Input to NRC Decadal Survey from NASA SERVIR Lower Mekong Hub Region

Q.1 What are the key challenges or questions for Earth System Science across the spectrum of basic research, applied research, applications, and/or operations in the coming decade?

Key challenges/questions identified by approximately 10 respondents living or working in the Lower Mekong NASA SERVIR hub region are presented below (not listed in order of priority). Respondents represented regional non-governmental organizations (2 respondents), global organizations (2 respondents), academic institutions (2 respondents), private sector (2 respondents), and other sectors (2 respondents). Responses are presented verbatim, with minor editing to improve understanding and combine similar comments.

Data Accessibility, Dissemination, and Challenges

1. Can data really be open to all?
2. There is a misperception that satellite technology is not for non-scientific users. How do we bring satellite applications closer to those end users?
3. Understanding the human aspects of transitioning Earth science research to diverse decision making contexts.
4. How can we convince policy makers to use land management observations in decision-making to reduce climate change impacts?
5. How can we increase automation of complex data-intensive analyses such as multi-temporal analysis over large areas?
6. How can high-technology/science be applied and used to help people who are affected by particular disasters?
7. How can we calculate return on investments in Earth science and satellite applications within multiple timeframes (e.g., yearly and decadal)?

Safety and Security

8. Where is it safe to live?

Weather

9. Resolving orographic precipitation in mountain areas
10. How can real-time weather information be disseminated?
11. How can we safely modify weather in order to reduce extreme events a notch or two?

Food Security

12. How can we regenerate the nourishing qualities of land?

Climate Change

13. Addressing uncertainty in seasonal climate projections and applications using seasonal climate model outputs, especially in low-flow and high-flow conditions (droughts and floods).
14. How can climate change impacts be monitored and predicted accurately at the local level?

15. Understanding complex positive and negative feedback loops in the global climate system, especially the role of water vapor and clouds in dampening or increasing GHGs' influence on global climate change.

Ecosystems

16. How can Earth observations be translated into forecasts about ecosystem status and stability, and how can forecasts best be used in planning by respective countries?

Other

17. What are the impacts of reducing Moon mass on tectonic activity?

Q.2 Why are these challenges/questions timely to address now especially with respect to readiness?

Respondents were not asked to comment on the timeliness of proposed key questions/challenges. Considering the extended time horizon of the Decadal Survey (2017-2027), timeliness of proposed key questions/challenges was not considered a critical factor.

Q.3 Why are space-based observations fundamental to addressing these challenges/questions?

To address proposed key challenges/questions, respondents offered several suggestions for continuing existing satellite observations or implementing new satellite observations, and facilitating the use of satellite data.

Existing observations that should be continued to support decision-making or application development include:

- ATom, Aura, CALIPSO, CLARREO, CloudSat, CYGNSS
- GRACE – to support decision-making for water resource management
- Landsat, GPM, Aqua, Terra, Jason – for Earth observations
    - GPM provides high value to a broad range of users, and data streams are part of systems that can save millions of lives from weather, water, disasters, and climate events.
    - Landsat provides high value to a broad range of users, and the historical archive offers significant additional value to ongoing observations related to ecosystems, biodiversity, water, agriculture, disasters, and health.
- Hubble – for inspiration
- International Space Station – for a desire for cooperation
- Weather observations, especially accurate rainfall estimations, are crucial for forecasts and early warning (e.g., of floods and landslides).

Continue satellite missions such as Landsat and MODIS (Level 1b/2), with free/easy operational subscription access or even access within cloud computing infrastructure for rental, for efficient value-added production chains.

Global land observation missions, such as the Landsat series, are crucial to providing a long-term, consistent perspective on global to local changes.

Hyperspectral and SAR continue to be research areas for NASA, but the immediate benefits range from better water quality and ecosystem service assessment to situational awareness of hazards when awareness is needed the most (not waiting for clouds to clear).

Suggestions for additional investments include:

- A high-resolution satellite (spatially and also temporal) whose data are freely and publicly accessible and not subject to cloud cover.
- Higher resolution topographic data would provide high value for a broad spectrum of users and add value to many other products with respect to Water / Disasters / Ecosystems / Biodiversity / Energy.
- A “long-term” mission commitment to higher resolution multiband optical/multi-spectral radiometry products (e.g., higher-res Landsat) would provide high value for a broad spectrum of users, and is particularly critical as Earth surface changes accelerate – relevant to Agriculture / Water / Disasters / Biodiversity / Climate / Ecosystems / Health.
- Active instrument of SMAP – key for food security, agricultural forecasting and planning – relevant to Agriculture / Water / Ecosystems / Health / Disasters.
- More near-real time weather monitoring applications to enhance early warning.
- Data related to weather and short/medium and long-range forecasts, to make them more accurate at high resolution.
- Altimetry provides key inputs into global circulation models as well as riverine flood forecasting. Expansion of inland bodies of water covered would result in greater immediate benefit where ground data are lacking.
- More real-time and higher resolution soil moisture measurements could provide better inputs into drought, crop productivity, and hydro-meteorological hazards nowcasting and forecasting.
- Improved access and interpretability of SAR for rapid response.
- Repeat dual or quad pole SAR will greatly enhance ecosystem monitoring, agricultural and rangelands health, and situational awareness during disasters such as floods, oil spills, landslides.
- Global DEMs that are updated every few years, at least 30 m spatial resolution; myriad hydrological and surface process applications in agriculture, water management, and disaster management.
- Monitoring the rich environment of coastal cities, in particular in island countries.
- A high-resolution terrain observation satellite (follow up of SRTM) to provide detailed elevation of Earth’s surface.
- Better monitoring of river sediment concentrations.
- High-resolution inundation patterns, especially in urban areas.
- Processed datasets that can be directly consumed by decision-makers in a timely manner.
- Constellation of high-resolution InSAR satellites/instruments producing freely available radar datasets; these types of data are often expensive, and coverage is not great.

Water management remains one of the major problems for the Lower Mekong. The region can experience extreme drought in one year, and then very wet seasons the next year, often causing major problems in the agriculture sector. An ability to predict, with acceptable accuracy, weather patterns (e.g., storms, precipitation, etc.) over a medium term (e.g., one year) will help the region greatly in managing water situations.

A more dynamic and global digital elevation product will contribute to many of the thematic areas that we address. At the global and macro-levels, elevation has been treated as a constant, but it is dynamic. Looking at surface changes offers insight into groundwater levels for water resource management and food security, surface deformation gives us insight into hazards that could turn into disasters, and DTM and DSM can provide a better picture of carbon and biomass in critical ecosystems.

There is a great need for accurate vertical elevation data all over the world and especially in less developed countries. SRTM provides too coarse resolution and vertical accuracy is not good. Airborne solutions (LIDAR) are very costly.

To increase the value of data and enable end users to fully understand satellite data and how it can be used, it would be useful to provide:

- Metadata (geographic scope, time series length)
- Information on the uncertainty of satellite data
- Data latency
- Investment should be made in the geo-database structure to increase the ability to extract all of the above in automated ways.