Team Projects at the International Space University Relating to Water Management

Presented by
Elisabeth Ackerler, M.Sc. In Space Management
and
Ola Abraham, M.Sc. In Space Management

Agenda

1. International Space University
2. SAOTEC
3. STREAM
4. Conclusion

International Space University

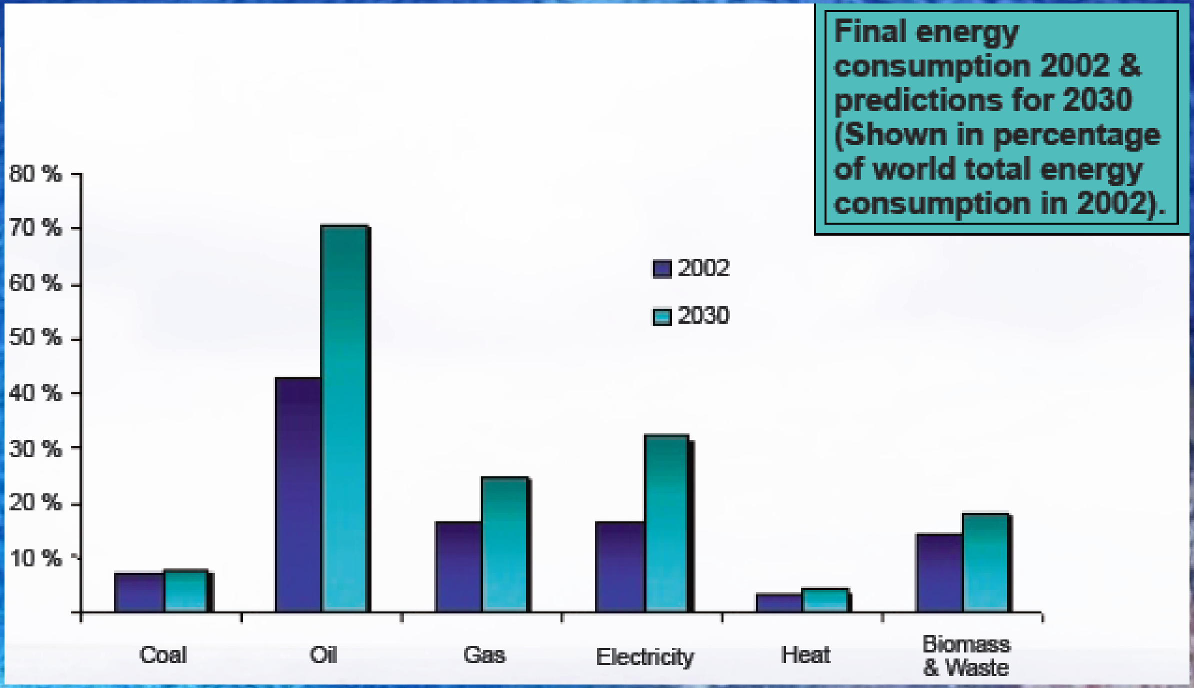
- Interdisciplinary, International, Intercultural
- Foremost Space University
- M.Sc. in Space Studies (MSS)
- M. Sc. in Space Management (MSM)
- Summer Session Programme (SSP)
- High Points of Program
  - →Team Projects
  - →Independent Project
  - →Space Industry Internship

International Space University – Parc d'Innovation – F-67400 Illkirch-Graffenstaden
www.isunet.edu

Space Aided Ocean Thermal Energy Conversion (SAOTEC)

- Space Aid for Energy, Environment and Economics (SAFE[3])
- MSS/MSM 05

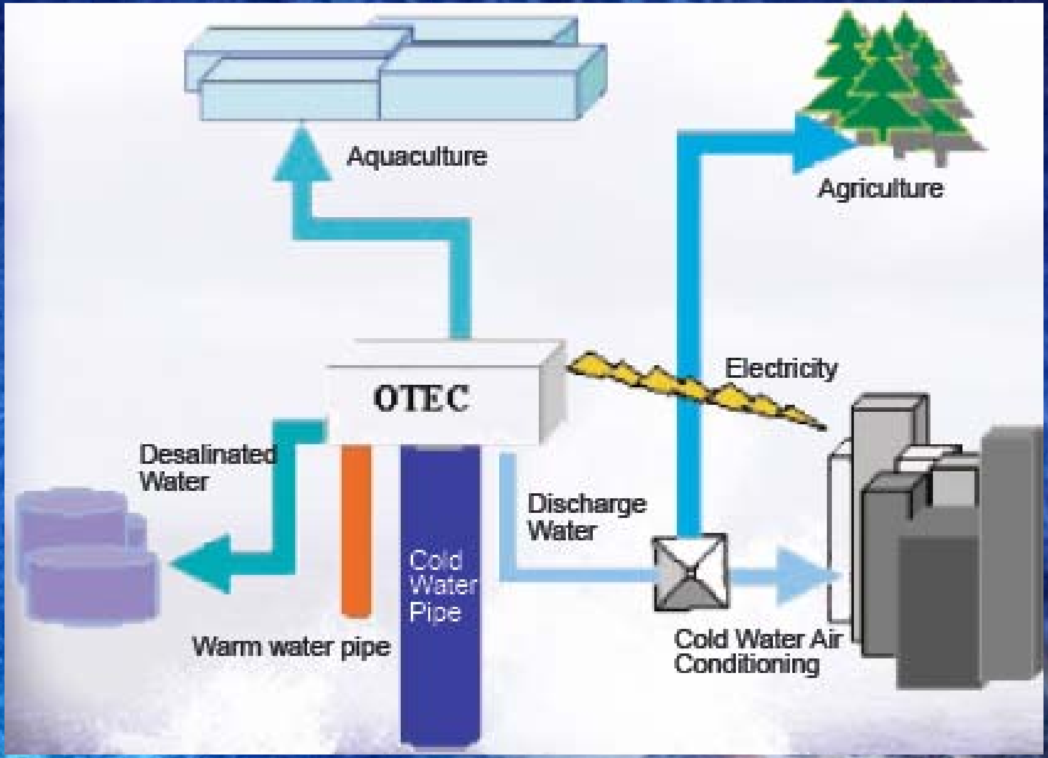
World Energy Situation



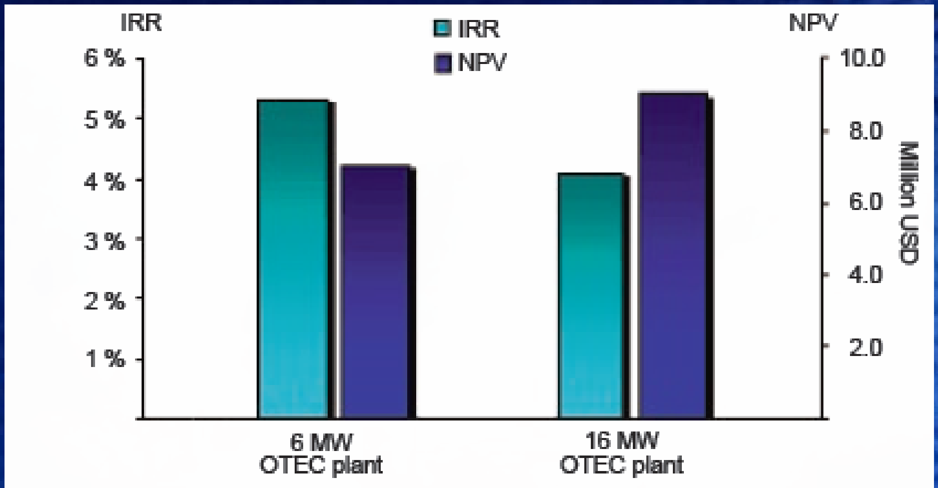
International Energy Agency: World Energy Outlook 2004

Technical Concept

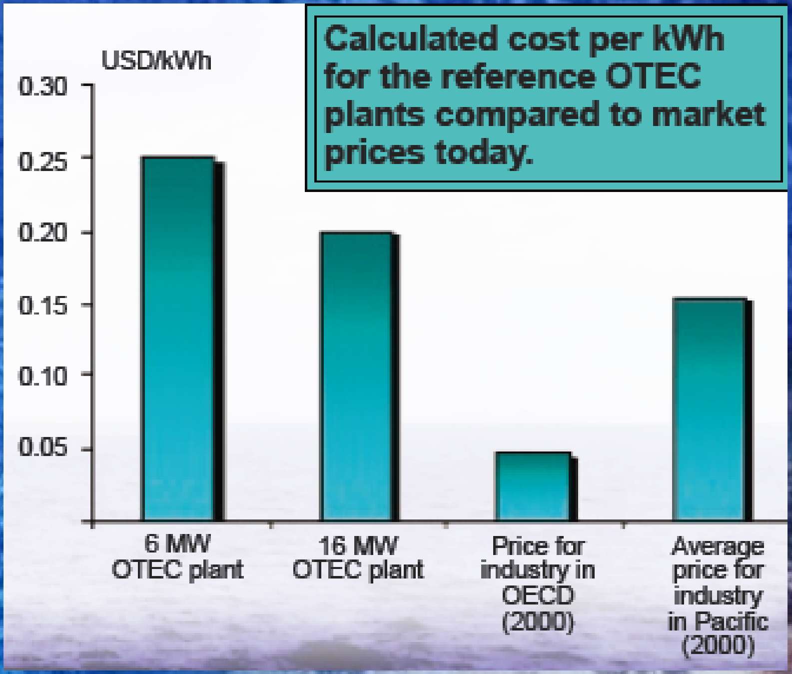
- Surface and Deep Water Temperature difference
- Electricity, Desalinated Water, Hydrogen, Ammonia Aquacultural Food, and Minerals
- Study: 6MW, 16MW



Economic Feasibility (OTEC)



Calculated Net Present Value (NPV) and Internal Rate of Return (IRR) for the reference 6 MW and 16 MW OTEC plants.

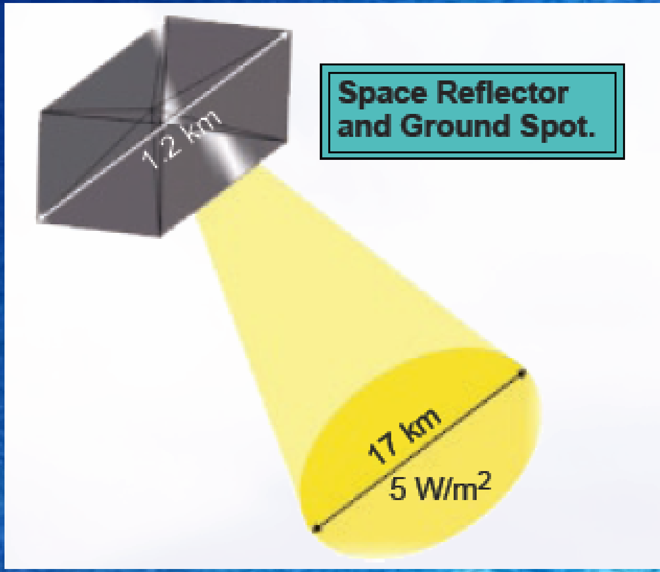


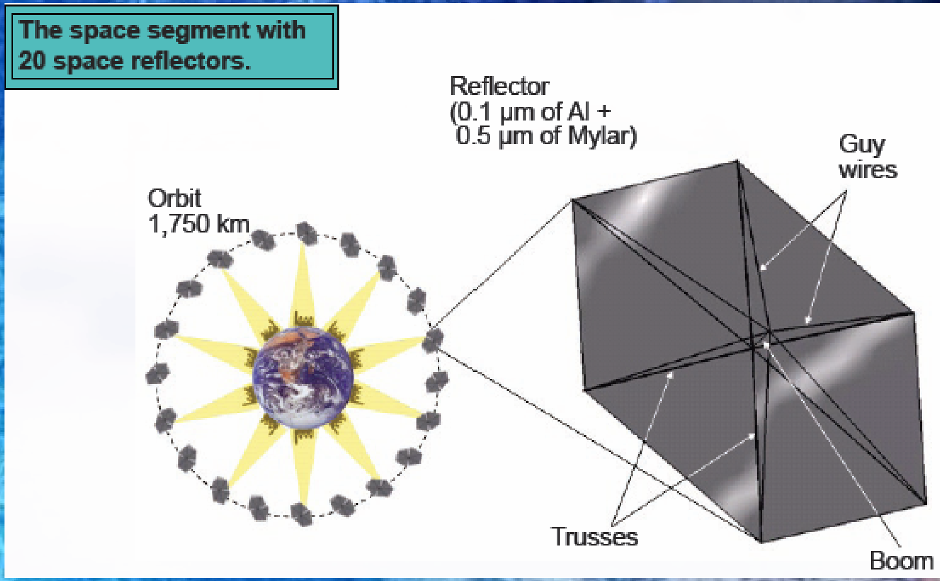
NPV & IRR: Too small to attract private investors

→ Concentrate on By-products

The Space Reflector

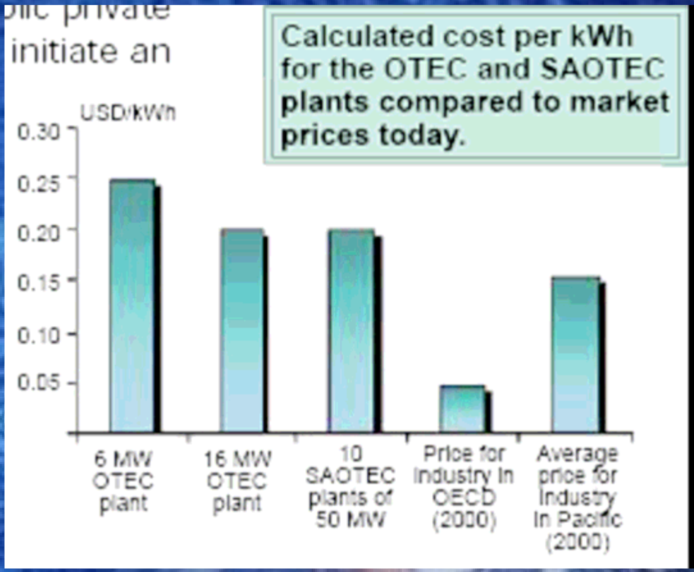
- Increase the temperature of the ocean surface water (from 40 °C to 60 °C)
- Constellation of 20 space reflectors: altitude: 1,750 km, cost: $377m development + 177m construction/reflector (cost estimated using the PRICE cost estimation model)
- 10 SAOTEC plants: 16 → 50 MW

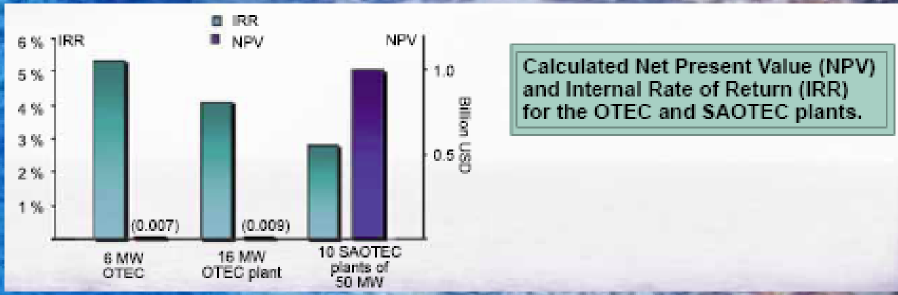




Economic Feasibility (SAOTEC)

- Cost per kWh: 10 (50MW) SAOTEC = OTEC 16 MW
- High Investment Cost needed
- High Level of Risks
- IRR & NPV: Not high enough to attract private investors
- Future Development of the space reflector and reduction of launch costs will improve financial results
- Funding will be required from governments, international organizations
- Again, public private partnerships will be needed to initiate the project





Water Related High Points

Parameters	16 MW OTEC	50 MW SAOTEC
Temperature difference	36 °C	56 °C
Net power output	16 MW	50 MW
Desalinated water output	36,000 m^3/day	67,000 m^3/day
Warm water mass flow rate	10 m^3/s	10 m^3/s
Cold water mass flow rate	17 m^3/s	43 m^3/s

Desalinated Water Output for 16MW OTEC = 36,000 m^3/day

Desalinated Water Output for 50MW SAOTEC = 67,000 m^3/day

Concerns

SAOTEC

Environmental

+ No greenhouse gases

+ Reduced amount of carbon dioxide (CO_2)

+ Transportation of nutrient rich water from the ocean depth to the surface → growth of phytoplankton and micro-algae: convert CO_2 into oxygen via photosynthesis

- Spillage or over-release of chemical biocides may occur

- Heating of water

- light from the space reflector → ecosystems

Ethical

-/+ Reaction of local communities

- Space reflector: Interference with astronomical observations

- Constant light

- Atoll → warm water reservoir

Legal

- Lack of regulation (only US)

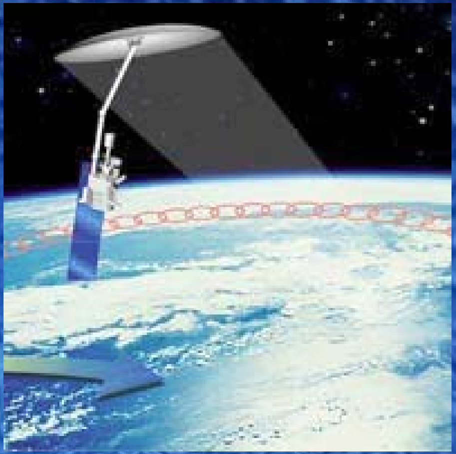
+ Compliance with established international treaties (WTO regulations, space law)

STREAM

Presentation Overview

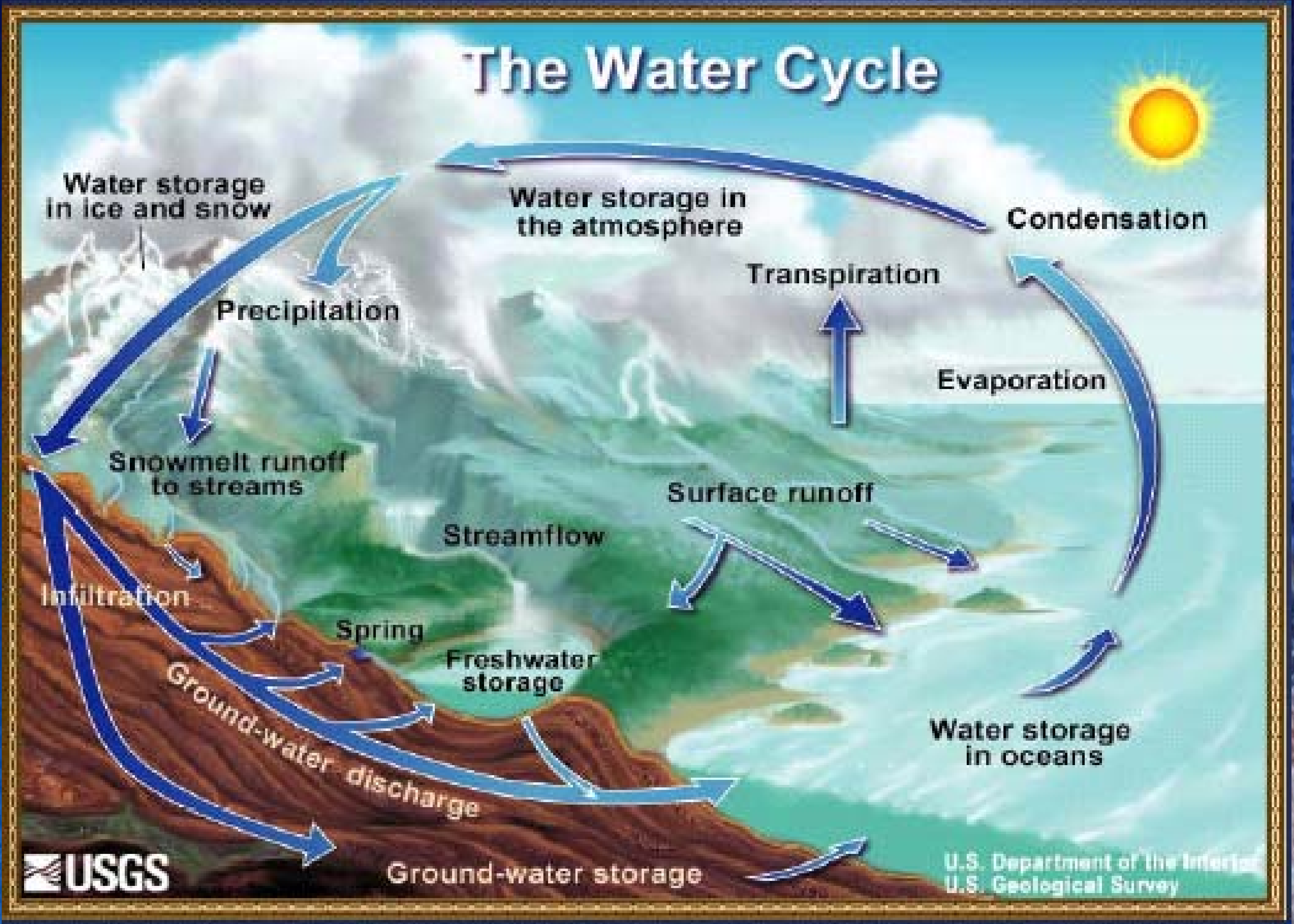
- Team Project Mission
- The Global Water Cycle
- Murray-Darling Basin - Weather, Climate and Environment
- Space Technologies for Water Management
- Soil Moisture Monitoring in the MDB
- Outreach Outreach
- Conclusions & Recommendations

STREAM Mission



To assess the capability of space technology to enhance water resource management.

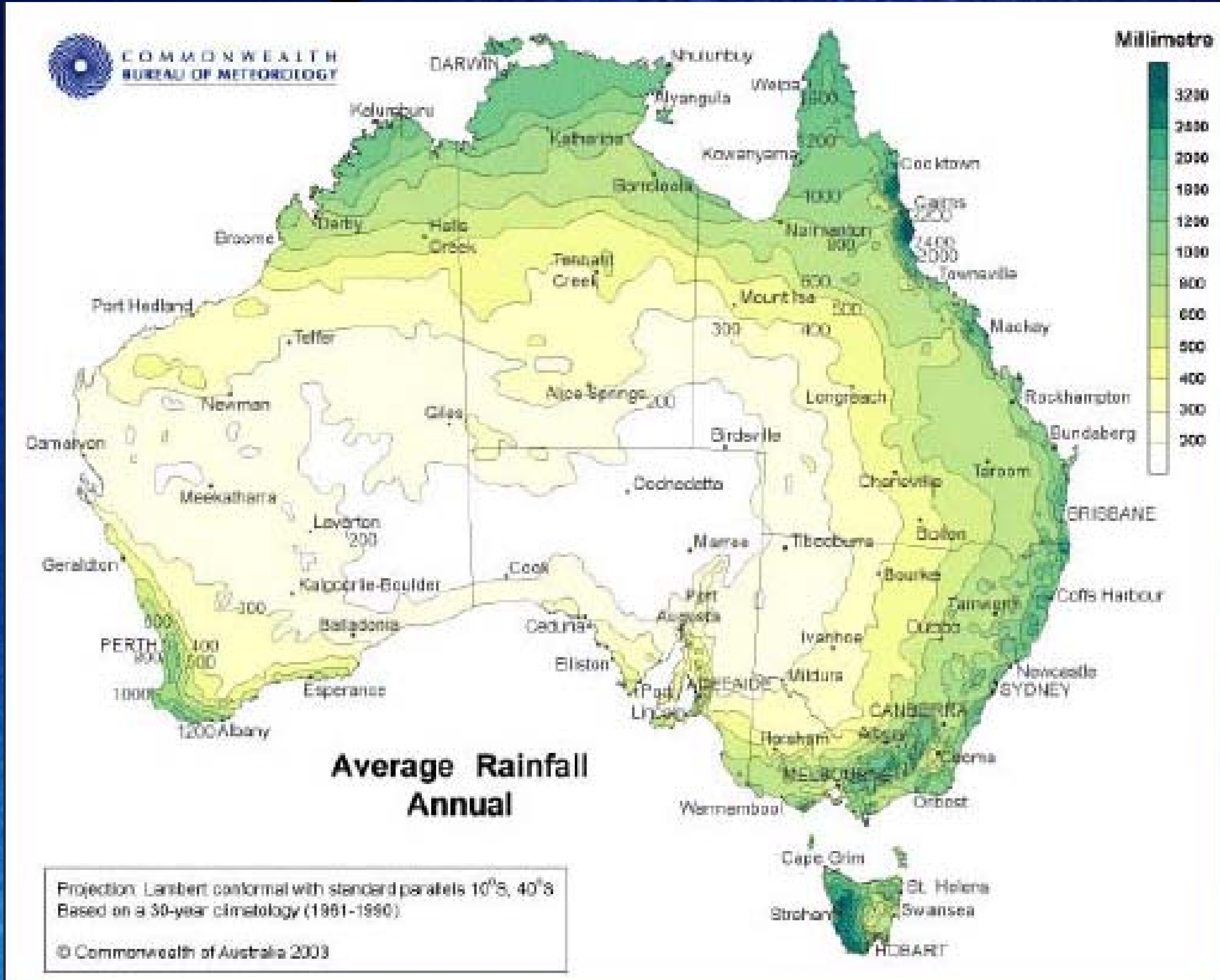
The Global Water Cycle



Facts about the MDB

- Largest river system in Australia
- 14% of the Australian continent
- Catchment area: 1,057,000 km^2
- Total length 3 780 km
- Consists of three rivers: Murray, Darling and Murrumbidgee
- Population: 2 million
- 1.25M people outside basin depend on it for water supply
- Resources administered by MDB Commission
- 42% of Adelaide water (90% during draught) from MDB

Average Annual Rainfall



Credit: Commonwealth Bureau of Meteorology

Climate and Environment

- Cool Rainforests
- Temperate mallee country
- Subtropics
- Semi-arid country
- Arid country
- Wetlands & marshes
- Forests
- High alpine country

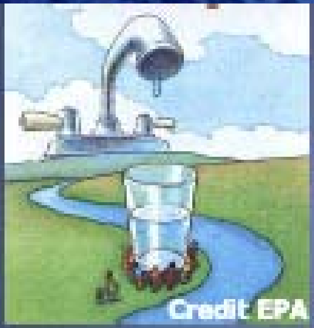
Floods in the Basin

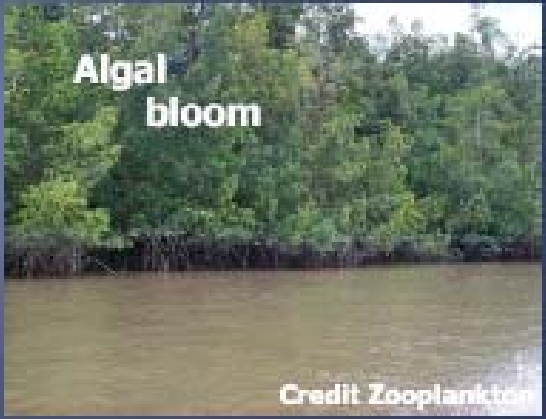
- Impact great areas
- Many small rivers rely on floods
- Two types of controlled flow
- Dams affect floods

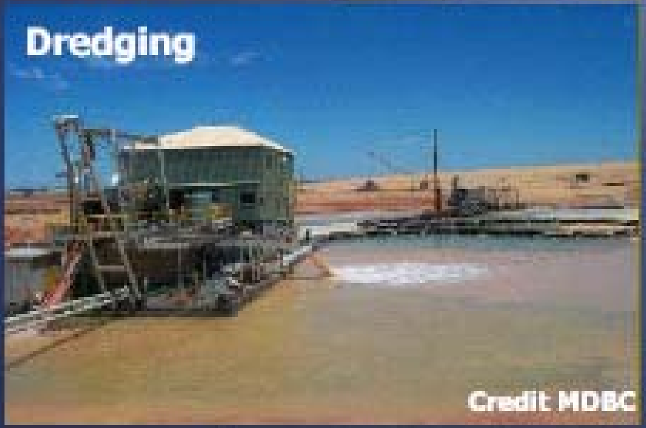
Credit MDBC

Water Quality

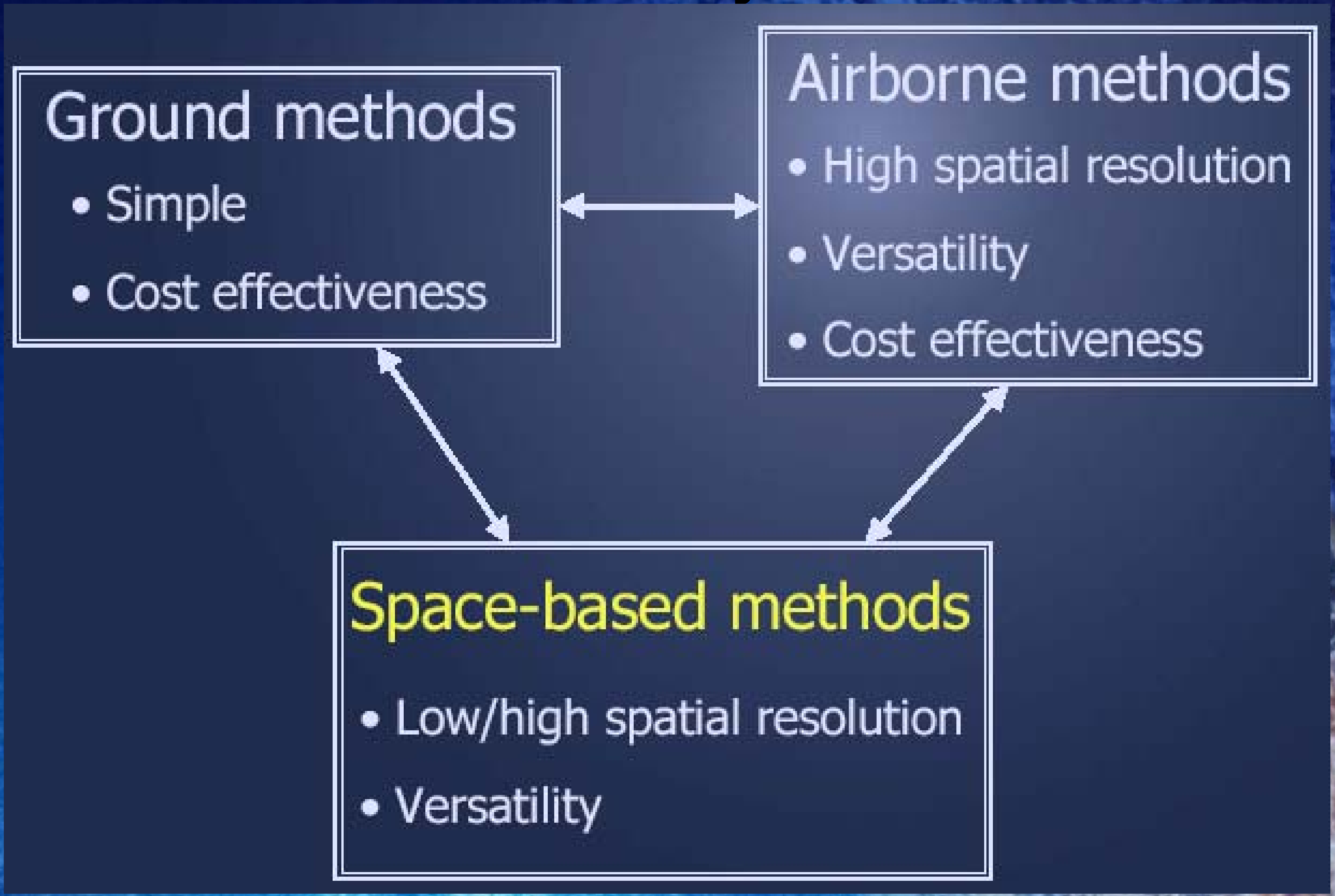
- Temperature
- Salinity
- Turbidity
- Nutrient load
- Pollution







RS Technologies for Monitoring the Water Cycle



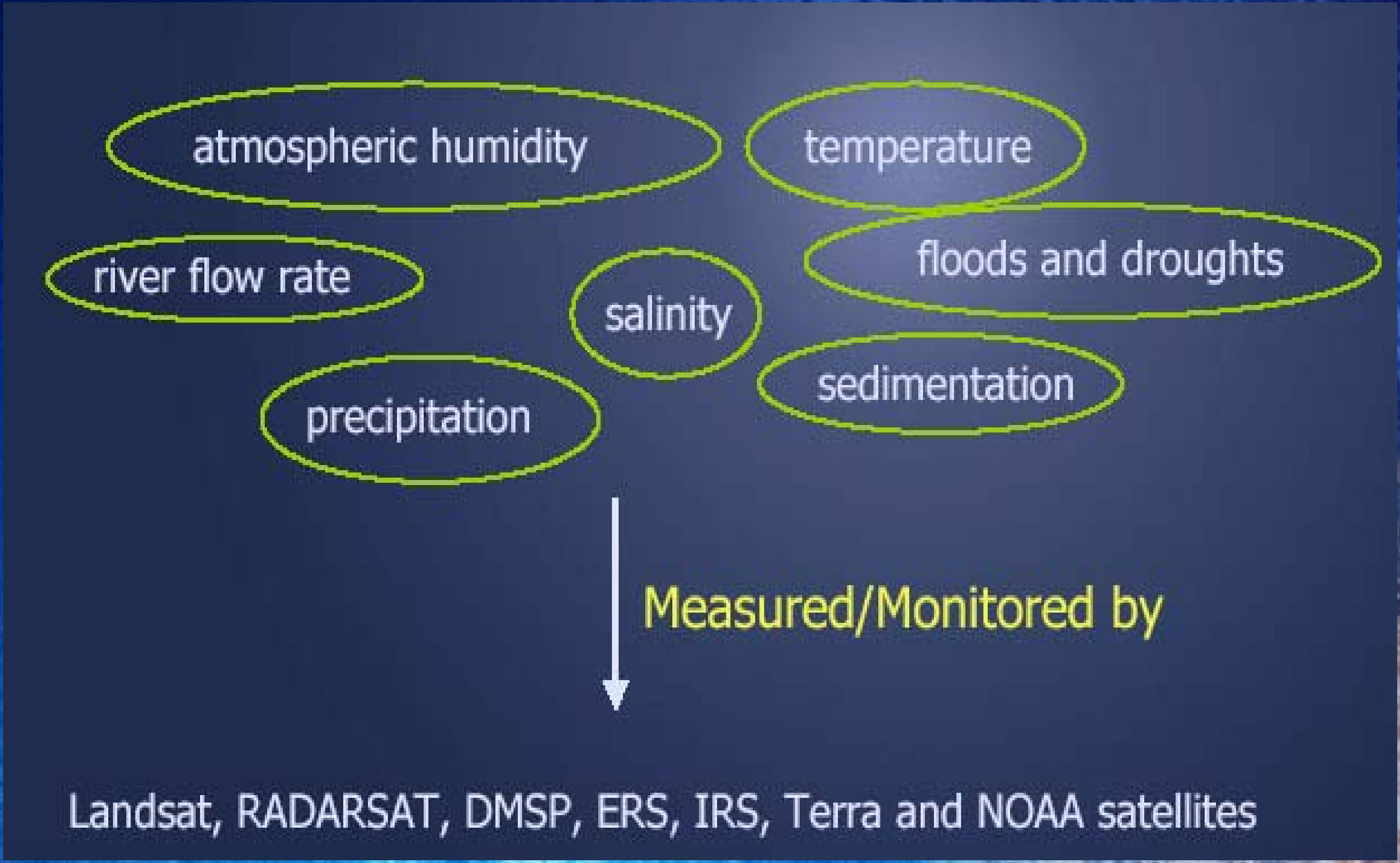
Space-based Technologies for Monitoring the Atmosphere

- Atmospheric Winds
- Cloud Cover
- Tropical Precipitation
- Geostationary Meteorological Satellites
- - Meteosat series, GOES, GMS, INSAT
- Atmospheric Humidity
  - DMSP Series, NOAA

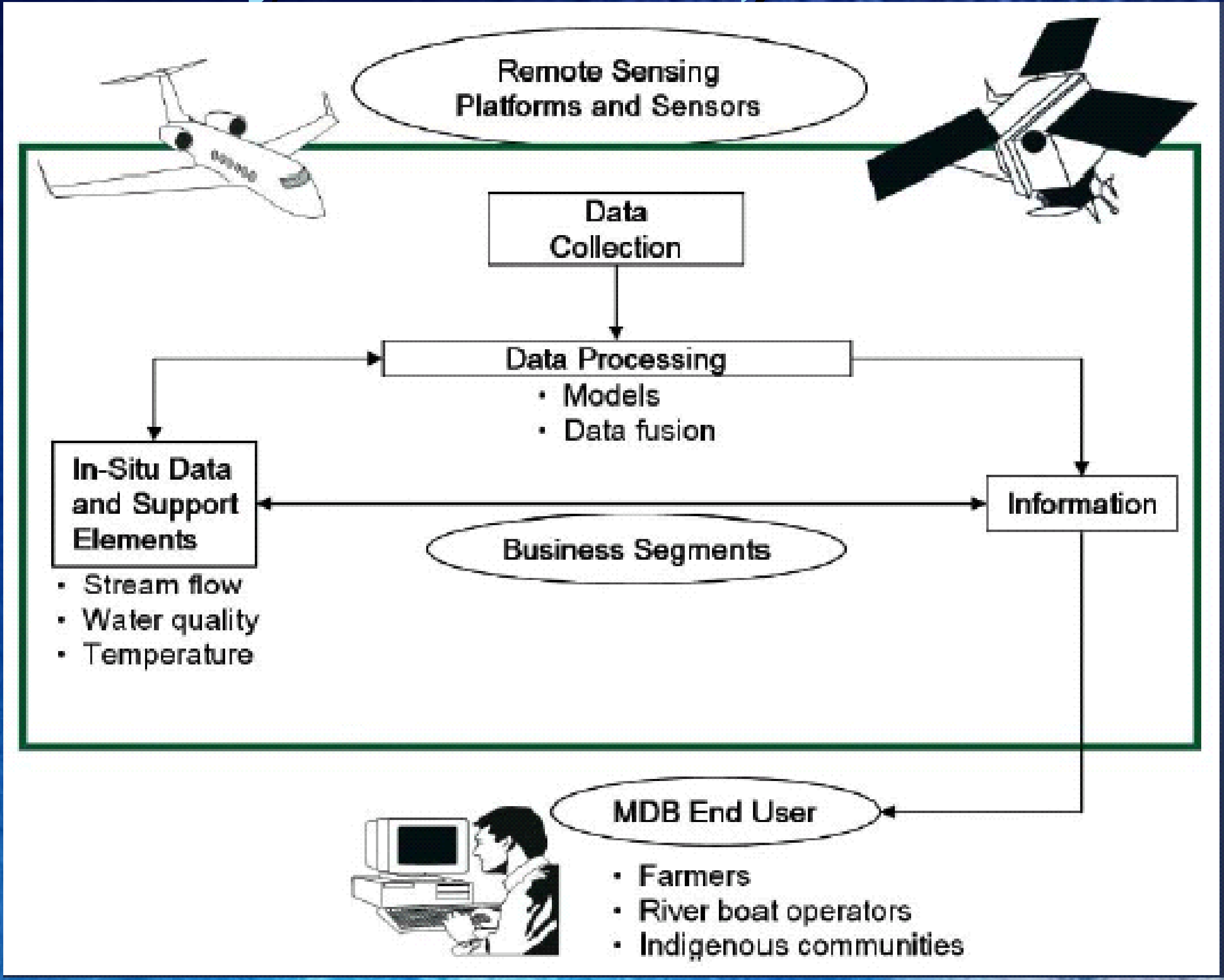
Space-based Technologies for Monitoring Land and Sea

- High resolution optical imagery
  - AVHRR-3 on NOAA-M
  - VEGETATION on SPOT-5
  - ETM+ on Landsat-7
  - MODIS on Terra, Aqua
- Imaging Radar
  - SAR on RADARSAT-1
  - ASAR on Envisat

RS Technologies for Monitoring Water Cycle in MDB



Getting information (Merged GIS and Remotely sensed data) to the end-user



Soil Moisture

- **Soil Moisture is a key parameter to**
  - Improving and Understanding the water cycle
  - Improving operational monitoring and prediction techniques for water management

Space Technology to Monitor Soil Moisture

- Current space-based systems provide good estimations of surface soil wetness
- Space techniques are not capable of performing direct measurements of the moisture throughout the profile below thin surface layer
- Soil moisture values are calculated through correlation techniques from ground, air-borne and space remote sensing instruments

Soil Moisture Monitoring from Space

- **Precipitation Radar**
  – Mainly for tropical rainfall but applicable for some soil moisture measurements
- **Passive Microwave Radiometer**
  – detects emissions from earth's s surface
- **Synthetic Aperture Radar (SAR)**

- Radar technique used to detect small changes in topography

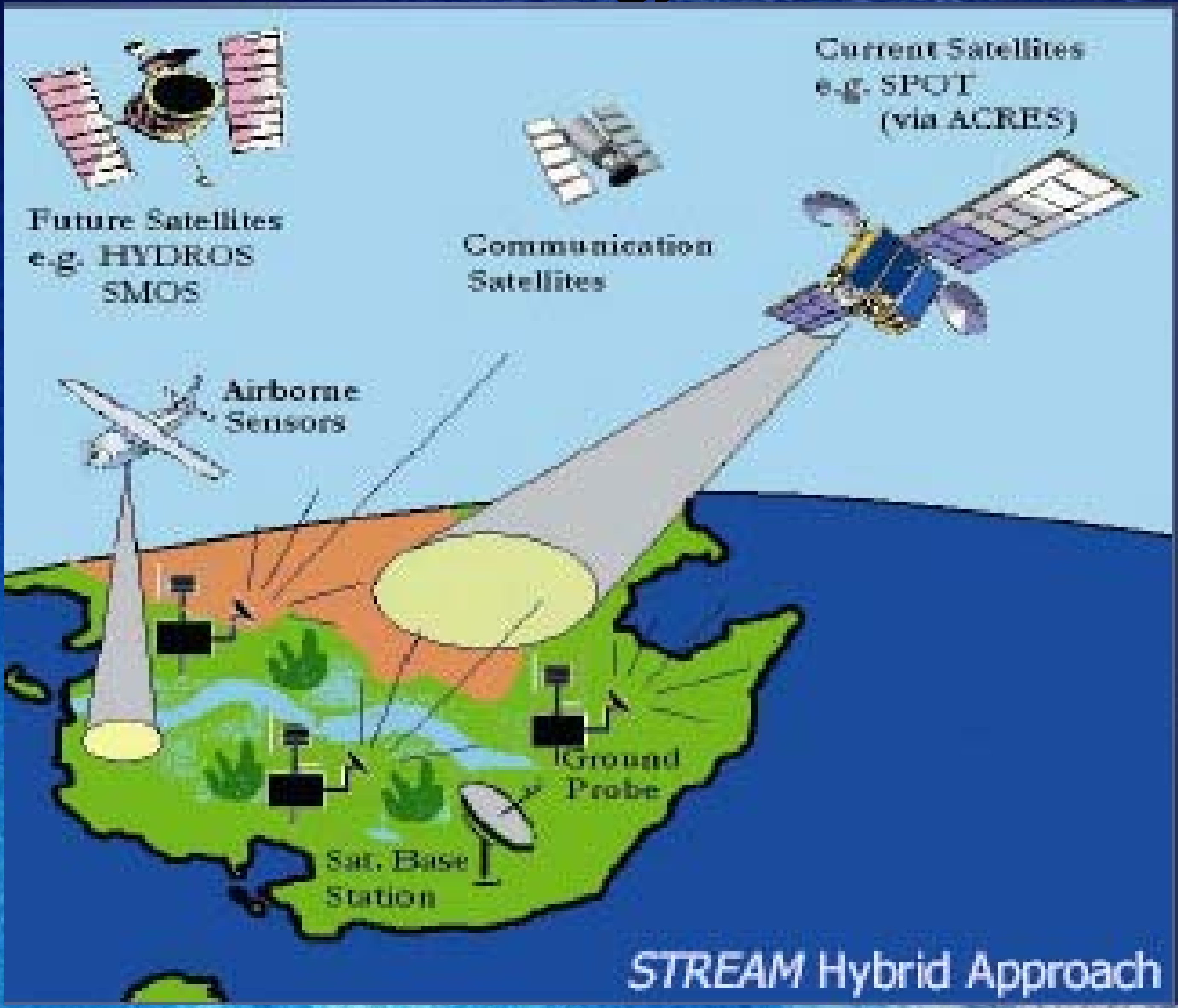
- Monitor deforestation and surface hydrological states

- Raw measurements do not correspond directly to soil moisture - processing with other variables is required

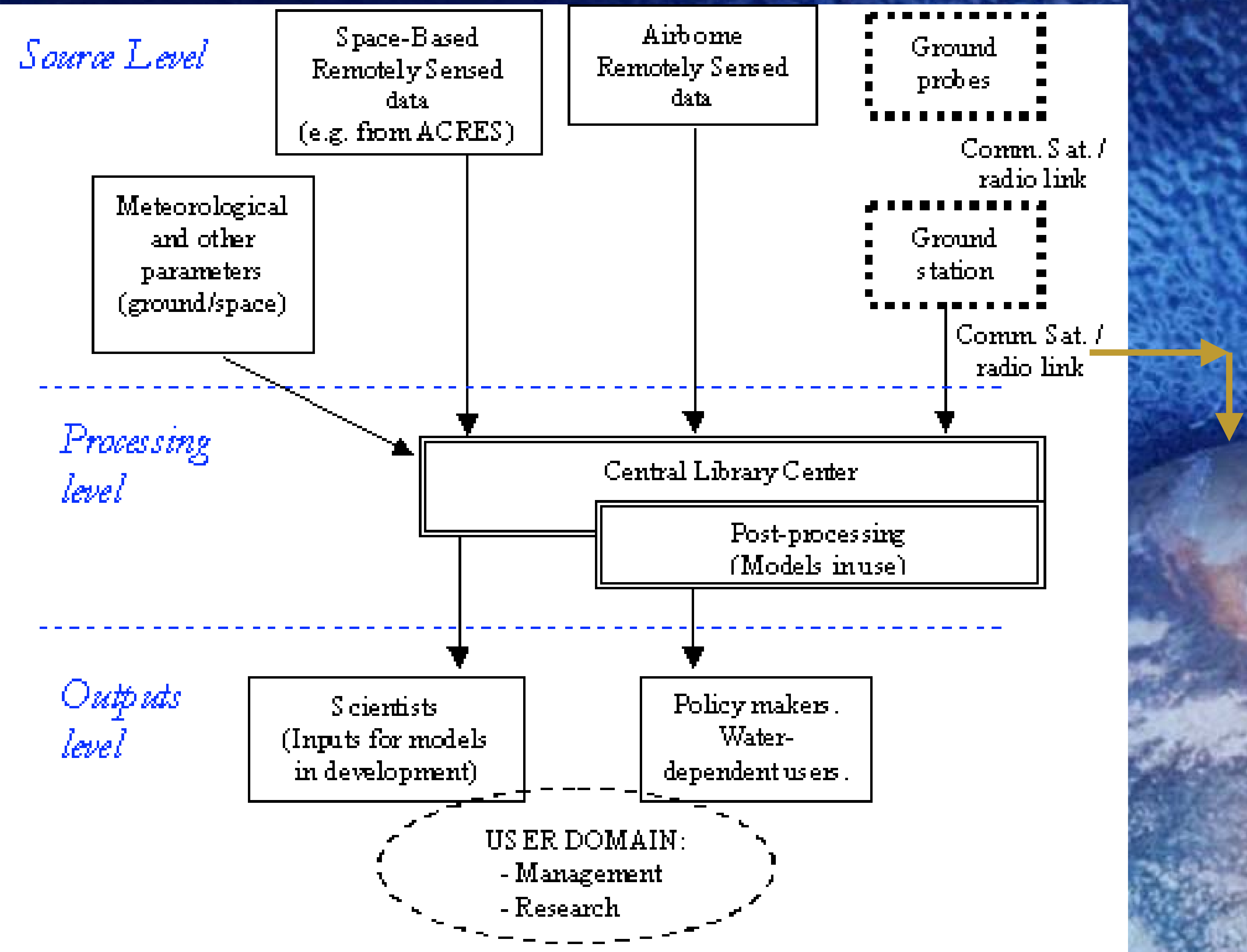
STREAM Soil Moisture Management Strategy

- STREAM RECOMMENDATION
  - Conduct a feasibility study – 3 months
  - Install ground probe systems (small regions) - five years
  - Prepare for data acquisition and processing from new soil moisture space missions
  - Establish a Central Library Center (National level) – data matching – commence 2005
  - Continue development of water cycle models
  - Select areas of interest (hybrid system)
  - Estimated cost is US$250,000 for the five year period
  - Considered feasible

STREAM Soil Moisture Management Strategy



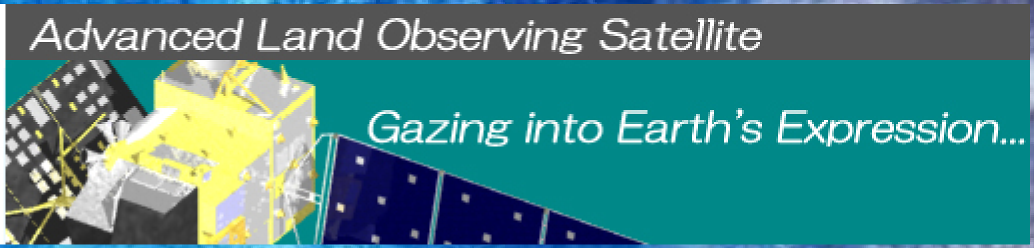
Soil Moisture Monitoring Implementation



Up-coming Space Sensors for Soil Moisture Monitoring in MDB

The SMOS mission is a direct response to the current lack of global observations of soil moisture and ocean salinity which are needed to further our knowledge of the water cycle, and to contribute to better weather and extreme-event forecasting and seasonal-climate forecasting. **LAUNCH 2007**

Hydros provides the first global view of the Earth's changing soil moisture and surface freeze/thaw conditions, enabling new scientific studies of global change and atmospheric predictability, and making new hydrologic applications possible. **LAUNCH 2009-2010**



STREAM Outreach Targets

Targets	Constituents
Decision Makers	MDB Agreement Institutions, Politicians, Local Authorities
Private Industries	Remote Sensing companies, Processing/ Manufacturing Companies, Mining Industry
User Associations	Farmers' Associations, River Tour Operator Associations, Environmental Associations
Institutions	Research Centers, Space Agencies Universities, Environmental Agencies
Experts	Experts from research institutions Experts from commercial companies
General Public	Students, Children Others

STREAM Outreach for Farmers and the Next Generation

- FARMERS:
  - Conduct surveys to assess the level of use and understanding about space technology
  - Provide courses on satellite data analysis e.g. soil moisture
- NEXT GENERATION:
  - Environmental courses as part of the primary and secondary school curricula
  - Various types of games, such as board games, internet-based games
  - National environmental quiz
  - Advertising campaigns targeted specifically at children

Aim of the STREAM Outreach

- **To increase awareness of the possible utilization of space applications**
- **To make appropriate data available to the end-users**
- **To enable the end-users to leverage the data to its full potential**

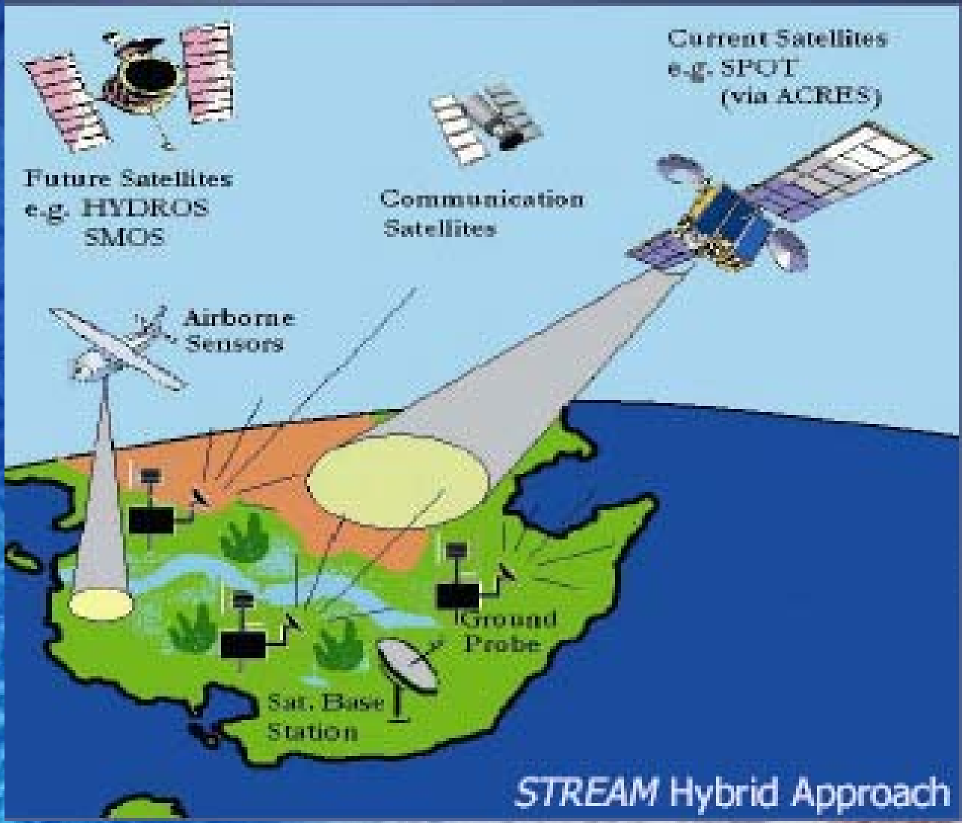
- *Developing public interest for the use of space technology in water management is a key factor for the success of the STREAM project*

STREAM –Global Relevance

- Technology, governance and outreach lessons learned from the MDB case study can be applied to other areas of the world.
- Problems vary according to regional climate and geographical differences
- Common threads can be found where space technologies could provide significant benefits in the management of water:
  - Erosion
  - Ice, Flood, Precipitation Monitoring
  - Water Quality Monitoring
  - Public Outreach

STREAM Project Summary

- Many countries face significant challenges in providing equitable access to fresh water
- Satellites are a vital element in the information chain
- Fusing satellite and in-situ data allows water resource managers to gain a detailed understanding of the basin
- Soil moisture – important factor in water management



Recommendations: Global Water Management

- The United Nations should implement a Charter for Water Management focusing on:
  - Planning and launch of a global water monitoring system in which the data is owned by the UN for free distribution to all member States
  - Harmonization of water management policies among nations
  - Provision of a conduit for water-related data sharing
  - Collection of more soil moisture data by:
  - Application of hybrid model of ground-based, airborne and space-based data as an interim solution
  - Integration of SMOS and HYDROS soil moisture data into current data collection system once these satellites are launched

Conclusions

- Both team projects address water issues in:
  - coastal / ocean bordered regions and
  - land locked, semi-arid regions of the globe.
- Space based solutions are integral part of the global water management system
- Ground probes and Airborne Data are also needed for integrated systems
- It is not about technology but people so Outreach, Outreach, Outreach particularly to stakeholders
- Solutions from team projects can be ported and adapted for implementation in several parts of the world

Thank You