Remote Sensing in Support of Multilateral Environmental Agreements

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Presented at the Satellites and the Law Enforcement Meeting
London, England
5 December 2008

Since 1970s: A rapid change in…

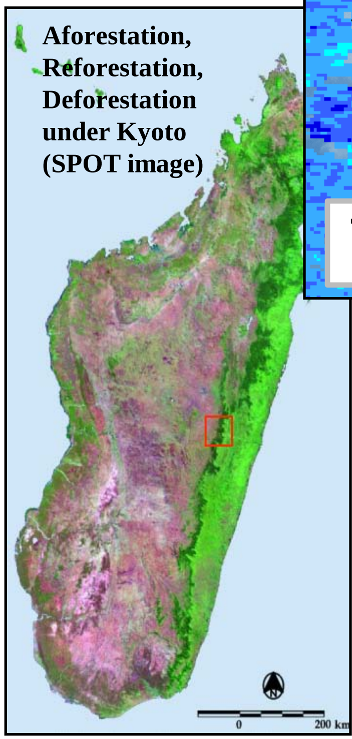
- the complexity and critical nature of international environmental problems
- the number of multilateral environmental agreements – almost tripling, from 172 in 1970 to more than 475 today
- the sophistication of remote sensing and geospatial technologies such as GIS, GPS, etc.
- computing power and 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

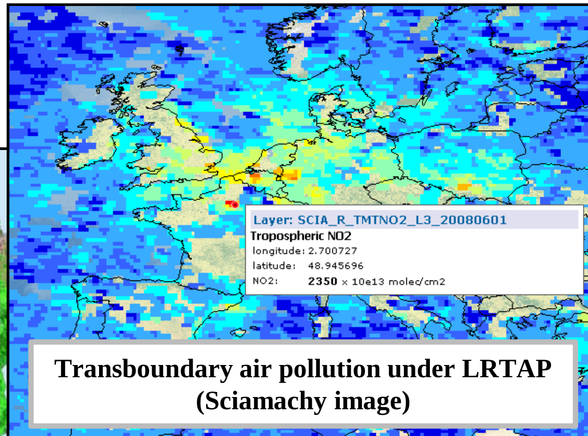
- CBD Decision 3.9 (1996): "Implementation of Articles 6 & 8" …Urges Parties to identify *indicators* of biological diversity…in particular commending the value of rapid biological diversity assessment …, and recognizing also the role of **remote sensing** as a useful tool for monitoring.
- CBD Decision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

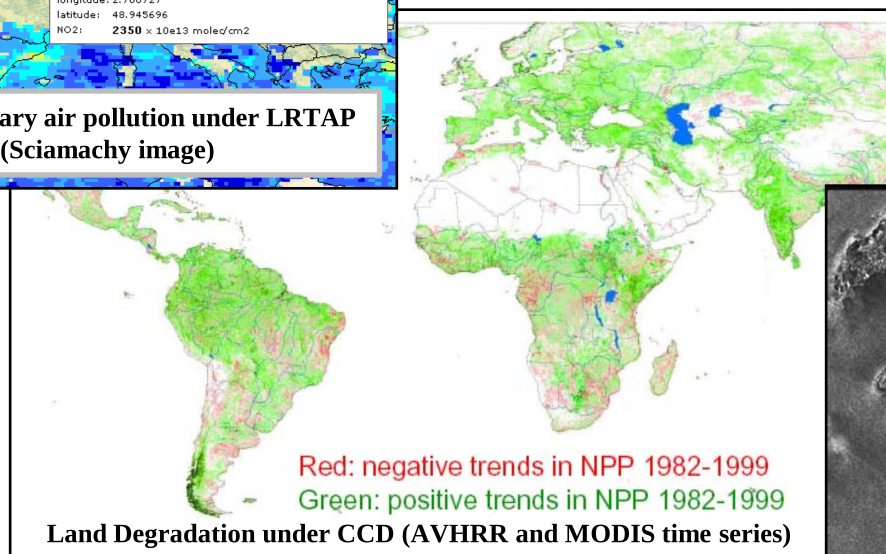
Sample Applications



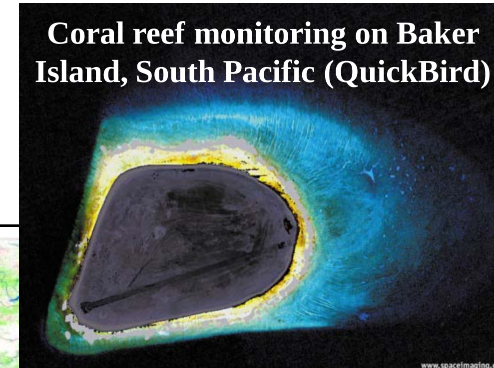
Aforestation, Reforestation, Deforestation under Kyoto (SPOT image)



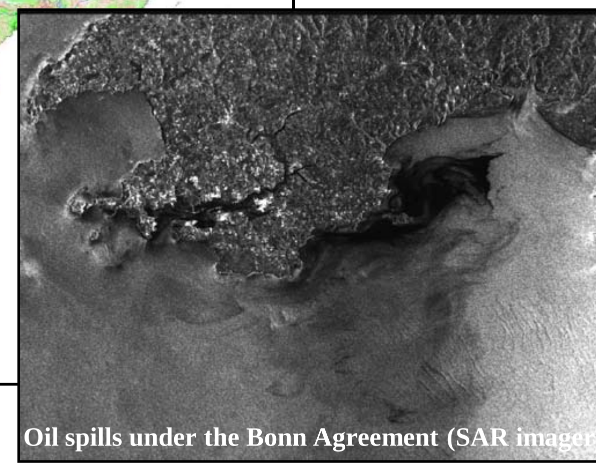
Transboundary air pollution under LRTAP (Sciamachy image)



Land Degradation under CCD (AVHRR and MODIS time series)



Coral reef monitoring on Baker Island, South Pacific (QuickBird)



Oil spills under the Bonn Agreement (SAR imagery)

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

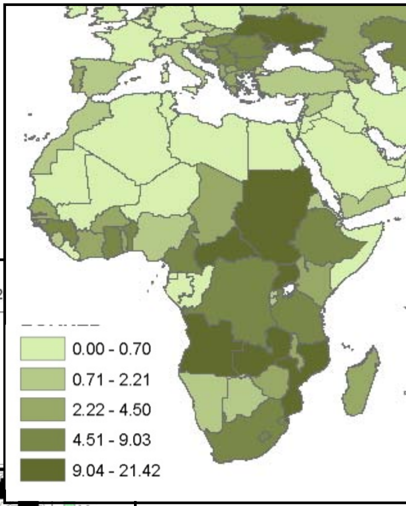
Current Status

- 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

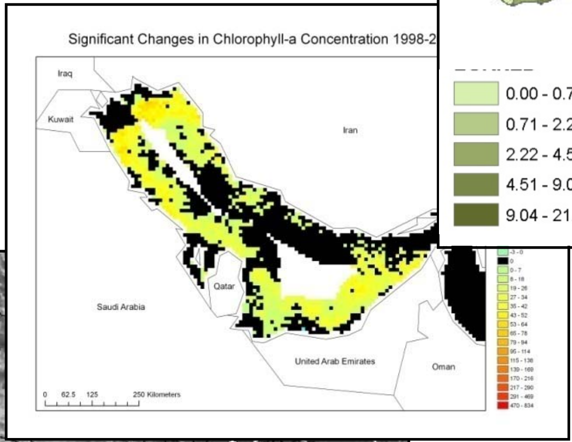
- Future instruments
  - CLARREO: radiometer for solar and Earth radiation to understand climate forcing
  - IceSat-II: laser altimeter for ice sheet height changes owing to warming
  - DESDynI: laser altimeter for vegetation structure and above ground biomass
  - GEO-CAPE: Three instruments for atmo-spheric 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

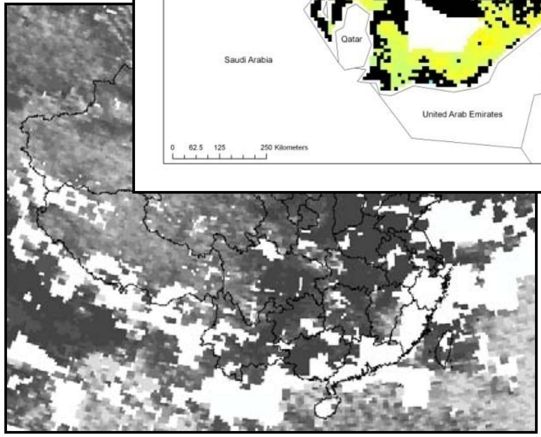
- Indicator development for policy implementation
  - 2008 Environmental Performance Index (EPI)
  - Abu Dhabi EPI
  - China EPI



Burned Area as a Percent of Land Area (L3JRC based on SPOT VEGETATION)

Change in Coastal Chlorophyll Concentration in Persian Gulf (SeaWiFS)





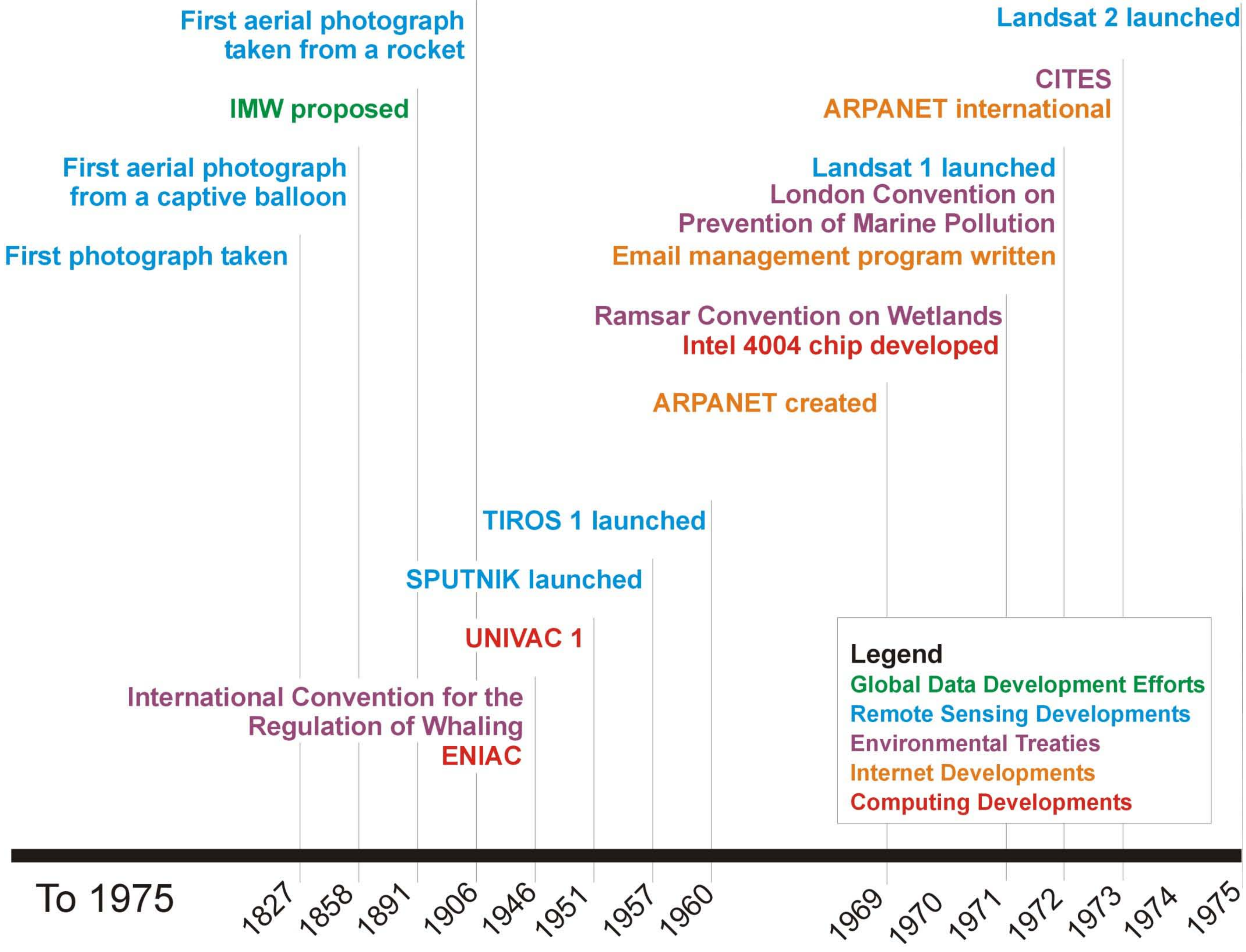
NO2 Concentration over China (Sciamachy)

Thank you!

For more information, please visit

http://sedac.ciesin.columbia.edu/rs-treaties/

Additional Slides



First aerial photograph taken from a rocket
Landsat 2 launched
CITES
ARPANET international
IMW proposed
First aerial photograph from a captive balloon
Landsat 1 launched
London Convention on Prevention of Marine Pollution
First photograph taken
Email management program written
Ramsar Convention on Wetlands
Intel 4004 chip developed
ARPANET created
TIROS 1 launched
SPUTNIK launched
UNIVAC 1
Legend
Global Data Development Efforts
Remote Sensing Developments
Environmental Treaties
Internet Developments
Computing Developments
International Convention for the Regulation of Whaling
ENIAC
To 1975
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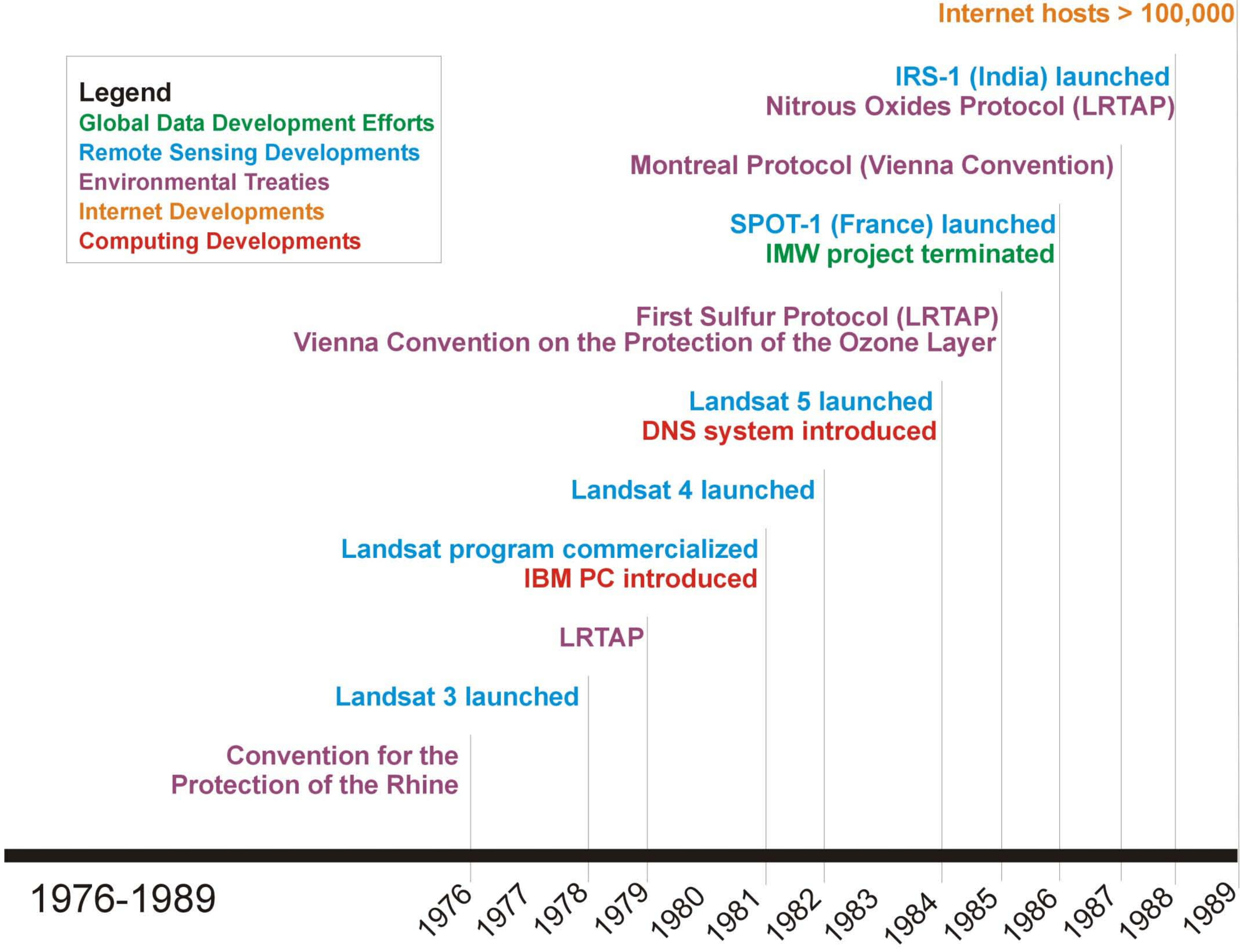
Internet hosts > 100,000
Legend
Global Data Development Efforts
Remote Sensing Developments
Environmental Treaties
Internet Developments
Computing Developments
IRS-1 (India) launched
Nitrous Oxides Protocol (LRTAP)
Montreal Protocol (Vienna Convention)
SPOT-1 (France) launched
IMW project terminated
First Sulfur Protocol (LRTAP)
Vienna Convention on the Protection of the Ozone Layer
Landsat 5 launched
DNS system introduced
Landsat 4 launched
Landsat program commercialized
IBM PC introduced
LRTAP
Landsat 3 launched
Convention for the Protection of the Rhine
1976-1989
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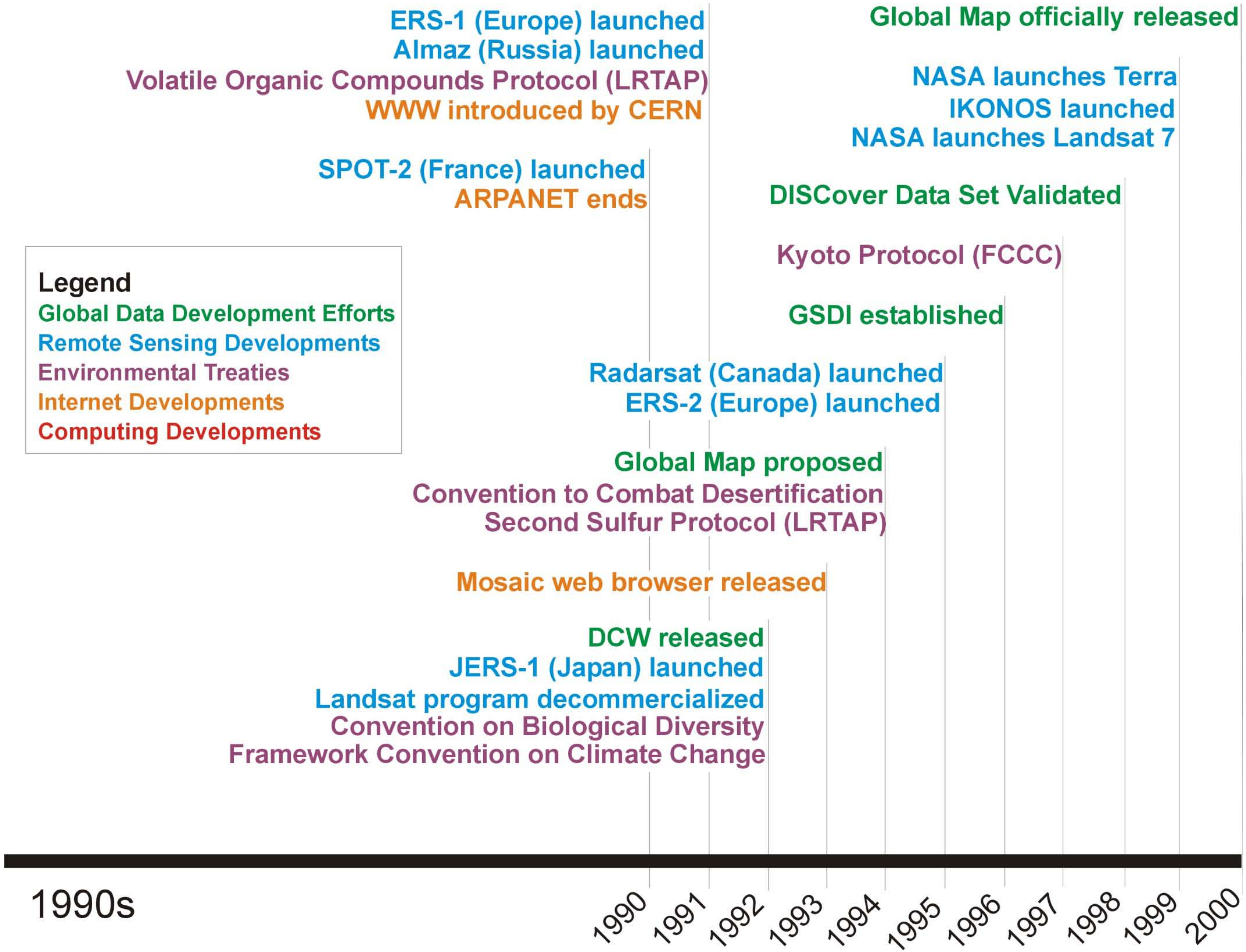
ERS-1 (Europe) launched
Almaz (Russia) launched
Volatile Organic Compounds Protocol (LRTAP)
WWW introduced by CERN
SPOT-2 (France) launched
ARPANET ends
Global Map officially released
NASA launches Terra
IKONOS launched
NASA launches Landsat 7
DISCover Data Set Validated
Kyoto Protocol (FCCC)
GSDI established
Legend
Global Data Development Efforts
Remote Sensing Developments
Environmental Treaties
Internet Developments
Computing Developments
Radarsat (Canada) launched
ERS-2 (Europe) launched
Global Map proposed
Convention to Combat Desertification
Second Sulfur Protocol (LRTAP)
Mosaic web browser released
DCW released
JERS-1 (Japan) launched
Landsat program decommercialized
Convention on Biological Diversity
Framework Convention on Climate Change
1990s
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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 usi Agency

Project on Remote Sens CIESIN (fund

International Environme

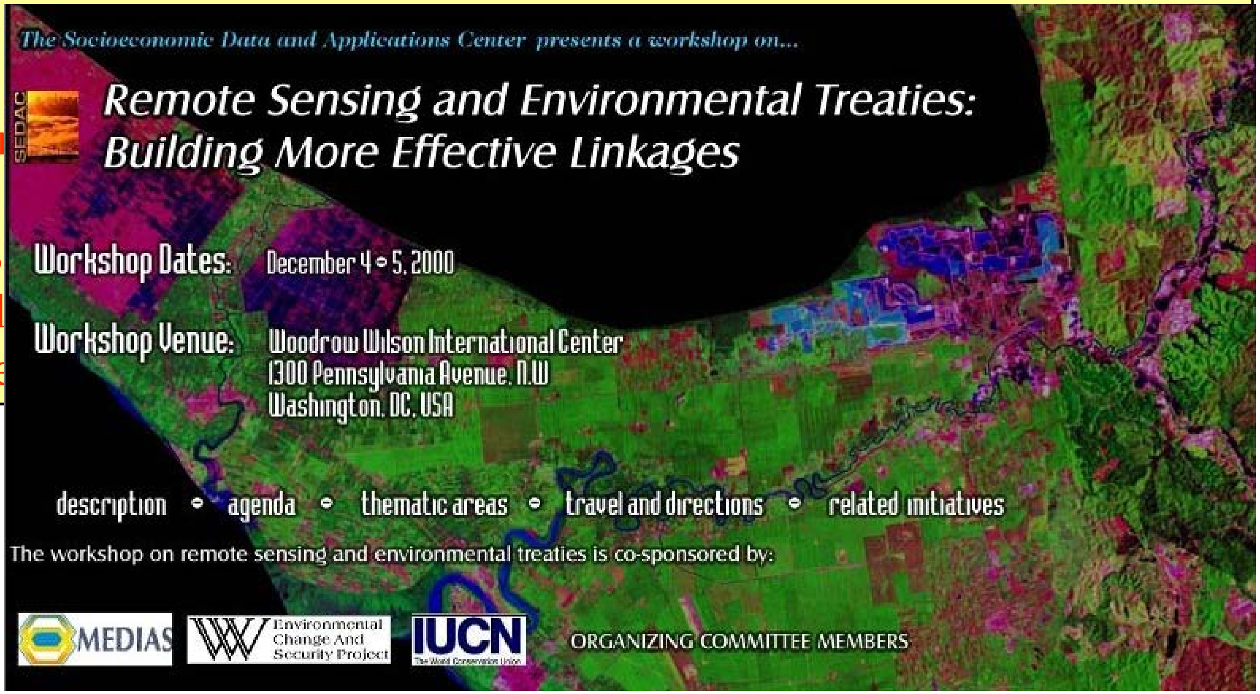
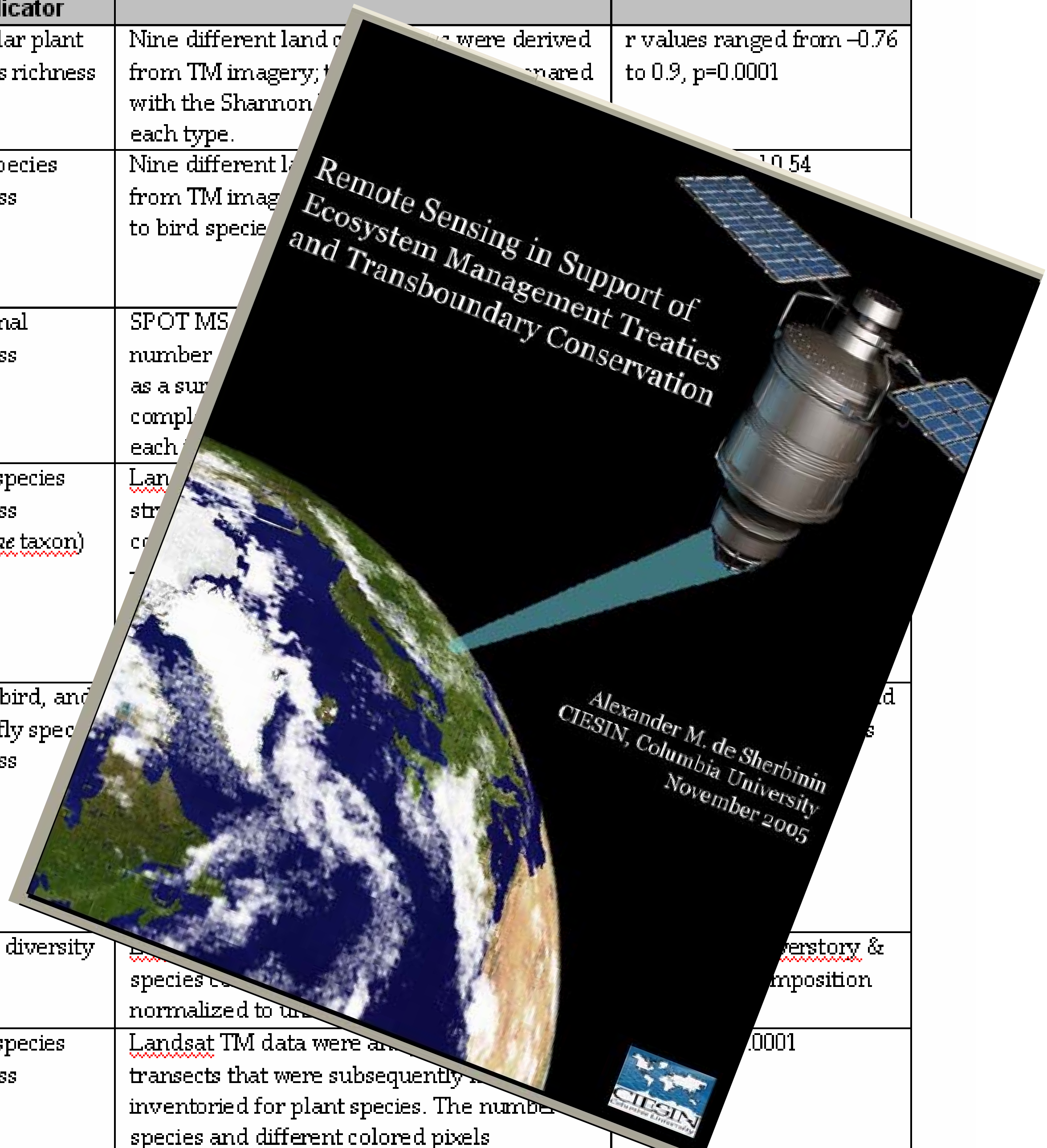


Table 1. Summary of studies that sought to predict species presence/absence or richness using RS data

Location (Author)	Species/ Indicator	Summary of Methods	Degree of Prediction
Southwestern Finland (Luoto *et al.* 2002)	Vascular plant species richness	Nine different land c... were derived from TM imagery; t... pared with the Shannon ... each type.	r values ranged from –0.76 to 0.9, p=0.0001
Southwestern Finland (Luoto *et al.* 2004)	Bird species richness	Nine different l... from TM imag... to bird specie...	...0.54
Islands in the Gulf of Maine, USA (Podolsky 1995)	Mammal richness	SPOT MS... number... as a sur... compl... each...	
Cornwall, England (Griffiths *et al.* 2000)	Plant species richness (*Poaceae* taxon)	Lan... str... c...	
Greater Yellowstone Ecosystem, USA (Debinski *et al.* 1999)	Plant, bird, and butterfly spec... richness		...d ...s
Yellowstone NP, USA (Jakubauskas and Price 1997)	Forest diversity	... species c... normalized to ...	...erstory & ...mposition
Joshua Tree National Monument, USA (Podolsky 1995)	Plant species richness	Landsat TM data were a... transects that were subsequently i... inventoried for plant species. The number... species and different colored pixels	...0001



Current and Future Space-Based Earth Observation Systems	Related Monitoring Applications
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, PARASOL	Ozone mapping and profiling, atmospheric pollution, cloud cover, atmospheric CO_2, stratospheric aerosols, volcanic ash cloud tracking, tropospheric wind profiles

Source: American Institute of Aeronautics and Astronautics, Sixth International Space Cooperation Workshop Report, March 2001, P. 40.