Lagoons, Indicators and Sustainable Water Futures

ESA-FEC Lagoon Workshop

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MaREI Centre
Cork, Ireland

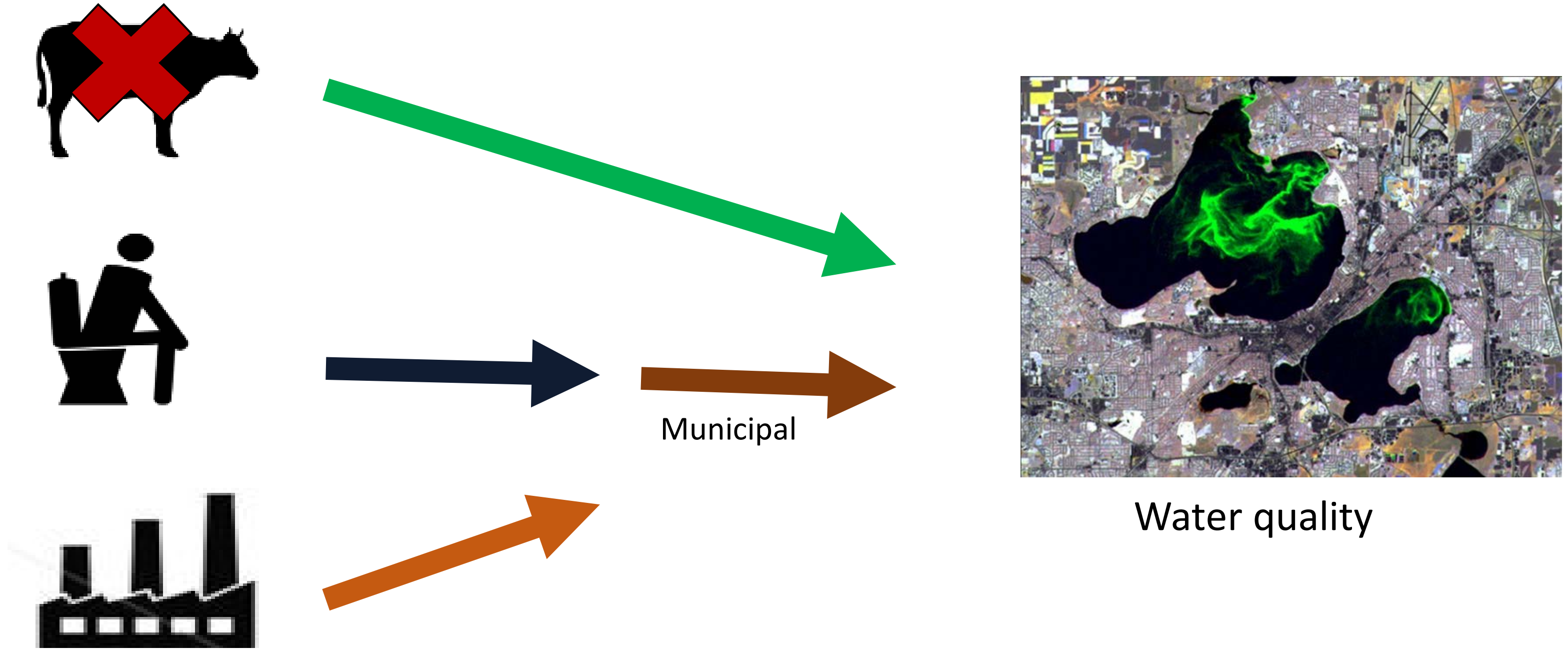
Obstruction to the flow of water

Lagoons:

- Subject to pollution
- Subject to changing lagoon use
- Subject to local land use change
- Subject to climate change
- Subject to extreme events (hurricanes)-flood water retention
- Subject to biogeochemical stresses on their fragile ecosystems
- Subject to industrial development
- Subject to fresh water inputs
- etc.

Photo by NASA - http://eol.jsc.nasa.gov/sseop/EFS/photoinfo.pl?PHOTO=STS073-701-33, Public Domain,

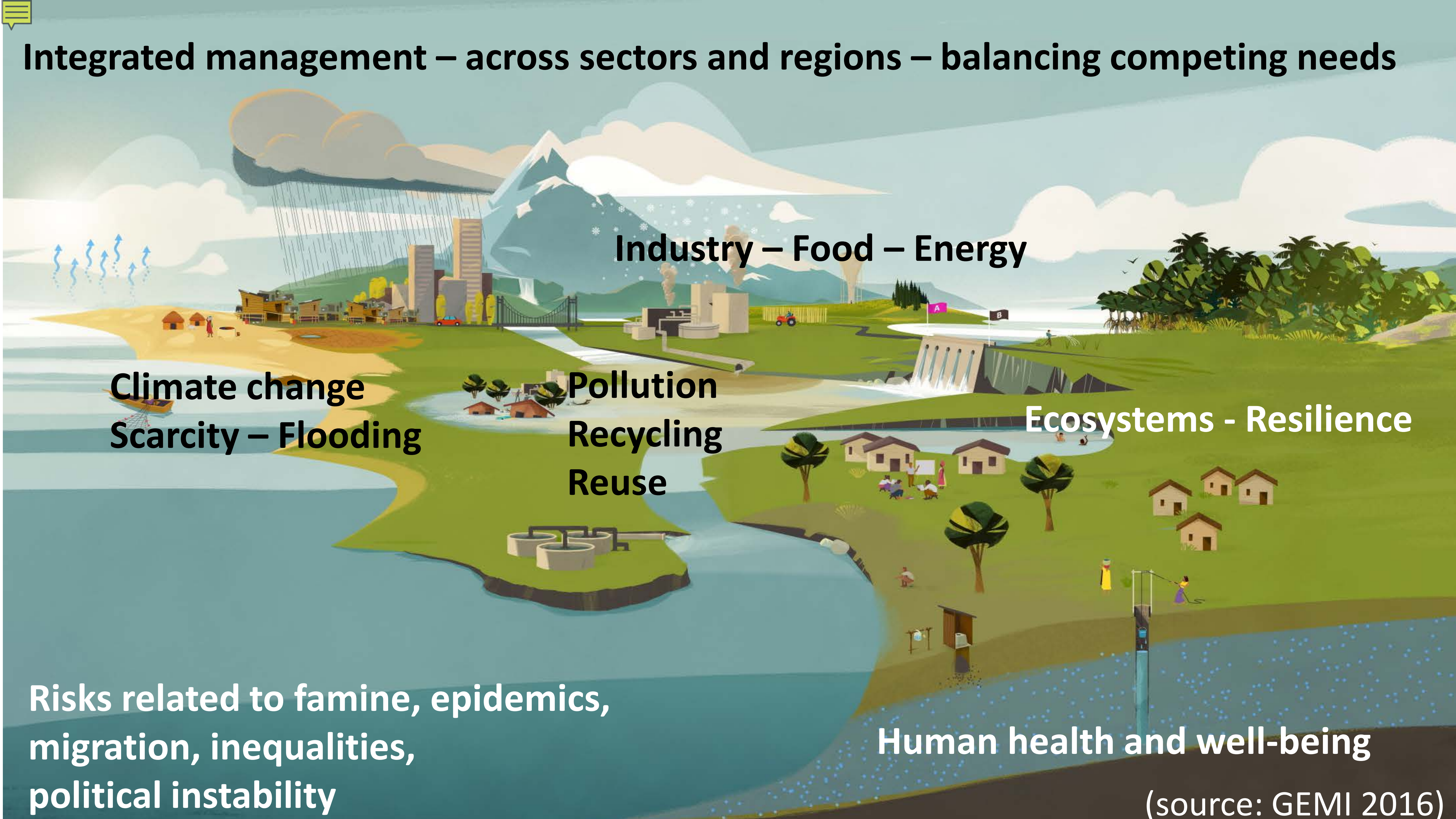
Wastewater Management and Water Quality



Water quality

Wastewater monitoring establishes causes of poor water quality

Water quality monitoring verifies progress on wastewater management


Integrated management – across sectors and regions – balancing competing needs
Industry – Food – Energy
Climate change
Scarcity – Flooding
Pollution
Recycling
Reuse
Ecosystems - Resilience
Risks related to famine, epidemics,
migration, inequalities,
political instability
Human health and well-being
(source: GEMI 2016)

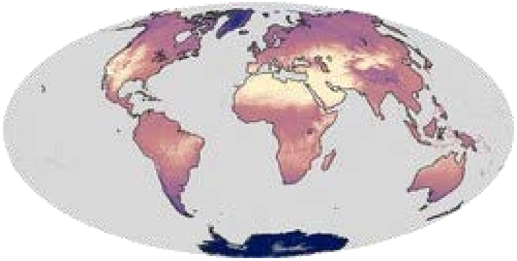
“IMPAIR-THEN REPAIR WATER” IS THE DOMINANT APPROACH TO HUMAN WATER SECURITY.....

CAN WE DO BETTER IN THE FUTURE?

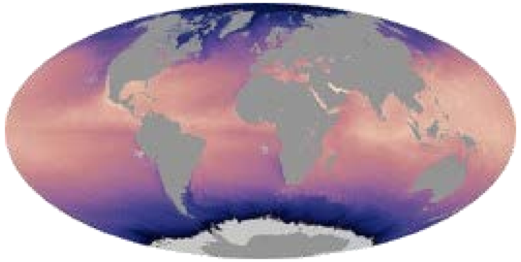
Steps to “Doing Better”

- Set up a monitoring program to understand the nature and scope of problems.
- Bring stakeholders together to define a vision for what they want for the lagoon.
- Agree to steps for improving the lagoon and set goals for achieving them.
- Monitor progress towards those goals.
- Develop links to larger programs and activities to encourage accountability

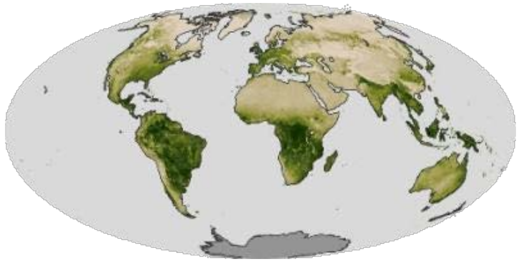
Some options for using Satellite data



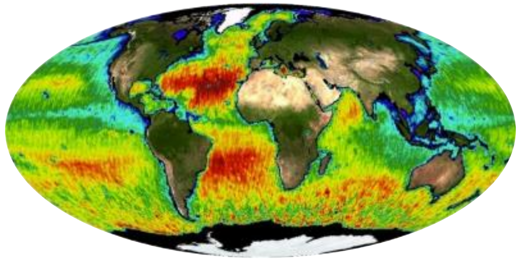
Land Temperature



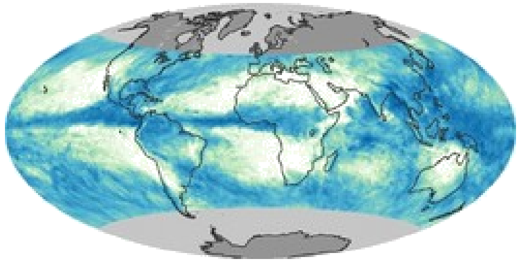
Sea Surface Temperature



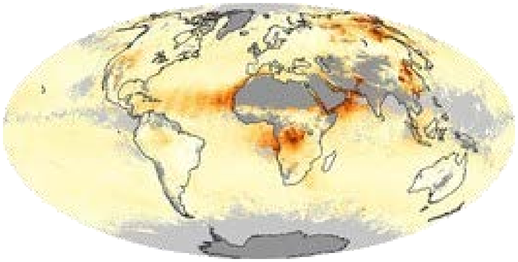
Vegetation



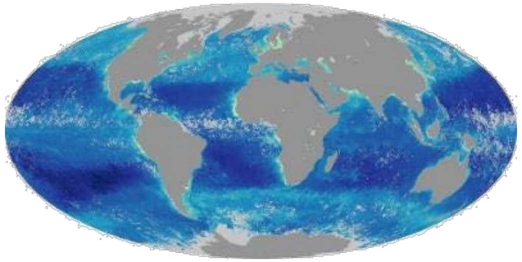
Sea Surface Salinity



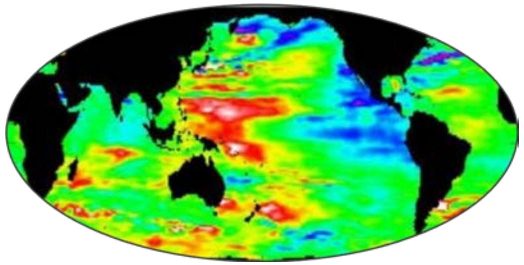
Total Rainfall



Aerosols



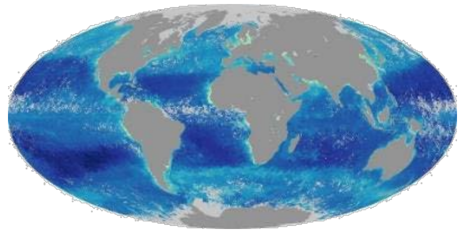
Chlorophyll



Sea Surface Height

(NASA)

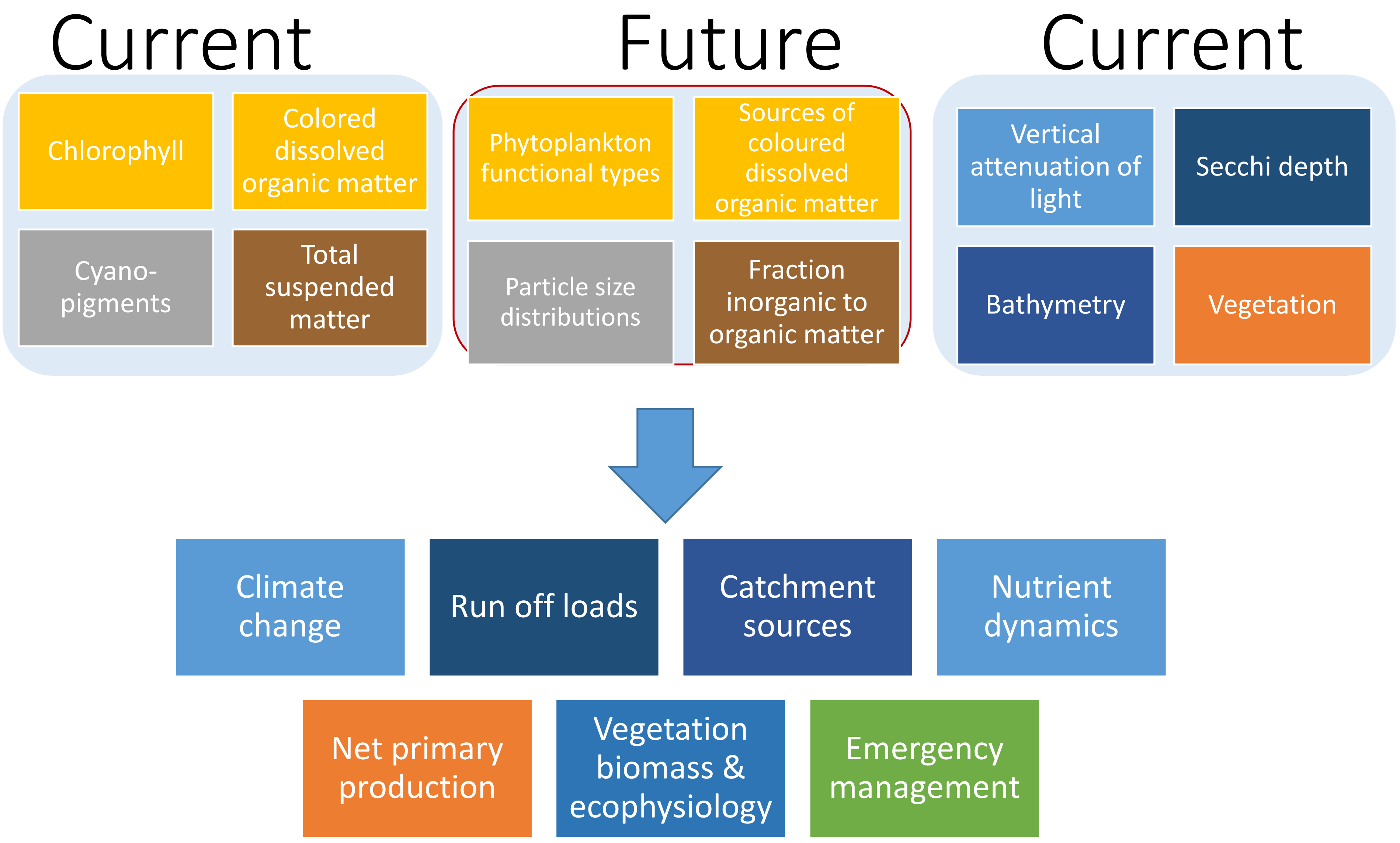
Examples of variables that can be measured directly using Remote Sensing



- Water Column Properties (Could become indicators!)
  - **Chlorophyll-a, Phaeophytin (all photosynthesizing orgs)**
  - **Cyanophycocyanin & CP-erythrin=>Cyanobacteria**
  - **Total Suspended Matter**
  - **Coloured Dissolved Organic Matter**
  - **Transparency/Turbidity/Vertical Attenuation of Light**
- 3-D Information (if the bottom is visible)
  - **Bathymetry (depth of substrate)**
  - **Bottom Relief (topography)**

Challenges: validation of satellite data

- Creation of statistical data bases for specific domains from geospatial data (an issue for SDGs).
- Scaling and supplemental observations


Current
Future
Current
Chlorophyll
Colored dissolved organic matter
Cyano-pigments
Total suspended matter
Phytoplankton functional types
Sources of coloured dissolved organic matter
Particle size distributions
Fraction inorganic to organic matter
Vertical attenuation of light
Secchi depth
Bathymetry
Vegetation
Climate change
Run off loads
Catchment sources
Nutrient dynamics
Net primary production
Vegetation biomass & ecophysiology
Emergency management

Other contributing inputs to the monitoring of lagoons:

In-situ observations: provide regular high-frequency measurements at specific locations.
Citizen science and “big” data (ship traffic and other use data)

Models be used:
- to standardize outputs (and account for time and space scales)
- to estimate variables which cannot be measured.
- to provide predictions or produce scenarios under “what if” conditions.

International Science-Policy Interface

(GEO)

- Integrated framework (SDG’s)
  - Goals, Targets, Indicators
- **Observations and Data (GEO, UN)**
- Analytics and Information (SDSN: World 2050)
- Assessments (e.g., IPCC, IPBES, GEA)

Bottom line: 1) Visioning and facilitating integration should be a top priority for the science community. What is the best way to proceed with this challenge.
2) While metrics and monitoring to assess progress are good, science has much more to offer to achieving SDGs, including providing evidence to show people how to live sustainably today.

<u>Governance through Goals</u>
Conceptualizing a New Governance Strategy for Sustainable Development

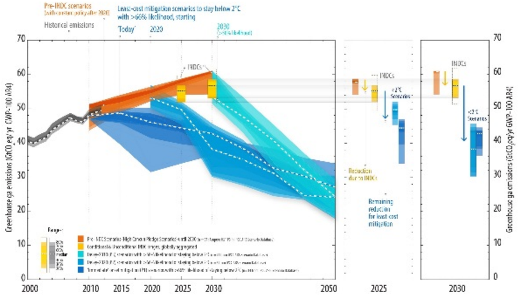
International Regimes and MEAs

⇒ Governance through rules

<u>Pledge what is achievable/possible</u>

Insufficient actions

Lack of Ambitions (the level of ambitions too high)



- Raise ambition
- Integrated approach

SDGs: Start with aspiration and set goals

NO implementation set forth (when goals are set)

NO legal obligations

But, monitoring and reviews

<u>Kanie and Biermann eds (forthcoming)</u>
<u>Governing through Goals (MIT Press)</u>

Building on the Sustainable Development Goals

GOALS (17)

TARGETS (155)

INDICATORS (211)

Indicator is a “variable” that can measure change against objective. Indicators can be quantitative or qualitative.

Index: In some cases an index is a scaled composite **indicators.** An index can also be a kind of summary measure designed to capture some property in a single number.

In the case of an indicator it must be compared to some baseline which could be a natural or historical reference or a specially designed baseline condition.

Indicators (after Fekete):

WWDR concluded water indicators and indices are highly fragmentary, poorly integrated with each other and only tangentially related to water (e.g. industrial indexes). There are lots of data but no formal accounting process for water.

Some problems with indicators:

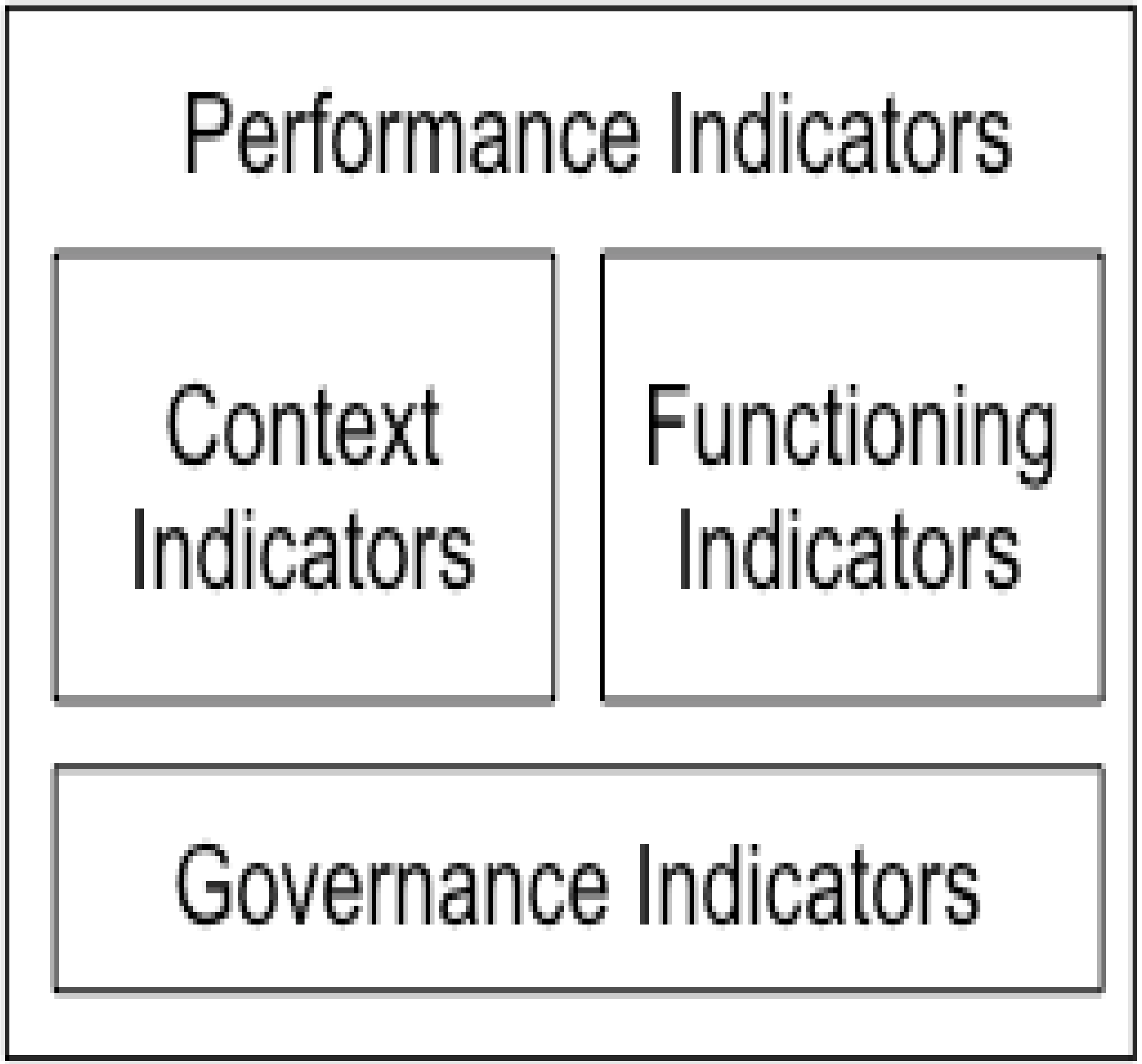
Simplistic formulation of the indicator results in misleading conclusions.

Indicators are often provided over domains that are not sufficiently representative.

Indicators expressed in high geospatial specificity are difficult for policy decision makers to use.

Some types of information are only available by administrative unit

Indicator Types:



Performance Indicators synthesize the three core indicators (context, functioning, governance) as a targeted consideration of the functioning of a particular sector in relation to its objectives

Context Indicators include environmental context, infrastructure, and human and economic capitals. They act as benchmarks when assessing territories.

Functioning Indicators relate to inputs, outputs and outcomes.

Governance Indicators track the differences in levels of performance achieved through the intervention of various policies, programs and regulations

Goal 6: Ensure availability and sustainable management of water and sanitation for all

Targets

- 6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all

  6.1.1 Proportion of population using safely managed drinking water services

- 6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

  6.2.1 Proportion of population using safely managed sanitation services,

  including a hand-washing facility with soap and water

- 6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

  6.3.1 Proportion of wastewater safely treated

  6.3.2 ***Proportion of bodies of water with good ambient water quality***

Goal 6 Targets (cont'd)

- 6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity

6.4.1 Change in water-use efficiency over time

6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

- 6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.5.1 Degree of integrated water resources management implementation (0-100)

6.5.2 Proportion of transboundary basin area with an operational arrangement for water cooperation

- 6.6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.6.1 ***Change in the extent of water-related ecosystems over time***

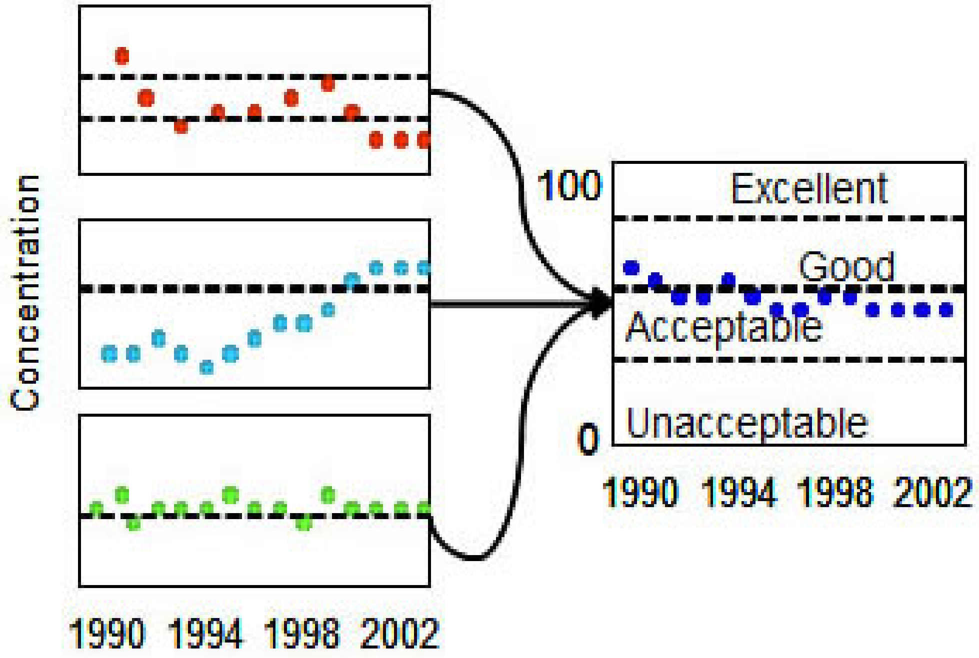
Calculation of Global Water Quality Indices

(UNEP)

Water Quality Index Calculation

Important WQ variables compared to appropriate guidelines; results combined to produce a single number categorizing WQ as excellent, good, fair, marginal and poor.

$$\textit{WQ Index} = 100 - \frac{\sqrt{(F_1^{\,2} + F_2^{\,2} + F_3^{\,2})}}{1.732}$$



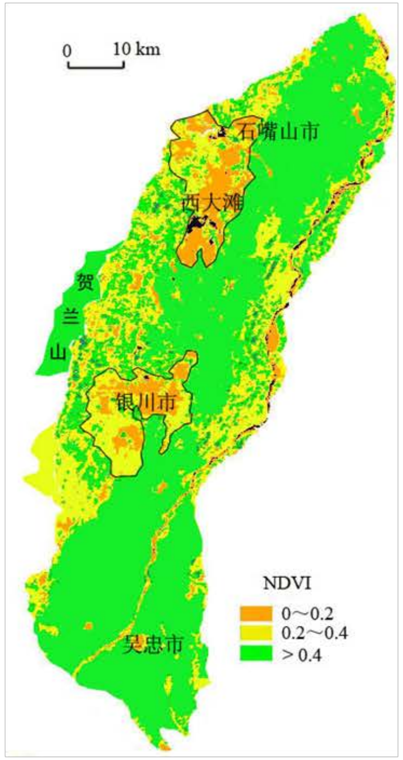
Where:

F1 = percentage of failed variables (scope)

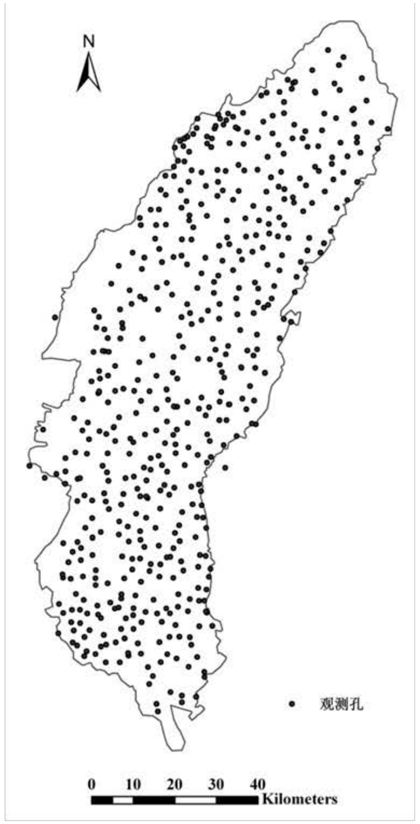
F2 = percentage of failed tests (frequency)

F3 = amount by which failed tests exceed guidelines (magnitude)

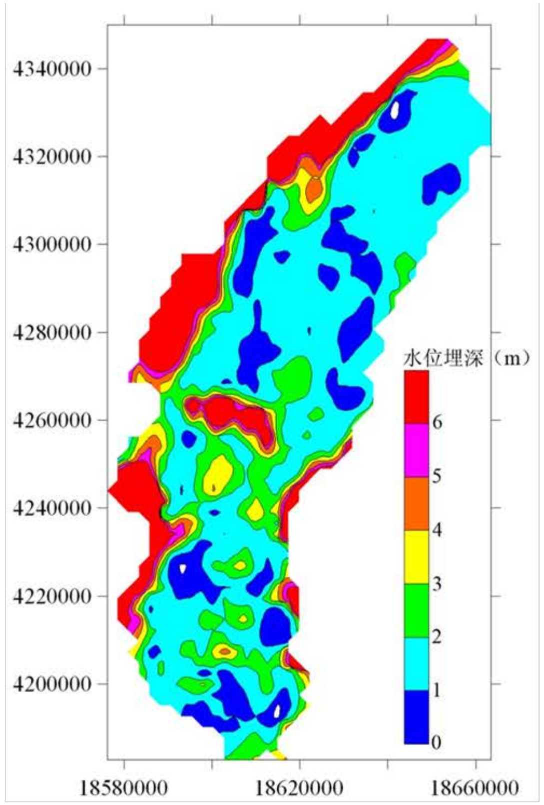
1. Ecosystem health indicator



MODIS NDVI



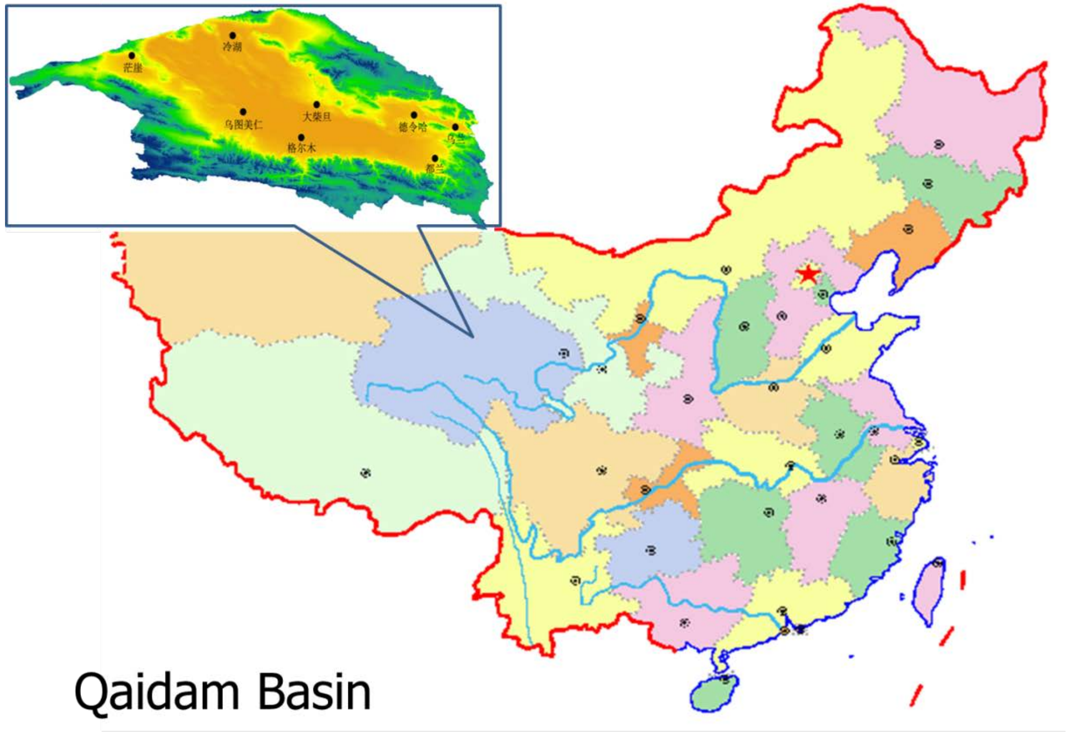
Observations



GW depth

(Jin, X. et al. 2013)

1. Ecosystem health indicator



- Area is 276,233 km^2
- Annual precipitation ranges between 16 and 190 mm from west to east.
- Annual evaporation is 1974 - 3183 mm from west to east.
- 48 salt lakes are distributed

(Jin, X. et al. 2013)

What do Managers Need from Optical Remote Sensing in Aquatic Ecosystems (or we could also say lagoons)?

- Status, Condition and Trend & Anomalies:
  - **Status (survey, classify and map**)
    - **what is where? (=99%of current remote sensing effort)**
      - **(is it absent when it should be present) or**
      - **(is it present when it should be absent?)**
  - **Condition:**
    - **is it healthy?, is it stable?**
    - **Is it stressed?**
  - **Trend:**
    - **Is it getting worse or is it improving?**
      - **Remote Sensing can do retrospective analysis and near-real-time**
      - **Model data fusion needed for forecasting**
  - **Anomalies:**
    - **Normal (to be expected) or exceptional (indicating exceptional change from before? E.g. climate change indication?)**

(GEO)

(WEF Issues) Feasibility of implementing integrated management between lands and coasts

(Endo)

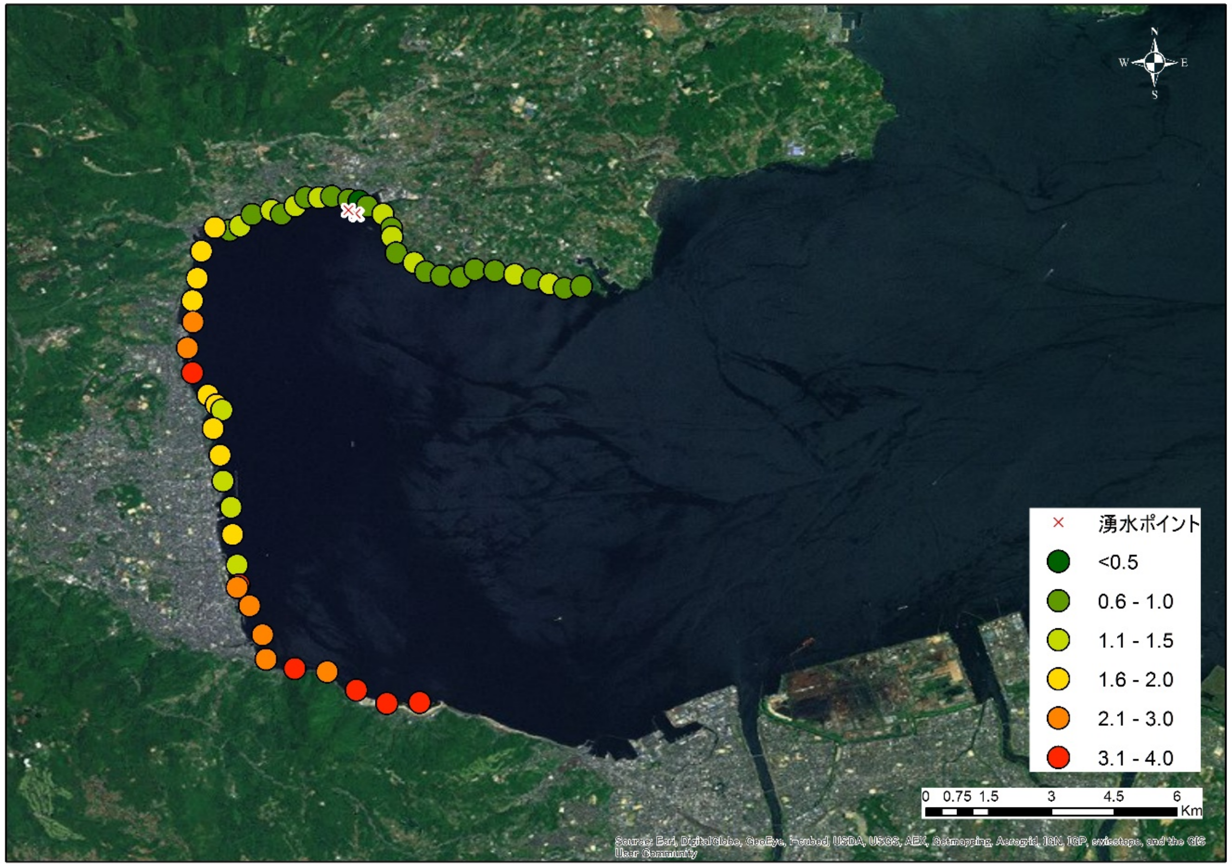


Figure: Distribution of ^{222}Rn concentration level on the eastern side of Beppu Bay (Sugimoto R. , Honda H., et al., 2014)

☐ Submarine Groundwater Discharge (SGDs)

-environmental flow with nutrient from land to the ocean might affect coastal ecosystem
-water uses on land might affect fisheries productions

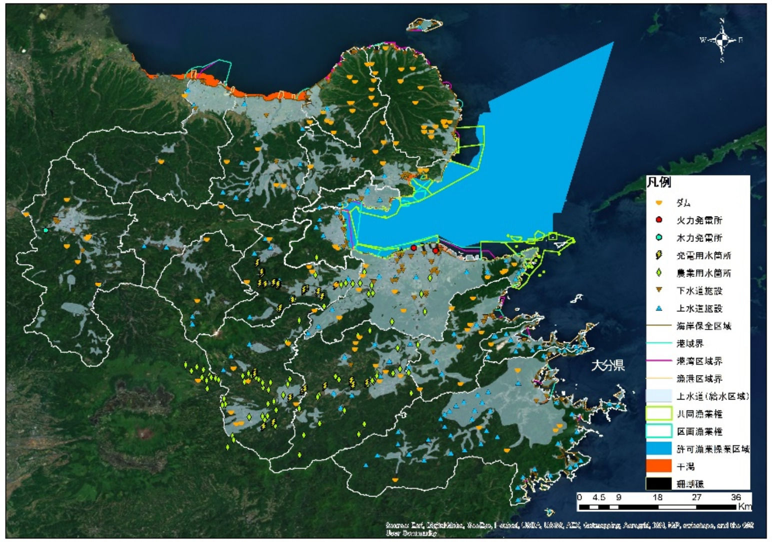
✔ Water × Food (fishery) Nexus
⇒optimizes water-food connections to maximize human-environmental security

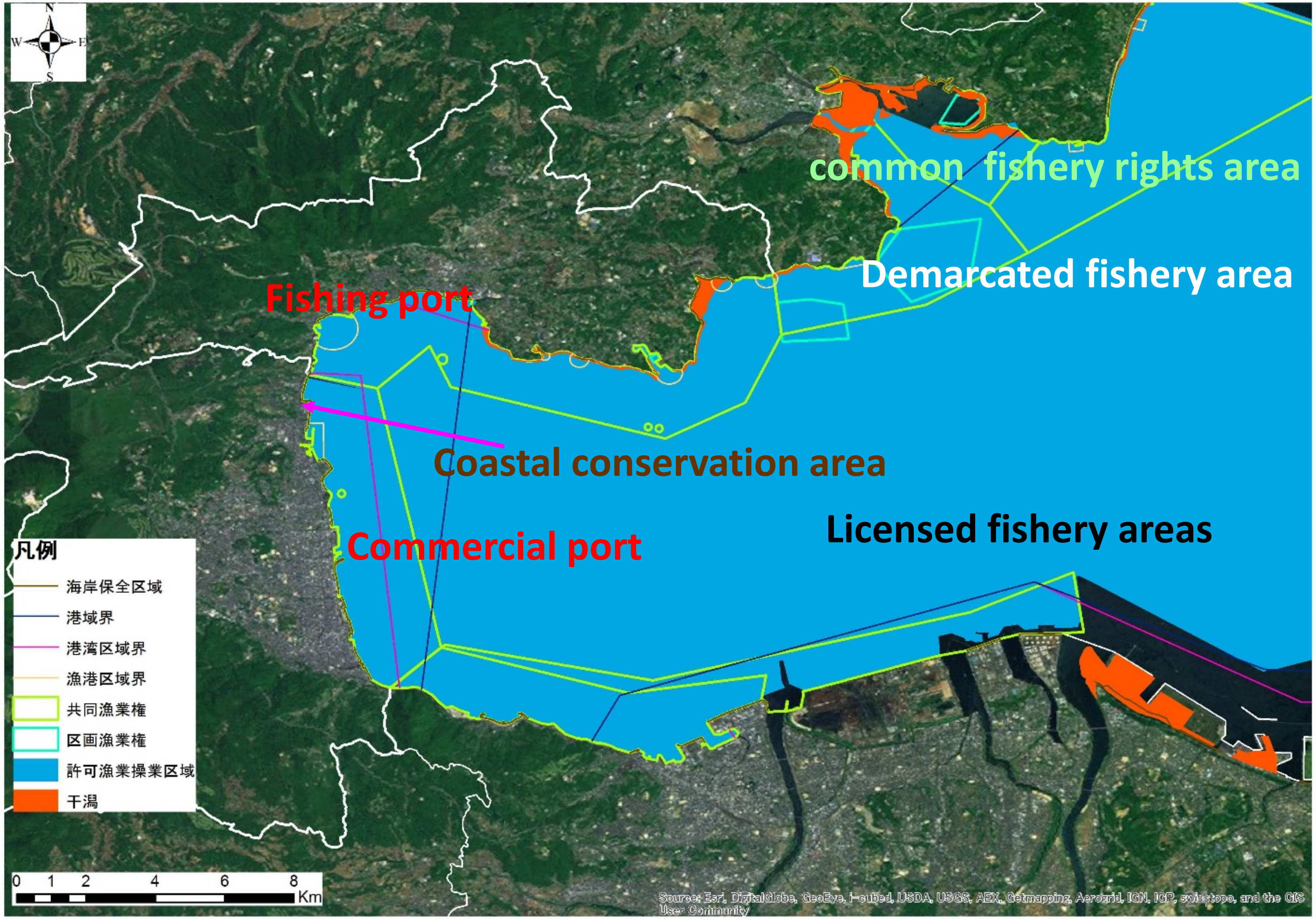
-challenges to quantify SGDs
-^{222}Rn is one of the potential indicators to identify SGDs

Feasibility of implementing integrated management between lands and coasts

(Endo)

Overlay Multiple Map: Actual conditions of utilization of coastal areas





✔Each competent body manages different targets sectorally

✔Nobody manages whole bay!

Future Earth

1. Integrative research on global water system
2. Adoption of science-based evidence into the implementation and monitoring of goals for SDGs
3. Knowledge Synthesis about water system
4. Capacity building of the next generation of water scientists and practitioners in water research.
5. Stimulate innovation in water institutions with a balance of technical and governance based solutions

waterfuture

Sustainable Water Future Programme

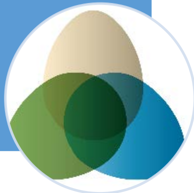
Key Elements

- Global water system assessments focusing on sustainable development goals to support improved decision-making and management under increasing risk and uncertainty

TARGETTED WATER ASSESSMENTS

- Explore the water, energy and food security nexus, the water-carbon (energy) link and interfaces with water and health, as well as water biodiversity (ecosystem services) issues.

EXPLORING NEXUS AREAS



- Integrated Research, developing conceptual and methodological innovations to improve analysis and diagnostic capabilities.

BASIC RESEARCH

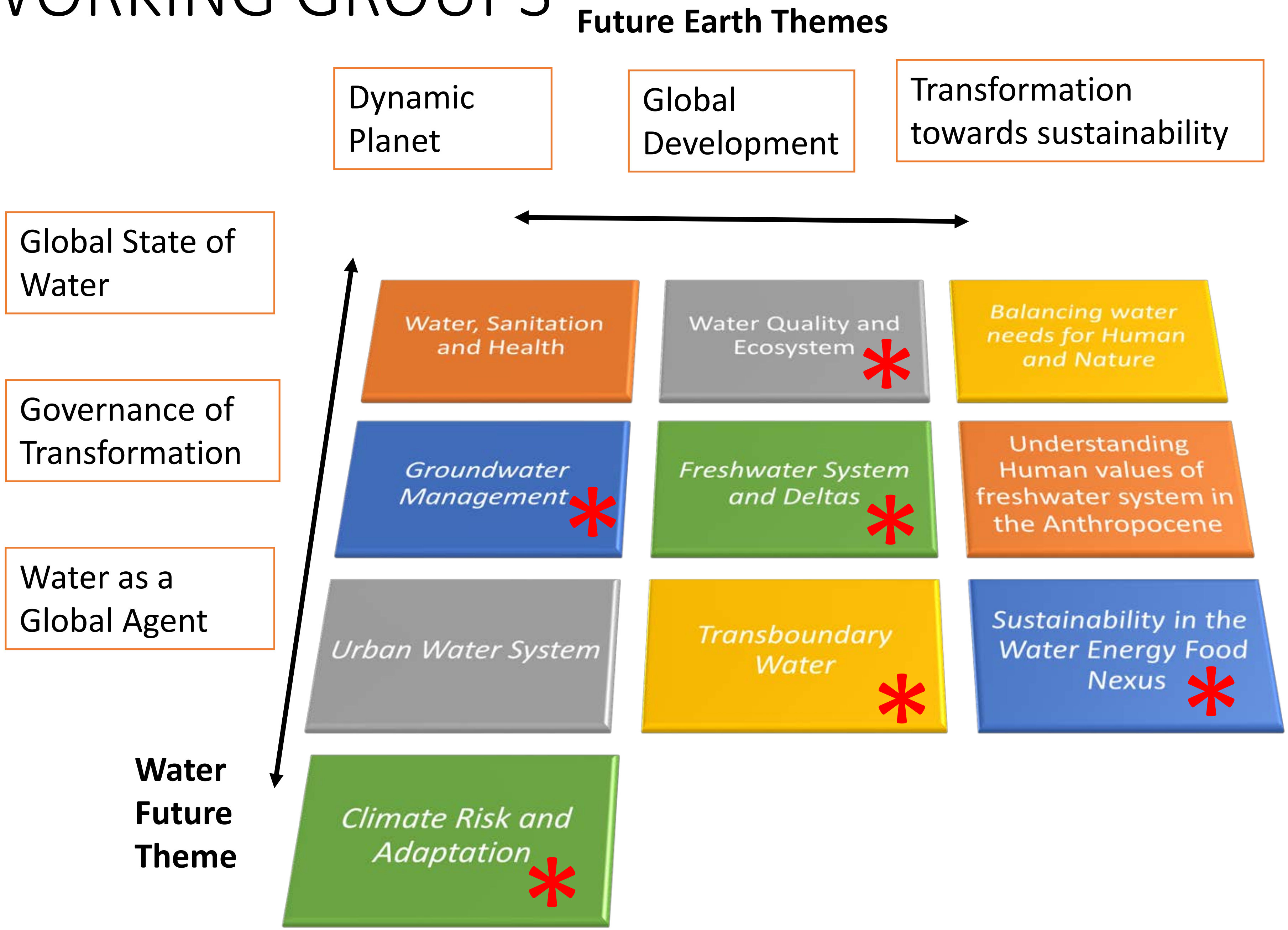
- Aimed at bringing together the world's leading knowledge providers and Implementer to tackle specific water problems in their host country

WATER SOLUTIONS LAB NETWORK

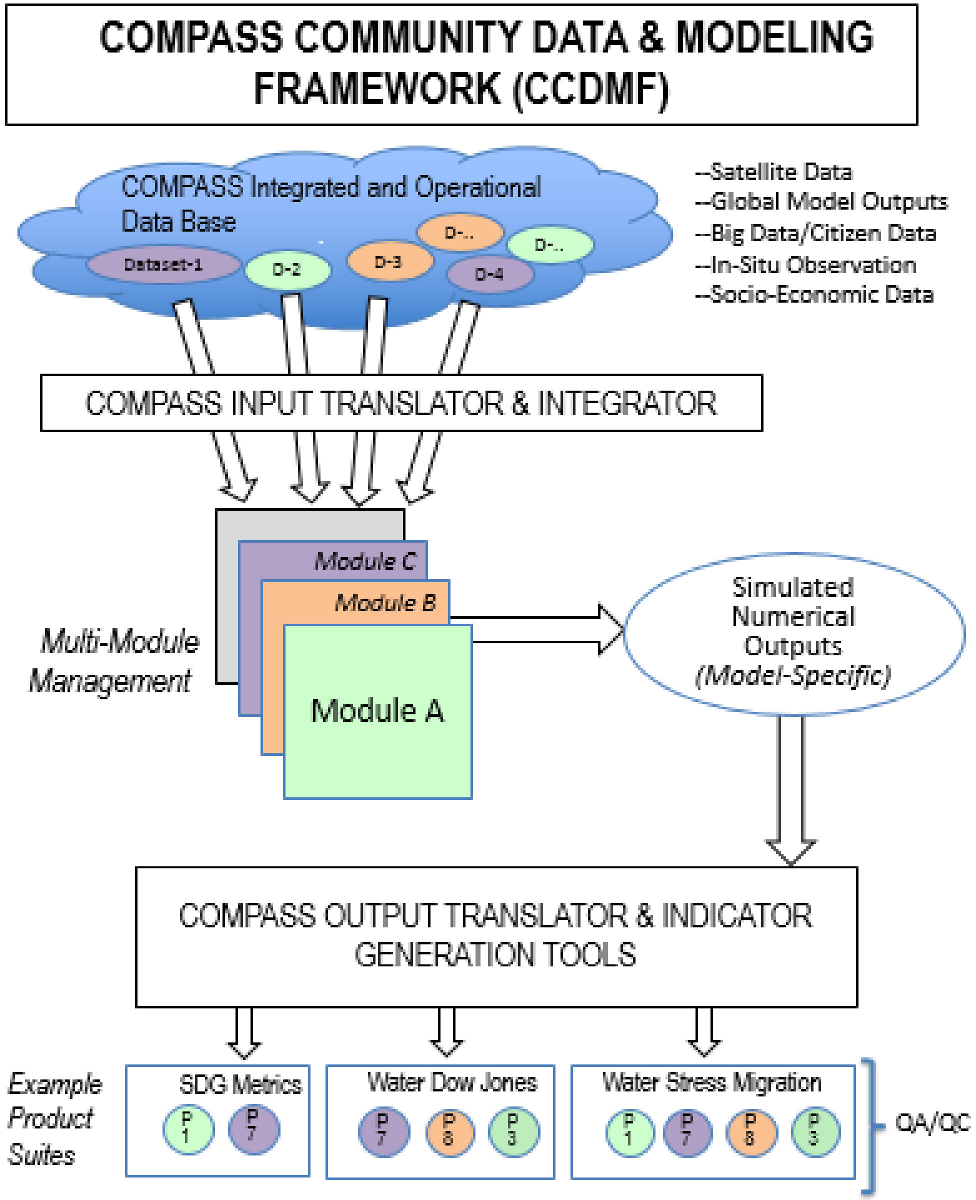
- Dynamic society-nature interface and interactions at and across different scales in terms of governing the transition towards a sustainable water future.

WATER GOVERNANCE

WORKING GROUPS



The COMPASS (Comprehensive Assessment of Water Resources System)



- Support to national governments and international bodies addressing water resources and SDGs.
- Use water intelligence to assess business opportunities.
- Improve the efficiency of deploying costly infrastructure and policy solutions.
- Provide a basis for capacity development.
- A global perspective for water management services
- Opportunities for the science community to access research funding and influence.

(SWFP)

GEOGLOWS brings diverse regional water projects into a global framework for improving water sustainability

US GEO Water

Global Data Products, Capacity Building, etc.

NextGEOSS (Europe)

Validation data

Regional projects

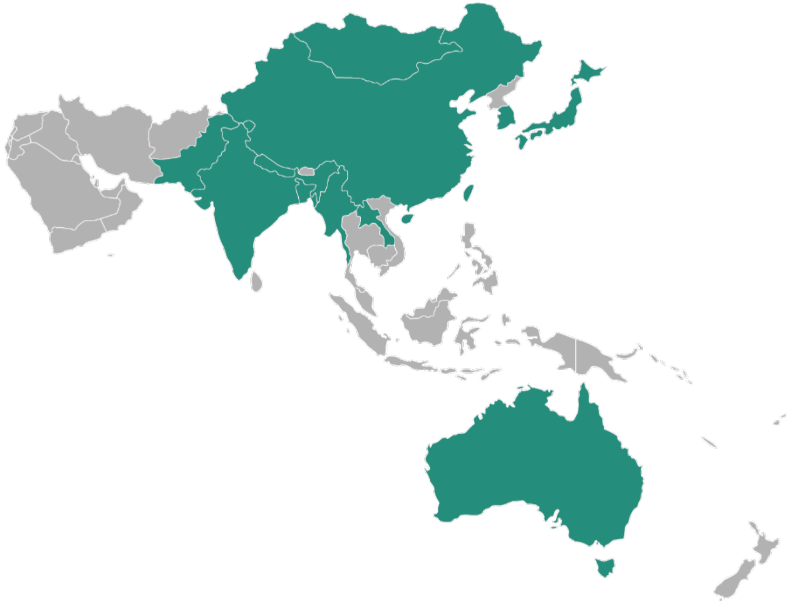
Regional expertise

AfriGEOSS

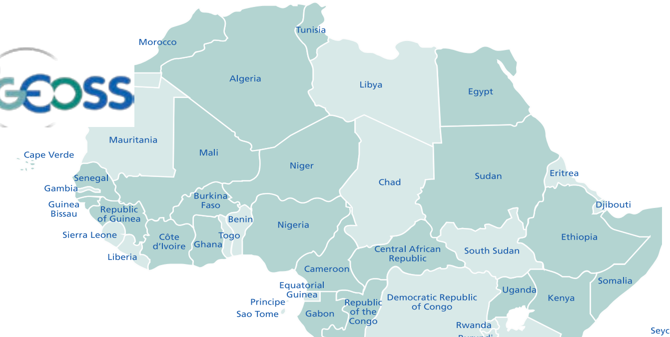
AmeriGEOSS

AO GEOSS

Membership



AfriGEOSS: Enhance Africa's capacity for producing and using Earth observation data and information



GEO EO4SDG Initiative: Engagement with UN Process

GROUP ON EARTH OBSERVATIONS

EO4SDG

THE GLOBAL GOALS For Sustainable Development

GEO (and EO4SDG) is involved in the UN “IAEG-SDG” Working Group on Geospatial Information, WGGI

WGGI contributes knowledge and expertise on Earth observations and geospatial information to discussion of SDG Indicators.

WGGI: Case studies on 3 Tier III (low) Indicators and 3 common issues

GEO (via CEOS & EO4SDG) led two Tier III Indicator case studies:

- » 6.6.1, water quality
- » 15.3.1, land degradation

EO4SDG, in coordination with GEO Sec, looks to support:

- » 6.6.1: UNEP (lead custodial agency) data study that aims to collect national inputs on this Indicator. Opportunities with 14.1.1 & 14.2.1.
- » 15.3.1: UNCCD (lead custodial agency) collaboration with CEOS and others to help provide 15.3.1–relevant, space-based information and in-situ measurements and assist in fulfilling reporting

(GEO)

Summary

1. Lagoons play a significant role in water resource management and climate adaptation. Their special needs and attributes should be recognized in water resource planning.
2. Data can be used as a basis of discussions for planning and governing lagoons. We need to engage more effectively.
3. Tracking the condition of lagoons will have the most benefits for local managers and communities but state or national governance processes should also be engaged to help mainstream the solutions.
4. One method to address lagoon issues could be to develop a meaningful, comprehensive indicator and then mainstream it, possibly through the SDGs, so policy makers will feel obligated to respond to it.