GROUP ON EARTH OBSERVATIONS

GEO User Interface Committee:

Status and Preliminary Results of GEO Task US-09-01a

Task Lead & UIC Member:
Lawrence Friedl, USA-NASA

Lead UIC Co-Chair Contact:
Ellsworth LeDrew, IEEE (Canada)

Task Coordinator:
Amy Jo Swanson, USA-NASA

UIC Meeting • Washington, DC USA
16-November-2009

Group on Earth Observations

Task US-09-01a

GEO Task US-09-01a:

Establish a GEO process for identifying critical Earth observation priorities common to many GEOSS societal benefit areas, involving scientific and technical experts, taking account of socio-economic factors, and building on the results of existing systems' requirements development processes.

http://sbageotask.larc.nasa.gov/

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Task US-09-01a

Key Tenets Followed:

- Harvest information expressed in existing, publicly-available documents; avoid duplication of efforts already performed by GEO MC & PO.

- Representative of GEO MC & POs
(broad geographic representation, developed/developing countries)

-Documents need to span a range of User-Types within each SBA
(e.g., scientists, managers, researchers, policy makers, forecasters, others)

- Focus is on the "demand" side of Earth observations, independent of the specific sensor technology, collection method, or current availability.
    - Task is designed to be objective *(not subjective to existing technology)*

- For the task, the term Earth observations refers to parameters and variables (e.g., physical, geophysical, chemical, biological) sensed or measured, derived parameters and products, and related parameters from model outputs.

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GEO UIC US-09-01a Process: Nine Steps

-The process lists the steps serially, yet some of them can be done in parallel.

Step 1: UIC Members identify Advisory Groups and Analysts for each SBA
Step 2: Determine scope of topics for the current priority-setting activity
Step 3: Identify existing documents regarding observation priorities for the SBA
Step 4: Develop analytic methods and priority-setting criteria
Step 5: Review and analyze documents for priority Earth observations needs
Step 6: Combine the information and develop a preliminary report on the priorities
Step 7: Gather feedback on the preliminary report
Step 8: Perform any additional analysis
Step 9: Complete the final report on Earth observations for the SBA

When all SBA reports are complete, the Task Lead (and others) will perform a meta-analysis on the 9 SBA reports & parameter lists. They will write an over-arching report, including a parameter list on “Earth observation priorities common to many SBAs.” The report will include lessons learned and recommendations.

GEO Task US-09-01a

SBA Progress (as of 6-Nov-2009)

GEO User Interface Committee: Progress in Task US-09-01a by Societal Benefit Area

Note: The GEO UIC has a 9-step process that each Analyst is following. Analysts may be working more than one step in that process, and some steps are more open-ended then others. This table reports the step that the Analysts have focused a majority of their efforts for the month. The Comments field describes all the steps the Analyst is working.

Societal Benefit Area	Analyst	# in Advisory Group	# of Documents	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09
				Major Steps in Process												
Agriculture	Michael Brady	11	15	0	1	2	2	3	4/5/6	4/5/6	4/5/6	4/5/6	4/5/6	4/5/6	4/5/6	4/5/6
Biodiversity	Greg Susanke	8	60	0	1	3	3	3	3/4/5	3/4/5	3/4/5	3/4/5	3/4/5	6	7	7
Climate	Molly Macauley	7	35	0	2	4/5	4/5	4/5	4/5/6	4/5/6	7	7	8	8	8/9	8/9
Disasters	Stephanie Weber	13	40	0	3	4/5	4/5	4/5/6	4/5/6	4/5/6	7	7	8	8	8/9	8/9
Ecosystems	Glynis Lough	11	71	0	2	4/5	4/5	4/5	4/5/6	4/5/6	7	7	8	8	8/9	8/9
Energy	Erica Zell	14	53	1	3	4/5/6	4/5/6	4/5/6	4/5/6	4/5/6	7	7	8	8	8/9	8/9
Human Health: Aeroallergens	Hillel Koren	16	126	0	0	0/1	1/1	2	3	1 & 3	1/3/4/5	1/3/4/5	3/4/5	6	7	7
Human Health: Air Quality	Rudy Husar & Stefan Falke	11	83	0	0	0	1	2	3	1 - 3	3	3	3/4/5	6	7	7
Human Health: Infectious Disease	Pietro Ceccato	19	822	1	1	1	1	2	3	1/3/4	3 & 4	4/5	5/6	7	7/8	7/8
Water	Sushel Unninayar	11	180	0	1	2	2	3/4/5	5/6/7	6/7	6/7	6/7	6/7	7	7/8	7/8
Weather	Michael Nyenhuis	7	34	0	1	1/3/4	1 - 4	1 - 5	6	6	6	7	7	8	8/9	8/9

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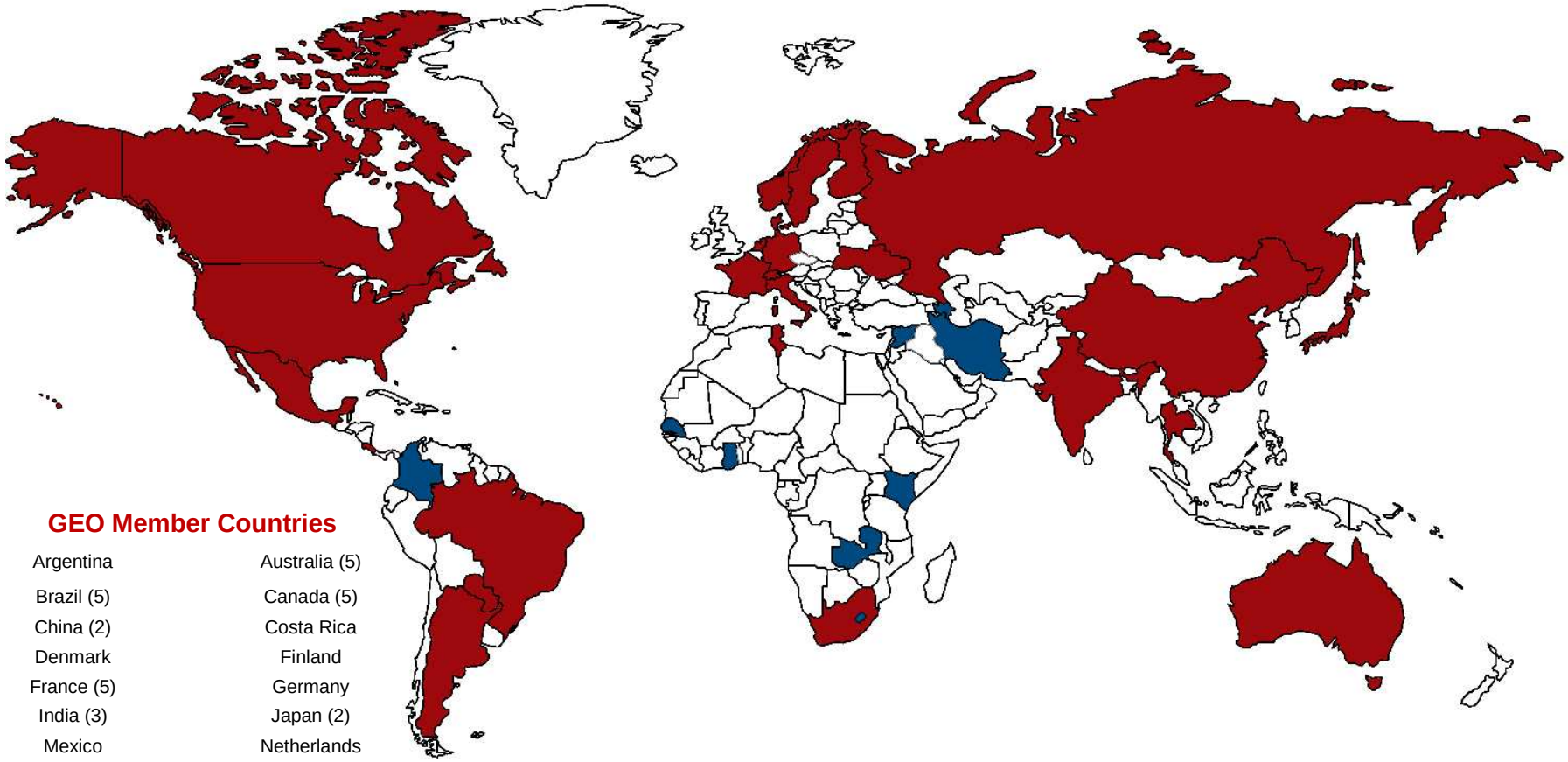
Earth Observation Priorities (Task US-09-01a)

Documents Reviewed & ad hoc Advisory Groups Members, by SBA
(figures as of 4-August-2009)

GEO Societal Benefit Area	Advisory Group Members	Documents in Meta-Analysis
Agriculture	11	15
Biodiversity	8	55
Climate	7	35
Disasters	13	40
Energy	14	53
Ecosystems	11	71
Human Health: Aeroallergens	16	117
Human Health: Air Quality	10	35
Human Health: Infectious Disease	17	165
Water	9	56
Weather	5	34
Total	***121***	***676***

Analysts and Advisory Groups include people from Australia, Austria, Canada, China, Costa Rica, Denmark, Germany, Finland, France, Ghana, India, Iran, Italy, Kenya, Japan, Mexico, Norway, Paraguay, Russia, USA, Senegal, South Africa, Thailand, Tunisia, CEOS, DIVERSITAS, ECMWF, ESA, FAO, GCOS, IEEE, UNESCO, WMO, and others. Full Analysis at Nov. 2009 UIC Meeting.

US-09-01a Advisory Group Representation



GEO Member Countries

Argentina
Australia (5)
Brazil (5)
Canada (5)
China (2)
Costa Rica
Denmark
Finland
France (5)
Germany
India (3)
Japan (2)
Mexico
Netherlands
Norway
Paraguay
Russian Federation (2)
South Africa (3)
Sweden
Switzerland
Thailand
Tunisia
Ukraine
United States (27)

Not Currently GEO Members

Azerbaijan
Colombia
Ghana
Iran
Kenya
Lesotho
Senegal
Syria
Zambia

Participating Organizations

CEOS (2)
DIVERSITAS (2)
ECMWF
ESA (2)
EUMETNET
FAO (4)
GCOS (2)
GTOS (2)
IEEE
UNESCO
WCRP (2)
WMO (4)

Other Entities Involved

ARGOSS
BirdLife International
ESRI
Epuron
HCF
ICL (2)
IGOS
INECOL (2)
ISES
RCMRD
Stella Group
TERI
UNECE
UN-ESCAP
WHO (2)
WOVO/IAVCEI

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Task US-09-01a

Prioritization Approaches of the SBAs

Agriculture	Preliminary Report still in work
Biodiversity	Aggregate by broad category
Climate	Frequency; Use of Global & Regional-based Index Value
Disasters	Aggregated-Weighted Index (Frequency & Document Factors)
Ecosystems	Frequency; Commonality to Multiple Sub-Types; Validation Step
Energy	A. Frequency/Commonality to Renewable Energy Types B. Alignment with International Energy Agency's projections of prominent renewable energy types for 2006-2030
Health - *Allergen*	Frequency combined with User-Based Best-Predictor Ratings
- *Inf.Dis.*	Burden of Disease based: Disability-adjusted life year (DALY)
- *AQ*	Health-effect Potency, Coverage and Utility based
Water	Sector- and User-Type Weighting Scheme
Weather	Broad Collection

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Task US-09-01a

Presentations by Analysts

Disasters, A. Carpenter

Ecosystems, G. Lough

Energy, E. Zell

Health – Infectious Disease, P. Ceccato (via WebEx)

Weather, M. Nyenhuis

Water, S. Unninayar

Task Website:
http://sbageotask.larc.nasa.gov/

Email address:
geo-task-us-0901@lists.nasa.gov

Back-up Materials

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Task US-09-01a

Current & Future States of Critical Earth Observation Priorities

Results of Gap Analysis can be shown in such a diagram.

Critical Earth Observation Priorities		Currently Available: Yes	Currently Available: No
Available in Future	Planned	Good situation	In waiting
Available in Future	No Plan	Possible crisis	Major gap

Is this because the science & technology isn't mature?

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Task US-09-01a

UIC Follow-up

Nature of the parameter lists

- Breadth of user types represented & achieved in analyses

Key Known Gaps and Solutions

- Agriculture: Addresses only Forests.
  - Doing follow-on report for Agriculture topics
  - Agriculture CoP & Global Ag Monitoring Task Representatives involved
- Ecosystems: Limited number of Ecosystems
  - Doing follow-on report for 3-4 other major ecosystems
- Disasters: Addresses only 3 major disasters
  - Doing follow-on report for 3-4 other disaster types

Follow-on:

- Gap analysis of current/future availability of the observations
- Similar assessment of user needs for visualization tools, decision support tools, etc. associated with ability to use the observations

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Task US-09-01a

Topics for Discussion: UIC & STC

Following completion of the meta-analysis, UIC to perform a gap analysis regarding the current/future availability of the "priority Earth observation parameters"

- Opportunity for S&T support in this analysis

The task identifies "demand-side" observation priorities & needs

- Reports do not address the specific source of the observations or sensor technology involved with producing the obs.
- Independent of existing or available technology, algorithms, scientific foundation, calibration/validation, etc.

Do we have the Science & Technology means to achieve some of the advanced observations (direct or derived) identified in the US-09-01a task?

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Disaster SBA Prioritization Results

GEO Task US-09-01a

Analyst: Stephanie Weber, Battelle, WeberS@Battelle.org
Adam Carpenter, Battelle, CarpenterA@Battelle.org presenting in Stephanie's Absence

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16-November-2009

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Disasters SBA - Scope

- Identify critical Earth observation priorities within Disaster SBA
- Useful for future Earth Observation planning and development
- Consulted with Advisory Group members to limit the scope to an appropriate number of high priority topics

- Focus on observation priorities for:
  - Earthquakes
  - Landslides
  - Floods

GEO Task US-09-01a

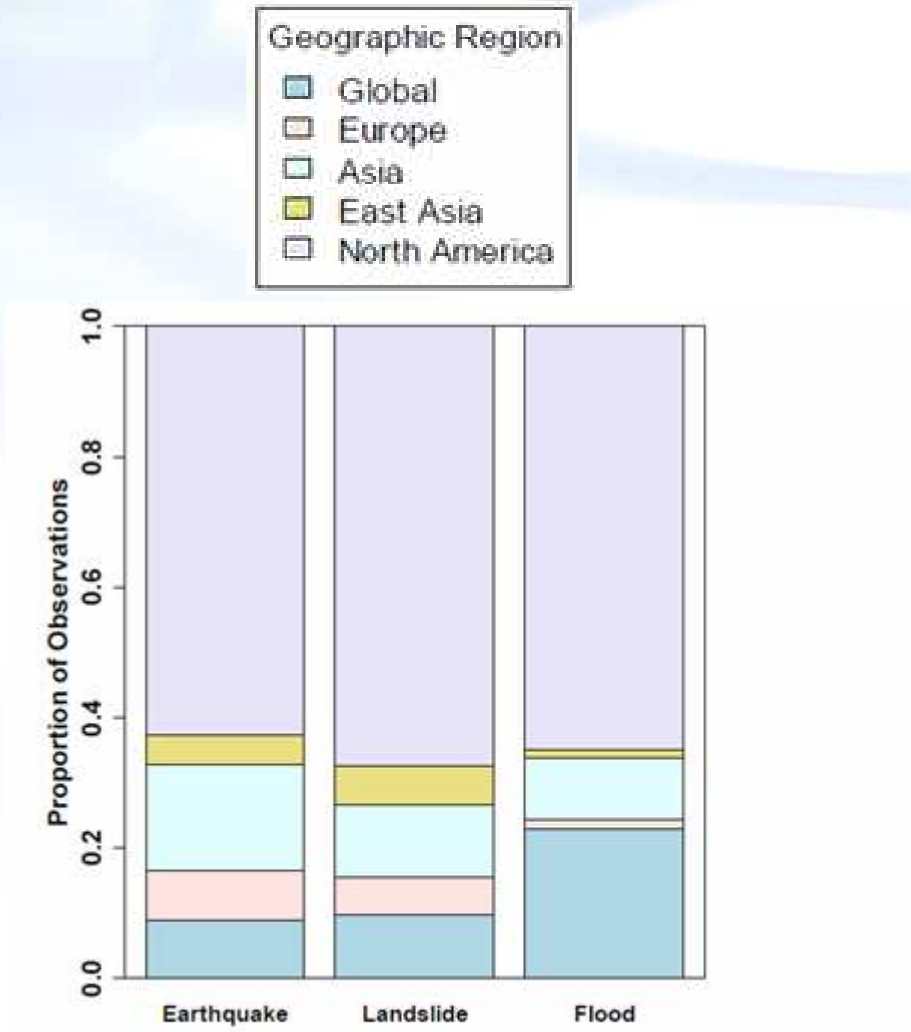
Disasters SBA – Advisory Group

Name	GEO Country or Organization	Affiliation	Geographic Region	Area of Expertise/ Specialty
Rosario ALFARO	Costa Rica	Instituto Meteorologico Nacional	South/Central America	Broad Disasters Experience
Jay BAKER	United States	Florida State University	North America	Hurricanes/Floods
Jerome BEQUIGNON	European Space Agency	European Space Agency	Europe	Disasters
George CHOY	United States	United States Geological Survey (USGS)	North America	Seismic Hazards
Silvia Burgos SOSA	Paraguay	Paraguaian Institute for Environmental Protection	South/Central America	Broad Disasters Experience
Nicola CASAGLI	Italy	International Consortium on Landslides	Europe	Landslides
Mumba Dauti KAMPENGELE	Zambia	National Institute for Scientific and Industrial Research	Africa	Broad Disasters Experience
Ivan KOULAKOV	Russia	Institute of Petrol Geology and Geophysics	Europe	Seismic Hazards
Goneri Le COZANNET	France	French Geological Survey	Europe	Disasters
William LEITH	United States	USGS	North America	Seismic Hazards
Warner MARZOCCHI	Italy	World Organization of Volcano Observatories	Europe	Volcanoes
V. Madhava RAO	India	National Institute of Rural Development	Asia/Middle East	Broad Disasters Experience
Kaoru TAKARA	Japan	International Consortium on Landslides	East Asia	Floods/Landslides

GEO Task US-09-01a

Disasters SBA - Documents

- Identified 22 documents of relevance (out of 52 potentially relevant documents):
  - 11 with a North American focus
  - 7 with an Asian / Pacific focus
  - 1 with a European focus
  - 3 were global in nature
  - None in Africa or South America



Proportion of observations by geographic region for earthquake, landslide and flood disasters.

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Disasters SBA – Prioritization Methods

Each observation category discussed within a document was assigned a score (1-3) for both of the following characteristics:

1. Applicability to multiple disaster types: parameter discussed in a document was assigned a value between 1 (lowest) and 3 (highest) based upon number of disaster types it applied to.

2. Source Document type:
   - Highest rank (3): International working group or consensus documents
   - Medium rank (2): National level government or working group documents
   - Lowest rank (1): Journal articles, conference proceedings, presentations, etc

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Disasters SBA – Prioritization Methods

- The weight of an observation (i_{d_o}) within a document was the product of the number of disasters (W_{n_o}) and the weight of the document it comes from (W_d).

$$i_{d_o} = w_{n_o} w_d \quad \text{(Equation 1)}$$

- The weight of an observation category within a document could range anywhere from 1 to 9.

- All of the weights were totaled to determine the total weighted index for that observation category:

$$I_o = \sum_d i_{d_o} \quad \text{(Equation 2)}$$

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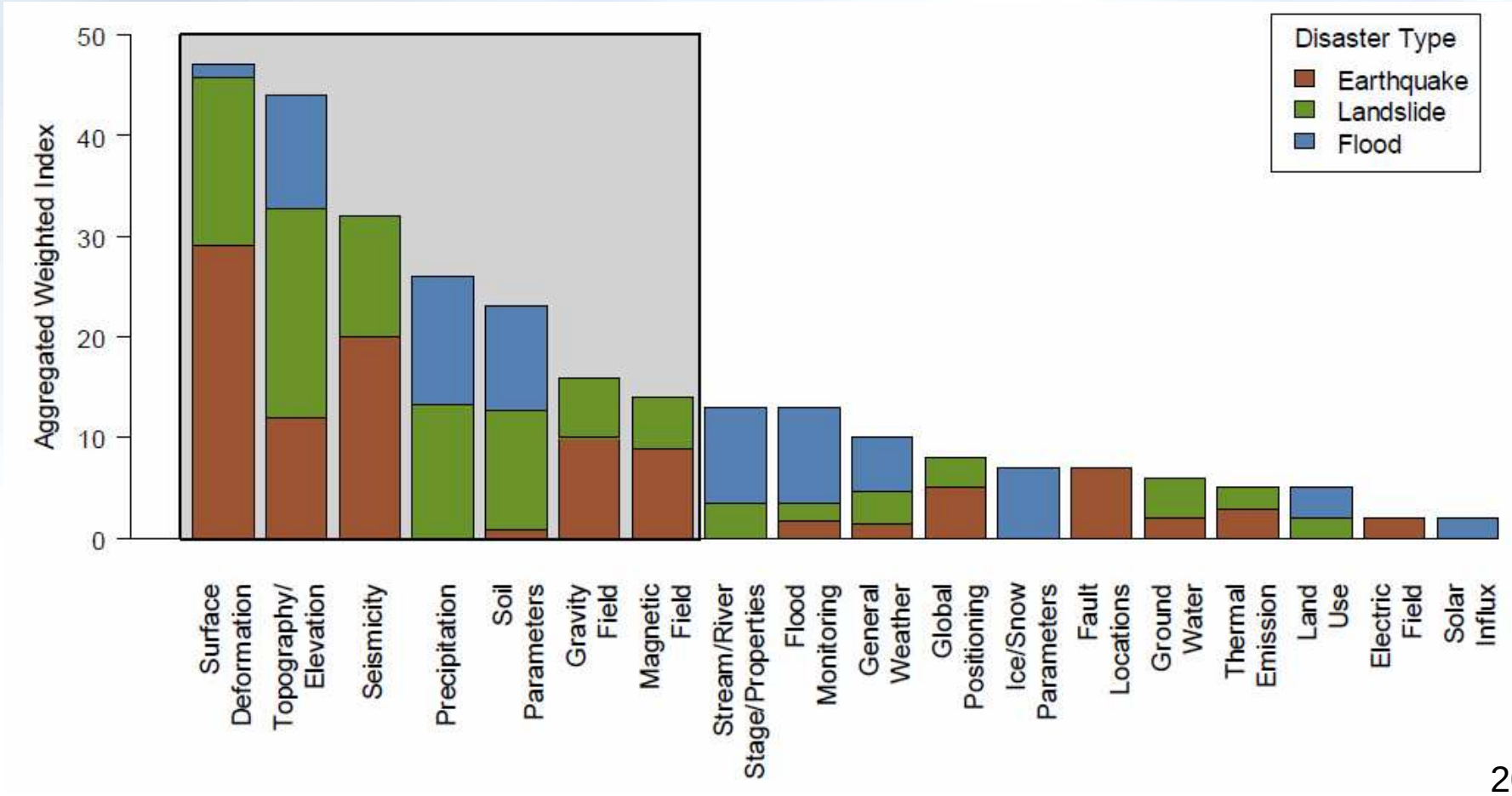
Disasters SBA – Results

- Then, a weighted index of each *observation category* was created by aggregating the scores from all the documents:



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Disasters SBA – Detailed Results (Example)

The 7 categories (each containing several parameters) were chosen for the final prioritization, representing 75% of total weighted score:

1. **Surface deformation**
2. **Topography / Elevation**
3. **Seismicity**
4. **Precipitation**
5. **Soil Parameters**
6. **Gravity Fields**
7. **Magnetic Fields**

Example Priority Parameters for Surface Deformation

		Aggregated Characteristics of Priority Observation Parameters				
Observation Category	**Parameter**	**Coverage/ Extent**	**Spatial Resolution**	**Temporal Resolution**	**Accuracy**	**Latency**
Surface Deformation	Slip	• Seismically active areas • Along active fault lines/ near fault zones	• Moderate to High			
	Slope Movement	• Seismically active areas • Along active fault lines/ near fault zones	• 1 mm - 1 cm	• High Frequency		• Real-Time
	Strain	• Seismically active areas • Along active fault lines/ near fault zones	• 50 – 75 m	• Weekly	• Sub-cm	
	Deformation	• Seismically active areas • Along active fault lines/ near fault zones	• 1 m - 75 m	• 1 sec – 1 week • 1 month - 1 year	• sub-mm – 1 cm	

a Blank fields indicate that no specific requirement was reported in the documents.

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Disasters SBA – Next Steps and Acknowledgements

Next Steps:

- Will conduct another analysis on additional high priority topics (specific topics are to be determined)
- Will build upon “lessons learned” from this experience to further refine techniques

Acknowledgements:

- NASA: US-09-01a Task Co-Lead Lawrence Friedl, Amy Jo Swanson
- Disasters SBA Advisory Group Members
- Battelle: Vince Brown

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Ecosystems SBA Prioritization Results

GEO Task US-09-01a

Analyst Team: Glynis C. Lough, Ph.D, loughg@battelle.org
Thomas C. Gulbransen
Adam T. Carpenter

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16-November-2009

GEO Task US-09-01a

Ecosystems SBA - Scope

- Identify critical Earth observation priorities within Ecosystems SBA
- Selected 3 sub-areas representing major topics of focus in the literature:
  - **Forests**: All types and latitudes; function, structure, composition, and productivity
  - **Coastal and near-shore marine**: Oceans, estuaries, wetlands, and bottom types
  - **Watersheds**: Land cover, extent and location of ecosystem elements, and seasonal and interannual dynamics

GEO Task US-09-01a

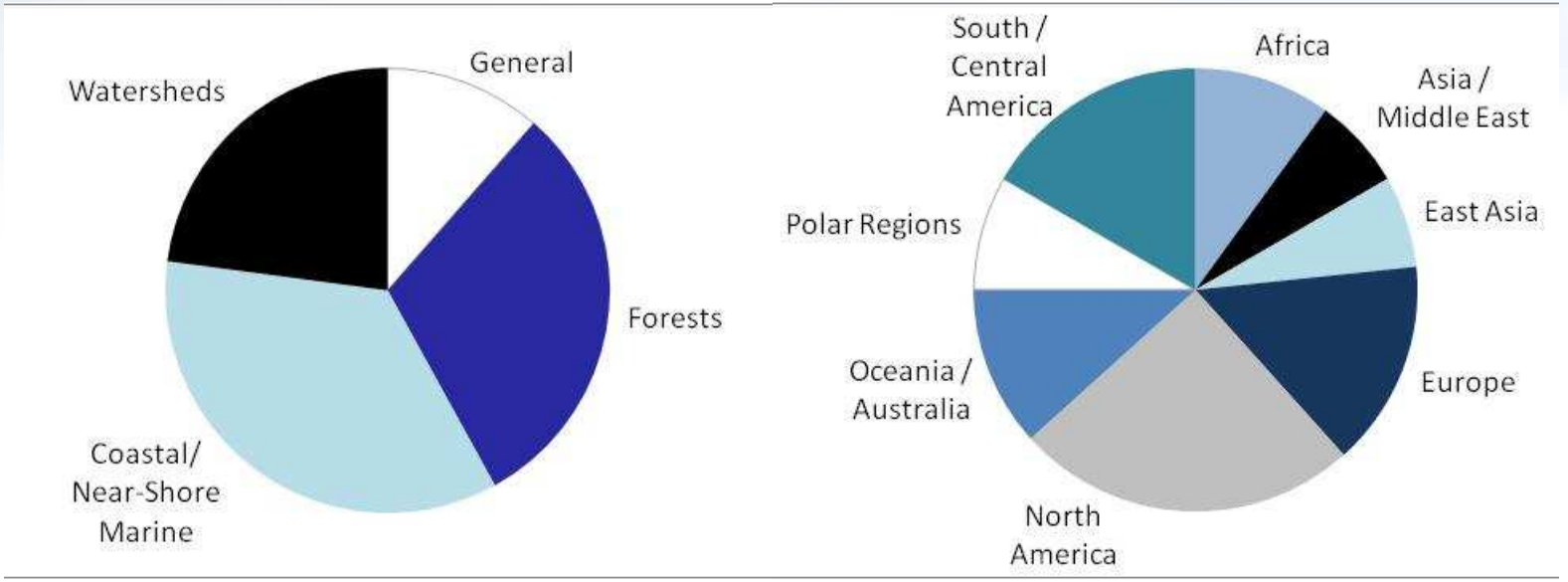
Ecosystems SBA – Advisory Group

NAME	AFFILIATION	GEOGRAPHIC REGION	AREA OF EXPERTISE/ SPECIALTY
Ana Laura Lara DOMINGUEZ	Instituto de Ecologia A.C., Mexico	North America	Coastal/Estuarine ecology and management
Hussam HUSEIN	General Comm. for Scientific Agricultural Research, Syria	Asia/Middle East	Soils and GIS
Sevda IBRAHIMOVA	National Aerospace Agency, Azerbaijan	Europe	Land use and GIS
Anna KOZLOVA	Scientific Centre for Aerospace Research of the Earth, Ukraine	Europe	GIS and Remote Sensing, forest ecosystems
Jorge LÓPEZ-PORTILLO	Instituto de Ecologia A.C., Mexico	North America	Coastal/Estuarine ecology and management
Stuart PHINN	University of Queensland, Australia	Oceania/Australia	Biophysical remote sensing
Mukund RAO	ESRI, India	Asia/Middle East	Remote sensing and GIS
Roger SAYRE	U.S. Geological Survey, USA	North America	Biogeography and remote sensing
Gray TAPPAN	U.S. Geological Survey, USA	North America	Biogeography, remote sensing, and monitoring specializing in Africa
Mphethe TONGWANE	Lesotho Meteorological Services, Lesotho	Africa	Applied Meteorology, Land Use, Climate Change
Andrea Ferraz YOUNG	Population Studies Centre, Brazil	South America	Land use, population issues

GEO Task US-09-01a

Ecosystems SBA - Documents

- Identified 75 documents of relevance, including:
  - 12 consensus documents
  - 44 peer-reviewed journal articles
- Breakdown by Ecosystem Sub-Area
- Breakdown by Region



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Ecosystems SBA – Prioritization Methods

The Analyst Team applied 4 filters to determine the priority ecosystem observations:

1. Frequency of application or recommendation in the documents

2. Applicability across multiple Ecosystem sub-types

3. Combination of parameters derived from the same observations

4. Specific recommendations of Advisory Group members and conclusions of published consensus reports

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Ecosystems SBA – Results

Example of initial parameter prioritization across the 3 sub-types
(Final parameter list included 82 parameters)

Parameter	Documents (#)	Ecosystem Categories (#)	Advisory Group Priority	Consensus Document Priority
Biomass	42	1		2
Biodiversity	35	1		
NDVI	30	2	F	1
Precipitation	29	2		1
Hydrology	29	1	C	
Temperature (surface, air)	28	1		1
Topography	26	1	W	1
Chlorophyll	23	2	C	1
Leaf Area Index (LAI)	22	2	F,W	1
Phenology	22	1		
Salinity	22	1	C	2
Species composition	22	2		2
Evapotranspiration	21	1		1
Primary productivity	21	3		2
Attenuation coeff. (clarity)	21	1		
Albedo	21	1	W	
Nutrients	20	1		2
Pollutants	20	1		3

F = Forests; C=Coastal; W=Watersheds

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Ecosystems SBA – Prioritization Methods

- The final priority list was divided into DIRECT and INDIRECT

- INDIRECT parameters require multiple types of observations, models, time series of measurements, or other methods of derivation and calculation
  - Many of the highly ranked parameters are indirect
  - Ex: biomass, biodiversity, and primary productivity were very frequently mentioned as proxies for mass of total living matter and ecosystem health, but were rarely applied functionally

- DIRECT observations are directly observed, or are obtained from the same type of observations
  - Ex: vegetation indices derived from multiple wavelengths observed simultaneously

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Ecosystems SBA – Priority Indirect Parameters

- Disturbance
- Leaf Area Index (LAI)
- Hydrology
- Biomass
- Primary productivity
- Biodiversity
- Fuel characteristics
- Impervious surface
- Phenology
- Forest structure
- Groundwater
- Carbon (stores, uptake, flux)
- Sedimentation
- Litter (forest)
- River discharge quantity
- Stand density
- Woody vegetation cover

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Ecosystems SBA – Priority Direct Parameters

- Vegetation indices (NDVI, SAVI, EVI)
- PAR, fPAR, FAPAR
- Chlorophyll
- Soil moisture
- Topography
- Salinity
- Precipitation
- Depth (shallow near-shore)
- Sea Level
- Nitrogen
- Species composition
- Evapotranspiration
- Albedo
- Nutrients
- Pollutants
- Bathymetry
- Burned area

- Sea Surface Temperature (SST)
- Ocean color
- Attenuation coefficient (clarity)
- Currents
- Waves
- Submerged Aquatic Vegetation (extent and composition)
- Soil type
- Stand height
- Snow cover extent

GEO Task US-09-01a

Ecosystems SBA - Acknowledgements

- NASA: US 09-01a Task Co-Lead Lawrence Friedl, Amy Jo Swanson
- US 09-01a Task Co-Lead Ellsworth LeDrew, (U. Waterloo, Canada)
- Advisory Group Members
- Battelle: Vince Brown, Tom Gulbransen, Adam Carpenter

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Energy SBA Prioritization Results

GEO Task US-09-01a

Analyst: Erica Zell, Battelle, zelle@battelle.org

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16-November-2009

GEO Task US-09-01a

Energy SBA - Scope

- Identify critical Earth observation priorities within Energy SBA
- Consulted with UIC Task Co-leads and Advisory Group to narrow scope
- Renewable energy electricity generation from:
  - Solar power (CSP and PV)
  - Wind power (onshore and offshore)
  - Hydropower
  - Geothermal
  - Bioenergy

GEO Task US-09-01a

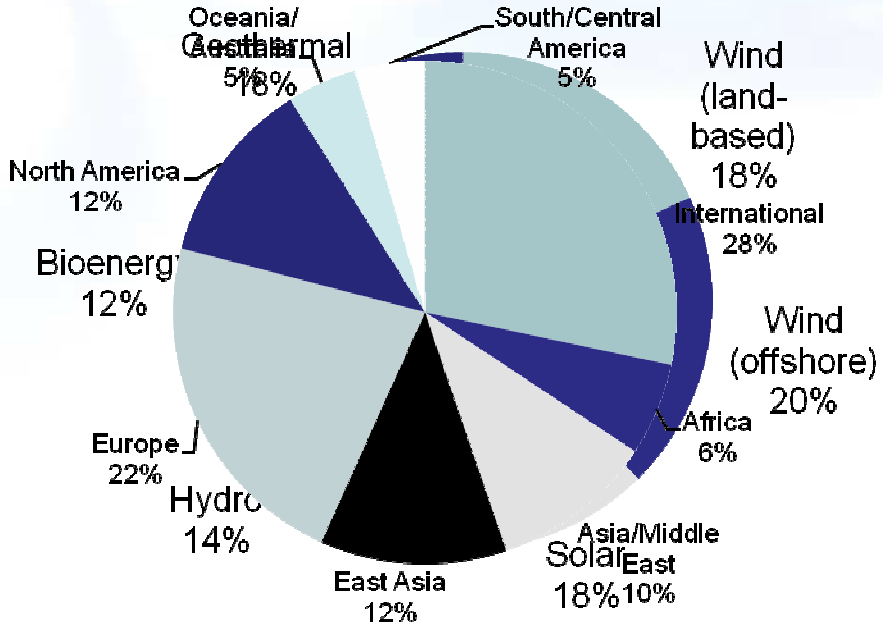
Energy SBA – Advisory Group

Name	GEO Country/ Organization	Affiliation	Geographic Region	Area of Expertise/ Specialty
Charlotte Bay HASAGER	Denmark	Risoe National Laboratory, Technical University of Denmark	Europe	Wind
Amit KUMAR	India	The Energy and Resources Institute (TERI)	Asia/Middle East	Broad renewable energy
Ellsworth LEDREW	Canada	University of Waterloo	North America	Chair of GEOSS Energy COP
Maxwell MAPAKO	South Africa	Natural Resource and Environment, CSIR	Africa	Broad renewable energy
Pierre-Philippe MATHIEU	European Space Agency	European Space Agency	Europe	Broad renewable energy
Richard MEYER	Germany	EPURON GmbH	Europe	Solar
Monica OLIPHANT	Australia	International Solar Energy Society	Oceania/Australia	Solar
Enio PEREIRA	Brazil	INPE (Brazilian National Agency for Space Research)	South/Central America	Broad renewable energy
Thierry RANCHIN	France	Ecole des Mines de Paris and Co-Chair of the GEO Energy Community of Practice	Europe	Broad renewable energy
David RENNE	United States	Department of Energy, National Renewable Energy Laboratory	North America	Solar and wind
Scott SKLAR	United States	Stella Group	North America	Broad renewable energy
Gerry SEHLKE	United States	Department of Energy, Idaho National Laboratory	North America	Hydropower
Han WENSINK	The Netherlands	ARGOSS	Europe	Ocean
Gu XINGFA	China	Institute of Remote Sensing Applications	East Asia	Broad renewable energy

GEO Task US-09-01a

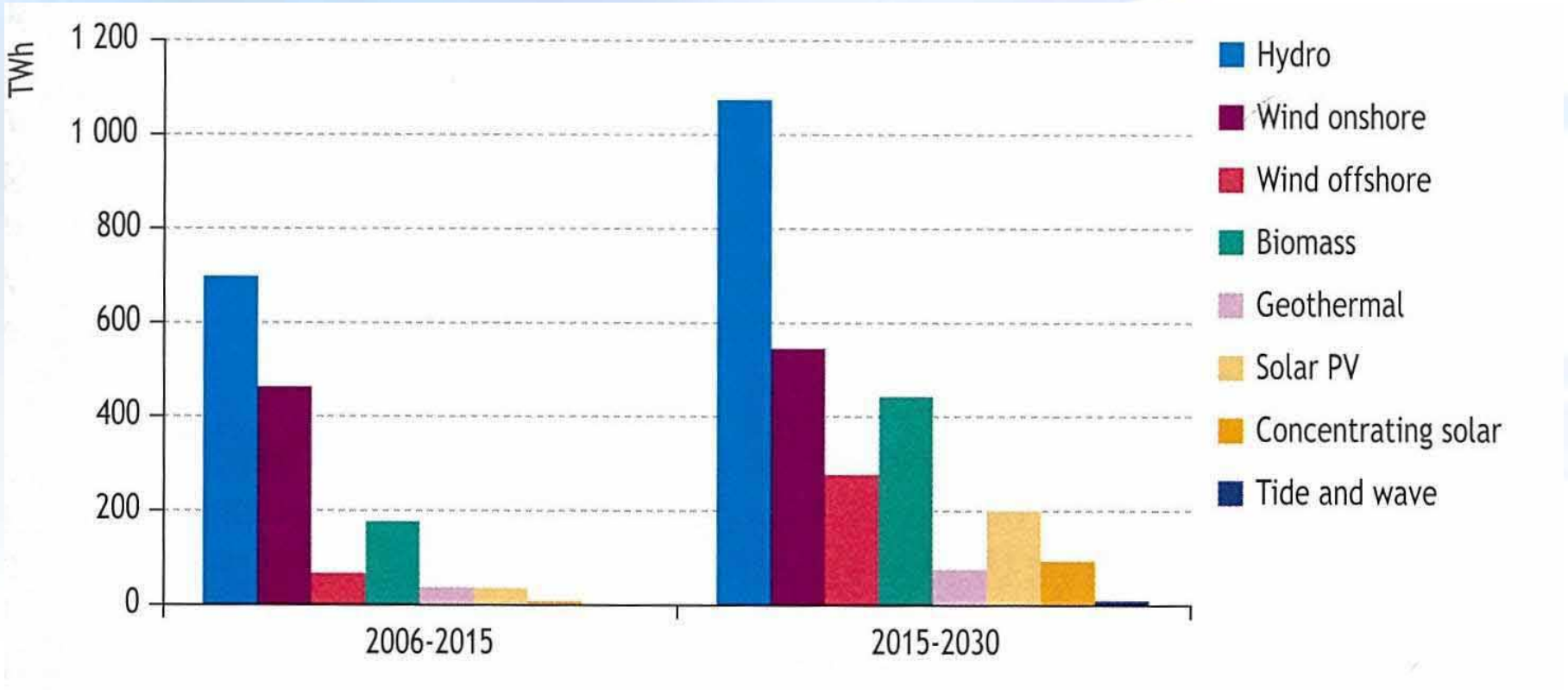
Energy SBA - Documents

- Identified 47 documents of relevance:
  - 8 prioritization documents of international agencies
  - 26 peer-reviewed journal articles
  - 11 gray literature articles
  - 2 websites
- Breakdown by Renewable Energy Type
- Breakdown by Region



GEO Task US-09-01a

Energy SBA – Prioritization Methods



Increase in World Electricity Generation from Renewable Energy in the World Energy Outlook 2008 Reference Scenario.
Source: IEA World Energy Outlook 2008, Figure 7.3

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Energy SBA – Method 1: Results

Priority Parameters based on Cross-Cutting Analysis

Parameter*	Required by # of Renewable Energy Types
Land cover	5
Elevation / topography	5
Wind speed	4
Relative humidity	4
Air temperature	4
Surface temperature	4
Precipitation	4
Wind direction	3

*For each parameter, we considered required characteristics: coverage/extent; spatial and temporal resolution; timeliness; accuracy/precision

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Energy SBA – Method 2: Results

Priority Parameters for High-Ranking Renewable Energy Types

High-Ranking Renewable Energy Type	Priority Parameters Required	
Hydropower	Precipitation Reservoir/lake height Elevation	Water runoff (modeled) Snow water equivalent
Onshore wind power	Wind speed Wind direction	Wind shear Elevation Land cover
Bioenergy	Land cover Net primary productivity Precipitation	Evapotranspiration Normalized Difference Vegetation Index (NDVI)
Offshore wind power	Wind speed Wind direction	Wind shear Wave height
Solar PV and CSP	Global horizontal irradiation (GHI) Direct normal irradiation (DNI) Inclined plane radiation	Air temperature Wind speed Wind direction Relative humidity
Geothermal	Water temperature at depth Fluid Pressure	Rock Permeability Water Chemistry Land Cover

GEO Task US-09-01a

Energy SBA – Integrated Tiered Results

Tier	Parameter	Characteristics of the Observations Parameters				
		Coverage/Extent	**Spatial**	**Temporal**	**Accuracy**	**Latency**
Tier 1	**Precipitation**	Global	0.25 degrees x 0.25 degrees	Monthly	Unknown	Ranges from unimportant, to needed in advance
Tier 1	**Elevation / topography**	Global to site level	1 km^2 to m-scale (5-10 m vertical contours)	One-time measurement	Unknown	Not important
Tier 2	**Wind speed**	Global land surface and marine coastal zone (5-50 km offshore)	<1km^2 to ~20 km^2 horizontal, 10-200m+ vertical	Every 10 – 30 min	Within 10% of annual average wind speed, or within 0.3 m/s	Ranges from unimportant, to needed in advance
Tier 2	**Wind direction**	Global land surface and marine coastal zone (5-50 km offshore)	<1km^2 to ~20 km^2 horizontal, 10-200m+ vertical	Every 10 – 30 min	Within 3 degrees	Ranges from unimportant, to needed in advance
Tier 2	**Land cover**	Global land surface	80m – 10 km	Unknown	Unknown	Unknown
Tier 3	**Relative humidity**	Unknown				
Tier 3	**Air temperature**	Unknown				
Tier 3	**Surface temperature**	Unknown				

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Energy SBA - Acknowledgements

- NASA: US 09-01a Task Co-Lead Lawrence Friedl, Amy Jo Swanson
- NASA and CEOS: Richard Eckman
- US 09-01a Task Co-Lead Ellsworth LeDrew, (University of Waterloo, Canada)
- Advisory Group Members
- Battelle: Vince Brown, Adam Carpenter

Battelle
The Business of Innovation

GROUP ON EARTH OBSERVATIONS

Human Health Infectious Diseases SBA Prioritization Results

GEO Task US-09-01a

Analyst: Pietro Ceccato

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GEO Task US-09-01a

Human Health Infectious Diseases SBA – Scope

- Identify critical E.O. priorities within Human Health Infectious Diseases
- Consulted with UIC Task Co-leads and Advisory Group to narrow scope
- Infectious Diseases include:
  - Vector-Borne Diseases: transmitted by an Arthropod vector (23 diseases)
  - Non Vector-Borne Diseases: transmitted by water, food, body fluids, air or zoonotic hosts (21 diseases)
- Aeroallergens and Air Quality treated separately

GEO Task US-09-01a

Human Health Infectious Diseases SBA – Advisory Group

19 A.G. members

Name	GEO Country or Organization	Affiliation	Geographic Region	Area of Expertise/ Specialty
Ulisses E.C. CONFALONIERI	Brazil	FIOCRUZ	Americas	Remote sensing, Public Health
Stephen J. CONNOR	USA	IRI - WHO – PAHO	Africa Americas Asia	Remote sensing, Environment, Infectious Diseases
Pat DALE	Australia	Griffith University	Australia	Remote sensing, Environment, Infectious Diseases
Joaquim DASILVA	Zimbabwe	WHO - AFRO	Africa	Medicine, Public Health, Disease control systems
Ruth DEFRIES	USA	Columbia University	Africa Americas Asia	Remote Sensing, Land Cover Change
Gregory GLASS	USA	JHBSPH	Americas	Modeling Infectious Disease Risk
John HAYNES	USA	NASA	Americas	Meteorology, Remote Sensing
Darby JACK	USA	MSPH	Africa Americas	Development, economics, environmental health
Isabelle JEANNE	France	Consultant	Africa	Remote Sensing and Public Health

GEO Task US-09-01a

Human Health Infectious Diseases SBA – Advisory Group

Name	GEO Country or Organization	Affiliation	Geographic Region	Area of Expertise/ Specialty
Erick KHAMALA	Kenya	RCMRD	Africa	Remote Sensing
Patrick KINNEY	USA	MSPH	Africa Americas	Public Health
Uriel KITRON	USA	Emory University	Africa Americas	Infectious diseases ecology, GIS, Remote Sensing
Murielle LAFAYE	France	CNES	Europe-Africa	Human Health -Environment
Forrest MELTON	USA	CSUMB	Americas	Remote sensing, ecosystem modeling, decision support system
Jacques André NDIONE	Senegal	CSE	Africa	Climatologist working on Environment Changes and Health issues
Masami ONODA	Switzerland	GEOSS	International	Environmental policy, satellite program management and data policy
David ROGERS	Switzerland	HCF	Africa Americas	In-situ observation and utilization of E.O. information
Leonid ROYTMAN	USA	NOAA-CREST	Asia	Remote Sensing for Infectious Diseases
Juli TRTANJ	USA	NOAA	Americas	Human Health, Oceans

GEO Task US-09-01a

Human Health *SBA - Documents*

- The analysis used literature reviews, internet searches, and Advisory Group recommendations to identify documents which included references to Earth Observation parameters.

- A wide range of documents from **English, Spanish, Portuguese, French and Chinese** literature was examined including:

  - Peer-reviewed documents selected for the period 2000-2009 through:
    - ISI Web of Knowledge,
    - Google Scholar
    - CHAART Remote Sensing/GIS Human Health web site: http://geo.arc.nasa.gov/sge/health/rsgisbib.html
  - Reports obtained from:
    - UN World Health Organization (WHO)
    - UN World Meteorological Organization (WMO)
    - US National Aeronautics and Space Administration (NASA)
    - US National Oceanic and Atmospheric Administration (NOAA)
    - US The National Academies
    - International Federation of Red Cross and Red Crescent Societies (IFRC)

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Human Health SBA - Documents

- Other documents obtained through:

  - Requests made to Universities and Governmental agencies including:
    - Emercom of Russia, Federal Center of Science and High Technologies, Civil Defense and Disaster Management All Russian Science Research Institute, FSO VNII GOChS (FC), http://www.ampe.ru/web/guest/englishProf. Vladimir Badenko, SPb State Polytechnical University, 195251, Saint-Petersburg, Russia
    - Antioquia University, Columbia (email: coocurpme_fcbog@unal.edu.co)
    - Universidad Nacional de Colombia (email: coocurpme_fcbog@unal.edu.co)
    - Ministry of Health and Infectious Diseases Control Bureau in China (emails: service@newhealth.com.cn, manage@moh.gov.cn)

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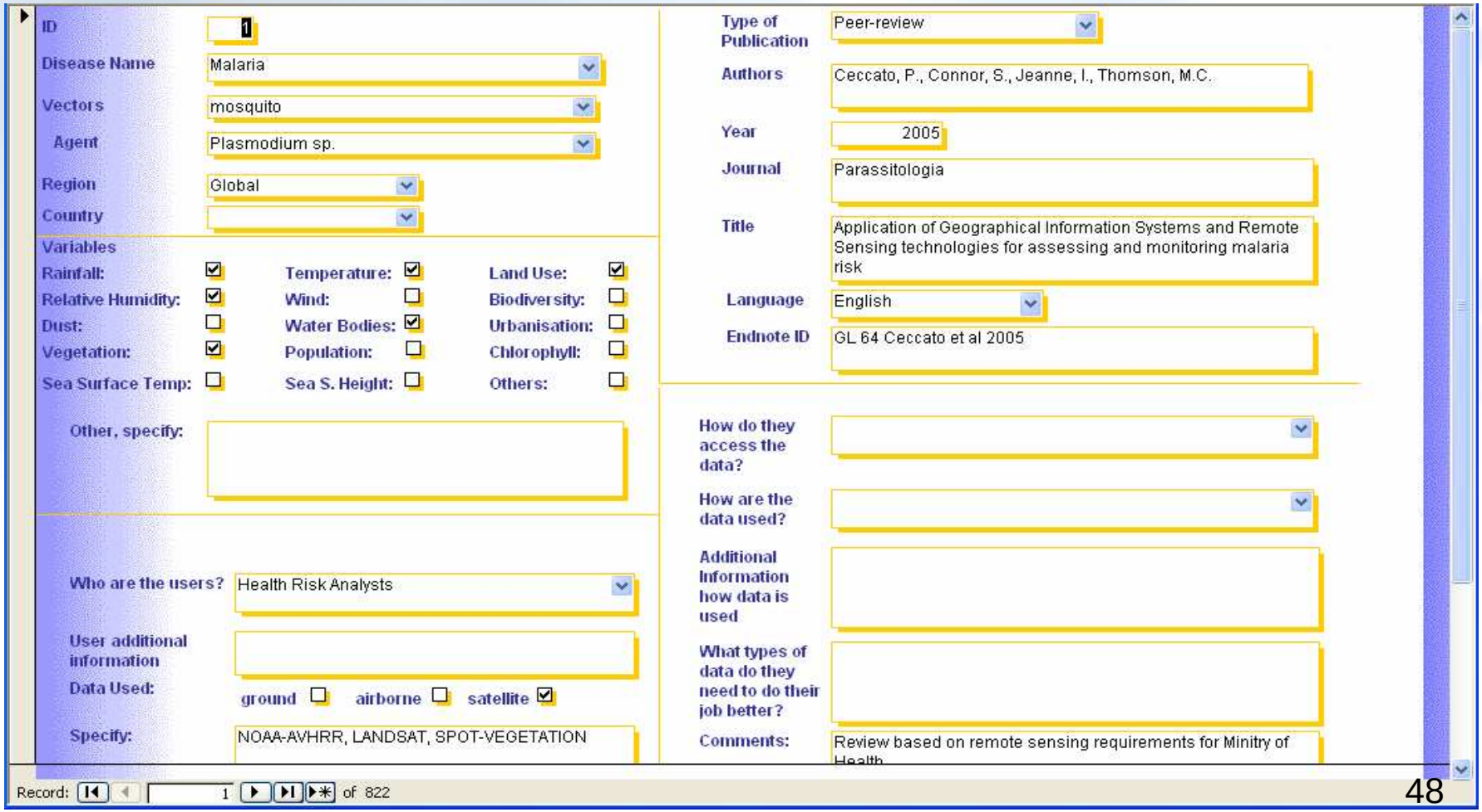
Human Health *SBA - Analysis*

A database was created to analyze the documents



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Human Health *SBA - Documents*

- Identified 822 documents:

Region	Number of Reports
International	198
Africa	130
Asia	198
Europe	64
North America	91
Oceania/Australia	39
Polar Region	1
South/Central America	101

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Human Health *SBA - Prioritization*

- Prioritization of E.O. based on the burden of disease

  - Diseases Burden list produced by UN WHO (2005); based on the "disability-adjusted life year (DALY)" a time-based measure that combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health

  - The E.O. parameters are ranked based on the DALY values using a cumulative impact computed as follows:

$$Cumulative\_Impact = \sum_{i=1}^{n} DALY_i(x_i)$$

Where n = number of diseases; x_i = EO parameter for disease i; and $DALY_i$ = DALY value for disease

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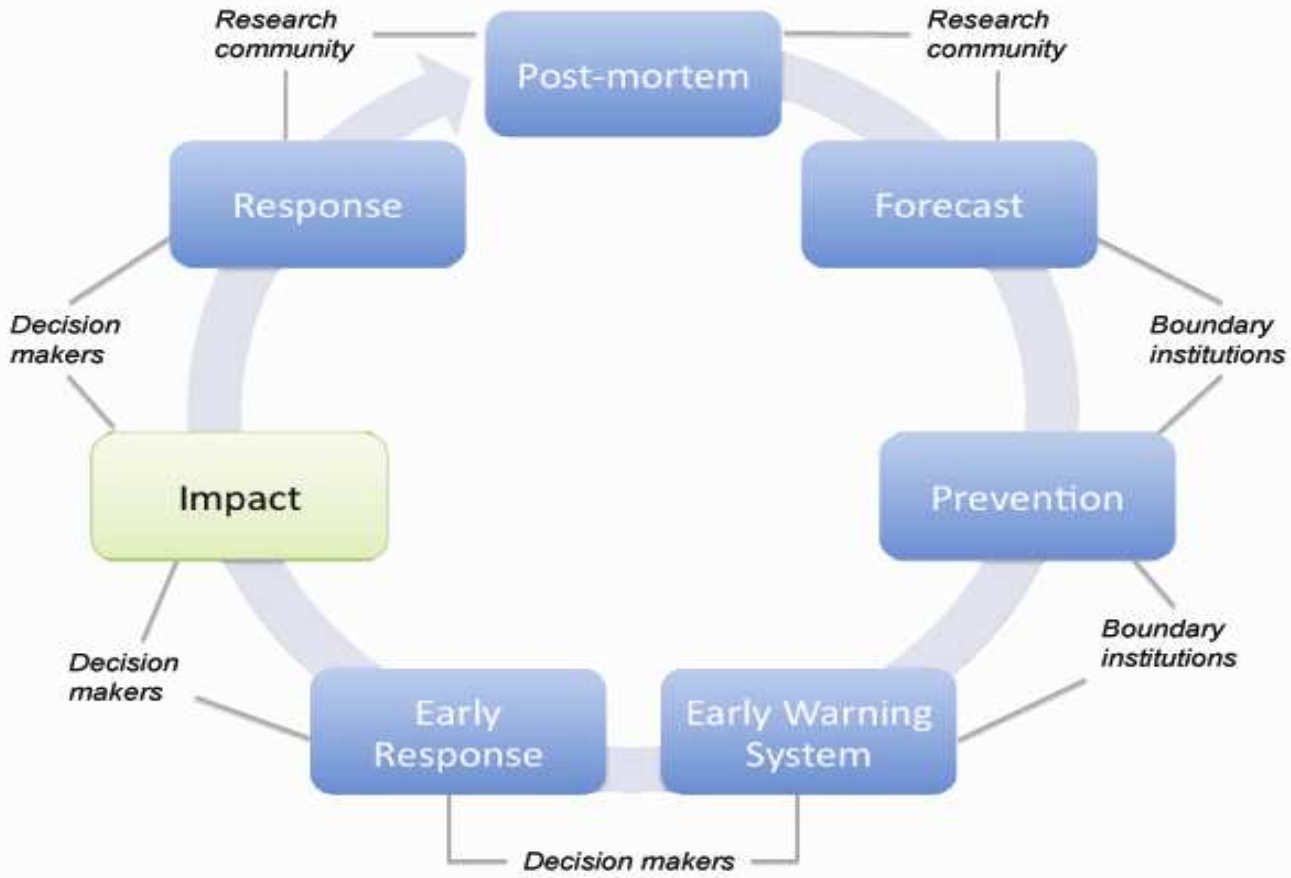
Human Health *SBA - Results*

User Type	Examples found in the literature review and suggested by A.G. members
1. Research Communities	***e.g.*** Modelers, Epidemiologists, Animal health scientists, Biologists, Climatologists, Ecologists, Entomologists, Environmental scientists, Epidemiologists, Geographers, Marine biologists, Parasitologists, Public Health risk modelers, Public health scientists, Remote sensing specialists, Veterinarians, Zoologists, Development researchers, some social science and political science researchers
2. Boundary organizations	***e.g.*** UN WHO, UN WMO, UN FAO, National Meteorological and Hydrological Services, IRI, PAHO and USAID FEWSNet for Malaria Early Warning System, NASA (Applied Sciences Program), NASA SERVIR, Public Health Department Canada (Global Public Health Intelligence Unit), ISID (Pro-MED program), CNES (RedGems), ESA (Epidemio program), IFRC, Institut Pasteur, MARA, RBM, MARC (Australia)
3. Decision Makers	***e.g.*** National and Sub-national Public Health Agencies, Policy Makers, General public, NGOs and Advocacy Group, World Bank

GEO Task US-09-01a

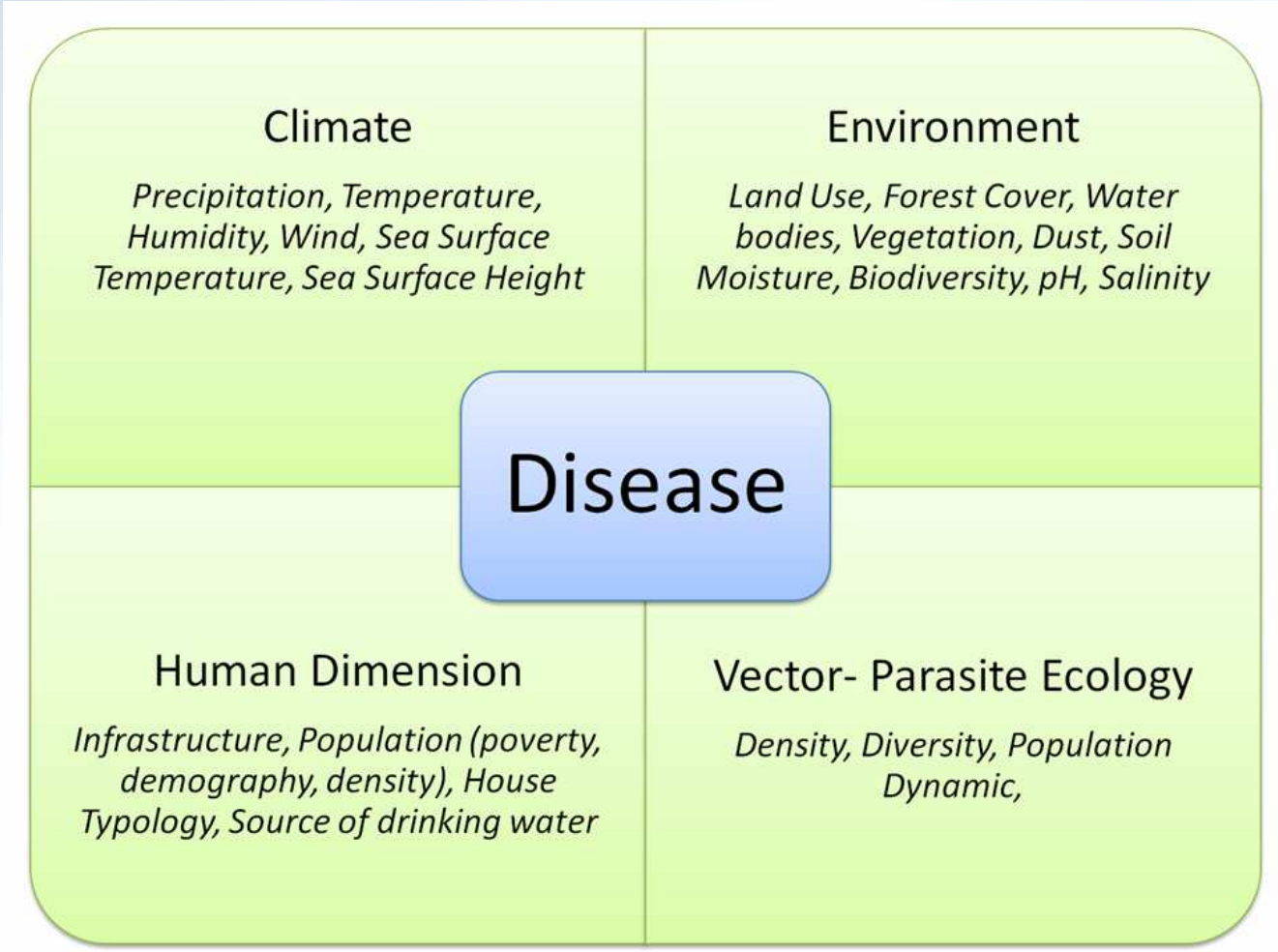
Human Health *SBA - Results*



GEO Task US-09-01a

Human Health *SBA - Results*

Data, Information, Products are classified into 4 Observation Categories



GEO Task US-09-01a

Human Health *SBA - Results*

Observation Category	Parameter		Characteristics of the Observations Parameters					
		Data-Information - Products (in-situ - airborne - satellite)	Coverage/ Extent	Spatial	Temporal	Accuracy	Latency	Disease
Climate								
	Precipitation	**1.In-situ:** Data Weather Stations managed by the National Meteorological and Hydrological Services Products gridded data products derived from station observations	Local. Extent depends on the country infrastructure established by the Met Services, sometimes supplemented by rain gauges installed by the Ministry of Health	Local measurement	Hourly, Daily, 7-days, 10-days, Monthly data	N/A	Depends on the met services (from real-time to days/months later. Data not necessarily free.	Acute Respiratory Virus, African Eye Worm, Barmah Forest Virus, Blue Tongue, Chagas, Chikungunya, Cholera, Dengue, Diarrheal Diseases, Fascioloisis, Hantavirus, Japanese Encephalitis, Leishmianasis, Lyme's Disease, Lymphatic filariasis, Malaria, Meningococcal Meningitis, Plague, Rift Valley Fever, Ross River Virus, Shigellosis, Trachoma, West Nile fever, Yellow fever, Leptospirosis, Plague, Hemorrhagic fever, Fasciolosis, Hantavirus, Plague, West Nile fever

GEO Task US-09-01a

Human Health *SBA - Results*

Observation Category	Parameter		Characteristics of the Observations Parameters					
		Data-Information - Products (in-situ - airborne - satellite)	Coverage/ Extent	Spatial	Temporal	Accuracy	Latency	Disease
Climate								
	Precipitation	**2. Satellite** (GOES, Meteosat, GMS, GOMS, TRMM, SSMI, INSAT) Data: VS, IR, TIR, PM channels Information: rainfall estimate (*e.g.* CCD, CMAP, CMOPRH, RFE, TRMM) Product: rainfall anomalies rainfall forecast (from GCM model outputs)	Sub-national, National, Regional Continental to Global	11km, 0.25°, 0.5°, 1°, 2.5°	3-hourly, Daily, 10-day, monthly data	Depends on the region, time-scale, products used (see Dinku *et al.* 2008a, b; Dinku *et al.* 2007 for more precision on accuracy)	Almost real-time (daily to three days after the last satellite acquisition Rainfall forecast 3-6 months	Acute Respiratory Virus, African Eye Worm, Barmah Forest Virus, Blue Tongue, Chagas, Chikungunya, Cholera, Dengue, Diarrheal Diseases, Ebola, Fascioloisis, Hantavirus, Japanese Encephalitis, Leishmaniasis, Lyme's Disease, Lymphatic filariasis, Malaria, Meningococcal Meningitis, Plague, Rift Valley Fever, Ross River Virus, Shigellosis, Trachoma, West Nile fever, Yellow fever, Ross River Virus

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Human Health *SBA – Results Prioritization*

GEO Task US-09-01a: Priority Earth Observations for Human Health Infectious Diseases SBA Disease Burden Classification		
Diseases	**E.O. Parameter**	**Global Burden (1000 DALYs)**
Influenza (Acute respiratory virus)	Temperature, Humidity, Rainfall, Wind, Urbanization, Population density, Vector population (Bird migration), Land use, Vegetation, Water bodies, Biodiversity, ENSO	94 603
Diarrheal diseases	Rainfall, Water Bodies, Land use, Urbanization, Sea surface temperature, Sea Surface Height, Salinity, Infrastructure (wells, latrines). pH, ENSO, SOI	61 966
Malaria	Rainfall, Temperature, Humidity, Population Density, Vegetation, Water bodies	46 486
Meningococcal meningitis	Temperature, Rainfall, Relative humidity, Wind, Dust, Land use, Population Density	6 192
Lymphatic filariasis	Rainfall	5 777
Intestinal nematodes	Rainfall, Water Bodies, Land use, Urbanization, Sea Surface Temperature, Sea surface height, Salinity, Infrastructure (wells, latrines)	2 951
Trachoma	Rainfall, Temperature, Relative humidity	2 329
Leishmaniasis	Rainfall, Temperature, Land use, Vegetation, ENSO	2 090
Schistosomiasis	Temperature, Water bodies, Land use, Urbanization, Soil moisture, Vegetation, pH	1 702
Africa Trypanosomiasis	Vegetation	1 525
Japanese encephalitis	Rainfall, Temperature, Relative Humidity	709
……		

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Human Health *SBA – Results Prioritization*

GEO Task US-09-01a: Priority Earth Observations for Human Health Infectious Diseases SBA Climate Category		
E.O Parameter	**Data – Information - Products**	**Ranking (Cumulative Impact)**
Precipitation (*R*)	1. In situ measurements 2. Satellite: • Data: Infrared, Thermal Infrared, Passive Microwave channels • Information: rainfall estimates (CCD, RFE, CMAP, CMORPH, TRMM, GPCP) • Products rainfall anomalies, Model output: rainfall forecast	$R_{imp} = 94603+61966+46486+6192$ $+5777+2329+2090+709+667$ $+616+1+1+1+1+1+1+1+1+1+1$ $+1+1+1+1+1+1+1+1+1$ $R_{imp} = 221454$
Sea Surface Temperature (*SST*)	1 In-situ: 2 Satellite: • Data: TIR channels • Information: ENSO, ONI, SOI, PDO, NAO, IOI • Product: model forecast output	$SST_{imp} = 94603+61966+2090$ $+667+616+1+1+1$ $SST_{imp} = 159945$
Temperature (*T*)	1. In situ measurements (Tmin, Tmean, Tmax) 2. Satellite: • Data: TIR channels • Information: Land Surface Temperature (LST) • Products: air Temperature derived from LST, Temperature anomalies, Model output: Temperature forecast	$T_{imp} = 94603+46846+6192+2329$ $+2090+1072+709+667+616$ $+1+1+1+1+1+1+1+1+1+1+1$ $+1+1+1+1+1+1$ $T_{imp} = 155141$
Wind (*W*)	1. In situ 2. Model output (from ECMWF)	$W_{imp} = 94603+6192+1+1$ $W_{imp} = 100797$

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Human Health *SBA – Additional findings*

- Towards more Integration between Epidemiology and E.O.
  - Maintain and strengthen diseases surveillance systems
  - Acquire, archive and access long-term environmental and epidemiological data
  - Develop capacity and train Decision-Makers to analyze and interpret data, information and products
  - ……
- Gaps Analysis
  - Gaps in Data
  - Gaps in Data Delivery
  - Gaps in Development and Feedback Mechanisms for Integrating epidemiology and E.O.
  - …..

GEO Task US-09-01a

Human Health *SBA - Acknowledgements*

- NASA: US 09-01a Task Co-Lead Lawrence Friedl, Amy Jo Swanson
- EPA - ERG
- Advisory Group Members
- Catherine Vaughan, Gilma Mantilla, Gino Chen

GROUP ON
EARTH OBSERVATIONS

Weather SBA Prioritization Results

GEO Task US-09-01a

Analyst:
Michael Nyenhuis, University of Bonn

13th UIC Meeting • Washington, D.C.
16-November-2009

GEO Task US-09-01a

Weather SBA - Scope

- **Focus lies on Earth observations for the Weather SBA, to**
  - "Improve weather information, forecasting and warning" (from GEO TYIP)
- **Sub-areas analysed in this study**
  - Global Numerical Weather Prediction (G-NWP)
  - Regional Numerical Weather Prediction (R-NWP)
  - Synoptic Meteorology
  - Nowcasting and Very Short Range Forecasting (NWC/VSRF)
  - Seasonal and Inter-annual Forecasts (SIA)
  - Aeronautical Meteorology
  - Marine Meteorology / Met-ocean Forecasting
  - Agricultural Meteorology
  - Hydrology / Hydrometeorology

GEO Task US-09-01a

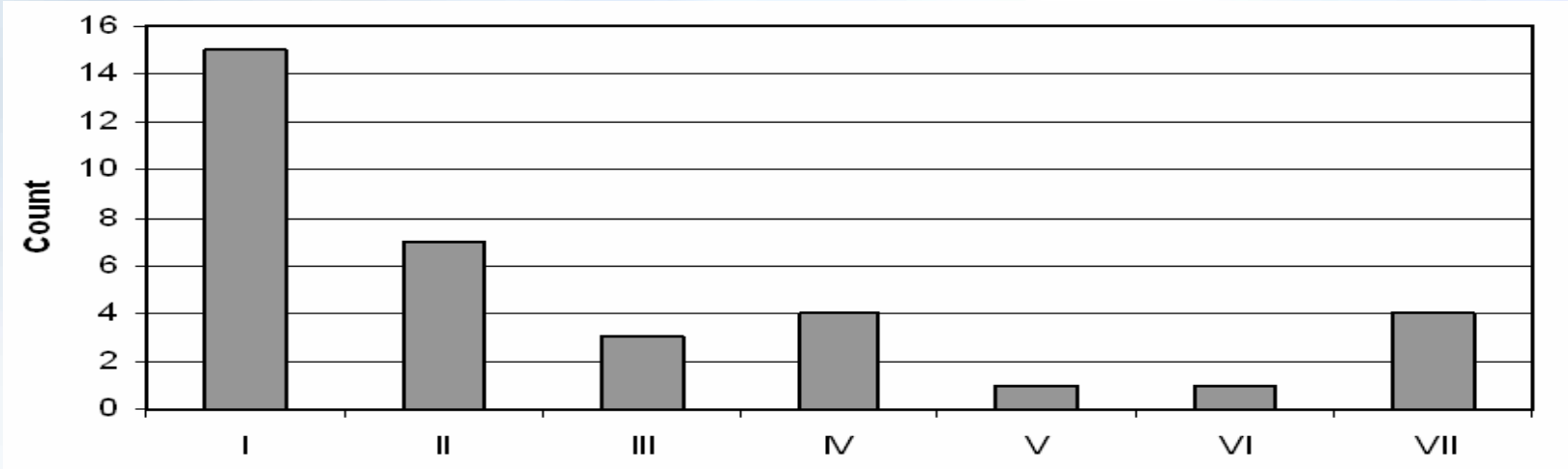
Weather SBA – Advisory Group

Name	GEO Country or Organization	Affiliation	Geographic Region
Manfred Kloeppel	ECMWF	ECMWF	Europe
Paul Counet	CEOS	EUMETSAT	Europe
Robert Husband	CEOS	EUMETSAT	Europe
Jochen Dibbern	EUMETNET	Network of European Meteorological Services	Europe
Jerome Lafeuille	WMO	WMO Space Observing Systems Division, OBS Department	International
Geoffrey Love	WMO	WMO Weather and Disaster Risk Reduction Department (WDS)	International
Wenijan Zhang	WMO	WMO Observing and Information Systems Department	International
Stephan Bojinski	GCOS	GCOS Secretariat	International

GEO Task US-09-01a

Weather SBA – Documents

- **7 document categories**



- 34 documents analyzed (cited)
- 26 contained EO parameters and were used to identify EO priorities
- Int. meteorological organizations have developed mature mechanisms to identify user requirements (esp. WMO RRR)

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Weather SBA – Prioritization

- **3 priority levels**
  - **Level 1:** All relevant EO parameters mentioned in the analyzed literature ("relevant" = all parameters mentioned, discussed, assessed in the available documents, irrespective of assigned priorities)
    > 200 geophysical parameters
  - **Level 2:** All EO parameters, which have been identified as priority parameters in the literature
    > 100 geophysical parameters
  - **Level 3:** High priority EO parameters – subset of the EO parameters identified under Level 2.
    86 geophysical parameters
- **No bibliographical indices were developed**
  - Weighting of documents difficult
  - Frequent cross-references
  - Some application communities refrained from assigning priorities

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Weather SBA – High priority parameters

Source: EUMETSAT position paper

Annex A – User requirements tables

Table 1 of 8		Accuracy (r.m.s.)				Bias	Stabil	Δx (km)			Δz (km)			Δt (h)			δ (h)			Priority		Note
Parameter	Application	Unit	thresh	break	obj		decade	thresh	break	obj	thresh	break	obj	thresh	break	obj	thresh	break	obj	global	hi.lat	
Cloud imagery	NWC, synoptic	MTF^{-1}	10	3.3	1.4			2	0.5	0.1	-	-	-	6	1	0.25	0.5	0.17	0.08	1	1	1
Water vapour imagery	NWC, synoptic	MTF^{-1}	10	3.3	1.4			10	3	1	2 layers	3 layers	5 layers	6	3	0.25	0.5	0.17	0.08	2	1	2
Cloud mask	NWP global	HR/ FAR	80/25	90/15	95/10			2	0.5	0.1	-	-	-	12	3	1	6	2	0.5	2	2	3
	NWC,NWP regional	HR/ FAR	85/20	95/10	98/5			2	0.5	0.1	-	-	-	6	1	0.5	0.5	0.35	0.25	3	2	3
Cloud cover profile	NWP global	%	20	10	5			50	15	5	1 layer	2 layers	3 lay	12	3	1	6	2	0.5	1	1	4,5
	NWP regional	%	20	10	5			20	5	2	1 layer	2 layers	3 lay	6	1	0.5	0.5	0.35	0.25	1	1	4,5
	climate	%	20	5	1	1	0.3	250	50	5	1 layer	3 layers	0.1	12	6	3	720	72	6	1	1	4,5
Cloud type	NWP regional	Classes	6	8	10			20	5	2	-	-	-	3	1	0.5	0.5	0.35	0.25	4	4	
	NWC, synoptic	Classes	6	8	10			20	5	2	-	-	-	3	1	0.5	0.5	0.35	0.25	2	1	5a
	climate	Classes	4	6	10			250	50	5	-	3 layers	0.1	12	6	3	720	72	6	3	4	
Cloud optical depth	NWP global	%	50	20	10			50	15	5				12	3	1	6	2	0.5	1	1	6
	NWP regional	%	50	10	10			20	5	2				6	1	0.5	0.5	0.35	0.25	2	1	6
	climate	%	20	10	5	10	2	250	50	5	-	-	-	24	6	3	720	72	6	2	2	6
Cloud top height	NWP global	km	1	0.5	0.2			50	15	5	-	-	-	12	3	1	6	2	0.5	2	2	7
	NWP regional	km	1	0.5	0.2			20	5	2	-	-	-	6	1	0.5	0.5	0.35	0.25	3	2	7,8
	NWC, synoptic	km	1	0.5	0.2			10	3	1	-	-	-	6	1	0.25	0.5	0.35	0.25	3	2	8
	climate	km	1	0.5	0.2	0.15	0.03	250	50	5	-	-	-	12	6	3	720	72	6	2	2	
Cloud top temperature	NWP global	K	5	2	1			50	15	5	-	-	-	12	3	1	6	2	0.5	1	1	
	NWP reg., NWC	K	5	2	1			20	5	2	-	-	-	6	1	0.5	0.5	0.35	0.25	2	1	
	climate	K	5	1	0.3	1	0.2	250	50	5	-	-	-	12	6	3	720	72	6	2	2	
Cloud base height	NWP global	km	1	0.5	0.2			50	15	5	-	-	-	12	3	1	6	2	0.5	3	3	
	NWP reg., NWC	km	1	0.5	0.2			20	5	2	-	-	-	6	1	0.5	0.5	0.35	0.25	4	3	
	climate	km	1	0.5	0.2	0.5	0.1	250	50	5	-	-	-	12	6	3	720	72	6	3	3	
Height of tropopause	NWC, synoptic	km	1	0.5	0.25			300	100	30	-	-	-	24	6	1	6	2	0.5	3	3	
Height of the	NWC,	km	0.4	0.2	0.1			150	50	15	-	-	-	12	3	1	6	2	0.5	3	3	
Freezing level height in clouds	NWP global	km	1	0.5	0.25			50	15	5	-	-	-	12	3	1	6	2	0.5	4	4	9
	NWP reg., NWC	km	0.5	0.25	0.1			20	5	2	-	-	-	6	1	0.5	0.5	0.35	0.25	4	4	9
	NWP global	km	0.5	0.25	0.1			50	15	5				12	3	1	6	2	0.5	4	4	9

Thank you !

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universitätbonn Geographie

GROUP ON
EARTH OBSERVATIONS

Water SBA Prioritization Results

GEO Task US-09-01a

Analyst: Sushel Unninayar, sushel.unninayar@nasa.gov

13th UIC Meeting • Washington, D.C.
16-November-2009

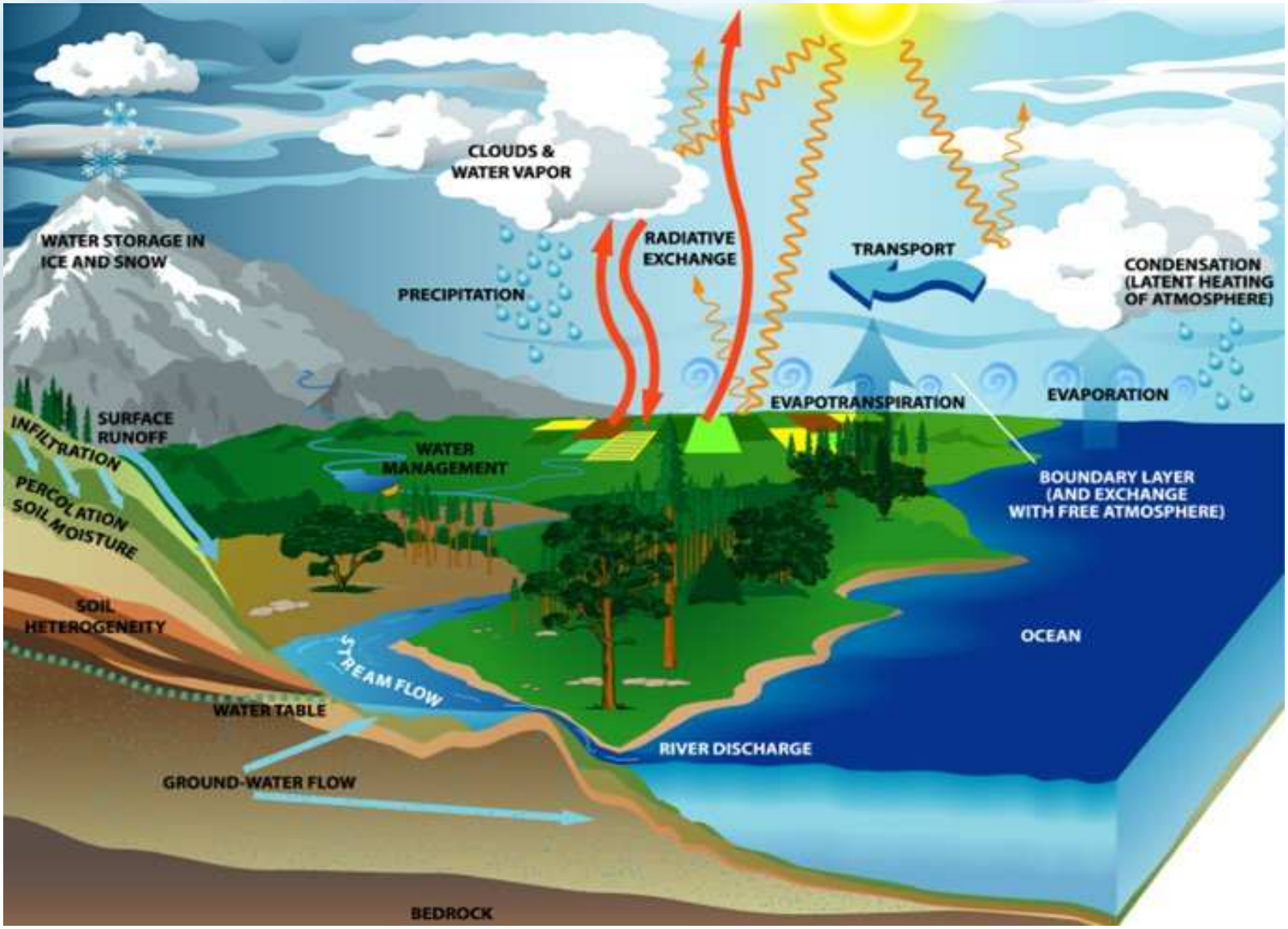
GEO Task US-09-01a

Water SBA – Advisory Group

Name	Country / Organization	Affiliation	Geographic Region	Area of Expertise
Abou Amani	Ghana	Unesco	Africa	Hydro/W-Resource
Maria Donoso	Paraguay	Unesco	South America	Hydro/W-Resource
Jay Famiglietti	USA	UC-Irwine	N-America & Global	Hydro & Climate
Wolfgang Grabs	Switzerland	WMO/HWR	Internatnl & Reg. Assoc I - VI	Hydro/W-Res/Clim
Stephen Greb	USA	State of Wisconsin & USGS	North America & International	Hydro/W-Resource & W-Quality
Annuka Lipponen	Belgium	UN-ECE	Balkans, Caucasus, Central Asia	Trans-boundary Waters
Jinping Liu	Indonesia	UN-ESCAP	Asia & Pacific	Typhoon Committe
Julius Wellens-Mensah	Ghana	Hydro Dept—Accra, Ghana & WMO-TC	Africa	Hydrology & W-Resources
Massimo Menenti	Austria	EC & CEOP	Europe/Global	Hyd/W-Res/R-Sens
Osamu Ochai	Japan	JAXA/CEOS-Water	Asia & Global	R-Sensing
Bruce Stewert	Australia	BoM & WMO	Asia & Pacific & International	Hydo/Agromet/Weather/Climate
Jeniffer Read (TBI)	USA	U. Wisc & Mich-Seagrant	Great Lakes-US/Canada	Hydro/W-Res Man
Rick Lawford GEO-UIC-Water	Canada	U. Winn; UMBC; IGWCO; CoP	International-Global	Hydro/W-Resources, et al
Masami Onoda	Switzerland	GEOSEC	International	International

GEO Task US-09-01a

Water SBA – Global Water Cycle



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Water SBA – Requirements/User Needs

SYSTEM STATE VARIABLES

ATMOSPHERE-COMPONENT

- wind (I/s)[**W**]
- upper air temperature (I/S)[**W**]
- surface air temperature (I/s)[**W**]
- sea level pressure (I)
- upper air water vapor (I/S)[**W**]
- surface air humidity/Wv (I/s)[**W**]
- precipitation (I/S)[**W**]
- clouds (i/S)**[W]**
- liquid Water content (i/S)[**W**]

FORCING OR FEEDBACK VARIABLES ON ATMOSPHERE

- **sea surface temperature (I/S) [W]**
- **land surface soil moisture/temperature (i[/s)[W]**
- **land surface structure and topography (I/S) [W]**
- **land surface vegetation (I/S)[W W**
- **GHGs, ozone & chemistry, aerosols (i/S)[W]**
- **evaporation and evapotranspiration (i/s)[W]**
- **snow/ice cover (i/s)[W]**
- **SW and LW radiation budget--surface (i/s)[W]**
- **Solar Irrad. & Atm. SW/LW radiation Budget (S)**

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Water SBA – Requirements/User Needs

SYSTEM STATE VARIABLES

OCEAN-COMPONENT

- upper ocean currents (I/s)
- surface ocean temperature (I/S)[W]
- sea level/surface topography (I/S)
- upper ocean surface salinity (I/s)[W]
- sea ice (I/S)[W]
- mid and deep ocean currents (i)
- sub-surface thermal structure (I)
- sub-surface salinity structure (I)
- ocean biomass/phytoplankton (i/S)

FORCING OR FEEDBACK VARIABLES ON OCEAN

- ocean surface wind & wind stress (i/S) [W]
- incoming surface shortwave radiation (i/s)
- downwelling longwave radiation (i/s)
- surface air temperature/humidity (I/s)[W]
- precipitation (fresh water/salinity flux) (i/s)[W]
- fresh water flux from rivers & ice melt (i/s)[W]
- evaporation (i/s)[W]
- geothermal heat flux--ocean bottom (i)
- organic & inorganic effluents (into ocean) (i/s)

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Water SBA – Requirements/User Needs

SYSTEM STATE VARIABLES-

TERRESTRIAL: LAND/WATER

- topography/elevation (I/S) [W]
- land cover (I/S)[W]
- soil moisture/wetness (I/s)[W]
- soil structure/type (I/s) [W]
- vegetation/biomass vigor (I/S)[W]
- Water runoff (I/s)[W]
- surface ground temperature (I/S)[W]
- snow/ice cover (I/S)[W]
- sub-surface temp & moisture (I/s)[W]
- soil C,N,P, nutrients (I)
- necromass (plant litter) (i)
- sub-surface biome/vigor (i)
- land use (I/S)[W]
- ground water (& subterra flow)(i/s)[W]

FORCING/FEEDBACK VARIABLES ON TERRA-L/WATER COMPONENT

- incoming shortwave radiation (I/S)[W]
- net downwelling longwave radiation (i/s)[W]
- surface winds (I)[W]
- surface air temperature & humidity (I/s)[W]
- evaporation & evapotranspiration (i/s)[W]
- precipitation (I/S)[W]
- land use & land use practices (I/s)[W]
- deforestation, (i/s) [W]
- human impacts--land degradation (i/s) [W]
- erosion, sediment transport (i/s) [W]
- Fire occurrence (I/S) [W]• volcanic effects (on surface) (I/s)

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Water SBA – Requirements/User Needs

SYSTEM STATE VARIABLES

TERRESTRIAL: LAND/WATER (CONTD)

- **lakes and reservoirs (I/S)[W]**
- **rivers and river flow (I/s) [W]**
- **glaciers and ice sheets (I/S)[W]**
- **water-turbidity, N, P, dissolved O (I/s)**

FORCING OR FEEDBACK VARIABLES ON TERRA—L/WATER (CONTD)

- **biodiversity (i/s)**
- **chemical (fertilizer/pesticide & gas exchange) (i)**
- **waste disposal & other contaminants (i) [W]**
- **earthquakes, tectonic motions (I/S)**
- **nutrients and soil microbial activity (i)**
- **coastal zones/margins (I/S)[W]**

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Water SBA - Focus

- **Water SBA Sub-Areas:**

- (1) **Surface Waters and Fluxes** (Primarily, Land Surface Water Cycle Processes);

- (2) **Ground Water Processes** (Including Recharge/Discharge & Regolith Processes…);

- (3) **Forcing Elements on Terrestrial Hydrology** (E.g., Surface Meteorology/Hydromet, Surface Radiation budget and Clouds, etc …)

- (4) **Water Quality & Water Use** (Including Organic, Inorganic, Isotopic & Nutrient/Contaminant Fluxes, and E.g., Water Demand/Draw/Regulation etc……)

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Water SBA – Prioritization Criteria

- **Not Constrained By Existing Observing System Technology—Special Attention on Deficiencies/Gaps in Existing (Legacy) Statements of Priority Variables/Parameters**
- **Not Constrained by Existing National, Regional, International Data Exchange Systems**
- **Includes:**
- **Physical/Dynamical Characteristics of Global/Regional/Local Water Cycle System and Processes**
- **Use or "Requirements for Use" of W-C Data in Various Applications (User Sectors)—Leading to Substantive Societal Benefits**
- **Consideration of both System State Variables and Forcing/Feedback Variables—The Latter Determine "System" Variability and Long-Term "Change"**
- **Consideration of Derived Variables/Parameters—Algorithmic, Dynamical/Empirical Models, Analysis Schemes, DSS, etc**

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Water SBA - Documents

	International Documents-- International Organizations, Agencies— Programs/Projects/Studies/Reports/Papers	Regional &/0r National-- Agencies, Institutes, Programs, Projects, Studies…	Local/National/ Sub-National— Agencies, Institutes, Programs, Projects, Studies….
Global-Scale: Generally referring to large-scale requirements for global observations and data exchange systems/platforms	N(1,1)	N(1,2)	N(1,3)
Regional-Scale: Includes multi-national, trans-boundary, and/or multi-state/province within large countries/regions	N(2,1))	N(2,2)	N(2,3)
Local-Scale: Generally referring to national or sub-national and local area space scales	N(3,1)	N(3,2)	N(3,3)

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Water SBA – Priority Variables

- **(1) Surface Waters, Fluxes, and Processes:**
- Precipitation (liquid/snow/ice)
- Soil Moisture/Temperature (Surface and Vadose Zone)
- Evaporation and Evapotranspiration
- Runoff & Stream Flow/River Discharge/Stage…
- Lake/Reservoir-Area/Level/Depth….
- Snow/Ice Cover & Depth/SWE & Freeze-Thaw Margins,….
- Glaciers/Ice Sheets, Permafrost, Frozen Ground—Area/Depth/Mass balance…
- **(2) Ground Water (Including Recharge/Discharge & Regolith Processes)**
- Ground Water Table and Charge/Recharge Rates
- Aquifer Levels, Geologic Stratification, Volumetric…
- Soil type/Texture, Composition, Porosity/Conductivity..
- **(3) Forcing Elements (e.g., Surface Meteorology, Surface Radiation Budgets and Clouds**
- SW, LW Surface Radiation Budgets, Albedo, Emissivity, and Clouds
- Surface Air Temperature, Relative Humidity/Specific Humidity, Winds, Pressure..
- Vegetation Cover/Type, Land Cover & Land Use
- Topography and/or Geology
- **(4) Water Quality and Use**
- Water Quality/Composition—Organic/Inorganic/Isotopic
- Nutrient and Contaminant Effluents/Fluxes into Water Bodies
- Water Sources, Water Demand/Use & Regulation

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Water SBA – End-User Applications

- Water Resource(s) management
- Climate and Global Change
- Weather and Extremes
- Climate Prediction (S-to-IA)
- Industrial and Economic Aspects
- Environmental Aspects/Dimensions
- Emergency Management Aspects
- Transportation Industry Needs
- Health and Water Related Vectors
- Tourism and Recreation

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Water SBA – User Needs Parameters

Sub-Areas----->		Surface Waters / Gnd W	Precipitation (liquid/snow/ice)	Soil Moisture/Temperature (Surface & Vadose Zone)	Evaporation & Evapotranspiration	Runoff & Stream Flow / River Discharge (Stage-...	Lake/Reservoir Area/Level/Depth	Snow/Ice Cover & Depth/SWE/Freeze/Thaw Margins	Glaciers/Ice Sites, Permafrost/Frozn Grnd-areal/depth	Gnd Wat r Sate & Change/Recharge/Infiltration Rates	Aquifer Levels, Geologic Stratification, Volume	Soil Hydraulic Properties, Composition, Conductivity...	Surface Radiation Budget & Albedo-SW, LW & Clouds	Hydromet-Stc, Air Temp, Humidity/Moisture, Winds, Press...	Vegetation Cover/Type, Land Cover & Land Use	Topographic-and/or Geological and Geomorphological	Water Quality/Composition--Organic/Inorganic/Isotopic	Nutrient/Contaminant Effluents/Fluxes--Water Bodies	Sources/Demand/Use/Consmptn/Withdrawals-Surface/Groundwater/Demndgr	Obs-Time Series+Statistics & Paleo/Proxy	Dynmic/Statistical Model Outp/Analysis	Decision Support Information/Output	Average Score	Average Score Excluding LOW 1's ("Yellow") Cells
COLR CDE/#VALUE	HIGH		10			MED				5				LOW			1			N/A					
WATR RES. MANGMNT																								
Resrch Hydrology		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	5	9.8	9.8
Lnd Sfc/Hydro Modeling		10	10	10	10	10	10	10	5	10	10	10	10	10	10	5	10	10	10	10	10	9.5	9.5
Stream/River Frcasting		10	5	5	10	10	10	10	5	5	10	5	10	10	10		5	1	10	10	10	7.9	8.3
Flood Forecasting		10	10	10	10	10	5	5	10	5	10	5	10	10	10	1	5	1	10	10	10	7.9	8.6
Reservoir Management		10		10	10	10	10	10	5	5	5	10	10	10	10	10	10	10	10	10	10	9.2	9.2
Water Res. Allocation		10	5	5	10	10	10	5	10	10	10	5	10	10		10	10	10	10	10	10	8.9	8.9
Water Res. Planning		10	5	5	10	10	10	10	10	10	10	5	10	10	10	10	10	10	10	10	10	9.3	9.3
Urban Water Supply		10			10	10	10	5	10	10			10	10	1	10	10	10	5	10	10	8.8	9.3
Water Qualty Managmnt		10	1	1	10	5	1	1	5	10	5	1	1	10	5	10	10	10	5	5	10	5.8	7.9
Drought Monitoring		10	10	5	10	5	5	1	5	1	1	5	10	5	1	1	1	1	1	10	10	5.4	7.7
Drought Forecasting		10	10	10	10	5	10	1	5	1	1	1	10	5	1	1	1	1	10	10	10	5.7	8.8
Drought Miti. Mangmnt		10	1	1	10	10	10	5	10	10	5	1	10	10	10	5	5	10	1	5	10	6.8	8.7
Flood Control Managmnt		10	10	1	10	10	5	5	10	5	10	1	5	10	10	5	10	10	5	5	10	7.4	8.1
Flood Control Planning		10	10	1	10	10	5	10	10	5	10	1	5	10	10	5	10	10	5	5	10	7.6	8.3
Catchment Management		10	10	10	10	10	5	10	10	10	10	10	10	10	10	1	10	10	10	10	10	9.3	9.7
CLIMATE & GLOBAL CHANGE																								
UN/IPCC		10	10	10	10	1	5	10	5	5	1	10	10	10	5	1	1	1	10	10	10	6.8	8.7
UN/FCCC		10	10	10	5	1	5	10	5	1	1	10	10	10	5	1	1	1	10	10	10	6.3	8.6
Climate Science		10	10	10	10	10	10	10	10	10	5	10	10	10	10	5	5	5	10	10	10	9.0	9.0
Clim. Adapt/Mitigatn		10	10	5	10	10	10	10	5	10	5	10	10	10	10	10	10	10	10	10	10	9.3	9.3
Climate Chnge Modeling		10	10	10	5	1	10	10	5	5	5	10	10	10	10	1	5	1	10	10	10	7.4	8.5
Downscaling Glob--Reg		10	10	10	10	5	10	1	10	10	5	10	10	10	10	1	5	1	10	10	10	7.9	9.1
Clim. Simulatn Modeling		10	10	10	5	5	10	10	5	5	5	10	10	10	10	1	5	1	10	10	10	7.6	8.3
WEATHER & EXTREMES																								
Weather Research		10	10	10	1	5	10	1	1	1	1	10	10	10	10	1	1	1	10	10	10	6.2	9.6
Weather Forecasting		10	10	5	5	5	10	1	1	1	1	10	10	5	10	1	1	1	10	10	10	5.9	8.5
Hurricanes		10	1	1	1	10	1	1	5	1	1	1	10	10	1	1	1	1	10	10	10	4.4	9.4
Storm Surge		10	1	1	5	10	1	1	5	1	5	1	10	10	10	5	5	1	10	10	10	5.6	8.1
Snow/Blizzrd/Avalanch		10	1	1	1	1	10	1	1	1	1	5	10	10	10	1	1	1	10	10	10	4.8	9.4
Tornadoes		10	1	1	1	1	1	1	1	1	1	1	10	10	1	1	1	1	10	10	10	3.7	10.0
CLIMATE PREDICTN (S&A)																								
Med-Term W-Predictn		10	10	5	1	1	10	1	1	1	1	5	10	5	5	1	1	1	10	10	10	5.0	8.2
Mnthly-Season Predictn		10	10	10	1	1	10	1	1	1	1	5	10	5	5	1	1	1	10	10	10	5.2	8.6
Interannual Clim Predictn		10	10	10	5	5	10	5	1	1	1	5	10	5	5	1	1	1	10	10	10	5.8	7.9
Clim Applicatns Analysis		10	10	5	10	10	10	5	5	10	1	10	10	10	10	10	10	5	10	10	10	8.6	8.9
Clim. Impacts Analysys		10	10	5	10	10	10	10	10	10	1	10	10	10	10	10	10	5	10	10	10	9.1	9.5
INDUSTRY/ECONOMIC																								
Agronomy/Farming		10	10	10	10	5	10	5	10	10	10	10	10	10	10	1	5	10	10	10	10	9.5	9.5
Irrigation Scheduling		10	10	10	10	10	10	1	10	10	10	10	10	10	10	1	5	10	10	10	10	8.9	9.7
Hyd-Power Enigneering		10	1	10	10	10	10	5	1	1	1	1	1	5	1	10	1	1	10	10	10	5.9	9.2
Energy(other) Enginrng		10	1	5	5	5	5	1	1	1	1	1	5	1	1	1	1	5	10	10	10	4.0	7.0
Hting/cooling Enginr		5	1	10	1	1	10	1	1	1	1	5	10	1	1	1	1	5	10	10	10	4.3	8.3
Land Use Planning		10	10	1	10	1	10	1	10	10	10	10	10	10	10	10	10	10	10	10	5	8.2	9.4
Insurance Industry		1	1	1	10	1	1	1	1	1	1	5	10	5	10	1	1	1	10	10	5	4.0	7.0
Urban Planners		5	10	1	5	5	10	1	5	5	10	5	10	10	10	10	10	10	10	10	5	7.4	8.1
City Developmnt Zoning		5	10	1	5	5	10	1	5	5	10	1	10	10	10	10	10	10	10	1	10	7.0	8.4
Inland Water Fisheries		5	1	1	10	10	1	1	1	1	1	1	10	10	5	10	10	10	10	1	10	5.5	9.1
Coastal Fisheries		5	1	1	5	1	1	1	1	1	1	1	10	1	1	10	10	1	10	1	10	3.7	8.6
ENVIRONMENTAL																								
Forest Management		10	10	5	10	5	10	5	10	5	10	10	10	10	10	10	10	5	10	5	10	8.5	8.5
Forest Conservation		10	10	5	10	5	10	5	10	5	10	10	10	10	10	10	10	5	10	5	10	8.5	8.5
Ecosystems		10	10	5	10	5	10	1	10	5	10	10	10	10	10	10	10	10	10	5	10	8.6	8.9
Env. Engineering		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10.0
Env. Imapact Assessmnt		10	10	1	5	10	10	10	10	10	10	5	10	10	10	10	10	10	10	10	10	9.1	9.5
Estuary Management		5	10	1	10	10	1	1	1	1	5	5	10	10	10	10	10	10	10	5	10	6.5	8.3
Wetland Conservation		10	10	5	10	10	5	1	10	10	10	10	10	10	10	10	10	10	10	5	10	8.8	9.2
Sea Level Rise		1	5	1	1	1	10	1	1	1	10	1	1	5	10	1	1	1	10	10	10	4.1	8.8
Salinity & Intrusion		10	5	1	10	5	1	1	10	1	10	1	1	5	10	10	1	1	5	10	10	5.4	8.3
EMRGNCY MANGMNT																								
Fire Prevention Planning		10	10	5	5	10	10	1	1	5	5	1	10	10	5	1	1	1	1	1	10	5.2	7.9
Fire Fighting		10	5	1	1	1	1	1	1	5	5	10	10	10	5	1	1	1	1	1	10	3.6	7.5
Env. Potect. Managmnt		10	10	5	10	10	10	5	5	1	10	10	10	10	5	10	10	10	10	10	10	8.9	8.9
Nat. Disaster Managemnt		10	5	1	10	5	5	1	1	10	10	1	10	10	5	10	5	5	10	5	10	6.5	7.8
Nat. Haz. Risk Assessmnt		10	5	1	10	5	5	1	10	5	10	1	10	10	5	10	5	5	10	5	10	6.7	7.6
TRANSPORTATION																								
Civilian Use/demand		10	5	1	1	5	10	1	1	1	5	1	10	10	5	10	1	10	1	1	10	5.0	8.2
Road/Traffic Managemnt		5	1	1	1	1	10	1	1	1	1	1	10	10	5	1	1	1	10	5	10	3.9	8.1
Aviation Control		10	1	1	1	1	10	1	1	1	1	1	10	1	1	1	1	1	5	5	10	3.2	8.8
Shipping Control		5	1	1	1	1	10	1	1	1	1	1	5	1	1	1	1	1	5	5	10	2.7	6.7
Airlines		10	1	1	1	1	10	1	1	1	1	1	10	1	5	1	1	5	5	5	10	3.6	7.5
Coastal Navigation		5	1	1	1	1	10	1	1	1	1	1	5	1	1	5	1	1	5	5	10	2.9	6.4
River/Canal Transport		5	1	1	5	10	10	1	5	5	5	1	5	5	1	5	1	1	5	5	10	4.4	6.2
HEALTH																								
Epidemiology		10	10	1	1	1	5	1	1	1	1	1	10	5	1	5	5	1	10	10	10	4.5	8.0
Disease Outbrk Predictn		10	10	5	1	1	1	1	1	1	1	1	10	5	1	10	5	1	10	10	10	4.8	8.5
Water Qual. Assessmnt		10	5	1	10	10	1	1	10	10	10	1	1	10	1	10	10	10	10	5	10	6.8	9.3
Water Pollutn Forecstng		10	5	1	10	10	1	1	10	10	10	1	1	10	1	10	10	10	5	5	10	6.6	8.9
TOURISM/RECREATN																								
Hotel Management		5	1	1	1	5	10	1	1	1	1	5	10	10	5	10	1	1	1	1	5	3.8	7.2
Beach Resort Mngmnt		10	1	1	5	5	1	1	1	1	1	5	10	5	5	10	1	1	1	1	5	3.6	6.7
Skii Resort Managmnt		10	5	1	1	1	10	10	1	1	1	5	10	5	10	5	1	1	5	5	10	4.9	7.5
Travel Planning		5	1	1	1	1	10	1	1	1	1	5	10	1	10	10	1	1	1	1	5	3.4	7.9
Lake Resort Managmnt		10	1	5	10	10	5	5	5	1	5	5	10	10	10	5	10	5	5	5	10	6.7	7.6
Others--TBD																								
Average Score (AS)		9	6.542	4.452	6.554	5.892	7.297	3.838	5.068	4.644	5.028	5.000	8.851	8.027	6.671	5.795	5.297	5.000	8.338	7.284	9.662		
AS Excl Yellow("1's")		9	9	8	9	8	9	8	8	8	8	8	9	9	8	9	9	9	9	8	10		

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Water SBA – User Needs Parameters

WATER-SBA DATA USE/NEEDS: PARAMETER(S), USER CLASSES BY CATEGORY (SUB-AREA) and USER TYPE/FUNCTION & PRIORITY RANKING	Critical Terrstr-Water Cycle Parameter(s)	Precipitation (liquid/snow/ice)	Soil Moisture/Temperature (Surface & Vadose Zone)	Evaporation & Evapotranspiratn	Runoff & Stream Flow /River Discharge /Stage..	Lake/Reservoir-Area/Level/Depth	Snow/Ice Cover & Depth/SWE/Freeze/Thaw Margins	Glaciers/Ice Shts, Permafrst/Frozn Grnd-area/depth	Grnd Watr Table & Charge/Recharge/Infiltration Rates	Aquifer Levels, Geologic Stratification, Volumetric	Soil type/Textur Porosity/C
Sub-Areas----->		Surface Waters / Gnd W							<-GW&R / Forcing><WQ/ Use>			
COLR CDE/#VALUE	HIGH		10			MED			5			L
WATR RES. MANGMNT												
Resrch Hydrology		10	10	10	10	10	10	10	10	10	10	
Lnd Sfc/Hydro Modeling		10	10	10	10	10	10	10	5	10	10	
Stream/River Frcasting		10	5	5	10	10	10	10	5	5	10	
Flood Forecasting		10	10	10	10	10	5	5	10	5	10	
Reservoir Management		10		10	10	10	10	10	5	5	5	
Water Res. Allocation		10	5	5	10	10	10	5	10	10		
Water Res. Planning		10	5	5	10	10	10	10	10	10	10	
Urban Water Supply		10			10	10	10	5	10	10		
Water Qualty Managmnt		10	1	1	10	5	1	1	5	10	5	
Drought Monitoring		10	10	5	10	5	5	1	5	1	1	
Drought Forecasting		10	10	10	10	5	10	1	5	1	1	
Drought Miti. Mangmnt		10	10	1	10	10	10	5	10	10	5	
Flood Control Managmnt		10	10	1	10	10	5	5	10	5	10	
Flood Control Planning		10	10	1	10	10	5	10	10	5	10	
Catchment Management		10	10	10	10	10	5	10	10	10	10	

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Water SBA – User Needs Parameters

Table 5-a: Priority/Critical Water Cycle Variables/Parameters for Terrestrial Hydrology & Water Resources—Space/Time Resolutions, Accuracy, Latency, Documentation References

Primary/Critical Terrestrial Water Cycle Variables and Parameters	Horiz. -Res.	Time-Res.	Vert.-Res. Height/Depth	Accuracy/Units	Latency	Doc. Refs. (Sub-Set Exmpls)
SUB AREA-1: SURFACE WATERS (SW)						
Precipitation (liq./solid) **[Sub-Area: SW]**	L: 1km R: 10km G: 50 to 100 km to 500km Also stated variably as 5km to 50km etc.	L: 1 hr R: 3 hr G: 1 d. Also stated variably as: 0.08hr to 0.5hr; 1h to 12h, or 1d to 3d	N/A [Standard Height]	0.1mm/5% Also stated variably as: 0.1mm/h to 1mm/h or 0.5mm/hr to 3mm/hr; 0.5 mm/d to 5 mm/d; 2 mm/d to 10mm/d	0.1h to 6h or 3 hr-24hr; 1 d-2d; 7d to 30d; or RT and DT (App. Dependent)	GEO-10 A-45 E-65 C-24 C-78 G-37 W-WM SOG-H IGWCO WMO GCOS GTOS FAO WCRP IGBP NRC
Soil Moisture	L: 0.1km to 1km	L/R: 1 to 6 hrs (1-10d	10 cm Res. to 1m	0.02 m^3/m^3. Or stated variably	Stated variably as	GEO-10 A-45

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Water SBA - Acknowledgements

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