Needs Assessment for the Use of NASA Remote Sensing Data for Regulatory Water Quality

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Our project

NASA ROSES Solicitation: NNH08ZDA001N-DECISIONS

Title: *Satellite Earth Image Products Applied to the Development of Regulatory Water Quality Standards*

A better understanding of the causes and both short-and long-term effects of increased Kd (Light attenuation, loss of light), *Chl*-a (chlorophyll *a*), TSM (total suspended matter) and CDOM (colored dissolved organic matter), at regional scales, is needed to develop protective standards for valued aquatic resources and ecosystems in estuarine and coastal regions of the Gulf of Mexico

***Project Description**: Therefore, the goal of this project is to provide information for decision-making activities (water quality standards) using remotely sensed/satellite based water quality data: Kd, Chl-a, TSM and CDOM from MODIS and Landsat*

Decision-making overview

The following must be explicitly identified *as related to the current status of water quality decision-making activities so that remote sensing data can be used* :

- What is the decision-making activity to be enhanced or created?
- What management, business or policy topics does this activity serve?
- What quantitative information is required regarding it's use?
- What are the end-user organizations and their responsibility and/or mandate that they are required to address?

Understanding the water quality decision-making process

- What is the decision-making activity?
- What is the end-users' current basis for making these decision?
- Who uses this information and how do they use it in their decision-making process?
- What analyses will this information support and what actions and decision will be made?
- What measures/metrics will users employ to determine the value or quality of their decision-making?
- What are the reasons and needs for creating the decision making activity?

Understanding the water quality decision-making requirements

The following must be quantified,

Pre-project:

baseline performance of the decision-making activity, using end-users' measures, as well as other quantitative measures to track progress

Since specific decision making activities are being defined:

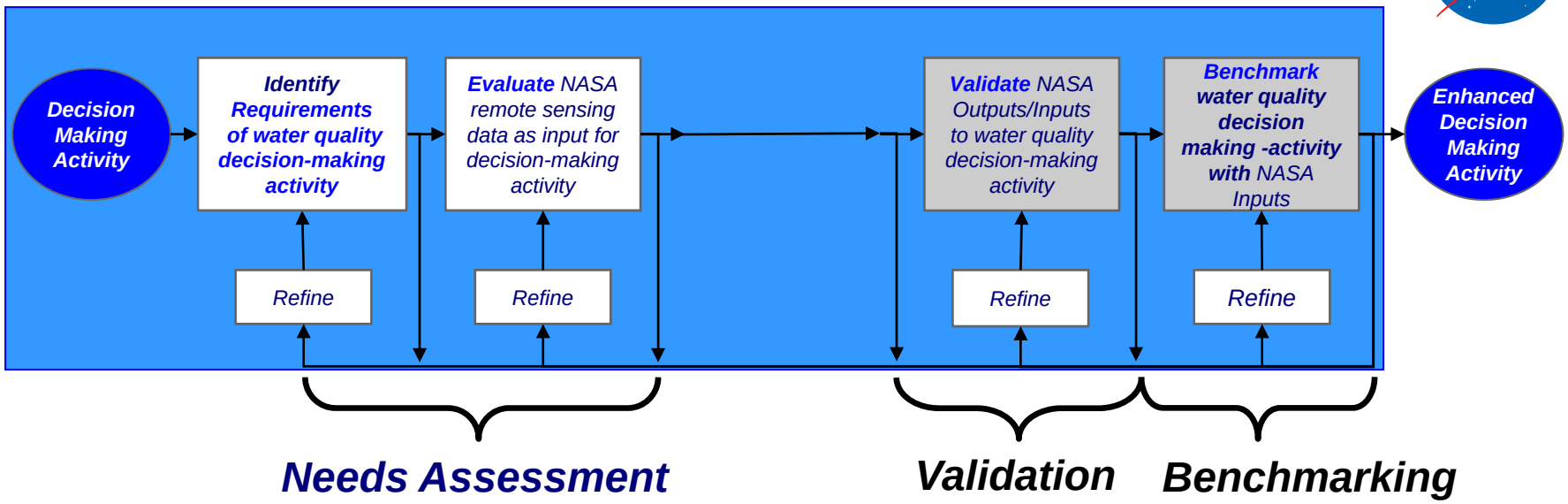
The baseline performance of the end-user's decision making process/capability must be quantified, and is done so via a **Needs Assessment**

For our project, we must understand user's/decision-maker's needs

We will perform a **Needs Assessment**

- By making assessments of light requirements to support healthy communities of Submerged Aquatic Vegetation (SAV) and coral reefs
- By making assessments of historical Kd, *Chl-a*, TSM and CDOM
- And then by providing technical guidance on use of remote sensing imagery in the development of water quality standards for decision making activities

Systems Engineering/Systematic approach



Use of *Systems Engineering/Systematic approach* to attain scalable and sustainable solutions and processes, which in turn can increase the success of meeting the goals and objectives of water quality monitoring

This method implements:

- ***Needs Assessment***
- **Validation**
- **Benchmarking**

Evaluating water quality monitoring requirements

- Need Assessment
  - Assess requirements for coastal water quality decision makers
  - Quantify remote sensing requirements by analyzing responses to questions/questionnaire
  - Provide information back to project PI and inform as to users need
- Validation
  - Validation of any tailored NASA remote sensing inputs for developing new decision-support tools
  - Then, assess how project currently does vs. requirements
- Benchmark
  - Assess the use, usefulness, and usability of the implemented water quality information products
  - See how professionals judge effect of remote sensing data upon decision making framework

Why is a Needs Assessment important?

The key points of a successful **Needs Assessment** are:

- To **identify** the relevant decision makers served by the decision support
- To **understand** decision maker information **requirements** for decisions related to water quality
- To **trace** those to decision support input requirements
  - Ideally, water quality requirements, as defined by the CWA, are formulated as specifications, but may be
    - Varied from state to state
    - Formulated without reference to decision maker information requirements
    - Not well defined
- End result: remotely sensed decision support input requirements can be correlated with appropriate NASA observations, products or models

Facilitate a Needs Assessment in August

- We want to understand **framework for decision-making** regarding water quality
  - What decisions are made
  - What parameters affects decision making
- We want to understand **what are the requirements** used to make these water quality decisions
  - **Trace** these requirements to physical measurements
  - **Trace** these requirements to remote sensing data, if applicable
    - How accurate do these measurement need to be
    - How often do these measurements need to be taken
- **Use and Usability**
  - How do you like the current information that you use to support decision making
    - i.e. sufficient, too little, timely enough, confident enough

What is the decision-making framework?

- EPA Clean Water Act (CWA), Section 303,
  - development of numeric water quality standards
- State requirements
  - FDEP, Florida Department of Environmental Protection, Chapter 62
    - Florida Administrative Code (FAC)
    - Impaired Waters Rule
  - ADEM, Alabama Department of Environmental Management, Water Division Water quality Program, chapter 335-6-10, Water Quality Criteria
  - MDEQ, Mississippi Department of Environmental Quality
    - State of Mississippi Water Quality Criteria
  - LDEQ, Louisiana Department of Environmental Quality,
    - Water Quality Assessment Division

Ex: Decision-making framework for FDEP

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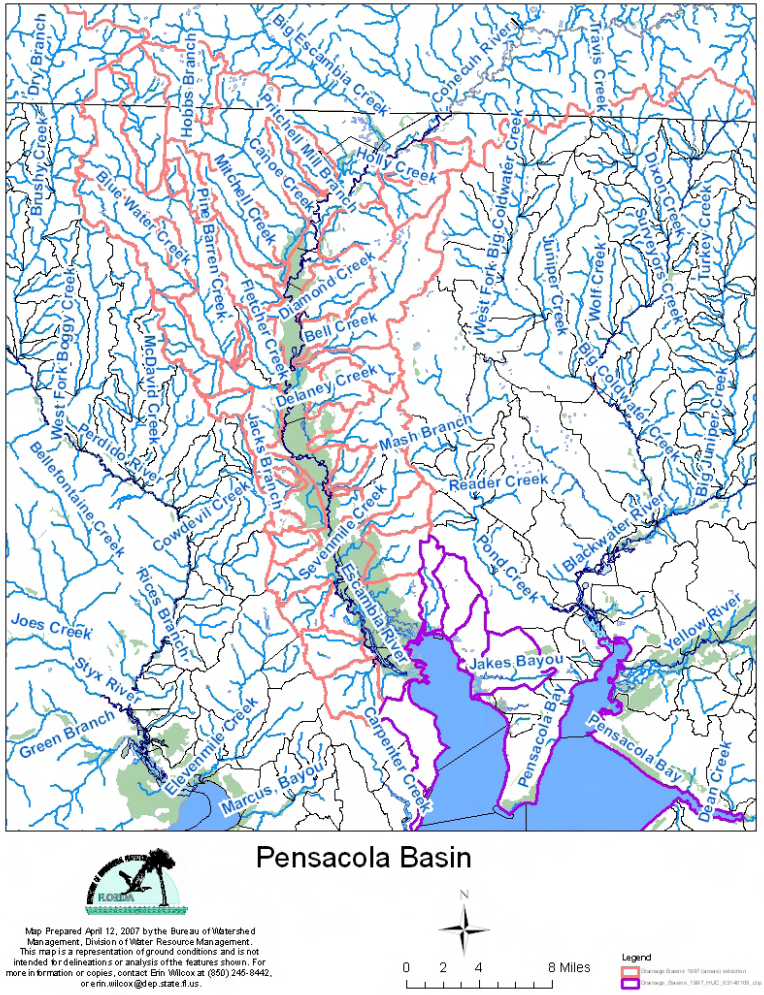

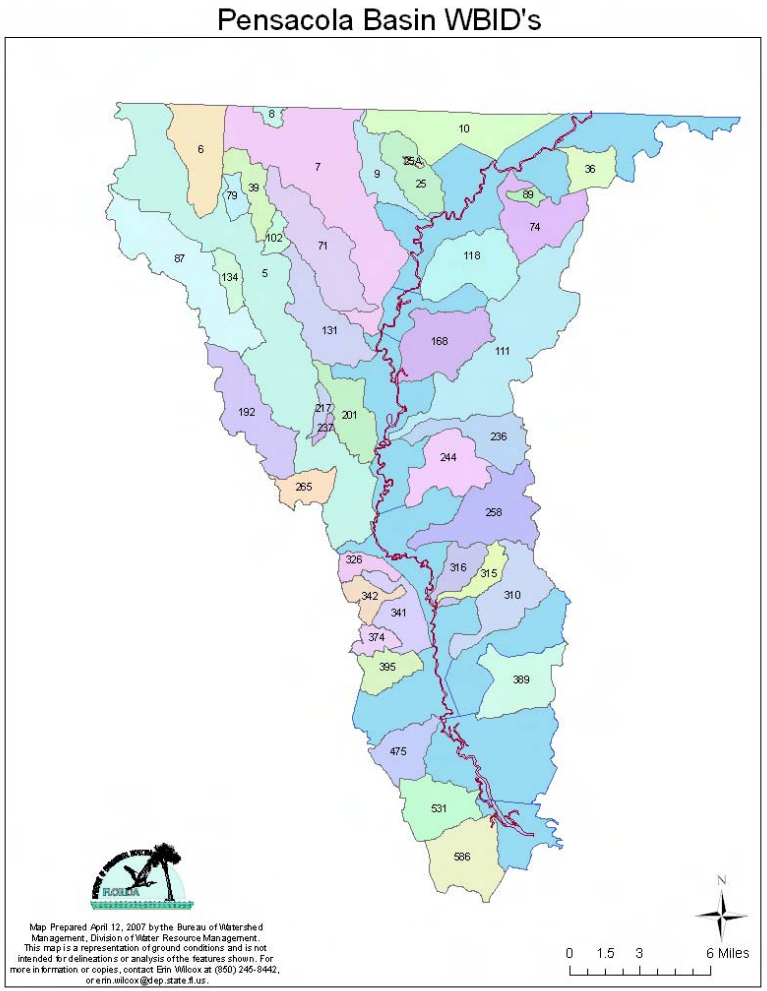

Proposed TOTAL MAXIMUM DAILY LOAD (TMDL)For Nutrients In Escambia Bay WBID 548A,
Prepared by: US EPA Region 4, 61 Forsyth Street SW Atlanta, Georgia 30303 ***September 2007***

Verified impaired segments in Pensacola Bay

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WBID	Waterbody Segment	Parameters Identified Using the IWR	Priority for TMDL Development	Projected Year for TMDL development
676	CARPENTER CREEK	Fecal Coliform	Low	2011
738	TEXAR BAYOU	Fecal Coliform	Low	2011
846	BAYOU CHICO	Fecal Coliform	High	2006
915	SANTA ROSA SOUND	Fecal Coliform (Shellfish Harvesting	Medium	2012
548A	ESCAMBIA BAY (N)	Nutrients (Historic Chlorophyll)	High	2006
548AB	FLORIDATOWN PARK	Nutrients (Chlorophyll) Medium	Medium	2012
548BB	BAY BLUFFS PARK	Bacteria	Medium	2012
548FB	NAVY POINT	Bacteria and Fecal Coliform	Medium	2012
548H	EAST BAY	Nutrients (Historic Chlorophyll)	Medium	2012
738AB	BAYVIEW PARK PIER	Bacteria and Fecal Coliform	Medium	2012
846A	JONES CREEK	Fecal Coliform	Low	2011
846B	JACKSON CREEK	Dissolved Oxygen, and Fecal Coliform	Low	2011
846CB	BAYOU CHICO BEACH	Bacteria, Nutrients (Chlorophyll), and Fecal Coliform	Medium	2012
848DA	SANDERS BEACH	Bacteria and Fecal Coliform	Medium	2012
915A	WOODLAWN BEACH	Bacteria	Medium	2012
915B	NAVARRE PARK HWY 98	Bacteria	Medium	2012
915C	LIZA JACKSON PARK	Bacteria	Medium	2012
915D	MARLER	Bacteria	Medium	2012
8999	GULF COAST	Mercury (in fish tissue)	Low	2011

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What are the water quality decision-making requirements?

- Designated Use: from a water regulatory standpoint, what is the end point that is being protected?
  - Fishable
  - Swimmable
  - Oyster harvest
  - Seagrass beds
  - Fresh water
  - Industrial
  - Agricultural
- TMDLs (Total Maximum Daily Load)
  - For what is being protected, is water body not meeting designated use?
    - Is it listed impaired?
    - Why is it listed this way?
    - What values constitute impairment?

What are remote sensing requirements?

Based on insights into remote sensing measurements that can/do support decision making, what are requirements for those measurements?

- What remote sensing **parameters** should be measured?
  - Kd, Chl-*a*, CDOM, TSM
- **How often** should they be measured? (frequency)
- **How up-to-date/timely** should the measurements be? (lag time)
- What **accuracy** is required for various parameters?
- What **formats** are needed?
- What are the **quantitative uncertainties** that are acceptable?
- Are **trend developments** important?

To understand requirements

Potential needs assessment questions:

How valuable…

- For your decision making, how valuable is Kd? chl-*a*? CDOM? TSM?
- For your decision making, how valuable are data products

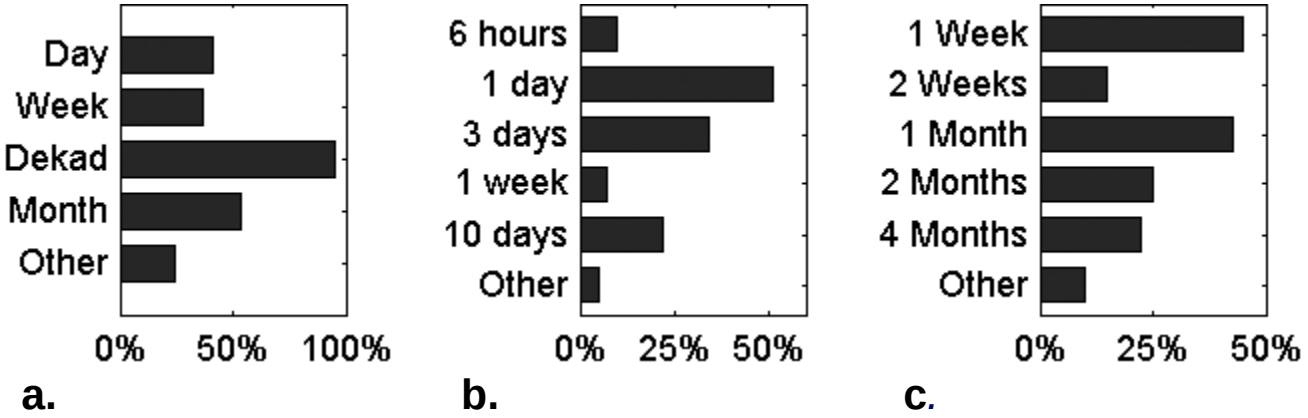
How often…

- How often do you use Kd? chl-*a*? CDOM? TSM?

How sufficient . . .

- Are the tools you use now relevant?
- Do the tools make it easier to reach critical conclusions?
- Do the tools increase confidence in critical decisions?
- Are there other tools that would help increase confidence in decision making?

Needs Assessment results: example of user **requirements** results



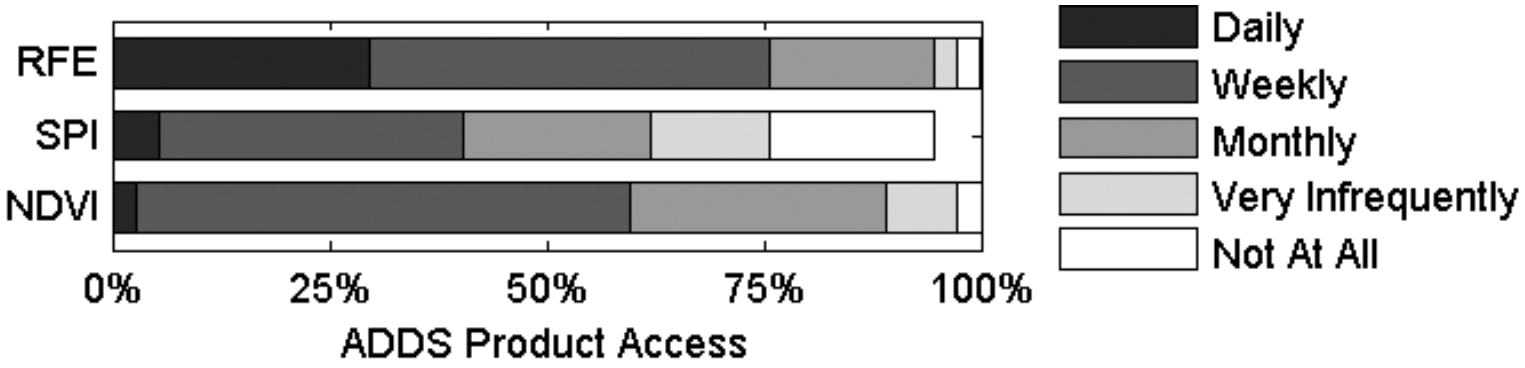
FEWS NET professional reviewers' identification of temporal qualities considered necessary for their analysis or decision making, as it relates to food security. (a) Temporal frequency. (b) Latency. (c) Prediction timescale.

Ross, KW, ME Brown, J Verdin and **LW Underwood**, 2009. Review of FEWS NET biophysical monitoring requirements, Environmental Research Letters, 4 024009, doi: 10.1088/1748-9326/4/2/024009 (accessed May 19, 2010).

What is the **traceability** of decision-making requirements to Earth observations?

- Are policy/regulatory requirements linked with Earth observation?
- If so, or if there is potential, what are the links?
- We want to compile into a traceability matrix to track this

Example: Traceability



Reported frequency of selected data accessed through the Africa Data Dissemination Service (ADDS) data portal.

Ross, KW, ME Brown, J Verdin and LW Underwood, 2009. Review of FEWS NET biophysical monitoring requirements, Environmental Research Letters, 4 024009, doi: 10.1088/1748-9326/4/2/024009 (accessed May 19, 2010).

Example: Traceability Matrix (USDA PECAD)

Working assumptions regarding PECAD's DSS requirements.			
DSS Property		**Requirement**	**Drivers**
Data Frequency (time step)	Monthly reporting	1 day, with 10-day summaries	Need to establish trends within 1-month cycle, legacy time step of CADRE
	Food security	1 day	Time requirements of emergency response planners
Latency	Monthly reporting	24 hours or less	Relevance of DSS inputs
	Food security	6 hours or less	Time requirements of emergency response planners
Spatial Resolution	Monthly reporting	Synoptic analysis: 25 km or better	Legacy spatial resolution of CADRE
		Field-level analysis: 50 m or better	Smallest interesting field dimension
		Port monitoring: 1 m or better	Width of railroad cars/containers
	Food security	25 km or better	Legacy spatial resolution of CADRE
General Properties	Cost	Moderate resolution product should be free	Budget constraints
	Format	Simple (not HDF)	Capabilities of current and next generation of CADRE
	Accessibility	Web accessible	Continue greater public benefit leveraging being demonstrated in Crop Explorer
	Data validation	Validated and science team in place	Quality assurance
	Data redundancy	Multiple sources	Data continuity, convergence of evidence

What are Use and Usability

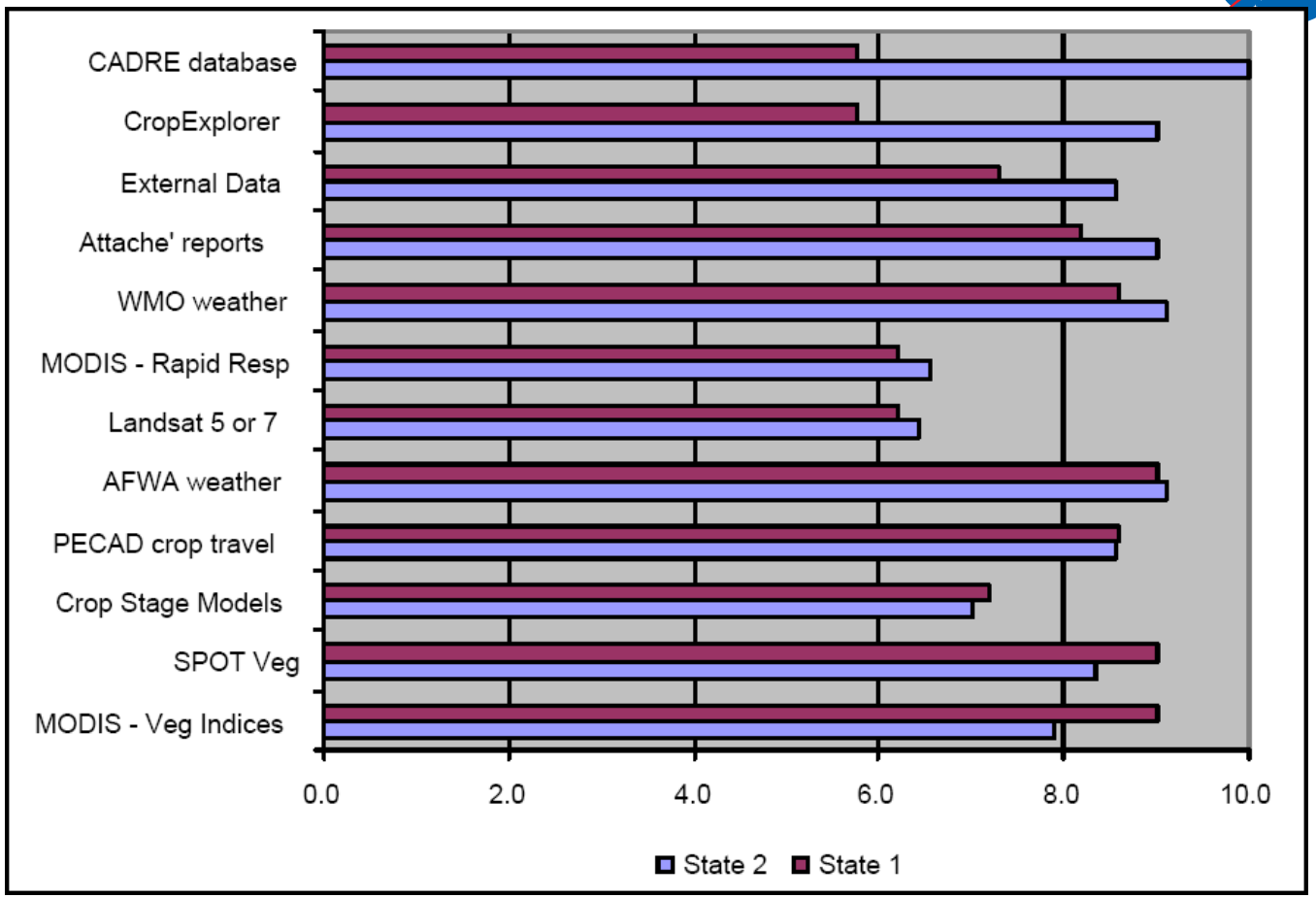
- **Use** measures how often content is being used, by whom, how long, etc. Web content can be followed by web statistics; hard copy can be followed by distribution statistics.

- **Usability** is a quality measure of "the extent to which a product can be used by specified users to achieve specified goals with *effectiveness*, *efficiency* and *satisfaction* in a specified context of use."[1] These qualities can be rated and measured through questionnaires or direct interview. Relevant topics to measure might include
  - Ease of decision making
  - Confidence in decision making

1. ISO 9241-11, "Guidance on usability"

PECAD Example: Usefulness[1]

Changes in importance of information sources used within the PECAD Decision Support System between State 1 (red) and State 2 (blue)



Kaupp, V., C. Hutchinson, S. Drake, T. Haithcoat, V. van Leeuwen, V. Likholetov, D. Tralli, R. McKellip and B. Doorn, 2006. Benchmarking the USDA Production Estimates and Crop Assessment Division DSS Assimilation v.3 (01.04.06) . Report submitted to Ed Sheffner (NASA HQ) and Brad Doorn (PECAD). US Department of Agriculture, Foreign Agriculture Service, Production Estimates and Crop Assessment Division. Washington. 199 p. http://aiwg.gsfc.nasa.gov/esappdocs/benchmarks/PECAD_Benchmark_V3_01_03_06.pdf, (accessed May 19 2010.)