



# **NSSI Remote Sensing & GIS Focus Group Meeting**

*Robert Shuchman, Michigan Tech Research Institute*

*Tom Heinrichs, GINA*

*John Payne, Bureau of Land Management*

*Ken Taylor, North Slope Science Initiative*

*Liza Liversedge, Michigan Tech Research Institute*

*February 6 & 7, 2007*

# Agenda 2/6/07

- 10:00 – 10:15 A.M. Welcome, Purpose of Workshop, and Presentation of Agenda (J. Payne)
- 10:15 – 11:15 A.M. GINA Vision and Unresolved Issues (T. Hendricks)
- 11:15 – 12:15 P.M. Review Data Layers (All – R. Shuchman, J. Payne, and T. Hendricks)
- 12:15 – 1:30 P.M. Lunch
- 1:30 – 2:30 P.M. Completion of Data Layer Review (All)
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- 4:00 – 5:00 P.M. Summary of Grids and Projections Findings (R. Shuchman)

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- 8:45 – 9:45 A.M. Review of System Functionality (T. Hendricks)
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- 11:00 – 11:30 A.M. Summary of Functionality Discussion (R. Shuchman)
- 11:30 – 12:00 P.M. NSSI Decision Support System Tools (R. Shuchman)
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- 2:30 – 3:00 P.M. Summary of Decision Support Systems Consensus
- 3:00 P.M. Concluding Comments, Meeting Adjourns

# Meeting Purpose

- Review, critique, and improve where necessary the proposed NSSI GIS/Remote Sensing Information system

# Meeting Topics

- Identify overall goal and objectives of the GINA based information sharing system. Address how this proposed system is different from the ARCUS data management system. How do they compliment each other?
- Examine, critique, and prioritize suggested NSSI GIS content list.
- Identify and prioritize a set of remote sensing data that should be available via the GINA delivery system.
- Generate a list of suggested derived remote sensing products (i.e. geophysical quantities) that should be part of a standard GINA offering.

## Meeting Topics (cont.)

- Discuss and approve, if possible, the requirement list for the NSSI GIS functionality and hardware/software.
- Discuss and generate a wish list for Decision Support Systems (DSS) that need to be part of GINA. What generic types of DSS are needed? For example, statistical decision theory, ecological risk assessment, decision tree model, or others such as sea ice cover or ice road approval.
- Identify any additional unresolved issues

# Goals and Objectives of a NSSI GIS

- Goal of NSSI: to provide a consistent approach to high-caliber science across the North Slope
  - A NSSI GIS should support this goal
  - Provide the baseline data inputs for science investigations
- Provide data needs for the diverse NSSI stakeholder group (federal, state, local, native, industry, academia, NGOs)
- Dedicated information management system that specifically encompasses the biotic and abiotic stressors/receptors related to oil and gas development
  - Legally defensible
  - Security
- Manage the data *and* provide information
  - A data storage system in and of itself is not enough
  - Decision support

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# North Slope Baseline Data Layer List

- A preliminary list of North Slope Baseline GIS Data Layers was generated during the March 2006 North Slope Data Management Meeting (hosted by GINA)
- Meeting participants represented a diverse set of North Slope stakeholders and expertise (UAF-GINA, EVOSTC, USGS, ADNR, BLM-NSTC, BLM-FDO, BLM-ASO, UAF-Toolik Lake, MTRI (formerly Altarum), Resources Data, Inc., ConocoPhillips, NSSI)
- The list that resulted from this meeting has been expanded and reorganized

# Expansion/Reorganization of the North Slope Baseline Data Layer List

- Baseline data layers list has be reorganized using the ISO (International Organization for Standardization) 19115 for Geographic Information Metadata Topic Category Code List
  - A high-level geographic data thematic classification
  - Contains metadata topic category code listing to assist in the grouping and search of available geographic data sets
- Additions to the North Slope baseline data layers list were the result of inputs from GIS professionals
- Further additions came out of the November 13, 2006 NSSI Science Technical Group, Remote Sensing and GIS Subgroup meeting (federal, state, and academic Alaskan GIS & remote sensing experts)

# Suggested NSSI GIS Layer List

SUGGESTED NSSI GIS LAYER LIST			
additional new layers			
ISO Category	Category Description	Baseline Data Layer	Authority
001 - Farming	Rearing of animals and/or cultivation of plants (agriculture, crops, livestock)	NA?	NA?
002 - Biota	Flora and/or fauna in natural environments? (flora and fauna, ecology, wetlands, habitat)	Fish Habitat -Over wintering -Terrestrial Mammals -polar bears -grizzly -caribou -musk-ox -moose -Birds -Invertebrates -Marine Mammals	(DNR Habitat Division/Arctic LTER/NSB)
003 - Boundaries	Legal land descriptions (political and administrative boundaries)	Administrative - Ownership (DNR/BLM) - Town/Villages (DNR/BLM) - Boundaries (DNR/BLM/NSB) - Withdrawals (BLM) - Master Title Plats (BLM) - OCS Grid (MMS) - OPD Grid (MMS) - Game Management Units (ADFG) - Native Allotments (BLM) - Lease Authorizations (DNR/BLM/MMS) - ASRC Leases (ASRC) - Microwave Temperature Profiler (DOE,ARM) - Units (DNR/Industry) Administrative Control - Use Restrictions (BLM/DNR/MMS/FWS) - Special Management Zones/Areas (BLM/DNR/MMS/FWS)	
004 - Climatology/Meteorology/Atmosphere	Processes and phenomena of the atmosphere	Climatology - Snowfall (NOAA) - Weather stations (NOAA) - Lightning (BLM, ACRF)	(USGS/NOAA/MMS/UAF/DOE)
005 - Economy	Economic activities, conditions, and employment	-Need STG and user input-	
006 - Elevation	height above or below the earth's surface (altitude, bathymetry, dem, slope, derived products)	Digital Elevation Measurements (USGS) Offshore Bathymetry (NOAA) Lake Bathymetry (NOAA, others)	
007 - Environment	environmental resources, protection, and conservation (natural resources, pollution, impact assessment, monitoring, land analysis)	Hazard Sites (DEC/BLM/JPO) Water Quality Monitoring (DEC) - ALWAS ACEC - Areas of Critical Environmental (BLM) Sound/Noise - Acoustics Data (NPS) Air Quality (DEC/EPA) Environmental Contaminants (AMAP, EPA)	
008 - Geoscientific Information	information pertaining to the earth sciences (geology, minerals, earthquakes, soils, permafrost)	Minerals/Mining (DNR/BLM) Top Hole/Bottom Hole (AOGCC) Active Layer (BLM, Industry, USGS,NSF) Geomorphology (landforms) UAF	
009 - Health	health, health services, human ecology, and safety (disease, illness, factors affecting health, hygiene, substance abuse)	NA?	NA?
010 - Imagery/Base Maps/Earth Cover	Remote Sensing		
010 200 - Base Maps	(annotations)	DRG - Scanned Topographic Maps DOQ	(USGS) (USGS)

		Permafrost Fire (BLM/DNR) Vegetation (USGS) Wetlands Inventory (FWS)	
010 202 - Imagery	Remote Sensing	Imagery	(BLM/USGS/UAF/DNR/DOE/Industry)
011 - Intelligence/Military	military bases, structures, activities	Distant Early Warning-DEW line Military sites/bases	(DOD) (DOD)
012 - Inland Waters	inland water features, drainage systems (rivers, glaciers, lakes, dams, water quality)	Gauging Stations (USGS) Watersheds (HUC) (USGS) Rivers / Lakes (USGS/ADNR) Water Quality (USGS/BLM/DEC/EPA/Industry) Navigable Waters (BLM/DNR/NOAA)	
013 - Location	positional information and services (addresses, geodetic networks, place names)	Place Names (USGS/NSB/Industry) Geographic Coordinate Database - Combined Federal/State Control (BLM/DNR) - Geodetic/CORS (NGS/Plate Boundary Observatory/UNAVCO) - Image Registration (NSB)	
014 - Oceans	features and characteristics of salt water bodies (tides, tidal waves, coastal info, reefs)	Coastline (NOAA Coastal Services Center, BLM, MMS, NGS, others) - Present and Historic - Several Scales Sea Ice (National Snowice Data Center) Ocean Currents (NOAA) Ocean Wind (NOAA) Sea State (NOAA) Frontal Boundaries (NOAA) Ocean Chemistry (NOAA) Acoustics (NOAA)	
015 - Planning/Cadastre	info used for appropriate actions for future land use (land use maps, zoning maps, land ownership)	Mining claims (MMS) PLSS - Public Land Survey System (BLM) Cabins & Camps (BLM NSB)	
016 - Society	characteristics of society and culture (anthropology, archaeology, religion, demographics)	Native Linguistics (Census/Commerce/ADEC/BLA) - (BAA, UAF) Census (Census) archaeology (NSB, NPS, BLM,DNR) Subsistence Maps (NPS,BLM, ADFG,FWS)	
017 - Structure	man-made construction (architecture, buildings, housing, shops, towers)	as-builts (CAD) - facilities and infrastructure (Industry, DOT) Camps and Cabins (BLM,DNR,NSB)	
018 - Transportation	means and aids for conveying persons and/or goods (roads, airports, nautical charts, trails)	Roads (Census/ADOT/NSB/DNR/Industry) - Ice Roads (Historical/Current) (Industry) - Air Strips (FAA) - TAPS/Feeders (JPO/Industry) - Power lines (DoD/USGS) Nautical Charts/Ports (NOAA) Trails and routes (NSB,BLM) Rails (ADOT, USGS) Easements/ROW (BLM,DNR) Culverts/bridges (Unit Operation/DNR)	
019 - Utilities/Communication	energy, water and waste systems, communications (hydroelectricity, water distribution, electrical)	Infrastructure Control - Communications (NSB Emergency Services) - Cell Phone (FCC) - Radio Towers (FCC)	

# Types of Remote Sensing Data

- Satellite, aircraft, ground and sea based
- Active and passive
- Electro-optical → Microwave
- Synoptic/coarse resolution → local/fine resolution
- Civil, DOD, commercial, and NTM
- U.S. and international sources
- Historical (circa 1970) → present

# Sources of Remote Sensing Data

- Earth Observing System Data Gateway  
<http://edcimswww.cr.usgs.gov/pub/imswelcome/>
  - Radar
    - RADARSAT
    - ERS-1 & ERS-2
    - GLAS/ICESat
  - ASTER & ASTER Derived Products
  - MODIS & MODIS Derived Products
  - AVHRR & AVHRR Derived Products
- Land Processes Distributed Active Archive Center Data Pool  
<http://edcdaac.usgs.gov/datapool/datapool.asp>
  - ASTER & ASTER Derived Products
  - MODIS & MODIS Derived Products
- USGS EarthExplorer <http://edcsns17.cr.usgs.gov/EarthExplorer/>
  - Landsat TM & ETM+
  - Hyperion
  - Corona
  - Several different series of aerial photography

# Sources of Remote Sensing Data (cont.)

- Global Land Cover Facility <http://glcf.umiacs.umd.edu/index.shtml>
  - Orthorectified Landsat TM & ETM+
- Digital Globe <http://www.digitalglobe.com/>
  - Quickbird
- National Snow and Ice Data Center <http://nsidc.org/>
  - Hundreds of data sets from all over the world dealing with snow and ice
- National Ice Center <http://www.natice.noaa.gov/>
  - Global Ice edges
  - Alaskan Ice Charts
- MDA <http://gs.mdacorporation.com/>
  - RADARSAT
  - ERS-1 & ERS-2

# Available Remote Sensing Data

- Landsat – 16 to 17 scenes are required for full coverage of North Slope
  - Landsat MSS from mid 1970's to 1980 – limited available – mosaic is better
  - Landsat TM from early 1980's to 1990's – limited coverage
  - Landsat 7 (ETM+) 1999 to 2003 – very good coverage, but sensor problems beginning in 2003 continue at present.
  - Landsat MSS Mosaic Circa 1978 – Covers entire North Slope, three spectral bands (green, red, near-ir); 50 m pixel spacing. 2 scenes from 1987.
  - Landsat TM – 4-scene mosaic of Prudhoe Bay and east. 30 m resolution
  - Landsat ETM+ images of portion of NPRA-northwest – 2 adjacent scenes from 2002



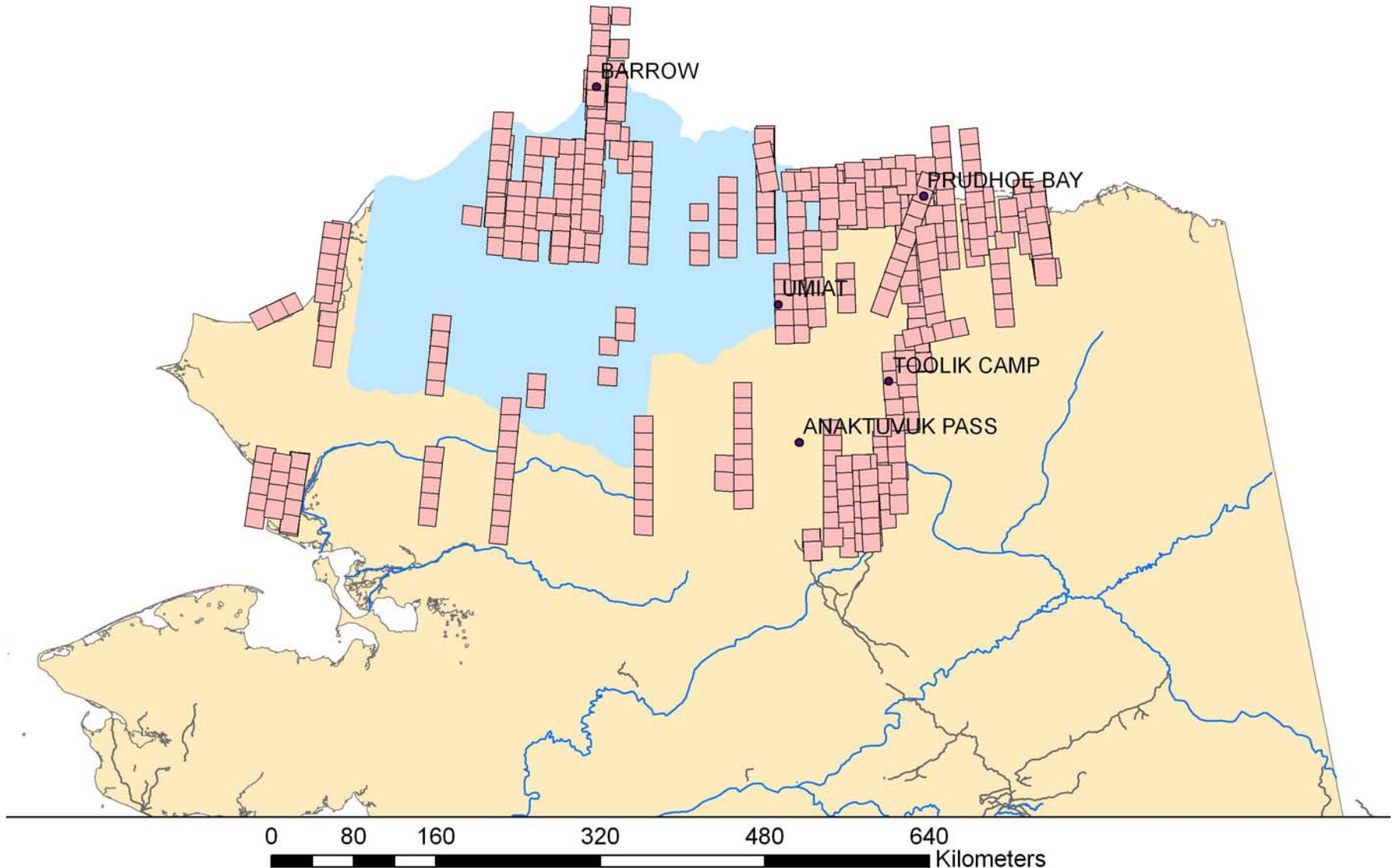
## Available Remote Sensing Data (cont.)

- AVHRR – one or two scenes required for full coverage. Composite data more useful than raw images.
  - AVHRR composite images – bi-monthly composites of Alaska for summers 1990 to 1992. 1 km resolution. May be available for 1993/4.
  - AVHRR imagery – available at least 2X per day from 1981 to present – difficult to use “raw” data (see composite images above)
- Synthetic Aperture Radar (SAR) – many data collections from each sensor
  - ERS-1/2 SAR – 300+ scenes needed for full NS coverage 1991 to present.
  - JERS SAR – 300+ scenes needed for full NS coverage 1994 To 1998
  - Radarsat standard beam – 300+ scenes needed for full coverage
  - Radarsat ScanSAR – 4 to 6 scenes needed to cover NS 1995 to present

## Available Remote Sensing Data (cont.)

- TERRA/AQUA sensors:
  - MODIS – multi-spectral system – data collected on 2 satellites – at least one morning and one afternoon collection each day. 250m to 1km resolution. Many data products being created (see below).
  - MISR & ASTER – multi-spectral sensors with small coverage per scene (smaller than Landsat). Targeted collections can be requested as a NASA investigator.

# QuickBird High Resolution Data Availability



# Available Remote Sensing Products

- Remote sensing products:
  - Vegetation index (NDVI) – AVHRR-derived; 15-day composite; 8-km resolution; global product for 1982 to 2000 available.
  - Vegetation index (NDVI/EVI) – MODIS-derived 16-day composite; 250 or 500 m resolution; global product for 2000 to present.
  - Snow cover – MODIS-derived; 8-day composite; 500 m resolution; global product, composite used to eliminate clouds. Algorithm is well tested and robust. Combination of MODIS snow cover product with passive microwave (AMSR on AQUA) can yield snow-water equivalent.
  - Active layer/thaw depth – Data from the CALM project – may not be RS-derived
  - Sea ice type and concentration – weekly maps from National Ice Center (NIC) as well as National Snow and Ice Data Center

# Land Cover Information Obtainable from Satellite Data

Feature	Satellite(s)	Spatial Resolution	North Slope Coverage	Remarks
Land Cover	Landsat MODIS	15m 250m	170 x 170km Daily (all)	Cloud cover and seasonal (light) dependent
Vegetation Cover & Index	Landsat ASTER MODIS AVHRR	15m 15m 250m 1km	170 x 170km 60km swath Daily (all) Daily (all)	Cloud cover and seasonal (light) dependent
Snow Cover	MODIS (Aqua) SSMI NOAA/AVHRR	250m 12k 1km	1200km swath 1500km swath 1200km swath	MODIS and AVHRR weather dependent
Topography (DEM)	Stereo from commercial EO InSAR RADARSAT (2)	1m 10m	16 x 16km frame 100km swath	EO weather and light dependent; InSAR course resolution
Hydrology	RADARSAT Landsat ASTER	25m 15m 15m	500km swath 170 x 170km 60 km swath	When visible, surface extent only
Water Depth	Landsat Commercial	15m 1m	170 x 170km 16 x 16km frame	20% accuracy
Infrastructure	Commercial	60cm – 2m	16 x 16km patches	Expensive and data intensive

# Sea Ice Information Obtainable from Satellite Data

Feature	Satellite(s)	Spatial Resolution	North Slope Coverage	Remarks
Sea ice concentration	DMSP SMM/I	12-25km	Daily (All)	Synoptic sea ice maps coverage back to 1979
Sea ice dynamics	DMSP SMM/I	12-25km	Daily (All)	Generalized ice movement
Ice type (age)	DMSP SMM/I	12-25km	Daily	Synoptic historical data
Detailed ice movement and reology	RADARSAT (SAR) Envisat (SAR) Palsar (SAR)	25-100m	100-500km swath	Detailed ice surface and movement; limited coverage
Leads	RADARSAT (SAR) Envisat (SAR) Palsar DMSP/NOAA	25-100m  1km	100-500km  Daily (all)	Limited coverage; EO cloud free only with multi-looks each day
Marginal ice zone (MIZ)	SSM/I RADARSAT Envisat Palsar	5km 25-100m	Daily 100-500km swath	Historical data available back to 1990s for SAR
Land fast ice	RADARSAT (SAR) Envisat Palsar	25-100m	100-500km swath	Historical data back to 1990s
Ice edge Ice free-board (.3 m)	Geosat Envisat Others?	2.5 km	Nadir view 10km swath	Historical data set to 1990s exist

# Oceanographic Information Obtainable from Satellite Data

Feature	Satellite(s)	Spatial Resolution	North Slope Coverage	Remarks
Surface wind speeds (2m/s)	Windscat (quikscat)	12km grid	2-4 times daily	Historical data back to approx. 2000
Wave height (.5m)	Geosat, Envisat, etc.	2km nadir	Strip of coverage	Historical coverage back to 1990s
Ocean currents dynamic height method	Geosat, Envisat, etc.	2km nadir	Full coverage over 36 Hr period	Data assimilated into GLMS
Wavelength and direction	RADARSAT (SAR) Envisat (SAR) Palsar (SAR)	25m – 100m	100km swath	Alaska SAR (Satellite) Facility archive back to 1991
Ocean frontal boundaries	RADARSAT (SAR) Envisat (SAR) Palsar (SAR)	25m – 100m	100km swath	Alaska SAR (Satellite) Facility back to 1991
Ocean temperature	NOAA AVHRR	1 km	2-4 times	Coverage back to 1970s
Color Chl, doc, sm	Aqua MODIS	1km	2 times daily	Ten years with SeaWiFS
Oil spills and surfactants	RADARSAT (SAR) Envisat (SAR) Palsar (SAR)	25m – 100m	100km swath	Dynamic tasking needed; integration into models

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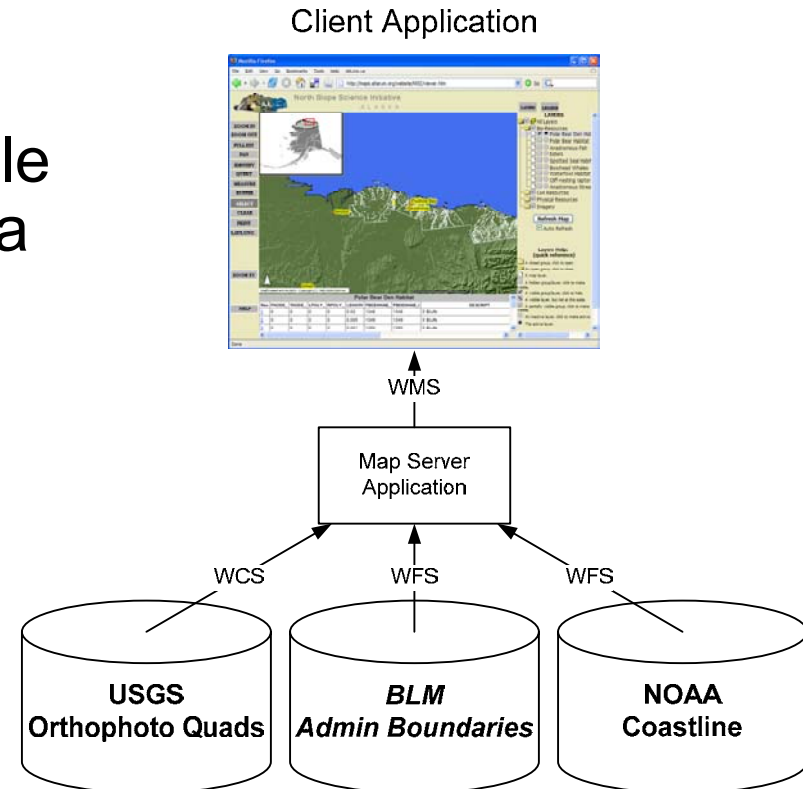
# Distributed Data Architecture

- A data system that allows for distributed dataset hosting decreases the cost and effort needed to create, maintain, and share geographic datasets
- The content and metadata of each dataset is maintained by the dataset's owner. Dataset owners provide their dataset to users by
  - Providing access through web services
  - Providing copies of the dataset
- Example: USGS DOQQ imagery
  - Web Service Access
    - TerraServer USA (<http://terraservice.net/webservices.aspx>)
  - Dataset downloads
    - Earth Explorer (<http://edcsns17.cr.usgs.gov/EarthExplorer/>)



# Geographic Web Services

- Enable organizations to share their geographic datasets using established standards
- Data exchange standards enable aggregations of geographic data from multiple sources
- Web service specifications are developed by the Open Geospatial Consortium (OGC). Important OGC specifications include:
  - Web Map Service (WMS)
  - Web Feature Service (WFS)
  - Web Coverage Service (WCS)



# Open Geospatial Consortium

- Open Geospatial Consortium (OGC) is an international voluntary consensus standards organization. OGC encourages the development and implementation of standards for geographical content and services, GIS data processing, and exchange.
- OGC publishes: technical specifications, best practices documents, and discussion papers
- <http://www.opengeospatial.org/>

# Issues Related to Distributed Data Systems

- Storage capacity need is reduced, since datasets accessed through web services do not need to be copied.
- Data access to data through web services is generally slower, due to network speeds. High bandwidth connectivity between user groups is beneficial.
- Client applications need to be tolerant of 'unavailable' datasets, due to network or other issues.
- Not all client applications currently support OCG Web Services as data sources.

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- 11:30 – 12:00 P.M. NSSI Decision Support System Tools (R. Shuchman)
- 12:00 – 1:30 P.M. Lunch
- 1:30 – 2:30 P.M. Generation of a List of Suggested Topics and Issues that could be Addressed through Decision Support Systems Functionality (All)
- 2:30 – 3:00 P.M. Summary of Decision Support Systems Consensus
- 3:00 P.M. Concluding Comments, Meeting Adjourns

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# Data Needs for an Effective GIS-based DSS

Spatial data layer	Desired spatial accuracy	Temporal sampling period	Status
<b>Topography (DEM)</b>	Submeter height 10m horiz res	1 time	30 -60m resolution avail. (see below)
<b>Land cover/land use (vegetation, bare ground, water, manmade)</b>	30m pixels	1 time for region 5 to 10 years for limited areas	50 m available for region from 1978 30 m avail for limited areas
<b>Vegetation type</b>	20m pixels	10-15 years	100 m Available for region 20 m avail for limited areas
<b>Fauna (animal population)</b>	1 km	Variable by species	Variable information
<b>Soil type</b>	1 km	1 time	STATSGO. Not validated.
<b>Permafrost</b>	1 km	5 years	1970
<b>Thaw depth/active layer</b>	1 km	5 years	Searching for data (CALM)
<b>Surface Hydrology (lakes, ponds, rivers, streams, wetlands)</b>	10m pixels	1 time	Coarse scale, circa 1980 maps avail from USGS 1:250,000. Not fully validated.

# Data Needs for an Effective GIS-based DSS (cont.)

Spatial data layer	Desired spatial accuracy	Temporal sampling period	Status
Lake depth	1m	5 years	Avail for small areas
Watershed boundaries	1:2M	1 time	Avail.
Water quality		5 years	Unknown
Snow cover	1 km	Bi-weekly in winter	MODIS product avail beginning 2000.
Meteorology (air temperature & pressure, air quality, cloud cover, etc.)	1 km	4 hrs	Interpolated data avail from various sources.
Air Quality		5 years	Avail for Barrow
Climate	1 km	1 time	Avail?
Jurisdiction boundaries	1 km	1 time	Avail.
Infrastructure (roads, trails, utility lines, pipelines, drill pads, etc.)	10m pixels	5 years	Incomplete
Demographics census tracts	Census tracts	10 years	Avail
Socioeconomics	1 km	10 years	Avail



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