Remote Sensing in Support of Multilateral Environmental Agreements

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London, England
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Since 1970s: A rapid change in...

- the complexity and critical nature of international environmental problems
- the number of multilateral environmental agreements – almost tripling, from 172 in 1970 to more than 475 today
- the sophistication of remote sensing and geospatial technologies such as GIS, GPS, etc.
- computing power and information distribution
- the number of global data sets
- the number of global and regional initiatives attempting to apply remote sensing (RS) and geospatial technologies to these issues:
  - NASA-NGO biodiversity working group
  - ESA’s Treaty Enforcement with Satellite Earth Observation (TESEO) and Data User Element (DUE) for MEAs
  - Group on Earth Observation (GEO) Global Earth Observation System of Systems (GEOSS)
COP Decisions Referencing RS

- CBD Decision 3.9 (1996): “Implementation of Articles 6 & 8” …Urges Parties to identify *indicators* of biological diversity…in particular commending the value of rapid biological diversity assessment …, and recognizing also the role of **remote sensing** as a useful tool for monitoring.

- CBD Decision 7.28 (2004): “Protected Areas” … Encourage the establishment and establishment use of new technologies including geographic information system and **remote sensing** tools for monitoring protected areas.

- Ramsar Res. VII.10 (1999): “Wetland Risk Assessment”…A range of rapid assessment approaches is being developed. These include rapid biological assessment using invertebrates, monitoring of birdlife, and **remote sensing**.

- UNFCCC Decision 11.9: “Global Observing Systems” …Invites the ad hoc Group on Earth Observations to treat global climate monitoring as a priority and to adopt a balanced approach to the application of in situ and **remote-sensing** systems for climate monitoring;

In CBD 2nd national reports, parties were asked if they were using rapid assessment or RS techniques: 33 replied “no” or “exploring”, 58 said “some’, and 13 “a lot.”
habitat loss, biodiversity conservation (CBD), wetland extent, site monitoring (Ramsar, World Heritage), desertification (CCD), transboundary air pollution transport (LRTAP), eutrophication of coastal waters (regional seas), and greenhouse gas emissions from land-based sources (UNFCCC), among others.
Pros and Cons of Remote Sensing

**Pros**
- Synoptic view with wall-to-wall coverage
- Data are “objective” and consistent across borders and over time
- Variety of imagery
  - Free imagery such as MODIS, SeaWiFS, Landsat, and CBERS
  - High resolution: Ikonos and QuickBird
  - Radar, hyperspectral
- Assess remote areas, no sovereignty concerns
- Rising awareness of RS imagery thanks to Google Earth, and hence rising expectations
- Integration with other data in GIS
- Promotes sci-tech collaboration

**Cons**
- Data gaps and cloud cover, which obscures many tropical regions
- Many instruments are experimental, not operational
- Few widely replicated algorithms
- Costs:
  - Imagery costs can still be prohibitive for large area coverage
  - Skilled personnel required
  - Commercial software
  - Ground-truthing
- Uncritical acceptance of RS-based findings, unrealistic expectations
- Many developing countries lack capacity
Current Status

- Remote sensing (RS) is used extensively in environmental assessment (e.g., IPCC, MA), which contributes to MEA information needs
- There have been precious few examples of RS being used for enforcement
  - Most MEAs are “soft law” and have little or no enforcement
  - RS imagery is generally not sufficient on its own to bring about enforcement action
- Nevertheless, interest among treaty secretariats remains very high
- RS images can help to generate public support for treaties – increasing the political will among Parties for strong implementation
- GEOSS is explicitly promoting RS for treaty applications. Ten year strategy addresses, among others:
  - Improving management of energy resources;
  - Understanding, assessing, predicting, mitigating, and adapting to climate variability and change;
  - Improving water resource management through better understanding of the water cycle;
  - Improving the management and protection of terrestrial, coastal, and marine ecosystems;
  - Supporting sustainable agriculture and combating desertification;
  - Understanding, monitoring, and conserving biodiversity.
Future Developments

• Future instruments
  – CLARREO: radiometer for solar and Earth radiation to understand climate forcing
  – IceSat-II: laser altimeter for ice sheet height changes owing to warming
  – DESDynI: laser altimeter for vegetation structure and above ground biomass
  – GEO-CAPE: Three instruments for atmospheric gases, ocean color, ecosystem health

• Many more instruments from ESA, developing countries, commercial providers

• Treaty applications for, e.g. Kyoto ARD, will require operational sensors and standardized algorithms

• Indicator development for policy implementation
  – 2008 Environmental Performance Index (EPI)
  – Abu Dhabi EPI
  – China EPI
Thank you!

For more information, please visit
http://sedac.ciesin.columbia.edu/rs-treaties/
Additional Slides
1976-1989

1976
- Convention for the Protection of the Rhine
- LRTAP

1977
- Landsat program commercialized
- IBM PC introduced

1978
- Landsat 4 launched

1979
- Lansat 3 launched

1980
- Landsat 5 launched
- DNS system introduced

1981
- Montreal Protocol (Vienna Convention)

1982
- SPOT-1 (France) launched
- IMW project terminated

1983
- First Sulfur Protocol (LRTAP)

1984
- IRS-1 (India) launched

1985
- Nitrous Oxides Protocol (LRTAP)

1986
- Internet hosts > 100,000

1987
- 1988
- 1989
Growing Interest in the Issue

Workshops
ISPRS workshop on RS applications in support of Kyoto Protocol – October, 1999
AARS conference on RS and the Environment – March, 2000
SEDAC/CIESIN workshop on RS & Environmental Treaties – December, 2000
State Dept. roundtable on RS, environmental change & implications for diplomacy - December 2000
AIAA workshop on RS contributions to development & implementation of MEAs – March, 2001

Projects
Treaty Enforcement using Satellite Earth Observation (TESEO), European Space Agency
Project on Remote Sensing Technologies for Ecosystem Management Treaties, CIESIN (funded by State Dept)
International Environmental Conventions, Data User Programme, ESA

Remote Sensing and Environmental Treaties: Building More Effective Linkages

Workshop Dates: December 4 - 5, 2000
Workshop Venue: Woodrow Wilson International Center
1300 Pennsylvania Avenue, N.W.
Washington, DC, USA

The workshop on remote sensing and environmental treaties is co-sponsored by:

[Logos of MEDIAS, WWF, and IUCN]

ORGANIZING COMMITTEE MEMBERS
<table>
<thead>
<tr>
<th>Location (Author)</th>
<th>Species/Indicator</th>
<th>Summary of Methods</th>
<th>Degree of Prediction</th>
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</thead>
<tbody>
<tr>
<td>Southwestern Finland (Luoto et al. 2002)</td>
<td>Vascular plant species richness</td>
<td>Nine different landcover classes were derived from TM imagery; diversity was compared with the Shannon index for each type.</td>
<td>r values ranged from −0.76 to 0.9, p=0.0001</td>
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<tr>
<td>Southwestern Finland (Luoto et al. 2004)</td>
<td>Bird species richness</td>
<td>Nine different landcover classes were derived from TM imagery; diversity was compared with the Shannon index for each type.</td>
<td>r = 0.54</td>
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<tr>
<td>Islands in the Gulf of Maine, USA (Podolsky 1995)</td>
<td>Mammal richness</td>
<td>SPOT MS data was used to estimate the number of species as a summary statistic of species composition, each pixel representing one species.</td>
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<tr>
<td>Cornwall, England (Griffiths et al. 2000)</td>
<td>Plant species richness (Poaceae taxon)</td>
<td>Landcover classes were derived from TM data; diversity was calculated for each taxon.</td>
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<tr>
<td>Greater Yellowstone Ecosystem, USA (Debinski et al. 1999)</td>
<td>Plant, bird, and butterfly species richness</td>
<td>Landcover classes were derived from TM data; diversity was calculated for each taxon.</td>
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<td>Yellowstone NP, USA (Jakubauskas and Price 1997)</td>
<td>Forest diversity</td>
<td>Landcover classes were derived from TM data; diversity was calculated for each taxon.</td>
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<td>Joshua Tree National Monument, USA (Podolsky 1995)</td>
<td>Plant species richness</td>
<td>USGS Thematic Mapper data were used to collect landcover classes and abundance estimates for plant species.</td>
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<td>Current and Future Space-Based Earth Observation Systems</td>
<td>Related Monitoring Applications</td>
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| **Land Remote Sensing Systems:**  
Landsat, SPOT, RADARSAT, IRS, 
CBERS, IKONOS, EROS-A1  
**Future Systems:** RADARSAT-2, SPOT-5, 
Pleiades/Cosmos-Skymed, SMOS, 
QuickBird, OrbView-3/4, IRS-2C, VCL | Land cover/land use and conversions,  
mining activities, vegetation and forest cover,  
biomass, wetlands monitoring,  
pollution sources, deforestation/reforestation,  
desertification |
| **Oceanic/Environmental Systems:**  
Topex-Poseidon, OrbView-2/SEASTAR, 
EOS-TERRA, Quick-SCAT, ERS,TRMM, IRS-P4  
**Future Systems:** JASON, EOS-AQUA, ICESAT, 
SMOS, CRYOSAT, GOCE, ADEOS-2 | Ocean color/phytoplankton, ocean biota,  
ocean currents and circulation, surface  
winds, sea surface temperature, ocean dumping, ship pollution, fishing activities, oil spill detection, ice caps and sea ice characteristics |
| **Atmospheric/Environmental Systems:**  
NOAA/POES, METEOSAT, GOES, 
GMS, INSAT, ERS, TOMS, TERRA,  
**Future Systems:** NPP, NPOESS, METOP, 
ENVISAT, ADEOS-2, MEGHA-TROPIQUES, 
EOS-CHEM/AURA, AEOLUS, CLOUDSAT, 
PICASSO/CENA, Parsons | Ozone mapping and profiling,  
atmospheric pollution, cloud cover,  
atmospheric CO₂, stratospheric aerosols,  
vulcanic ash cloud tracking, tropospheric wind profiles |