Alaska Department of Transportation & Public Facilities

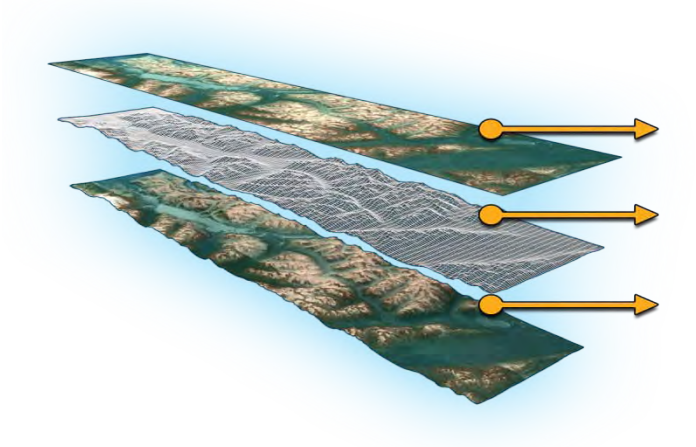
DIGITAL ELEVATION MODEL (DEM)

Nick Mastrodicasa

January 21, 2011

THE DEM IS FOUNDATIONAL

TO THE BASE MAP



Imagery

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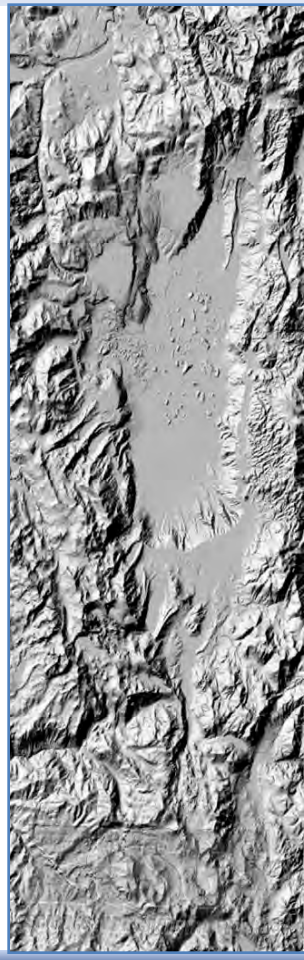
DEM

=

Precision Geospatial Dataset

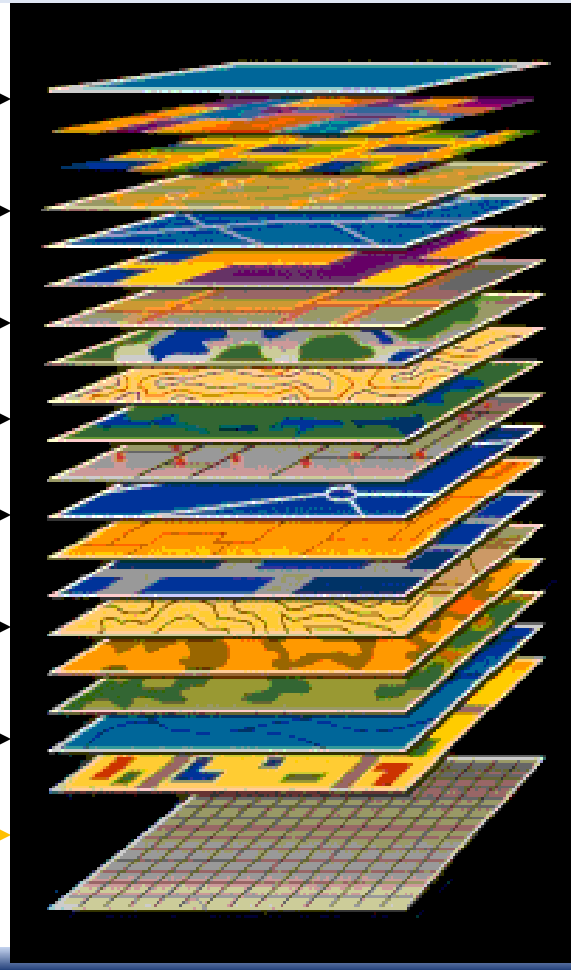
- A DEM that is inaccurate or of poor resolution will pass those characteristics onto other data layers…



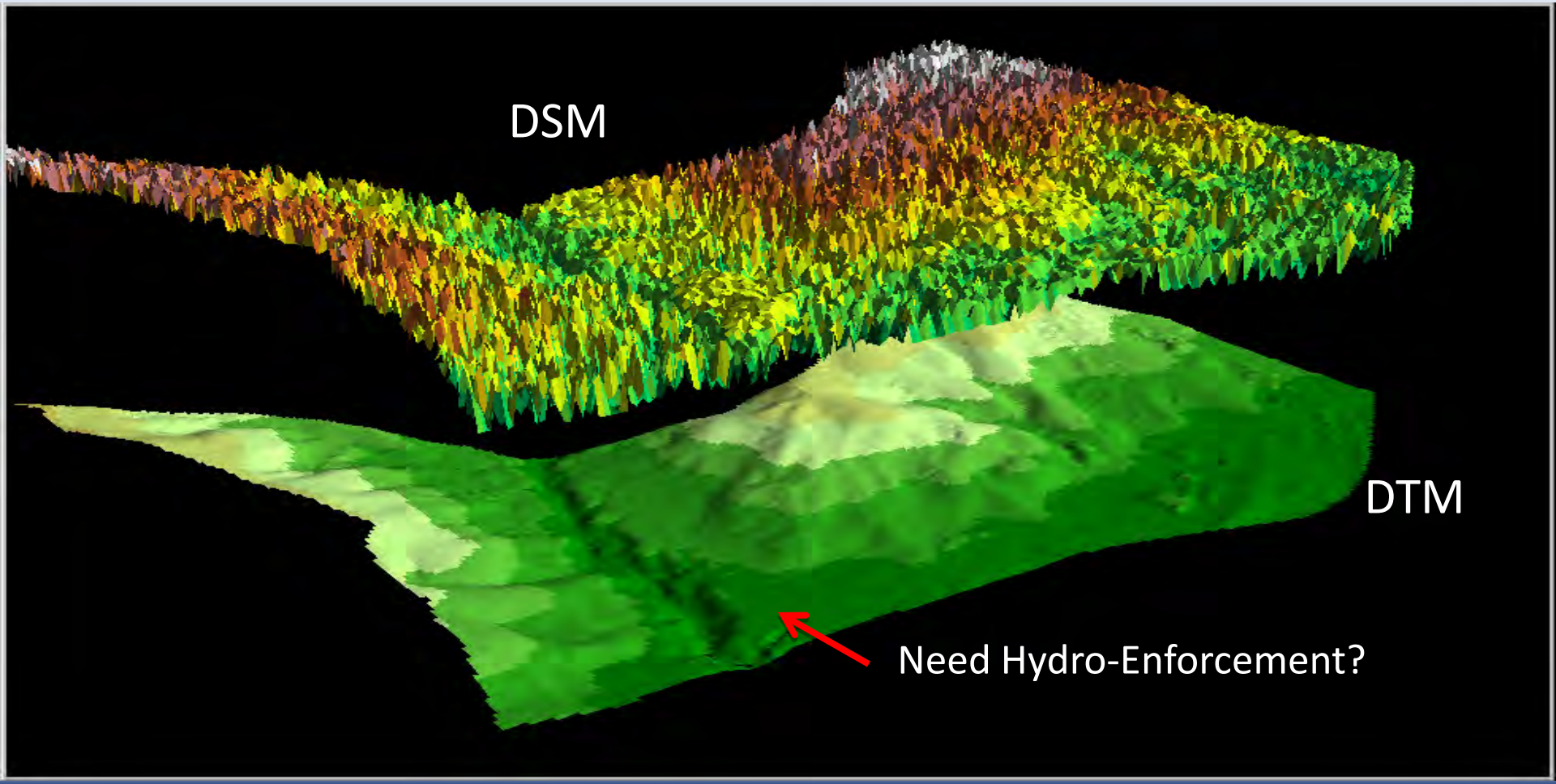
THE DEM IS FOUNDATIONAL

TO ALL GIS (Geospatial Information System) LAYERS

- ETC.
- Utilities
- Buildings
- Vegetation
- Land Parcels
- Hydrographic
- Imagery
- **Base Layer-DEM**



DSM vs. DTM



KEY DEM APPLICATIONS

- **DEM Applications-Coastal, Climate Change Research & Emergency Services:**
  - Shoreline Delineation
  - Climate Change / Change Detection
  - Sea Level Change
  - Coastal Management
  - Coastal Engineering
  - Coastal Inundation Modeling
  - Storm Surge Modeling
  - Tsunami Modeling
  - Safe Evacuation Routes
  - Saltwater intrusion
  - Water Supply and Quality
  - Storm water Management
  - *Hydrography**
  - Floodplain Management
  - Fire Propagation Modeling
  - Subsidence Monitoring
  - Disaster Preparedness, Mitigation and Response
  - Seismic Monitoring

- **Military Applications**
  - Battlefield Visualization
  - Battlefield Simulations and Fly-Throughs
  - Line-of-Sight Analyses
  - Cross Country Movement Analyses
  - Terrain and Slope Analyses
  - Weapons Guidance and Targeting
  - Defense Support to Civil Authorities
  - Military Planning

- **Commercial Applications**
  - Timber
  - Precision Farming
  - Mining
  - Recreation
  - Real Estate, Banking, Mortgage and Insurance Industries
  - Geospatial Industry
  - Software Development
  - Telecommunications, Utilities & etc.

- **Individual Applications:**
  - Flooding
  - Tsunamis
  - Storm Surges
  - Wild Fires
  - Landslides
  - Subsidence
  - **Evacuation Routes**

An Accurate DEM is Required

to Understand and Prepare for the Impacts of:

- Sea Rise-Saltwater/Lowland Inundation
- Water Supply & Quality
- Climate Change

- Coastal Erosion
- Storm Surge Analysis
- Tsunami Inundation

Village Relocation & Climate Change

- Site Selection for Villages in Peril;
- Safe Drinking Water;
  - Permafrost Thaw-Permeable;
  - Sewage lagoons;
  - New & Existing Water sources-groundwater & other;
  - Methane Poisoning???;
  - Predictive Hydrological Models;
- Sea Rise—Coastal / Lowland Inundation;
- Climate Change Research, and
- Adaptation.

COASTAL EROSION

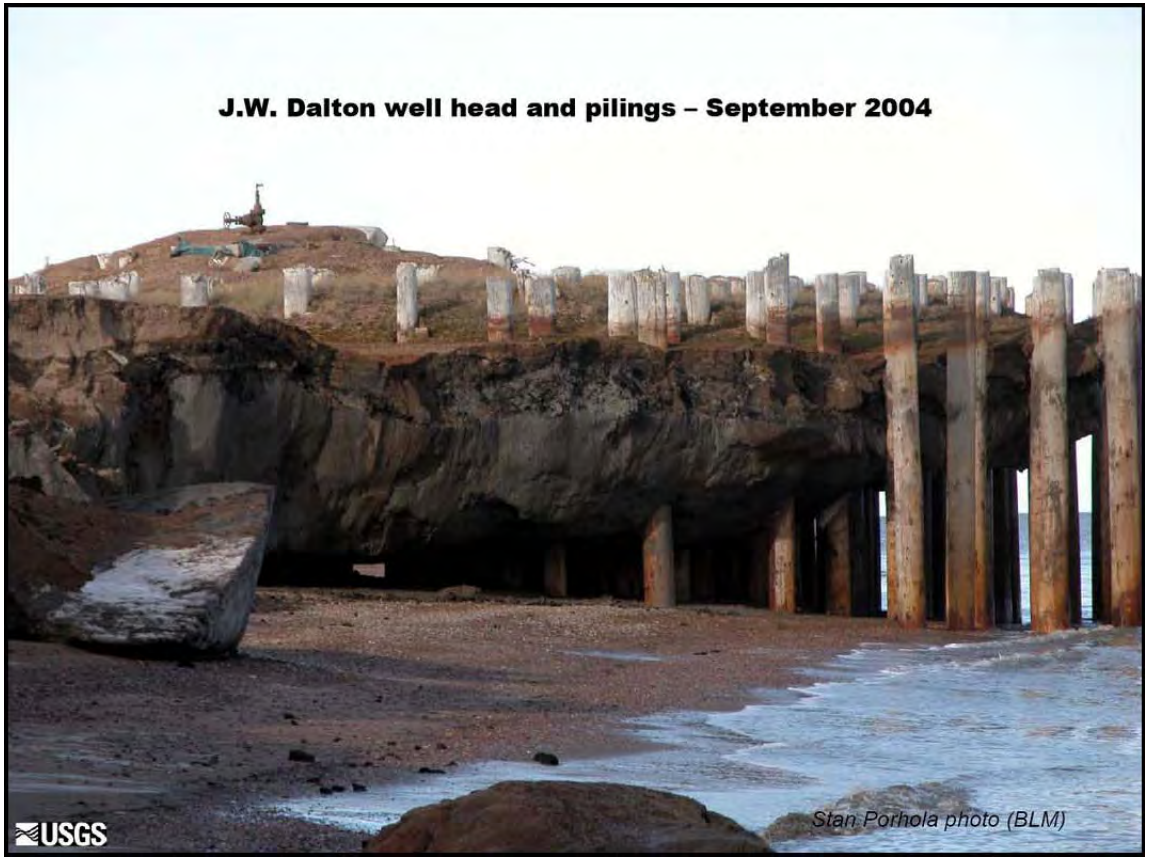
600’ OF LAND LOSS

- Predictive Modeling;
- Sea Wall Construction;
- Adaptation & Mitigation efforts;
- Salt Water Inundation.

JW Dalton Well

-- National Petroleum Reserve Alaska

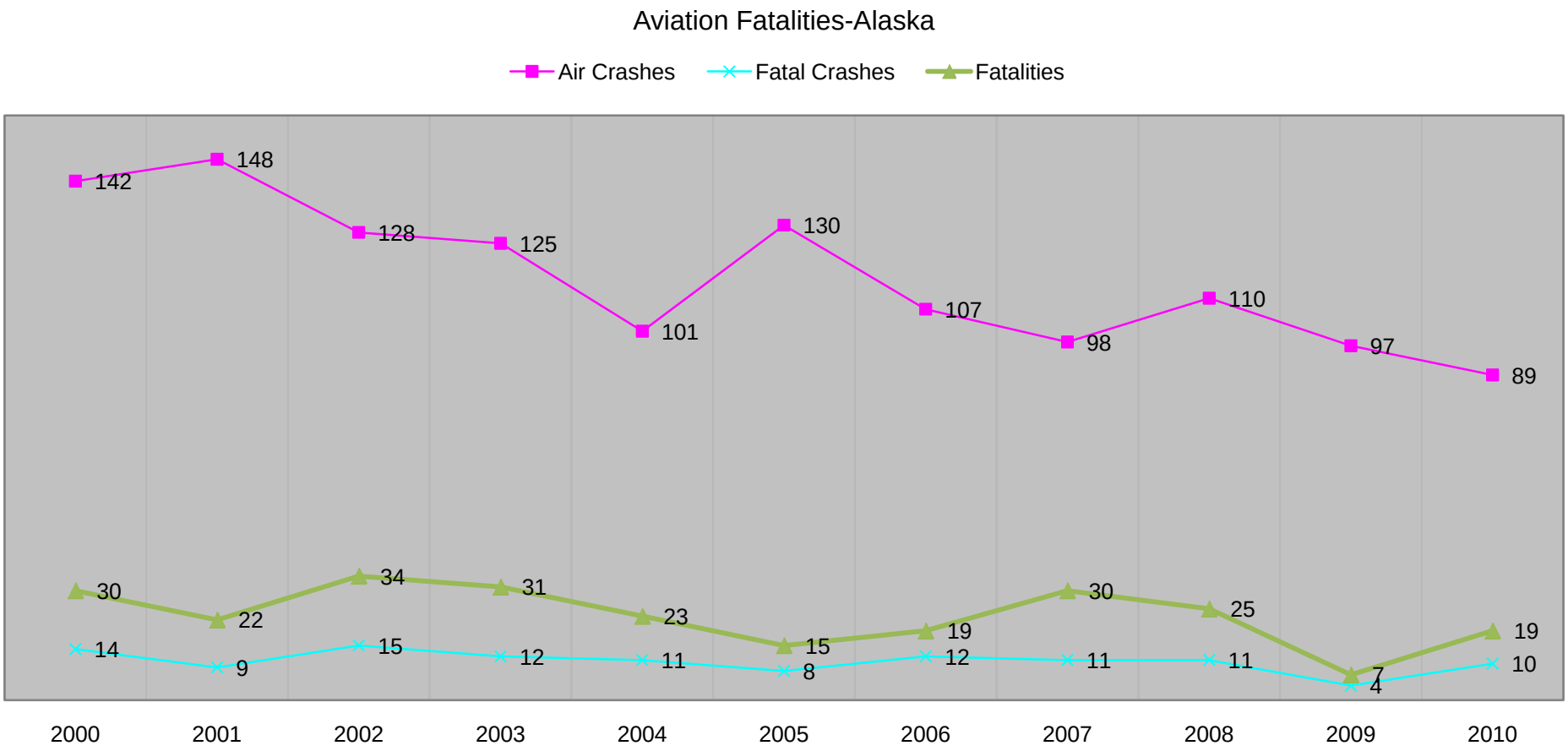
Motivation for Good Mapping: Coastal Erosion



Aviation Safety

- Synthetic Vision or In-Cockpit Moving Map:
  - Prevent CFIT;
  - Clear day view regardless of visual obscuration due to smoke or weather;
  - Improves Situational Awareness.
- CFIT is the number one reason for aviation fatalities in Alaska.
- An aviation Fatality occurs every two weeks in AK on average.

AVIATION FATALITIES



INFRASTRUCTURE DEVELOPMENT

- **Roads to Resources;**
- **Resource Development:**
  - Mining, Oil & Gas—Gas Line Route, Permitting & Right of Way;
  - Arctic Deep Water Port—Coast Guard Base;
    - Local Jobs;
    - Northern Security and Emergency Services;
  - Project Engineering;
- **Arctic Civil Infrastructure Workshop (ACIW) Fairbanks 2010:**
  - 35 representatives of public (State & Federal) and private concluded the over-arching common need among all was:
    1. Streamlined Permitting of Projects, and
    2. An Accurate DEM (Digital Elevation Model).

DISASTER MITIGATION & RECOVERY

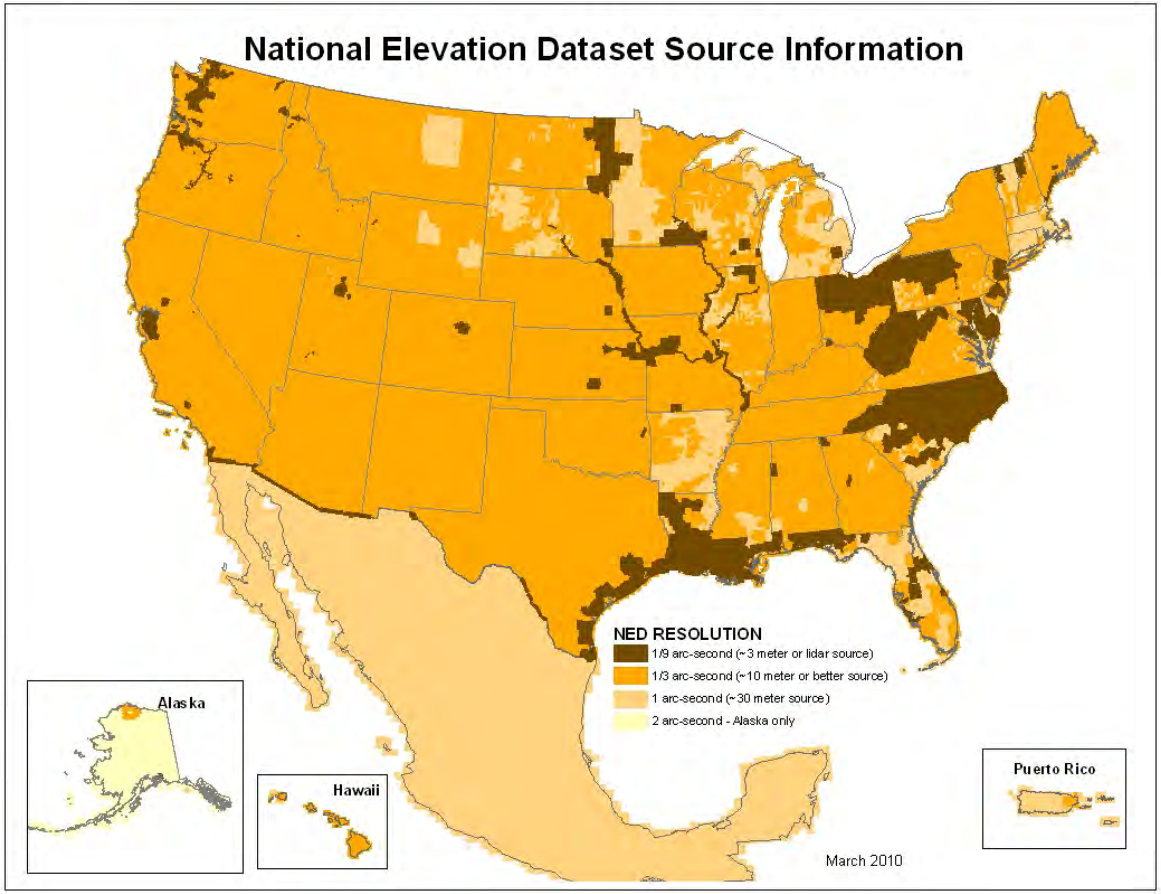
- Wildfire Modeling & Fire Line Propagation;
- Safe Evacuation Routes;
- Mitigation, Preparedness & Desktop Training, Simulations and Drills;
- Emergency Response (Situational Awareness);
- Search & Rescue/Recovery;
- Environmental Disaster Response & Recovery

Of the 20 biggest earthquakes in the U.S. 13 were located in Alaska

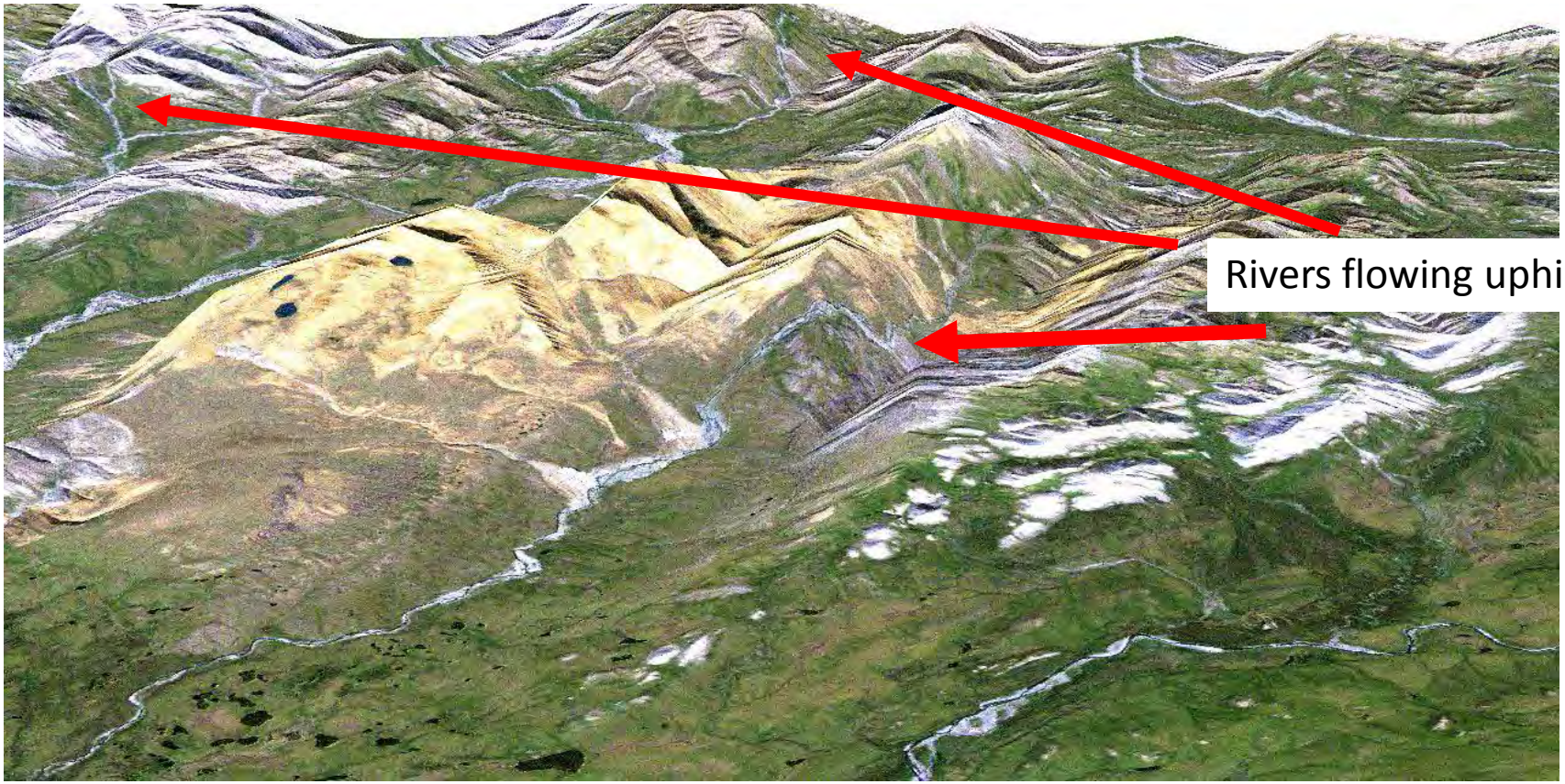
DOES ALASKA MEASURE UP?

ALASKA'S MAPS:

- USGS Topo maps created around statehood;
- The Alaska map never met National Map Accuracy Standards when created;
- No statewide digital maps;
- USGS Topos widely considered grossly inaccurate and incapable of supporting modern management practices.



RIVERS DO NOT FLOW UPHILL

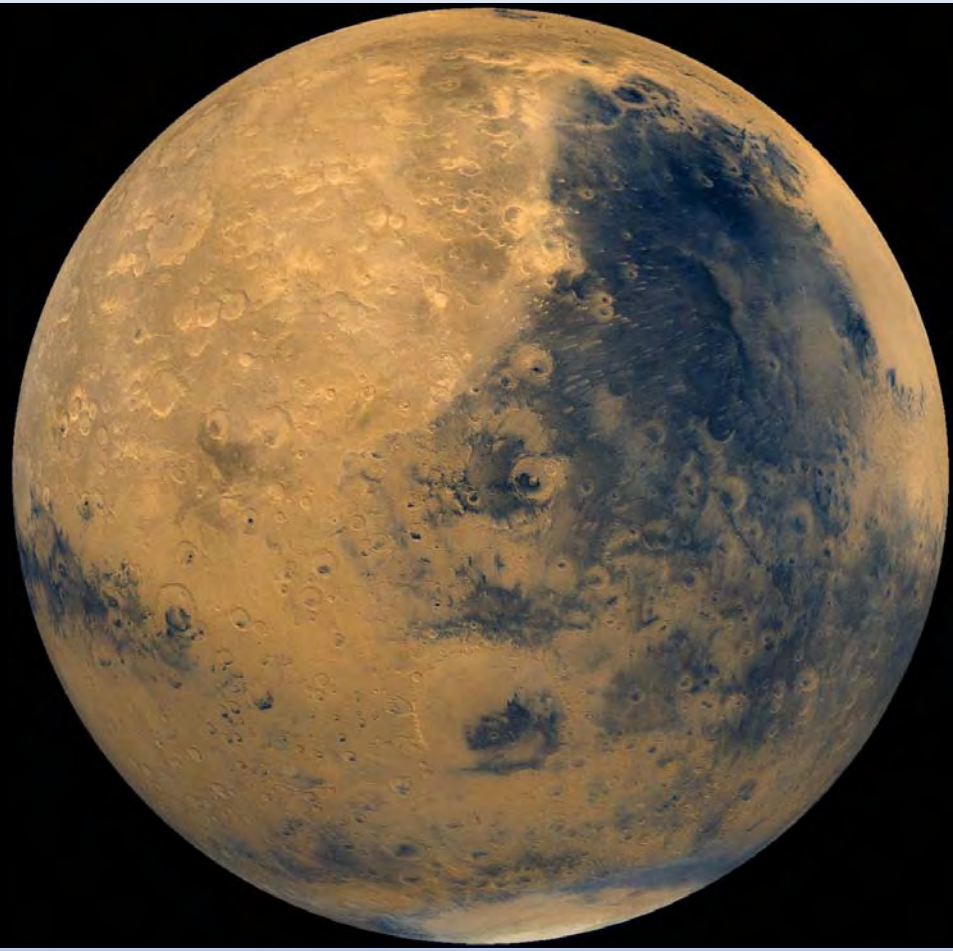


Imagery Provided by: Kevin Engle – UAF/GINA: http://www.gina.alaska.edu

HOW DOES ALASKA MEASURE UP?

MARS:

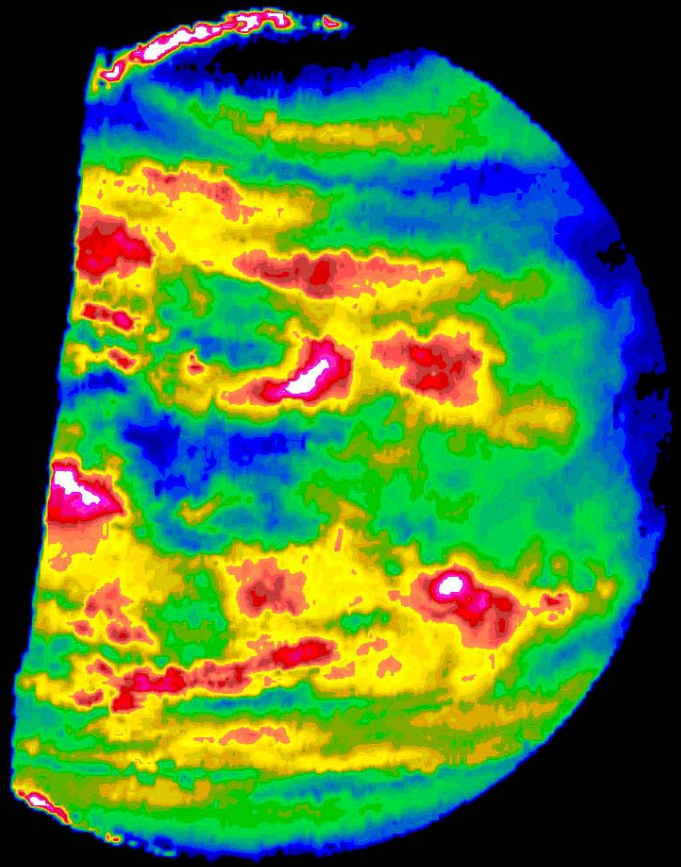
- More Accurately, More Extensively, and More Recently Mapped than Alaska.
- 20 m/pixel Resolution
- NASA Viking Missions



HOW DOES ALASKA MEASURE UP?

VENUS:

- More Recently Mapped than Alaska 1990-1994;
- 75 meter SAR DTM;
- Venus 98% Complete
- NASA Magellan Mission;
  - $431M Spacecraft



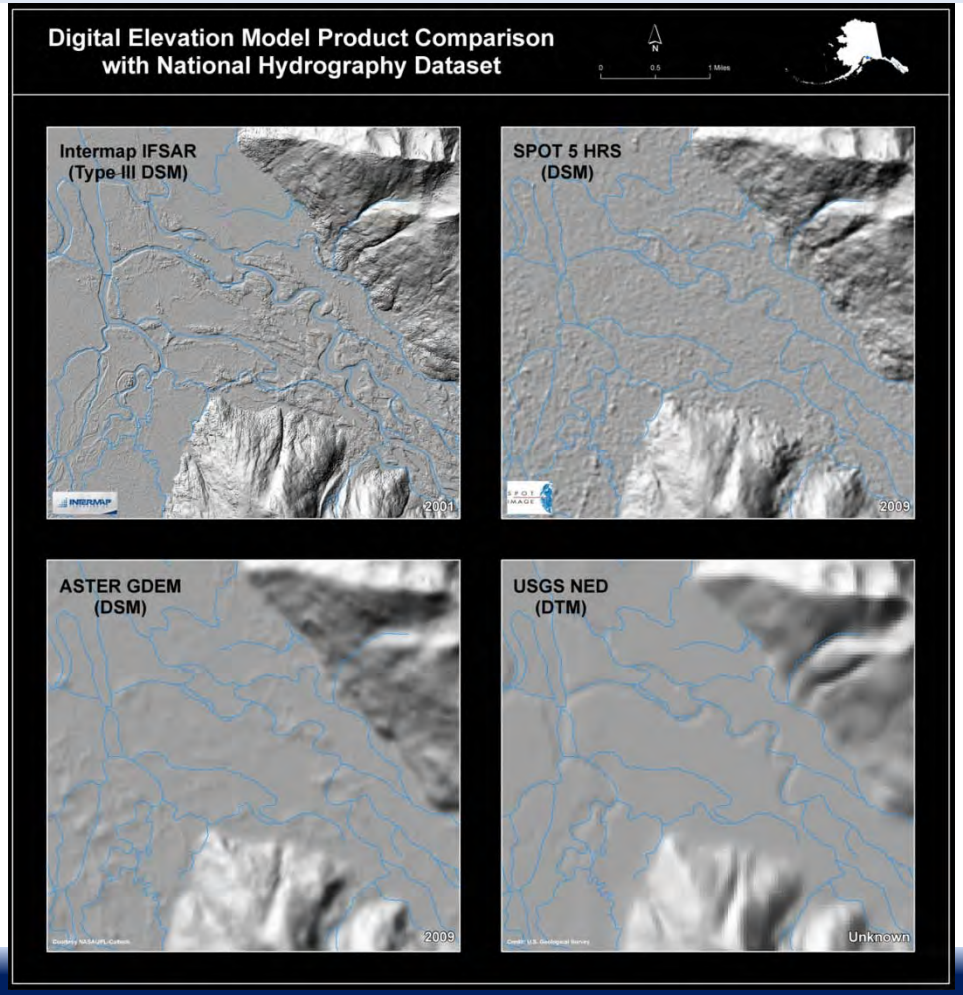
STAKEHOLDER DEFINED REQUIREMENTS

DEM User Groups	High-accuracy 10’ and below contour accuracy (Airborne LiDAR)	Mid-accuracy 20’ to 30’ contour accuracy (Airborne IFSAR)	Low-accuracy 40’ and higher contour accuracy (Satellite Sensors)
Alaska Aviation / FAA		20’ contour accuracy ICAO Area 2 standard	200’ contour accuracy ICAO Area 1 standard
Alaska DCCED	2’ contour accuracy		
Alaska DGGS	2’ & 10’ contour accuracy		50’ & 100’ contour accuracy
Alaska DNR			40’ contour accuracy
Alaska DOT	4’ & 10’ contour accuracy		
Alaska University Users	2’ & 10’ contour accuracy	30’ contour accuracy	50’ contour accuracy
BLM		20’ contour accuracy	
DOD		20’ contour accuracy	
NGA*		20’ contour accuracy	
NOAA	2’ contour accuracy	20’ contour accuracy	40’ contour accuracy
NPS			40’ contour accuracy
NRCS			40’ contour accuracy
USFS		20’ contour accuracy	
USGS	10’ contour accuracy (“ideal”)	20’ contour accuracy (“preferred”)	40’ contour accuracy (“acceptable”)
USF&WS			

80% OF ALL STAKEHOLDERS USE THE DEM FOR HYDROGRAPHY

DEM PRODUCT COMPARISON

- **IFSAR:**
- Airborne platform;
- All Weather, Day & Night Capable;
- Affordable;
- Resolution capable of Hydrology;
- Maps permanent snow & ice features well.



- **OPTICAL:**
- Satellite;
- Not all weather, day & night capable;
- Affordable;
- Resolution not capable of hydrology;
- Does not map permanent snow & ice features well.

ACCURACY MATTERS

6” Aerial Photo
30 m USGS NED

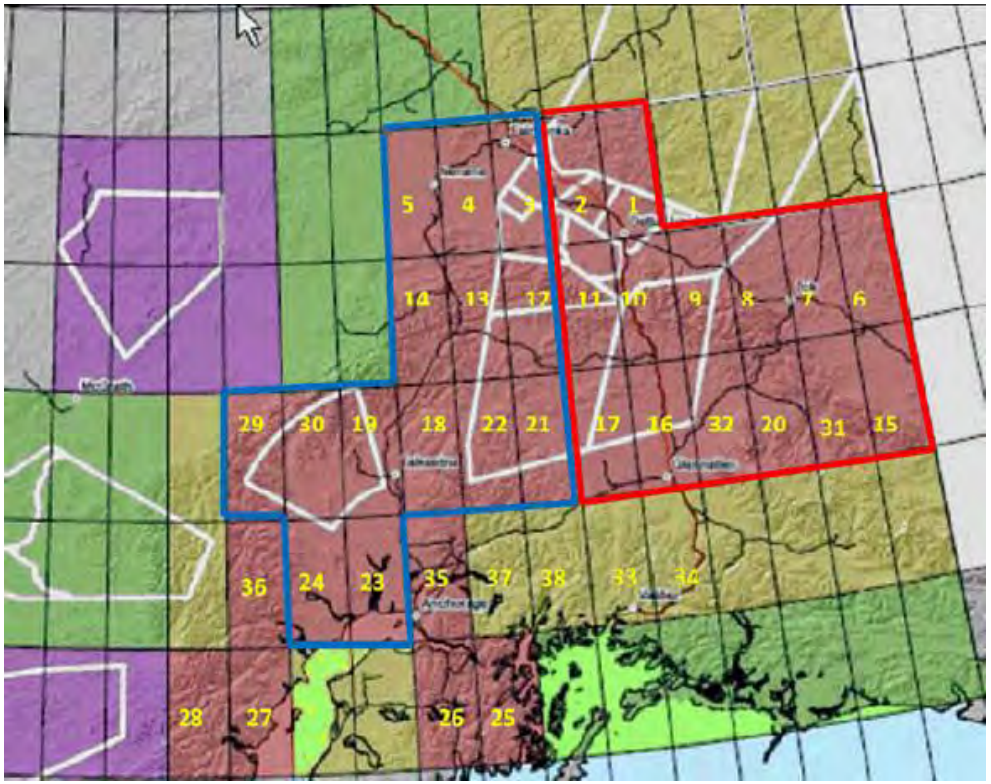
6” Aerial Photo
5 m NEXTMap DTM

2010 DEM COLLECT

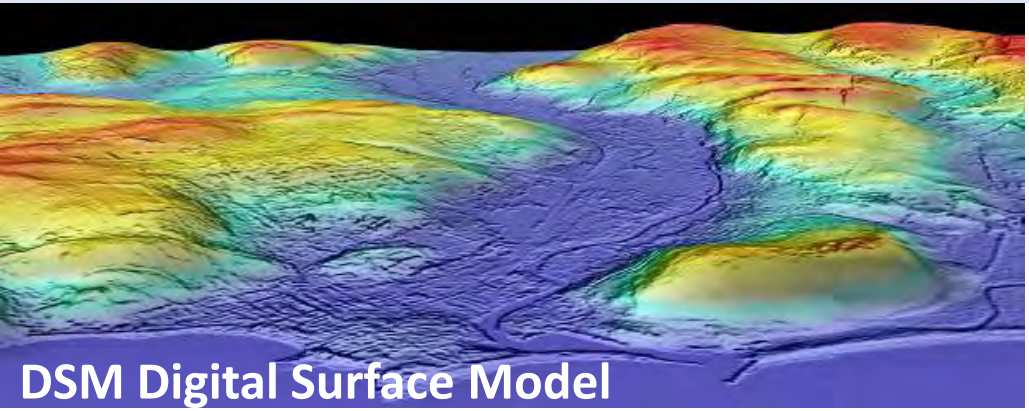
COST SHARING PARTNERS:

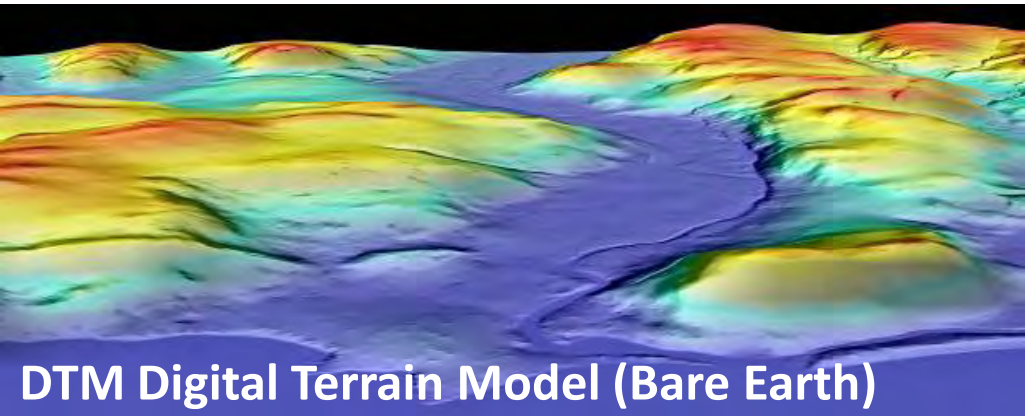
NGA	$2.4M	
USGS	$1.0M	
BLM	$200k	
NPS	$100k	
NRCS	$100k	
FED	**$3.8M**	**66%**
STATE	**$2.0M**	**34%**
TTL	$5.8M	

- 28 CELLS ACQUIRED
- 157,434 k^2 COLLECT
- $34.73/ k^2

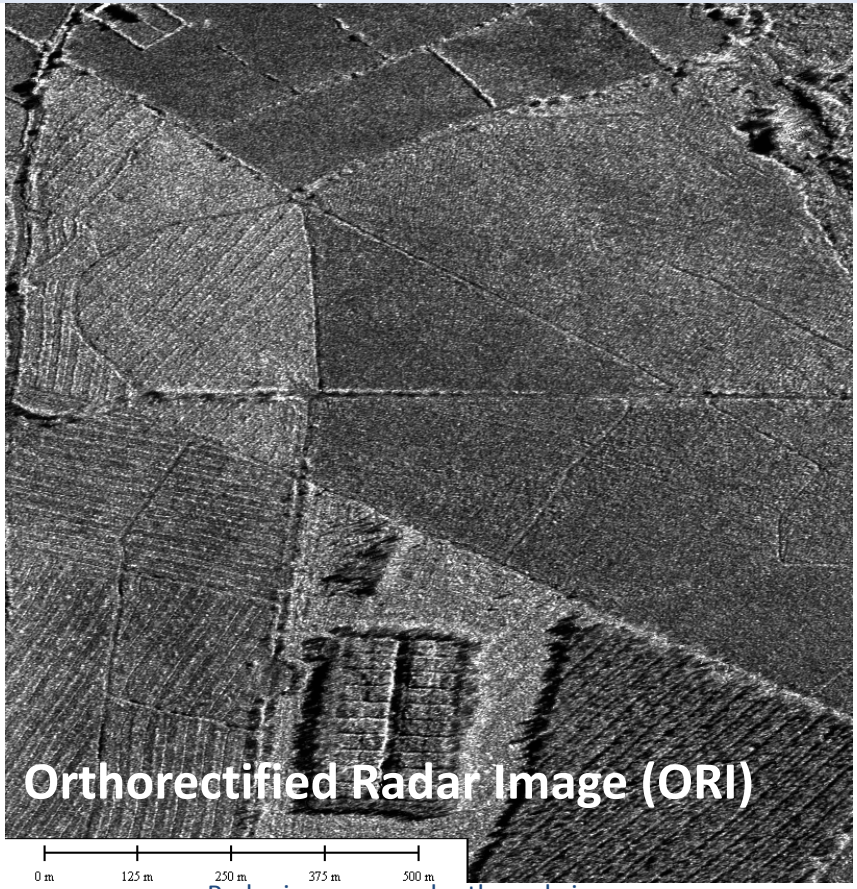


DELIVERABLES DSM / DTM / ORI





The USGS National Elevation Dataset (NED) seeks Digital Terrain Models (DTM) which the low resolution DEM does not provide



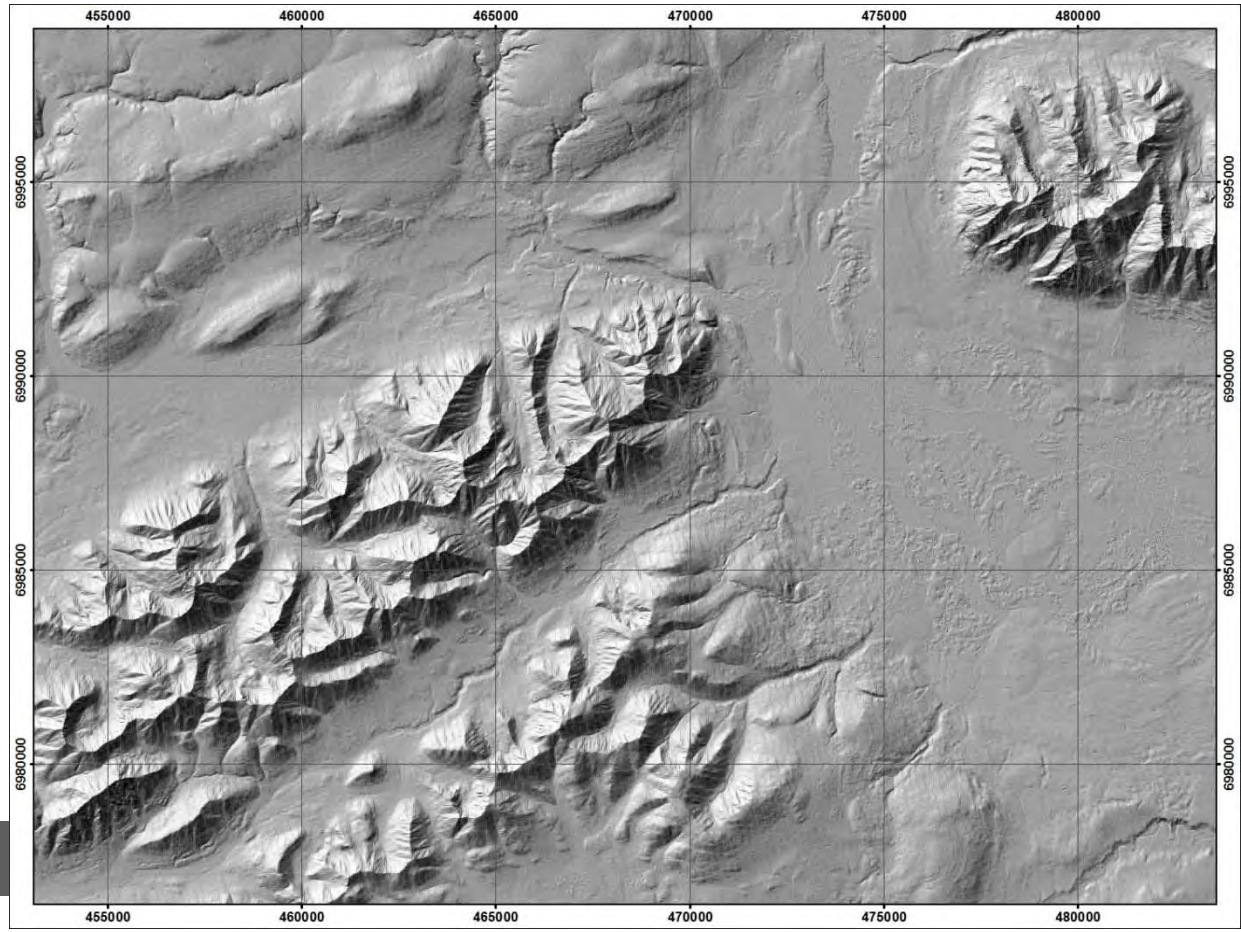
Radar images may be the only imagery available in areas of perpetual cloud cover

IFSAR ALREADY USED

F-22 Raptor Crash 11/2010:

- Slope analysis to determine avalanche danger to recovery crews.

- Unscheduled Emergency Delivery of IFSAR Data:
  - Raw Data
  - No QA/QC
  - High praise for product

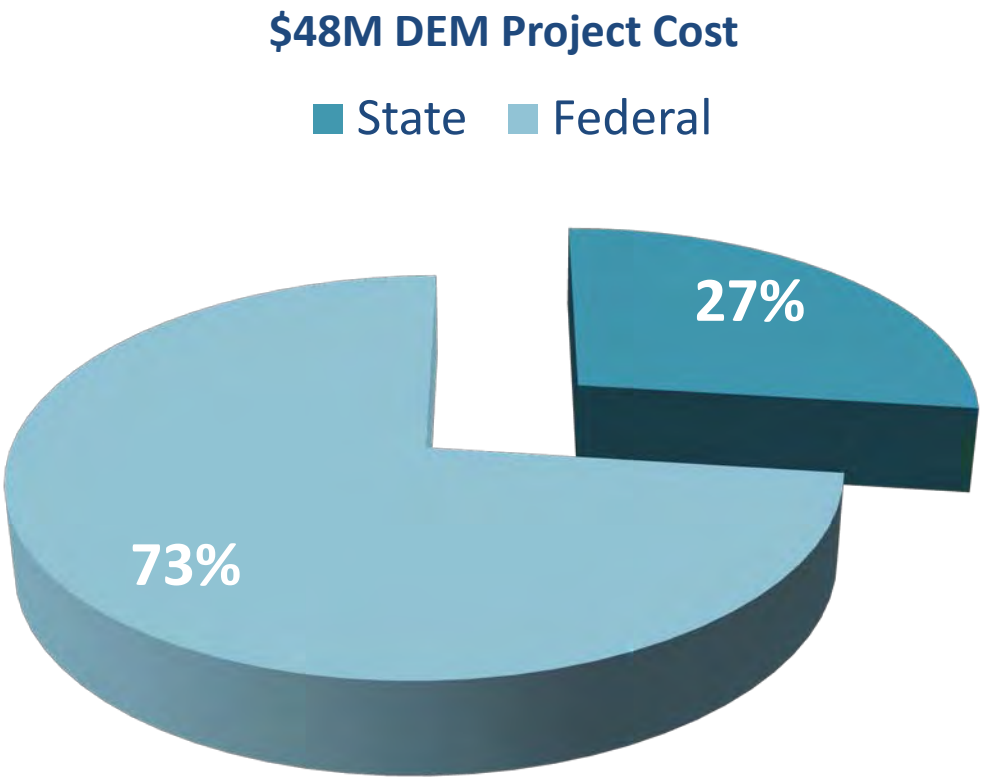


Hillshade from 5m IFSAR DEM

DEM FUNDING STRATEGY

State Cost
$12.96M

Federal Cost
$35.04M

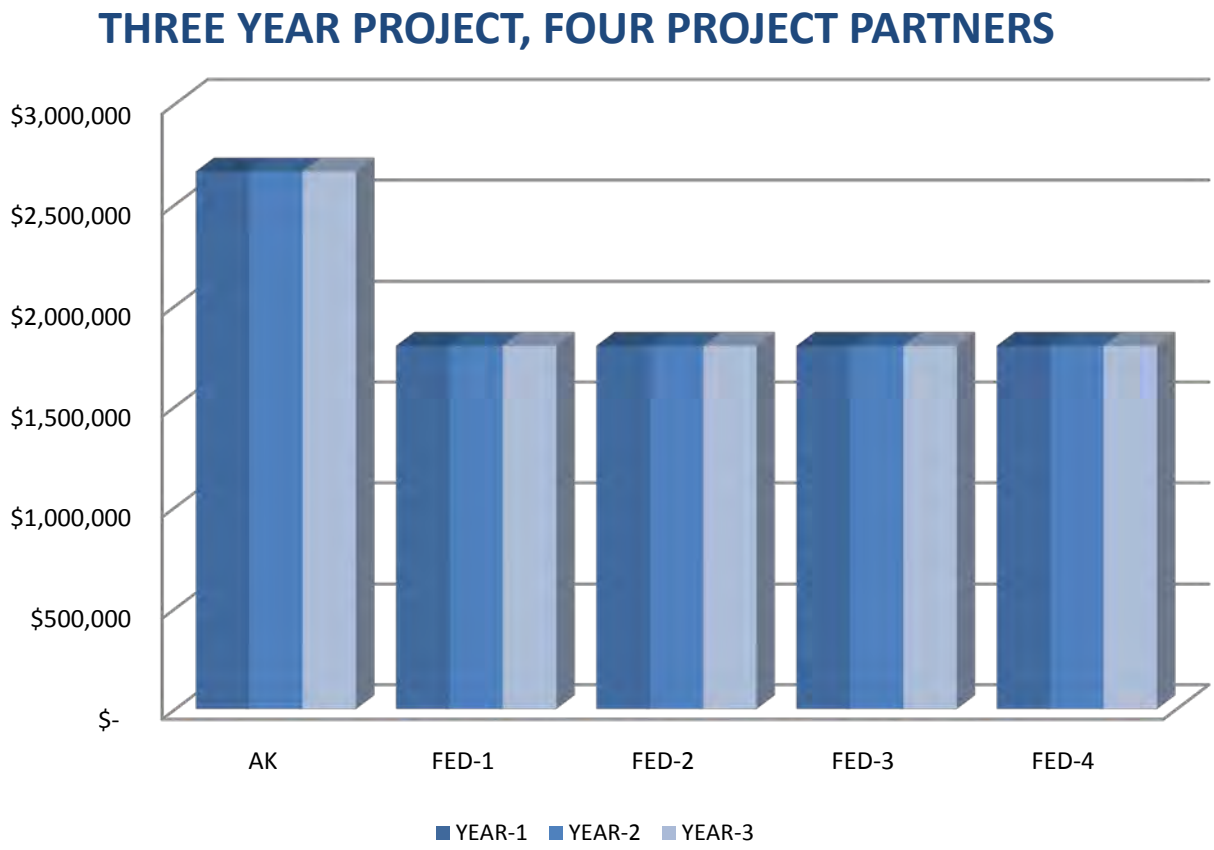


Three Years, Four Project Partners

STATE/YEAR
$4.32M

FED/YEAR TOTAL
$11.68M

AGENCY/YR
FOUR AGENCIES
$2.92M



WHAT IS BEING DONE?

- Washington Delegation letter to Intergovernmental Affairs Office, White House;
- Convening federal round table Washington DC (A top down approach to funding);
- Convening federal round table locally (A bottom up approach to funding);
- Potentially one of the Governor's requests to the Washington Delegation in the form of a federal budget request;
- Anticipate Lt. Governor & DOT staff visit with NGA & DOI leadership in DC, and
- Letters of endorsement & support solicited.

John Wesley Powell, 2nd Director of USGS

Testimony to Congress on December 5, 1884

"A Government cannot do any scientific work of more value to the people at large, than by causing the construction of proper topographic maps of the country"

This statement remains true today in Alaska where public safety, resource management and development are critical.