ECVs

- 50+ GCOS Essential Climate Variables (ECVs) (2010)
- GEOSS/GEOBON Essential Biodiversity Variables (EBVs)
  - Land cover, fAPAR, LAI, biomass, (fire) disturbance, soil moisture, soil carbon

Domain	GCOS Essential Climate Variables
Atmospheric (over land, sea and ice)	**Surface:**[1] Air temperature, Wind speed and direction, Water vapour, Pressure, Precipitation, Surface radiation budget. **Upper-air:**[2] Temperature, Wind speed and direction, Water vapour, Cloud properties, Earth radiation budget (including solar irradiance). **Composition:** Carbon dioxide, Methane, and other long-lived greenhouse gases[3], Ozone and Aerosol, supported by their precursors[4].
Oceanic	**Surface:**[5] Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Surface current, Ocean colour, Carbon dioxide partial pressure, Ocean acidity, Phytoplankton. **Sub-surface:** Temperature, Salinity, Current, Nutrients, Carbon dioxide partial pressure, Ocean acidity, Oxygen, Tracers.
Terrestrial	River discharge, Water use, Groundwater, Lakes, Snow cover, Glaciers and ice caps, Ice sheets, Permafrost, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (FAPAR), Leaf area index (LAI), Above-ground biomass, Soil carbon, Fire disturbance, Soil moisture.

http://gosic.org/ios/MATRICES/ECV/ECV-matrix.htm

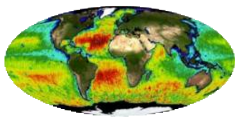
CONTINOUS FIELD ESSENTIAL BIODIVERSITY VARIABLES

AVAILABLE TYPES OF EARTH OBSERVATIONS

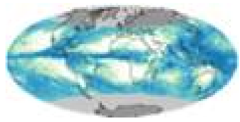
Land Temperature

Sea Surface Temperature

Vegetation



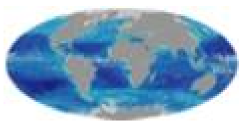
Sea Surface Salinity



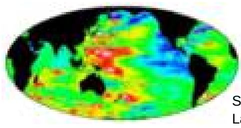
Total Rainfall

Aerosols

Fires & Thermal



Chlorophyll



Sea Surface Height

Source
Lawrence Friedl
NASA

Introduction | (RS-)EBVs | Environmental Synthesis | Continuous RSEBV | GBOS | Conclusions

CONTINUOUS RS-EBVs

- Direct retrieval
- Continuous: interval/ratio
- Physical model - deductive
- Scalable: global to local
- In-situ data for validation

EBV Class	Candidate RS-EBV	Potential support for Aichi targets
Species populations	Species distribution*	4,5,7,9,10,11,12,14,15
Species populations	Species abundance*	5,7,9,12,14,15
Species traits	Phenology (e.g., leaf-on and leaf-off dates; peak season)	5,9,11,12,14,15
Species traits	Plant traits (e.g., specific leaf area, leaf nitrogen content)	7,9,12,14
Community composition	Taxonomic diversity	8, 10, 12, 14
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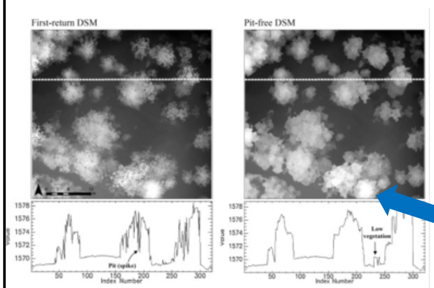
Introduction | (RS-)EBVs | Environmental Synthesis | Continuous RSEBV | GBOS | Conclusions

CONTINUOUS RS-EBV

VEGETATION HEIGHT



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International Journal of Applied Earth Observation and Geoinformation

Volume 52, October 2016, Pages 104–114

Generating spike-free digital surface models using LiDAR raw point clouds: A new approach for forestry applications

Anahita Khosravipour, Andrew K. Skidmore, Martin Isenburg

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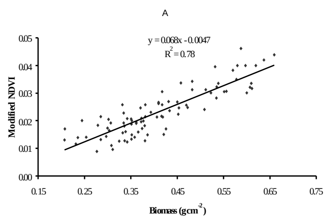
http://ezproxy.utwente.nl:2084/science/article/pii/S0303243416300873

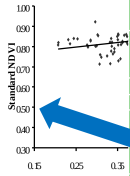
Introduction | (RS-)EBVs | Environmental Synthesis | Continuous RSEBV | GBOS | Conclusions

CONTINUOUS RS-EBV
VEGETATION BIOMASS

Mutanga and Skidmore 2003



Mutanga a



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(a) Grass biomass accurately estimated by vegetat... located in the red edge slope).

(b) Compare with the standard NDVI involving bands located in the near infrared and the red absorption trough.

(c) Results from 1986 – coarse sensor, poorer image processing & field techniques

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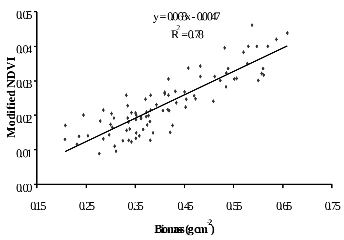
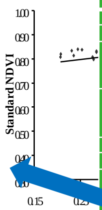
Introduction | (RS-)EBVs | Environmental Synthesis | Continuous RSEBV | GBOS | Conclusions

CONTINUOUS RS-EBV
VEGETATION HEIGHT

Mutanga and Skidmore 2003



Muta



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(c) Results from 1986 – coarse sensor, poorer image processing & field techniques

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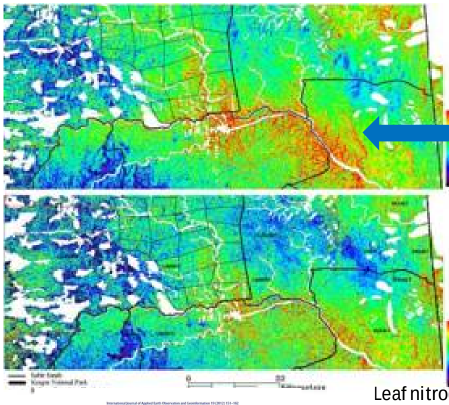
REMOTE SENSING EBVS FOR UPSCALING BIODIVERSITY

LEAF AND CANOPY NITROGEN - UP-SCALABLE TO GLOBAL

RapidEye 6 m & red edge
Environmental layers



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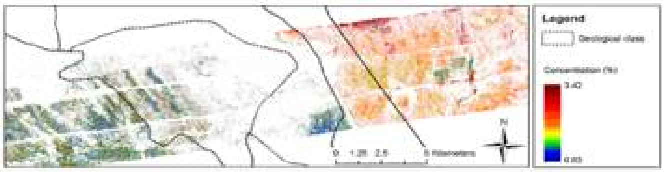
Leaf nitrogen (top) and canopy nitrogen (bottom) in savanna South Africa (Kruger NP to Sabi Sands). Red edge band of RapidEye

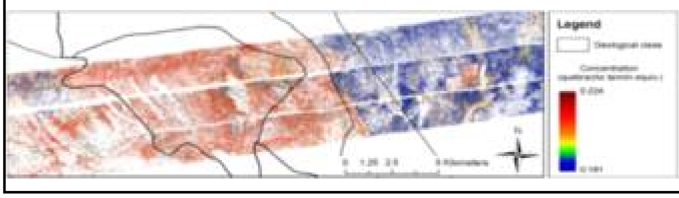
FOLIAR BIOCHEMISTRY – N AND TANNIN

FOLIAR NITROGEN KNP



Foliar nitrogen grasses

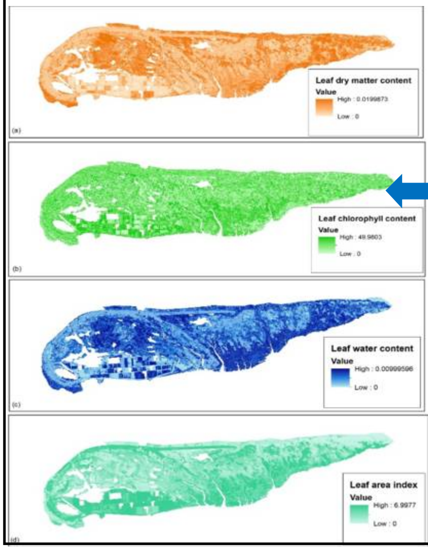
Foliar nitrogen mopane



Tannin mopane

LEAF BIOCHEMISTRY & STRUCTURE FROM RTM

SENTINEL-2 SALTMARSH AND GRASSLAND



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ESA Innovator III project RS4EBV (in press)

SURFACE WATER OCCURRENCE (1984-2015)

GLOBAL PRODUCT JRC

Global Landsat 30 m product
Frequency present water1984 – 2015
permanent (100% occurrence over 32 yea
Areas where water sometimes occurs pur

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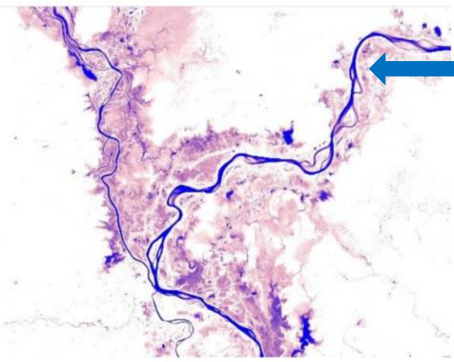


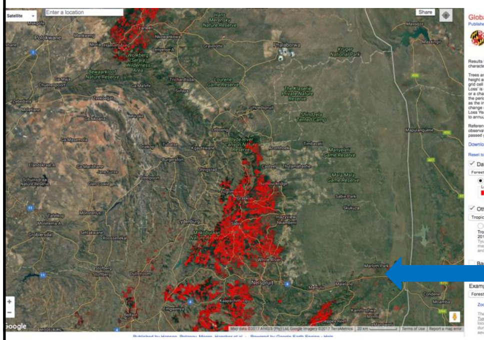

nature

NATURE | LETTER

High-resolution mapping of global surface water and its long-term changes

FOREST COVER %

FOREST COVER LOSS KNP



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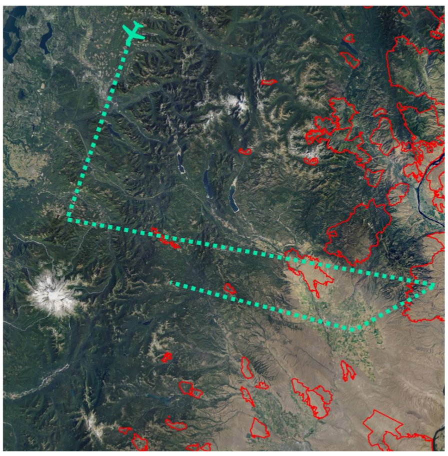
https://earthenginepartners.appspot.com/science-2013-global-forest

Introduction | (RS-)EBVs | Environmental Synthesis | Continuous RSEBV | GBOS | Conclusions

CONTINUOUS RSEBV

SOLUTIONS – HIGHER TEMPORAL RESOLUTION

Washington State "Flight" Path for Upcoming Animation



Legend for upcoming animation

Decreasing Trend (Decreasing Greenness)	Increasing Trend (Increasing Greenness)
< -0.3	0.05 - 0.1
-0.3 - -0.2	0.1 - 0.2
-0.2 - -0.1	0.2 - 0.3
-0.1 - -0.05	0.3 - 0.4

No trend

-0.05 - 0.05

Boston University
Woodcock et al.

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Introduction | (RS-)EBVs | Environmental Synthesis | Continuous RSEBV | GBOS | Conclusions

CONTINUOUS RSEBV

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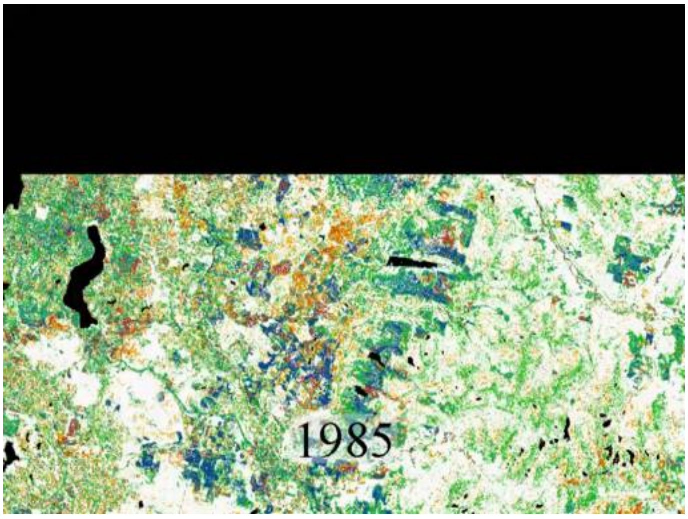

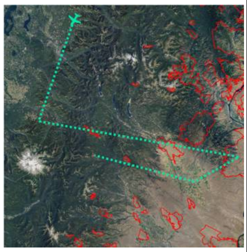

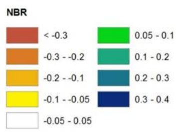

Boston University
Woodcock et al.

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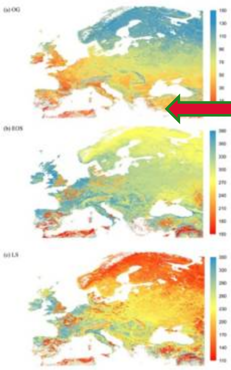
CONTINUOUS RS-EBVs

PHENOLOGY

Phenology maps of Europe in Julian days. A) onset on greenness (OG), B) end of senescence (EOS), C) length of the season (LS).



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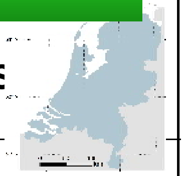
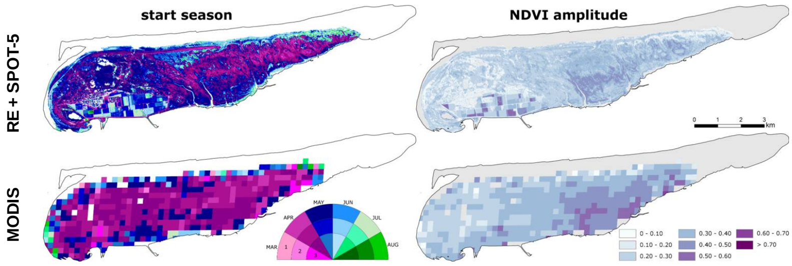
ADVANTAGE OF SENTINEL-2 FOR RANGELANDS



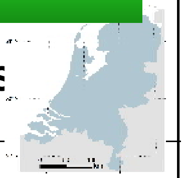
- Seasonality: timing of green-up / senescence
- Requires frequent observation throughout year
  - Coarse-resolution (>250m): MODIS / Proba-V / Sentinel-3
- Sentinel-2 → finer-resolution retrievals → towards species



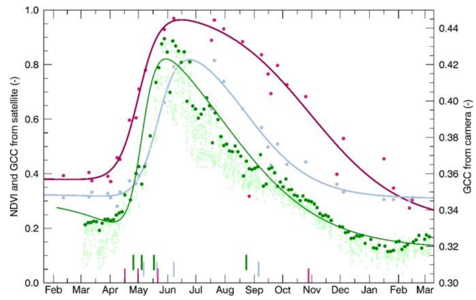
Vrieling A, AK Skidmore, T Wang, M Meroni, BJ Ens, et al. 2017. Spatially detailed retrievals of spring phenology from single-season high-resolution image time series. International Journal of Applied Earth Observation and Geoinformation, 59: 19-30.

Introduction | (RS-)EBVs | Environmental Synthesis | Continuous RSEBV | GBOS | Conclusions

ADVANTAGE OF SENTINEL-2 FOR RANGELANDS



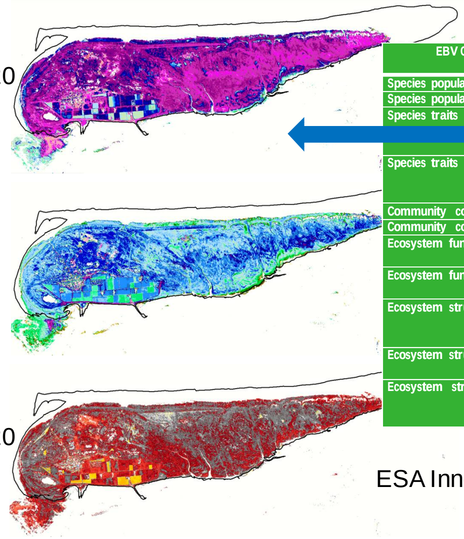
- ~27 cloud-free observations in 2016 with Sentinel-2a
  - model full season
  - link to camera data
    - differences linked to obs angle & VI



- Applications
  - represent seasonality better
  - differential green-up species
- expand to rangelands

PHENOLOGY FROM SENTINEL 2 TIME SERIES (2016)

SALTMARSH AND GRASSLAND



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ESA Innovator III project RS4EBV (in prep)

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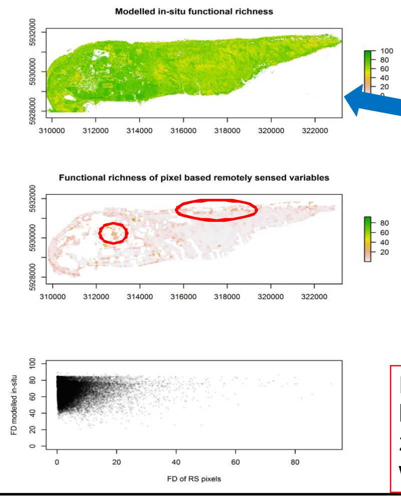
FUNCTIONAL RICHNESS

Functional richness



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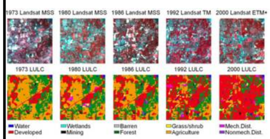
Ecosystem structure	Habitat structure (e.g., height, crown cover and density)	5,7,9,14,15
Ecosystem structure	Ecosystem extent and fragmentation	5,11,12,14,15
Ecosystem structure	composition by fEcosystem unctional type & land cover	5,7,10,12,14,15

Functional richness of the saltmarsh is very low but increases at vegetation transition zones. These ‘fronts’ or transition zones are well highlighted by the moving window.

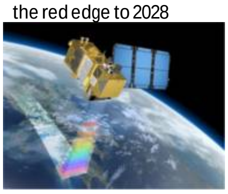
GLOBAL BIODIVERSITY OBSERVING SYSTEM

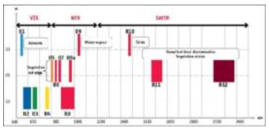
THE CONTINUOUS RSEBVS ARE GENERATED FROM NEXT GENERATION ASSETS

Landsat – systematic and global acquisition for next 25 years

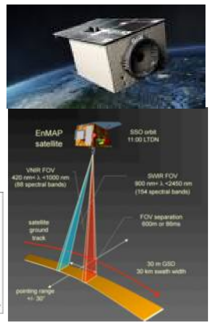


Sentinel-2 – systematic global acquisition including the red edge to 2028

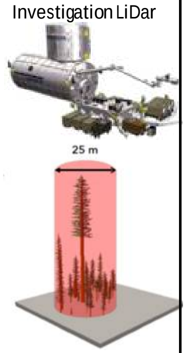




EnMAP - Environmental mapping and analysis program



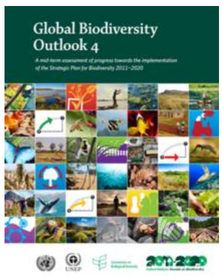
GEDI – Global Ecosystems Dynamics Investigation LiDar



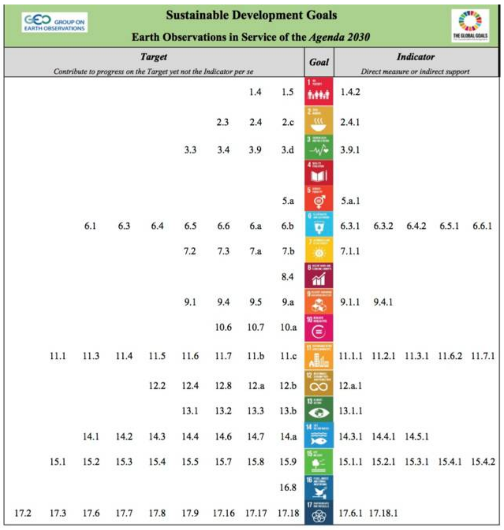
INFORM ON BIODIVERSITY TARGETS AND SDGS

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks have been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.



ALIGNMENT OF EO WITH SDG TARGETS



Sustainable Development Goals
Earth Observations in Service of the *Agenda 2030*

Target (Contribute to progress on the Target yet not the Indicator per se)									Goal	Indicator (Direct measure or indirect support)				
							1.4	1.5	1	1.4.2				
						2.3	2.4	2.c	2	2.4.1				
					3.3	3.4	3.9	3.d	3	3.9.1				
									4					
								5.a	5	5.a.1				
		6.1	6.3	6.4	6.5	6.6	6.a	6.b	6	6.3.1	6.3.2	6.4.2	6.5.1	6.6.1
					7.2	7.3	7.a	7.b	7	7.1.1				
								8.4	8					
					9.1	9.4	9.5	9.a	9	9.1.1	9.4.1			
						10.6	10.7	10.a	10					
	11.1	11.3	11.4	11.5	11.6	11.7	11.b	11.c	11	11.1.1	11.2.1	11.3.1	11.6.2	11.7.1
				12.2	12.4	12.8	12.a	12.b	12	12.a.1				
					13.1	13.2	13.3	13.b	13	13.1.1				
		14.1	14.2	14.3	14.4	14.6	14.7	14.a	14	14.3.1	14.4.1	14.5.1		
	15.1	15.2	15.3	15.4	15.5	15.7	15.8	15.9	15	15.1.1	15.2.1	15.3.1	15.4.1	15.4.2
								16.8	16					
17.2	17.3	17.6	17.7	17.8	17.9	17.16	17.17	17.18	17	17.6.1	17.18.1			

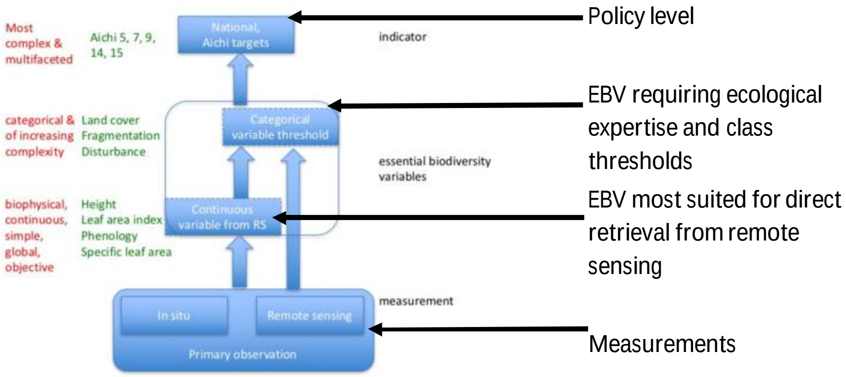
EO4SDG

Alignment of Earth Obs. and GEO to the Goals, Targets, and Indicators

Source
Lawrence Friedl
NASA

Introduction | (RS-)EBVs | Environmental Synthesis | Continuous RSEBV | GBOS | Conclusions

GLOBAL BIODIVERSITY OBSERVATION SYSTEM



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GLOBAL BIODIVERSITY OBSERVATION SYSTEM
TAKE HOME MESSAGE

- Environmentally synthesized information are focus of targets and SDGs
  - *Species and species composition*
  - *Land cover*
  - *Identifying individuals*
- Global continuous field variables from satellite remote sensing used to generate the environmentally syntesized
  - *Height*
  - *Foliar bio-chemicals*
  - *Surface inundation*
  - *Productivity etc*
- Global Biodiversity Observation System – from next generation satellites

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