SBG Applications: Terrestrial Ecosystems – Carbon and Conservation

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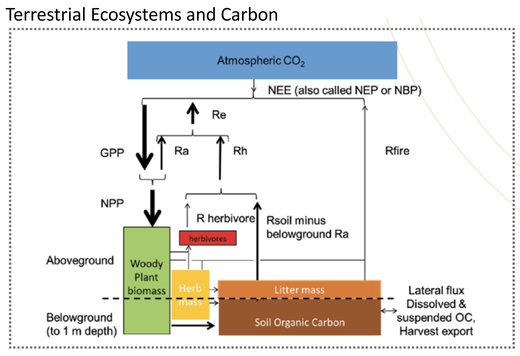
Decadal Survey

TABLE 8.1 Summary of Science and Application Questions and Their Priorities

Science and Applications Questions	Highest Priority Measurement Objectives (MI=Most Important, VI=Very Important)
E-1 **Ecosystem Structure, Function, and Biodiversity.** What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space? ("Structure" is the spatial distribution of plants and their components on land, and of aquatic biomass. "Function" is the physiology and underpinning of biophysical and biogeochemical properties of terrestrial vegetation and shallow aquatic vegetation.)	**(VI) E-1a.** Quantify the distribution of the functional traits, functional types, and composition of terrestrial and shallow aquatic vegetation and marine biomass, spatially and over time. **(MI) E-1b.** Quantify the three-dimensional (3D) structure of terrestrial vegetation and 3D distribution of marine biomass within the euphotic zone, spatially and over time. **(MI) E-1c.** Quantify the physiological dynamics of terrestrial and aquatic primary producers. Two additional objectives associated with this question were ranked Important.
E-2 **Fluxes Between Ecosystems, Atmosphere, Oceans, and Solid Earth.** What are the fluxes (of carbon, water, nutrients, and energy) *between* ecosystems and the atmosphere, the ocean, and the solid Earth, and how and why are they changing?	**(MI) E-2a.** Quantify the fluxes of CO_2 and CH_4 globally at spatial scales of 100-500 km and monthly temporal resolution with uncertainty <25% between land ecosystems and atmosphere and between ocean ecosystems and atmosphere. Two additional objectives associated with this question were ranked Important.
E-3 **Fluxes Within Ecosystems.** What are the fluxes (of carbon, water, nutrients, and energy) *within* ecosystems, and how and why are they changing?	**(MI) E-3a.** Quantify the flows of energy, carbon, water, nutrients, and so on sustaining the life cycle of terrestrial and marine ecosystems and partitioning into functional types. One additional objective associated with this question was ranked Important.
E-4 **Carbon Accounting.** How is carbon accounted for through carbon storage, turnover, and accumulated biomass? Have all of the major carbon sinks been quantified, and how are they changing in time?	Two objectives associated with this question were ranked Important.
E-5 **Carbon Sinks.** Are carbon sinks stable, are they changing, and why?	Three objectives associated with this question were ranked Important.

Terrestrial Ecosystems and Carbon



National Terrestrial Carbon Sink Assessment (2015) Department of Environmental Affairs, Pretoria, South Africa.

Case Study of early forest stress detection products for land managers using the Ecosystem Disturbance and Recovery Tracker (eDaRT) and remotely sensed canopy water content

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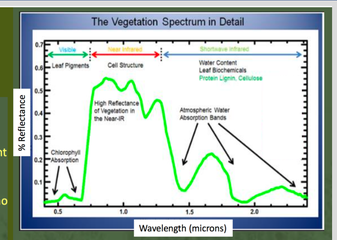
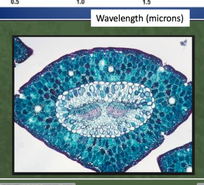
ForestSAT Oct 2018, College Park, MD

The line of evidence

- First stage of mortality evident in NIR & SWIR
  - Hart & Veblen 2015
- ~10% of eDaRT events have no visible canopy cover loss, but do have a drop in CWC
- SO, THERE ARE INVISIBLE EVENTS, WHICH MAY BE STRESS 😬





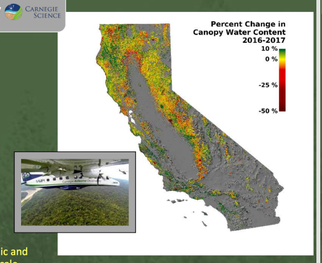
Canopy Water Content

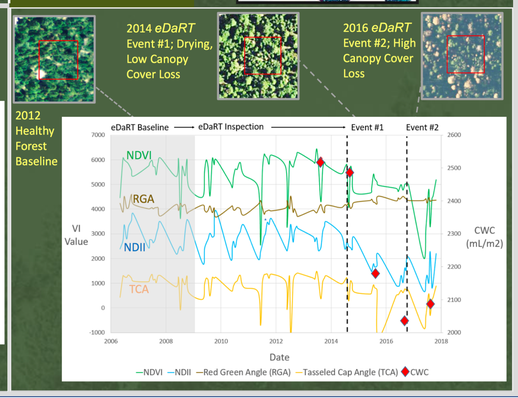
Carnegie Airborne Observatory

High Fidelity Imaging Spectroscopy (HiFIS)
- 427 channel 350-2485 nm range
- 5 nm increments
- 2 m resolution

LiDAR
- 4 laser shots/square m
- Tree canopy height, 1 m

Deep Learning Model & Extrapolation
- Landsat 8 Google Earth Engine mosaic and terrain data to extrapolate to 30 m scale
- Result is liquid water in canopy across California





DS Question	Application Focus Group	Decision Approach	L2+ VSWIR (one row) and TIR (another row)	Spatial	Temporal	Latency	Other Design Considerations	End Users	Auxillary	Additional Comments, such as key references
E-1. What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space?	Conservation	Provide alerts of spatial distribution of insect investation (e.g. Ash wood borer) and disease mortality as soon as possible	L4 - Mortality map L4 - Vegetation species L3 - Plant Functional Type L3 - Fraction green vegetation, non-photosynthetic vegetation, and substrate L2 - Surface Reflectance --- L4 - Evaporative Stress Index L3 - Evapotranspiration L2 - Land Surface Temperature	20-30m	5 days	2days		USFS, NPS, private forestry companies		
E-1. What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space?	Conservation	Use veg composition, structure, and health to target areas for conservation management related to endangered/protected species habitat	L4-Plant functional type L3-Dead/Dormant Vegetation L3-Green vs Non-Green/Non-Photosynthetic Veg L3/4-Vegetation Classification L2-Surface Reflectance --- L4 - Water Use Efficiency L4- Evaporative Stress Index L3 - Evapotranspiration L2 - Land Surface Temperature	100m x 100m	16 days	180 days	sun-sychronous	SERVIR Conservation International Gates Foundation WWF WRI REDD+ TNC	lidar for structure, field data to parameterize	Ustin presentation from HyspIRI closeout
E-1. What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space?	Conservation	Use rangeland quality metrics of leaf nitrogen and phosphorous content for livestock and wildlife management to avoid overstocking and animal mortality, i.e. stocking and take-off rates, movement of animals	L4 - Phosphorous: Nitrogen Ratio L3 - Leaf Nitrogen L3 - Leaf Phosphrous L2 - Surface Reflectance	30 m x 30 m	10-15 days	1-5days		Commercial livestock farmers, National Parks for countries with large hervivores populations .e.g. in Africa		Ramoelo and Cho (2018) Remote Sensing Ramoelo, A. et al. (2012) Int. J. Appl. Earth Obs. Geoinf 19, 151–162 Knox, N.M.; et al. (2012) Remote Sens 72, 27–35
E-1. What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space?	Conservation	Map alien invasive tree species for eradication and post-treatment monitoring	L3/L4 - Invasive Species Mapping L3 - Vegetation Functional Traits L2 - Surface Reflectance --- L4 - Water Use Efficiency L3 - Evapotranspiration L2 - Land Surface Temperature	20 - 30 m x 20-30 m	90-120days	30days		BLM, NRCS, FWS, NPS, USDA, USFS		
E-1. What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space?	Conservation	Use vegetation traits to monitor vegetation function, detect changes, inter-compare with other information sources to improve agricultural and forestry practices that facilitate biodiversity conservation	L4-Plant functional type L4-Crop Type L4-Dead/Dormant Vegetation Maps L3-Green Vegetation and Non-Photosynthetic Vegetation L3-Vegetation Traits: canopy density, chlorophyll, moisture, N, C, cellulose L2 - Surface Reflectance --- L4 - Water Use Efficiency L4- Evaporative Stress Index L3 - Evapotranspiration L2 - Land Surface Temperature	30 m x 30 m	16 days					
E-5. Carbon Sinks. Are carbon sinks stable, are they changing, and why?	Carbon	Monitoring, reporting and Verification (MRV) of carbon stock changes and the impact of mitigating activities by attributing biomass mapped with active sensors to specific species (e.g. Palm oil, alien species) by different forest states: regrowth, degradation, shrub encroachment, afforestation	L4 - Biomass gains (SAR-derived) attributed to specific species of life forms L4 - Plant functional type L3/4 - Vegetation Classification L3 - Landcover class: Tree, grass, shrub L3 - Dead/Dormant Vegetation L3 - Green vs Non-Green/Non-Photosynthetic Veg L2- Surface Reflectance --- L4 - Water Use Efficiency L3 - Evapotranspiration L3 - Latent Heat Flux L2 - Land Surface Temperature	20-30m	6 months	60-90 days		Agencies responsible for MRV under REDD+ SERVIR Conservation International Gates Foundation WWF WRI World Bank REDD+ TNC	SAR, LiDAR from NISAR, GEDI, IceSAT2, field data to parameterize	GOFC-GOLD, SOURCEBOOK OF METHODS AND PROCEDURES FOR MONITORING AND REPORTING ANTHROPOGENIC GREENHOUSE GAS EMISSIONS AND REMOVALS ASSOCIATED WITH DEFORESTATION, GAINS AND LOSSES OF CARBON STOCKS IN FORESTS REMAINING FORESTS, AND FORESTATION, http://www.gfoi.org/methods-guidance-documentation NISAR Forest and Disturbance Workshop
E-3. Fluxes Within Ecosystems. What are the fluxes (of carbon, water, nutrients, and energy) within ecosystems, and how and why are they changing? E-4 Carbon Accounting. How is carbon accounted for through carbon storage, turnover, and accumulated biomass? Have all of the major carbon sinks been quantified, and how are they changing in time?	Carbon	Quantify GHG emissions from conversion of land cover from forest to various land covers accourding to IPCC/REDD+ guidlines	L4 - Land cover change L4 - GPP and NPP L3 - Landcover L3 Physiological indices (LAI, fPAR, other narrow-band indices?) L2 Surface Reflectance --- L4 - Water Use Efficiency L3 - Evapotranspiration L3 - Latent Heat Flux L2 - Land Surface Temperature	20-30m	7-15 days	60-90 days		Agencies responsible for MRV under REDD+ SERVIR Conservation International Gates Foundation WWF WRI World Bank REDD+ TNC	Models of primary production, Light Use Efficiency	
E-1. What are the structure, function, and biodiversity of Earth's ecosystems, and how and why are they changing in time and space?	Carbon	Use vegetation traits to monitor vegetation function, detect changes, inter-compare with other information sources to improve agricultural and forestry practices and ecosystem management and facilitate increased yield	L4-Plant functional type L4-Crop Type L4-Dead/Dormant Vegetation Maps L3-Green Vegetation and Non-Photosynthetic Vegetation L3-Vegetation Traits: canopy density, chlorophyll, moisture, N, C, cellulose L2 - Surface Reflectance --- L4 - Water Use Efficiency L4- Evaporative Stress Index L3 - Evapotranspiration L2 - Land Surface Temperature	30 m x 30 m	16 days					
W-8.What processes determine observed atmospheric methane (CH4) variations and trends and what are the subsequent impacts of these changes on atmospheric composition/chemistry and climate?	Carbon	Use methane retrieval to measure known and unknown point sources, allowing for monitoring and potential mitigation	L3 - Methane L2 - Surface Reflectance	30m for largest point sources	monthly			EPA, NOAA, NGOs and private companies doing greenhouse gas emisisons monitoring		Methane retrieval is very sensitive to spectral resolution, with increasing ability to measure concentration as spectral resolution becomes finer

Comment Board

Info on who we are, charter, how to join

http://tinyurl.com/SBGApplicationsWG