**INPUT TO NRC DECADAL SURVEY ON *GLOBAL CAPACITY BUILDING* *AND APPLICATIONS* FOR SOCIAL GOOD USING SATELLITE EARTH OBSERVATIONS**

**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?**

Regarding societal applications and the building of necessary capacity to harness satellite earth observations, there are 5 key questions that the applications and capacity building community has identified recently at a workshop meeting held in Tacoma (June 23-25, 2015). These are:

*1. What types of value-added products/information should we provide for resource-constrained public and national stakeholder communities and agencies?*

*2. What types of industry or private-sector partnership will most benefit the scientific research needed to meet societal needs?*

*3. How can we leverage the combined observational power of our many Earth observing satellite missions (current and future) in a synergistic manner to rapidly multiply societal applications?*

*4. How do we make the scientific innovation from satellite remote sensing data trigger durable and robust applications that do not require long-term incubation or external support?*

*5. From an economic standpoint, what should be the optimal business model between scientific communities and the stakeholders to support a sustainable partnership?*

A full report is available on the key findings, community-wide recommendations as well as key questions/challenges broken down thematically and geographically at the following link:

<https://www.dropbox.com/s/seopjch0ftukiln/Capacity%20Building%20E2%20Decadal%20Survey%20NASA%20Workshop%20Report%20v5.doc?dl=0>

The specific themes addressed in the above report are: 1.public health and air quality; 2. disaster management; 3. ecosystems function; 4. water resources; 5. food and agriculture; 6. cross-cutting issues. Interested reader will find theme-specific and region-specific recommendations and key questions in the full workshop report linked above.

In addition, we wish to draw the attention of the NRC Decadal Survey panel to pages 57-62 of the workshop report linked above. Those pages have the community-based input for prioritization of future 2007 Decadal Survey missions that are not yet in planning stages and recommended funding breakdown.

Lastly, we wish to draw the attention of NRC Decadal Survey panel on three forthcoming wide-audience publications related to applications and capacity building of satellite earth observations. These are:

1. A Global Capacity Building Vision for Societal Applications of Earth Observing Systems and Data: Key Questions and Recommendations, *Bulletin of American Meteorological Society*, (available online at: <http://www.saswe.net/publications/PostWorkshopBAMS.pdf>)
2. Data for all: Using satellite observations for social good, *EOS (AGU)* (available online at: <https://eos.org/opinions/data-for-all-using-satellite-observations-for-social-good> and pdf at <http://www.saswe.net/publications/PreWorkshopEOS.pdf>)
3. Globalizing Societal Applications of Scientific Research and Observations from Remote Sensing: The Path Forward (Meeting Report), *EOS (AGU)* (in press; available online at <http://www.saswe.net/publications/PostWorkshopEOS.pdf>)

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

The above questions (identified in Q.1) are timely to address because of sustainability and the recently adopted Sustainable Development Goals (SDG) by more than 180 nations in 2015. As stated by NRC, “*Understanding the complex, changing planet on which we live, how it supports life, and how human activities affect its ability to do so in the future is one of the greatest intellectual challenges facing humanity*.” To continue. *“It is also one of the most important for society as it seeks to achieve prosperity and sustainability.”*

Sustainable livelihoods with human and economic development, as envisioned in the SDG, can only be made possible in a context of food security, water availability and environmental health. Societal applications of satellite earth observations should therefore be developed to monitor and support progress towards these goals. In developing regions of the world and in many regions of the developed world, easy access to safe water means reduced malnutrition, morbidity and child mortality, as well as time and the opportunity for girls, and children in general, to attend school. Health and food security are dependent on water availability and ecosystem health, which in turn is highly influenced by local resource management strategies. Disaster risk is modulated by land use cover and the ability of ecosystems to provide regulating and provisioning services. Because of the integrated nature of human-natural systems (and the need for environment-water-health-livelihoods sustainability/security), societal applications must draw on the combined observational power of different sensors and remote sensing products at adequate resolutions in space and time. While research and retrospective products enable useful hindsight, operational real-time products are essential to support present decisions and strategies that can positively impact mankind more positively and sooner. Earth scientists must work with the practitioner and stakeholder communities to best tackle the challenges on the ground and develop new innovative efforts ranging through large missions, the use of nanosatellites or crowdsourcing feedbacks.

Given the above, the science community that is reliant on earth observation data from remote sensing for exploring earth science has a responsibility to regularly update and prioritize societally-relevant scientific questions and the Earth observations required to answer them. It is for these reasons cited above that the five key questions highlighted under Question 1 are considered important for forging a global capacity vision for harnessing the value of earth observations for benefit of all mankind in the coming decade.

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

Satellite remote sensing offers a unique global observational platform for pursuing societal benefits in ways that are not feasible using only conventional ground-based approaches. Reaping these benefits requires an intimate engagement between the scientific community and a wide range of stakeholders. This issue has taken on a new urgency, as the strong interplay between human activity and nature drives change on almost all continents, with rules set by human activities as well as nature.

The pursuit of a more sustainable, safer, and happier future drives the study of planet Earth, with its changing environmental conditions and natural resources. Observations from visible, laser, infrared, and microwave satellite sensors already provide information for managing land, water, agriculture, energy, disaster response, and ecosystem functions. During the last few decades, we have been quite successful in taking advantage of the science and observations afforded by satellites to make spectacular societal impacts. We are gradually developing a plethora of more mature remote sensing technology missions for routine environmental monitoring. These include Landsat and altimetry missions, hydrologic missions like Global Precipitation Measurement, NASA's Gravity Recovery and Climate Experiment mission, and NASA's anticipated Surface Water and Ocean Topography mission. *However, we lack much of the capacity required to handle the petabyte-scale influx of satellite environmental data that will become available. Earth observations from remote sensing continue to be an underused resource for humanity* with applications mostly limited to important scientific research. To take advantage of satellite observational capability to enhance and accelerate societal applications around the world, scientists and other stakeholders must collaborate to find answers in the coming decade. Time is of the essence, as long gestation periods, sometimes decades, are often necessary to transition from scientific research to real-world benefits for stakeholders.

Thus far, the benefits of satellite earth observations have mostly accrued in the developed nations of Europe and North America. Global satellite observational coverage would be especially useful in the developing world because ground‐based measurements are often largely absent here. However, programs to apply satellite observations to challenges in the developing world often struggle for longevity and continuity. Also, the combined observational power of the multiple Earth-observing satellites too often places emphasis on the benefits from individual missions and observing systems. This observational power is currently not being harnessed to produce more durable societal benefits. The struggle for support and survival has often pitted various missions against each other. This competition ignores the synergistic power and benefits that combining data from the many Earth-observing satellites could provide, missing an opportunity to provide even more spectacular societal benefits.

Our current and future satellite constellation essentially provides us with a "compound eye" view of the world. Like the composite eye of a fly, coordinated satellites look with many eyes at the same time to see the world from many different angles, using an array of instruments. To take advantage of this composite view is to make better decisions, using an application that is wired to expect and accept all the different observations across multiple platforms simultaneously. Such a capability could be used to address upcoming issues in water management, or agricultural production. For all these reasons, satellite remote sensing of the earth is fundamental to achieving global-scale sustainable development for all mankind as envisioned by the NRC in its 2005 Interim Decadal Survey report.