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AP-BON WG Session 2: GEO Strategic Plan 2016-2025 and 2017-2019 Work Programme

Challenges and opportunities of *in-situ* observations in GEO 2017-2019 Work Programme

Hiroyuki Muraoka (Gifu University, Japan)
GEO Programme Board member (Japan alternate)

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GEO Vision

To realize a future
wherein decisions and actions,
for the benefit of humankind,
are informed by
coordinated, comprehensive & sustained
Earth observations & information.

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Earth Observation Domains (examples)

Scientific interests
User needs

Observation Fields	Observation Themes
Atmosphere	Climate
Land	Weather
(Lowland)	Carbon
(Mountain)	Water
Freshwater	Energy
(Lake)	Biodiversity
(River)	Land-use and change
Coast	Foods
Ocean	Disaster
Arctic	Disturbance
etc.	etc.

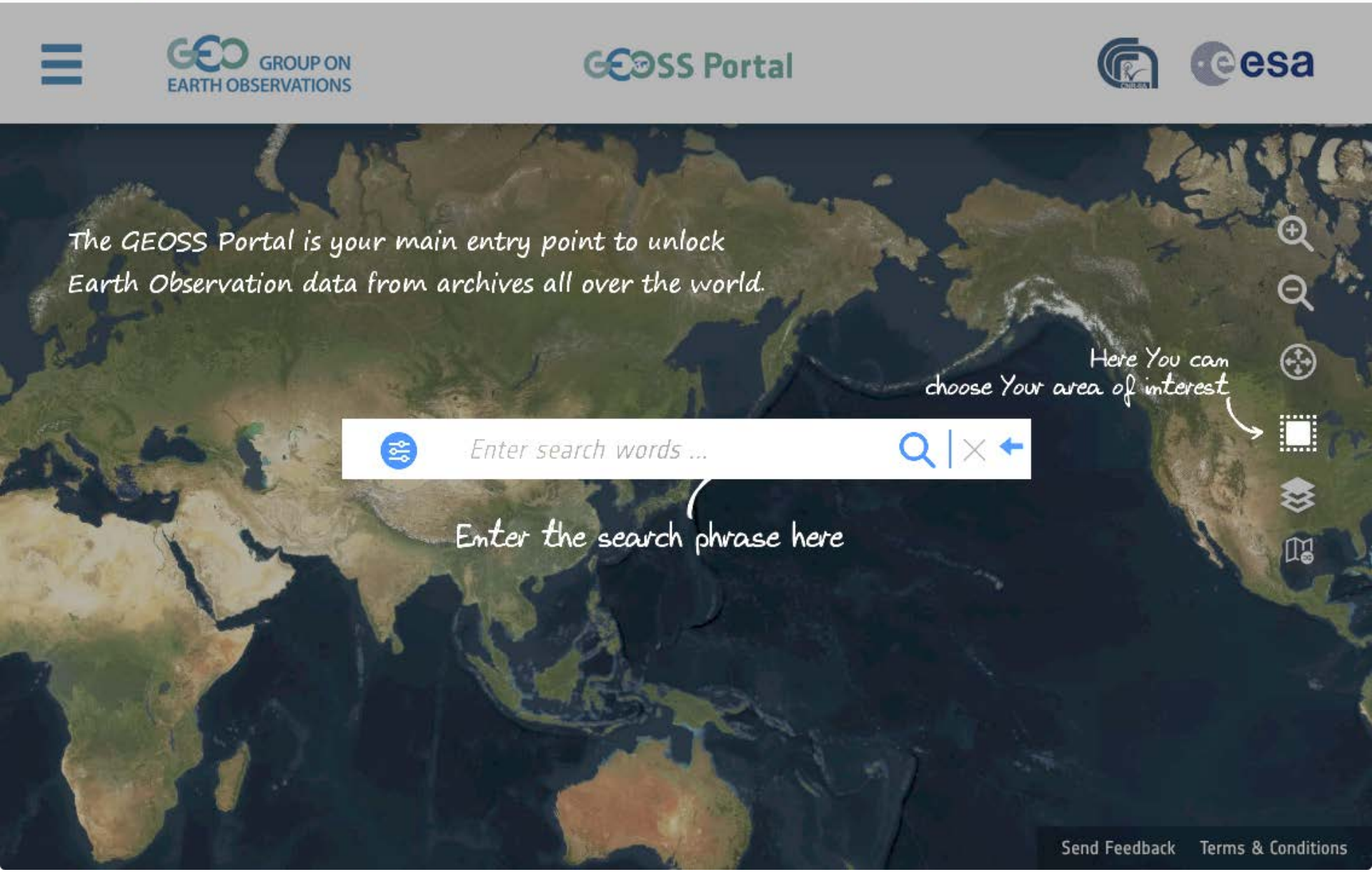
GEOSS

Data
Knowledge
Information

- SDGs
- Tacking climate change
- Sustainability of biodiversity

Sound decision making

GEOSS Portal www.geoportal.org



Two important documents

GEO Strategic Plan 2016-2025: Implementing GEOSS

[Approved at GEO-XII Plenary and Ministerial Summit in 2015, Mexico-city]

- GEO's Vision
- Strategic Objectives [Advocate, Deliver, Engage]
- Societal Benefit Areas (SBAs)… Application oriented
- Implementation mechanisms
  [Flagships, Initiatives, Community Activities, Foundational Tasks]

GEO Work Programme 2017-2019

[Approved at GEO-XIII Plenary in 2016, St. Petersberg]

- Flagships (4)
- Initiatives (22)
- Community Activities (31)
- Foundational Tasks (10)

Documents available at
https://www.earthobservations.org/index.php

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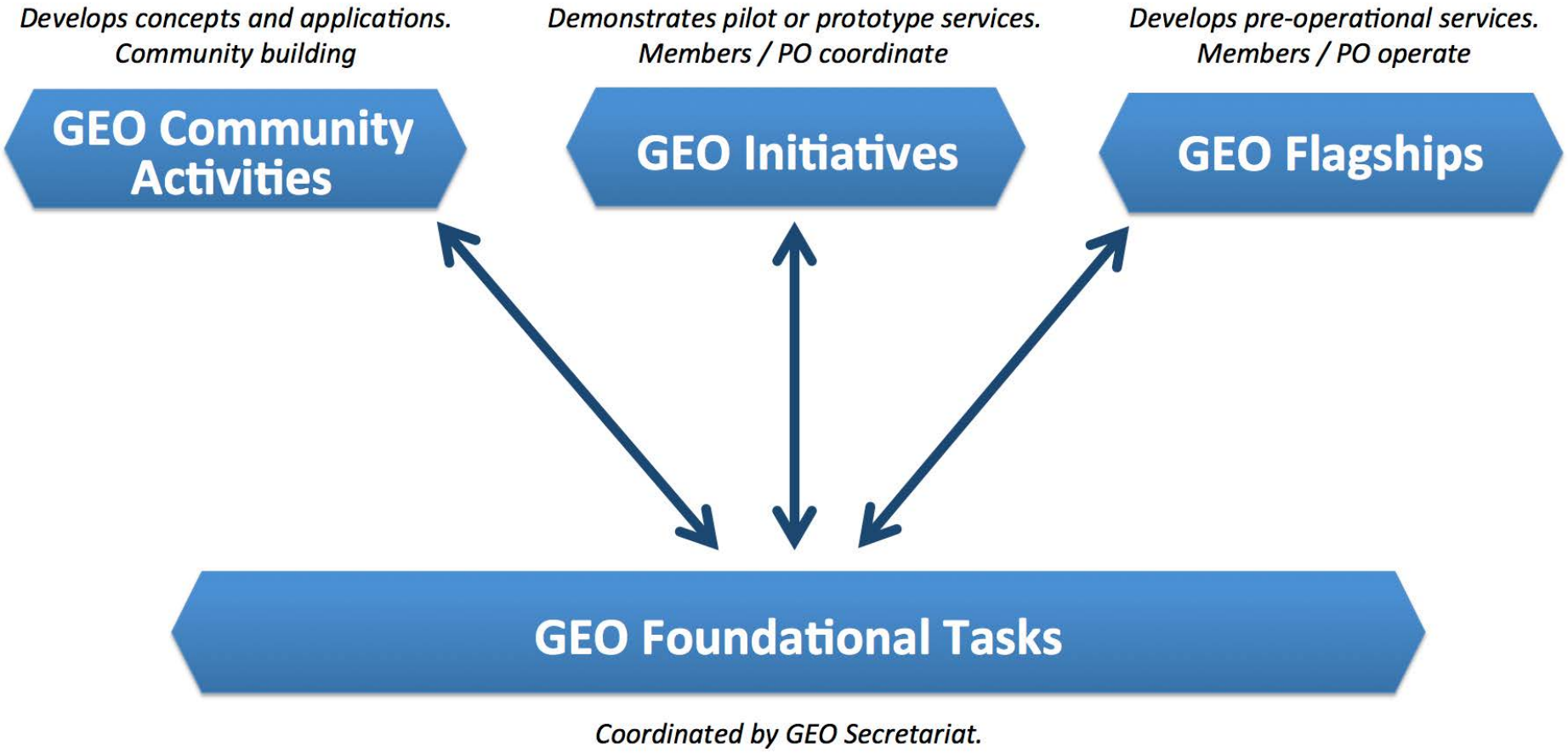
The Four Implementation Mechanisms to realize GEO's vision and maximize the benefits to users



From GEO Strategic Plan 2016-2025

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SBA: Biodiversity and Ecosystem Sustainability

Related activities (examples)

GEO Flagships

- GEO Biodiversity Observation network (GEO BON)
- Global Forest Observation Initiative (GFOI)

GEO Initiatives

- The GEO Global Ecosystem Initiative (GEO-ECO)
- GEO-GNOME Initiative: GEO Global Network for Observation and Information in Mountain Environments
- GEO Carbon and GHG Initiative
- Earth Observations for Ecosystem Accounting (EO4EA）
- Ocean and Society: Blue Planet

Community Activities

- Africa Global-scale Geochemical Baselines for mineral resource and environmental management: Capacity-building phase
- Harmful Algal Bloom (HAB) Early Warning System
- For Global Mangrove Monitoring

Foundational Tasks

- GEOSS development and GCI operations
  - *GEOSS in-situ observation resources*
  - *User needs and gap analysis*

Fostering networking(s) with other in-situ observations and satellite observations

What? Where? How? Who? Observational, cultural and other Gaps?

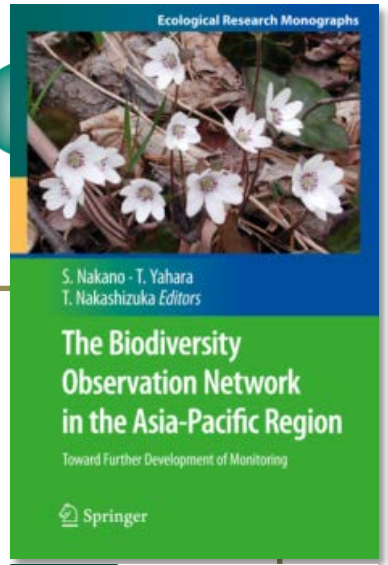
GEO Foundational Task: "In-situ observation resources"

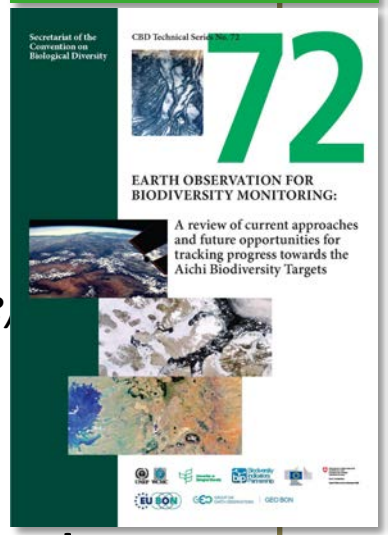
Objectives are to,

- Review the on-going in-situ observations, its locations, thematic coverage, and showcases, to identify the opportunities and risks;
- Analyze the user requirements and identify gaps of current in-situ observing systems such as sensor networks, air-borne and field monitoring;
- Foster and facilitate the data and information access from all in-situ observation networks in the task and integration with Space based observations; and
- Support and strengthen the improvement and coordination of individual existing and planned in-situ observing systems characterizing the Earth system domains (Atmospheric, Oceanic, Terrestrial);
- Analyze the current and expected science and technology to fill the observational gaps, and to help propose future strategies of cross-domain, cross-disciplinary and cross-platform observations (such as seeking cross-domain Essential Variables).

ILTER will help the Terrestrial domain for exercise… If interested, please contact Muraoka

Cross-scale & Multidisciplinary observation of Biodiversity and Ecosystem
(e.g., Satellite Ecology initiative)

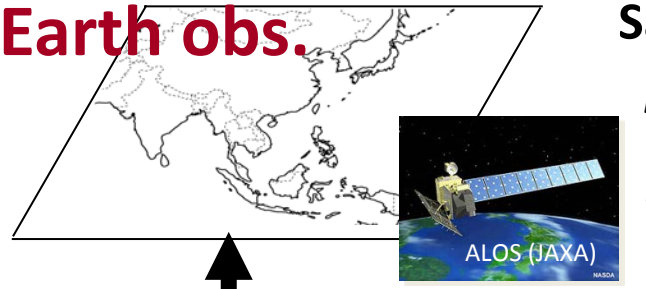




Earth system and ecosystems

Biological and ecological processes

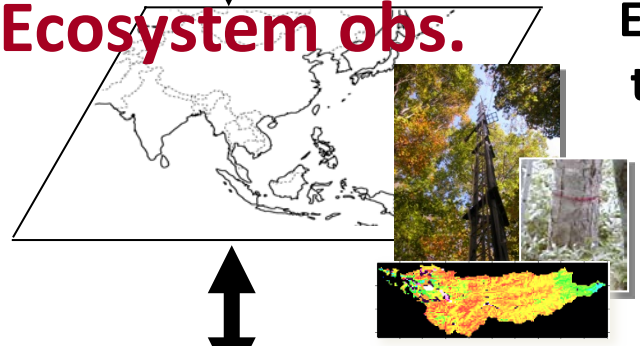
Earth obs.



Satellite remote sensing

Ecosystem and land-use types
Vegetation structure
Temporal change in ecosystems

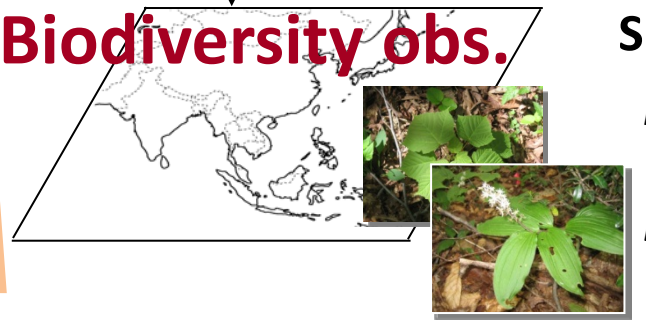
Ecosystem obs.



Ecological process research, tower flux obs. and modeling

Primary production (carbon cycle)
Eco-hydrology
Nutrient cycling

Biodiversity obs.



Species and genetic level research

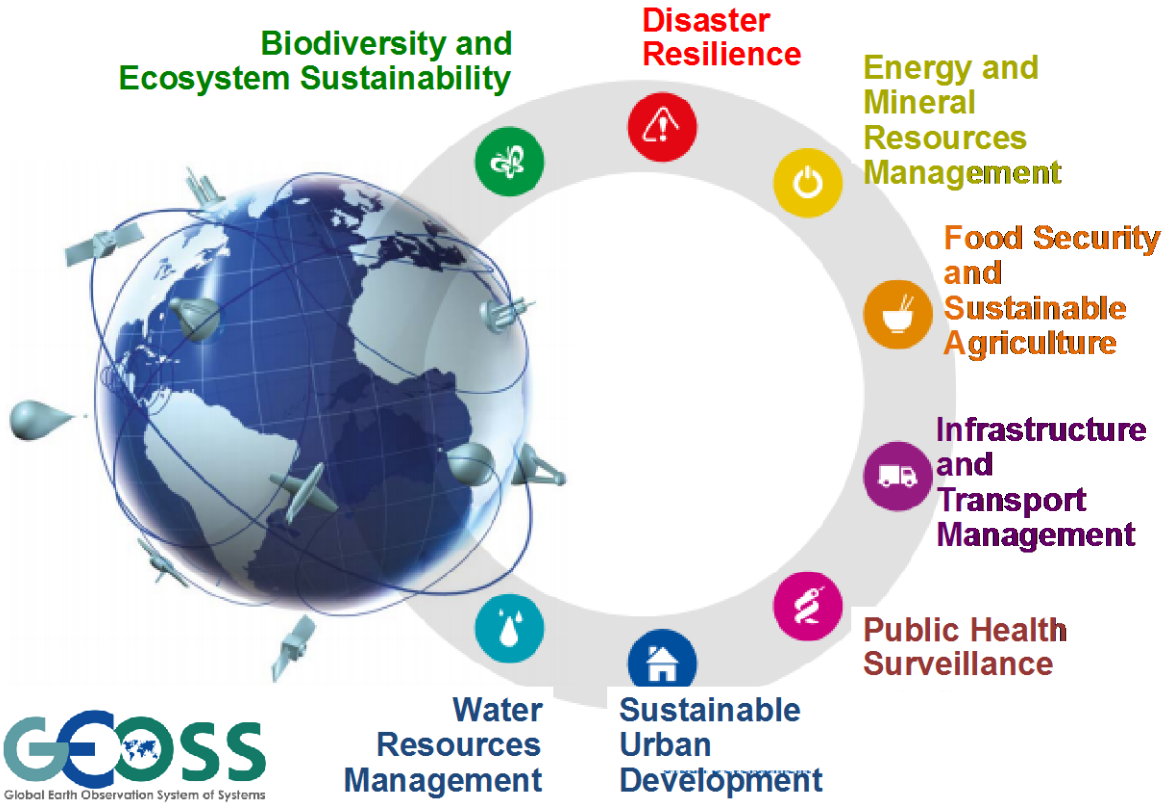
Plant species distribution
Wildlife habitat assessment
Biological interactions

(Muraoka et al. 2012)

Biodiversity and Ecosystem Sustainability:

by bridging multiple types of observation data and knowledge to provide information on the health of Earth's biological and ecological systems and their services to society;

in order to strengthen conservation, restoration and sustainable use of ecosystems and biodiversity, including marine planning and ocean use, in response to changes in climate and land use, through science-society collaborations at local, national, regional and global levels.



Concept to be shared?

Common theme?

Platform

- *Obs sites?*
- *Databases?*

Actionable plan?

Pilot / prototype activity?

Communications?

Players?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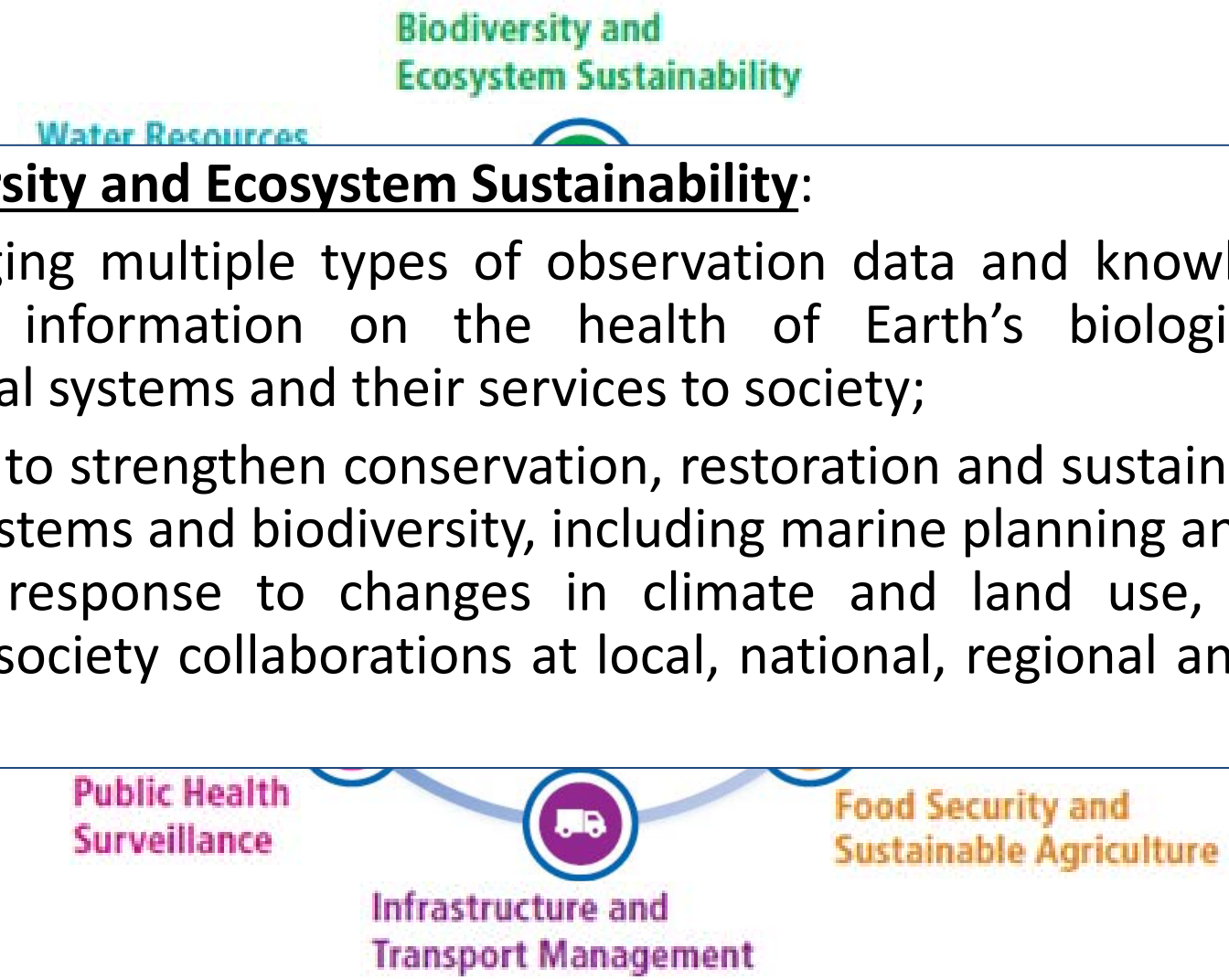
8 Societal Benefit Areas



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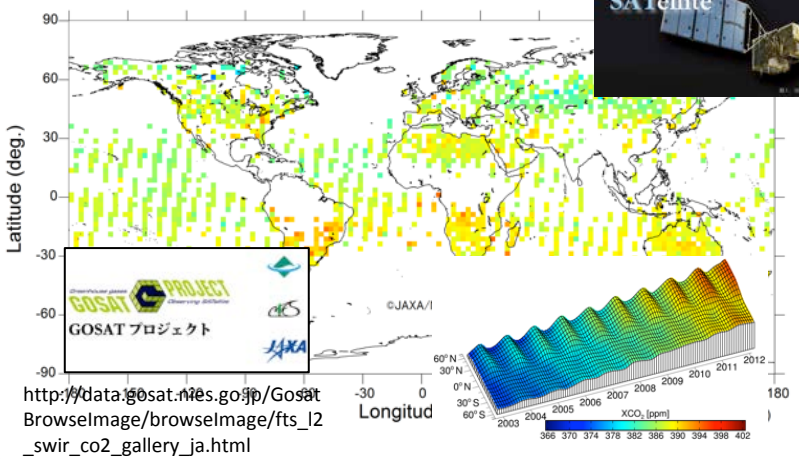
THE GLOBAL GOALS

For Sustainable Development

Integrated observations needed

Atmospheric CO_2



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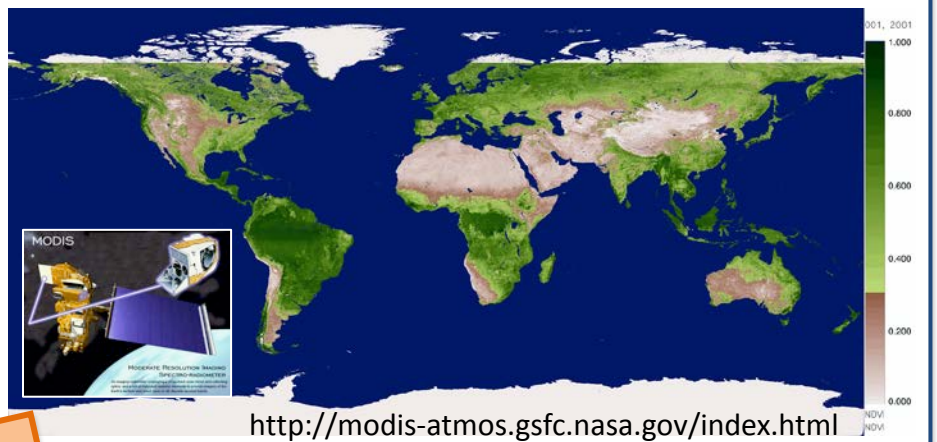
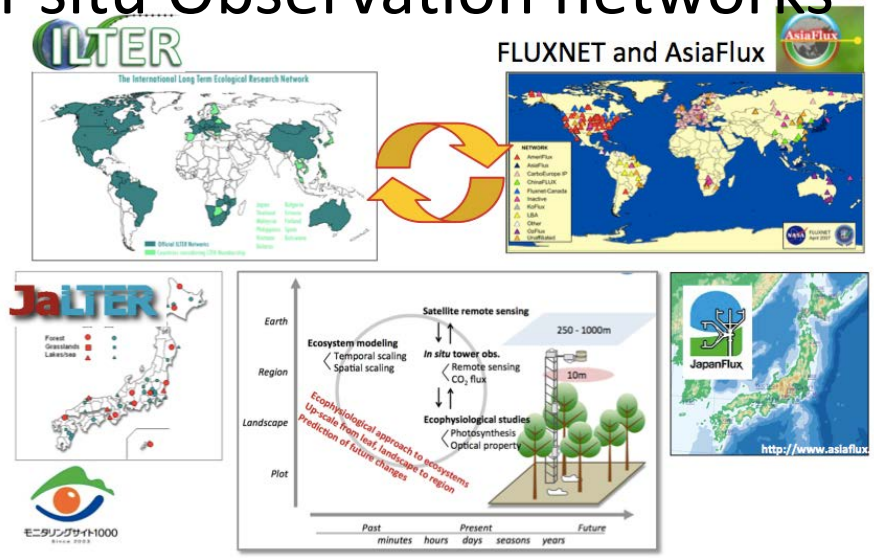
Global Surface status



http://modis-atmos.gsfc.nasa.gov/index.html

Biodiversity and Ecosystem In-situ Observation networks



CARBON and WATER as the major common components of Atmosphere, Ecosystems and Biodiversity

- Climate, Weather, CO_2
- *Changes in Biodiversity, Ecosystem functions and their services*
- Human activity

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Essential Biodiversity Variables

H. M. Pereira,[1*†] S. Ferrier,[2] M. Walters,[3] G. N. Geller,[4] R. H. G. Jongman,[5] R. J. Scholes
M. W. Bruford,[6] N. Brummitt,[7] S. H. M. Butchart,[8] A. C. Cardoso,[9] N. C. Coops,[10] E. Dulloo
D. P. Faith,[12] J. Freyhof,[13] R. D. Gregory,[14] C. Heip,[15] R. Höft,[16] G. Hurtt,[17] W. Jetz,[18] D. S. Ka
M. A. McGeoch,[20] D. Obura,[21] Y. Onoda,[22] N. Pettorelli,[23] B. Reyers,[24] R. Sayre,[25]
J. P. W. Scharlemann,[26,27] S. N. Stuart,[28] E. Turak,[29] M. Walpole,[26] M. Wegmann[30]

SCIENCE VOL 339 18 JANUARY 2013

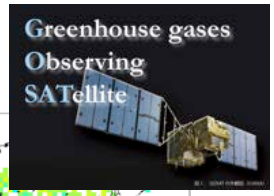
- ✓ What do we "deliver" to the users?
- ✓ Where and How do we observe and integrate them?
- ✓ How do we find the consequences with environmental changes (e.g., climate change)?

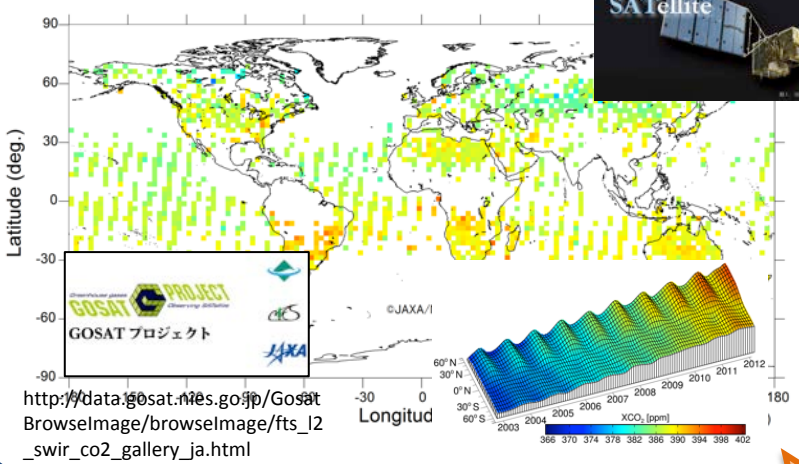
Examples of candidate Es

EBV class	EBV examples	Measurement and scalability	Temporal sensitivity
Genetic composition	Allelic diversity	Genotypes of selected species (e.g., endangered, domesticated) at representative locations.	Generation time
Species populations	Abundances and distributions	Counts or presence surveys for groups of species easy to monitor or important for ES, over an extensive network of sites, complemented with incidental data.	1 to >10 years
Species traits	Phenology	Timing of leaf coloration by RS, with in situ validation.	1 year
Community composition	Taxonomic diversity	Consistent multitaxa surveys and metagenomics at select locations.	5 to >10 years
Ecosystem structure	Habitat structure	RS of cover (or biomass) by height (or depth) globally or regionally.	1 to 5 years
Ecosystem function	Nutrient retention	Nutrient output/input ratios measured at select locations. Combine with RS to model regionally.	1 year

Integrated observations needed

Atmospheric CO_2





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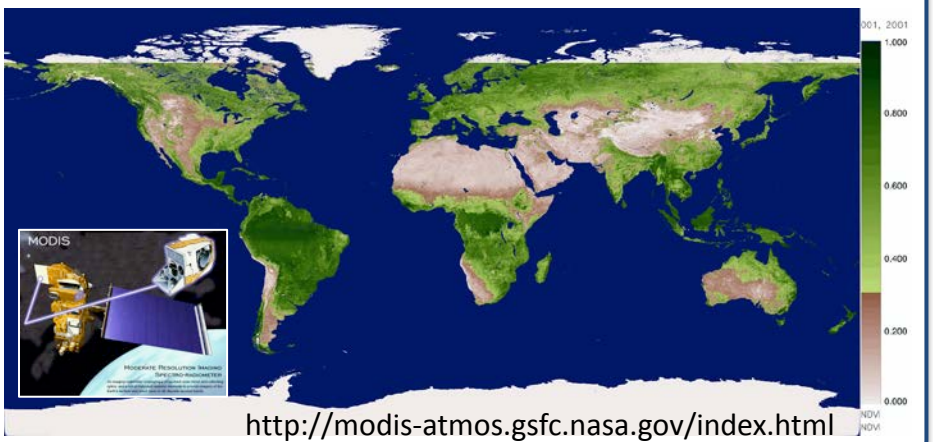
Global Surface status



http://modis-atmos.gsfc.nasa.gov/index.html

Biodiversity and Ecosystem observation networks

JaLTER

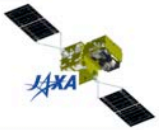
モニタリングサイト1000

JapanFlux

JAMSTEC

Ecosystem – biodiversity relationships at plots

Satellite observations
(canopy phenology, NPP, etc.)



Broad-scale ecosystem-biodiversity monitoring and understandings
(human impacts, disturbance and climate change, etc.)

- Climate, Weather, CO_2
- *Changes in Biodiversity, Ecosystem functions and their services*
- Human activity

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Planning the observation strategy for Biodiversity

Issues to be Considered in Biodiversity Observations

- Spatial distribution of the observation sites
- Delivery of Information and Knowledge to Users
- Link with other observations

What, Where and How?

- Site networks
- Cross-cutting issues over SBAs
- Community networks
- Integration
- Interpretation and Translation
- … “co-design” is also needed

Networking the Networks and Observation Sites

Potential reference sites for the calibration of remote sensing analysis

Each site has one or multiple plots where plant composition are fully identified. The colors of the pins indicates the following properties:
Blue : also flux measured, exact plot's positions confirmed
Green : flux not measured, exact plot's positions confirmed
White: flux not measured, exact plot's positions not confirmed

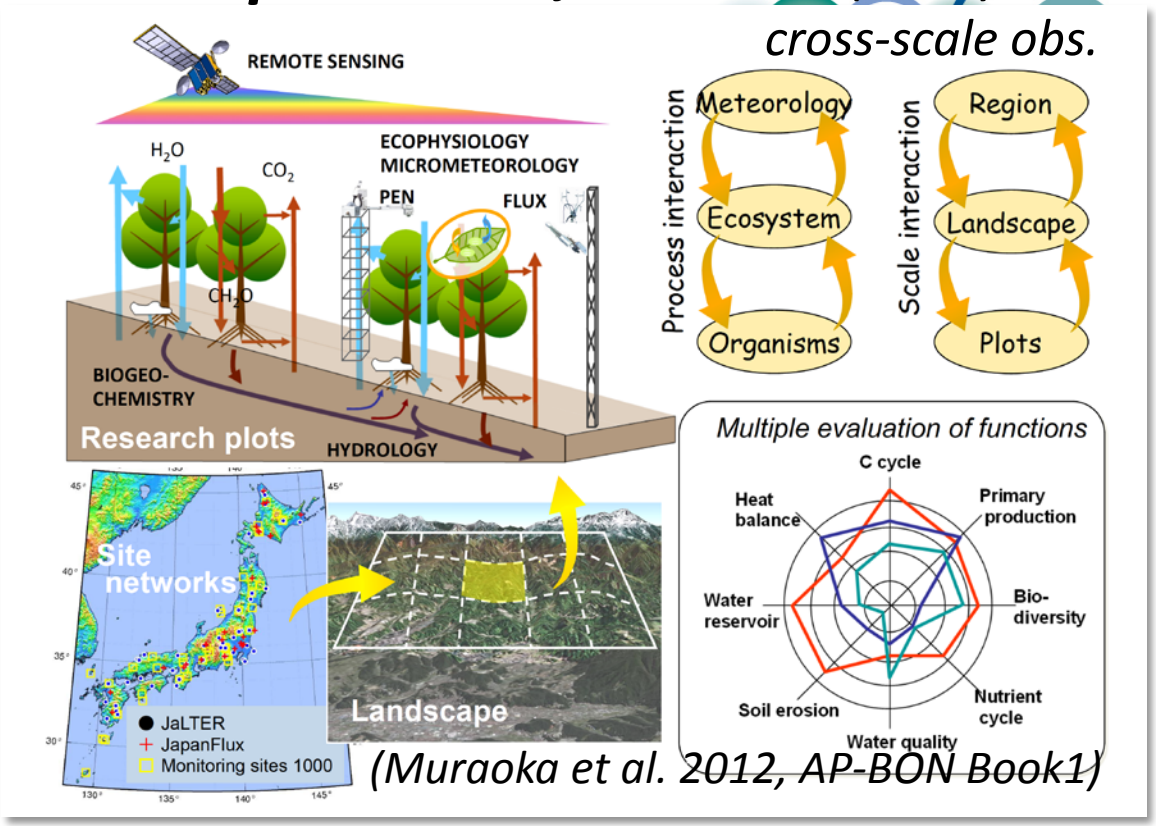
JaLTER

ILTER International Long Term Ecological Research

JapanFlux

Phenological Eyes Network

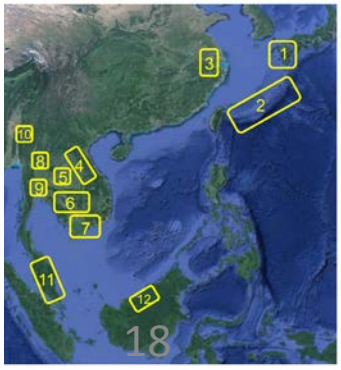
"Super-sites" for multi-disciplinary and cross-scale obs.



(Muraoka et al. 2012, AP-BON Book1)

Monitoring sites 1000 in Japan

Observation sites for inland water



Observation sites for the inland water ecosystem (esp. freshwater fish)

1) Mainland Kyushu; Kyushu Univ. (KU)
2) Nansei Island; KU, Ryukyu Univ.
3) Taihu Lake Basin; Tongji Univ., KU
4) Whole of Lao PDR: National University of Laos, Nagao Environmental Foundation (NEF)
5) Eastern Thailand: Ubon Rachatani Univ., NEF
6) Whole of Cambodia: Inland Fisheries Research and Development Institute, Kagoshima Univ., Seam Reap Research Lab., NEF, KU
7) Sourthen Vietonam: Can Tho Univ., NEF
8) Northen Thailand: Majo Univ., NEF, KU
9) Central Thailand: Kasetsert Univ., NEF
10) Inle Lake: Kyoto Univ., KU, Kasetsert Univ.
11) Peninsular Malaysia: Tun Hussein Onn Malaysia Univ., KU
12) Sarawak Malaysia: Sarawak Forestry Department, WWF Sarawak Malaysia, KU

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Recommendations

- ✓ "Network of networks" would foster long-term and cross-cutting observations and predictions (cf., BON, LTER, FluxNet, MRI, etc.)
- ✓ Shared scientific theme(s), with cross-cutting issues and hypotheses, can be the driver to link the networks and to progress 'cross-ecosystem' science in broad spatial scale
- ✓ Coordination of observation of biodiversity/ecosystems, atmospheric CO_2 (in-situ monitoring; satellites GOSAT, OCO-2) and climate, from landscape to global scales, are needed
- ✓ Super-site concept promotes integrated understanding of climate-biodiversity-ecosystem consequences and changes
- ✓ Ecophysiological and biophysical analyses of satellite RS data will help further observations, and development of new satellite sensors

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Overview of GEO implementing Mechanisms

	GEO Flagships	GEO Initiatives	GEO Community Activities	GEO Foundational Tasks
Purpose / character	pre-/ near-operational service(s)	pilot or prototype service(s);	develop, test, or demonstrate application(s);	enabling or support function(s)
Initiated by	Specified Members, Participating Organization		GEO Community	GEO Secretariat (PB to report on priorities)
Resourcing	**…Resources identified and committed**			**Sufficient resources** identified in GWP
Accepted by	Plenary (PB Recommends)	GEO Programme Board	GEO Secretariat Director	Plenary (with GWP)
Management & Coordination	Dedicated mechanism; coordinator		Community-based	GEO Secretariat or Working Group
User engagement	Specifically identified, fully engaged, **role in steering.**	Target user groups generally identified, with at least an **advisory role.**	May vary, depending on activity.	May vary, depending on Task.

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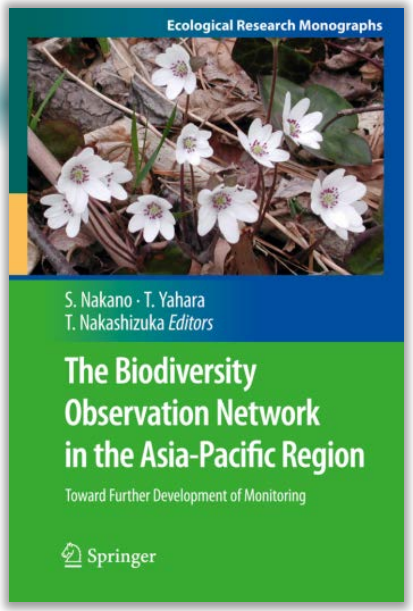
Recommendation



Existing local phenomena/data need to be examined together,
along the environmental gradients and changes,
by building multidisciplinary and cross-scale networks.

(1) "Vertically shallow - laterally dense network"

to find the general relationships between climate and the phenological events of plants, animals, birds and microorganisms. ***[Simple observations (e.g., camera)]***

(2) "Vertically deep - laterally sparse network"

to find consequences among climate, ecosystem structure and functions along the environmental gradients, by networking 'super-sites'. ***[Intensive / multiple obs.]***

(3) "Linking biological, ecological and climatic data by GIS"

to achieve a comprehensive understanding on the climate - phenology of plants and animals - ecosystem functions and services. ***[Integration]***

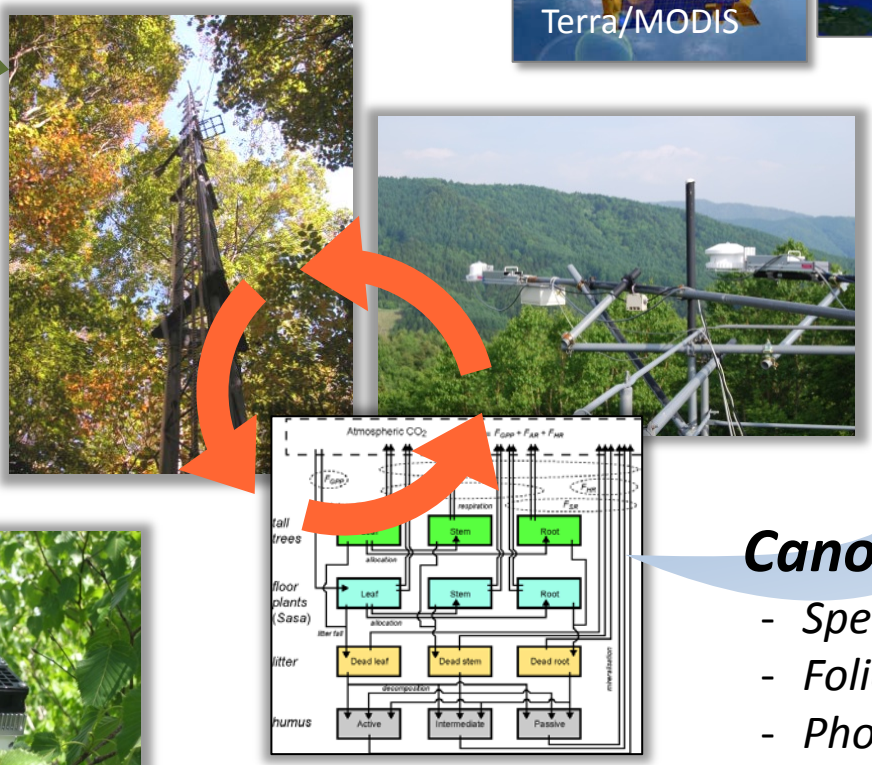
Phenology research by "**Satellite Ecology**" (since 2003)

"Satellite Ecology (SATECO)" is an inter-disciplinary approach to use satellite RS data from ecological, biophysical and ecophysiological viewpoints and understandings.

Satellite obs.

Leaf observations

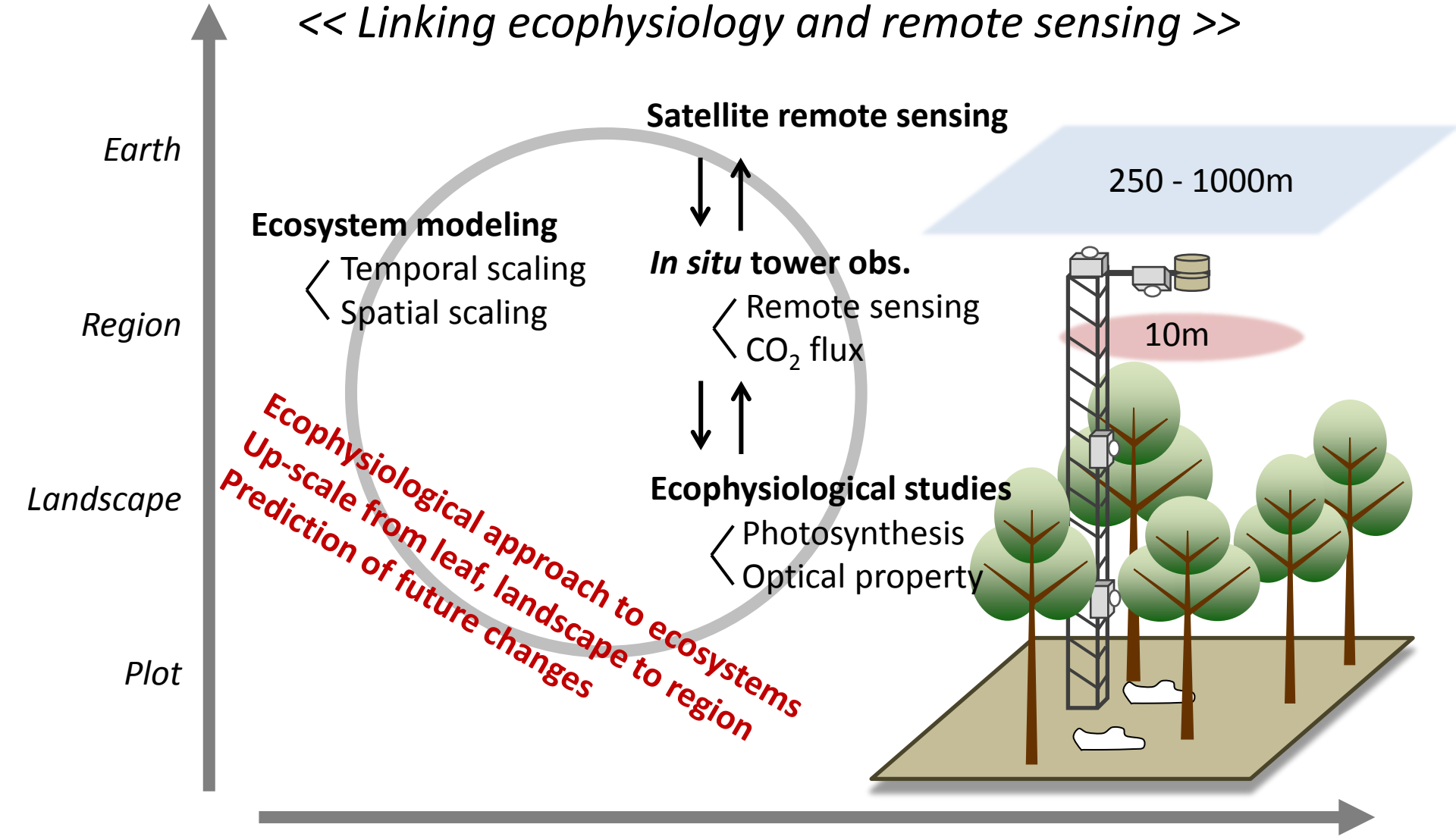
- *Photosynthesis*
- *Optical properties*
- *Species specificity*



Canopy obs. & models

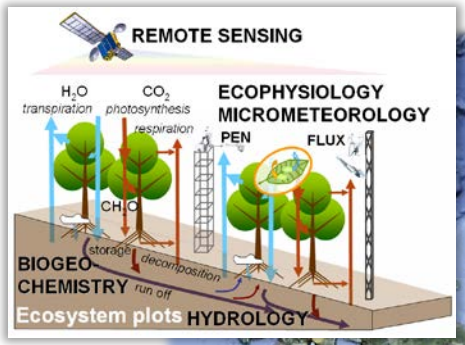
- *Spectral reflectance*
- *Foliage density (LAI)*
- *Photosynthesis and carbon cycle*

Multi-scale observation for phenology of photosynthesis



Muraoka et al. (2015) Ecol. Res.

Challenges in Japan



SATECO

JaLTER

モニタリングサイト1000

Phenological Eyes Network

JapanFlux

JAXA

JAMSTEC 独立行政法人 海洋研究開発機構
JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY

Ecosystem – biodiversity relationships at research sites

Satellite RS + model
(**canopy phenology, NPP**, etc.)

Broad-scale ecosystem-biodiversity monitoring and understandings
(human impacts, disturbance and climate change, etc.)

GEO Strategic Plan 2016-2025: Implementing GEOSS (under consultation)

Societal Benefit Areas

Biodiversity and Ecosystem Sustainability:

by bridging multiple types of observation data and knowledge to provide information on the health of Earth's biological and ecological systems and their services to society;

in order to strengthen conservation, restoration and sustainable use of ecosystems and biodiversity, including marine planning and ocean use, in response to changes in climate and land use, through science-society collaborations at local, national, regional and global levels.

What do we plan and contribute?

How do we implement?

Revisiting the Objectives and Expected Goals

Re-shaping and Sharing the Objectives and Processes

Some ideas from J-BON during the exercise

Site and community networks [*"Biodiversity Observation Super-Sites 3000" (BOSS 3000)*]

- **Enhancement of super-sites**: Increasing number of sites (plots) is required particularly in developmental countries, national parks, protected areas, and human-active areas.
- **The observations need to focus on ecosystem functions and services** (carbon storage, water cycle, resource supply, etc.), **with their external driving factors** (climate, CO_2, land-use, disturbance/disaster).

Analysis and Integration

- **Prediction of changes and scenario analysis** for ecosystem services by combining biodiversity data, climate change, human activity and economy.
- **Progress in analyses of biodiversity-related area for human well-being**: ecosystem functions, agriculture, disease.

Engagement

- **Capacity building** in both developed and developing countries, and among the SBAs for deeper understanding and co-working for biodiversity and ecosystem sustainability.
- **Engagement of citizen observations and stakeholders for co-desing** for detecting local changes in biodiversity and for spreading the understanding and knowledge on biodiversity.

Objectives to be shared

- **Planning and implementing strategies for sustainable use** of biodiversity and ecosystems, based on Data, Knowledge, and Information flows.
- **Towards "Aichi Biodiversity Targets" and IPBES** for sound decision making.

Exercise made for refining Biodiversity observation

Global Societal Challenges
for Sustainable Development

Refining SBA

Step 1: Re-visiting the GEOSS 10-Year IP (2005-2015) and "Strategic Targets" for SBAs
Step 2: Reviewing the achievements
Step 3: Defining further challenges and requirements
Step 4: Defining contributions of GEOSS

Biodiversity (and Ecosystems)

Steps 1 & 2

Exercise in Japan (J-BON, MEXT, MoE)
Needs further discussions by the communities

Expected key outcomes GEOSS 2005-2015

4.1.9 Biodiversity: Understanding, monitoring and conserving biodiversity

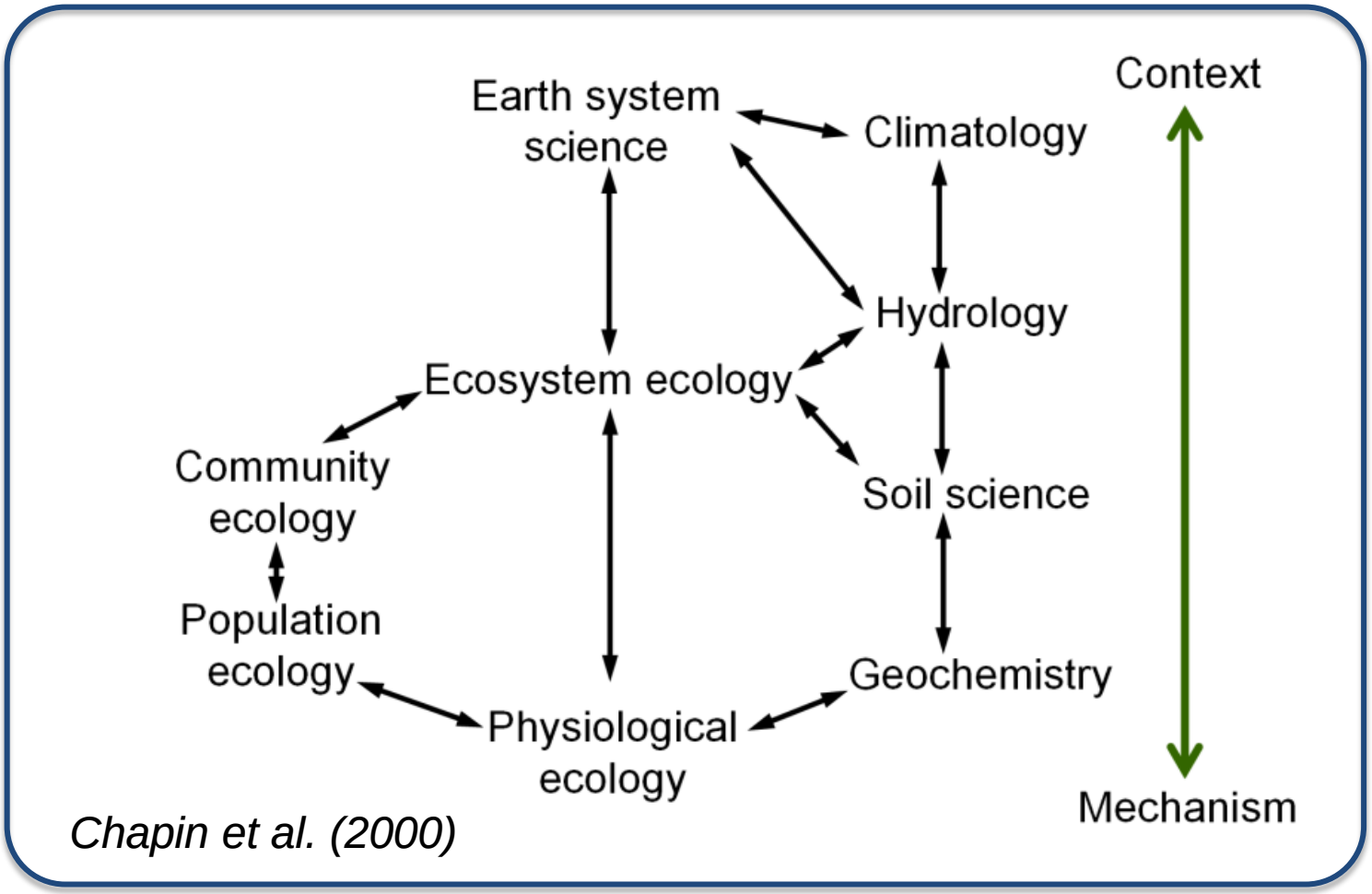
Issues in this area include the condition and extent of ecosystems, distribution and status of species, and genetic diversity in key populations. Implementing GEOSS will unify many disparate biodiversity-observing systems and create a platform to integrate biodiversity data with other types of information. Taxonomic and spatial gaps will be filled, and the pace of information collection and dissemination will be increased.

Achievements (HM referred to GEO BON reports)

- Establishment of biodiversity observation plots based on GEO BON and regional BONs, for investigating the status and changes of biodiversity at genetic, species and ecosystem scales. Efforts made to link satellite, airborne and *in-situ* observations, and modeling.
- Observations of biodiversity are tightly coupled with ecosystem types; terrestrial, freshwater, marine.
- Collaborations with institutions and networks (DIVERSITAS, EBONE, GBIF, ILTER, IUCN, NASA, UNEP, USGS, CBD, etc.)
- Intensive observations, ecosystem service evaluation and capacity building in developmental countries (AP-BON).
- Detections of "Hotspots" and changes of biodiversity due to human activities and environmental changes.
- To gain operational biodiversity indicators: "Essential Biodiversity Variables" （Pereira et al. 2013, Science）.
- Reviewing Earth observation for Biodiversity monitoring for Aichi Biodiversity Targets (with CBD).

Challenges and opportunities for ecology communities

- *Ecology meets Earth Observations* — Multidisciplinary / Cross-scale
- *Delivery of ecology to sustainable development* — Societal / User Needs
- *Engagement of broad communities* — Networking / Interdisciplinary



Chapin et al. (2000)

Targets: **Biodiversity (and Ecosystems)**

Steps 3 & 4

Exercise in Japan (J-BON, MEXT, MoE)
Needs further discussions by the communities

Challenges and further requirements

- Enhancement of biodiversity observation super-sites: Increasing number of sites (plots) is required particularly in developmental countries, national parks, protected areas, and human-active areas. Mountains, freshwater, arctic and ocean are also to be focused intensively as they are vulnerable to climate change. The observations should be linked with ecosystem types and their functions and services (carbon sequestration, water cycle, resource supply, agriculture, etc.), and should be coupled with meteorological observations and remote sensing. ["Biodiversity Observation Super-Sites 3000" (BOSS 3000)]
- Capacity building and communications in developed and developing countries for deeper understanding and co-working for biodiversity conservation.
- Prediction of changes and scenario analysis for ecosystem services by combining biodiversity data, climate change, human activity and economy.
- Planning and implementing conservation strategy of biodiversity and ecosystems, for sustainable use of natural resources and persistence of sound environments.
- Progress in analyses of biodiversity-related area for human well-being: ecosystem functions, agriculture, disease.
- Observations / evaluations on the resilience of biodiversity and ecosystems to disturbance, disaster and climate change.
- Collaborative works towards "Aichi Biodiversity Targets" for sustainable use of natural resources, by leading biodiversity and ecosystem observations and providing data and knowledge.
- Engagement of and co-design with citizen observations for detecting local changes in biodiversity and for spreading the understanding and knowledge on biodiversity.

Expected role of GEOSS 2016-2025

Biodiversity and Ecosystem Sustainability: Deeper and broader understandings, multiple and interdisciplinary observations, and conservation of biodiversity, by science-society partnerships.

Human well-beings are challenged to realize resilient societies by sustainable use of natural resources and conserving sound environments. Further progress and implementing GEOSS will enable us to bridge multiple observation data and knowledge to understand and detect current status and changes of biodiversity and ecosystems under climate change and human impacts, in order to clarify and predict their services and risks of our today and future environments in nations, regions and globe. GEOSS will be a platform for communications among Earth observation communities, stakeholders and citizens over the world for the progress of biodiversity conservation to sustain the Earth system.

(draft)

(Note: still needs further discussions by the communities)

Biodiversity and Ecosystem Sustainability

Global Challenges:
Sustainable Development Goals
Convention on Biological Diversity, 'Aichi Biodiversity Targets'

Shared targets

To secure our sustainable use and conservation of ecosystem resources and sound environments under climate change and human impacts at national, regional and global levels, by promoting deeper and broader understandings of biodiversity and ecosystems and their services, with enhanced science-society partnerships. The challenges promote our vision of "*Living in harmony with nature*".

Key contributions of GEOSS

GEOSS bridges multiple observation data and knowledge, and be a platform for science-society collaborations, to understand and detect current status and changes of biodiversity and ecosystems under climate change and human impacts, in order to clarify and predict their services and risks of our today and future environments.

- Enhancement of biodiversity & ecosystem (+ climate) observation super-sites, particularly in developmental countries, national parks, protected areas, and human-active areas, and places vulnerable to climate change [Biodiversity Observation Super-Sites]. Land-use is of particular environmental changes.
- Supports in achieving **"Aichi Biodiversity Targets" (CBD)** by promoting integration of various data from satellite to citizen science.
- Interdisciplinary understandings and evaluations on the resilience of biodiversity and ecosystems to disturbance, disaster and climate change (Eco-DRR), under current and future environmental and societal conditions in nations, regions and Earth.
- Prediction of changes and scenario analysis for ecosystem services by combining biodiversity data, climate change, human activity and economy. (Contribution to **IPBES**)
- Capacity building and communications in developed and developing countries for deeper understanding and co-working for biodiversity conservation and sustainable use of natural resources.

GROUP ON EARTH OBSERVATIONS

Mexico City Declaration

2. Affirm that GEO and its Earth observations and information will support the implementation of, inter alia, the 2030 Global Goals for Sustainable Development…

8. Call on GEO to launch a GEO initiative to leverage Earth observations to support the implementation, monitoring and evaluation of the 2030 Global Goals for Sustainable Development, building on the recent success of GEO's engagement with the United Nations on this issue.

GROUP ON EARTH OBSERVATIONS

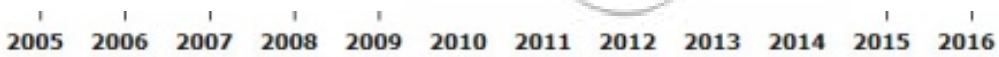
Resolve to strengthen & facilitate active participation of developing countries, including through Regional Initiatives – AfriGEOSS, AmeriGEOSS, AOGEOSS

Africa:	27
Americas:	16
Asia/Oceania:	19
C.I.S.:	7
Total:	103

AOGEOSS

Ameri GEOSS

AfriGEOSS



The GEOSS Construct has both Room and Need for a Spectrum of Activities

- Flagships
- Initiatives
- Community Activities
- Foundational Tasks

Each may support different objectives, have different users, and vary across spatial, temporal, and thematic scales

Biodiversity and Ecosystem Sustainability

Getting a better understanding of the diversity of ecosystems through Earth observation data, contributing to the Convention on Biodiversity and other Multilateral Environmental Agreements

Disaster Resilience

Earth observations contribute to disaster mapping and better mitigation and response, working with the Sendai Framework on Disaster Risk Reduction

Energy and Mineral Resource Management

Fossil fuel energy use accounts for more than two thirds of greenhouse gas emissions. Earth observations can be used to increase the global share of renewable energy sources such as solar and wind power, in combination with energy efficiency, to help limit a further rise in global temperature, in line with The Paris Agreement

Food Security and Sustainable Agriculture

Earth observations combined with other data contribute to better crop monitoring to counter food insecurity, a commitment upheld by all states under Sustainable Development Goal 2, End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Infrastructure and Transportation Management

Equitable access to Earth´s resources and proximity of communities to national services can be assessed using Earth observations to meet and measure SDG Goal 9, build resilient infrastructure, promote sustainable industrialization and foster innovation

Sustainable Urban Development

Use of Earth observations can promote equity, welfare and shared prosperity for all levels of human settlement, fostering nati… and showing land change over time to rethink the Urban Agenda

Public Health Surveillance

Public health alerts on air quality, outbreaks of disease carried by water-borne vectors, and assessments of access to health facilities are informed by Earth observations and help to achieve SDG Goal 3 on Good Health and Wellbeing

Water Resources Management

Technology allows for day-by-day tracking of extreme weather, alerting authorities to crop failures, monitoring inland water resources and tracing the steady spread of deserts and deforestation, water is central to all aspects of human life

GEO Flagship

GEO Biodiversity Ob

Global Forest Obse

GEO Initiatives

The GEO Global Eco

GEO-GNOME Initiat

Information in Mou

GEO Carbon and GH

Earth Observations

Ocean and Society:

Community Activiti

Africa Global-scale

environmental man

Harmful Algal Bool

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