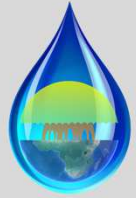# Kenyan coast Observations through Affordable Space Technology Applications

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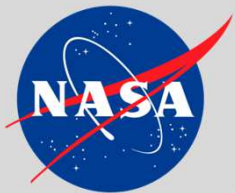
Index

- Introduction to the project
- Kenya: interaction of environment and society on the coast
- Institutional infrastructure and available technology
- Gap Analysis
- Team Koastal solutions
- Cost policy and education
- Conclusions

Sponsored by NASA

# Project Information

THE PROJECT:

- The project is a part of the 2013 Space Study Program, an interdisciplinary study program, at the International Space University, in Strasbourg.
- The group was made up 30 professionals from 12 countries, who shared an interest in sustainability.

MISSION OF STATEMENT:

- To suggest cost-effective solutions for managing resources and activities conducted in Kenya's coastal zones. This will be achieved by exploring space-integrated technologies, policy recommendations and activities related to environmental monitoring and sustainable resource management.

SCOPE:

- The project was sponsored by NASA who suggested as case study Kenya and Tanzania. The Team focused on Kenya and on marine and terrestrial water pollution, analysing existing infrastructures and technologies to develop an affordable space and ground integrated water pollution management and a livelihood support system.

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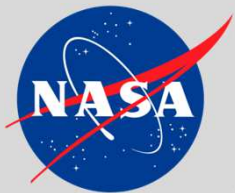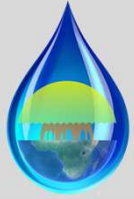
Kenya: Introduction

COUNTRY

- Kenya has 500 km coastline.
- It has a population of almost 40 million (KNBS, 2011), and 10% live along the coast.
- Mombasa is the principal city on the coast, with 525 000 people.
- Tourism forms 44% of the Kenyan economy as a whole.
- Almost 50% of the population lives on less than $1 a day and are highly dependent on local ecosystems.

COASTAL ECOSYSTEM

- Kenya's coastal ecosystem consists of the following main elements: coral reefs, seagrass, mangroves (75% of tropical sub-tropic coastline), coastal forest and dunes.
- Kenya's costal ecosystem is threatened by:
  - <u>Natural disasters </u>(Sea level rise, Climate change (droughts), Coral bleaching, Coastal erosion, Earthquakes, Tsunamis, Cyclones, Flood)
  - <u>Hazards from human activities </u>(Industrial water pollution, Agricultural water pollution, Overfishing, Oil spills, Solid waste).
- The most threatened ecosystem services within the coastal region are food, clean drinking water, energy and the ability to earn a livelihood.

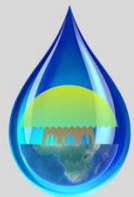# Coastal regions: Interaction between society and environment

Background and
challenges
Socio-economic Aspect
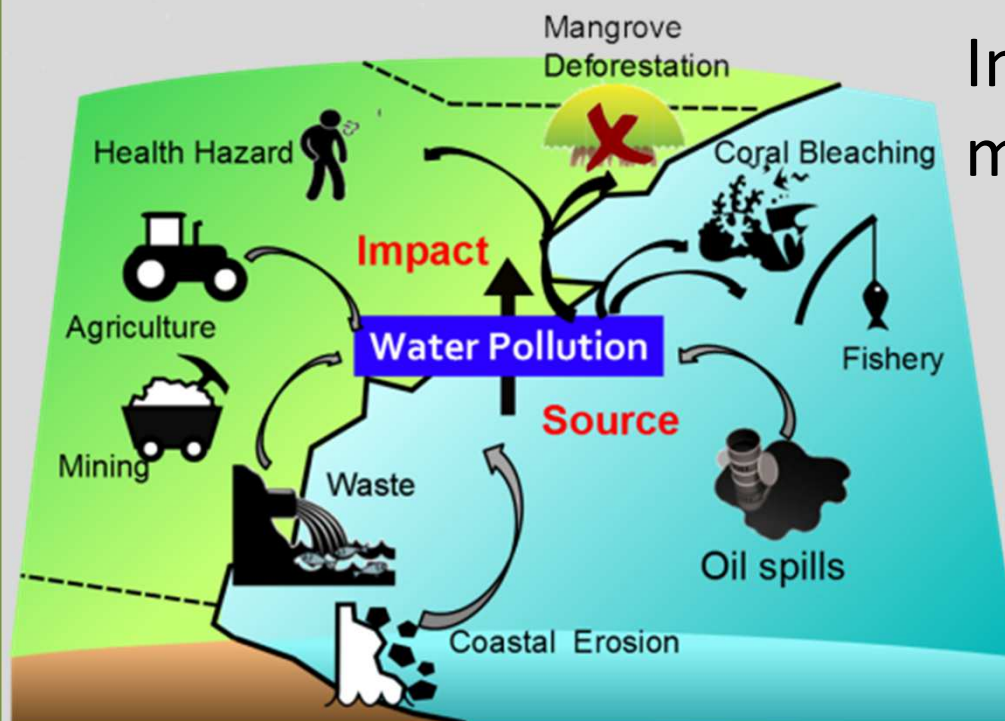
Focus of Team Project Koastal

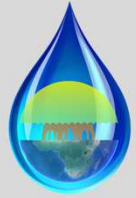## Marine and terrestrial water pollution

High impact

Interdependency

Integrated coastal management

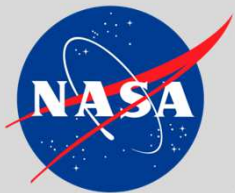Space integrated solution

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# Institutional Infrastructure and available technology

- **Kenyan national organizations and agencies:**
  - Kenya National Disaster Centre
  - Kenya Marine Fisheries Research Institute
  - Kenya meteorological department (data from GEONETCast)

- **Pan-African initiatives:**
  - African Association of Remote Sensing of the Environment
  - Bridging actions for GMES and Africa project (BRAGMA)
  - Europe-Africa Marine Earth Observation Network
  - Western Indian Ocean Marine Science Association (WIOMSA)

- **International Earth Observation initiatives covering Kenya:**
  - UN RCMRD (Regional Centre for Mapping of Resources for Development)
  - NASA SERVIR Project

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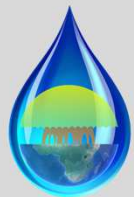
Gap analysis (1)

5 categories:

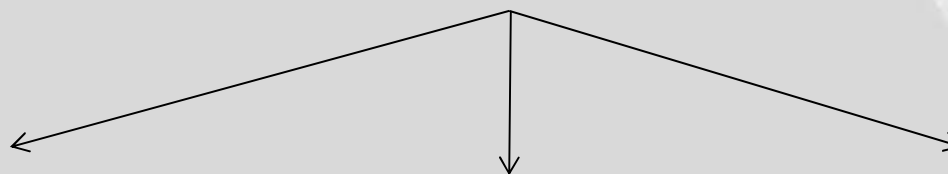| Data availability | Data processing | Data flow | Public awareness | Policy, law and education |

3 groups of gaps:

Presence
Koastal developed solution
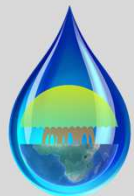
Partial gap
Enhanced by Koastal's solution

Absence
Integrated in Koastal's solution

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Gap analysis (2)

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Data availability

> Earth observation
> Gap: No

> Water pollution data
> Gap: Yes

Data processing

> Earth observation
> Gap: No

> Products
> Gap: Partial

> Disaster information
> Gap: Partial

> Water pollution
> Gap: Yes

Data flow

> National broacasting
> Gap: No

> Terrestrial mobile communication
> Gap: Yes

> Satellite communication
> Gap: No

Public awareness

> Pollution control and environment management
> Gap: Partial

Policy, law and education

> Awareness about water pollution
> Gap: Partial

Koastal's solution

Integrated marine and terrestrial water pollution management and livelihood support system for Kenyan coastal regions
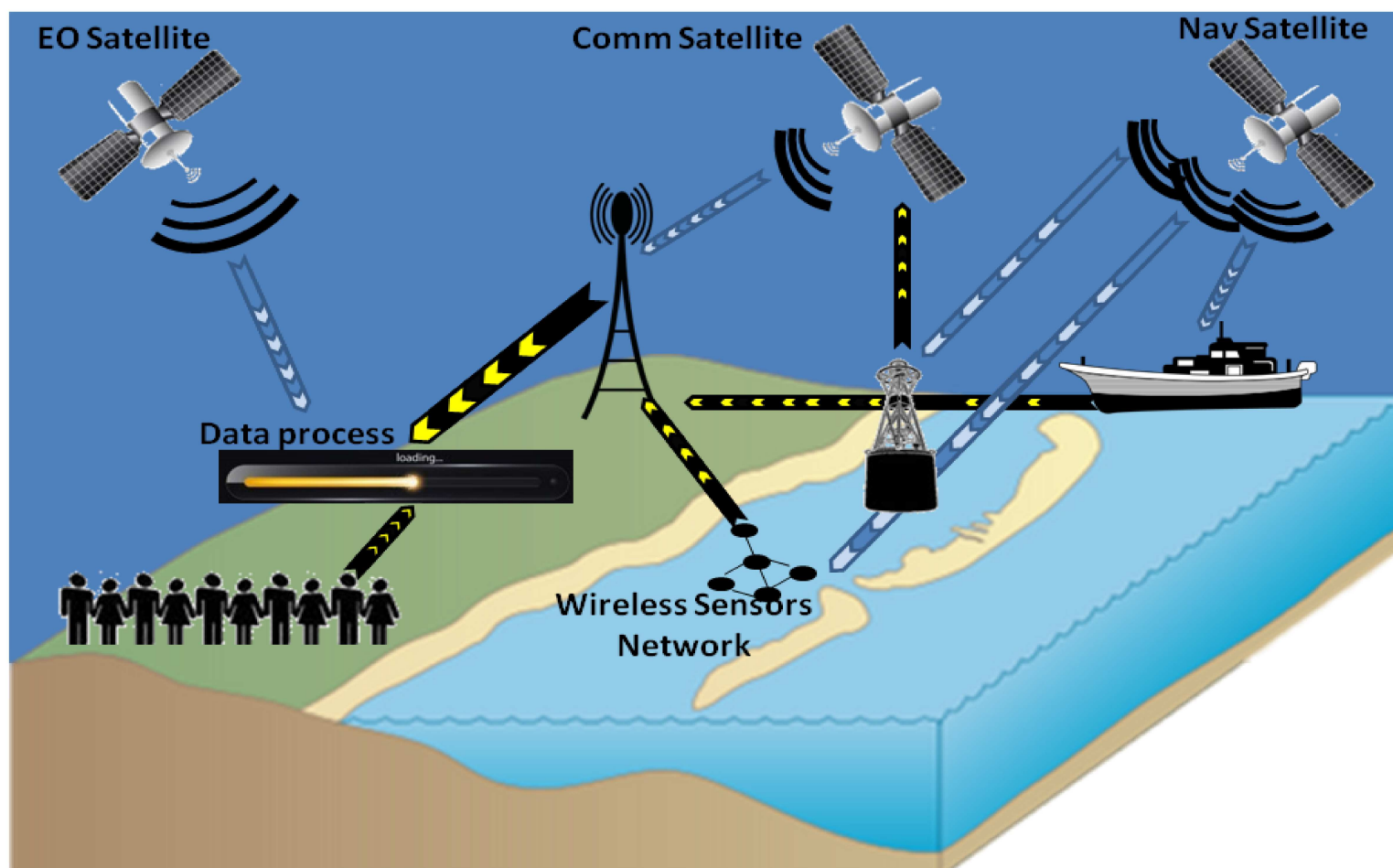

Sponsored by NASA
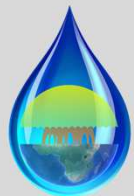
3 step solution for water pollution:
- Detection
- Response
- Regulation

12

Kostal Solution: Earth observation data

- Used for deriving sea surface temperature, mangrove degradation, coral bleaching, waste dumpsites, algal blooms, ocean wind and currents etc.

- Earth observation data from space use existing infrastructure to be cost-effective (satellite navigation and telecommunication)

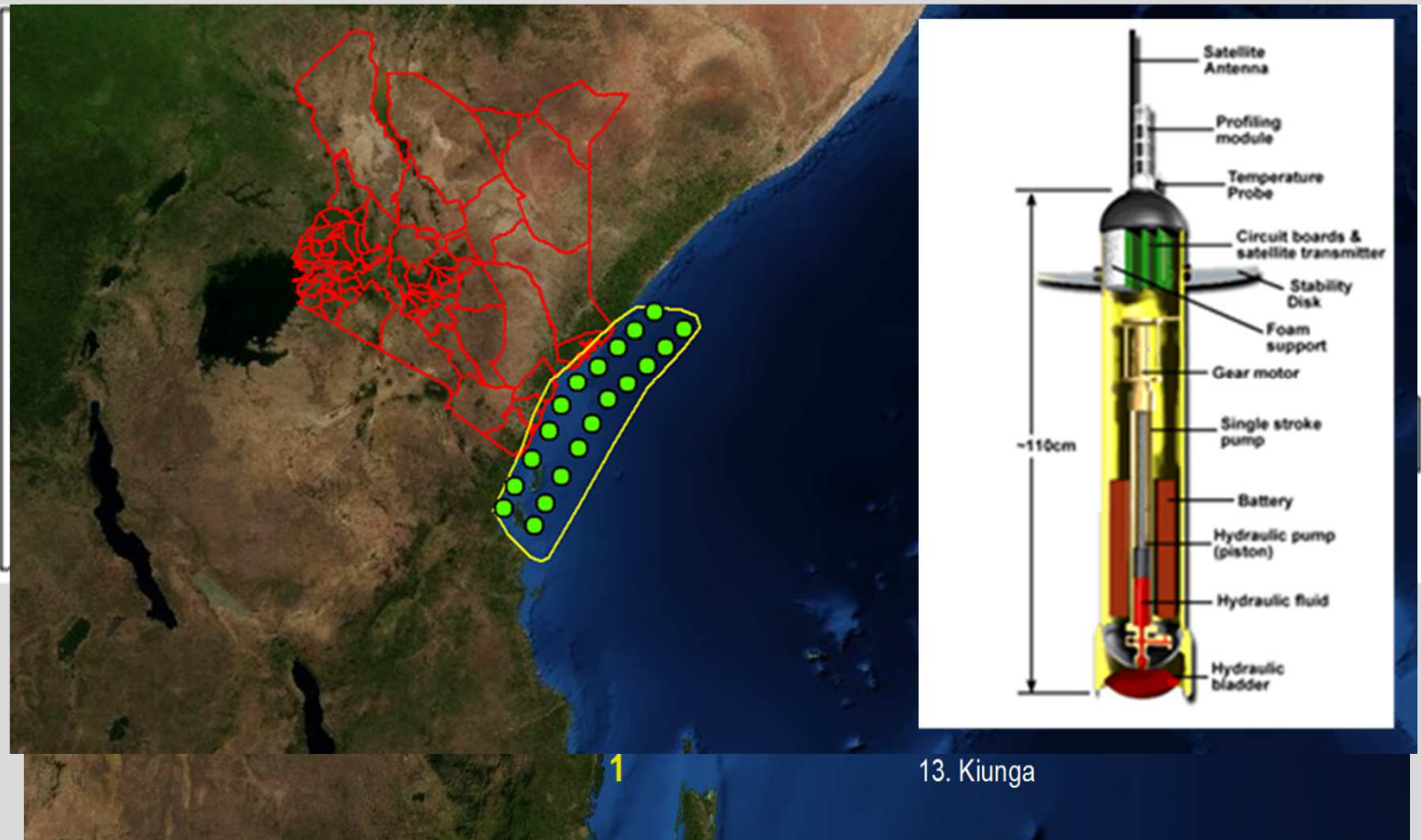- UN RCMRD, SERVIR, GEONETCast, Indian Ocean Tsunami Warning System etc.

Sponsored by NASA
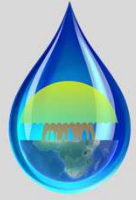
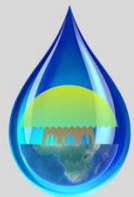# Koastal Solution: deep sea buoys

Pollution monitoring Locations

13. Kiunga

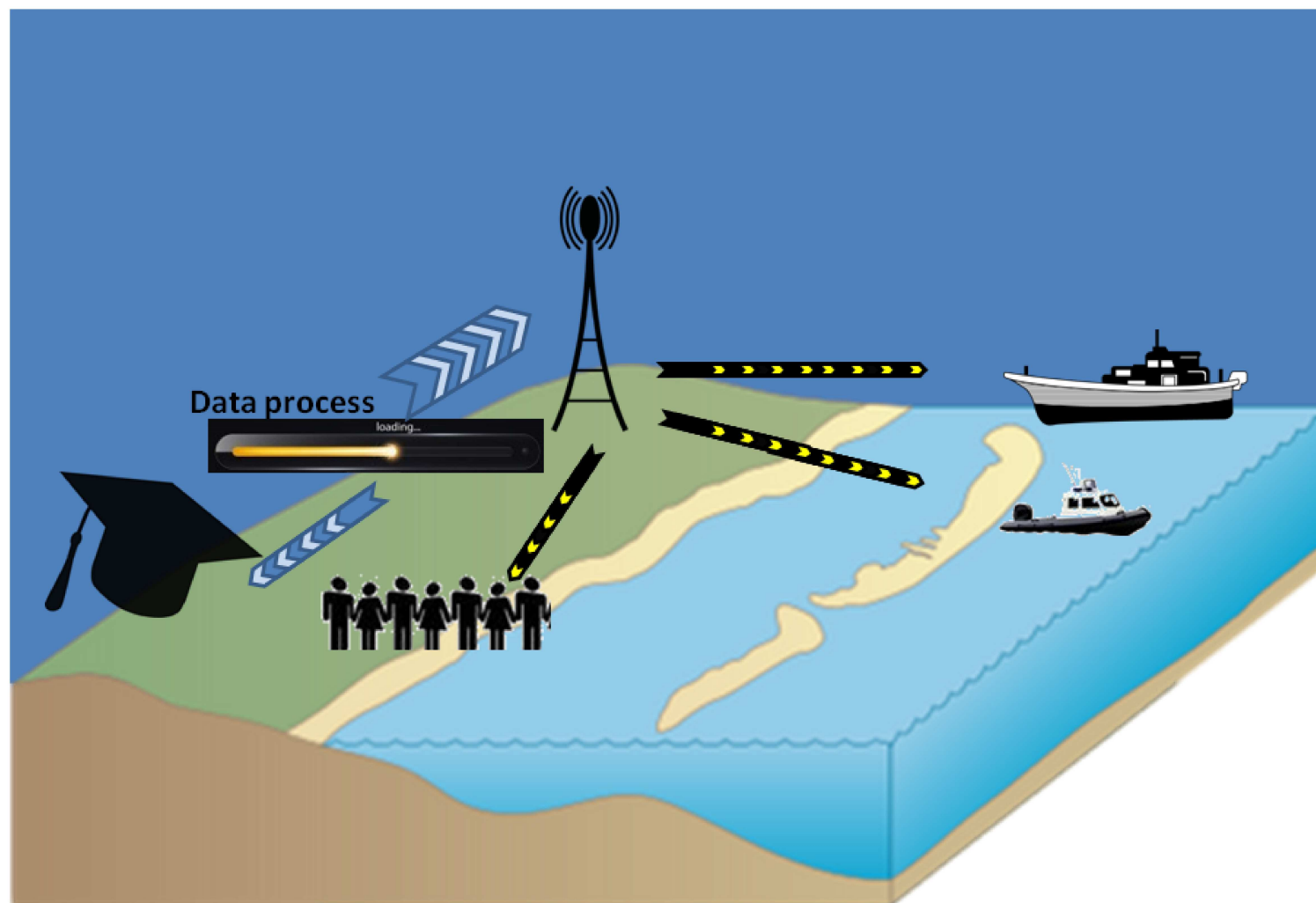Sponsored by NASA

15

Data process

loading...

Koastal Solution: data dissemination
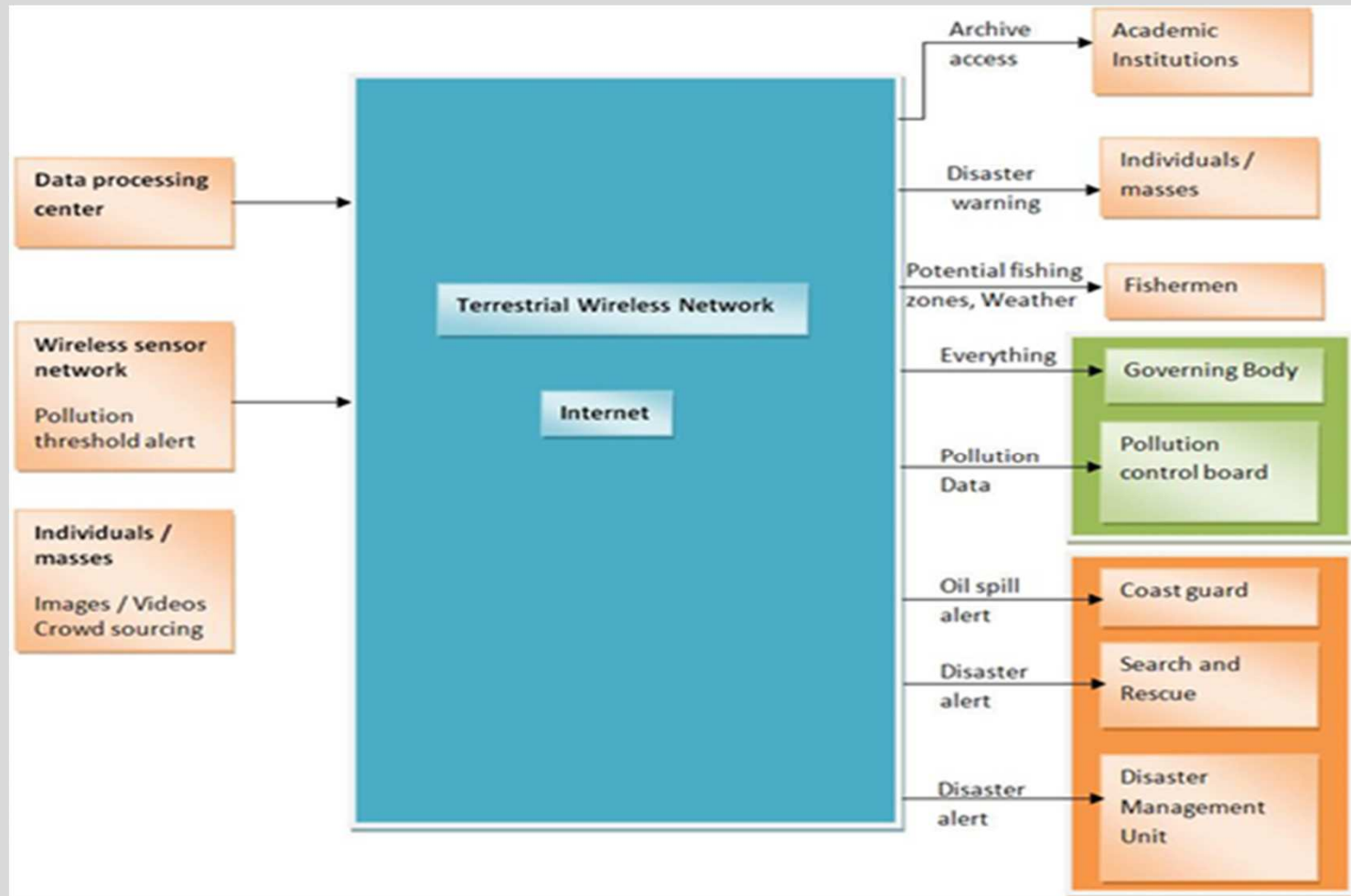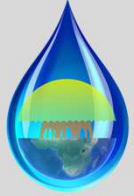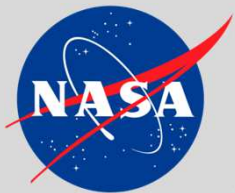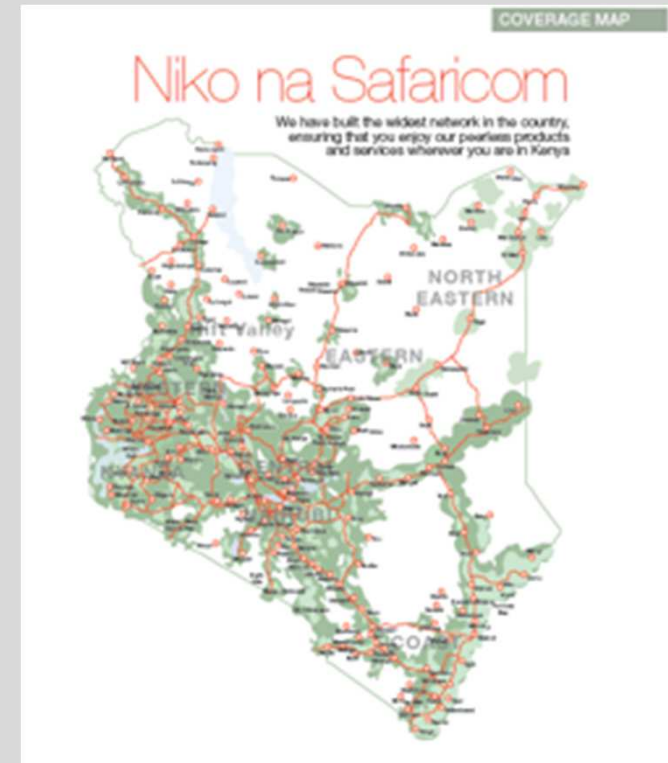
Mobile Phone Networks

- Despite low income over 30 million Kenyans have a mobile phone which correspond approximately to 75% of the population

- Around 84% of the Kenyan population is covered by the mobile network.

- The mobile phone network has significant potential for data exchange for reaching individuals as well as for building a virtual network.

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Koastal's solution: new software mobile phone applications

Fishing

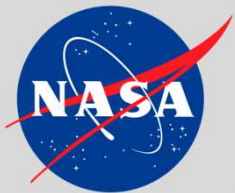Potential fishing zones

Maps, navigation, weather, etc.

M-Eye

Collects geo-tagged pictures and video

M-Collect

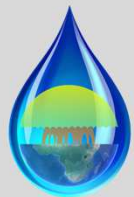Extracts data from instruments on boats

M-Spill

Alerts coast guard

Maps, navigation, weather etc.

Policy recomendations

- The UN Charter for Space and Major Disasters should be modified to include access to Earth Observation data to prepare for natural disaster.

- A legal framework should exist for local decision makers to acquire and process foreign owned satellite data domestically.
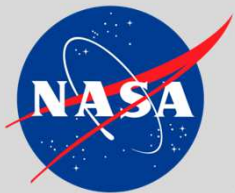
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Education and outreach recomendations

- TP Koastal proposes an education and outreach program to educate people about water pollution and its influence on the coast on clean drinking water and hygiene.

- TP Koastal suggests disaster prepardness training for the population of the coastal regions.

- TP Koastal proposes use of television, radio, community centers and schools with existing internet facilities as well as mobile phones to spread the word.
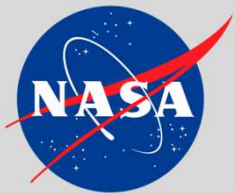
Sponsored by NASA
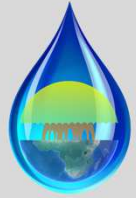
Conclusions

- Koastal suggests an integrated marine and terrestrial water pollution management and livelihood support system for Kenyan coastal regions.

- Creation of a new ground and maritime based wireless network of sensors to integrate ground and space observations of the coast of Kenya.

- Decision support system to improve response to water pollution, floods, and tsunamis.

- The proposed system has global relevance and can be applied to any coastal region in the world where humans depend from coastal ecosystems services.

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Aknowledegments

- ISU – International Space University: Faculty and staff and External Experts

- Sponsored by NASA

- Chair: Olga Zhdanovich – Russia

- Teaching Associate: Scott MacPhee – Canada

- Team Koastal: Australia, Belgium, Canada, China, France, India, Italy, Israel, Japan, Norway, The Netherlands, USA
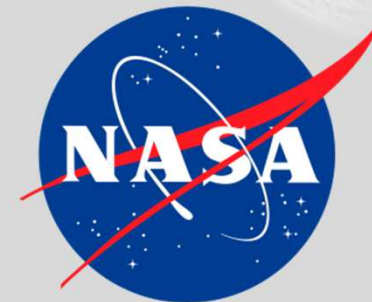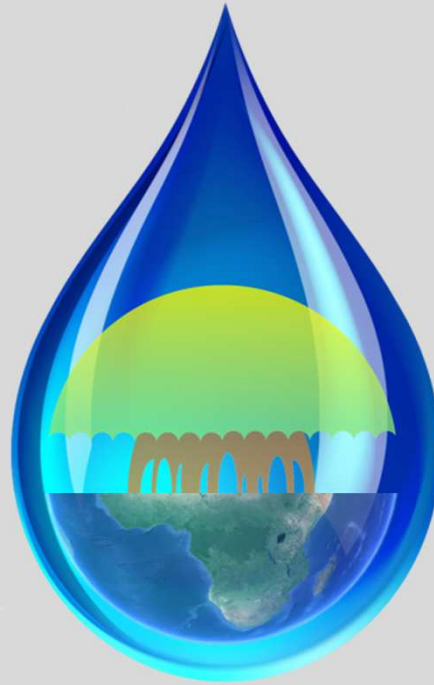
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Questions?

Koastal's solution: cost

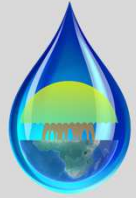To cover the entire coast: $7.15M as starting costs and annual running cost of $4.5M

Solution module		Costing elements	Unit cost $	Quantity	Total cost $
Monitoring	Ground segment	Pollution sensors	3,000	1175	3,525,000
		Near coast buoys	1,000	43	43,000
		Argo buoys	15,000	20	300,000
		Deployment and assembly costs			2,500,000
		DSS software development	30 per hour	640 hours	19,200
Respond	Alarm	SMS, radio alert system software	30 per hour	640 hours	19,200
	Manage	Conducted by other organizations	0	0	0
Regulate		Policy & Law	0	0	0
Education and Outreach		Educational materials	27,500		27,500
		Lecturers	30,000	10	300,000
		Apps	10,000	4	400,000

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Pollutants

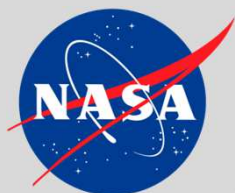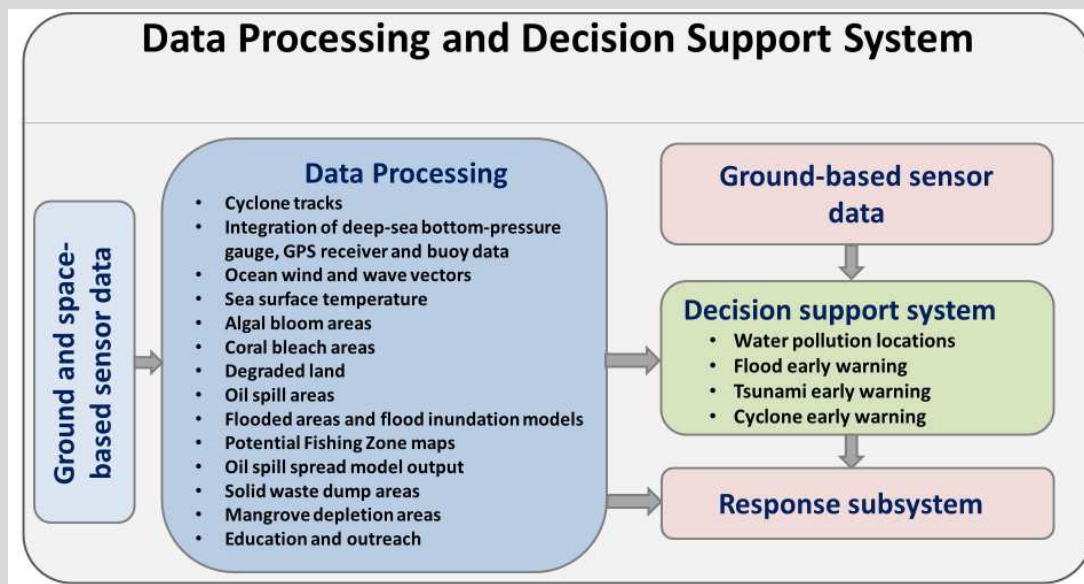|	
• pH	• Lead
• Dissolved Oxygen	• Zinc
• Temperature	• Mercury
• Conductivity	• Chromium
• Nitrates	• Cadmium
• Phosphates	• Chlorine
• Magnesium	• Iron
• Sulfur	• Total Dissolved Solids
• Potassium	• Organic matter
• Pesticides	• Water level height
• Copper	• GNSS Positioning
• Radioactivity	

23 pollutants. Each sensor can measure from 3 to 5 pollutant

Decision Support System

Data Processing and Decision Support System