



中国科学院遥感与数字地球研究所
Institute of Remote Sensing and Digital Earth, CAS

29th Sessions of the GEWEX Scientific Steering Group (SSG-29)

DBAR-Water and Ongoing Projects

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**Institute of Remote Sensing and Digital Earth (RADI)
Chinese Academy of Sciences (CAS)**



6-9 February, 2017, Sanya



Outline

- **DBAR-Water:**

Understanding spatial and temporal patterns of water resources and water use in the belt and road region by Earth observation

- **Ongoing Projects**

Belt and Road Initiative



Proposed by Chinese government in 2013, is an economic framework designed to connect economies in Asia, Africa and Europe.

- Involving more than 60 *countries* and a *population* of 4.3 billion;
- facing numerous challenges for ***sustainable development***

EO-based Technologies for the Belt and Road



land degradation

drought

flood

food security

heritage destruction

water scarcity

glacial melt

DBAR Initiative

- International Science Program
- Promotes cooperation among the Belt and Road countries
- Smart use of Big Earth Data



Objective:

- **Scientific contributions**

To address **knowledge gaps** in Earth system processes, which are limiting the **achievement of the SDG targets in the Belt and Road countries.**

- **Facilitating platform**

To promote **advanced science and decision support services** to extract effective information from massive and diverse data in light of Big Earth Data.

- **Stakeholders**

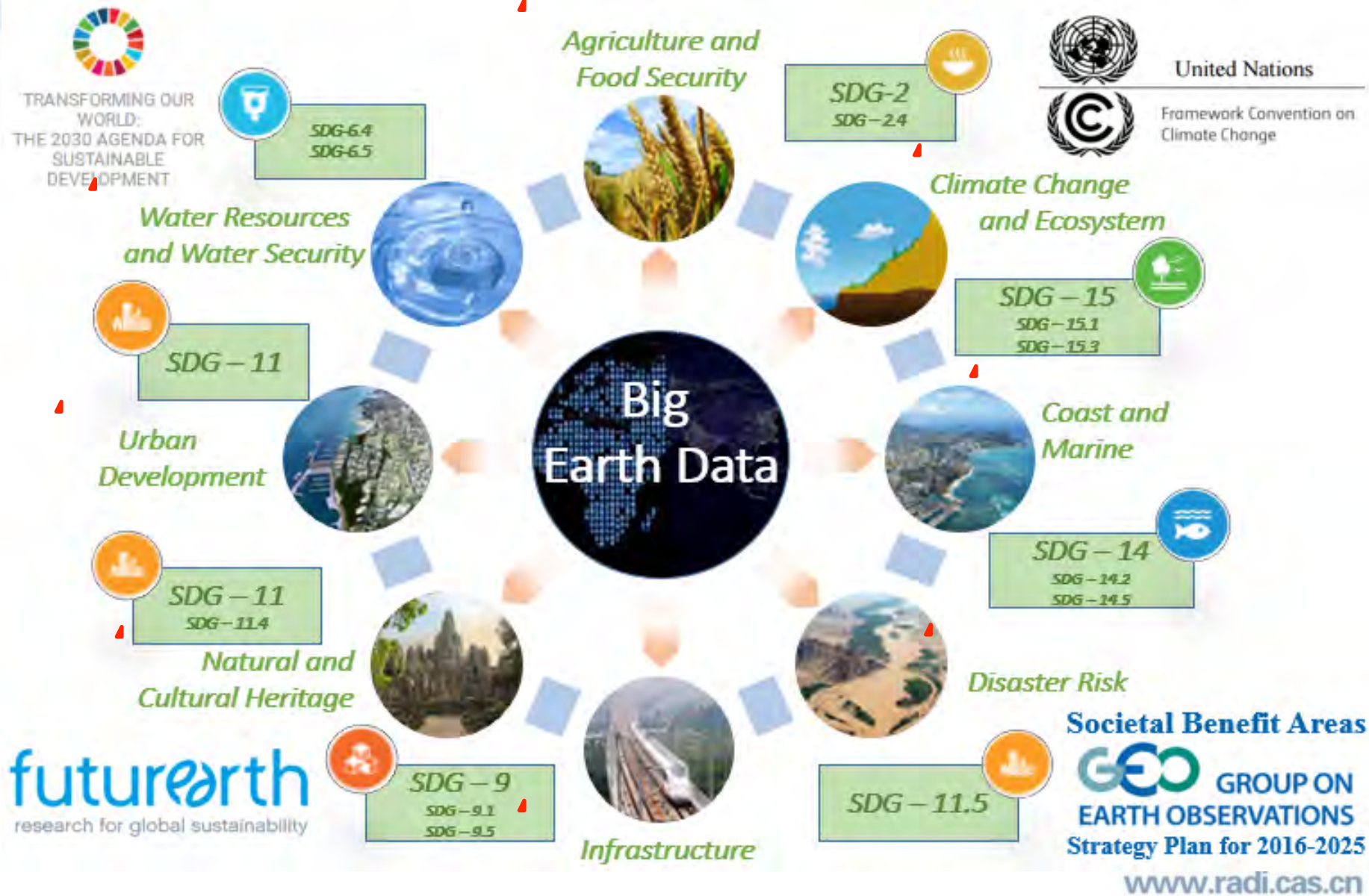
To enhance capacity building and technology transfer towards a system of **partnerships and research networks.**

Mission of DBAR

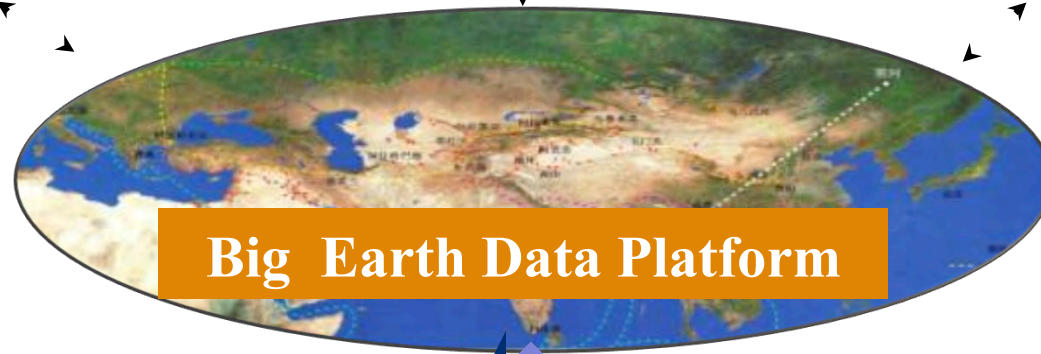


- Identify outstanding **knowledge gaps** and structure a comprehensive and well-articulated **research program**.
- Facilitate the **convergence of resources**.
- Promote national data policies towards **open access data**.
- **Improve the quality** of bio-geophysical data products
- **Exploit Earth Observation data** in the Belt and Road countries to improve the ICT infrastructure and **human resource capacities**.
- Promote and develop high level, EO-based **information services in the Belt and Road countries**.

DBAR Foci and linkage with UN SDGs



Framework of DBAR



6 Themes



2 Task Forces

DBAR Urban
DBAR Cold Region



International Programs

International Organizations



Ways to Benefit from DBAR

1 Data/Platform

EO Data Gateway



Observation Infrastructure



2 Project/WGs/RCs

New Big Data Science Mode

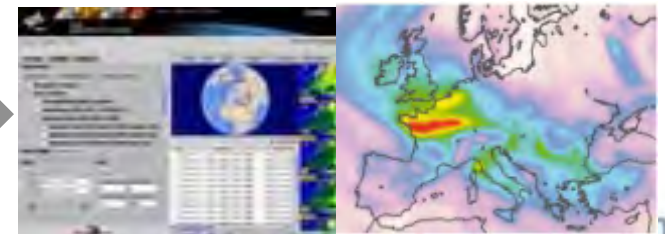


3 S&T Network

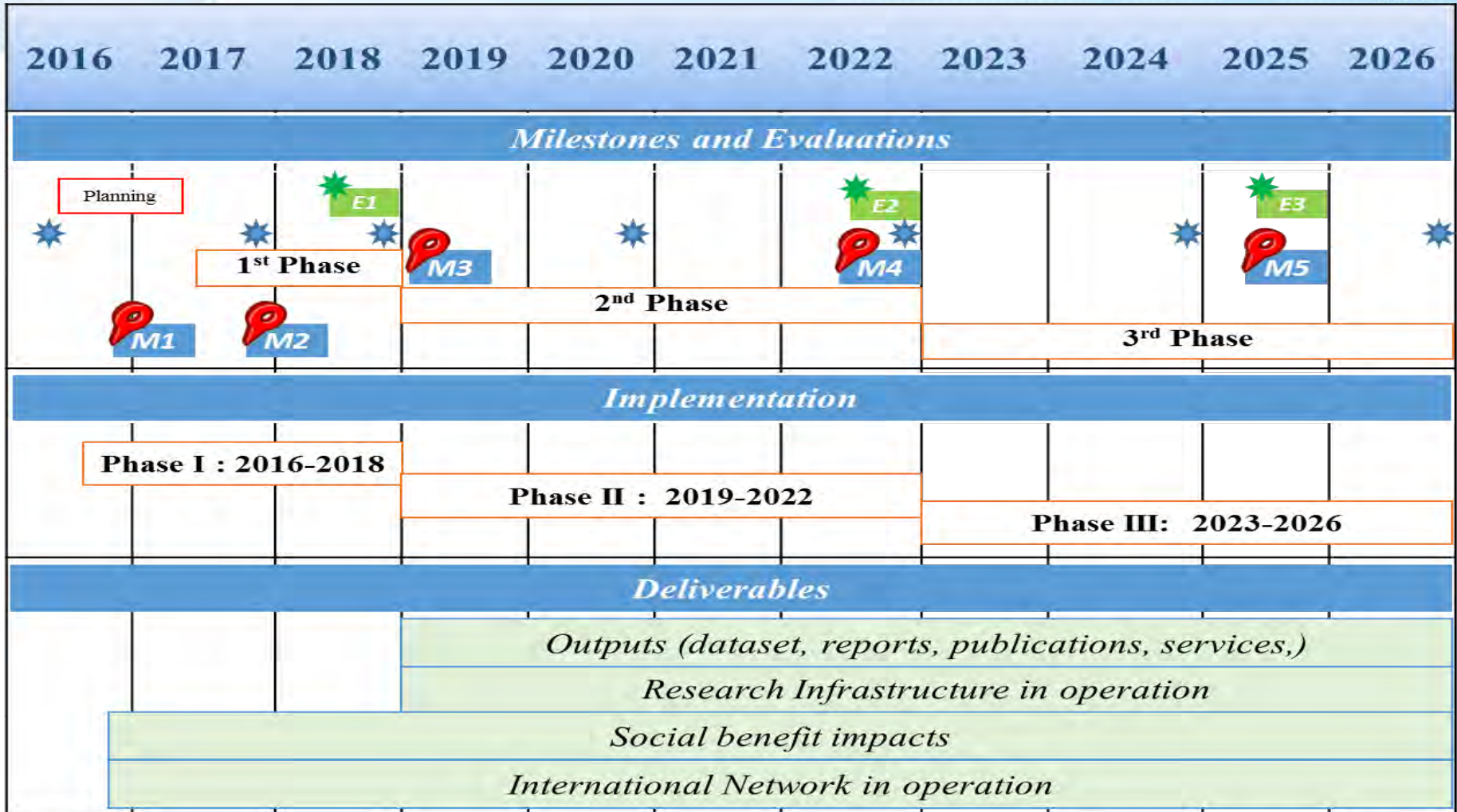
Institutional & Human Capacity



Science-Based Policy Making



DBAR Timeline



M1: Adoption of Science Plan
M3: First Evaluation Report
M5: Final Evaluation Report

M2: Release of Science Plan
M4: Mid-term Evaluation Report



Conferences



Evaluations

DBAR Conference



The 1st DBAR International Science Conference: December 2016, Beijing



The 2nd DBAR International Science Conference: 6-8 Dec. 2017, Hong Kong



The 2nd international conference of Digital Belt and Road (DBAR 2017)

The 3rd international conference on remote sensing applications in tropical and subtropical areas (RSATSA 2017)

第二届数字一带一路国际会议 暨
第三届热带与亚热带遥感应用会议

6-8 December 2017
The Chinese University of Hong Kong



Main Conference Topics:

1. Remote Sensing for Coast and Marine Ecosystems
2. Remote Sensing for Resources and Environment Monitoring and Assessment
3. Remote Sensing for Harbour and Port Cities Development
4. Remote Sensing for Disaster Risk Reduction
5. Remote Sensing for Natural and Cultural Heritage, and Tourism
6. Digital Earth and Spatial Information Infrastructure

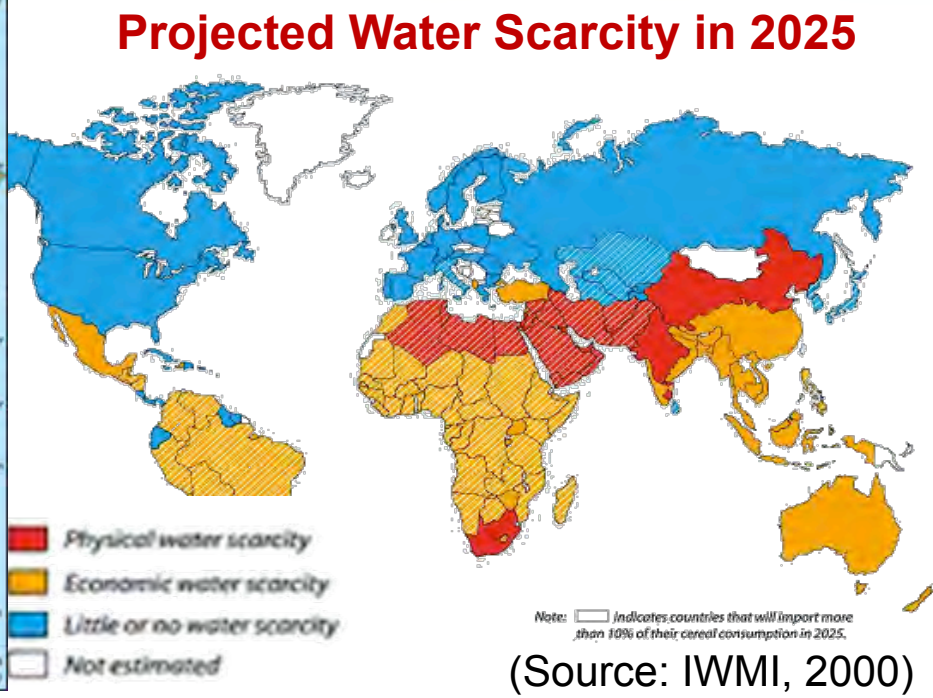
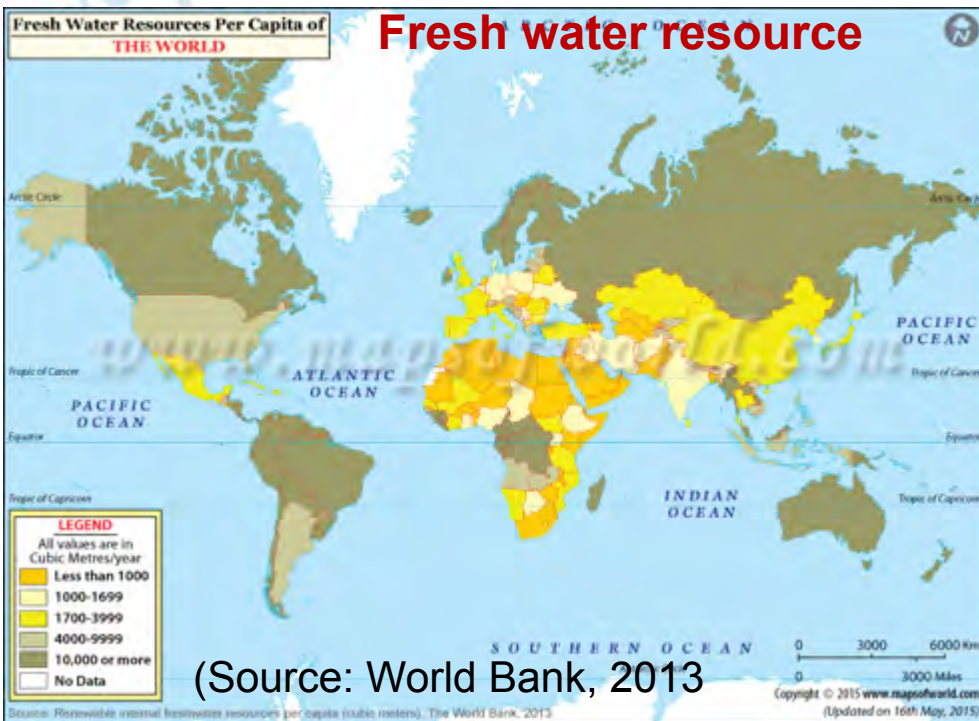
Important Dates:

- | | |
|--------------|--------------------------------|
| 31 May 2017 | Abstract submission deadline |
| 03 July 2017 | Notification of acceptance |
| 30 Sept 2017 | Full paper submission deadline |



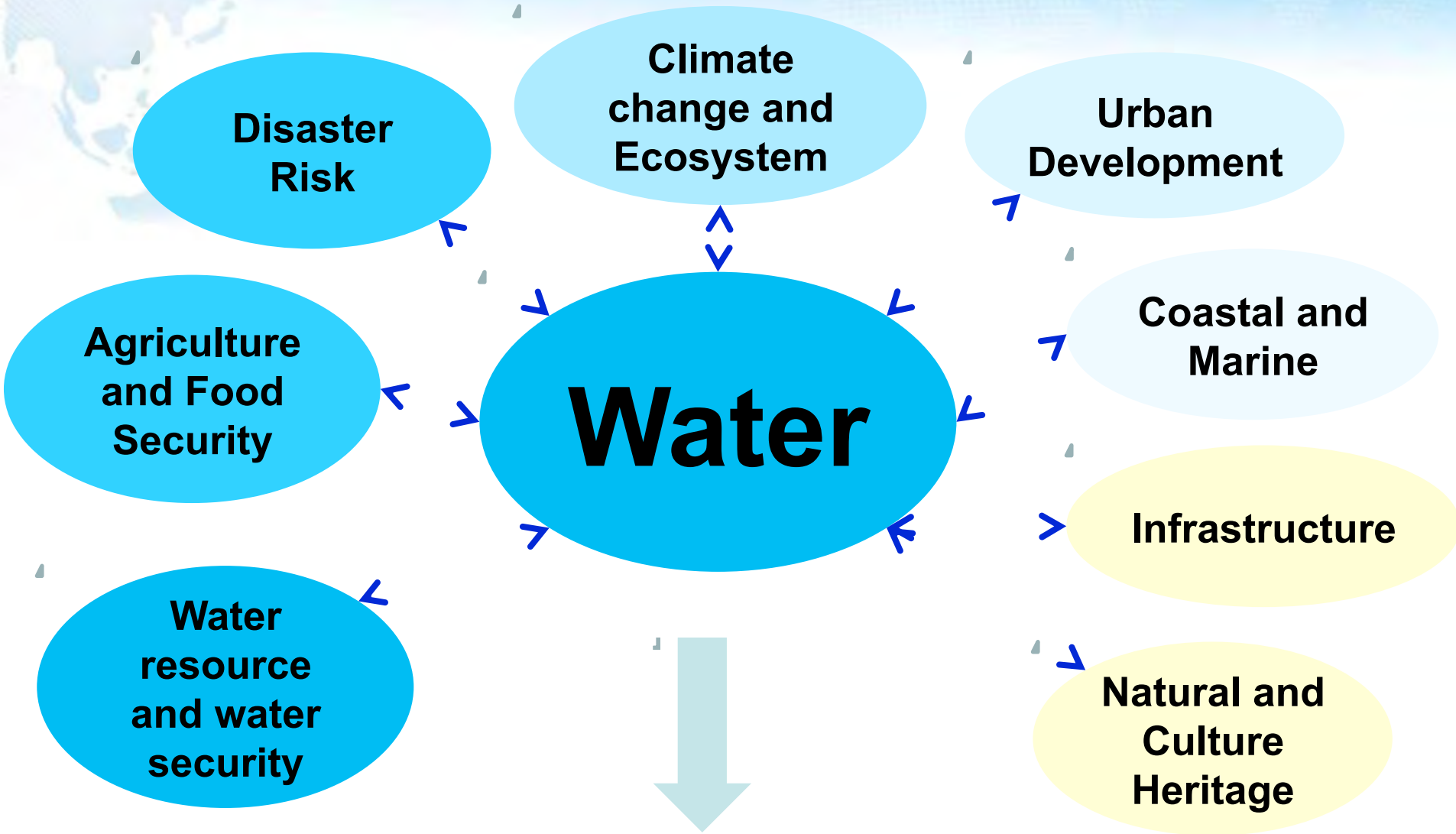
DBAR-Water Problem Identification

economic development **vs.** sustainable use of water resources



- shortage and uneven distribution of water resources;
- frequent drought and flood disasters;
- conflicts in demand and availability of water;
- glacier melting
- etc.

DBAR-Water vs Foci



Big Earth Data



To provide information and solutions to problems in water resources and water security in the area of the Belt and Road using Earth Observation technique through studies on crucial issues

This will require investments in capacity building on **Earth Observation for water resources assessment and management** in the Belt and Road Countries, by strengthening at the same time **international cooperation and communication** among partner countries and regions.

Such efforts will create **scientific evidence and essential information towards sustainable use of water the BAR countries.**

Good data

**Understanding
of processes**

Specific issues

**Task 1
General Water
Resource Mapping**

**Task 2
General Water
Quality Mapping**

**Task 3
Hydrosphere
processes vs
climate and human
activity**

**Task 4
Adaptation of water
management
systems**

**Task 5
Water productivity
of agriculture**

**Task 6
Drought and flood**

**Task 7
High elevation
hydrology**

**Task 8 ??
Urban Hydrology**

1. General Water Resource Mapping

- develop algorithms to create **time series of water resource components using satellite observations**:
 - precipitation,
 - evapotranspiration,
 - soil moisture,
 - lakes and reservoir,
 - glacier area,
 - snow cover dynamics,
 - wetlands,
 - groundwater
 - etc..
- **with proper temporal and spatial resolution**
- provide data to support the studies in other tasks of **DBAR-Water**



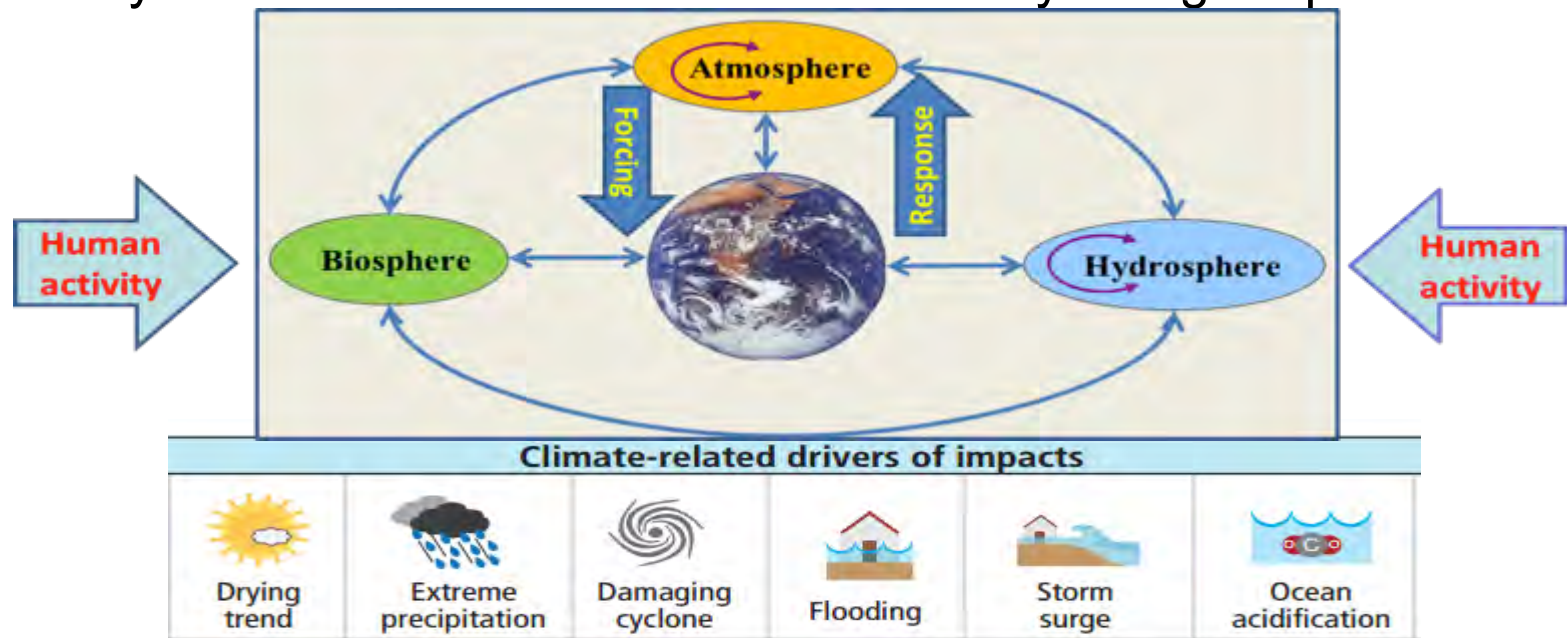
2. General Water Quality Mapping

- develop algorithms to create time series of water quality using satellite observations for inland freshwater and costal zone water using, e.g.:
 - Lake and costal zone water quality (e.g. algae blooms);
 - large river suspended sediment loads.
- develop methods for sewage outlet monitoring and control based on optical remote sensing.

• **High resolution multi / hyper-spectral satellite data**

3. Hydrosphere processes and climate

- to understand the interaction between the hydrosphere processes and climate through analyzing the spatial and temporal distributions and changes in water related variables in some typical basins,
- to clarify the main control factors of different hydrological processes.



provide scientific basis for regional water resources management in **DBAR-Water**

4. Adaptation of water management

- to analyze the temporal and spatial characteristics of water resources using multi-source earth observation data in key river basins in the region of the Belt and Road Initiative, **in particular in the regions where specific economic plans have been established.**
- to evaluate water availability, water use and water re-allocation in accordance to the new circumstance due to economic development under climate change.

■ Satellite observations → monitoring the actual water need under changing boundary conditions (human pressure and climatic forcing).

better understanding of vulnerabilities → identify options to mitigate or remove the underlying factors of vulnerabilities → options for the adaptation of water management systems.



5. Water productivity of agriculture

- to estimate **efficiency of agricultural water use and management** in the Belt and Road Countries by **applying middle-high resolution remote sensing data** to a process based model to **monitor crop water use and to assess crop water productivity**.
 - Beneficial water use: transpiration; biomes, crop yield
 - Non-Beneficial water use : other ET components
 - Ratio of beneficial to non-beneficial water use is highly related to LULC
 - **ETMonitor (multi-source RS)**

→ Improving water productivity seeks to get the highest benefits from water and hence can be viewed as a major contributor to water saving.

- Solutions will be proposed including alternative crops and advanced irrigation methods.



6. Drought and Flood

Drought and flood are two water related disasters, which should be linked to the theme on Disaster and Risks.

Drought:

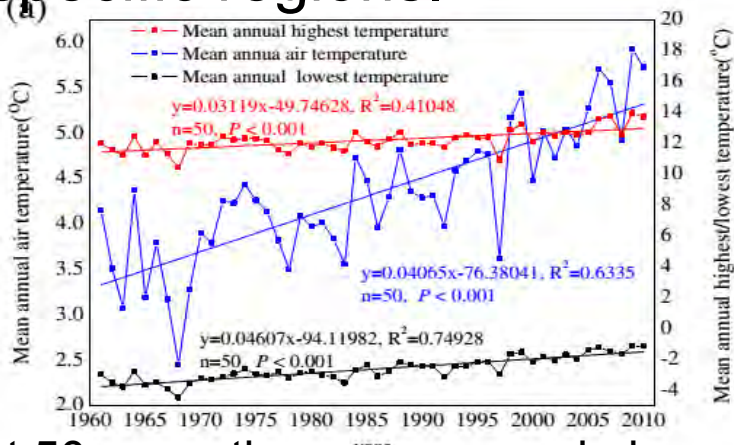
- Methods/indicators for drought monitoring using satellite observations: **short term weather impact and long term probability of climate scenarios**;
- Drought frequency, impact and driving mechanism.

Flood:

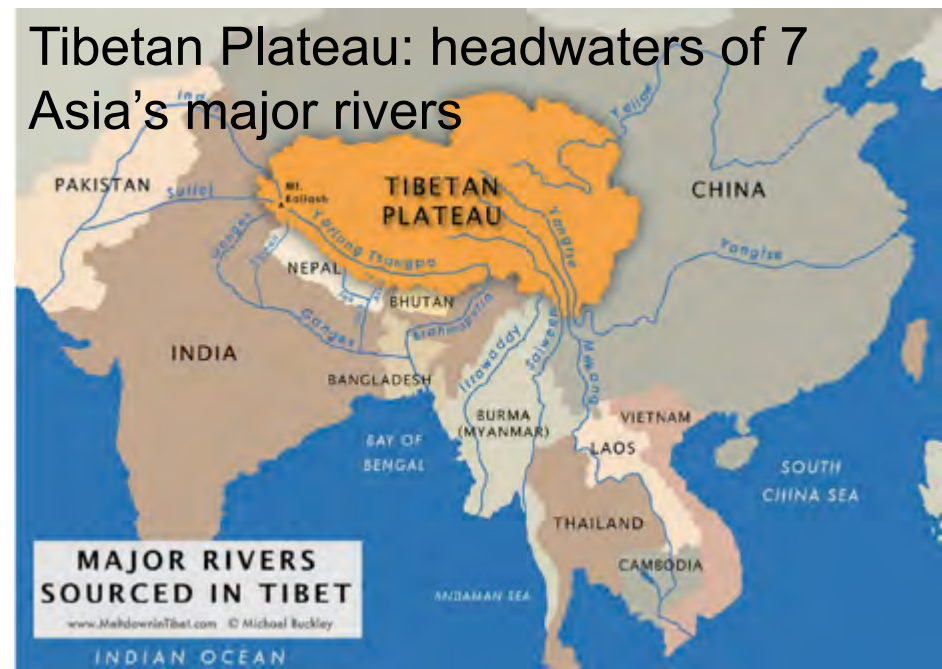
- Methods for flood early warning and monitoring using modeling and satellite observations;
- Flood mapping using satellite data;
- Post-flood environmental monitoring and assessment;
- Role of land use and land cover change on flood frequency and intensity;
- Advices for territorial resilience will be provided.

7. High elevation hydrology

- Impacts of glacier changes on regional water resources and ecological environment in the **High Mountain Asia, Africa, and Alps in Europe** under climate change and human activities will be analyzed using satellite observations and modeling;
- Impacts of snow cover dynamics on water resources in specific regions.



past 50 years the mean annual air temperature of Tibet Plateau(TP) has 22 increased by 2.0 °C (Shen et al.,2015)



DBAR-Water Output and Deliverables



- Harmonized **network** of Earth Observation for water resource assessment and management among the Belt and Road Countries;
- **Capacity building** on Earth Observation for water resources and water security among the Belt and Road Countries;
- **Datasets, atlases and information** of water resources/use elements derived from Earth Observation for the area of the Belt and Road Initiative (→Big Data Platform);
- **Reports** on crucial issues (related to Tasks) in specific target areas of the Belt and Road Initiative;
- Publications, seminars, exchange of personnel and training programs, etc.
- **Contribution/Linkage to international /regional programs**, i.e. UN-Water, GEOSS, GEO-Cold Regions, AfriGEOSS, GEWEX, FAO, etc.

Under construction

❑ Co-chairs:

- Prof. dr. Li Jia, RADI-CAS, China
- Prof. dr. Marco Mancini, POLITECNICO DI MILANO, Italy
- Prof. dr. Bob Su, Twente University, the Netherlands (NL)
- Prof. dr. Massimo Menenti, RADI-CAS / TUD Netherlands

❑ Members (not limited to)

- Prof. Kamal Labbassi, Chouaib Doukkali University, **Morocco**
- Prof. Wim Bastiaanssen, UNESCO-IHE, **NL**
- Prof. Xin Li, Northwest Institute of Eco-Environment and Resources (NIEER), CAS, **China**
- Dr. Peter van Oevelen, Director, International GEWEX Office, **USA**
- Prof. Ramakar Jha, National Institute of Technology (NIT), **India**
- Dr. Atta Ur-Rahman, University of Peshawar, **Pakistan**
- Dr. Samiullah Khan, University of Peshawar, **Pakistan**
- Dr. Hussein Farah, Regional Centre for Mapping of Resources for Development (RCMRD), **Kenya**
- Dr. Abdou Ali, AGRHYMET Regional Center, **Niger**
- Dr. Nabil Ben Khadra, Observatory of the Sahara and Sahel (OSS), **Tunisia**
- Dr. Yazidh Bamutaze, Makerere University (MU), Kampala, **Uganda**
- Prof. Yuanbo Liu, NIGLAS-CAS, **China**
- Dr. Vichian Plermkamon, Khon Kaen University (KKU), **Thailand**
- Dr. Vu Phan, Ho Chi Minh City University of Technology (HCM-UT), **Vietnam**
- Dr. Muhammad Zulkarnain bin Abd Rahman, Universiti Teknologi Malaysia (UTM), **Malaysia**
- And more from **Iran, Mongolia, Vietnam, Cambodia, Nepal, Tajikistan, China**

Outline

- **DBAR-Water:**

Understanding spatial and temporal patterns of water resources and water use in the belt and road region by Earth observation

- **Ongoing Projects**

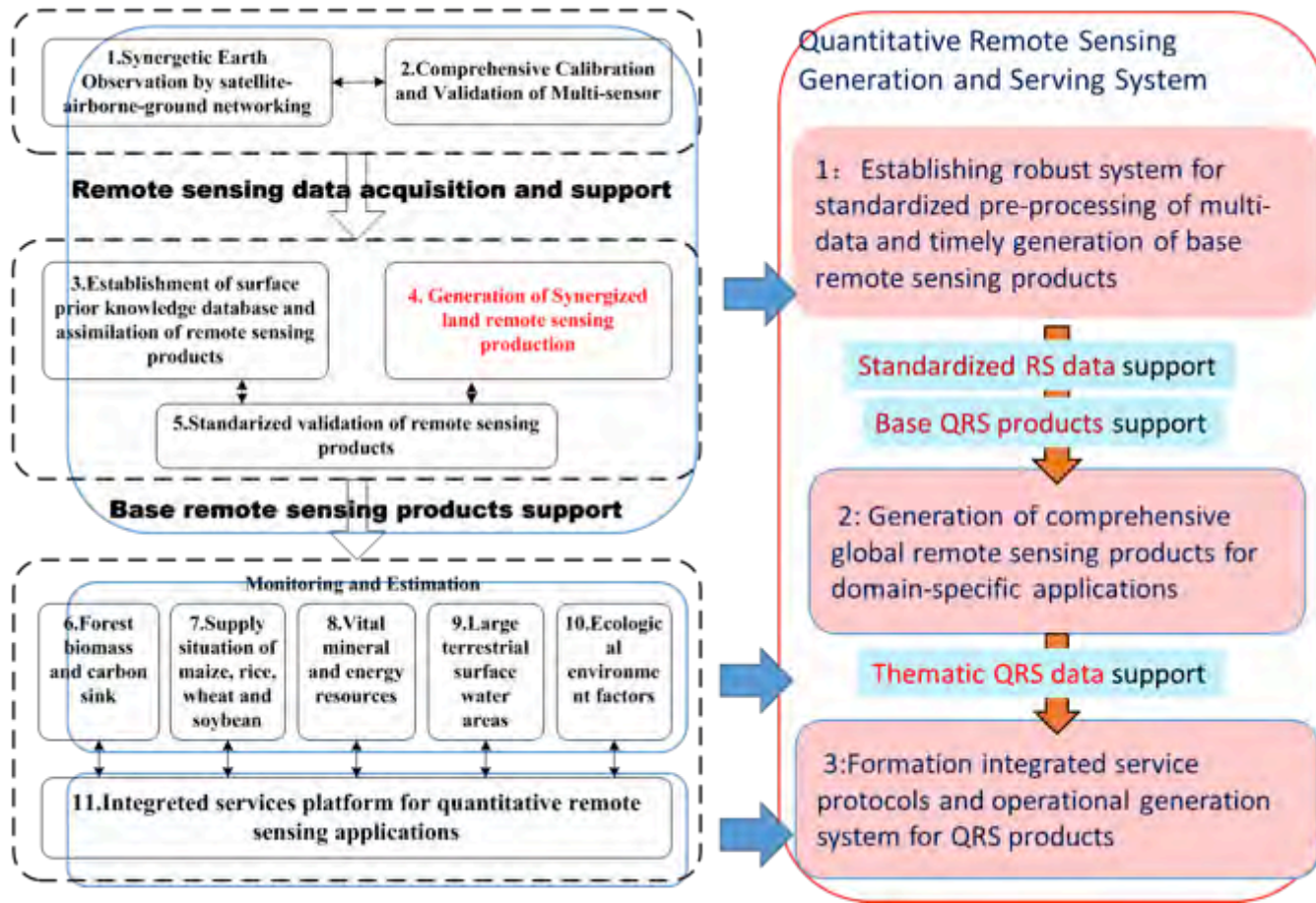
Research/Projects Highlights



1- Project funded by Ministry of Science and Technology (MOST) of China (National High Technology Research and Development Program):

Standardized generation and comprehensive applications of satellite-airborne-ground synergetic quantitative remote sensing (QRS) products

Period: stage 1: 2012 – 2014, stage 2: 2013 - 2015; PI: Prof. Q.H. Liu



Research/Projects Highlights



1- Project funded by Ministry of Science and Technology (MOST) of China (National High Technology Research and Development Program):

Standardized generation and comprehensive applications of satellite-airborne-ground synergetic quantitative remote sensing (QRS) products

Period: stage 1: 2012 – 2014, stage 2: 2013 - 2015; PI: Prof. Q.H. Liu

Outcome: Multi-source data Synergized Quantitative remote sensing production system (MuSyQ) :

- **Radiation Budget**

Parameter: PAR、Net radiation、LST、Albedo...

- **Vegetation Parameter:**

VI、LAI、VC、NPP、Biomass...

- **Hydrological Parameter:**

Precipitation、ET、Snow Cover.....

Earth Observations Ability in the Asia Oceania Region

- China

- ✓ FY, ZY, HY, HJ, CHEOS-GF series satellites
- ✓ Jilin Constellation, TripleSat Constellation

- Japan

- ✓ Advanced Land Observing Satellite (ALOS), JERS-1, ADEOS, ALOS, PALSAR, PRISM
- ✓ Greenhouse Gases Observing Satellite (GOSAT)
- ✓ Global Precipitation Mission (GPM)
- ✓ ADEOS-II Follow-on Mission (GCOM)
- ✓ Himawari-8 and -9

- Korea

- ✓ Kompsat-3

- India

- ✓ IRS
- ✓ Resource sat
- ✓ INSAT – 1,2, 3 series
- ✓ MeghaTropiques

- Other observations in AO Region www.radi.cas.cn

Research/Projects Highlights



1- Project funded by Ministry of Science and Technology (MOST) of China (National High Technology Research and Development Program):

Standardized generation and comprehensive applications of satellite-airborne-ground synergetic quantitative remote sensing (QRS) products

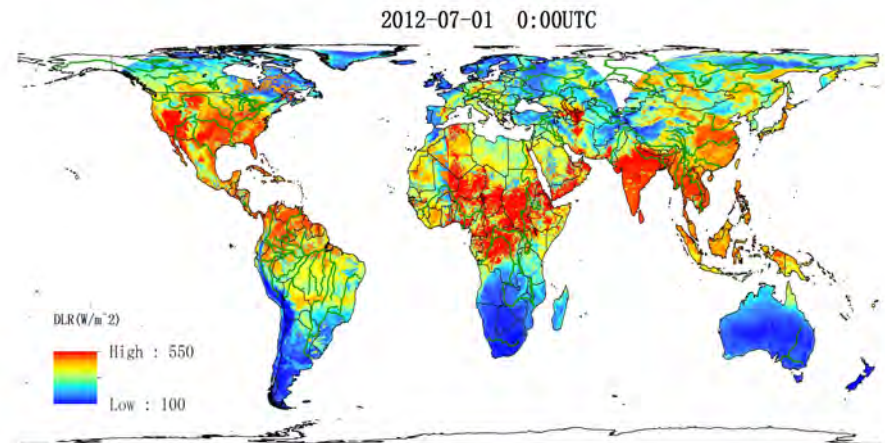
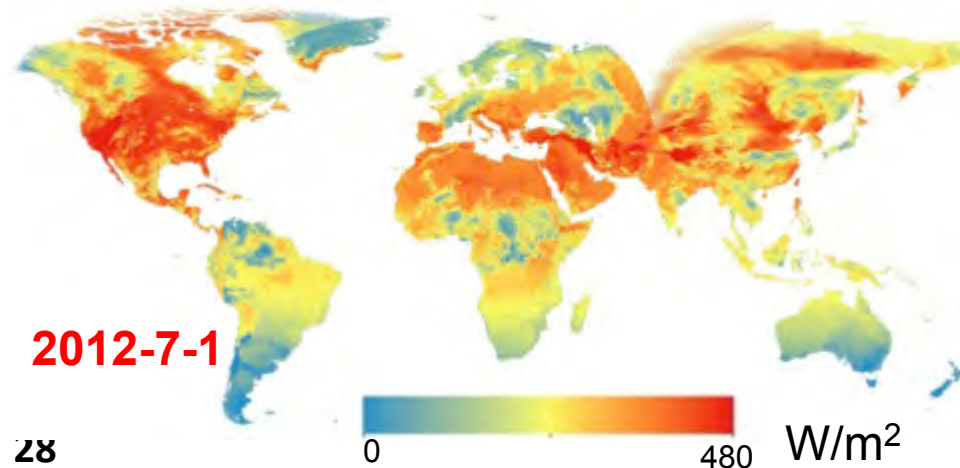
Period: stage 1: 2012 – 2014, stage 2: 2013 - 2015; PI: Prof. Q.H. Liu

Outcome: **Multi-source data Synergized Quantitative remote sensing production system (MuSyQ) :**

Downwelling Solar Radiation

Downwelling Longwave Radiation

3hrs, 5km



Research/Projects Highlights



1- Project funded by Ministry of Science and Technology (MOST) of China (National High Technology Research and Development Program):

Standardized generation and comprehensive applications of satellite-airborne-ground synergetic quantitative remote sensing (QRS) products

Product schedules

Products type	Products name	2015	2014	2013	2012	2011	2010
Basic products	aerosol optical thickness	√	√	√	×	×	×
	surface reflectance	—	√	√	×	×	×
	albedo	—	√	√	×	×	×
Land cover	Land cover	—					√
Radiation products	FPAR	—	√	√	×	×	×
	PAR	—	√	√	×	×	×
	photosynthetic thermal productivity	×	×	×	×	×	×
	downward long-wave radiation	—	√	√	×	×	×
Water balance products	precipitation	√	√	√	√	√	√
	evapotranspiration	—	√	√	√	√	√
	Water balance	—	√	√	√	√	√
Vegetation products	NDVI/EVI	—	√	√	×	×	×
	LAI	—	√	√	×	×	×
	FVC	—	√	√	×	×	×
	NPP	—	√	√	×	×	×
	vegetation phenology	×	×				
	Forest biomass above ground	—					×
Ocean disaster	Typhoon	√	√	√	√	√	√
	Sea wave	√	√	√	√	√	√
	Sea fog	×	×	×	×	×	×

Research/Projects Highlights



2- Project funded by Ministry of Science and Technology (MOST) of China (National Key Basic Research Program):

Improving the Understanding of Global Land Surface Energy and Water Exchange Processes in the Context of Global Change through Satellite Observations, Modelling and Assimilation

Period: 2015 – 2019; PI: Prof. JC Shi

Sub-projects:

- (1) Improving the accuracy of retrievals of essential variables related to water and energy exchanges from satellite observations (JC Shi, RADI-CAS)
- (2) Understanding water/heat exchanges and their scaling mechanism by remote sensing (Li Jia, RADI-CAS)
- (3) Optimization of parameters/parameterizations of land surface process model through assimilating satellite observations to improve the LSP model accuracy (Hui Lu, Tsinghua University)

Research/Projects Highlights



2- Project funded by Ministry of Science and Technology (MOST) of China (National Key Basic Research Program):

Improving the Understanding of Global Land Surface Energy and Water Exchange Processes in the Context of Global Change through Satellite Observations, Modelling and Assimilation

Period: 2015 – 2019; PI: Prof. JC Shi

List of variables to be derived from satellite observations:

- Net radiation (full sky condition, terrain correction)
- Dynamic water body area
- Soil moisture
- Snow cover fraction
- Freeze/thaw status (surface soil layer)
- Evapotranspiration (E, Tr, I_e, sublimation)

Research/Projects Highlights



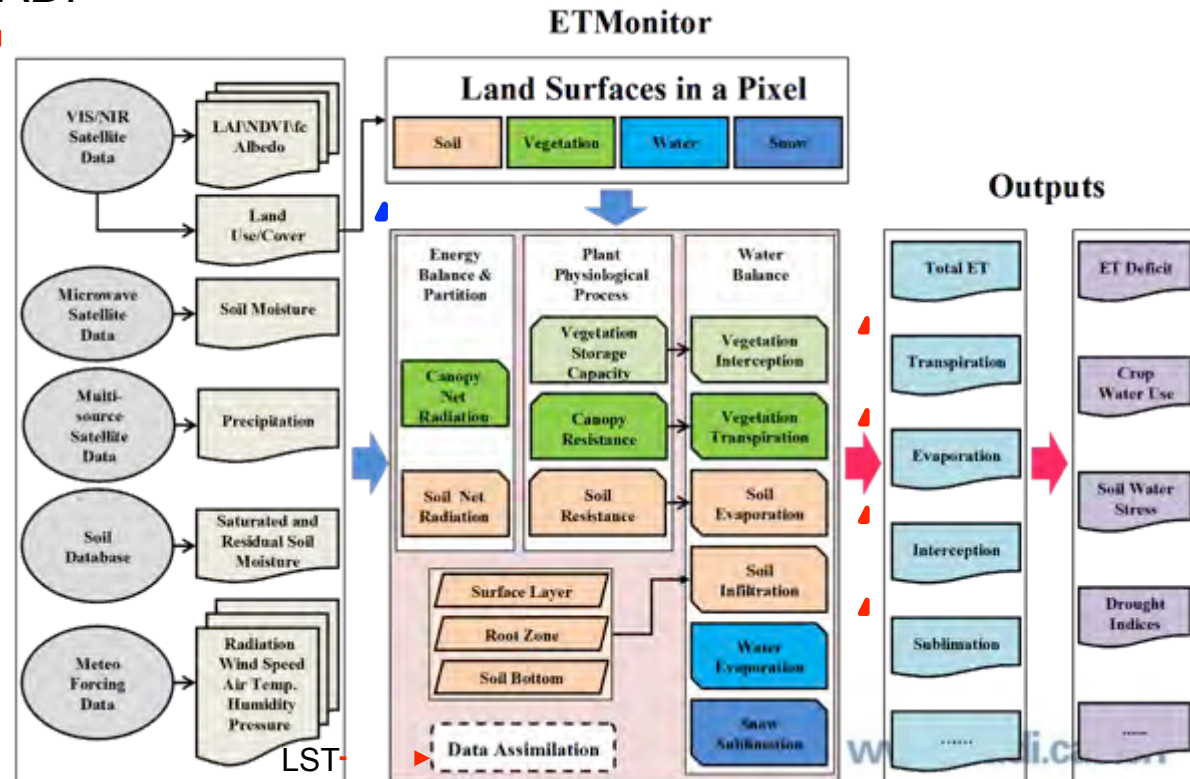
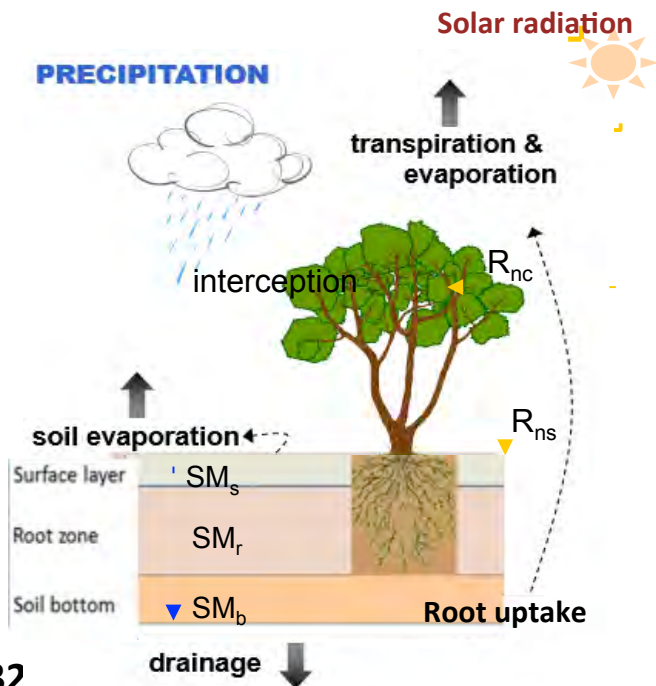
Evapotranspiration from Remote Sensing

ETMonitor:

A process based model implementing processes of **energy balance**, **plant physiology** and **soil water balance** developed by EOWater Lab at RADI

Hu and Jia, 2015, Remote Sensing
Cui and Jia, 2014, Water
Cui, Jia, et al., 2015, IEEE GRSL
Zheng, et al., 2016, IGARSS

- Combining optical and microwave remote sensing observations

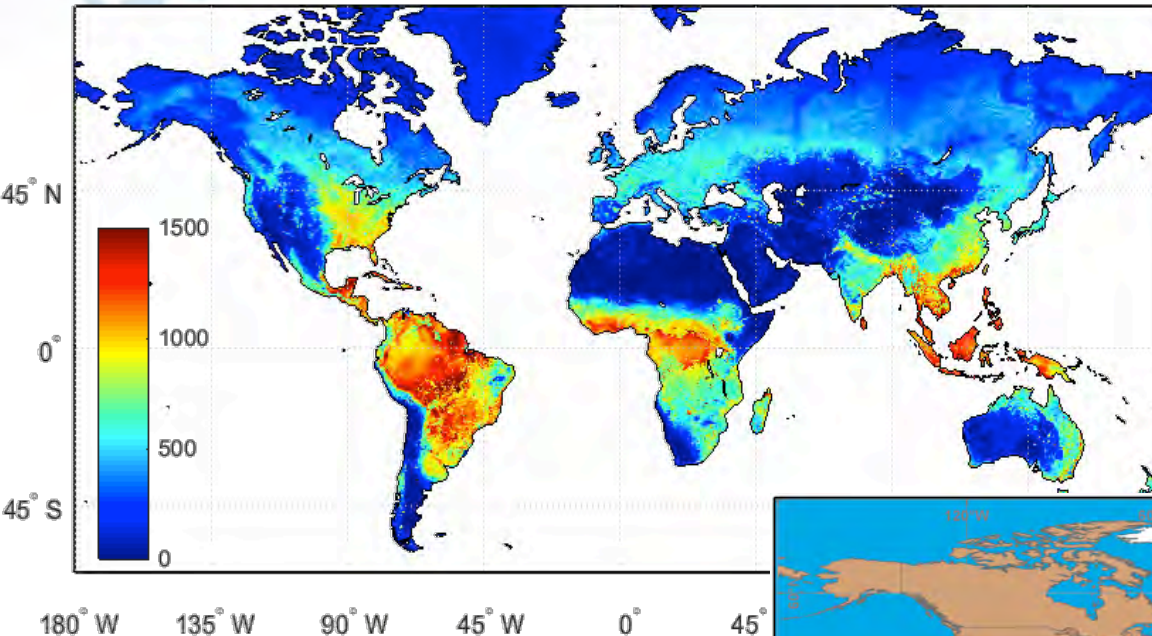


Research/Projects Highlights



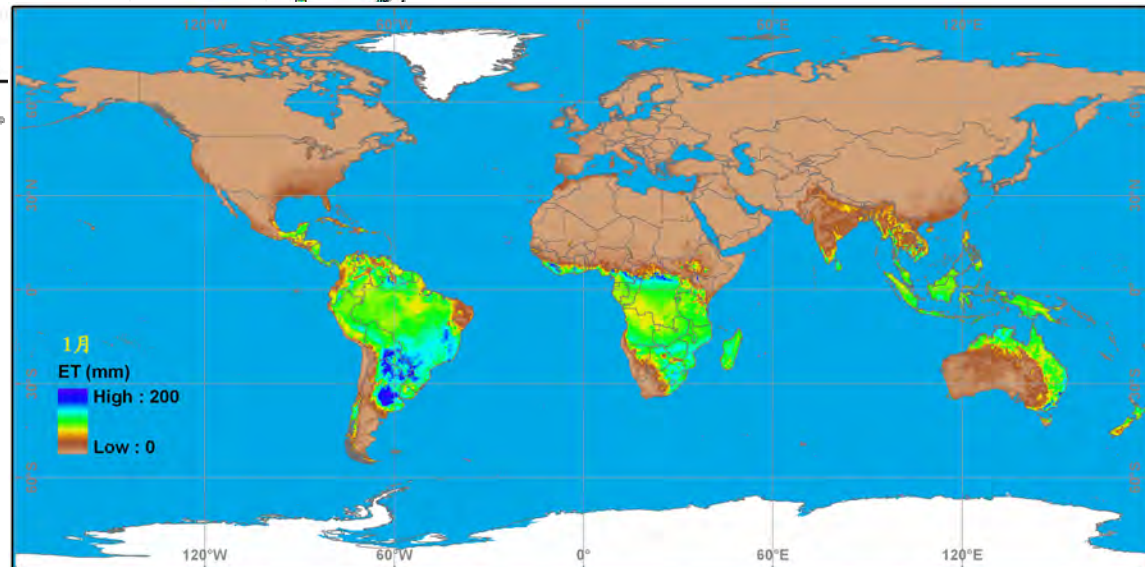
Global Evapotranspiration from ETMonitor ETMonitor Global ET Product

- @ daily temporal scale
- @ 1km spatial resolution
- @ global coverage



Yearly mean ET over 2008-2013,
1km spatial resolution

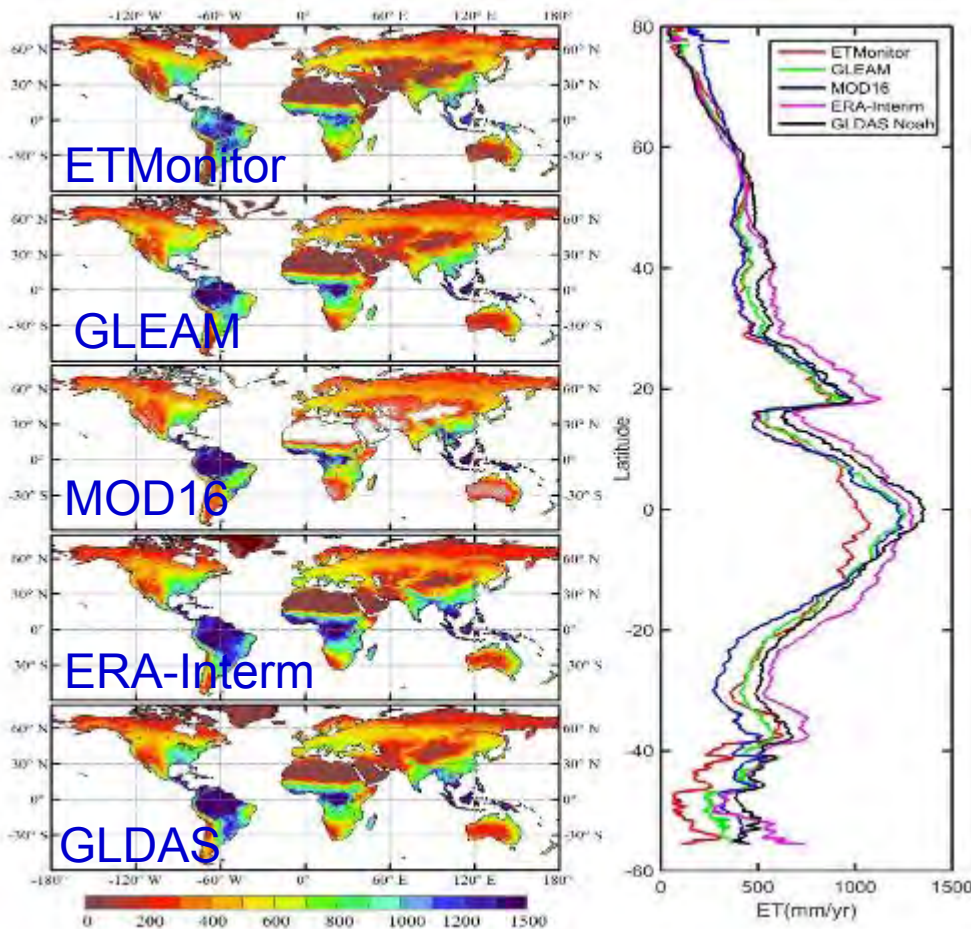
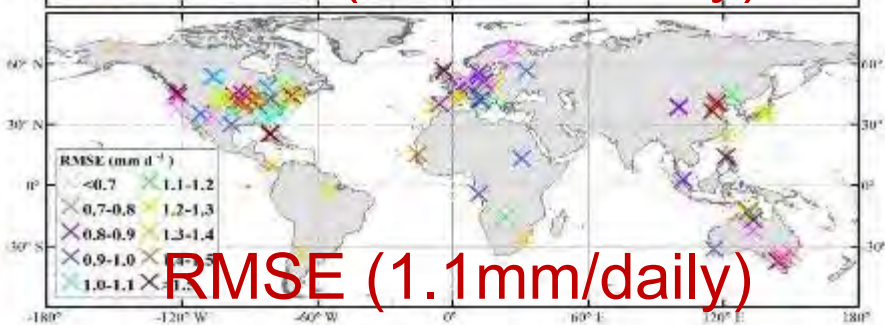
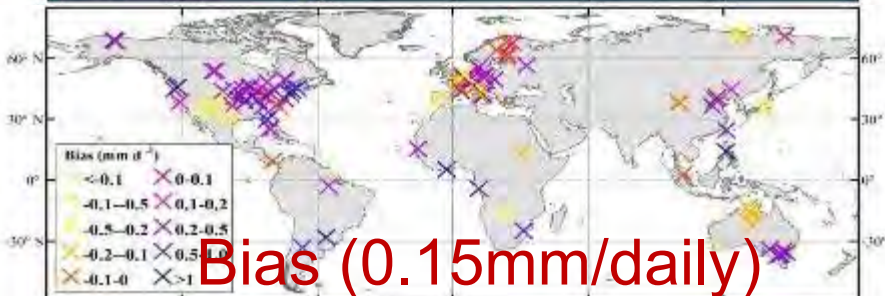
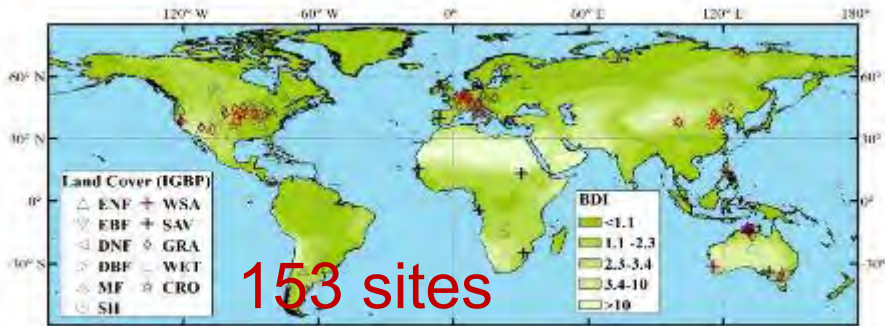
Monthly mean ET over 2008-2013,
1km spatial resolution



Research/Projects Highlights

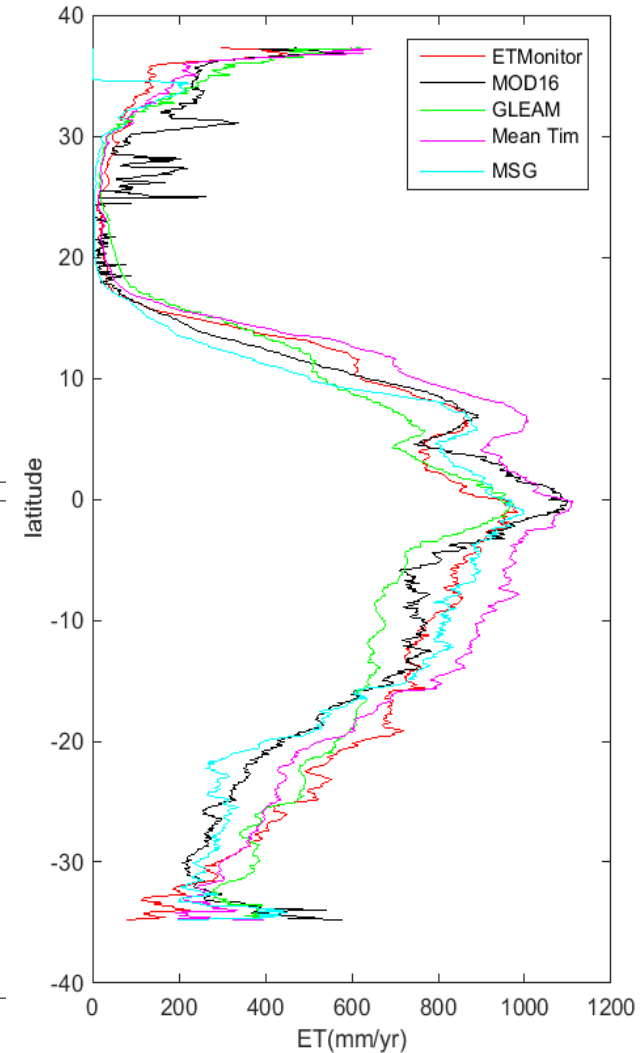
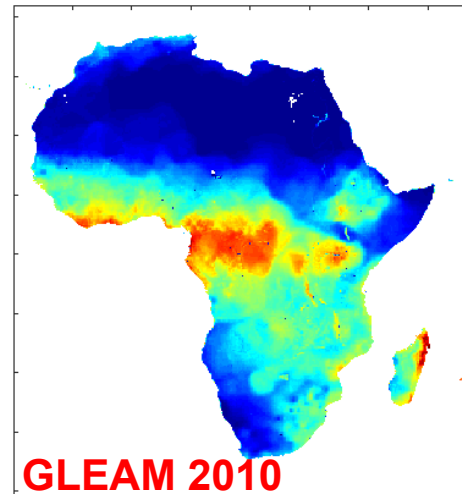
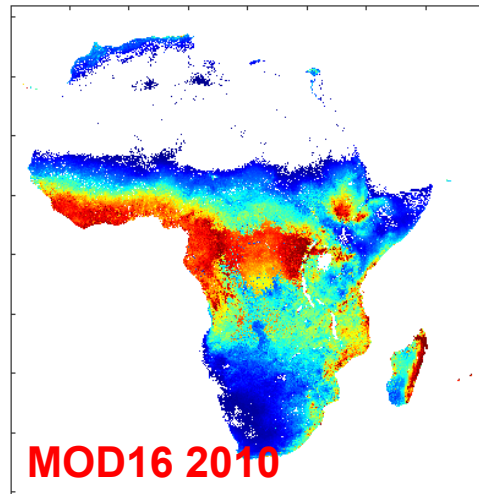
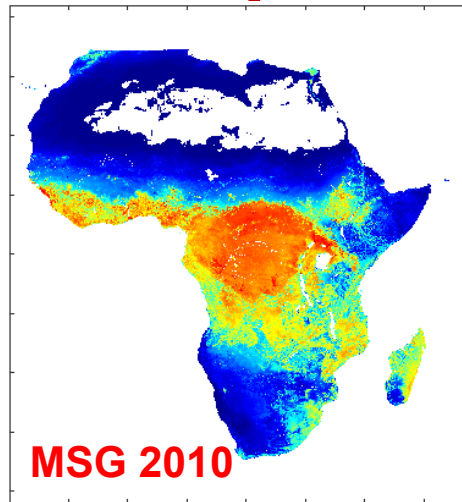
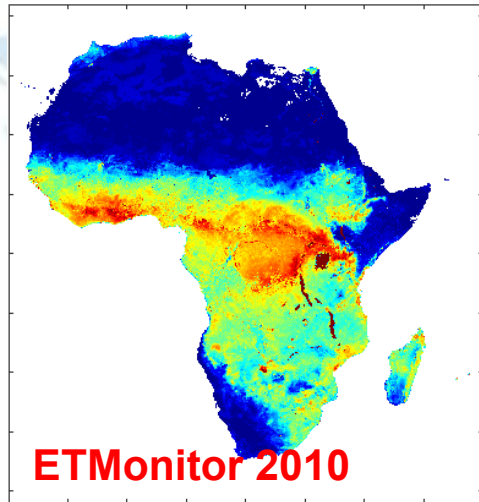


Global Evapotranspiration from ETMonitor



Research/Projects Highlights

Evapotranspiration from Remote Sensing: Intercomparison

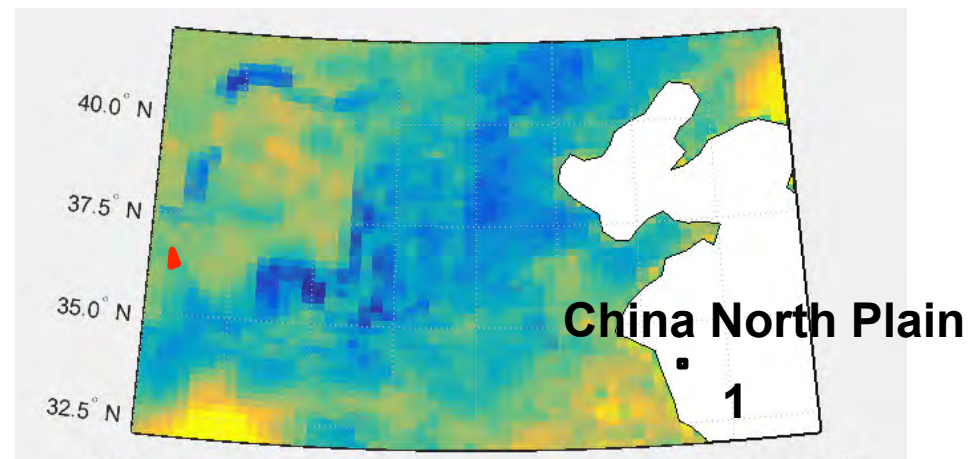
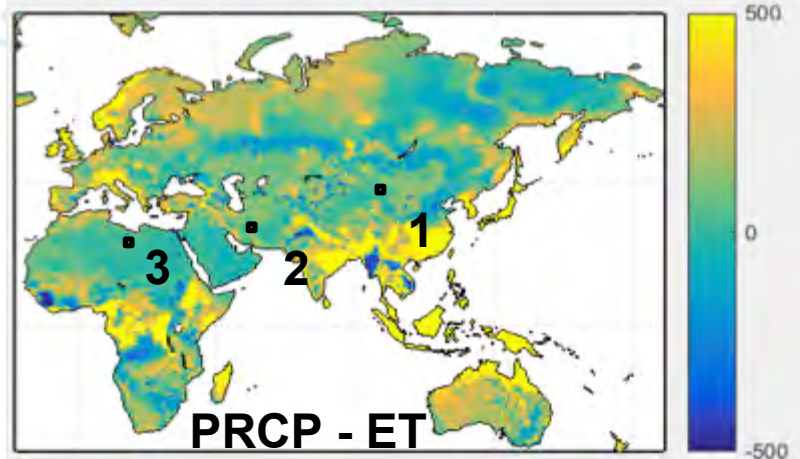


Research/Projects Highlights

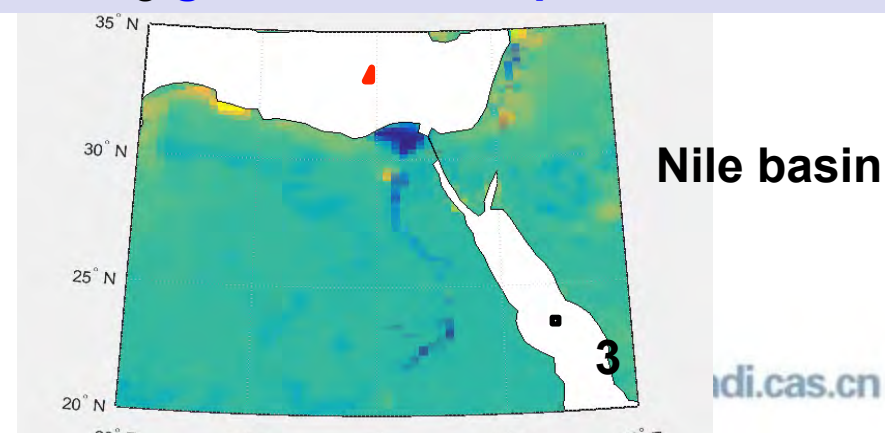
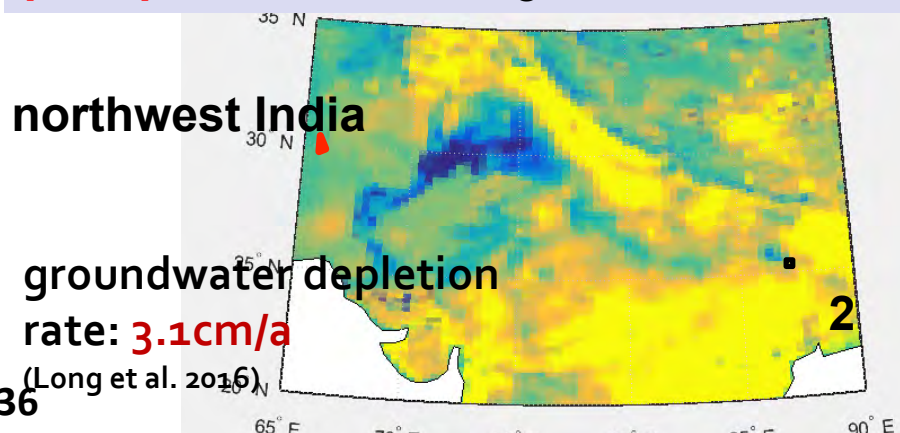


ET Based Water Resource Evaluation

PRCP – ET reflects local water use and can be applied to detect water depletion



Very low PRCP – ET value can be found in many agriculture regions, e.g. north China, northwest India, lower reach of the Nile basin, where **ET exceeds precipitation**, indicating **surface water** use or using **groundwater depletion**.

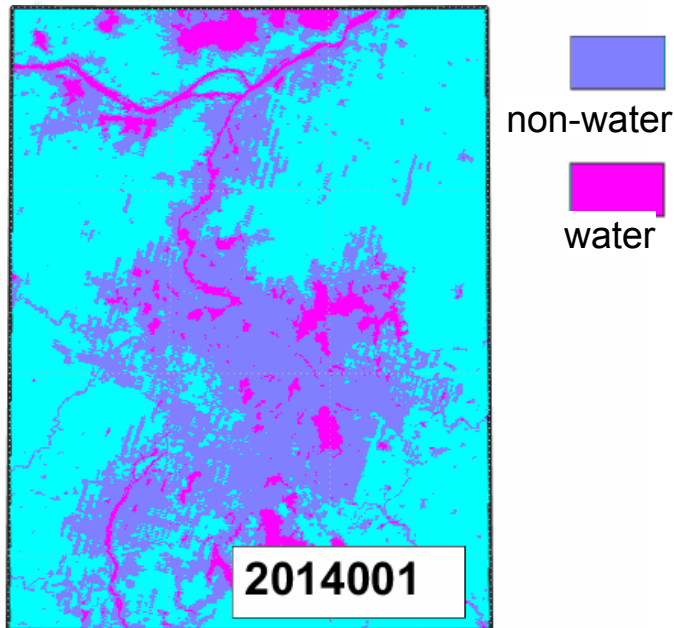


Research/Projects Highlights

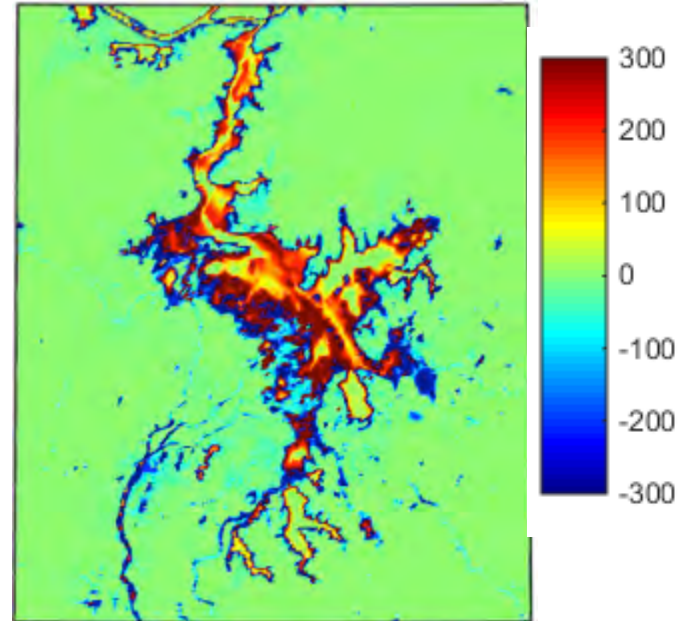


ET vs Dynamic Lake Area

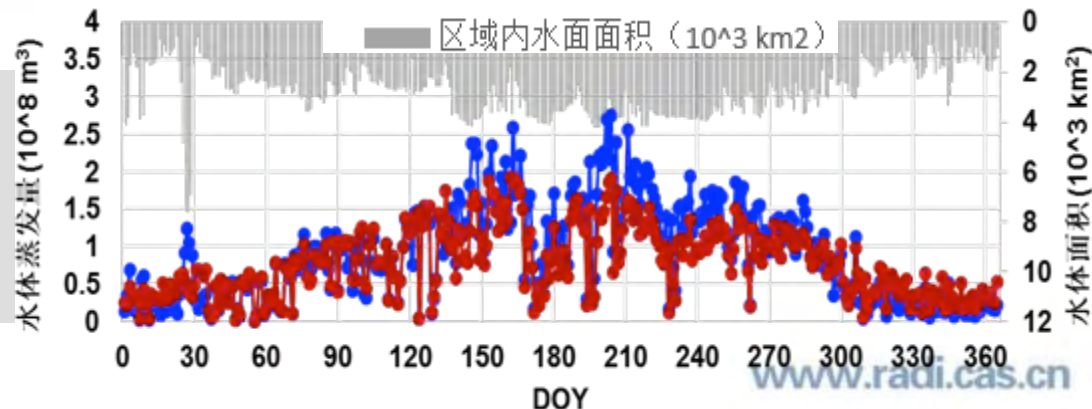
Poyang Dynamic lake area, 2014



ET(dynamic) – ET (static) (mm/yr)

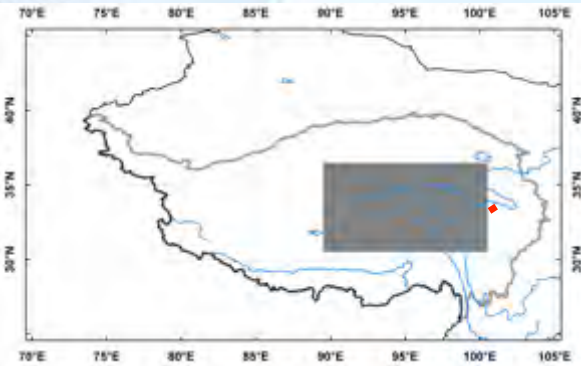


ET from Lake Basin:
 $3.238 \times 10^{10} \text{m}^3$ (dynamic lake area);
 $2.872 \times 10^{10} \text{m}^3$ (static lake area).
Relative bias: 12%.

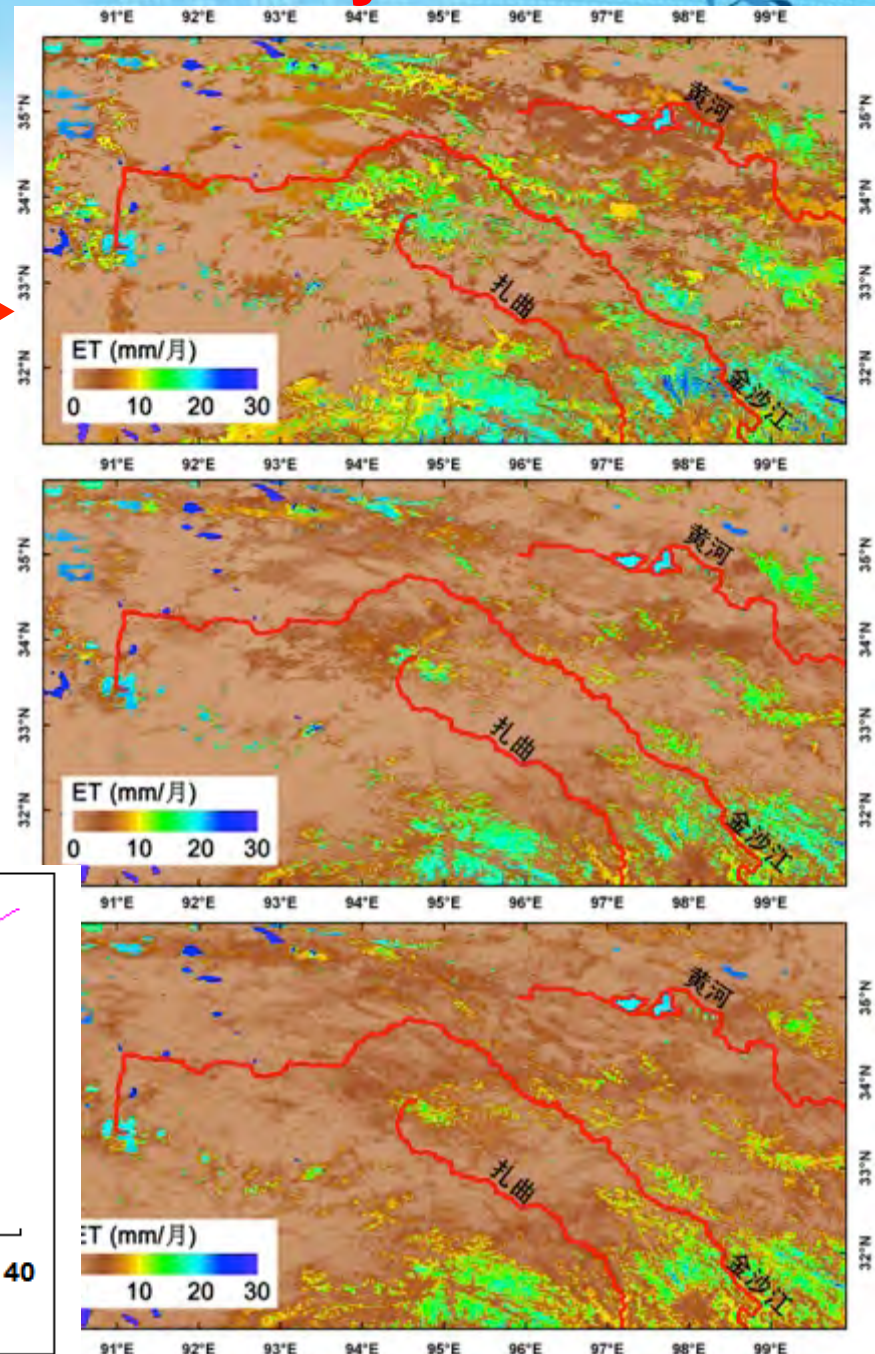


ET vs Snow Cover

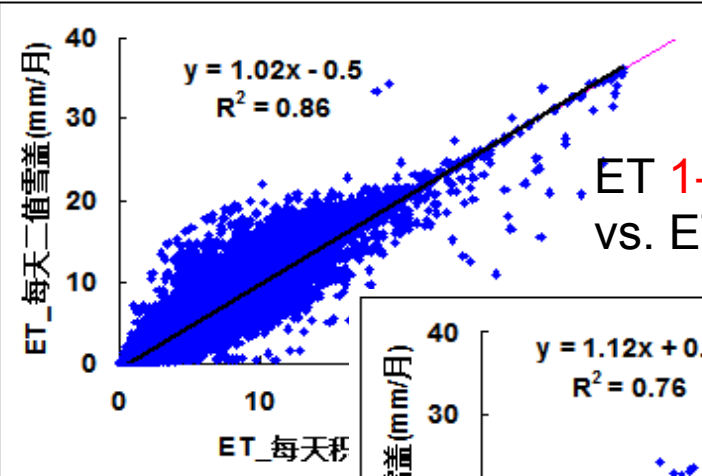
January 2010



Headwater Area of Three Rivers on TP

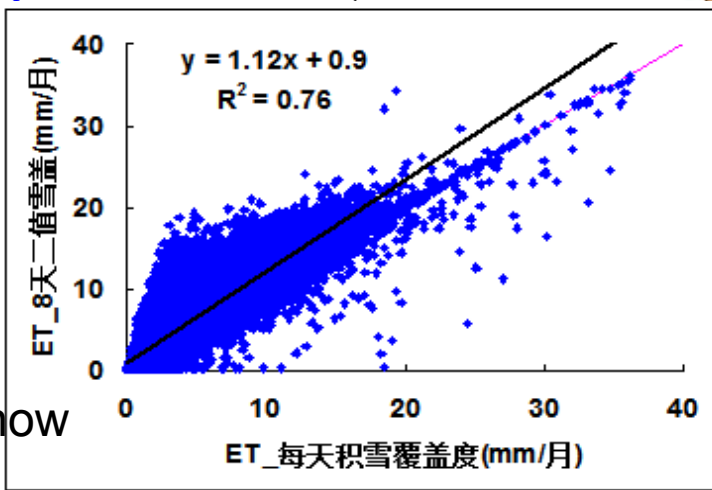


Impact of snow cover on ET estimate



ET 1-day SC vs. ET 1-day Fsnow

ET 8-day SC vs. ET 1-day Fsnow



Research/Projects Highlights



3- Project funded by NSFC-UNEP:

Driving Mechanisms of Land Use and Cover Change in the Sahel: Impacts and Responses (DIMECLUES)

Period: 2017 – 2021;

PI: Li Jia (RADI-CAS); Tsinghua Univ., IGSNRR, RCMRD, OSS, AGRHYMET

Objectives:

- Responses and impacts of land use and land cover (LULC) in the Sahel under climate and anthropic forcing
- Impact of Land Use and Cover Change (LUCC) on the water balance of the region
- Characterize climate forcing and land surface response using time series analysis of satellite data
- Ecosystem management for land and water conservation

Perspectives:

- Time series analysis of satellite data → from separate analysis of single signals to **cross-spectral analysis** to characterize processes and interactions;
- Detailed evaluation of **Land Use Land Cover Changes** across an extreme climate gradient
- Comparative evaluation of a global indicator of **water availability** and of detailed / local modeling of **water balance**
- Support better understanding of **land degradation** in the Sahel
- Information services towards adaptation of agriculture and water management systems

Research/Projects Highlights

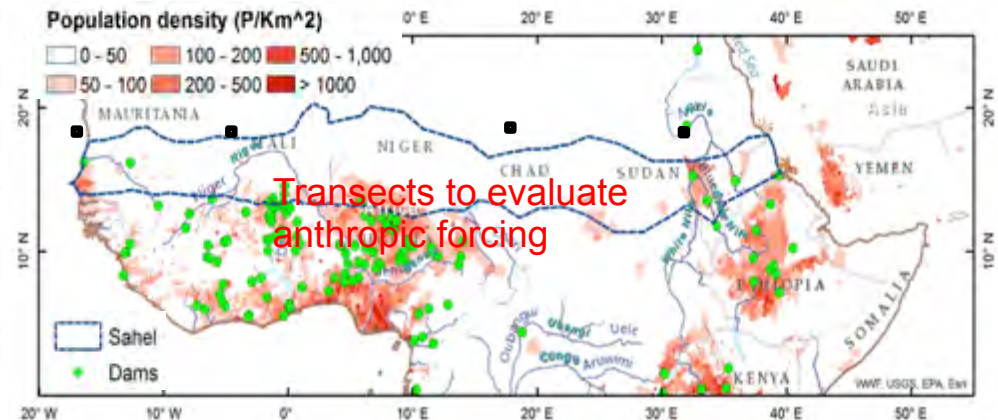


3- Project funded by NSFC-UNEP: *DIMECLUES*

- Extreme N – S climate gradient
- Land use determined by climate gradient with subtle local variability
- Large temporal variability
- Climate vs. anthropic forcing



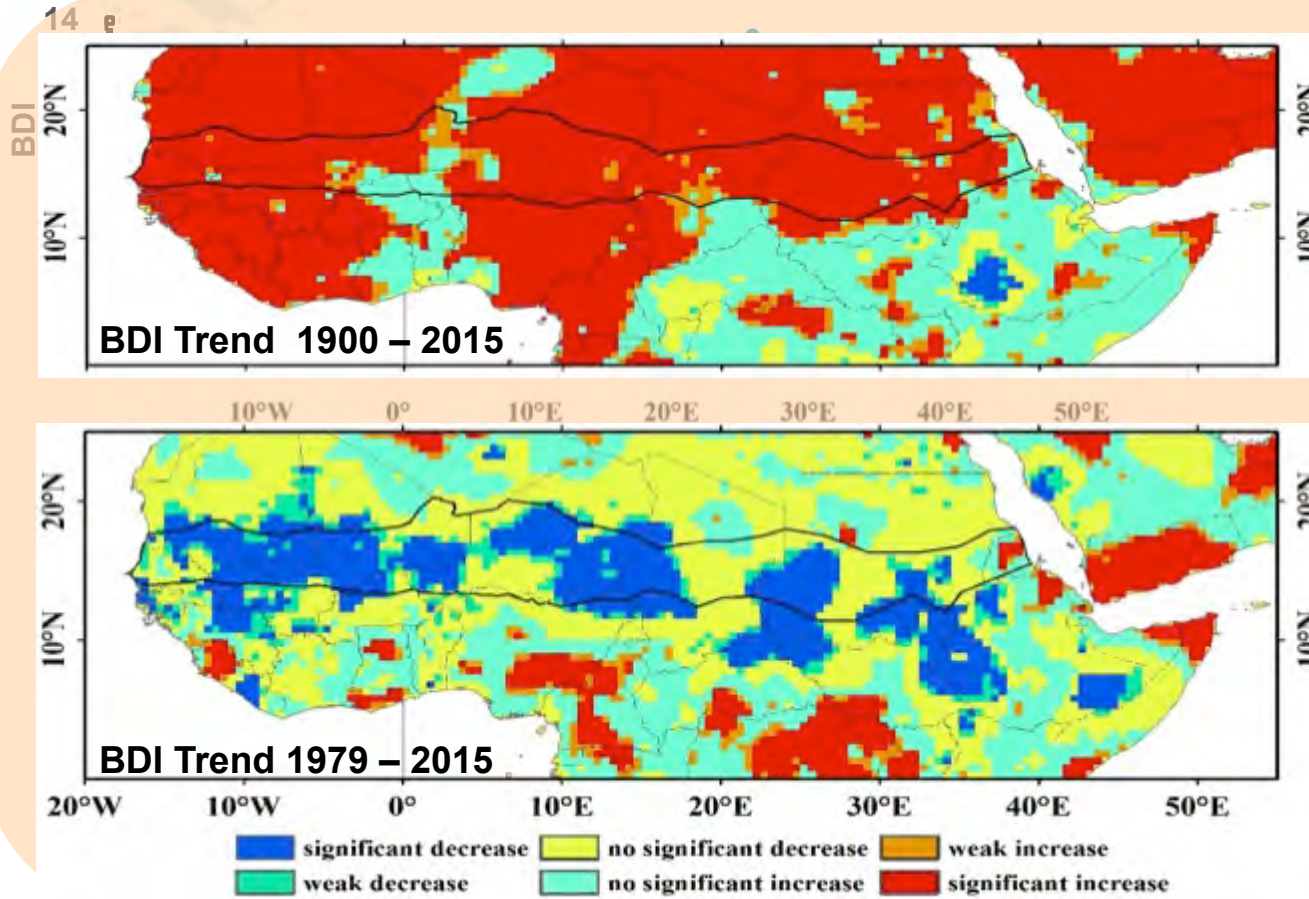
Land cover (UMD)



Research/Projects Highlights



3- Project funded by NSFC-UNEP: *DIMECLUES*



- ERA_20CM
- ERA_Interim
- University of Delaware

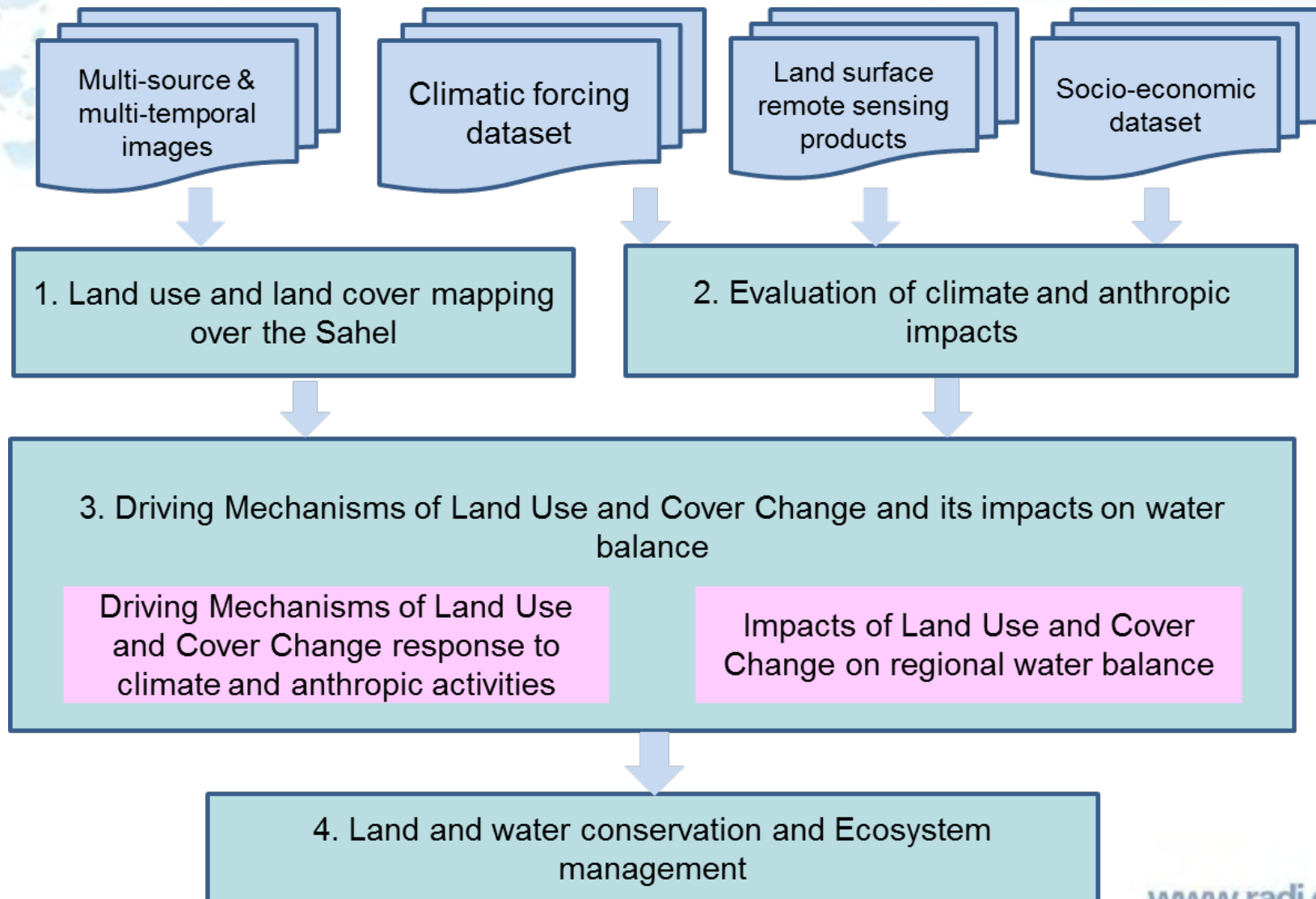
Budyko Drought Index

$$BDI = R_n / \lambda P$$

Research/Projects Highlights



3- Project funded by NSFC-UNEP: *DIMECLUES*



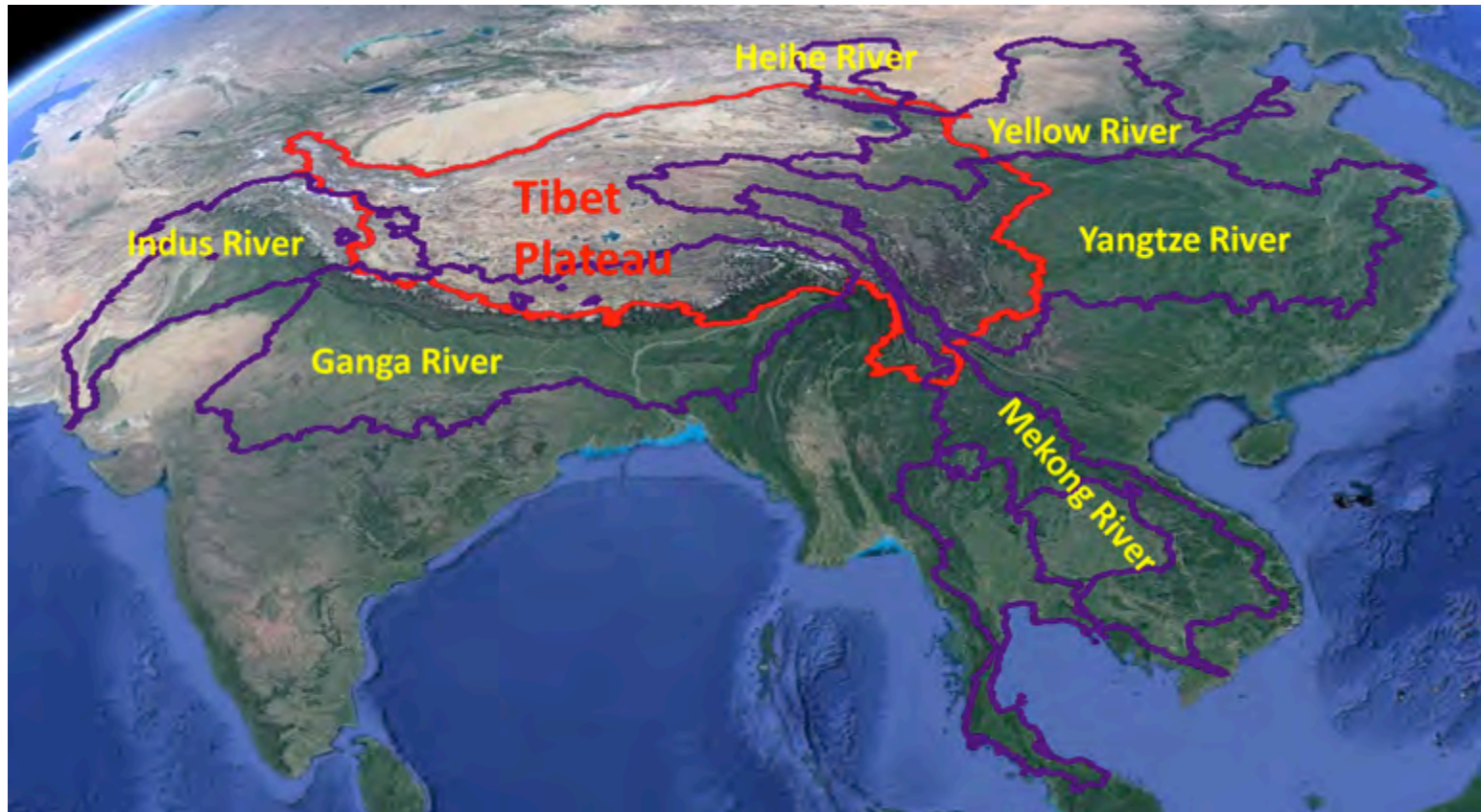
Research/Projects Highlights



4- Project funded by CAS (in cooperation with NASA):

High Mountain Asia Glaciers

- RADI + TPE + NIEER + IGSNRR
- 2016 - 2021



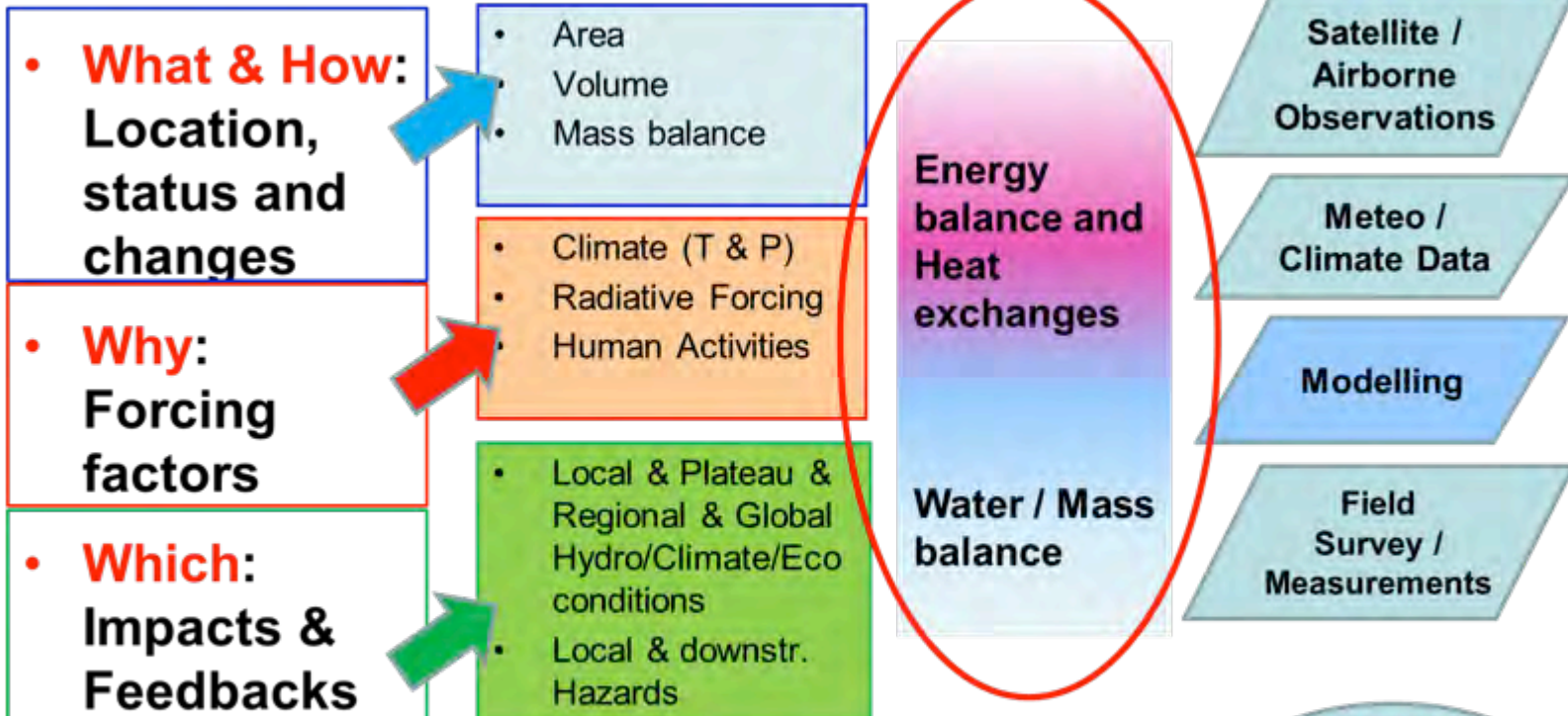
Research/Projects Highlights



4- Project funded by CAS (in cooperation with NASA):

High Mountain Asia Glaciers

High Mountain Asia (HMA) Glaciers



- Observing and Modeling Land Surface Energy and Water Balance in High Elevation Asia Using Satellite Data**

Research/Projects Highlights



4- Project funded by CAS (in cooperation with NASA):

High Mountain Asia Glaciers

- **Forcing:**
 - Net Radiation
 - Precipitation (distinguish snowfall and rainfall)
- **Surface status and processes:**
 - Albedo (energy)
 - Land surface Temperature (LST)
 - Soil Moisture
 - Snow Cover
 - Freeze/Thaw Status
 - Lake area
 - Glacier area and thickness change
 - Evapotranspiration

- **Observing and Modeling Land Surface Energy and Water Balance in High Elevation Asia Using Satellite Data**

Research/Projects Highlights



5- Project funded by FAO:

Using Remote Sensing in Support of Solutions to Reduce Agricultural Water Productivity Gaps

- UNESCO-IHE, RADI-CAS, etc; 2015 - 2018

• **Project components**

1. Database (FAO/"FRAME" consortium)
2. Water and land productivity assessment
3. Water accounting
4. Capacity development and outreach to farmers

• **Database at a glance:**



Database structure: Continental level (250 m ground resolution), Country / River Basin level (100 m), Scheme / Sub-basin level (30 m). **Variables:** Water productivity, land productivity, actual and reference evapotranspiration, land use, biomass, harvest index, precipitation, carbon dioxide uptake.

Countries (II level): Morocco, Tunisia, Egypt, Lebanon, Syrian Arab Republic, Jordan, Ghana, Kenya, South Sudan, Mali, Benin, Ethiopia, Rwanda, Burundi, Mozambique, Uganda, West Bank & Gaza Strip and Yemen. **Irrigation scheme / sub-basin (III level) - tentative:** pilot areas to be selected in the Jordan / Litani River Basin, Nile Delta, Awash River Basin, Niger inner Delta.

谢谢！



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