Building the Future of Land Remote Sensing
One Pixel at a Time

Pecora 16
Plenary Session IV

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The Environmental Information Infrastructure
Justified by Growing Needs and Substantial Benefits

• Proliferation of Environmental Treaties
  – The number of agreements and the impact of obligations have grown rapidly over the last several decades with increasingly large economic impacts
  – Earth observations are central to decisions on ratification, maintenance of treaty obligations, and compliance monitoring

• Vulnerability of Populations to Natural Hazards
  – The population is escalating in regions of the world prone to natural disasters, including hurricanes, earthquakes, volcanoes, droughts, and diseases
  – Earth observations are key to both preventative and responsive actions

• Sensitivity of Businesses to Weather and Environment
  – As markets mature, businesses operate closer to the margin
  – Information provides the leverage to operate efficiently and maintain margin
  – Earth observations are the basis for high leverage information
The Environmental Information Infrastructure
At Risk of Collapse

• The National Academy of Sciences stated in an April report
  “Today, [our] system of environmental satellites is at risk of collapse.”

• The report listed six examples of cancelled, descoped, or delayed missions

<table>
<thead>
<tr>
<th>MISSION</th>
<th>APPLICATION/BENEFIT</th>
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<tbody>
<tr>
<td>Global Precipitation Mission</td>
<td>precipitation monitoring</td>
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<td>Atmospheric sounding from GEO demo</td>
<td>weather forecasting</td>
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<td>Ocean Vector Winds</td>
<td>weather forecasting</td>
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<td>Landsat</td>
<td>forests, agriculture, resources</td>
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<td>Glory</td>
<td>aerosols for climate change</td>
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<td>Wide Swath Ocean Altimeter</td>
<td>coastal currents and tides</td>
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• Subsequent discussions have led to significant concerns regarding the potential delay of NPOESS
The Environmental Information Infrastructure

Challenges to be Faced

• Anticipating Future Needs
  – Policy decisions 40+ years from now may require 40+ year data sets that need to be initiated today – do we have a process?
  – The broadening, rapidly changing, and increasingly anonymous user base makes it difficult to identify user needs for geo-information

• Building Systems Faster
  – New satellite systems now require 10-15 years from initiation to use

• Effectively Transforming Science into Applications
  – A tremendous wealth of science has not been turned into practical use

• Leveraging the Private Sector
  – Environmental information has been largely a government activity, with notable exceptions (such as aerial mapping)
  – The private sector propels the next generation of geo-information use

• Harnessing Technological Advances
  – Computer and communications technologies have advanced rapidly in the last decade, but we are not yet employing them effectively for widespread dissemination and use of geo-information (such as tsunami warnings)
The US (NASA) Scientific Policy

- **Background**
  - In 2005, NASA initiated 14 strategic roadmaps to plan for 2005-2025+
  - Earth Science was covered by two roadmap teams: 1) Earth Science and Applications from Space (co-chairs: Charlie Kennel, Diane Evans, Orlando Figueroa), 2) Sun-Earth Connections

- **Relevance to Land Remote Sensing**
  - Guiding Science Question 5: “What causes changes to Earth’s surface and interior?” (other questions cover water, biosphere, weather, humans)
  - Mission timeline includes a variety of solid Earth and Earth surface missions

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**Exploration – The Delicate Balance of Cosmos and Earth**

“The NASA scientific program must be carefully constructed to address an underlying reality - knowledge of the Earth drives the economic growth and environmental security that allow us to be an exploring nation. This program must devote equal attention to both inspirational questions that underpin our outward desires, and practical questions that support our inward needs. A sustainable exploration program depends critically on this delicate balance of Cosmos and Earth.”
Global Earth Obs System of Systems (GEOSS)

*The International Observing System Policy*

**Background**
- The 2003 Earth Observation Summit, attended by 34 nations in Washington, DC, was convened to coordinate global Earth observing systems.
- This led to the Global Earth Observation System of Systems (GEOSS), a cooperative plan that links national observing systems, related information systems, and corresponding efforts such as education and capacity building.
- The process is explicitly chartered with the task of connecting Earth observations to *societal benefits*.

**Status**
- GEOSS now comprises 60 countries.
- US role involves 15 US government agencies.
- US portion is referred to as the Integrated Earth Observation System (IEOS).

**Relevance to Land Remote Sensing**
- Benefit Area 2. Reduce Loss of Life and Property from Disasters.
- Benefit Area 5. Support Sustainable Agriculture and Forestry, and Combat Land Degradation.
- Others among the nine areas are related to land (such as water, energy).
The NRC Decadal Survey
The “Community” Policy

• Background
  – Co-Chairs: Rick Anthes (UCAR), Berrien Moore (UNH)
  – Statement of Task: “The study will generate consensus recommendations from the Earth and environmental science and applications community regarding science priorities, opportunities afforded by new measurement types and new vantage points, and a systems approach to space-based and ancillary observations that encompasses the research programs of NASA and the related operational programs of NOAA.” (USGS added later)

• Status
  – Established “societal benefits” vision for coming decade
  – Interim Report released April
  – Final report due end 2006

• Relevance to Land Remote Sensing
  – Interim recommendations to NASA/NOAA/USGS
    • Review decision to fly Landsat on NPOESS
    • Review need for Landsat gapfiller mission
    • Report back by October 2005

INTERIM REPORT
“Today, this system of environmental satellites is at risk of collapse.”
The Transformation from Analog to Digital

Trend 1

• Today
  – Spaceborne data are fully digital - but much of the remaining Earth observation information is analog
  – Film and even paper are still alive (though vanishing gradually)

• Tomorrow
  – Fully digital datasets will make merging of data possible, enabling many new applications
  – Inter-data standards to support this merging will be increasingly important
  – Accurate reference datasets (such as DEMS) will provide the foundation
  – Data volumes will increase, with benefits and costs
From Engineering-Driven to Consumer-Driven

Trend 2

• Today
  – Geo-information is treated as a technical discipline, applied largely through engineering tools and used by specialists

• Tomorrow
  – Consumers will be the primary drivers behind the need for geo-information
  – Engineering standards will provide the basis for consumer information
  – The emerging internet “local search” will motivate a substantial portion of this - establishing both the need for varied datasets and the means to disseminate them effectively
  – The revenue model is likely ads
Blurring Spatial and Temporal Scale Distinctions

Trend 3

- **Today**
  - Datasets are defined by their data source
  - *Spatial datasets* tend to be characterized by a single spatial scale at a single point in time
  - *Time series* data have fixed intervals

- **Tomorrow**
  - Datasets will be defined by their purpose – they will integrate data from multiple sources at multiple spatial and temporal resolutions
  - These datasets will be routinely *pyramidized*, allowing the user to pull out needed information efficiently at the needed scale
Data Sources Customized to User Needs

Trend 4

• **Today**
  - The remote sensing data market is constrained by what suppliers are able to provide
  - Remote sensing spacecraft require years or decades to develop and tend to serve a single purpose
  - Aerial data systems can be developed faster, but still take many months to years

• **Tomorrow**
  - The data market will be driven by what buyers want, not what suppliers are able to provide
  - Successful providers will be those who can respond fastest to emerging needs with whatever data are requested
  - Spaceborne and aerial remote sensing systems (and related ground systems) will be designed to evolve rapidly to meet these needs
Increasing Importance of the “Built” Environment

*Trend 5*

• **Today**
  – The *natural* environment is often distinguished from the *built* (human-created) environment
  – People tend to specialize in one or the other – from science to applications

• **Tomorrow**
  – The science of the *built* environment and how it evolves will be just as important as the science of the *natural* environment
  – Treating both as elements of a coupled system will be standard practice
Out with 2D, In with 3D

Trend 6

• Today
  – Geo-information is largely communicated in 2D representations such as maps

• Tomorrow
  – Geo-information will be assumed to be fundamentally 3D, and will be represented in 3D to the greatest extent feasible
  – People will depend increasingly on visualization (as compared to description) to comprehend information
Summary

This is a very exciting time to be in the field of geo-spatial information – land remote sensing provides a critical foundation for this field.

The widespread use of this information in our everyday lives – getting down to the consumer level over the coming decade - will increase prosperity and improve security for society as a whole.