UNIVERSITEIT GENT

FACULTY OF BIOSCIENCE ENGINEERING

Marine pollution along the East African coast: problems and challenges

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International workshop - Sustainable use of coastal and marine resources in Kenya: from research to societal benefits – Oct 27-29, 2014

Unexplored beauty and richness of Kenyan marine waters/resources

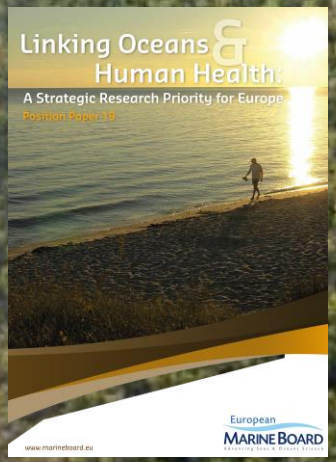
- 600 km of coastline, supports livelihoods of 2.7 million people

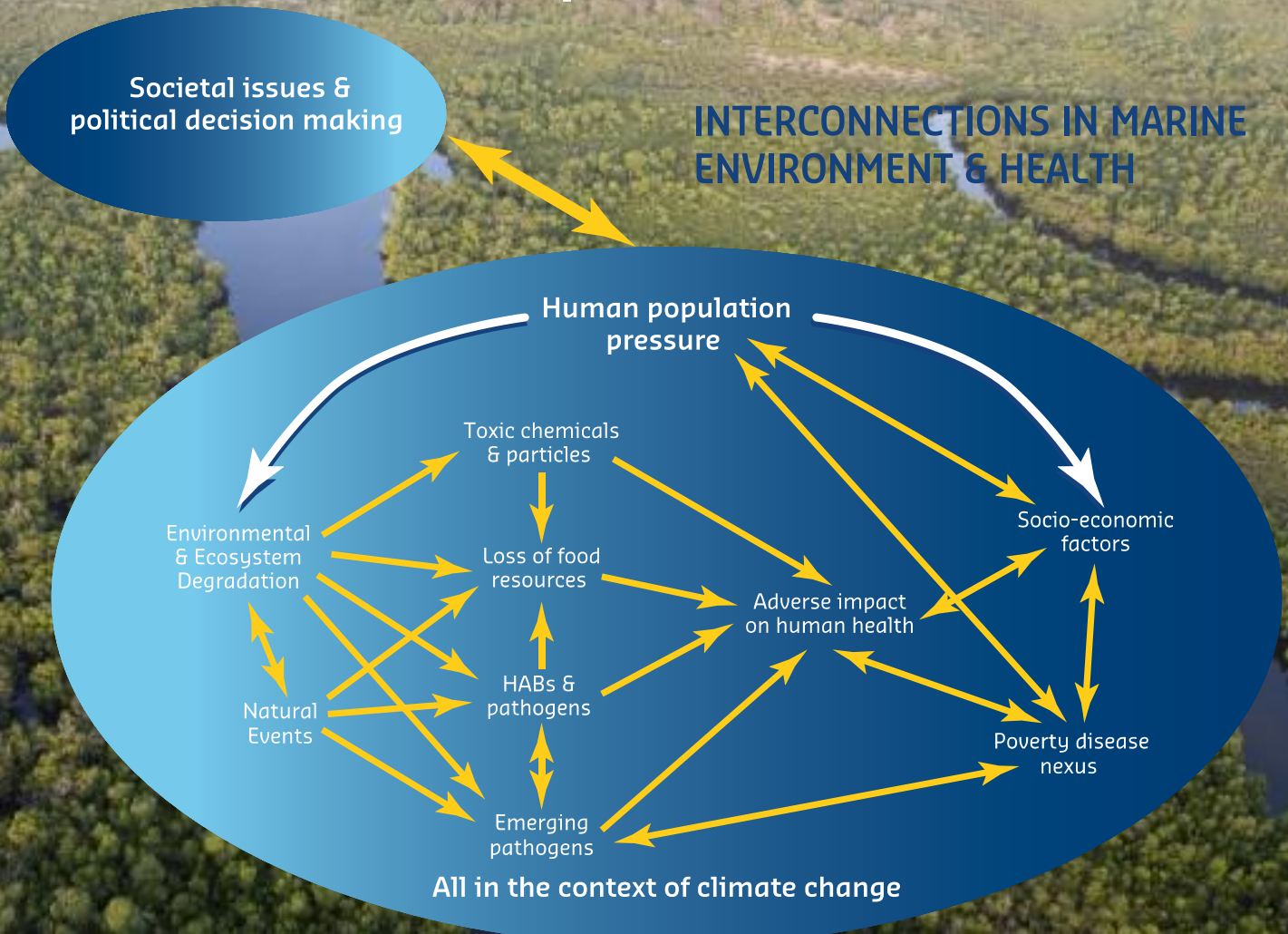
- % contribution of these resources to coastal economy:
  - tourism (45%)
  - ports & shipping (15%),
  - (artisanal) fishing (6%)… but main source of income for 60,000 households
  - agricultural industry, mining, …

- **however:** coastal and marine resources **@ risk**…
  - over-exploitation, overfishing, pollution, climate change, invasion of non-native species, rapidly growing human population…

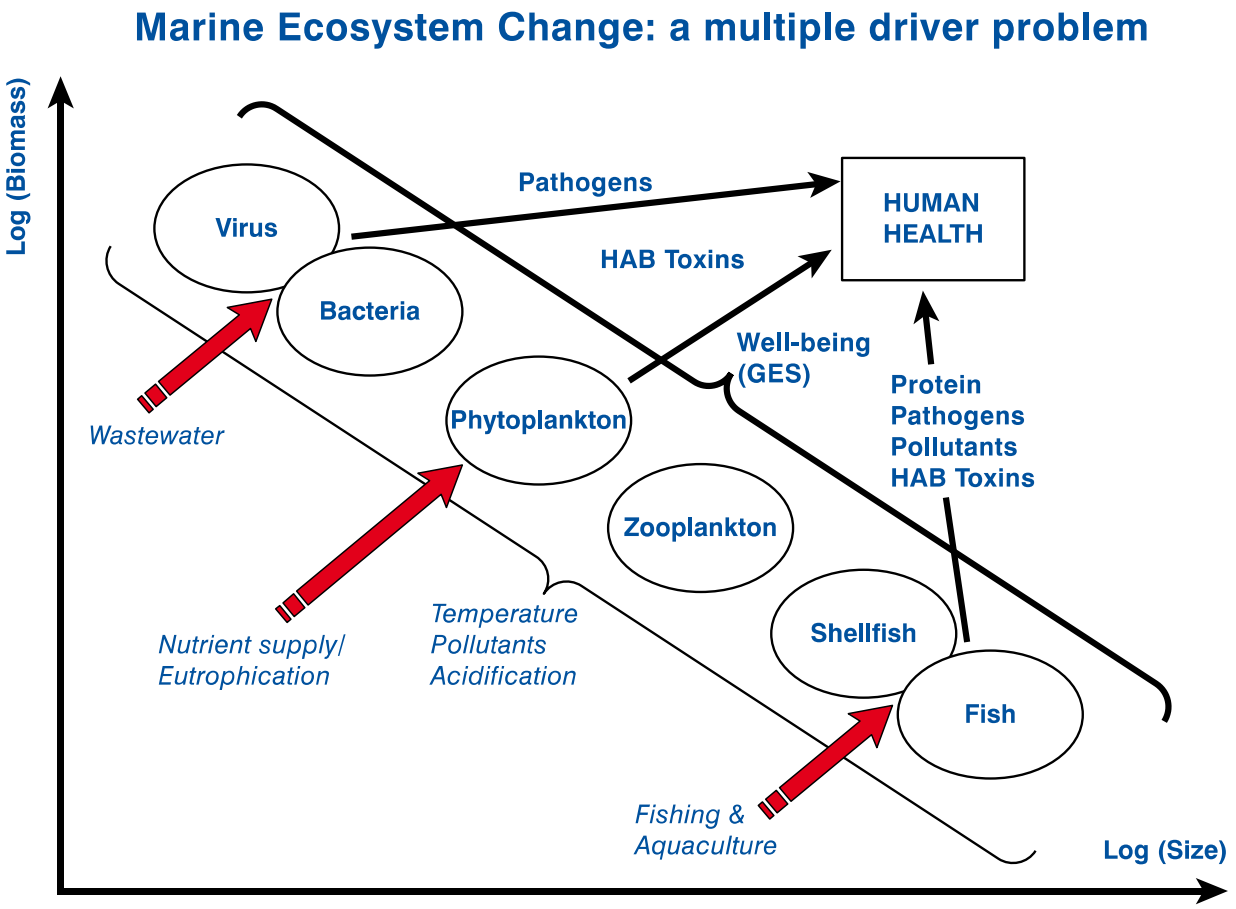
Workshop goal: Sustainable use of coastal and marine resources in Kenya: from research to societal benefits

➢ Linking Oceans & Human Health…
Coastal and open ocean





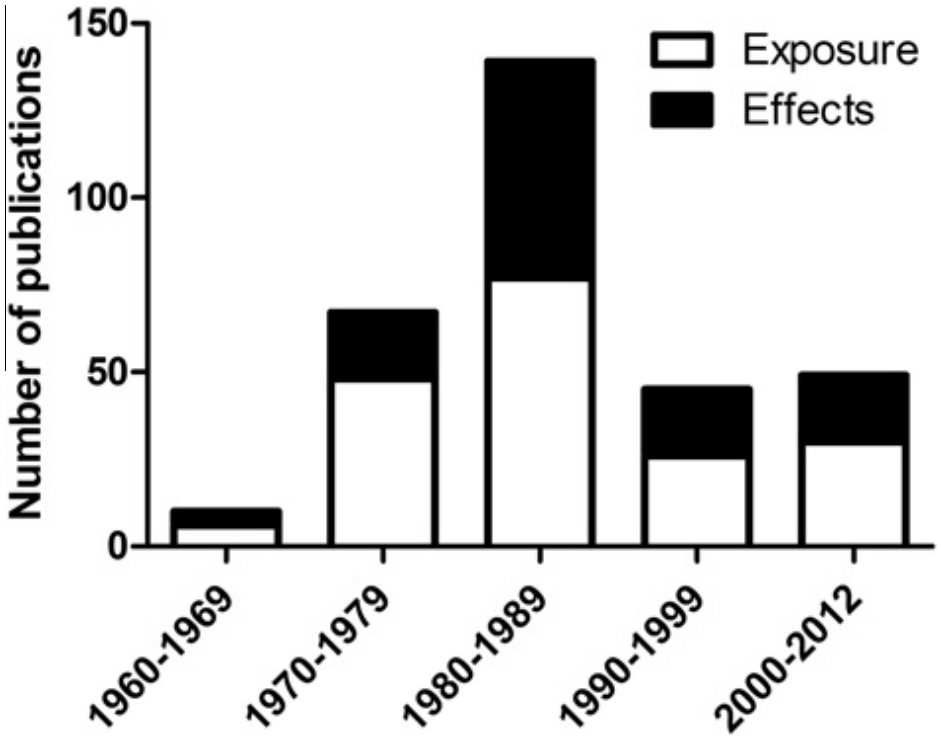
Linking Oceans & Human Health… coastal and open ocean



Marine pollution: East Africa

Brief (open) literature review

- Review Wepener & Degger:
  - 1960 – 2012
  - decline in number of papers from 1980s onwards
  - linked to absence of marine pollution monitoring programme
- Kenya?
  - fragmented: some papers on metals and nutrients…
  - no sustained monitoring of chemical substances (and others) in Kenyan waters



Wepener V. & Degger N., 2012. Status of marine pollution research in South Africa (1960 – present). Mar. Pol. Bull. 64:1508-1512.

Marine pollution: international monitoring

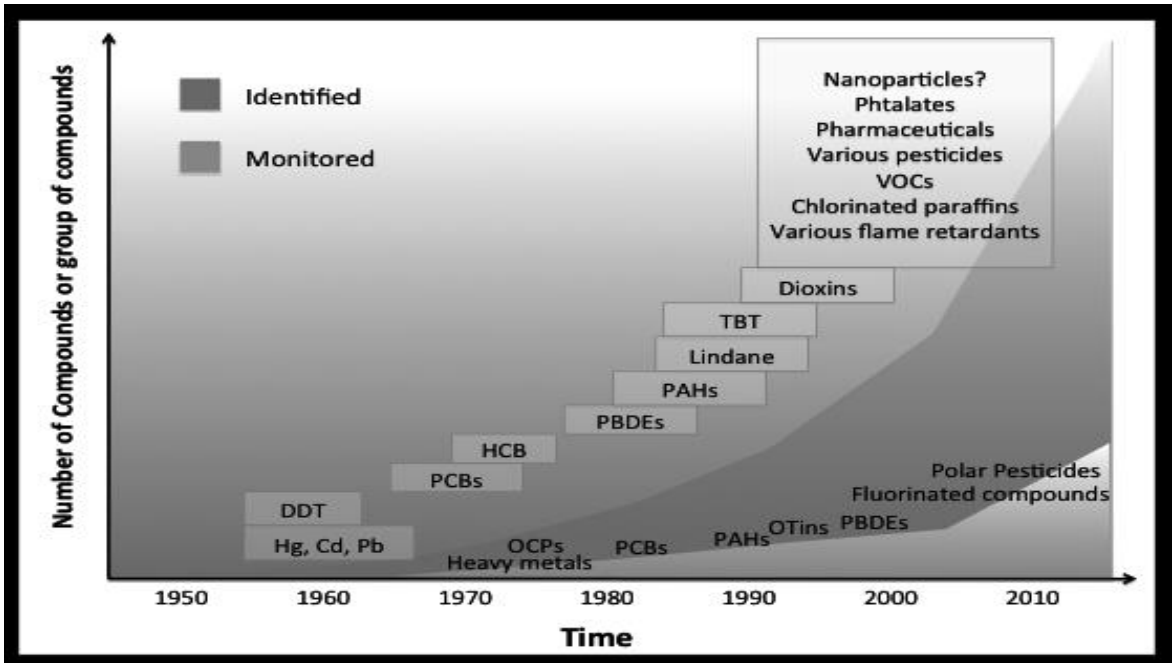
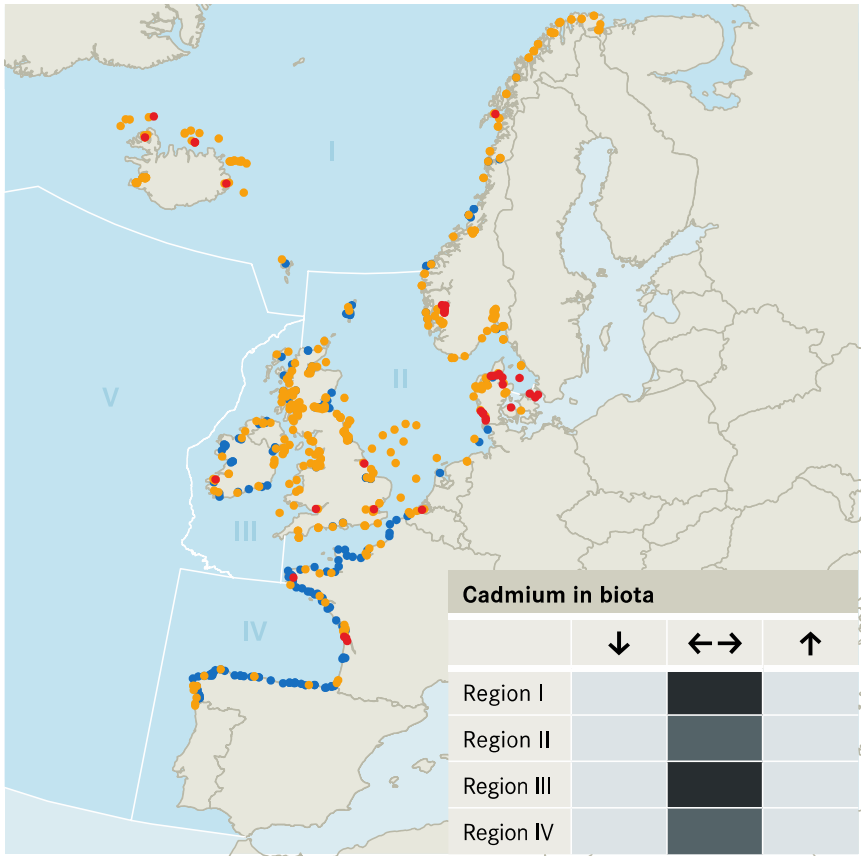


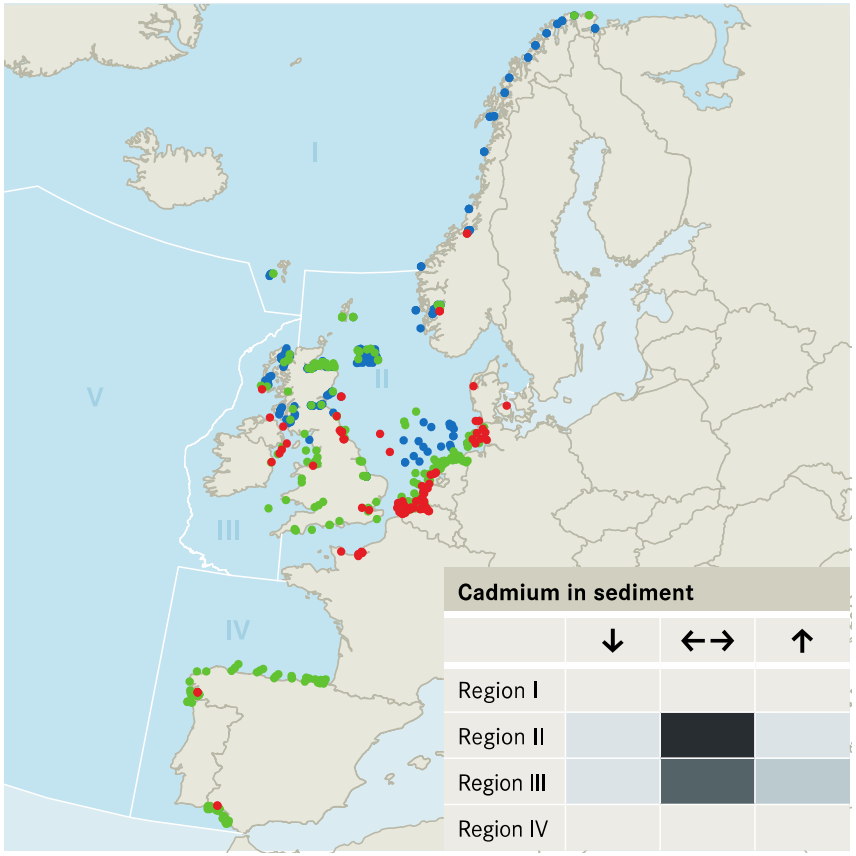
Table 3.1. Overview of some major well-established international monitoring programmes and the contaminants and matrices they measure (after Roose and Brinkman, 2005)

Organisation or programme[1]	Start of the programme	Parameters[2,3]	Sample types
AMAP	1978	HM, PCBs, PAHs, OCPs	biota, sediment, water, human tissue
HELCOM	1979	HM, PCBs, PAHs, OCPs, OTINs	biota, sediment, water
NS&T	1986	HM, PCBs, PAHs, OCPs	biota, sediment
IMW	1965	HM, PCBs, PAHs, OCPs	biota (bivalves)
OSPAR	1978	HM, PCBs, PAHs, OCPs, OTINs	biota, sediment

Janssen C., Roose P. et al., 2011. Chemical pollution in Europe's seas. Marine Board Position Paper 16. Marine Board – ESF, Ostend, Belgium

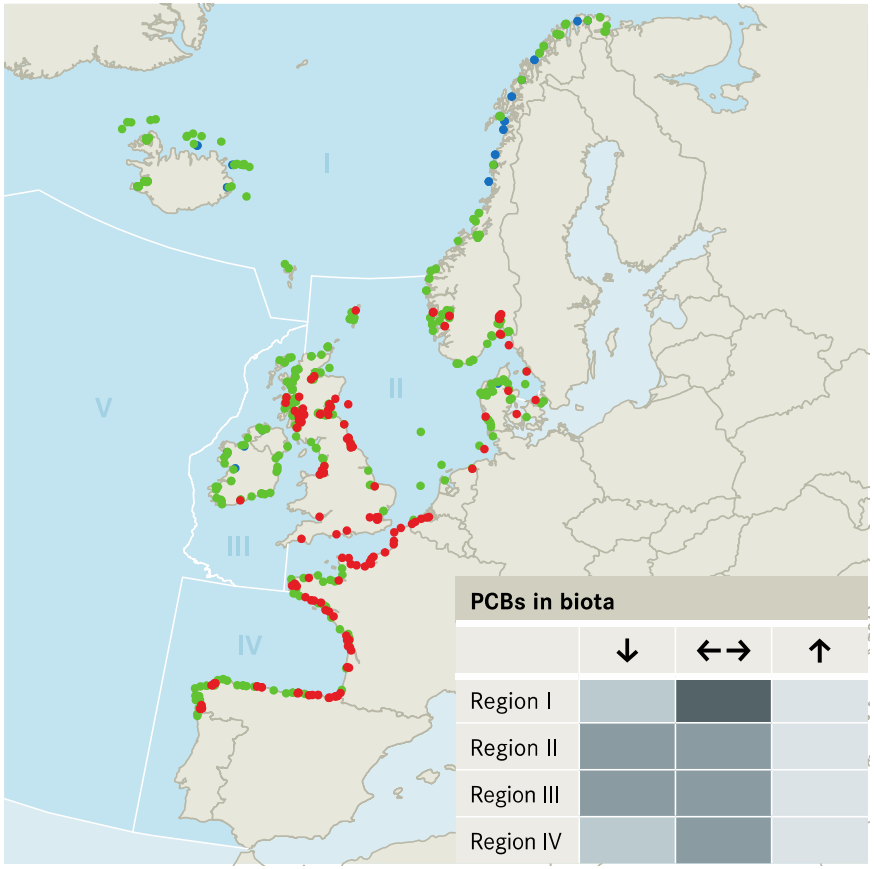
Marine pollution: international monitoring

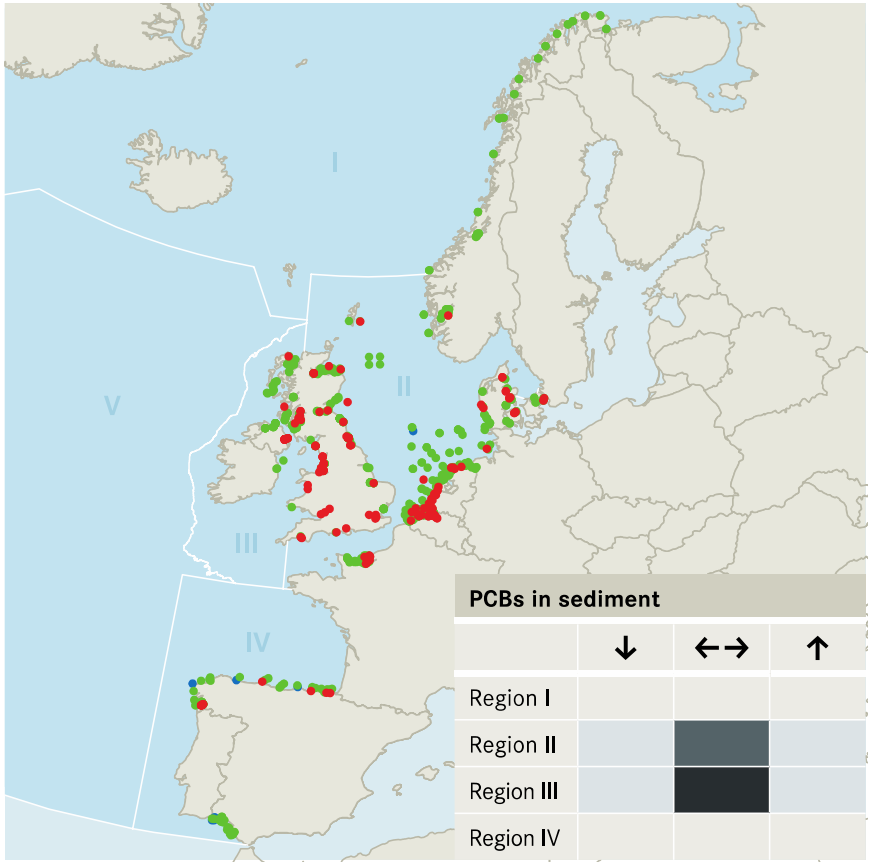




OSPAR, 2010. Quality Status Report. OSPAR Commission. London. 176 pp.

Marine pollution: international monitoring



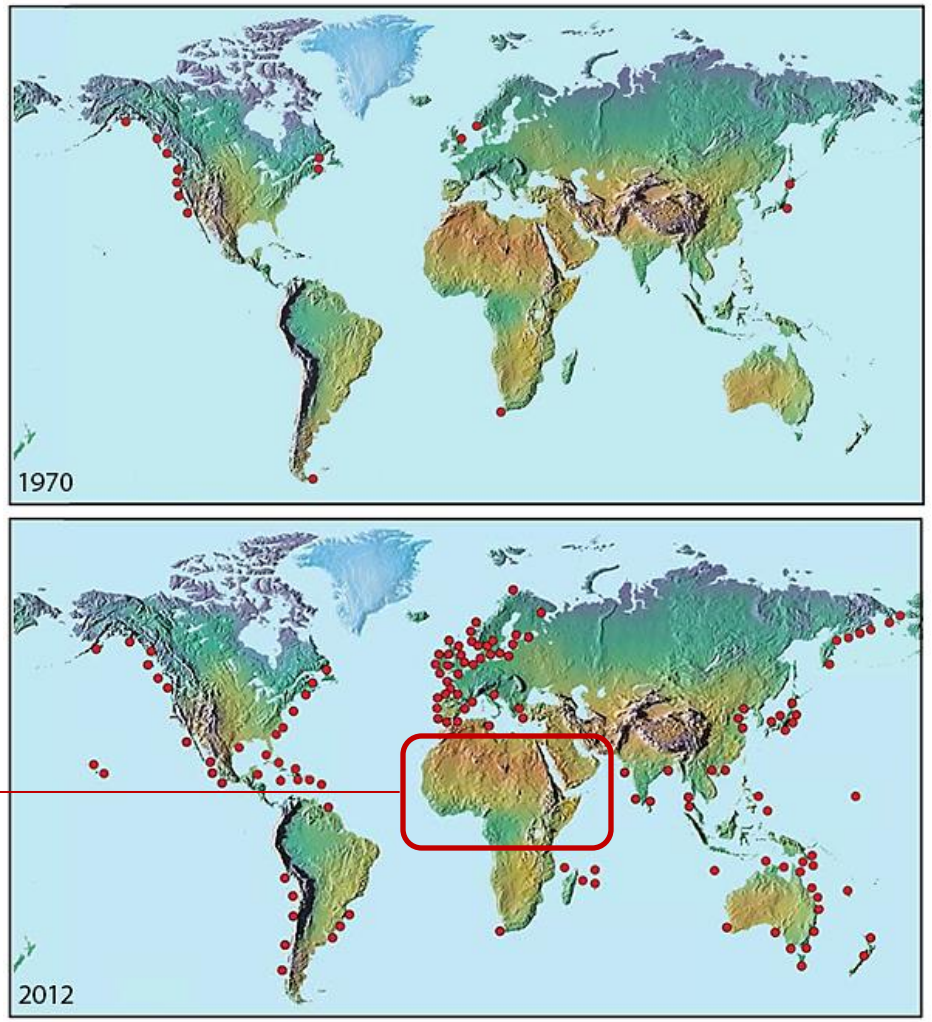


OSPAR, 2010. Quality Status Report. OSPAR Commission. London. 176 pp.

Harmful Algal Blooms

…near monospecific, high density aggregations (millions of cells.l^{-1})

"Red tides"



Harmful Algal Blooms

High biomass → anoxia & shading

Unpalatable gelatinous envelope → “starving” the food chain

Physical shape → damage to gill tissues

Marine toxins → neurotoxic to fish, birds, mammals and humans

HABs

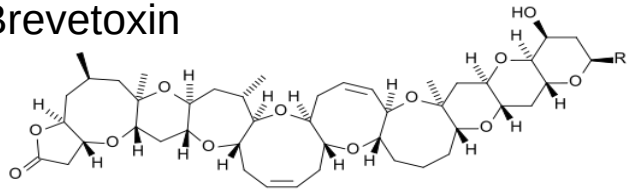
Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol. 3, No.9, 2013
www.iiste.org

Potentially Harmful Algae along the Kenyan Coast: A Norm or Threat.

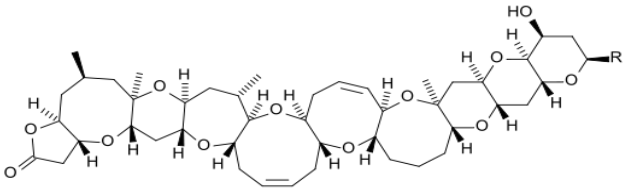
Linet *et al.*

Human illness	Main toxin	Producers present in the Kenyan coastal zone
Amnesic shellfish poisoning	Domoic acid	*Pseudo-Nitzschia* spp. ; *Nitzschia* spp.
Paralytic shellfish poisoning	Saxitoxin	*Alexandrium* spp. ; *Gymnodinium* spp. ; *Anabaena* spp.
Diarrhetic shellfish poisoning	Okadaic acid	*Prorocentrum* spp. ; *Dinophysis* spp.
Azaspiracid shellfish poisoning	Azaspiracid	*Protoperidinium* spp. ; *Azadinium* spp.
Ciguetera fish poisoning	Ciguatoxin	*Gambierdiscus* spp.
Ciguetera fish poisoning	Palytoxin	*Ostreopsis* spp.

Complex compounds with many structural subtypes e.g.
Brevetoxin



Brevetoxin A



Brevetoxin B

Brevetoxin-1 (PbTx-1) R = -$CH_2C(=CH_2)CHO$
Brevetoxin-7 (PbTx-7) R = -$CH_2C(=CH_2)CH_2OH$
Brevetoxin-10 (PbTx-10) R = -$CH_2CH(-CH_3)CH_2OH$

Brevetoxin-2 (PbTx-2) R = -CH2C(=CH2)CHO
Brevetoxin-3 (PbTx-3) R = -CH2C(=CH2)CH2OH
Brevetoxin-8 (PbTx-8) R = -CH2COCH2Cl
Brevetoxin-9 (PbTx-9) R = -CH2CH(CH3)CH2OH

Linet K. et al., 2013. Potentially harrmful algae along the Kenyan coast: a norm or threat. J. Env. Earth Science 3: 1-11.

HABs

Kenya @ Risk?... *Pseudo-nitzschia* spp. case

<u>If:</u>

- Natural reported density (in Kenya) increases from 830 cells.l^{-1} to 8300 cells.l^{-1}
- Average domoic acid content per cell: 0.9 pg.cell^{-1} (0.2-1.5 pg.cell^{-1})
- Average filtration rate of shellfish: 5 l.h^{-1} (0.5-10 liters.h^{-1})
- Accumulation rate: 8% of consumed particulate domoic acid
- Average weight of commercial shellfish: 9 g (3-15 g.individual^{-1})
- Legal limit of domoic acid in Europe: 20 µg.g^{-1}

<u>Then:</u>

Shellfish take up approximately 72 µg (7.9 µg.g^{-1}) DA every day

- ➢ It takes **2.5 days to reach the legal EU limit**
- ➢ Some species need **up to a year** to reduce the toxins below detection limits

This would be considered a **small-scale bloom** as dense *Pseudo-Nitzschia* spp. blooms can exceed 1000 cells.ml^{-1} and last for weeks!

Natural concentrations taken from Kiteresi *et al.* 2013/ DA levels: De Rijcke et al. 2014 / Filtration rates: Uline et al. 2013 / Ecomare / Accumulation rate: Novaczek et al. 1991 / Average shellfish weights: Van Cauwenberghe et al. 2014 / Depuration rates: Blanco et al. 2002

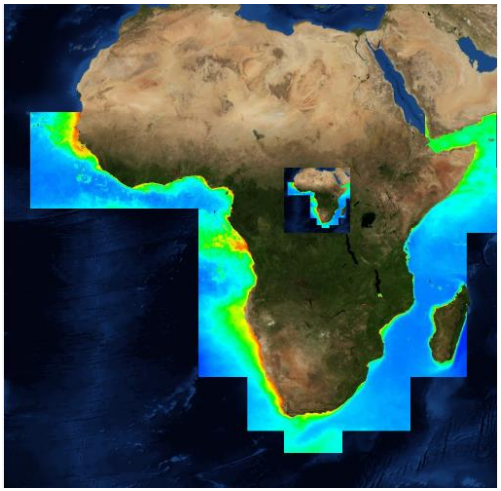
HABs

Harmful Algal Blooms

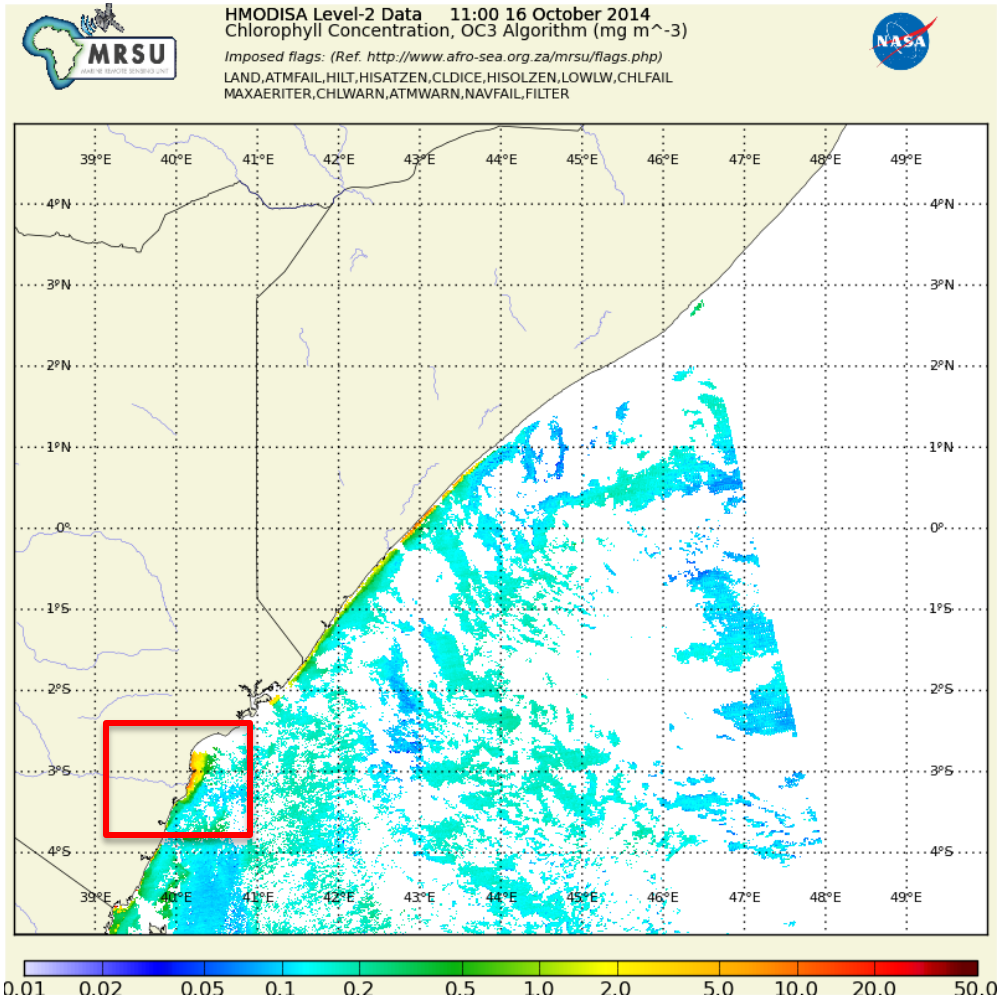
ACCESS
Africa Centre for Climate and Earth Systems Science

Need for routine monitoring

- Analytical methods: UHPLC-MS, ELISA, ...
- Phytoplankton monitoring: skilled experts, automated systems
- **Satellite imagery:** Chl A, surface t°, …



www.rsmarinesa.org.za

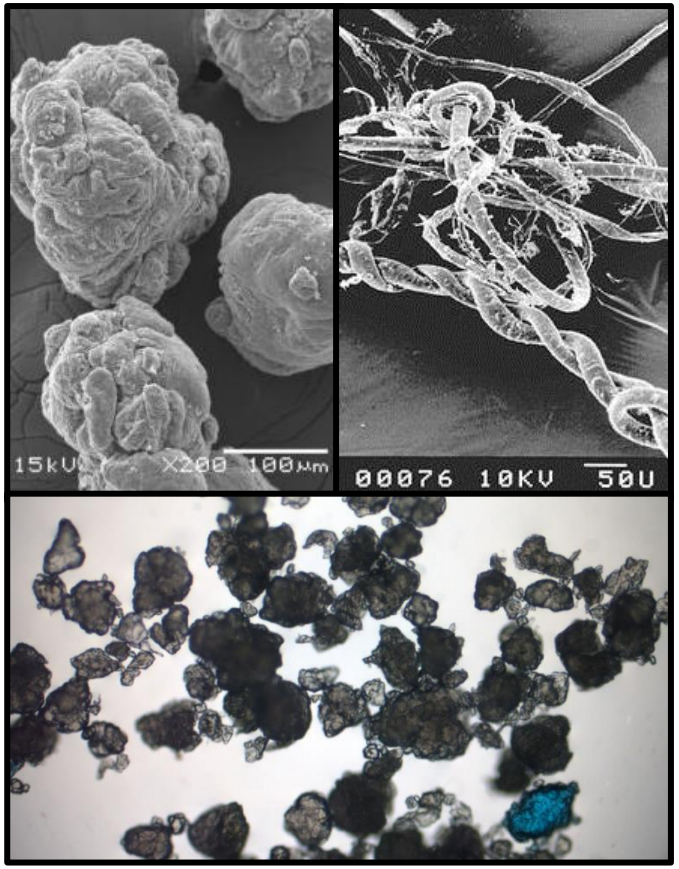


Microplastics

Plastic litter

Degradation

Small plastic particles (<1mm; <5 mm)



Synthetic clothing

Domestic wastewater

Cosmetics

Domestic wastewater

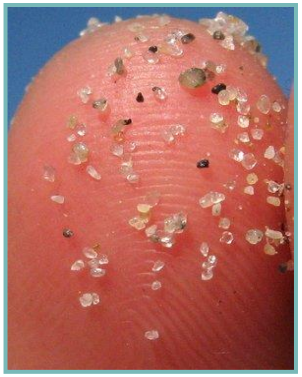
Why are microplastics dangerous?

Ingestion of microplastics demonstrated for several marine invertebrate species

Because of their <u>small dimensions</u>, microplastics become available for ingestion by organisms commonly not affected by larger marine debris

Size range of sand particles and algae

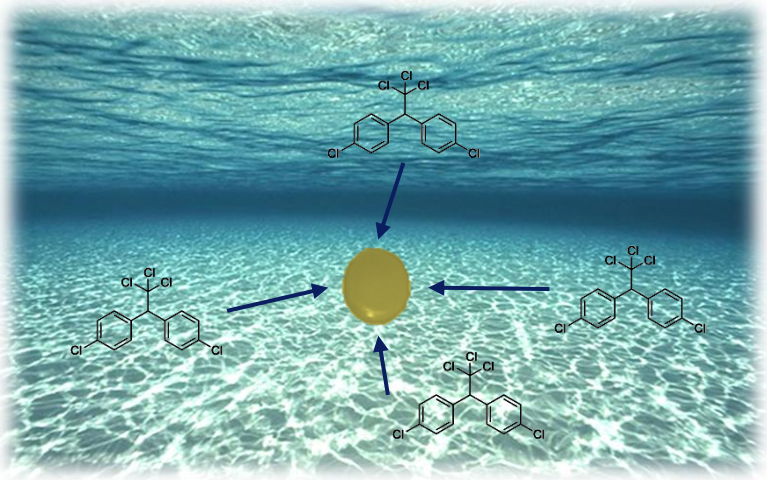
Microplastics from cosmetics



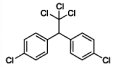
Sand grains

Why are microplastics dangerous?

Transport of sorbed environmental pollutants and toxic compounds



Concentrations can be up to a milion times higher than the surrounding seawater!



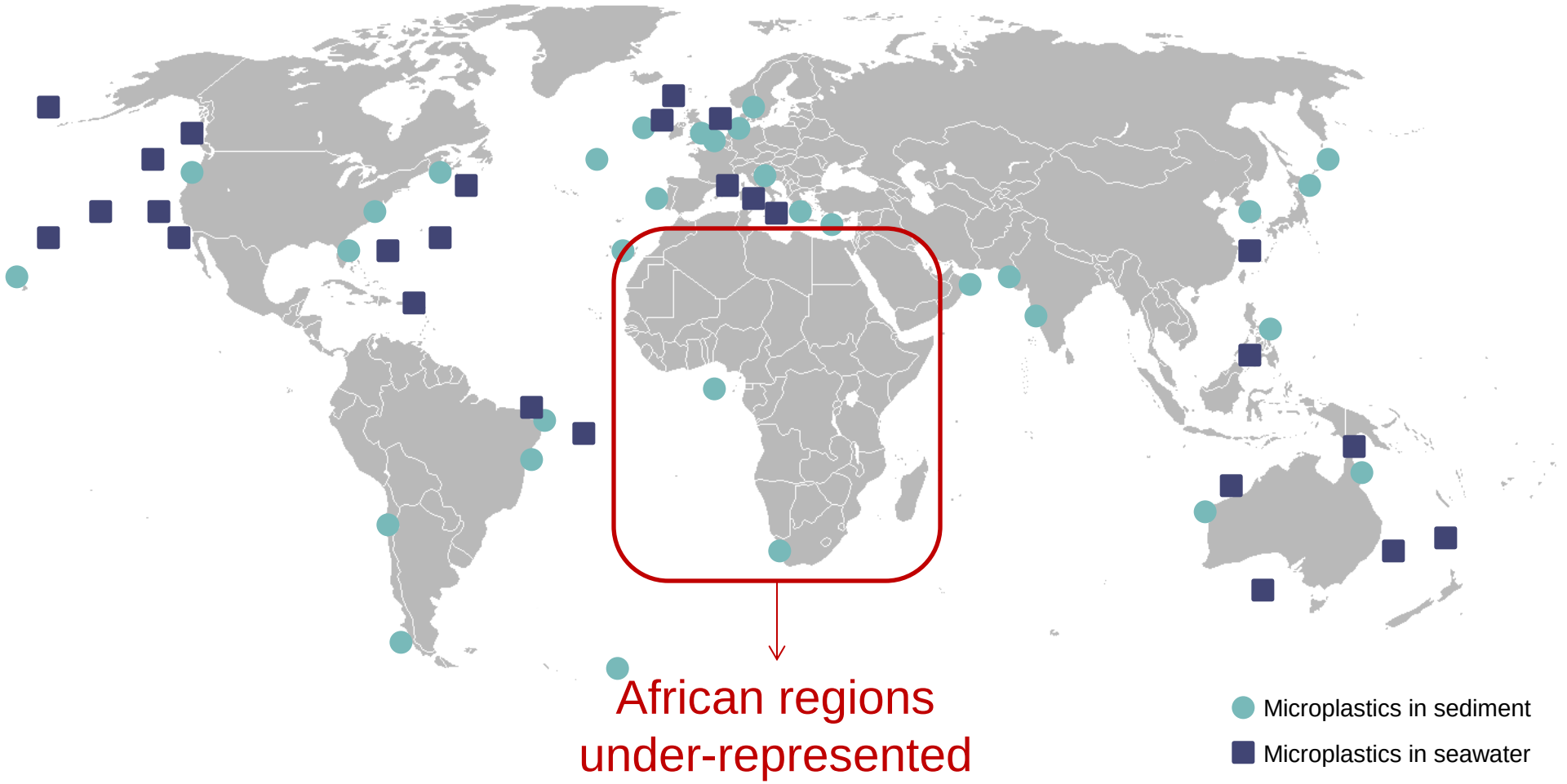
Environmental pollutant

Microplastic

Table: Dangerous additives and monomers present in plastics

Compound		**Toxicity**
Phthalates	Plasticizer	Endocrine disruptor
PBDE	Flame retardant	Neurotoxine & endocrine disruptor
Vinyl chloride	Monomer of PVC	Carginogen

Microplastics in seawater and sediments worldwide



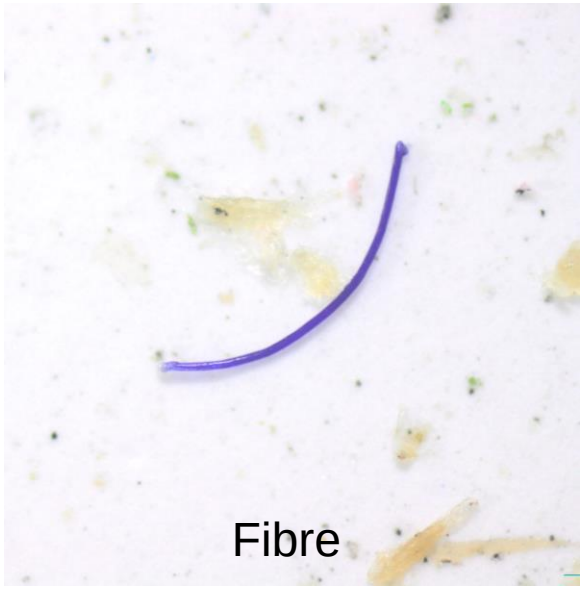
First results for Western Indian Ocean region (Gazi Bay, Kenya)

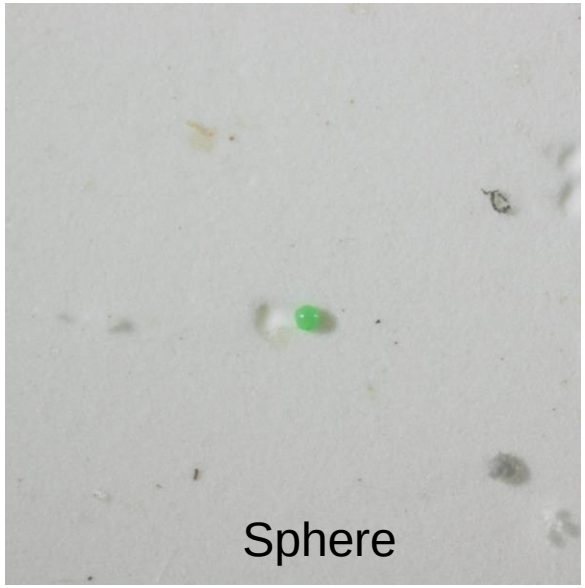
UGent - KMFRI - VLIZ cooperation

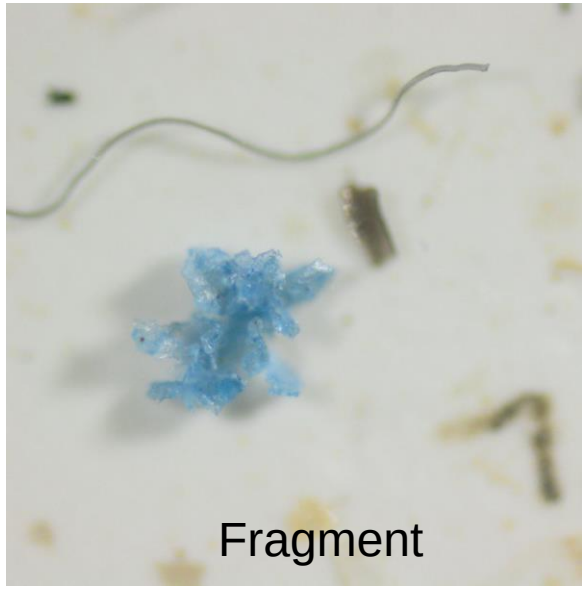
Lisbeth Van Cauwenberghe, Charles M. Kosore et al., Jan Mees & Colin Janssen

First results for Western Indian Ocean region (Gazi Bay, Kenya)

Some examples

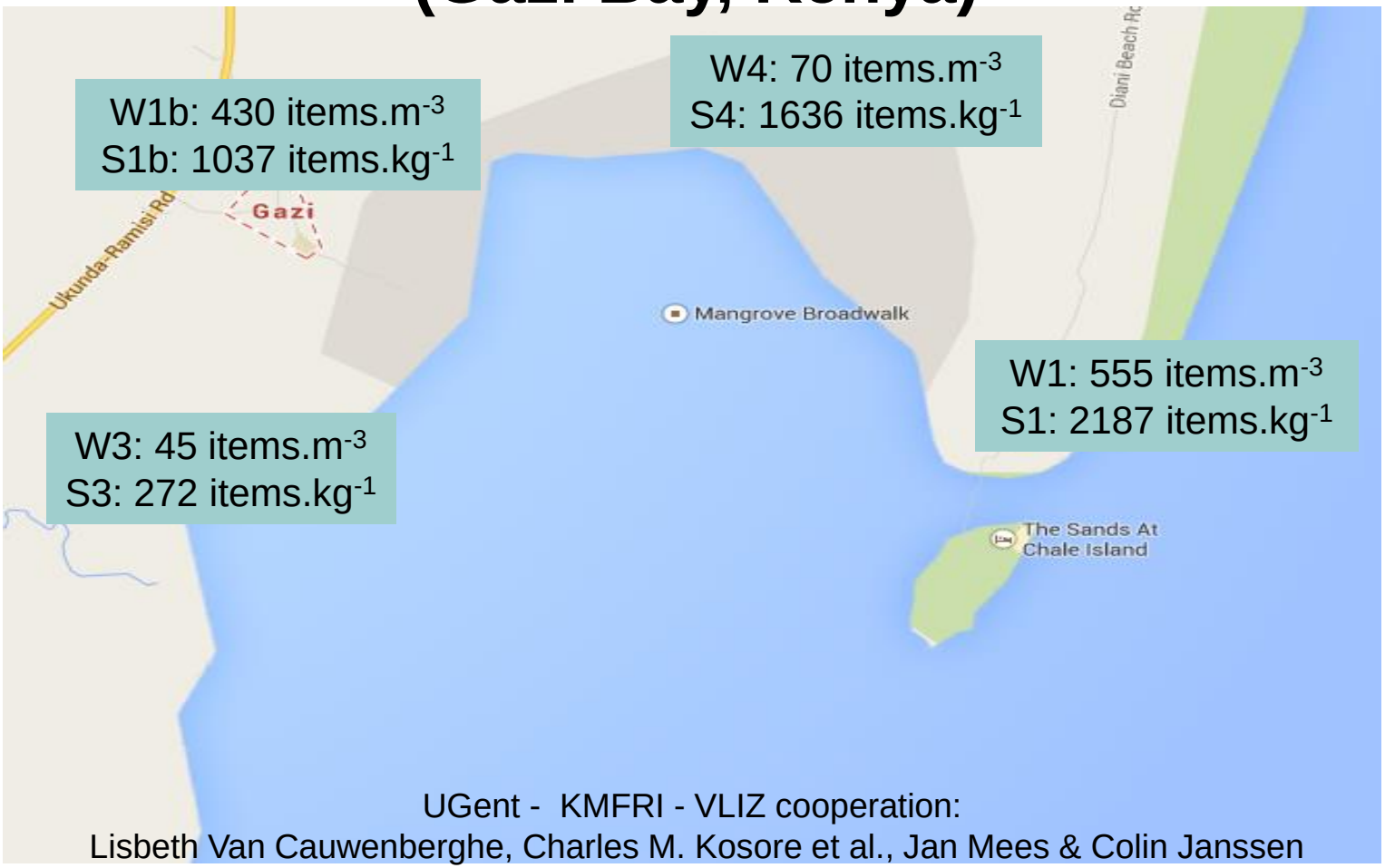






500µm

First results for Western Indian Ocean region (Gazi Bay, Kenya)



UGent - KMFRI - VLIZ cooperation:
Lisbeth Van Cauwenberghe, Charles M. Kosore et al., Jan Mees & Colin Janssen

First results for Western Indian Ocean region
(Gazi Bay, Kenya)

<u>Very high</u> degree of pollution

Comparable to the concentrations measured in some of the most polluted sites in the world:

Venice: 672 - 2175 items/kg
(Vianello et al., 2013)
Wadden Sea: 3600 – 49 600 items/kg
(Liebezeit & Dubaish, 2012)

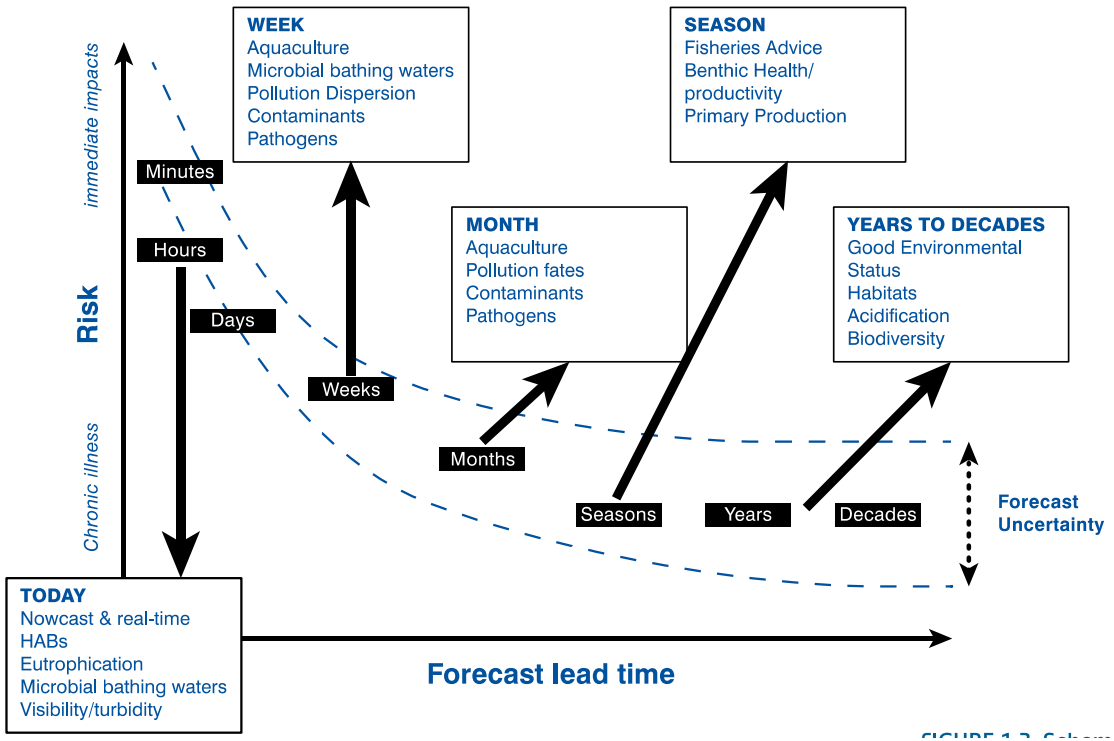
<u>High</u> degree of pollution

Similar concentrations as detected in the North Sea and East Pacific
(using similar sampling technique: 50µm net) (Desforges et al., 2014)

Linking Oceans & Human Health…

Needs:

- sustained fundamental and applied research will lead to…
- improved assessment, monitoring and prediction of potential risks and…
- sustainable management of coastal and marine resources for…
- the benefits of man and the environment




Research for **Sustainable use** of Coastal and Marine Resources in Kenya….
For me and you? Yes, we can!!!