise observed by Topex/Poseidon (1993-1999)



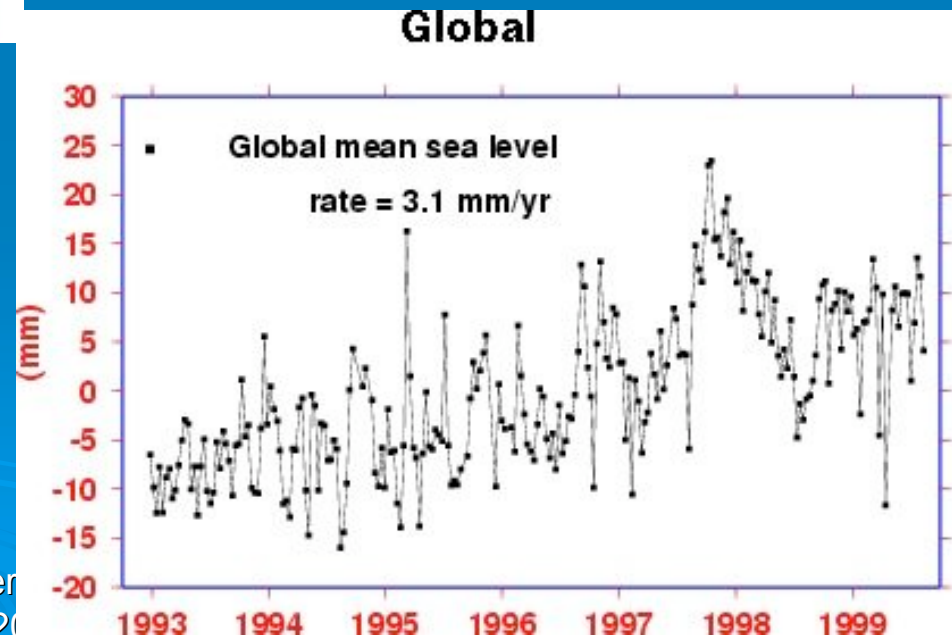
Sea level rise since 1982 (tide gauges in red, Topex in blue)

Observed sea level rise by  
the satellite

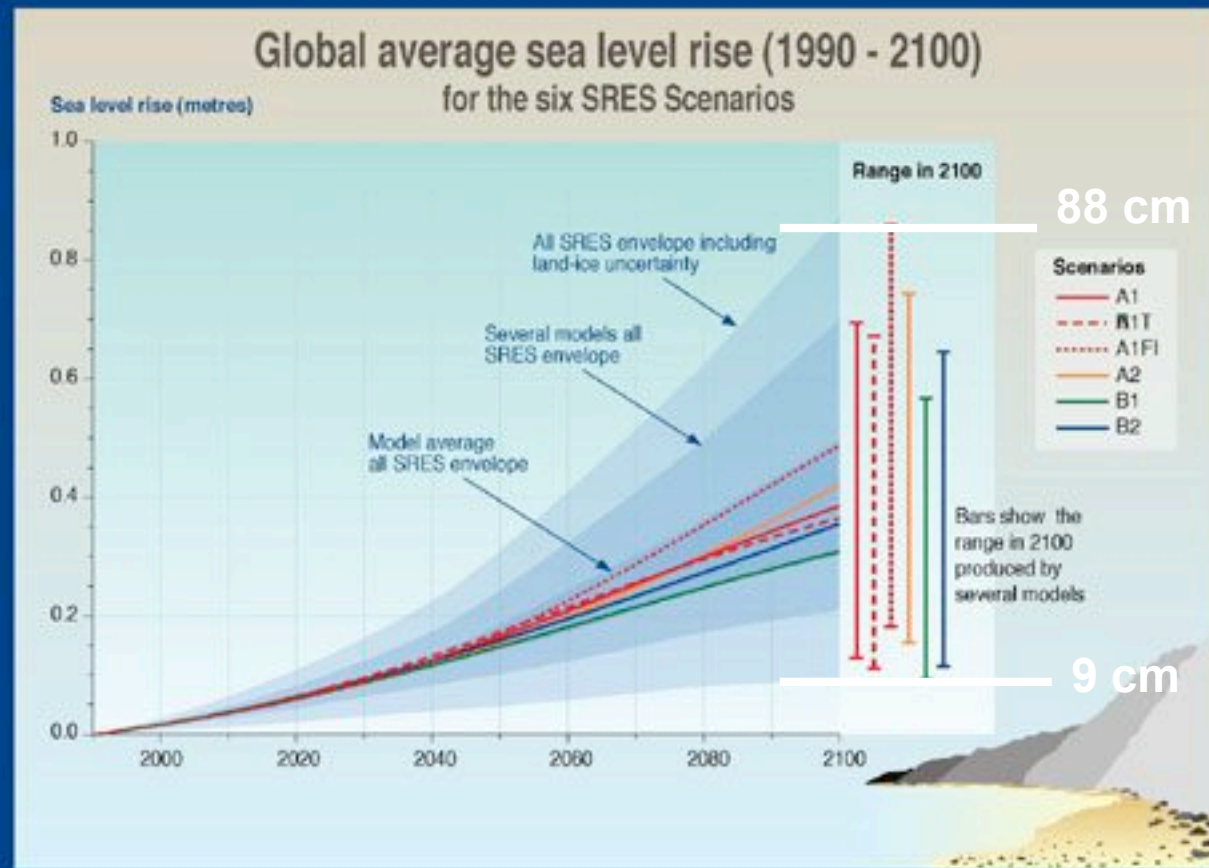


Acceleration of sea level rise (1-2 mm  
per year → 3 mm/year)

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2001



# Sea level rise according to the 3rd IPCC report (2001)



WG1 TS FIGURE 24

IPCC

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



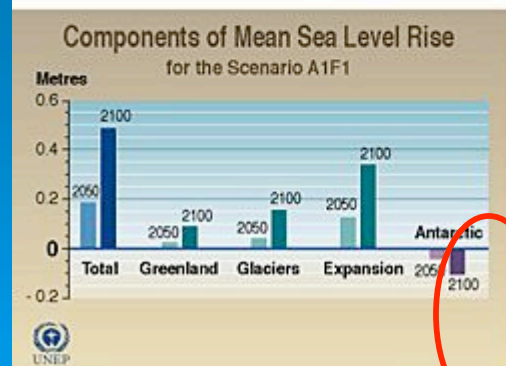
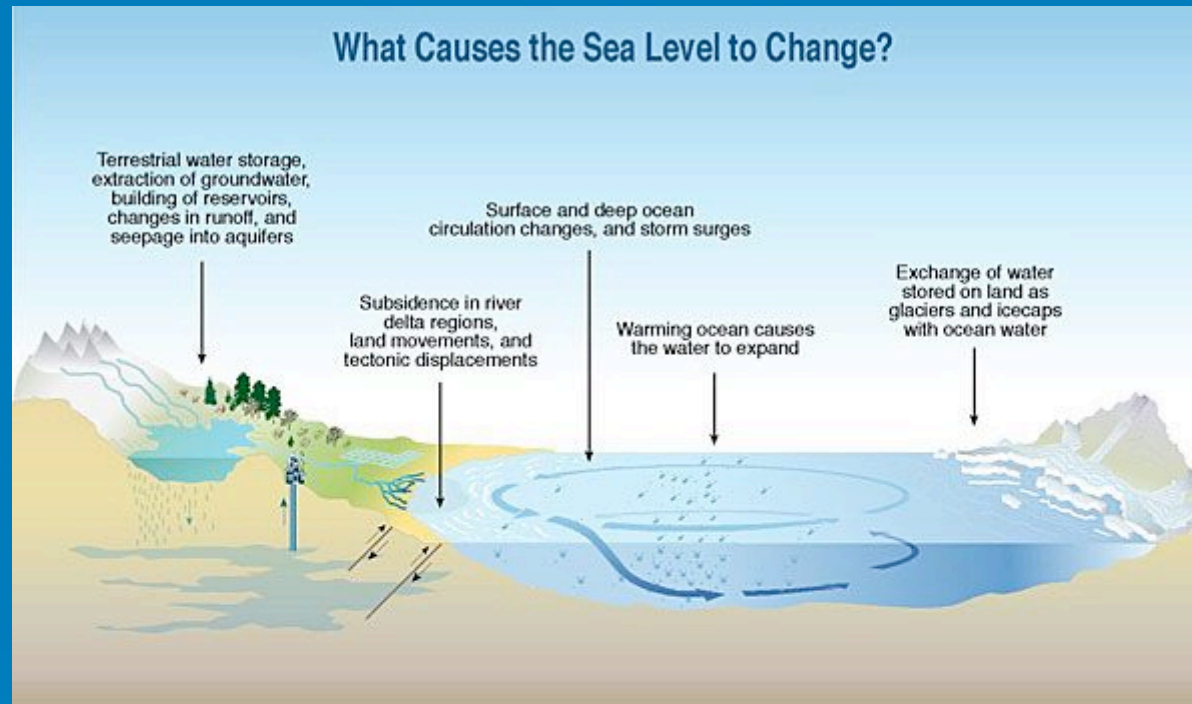
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# Climate change and sea level rise

- Recent studies seem to indicate that this rise could be more important
  - Melting of the antarctic ice cap: thinning of the western part while the eastern part is still thickening
  - Rapid melting of the arctic ice cap

# Climate change and sea level rise



**The A1 scenario family** describes a future of rapid economic growth, a global population that peaks in the middle of the 21st century and then declines, and the rapid introduction of new and more efficient technologies. The major underlying themes are convergence among regions, capacity-building, and increased cultural and social interaction, with a substantial reduction in regional differences in per capita incomes. The A1 scenario family develops into three groups with alternative directions of technological change according to their energy systems: fossil intensive (A1F), non-fossil energy sources (A1T), or a balance of both (A1B)

Source: David Griggs, in *Climate Change 2001, Synthesis report*, Contribution of working groups I, II and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, 2001.



# A case study: Senegal

- Define and quantify impacts of climate change on two coastal zones
- Define their vulnerability
- Identify and quantify adaptation options
- Multidisciplinary team (9)
- Based on the IPCC methodology
- Realized in 2000-2001

# Presqu'île du Cap Vert

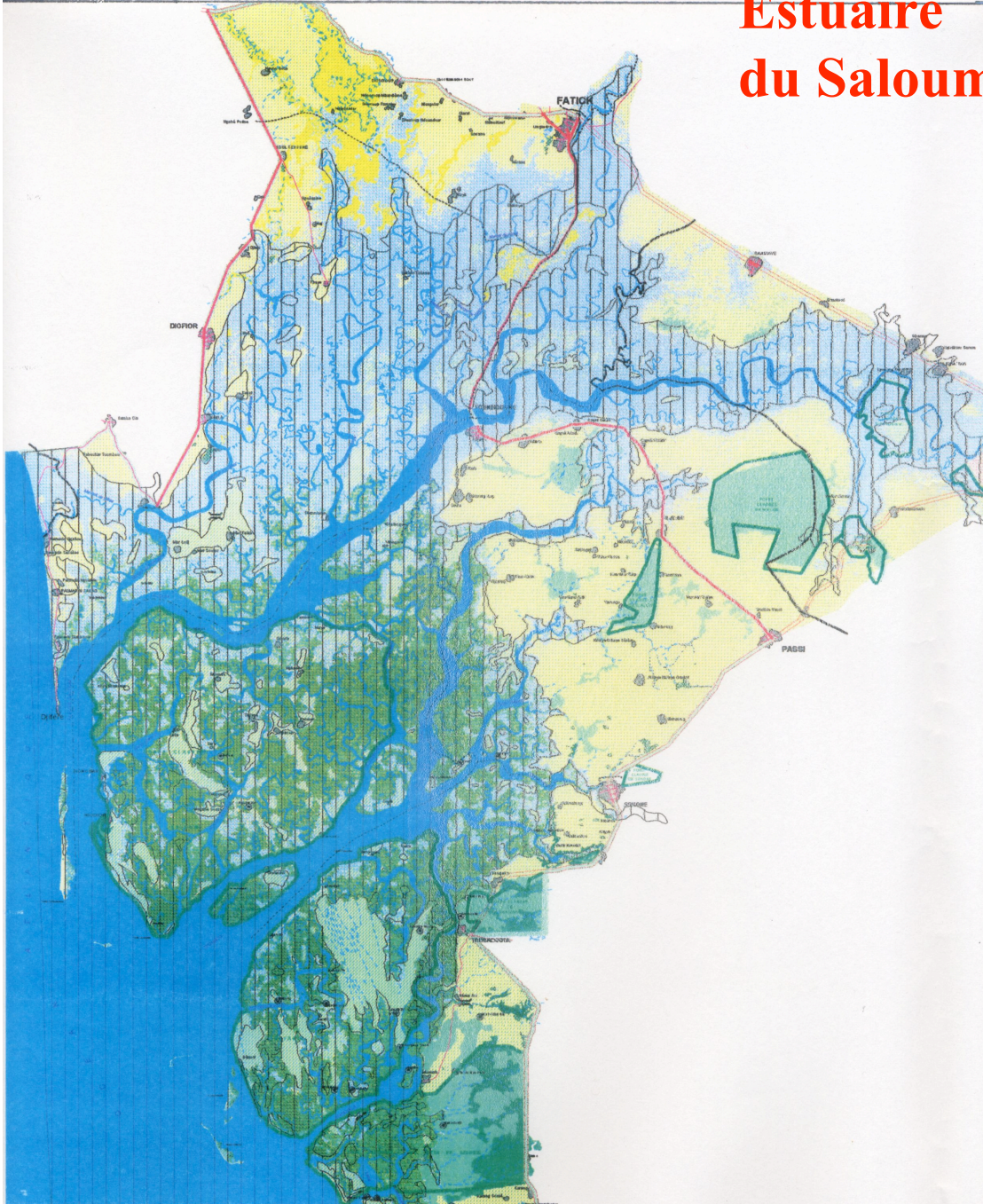
The map displays the Cap Vert Peninsula, a prominent landmass in Senegal. The city of Dakar is located on the western side, with its harbor and surrounding urban areas clearly marked. To the east of Dakar, the Rufisque area is shown, followed by the Bargny area. The map includes a scale bar indicating distances up to 10 Kilometers. Various landmarks and locations are labeled, including Pointe des Almadies, Yoff, Camberène, Ngor, Ndiaye, Rufisque, and BARGNY. The map also shows the coastline, major roads, and various landmarks.

## 3.5% de la zone totale étudiée

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## Estuaire du Saloum



Zones vulnérables avec  
un niveau minimum  
d'inondation de 2 m

52% de la zone étudiée

# Impacts on ecosystems

## The niayes

- On the basis of analysis of niayes evolution under drought (old inventories since 1940 and field measures)
- Limited changes if sea level rise doesn't go beyond 50 cm
- Beyond, development of halophiles species and regression of hydrophiles ones
- Important role of salinity



# The niayes



Interdune lows

Guinean relict  
vegetation

Outcropping  
groundwater

Market gardening

2007

ember

# Aquifer at the head of the Cap Vert peninsula

## FEFLOW model

Isovalues of dissolved salts ( $\text{mg.l}^{-1}$ )

A: now

B: with a 0.5 m sea level rise

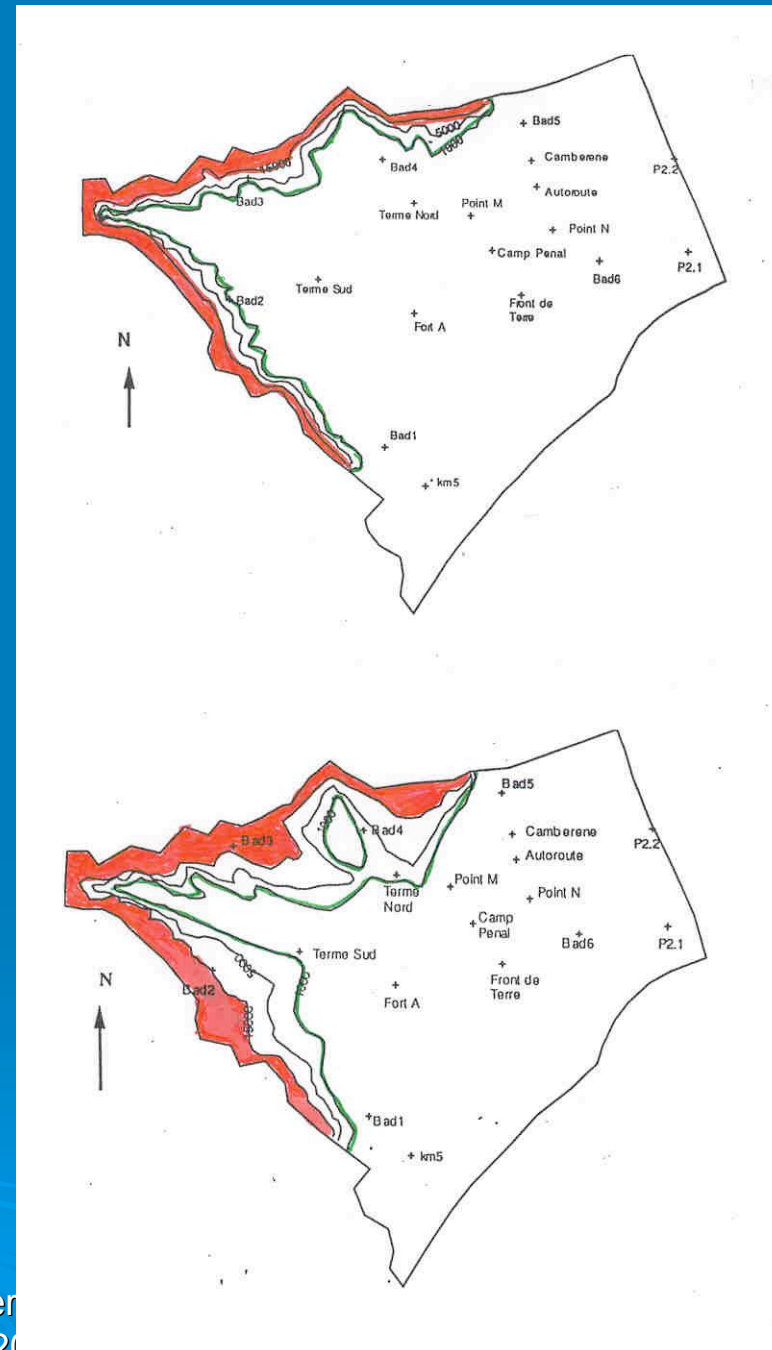


Values  $> 15,000 \text{ mg.l}^{-1}$



$1000 \text{ mg.l}^{-1}$  isovalue

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A

B



# Halieutic resources

- Expert judgment
- Will be affected by:
  - Modifications of coastal habitats (erosion, salinisation) which are breeding sites
  - Weakening of upwellings: pelagic species and groupers migration
  - Sea water warming: impacts on the presence of tuna (longer) and apparition of species not appreciated (balistes)

# Quantified impacts

	Cap Vert (1597 km <sup>2</sup> )	Saloum (4309 km <sup>2</sup> )
Land losses		
-Inundation	57 – 398 km <sup>2</sup>	1,690 – 2,911 km <sup>2</sup>
- Erosion	1.7 – 2.3 km <sup>2</sup>	0.5 – 2.3 km <sup>2</sup>
Population at risk (by 2100)	730 249 to 4 787 828	847191 to 11 807 410
Economic value at risk (with a 3% DR)	5 - 34 billion \$	4.6 - 64 billion \$

These values correspond to minimum and maximum inundation levels by 2100. For coastal erosion, the sea level rise considered was 49 cm by 2100



# Adaptation strategies

- Identification of adaptation strategies
  - Retreat and displacement of populations
  - Protection of coastal zones
    - Beach nourishment
    - Sea dykes
    - Dune afforestation
- Evaluation of these strategies
  - Only options for which experience and data were available were considered: sea dykes and afforestation
  - Costs evaluation and use of discount rates

# Evaluation of protection costs

	Cap Vert (1597 km <sup>2</sup> )	Saloum (4309 km <sup>2</sup> )
Economic value at risk (with a 3% DR)	5 - 34 milliards \$	4,6 - 64 milliards \$
Coastal length to be protected	14-31 km	400-418 km
Protection costs (3% DR)	0.005 – 0.03 M\$ 3 – 19% PIB	0.067 – 0.068 M\$ 43 – 43.6% GDP

These values correspond to minimum and maximum inundation levels and a 49 cm of sea level rise by 2100

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# Adaptation strategies

## ➤ Analysis of protection options

- The cost of protection options is much lower than economic value of threatened areas
- But in the Cap Vert peninsula protection works could impede fishing activities (mainly landings)
- In the Saloum estuary, sea dykes could prevent any adaptation of the mangroves
- Protection measures should be considered in a more global framework of integrated coastal zone management

# Impacts of climate change in African coastal countries

- Limited land losses but
- Populations at risk important
- Economic value at risk ( 5 to 600% of the GDP)
- **Very high economic vulnerability**

	Ben	Cam	Com	Cong	C. Ivo	Djib	Guin	Maur	Sén
Lands (km <sup>2</sup> )	230	330	n.d.	2146	1495	14,4	132-234	874,5	6050
Pop (x1000)	880	460* +41,5	1030	1176	2500	68,6	500	n.d.	150
Econ V Million\$	251,6	1909	400	n.d.	9240*	n.d.	n.d.	6330	603
Current GDP	2650	10181	218	3544	10225	553	3407	1064	4971

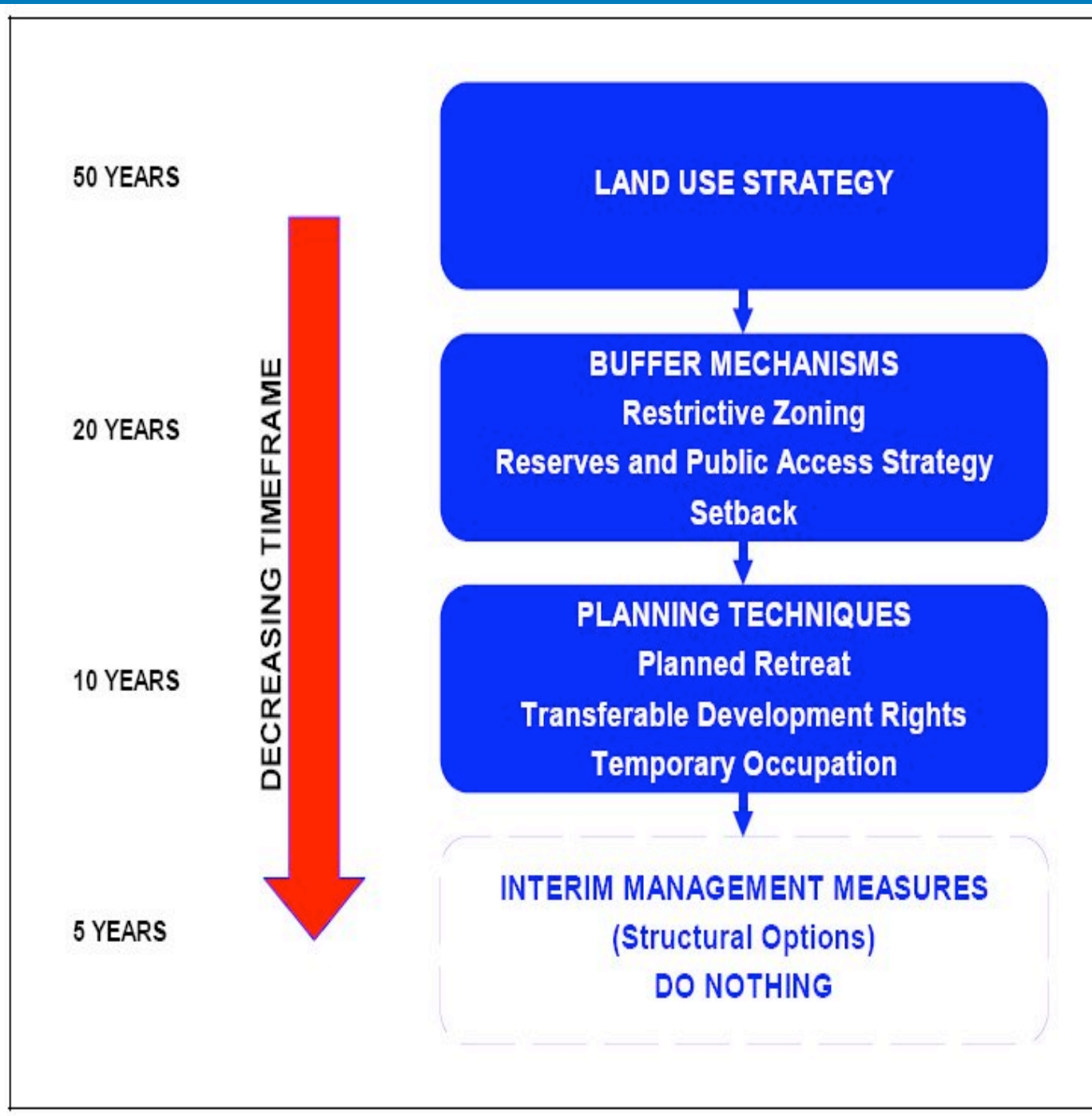
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# Adaptation costs in Africa

- Considered options are limited \_ limited expertise and data
- Costs are important but lower than economic value at risk
- **Which is the pertinence to invest in protection works?**

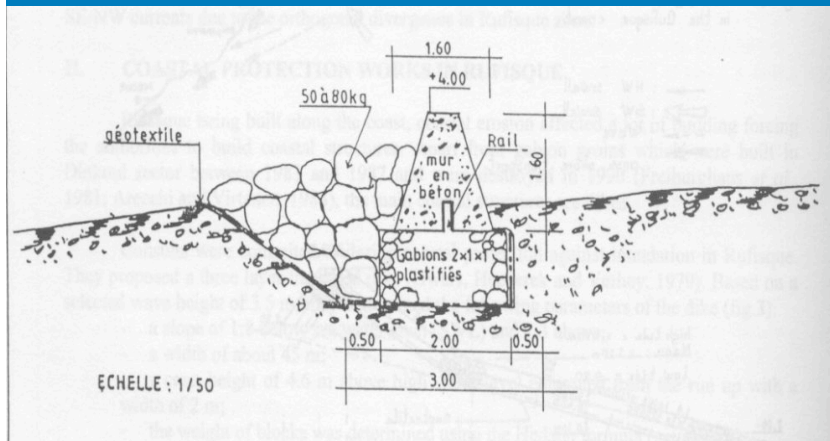
	Ben	Cam	Com	Maur	Sén
V. Éco Million\$	251,6	1909	400	6330	603
Coûts protect	215,3	44	82*	1824	845
PNB actuel	2650	10181	218	1064	4971



Projet  
EuroSION



## The concrete wall in Diokoul



Structure design

10 years after!



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# Problems



Failure of the concrete wall in August 2004

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# Conclusions

- Climate change and sea level rise is a real threat for all African coastal zones
- Adaptation options are available but
- Should be integrated into ICZM
  - To avoid maladaptation
  - To invest wisely
  - To take into consideration all stakeholders
- Initiatives difficult to be developed
  - Formal engagement of governments (Maputo and Cape Town declarations) but conflicts of interests, competence
  - Lack of information
  - Regional initiatives (PRCM)



# Protected marine areas



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Photo Hellio Van Ingen/FIBA  
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# Engaged men and women



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# Engaged men and women and children!!



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