Community Surface Dynamics Modeling System: Background

Why Earth-surface dynamics?

NRC “national imperatives”

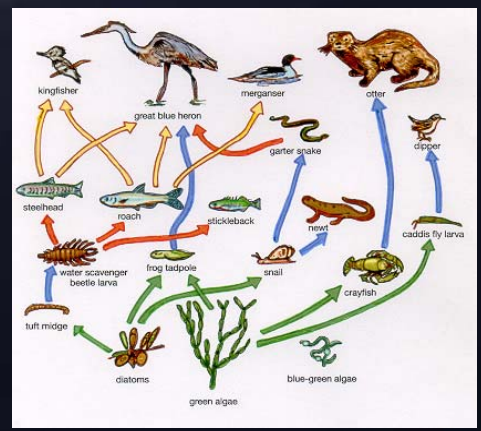
- Discovery, use, and conservation of natural resources
- Characterization and mitigation of natural hazards
- Geotechnical support of infrastructure development
- Stewardship of the environment
- Terrestrial surveillance for global security

National Research Council (2001) ***Basic Research Opportunities in the Earth Sciences***

Why Earth-surface dynamics?

The surface *is* the environment

- The surface is the arena for nearly all life
- Physical, chemical, and biological systems of the Earth's surface are so deeply interwoven that the surface might best be thought of as a kind of "living skin"

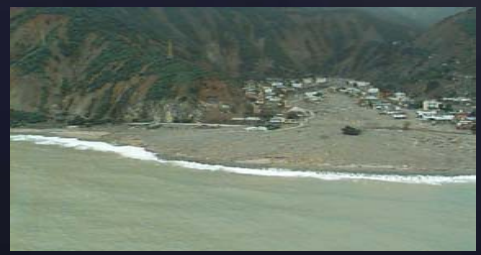


NRC imperative: Stewardship of the environment

Why Earth-surface dynamics?

Surface-dynamics hazards cost lives and dollars every year

- Flooding
- Landslides
- Coastal erosion

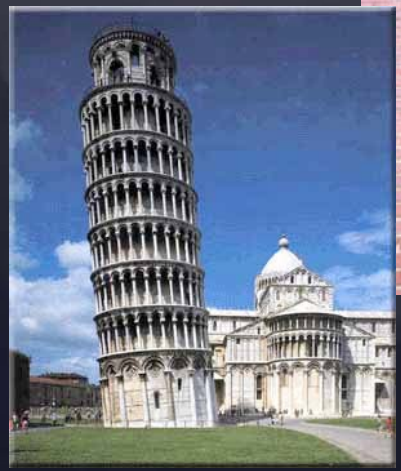


NRC imperative: Mitigation of natural hazards

Why Earth-surface dynamics?

Erosion and sedimentation affect soil and sediment physical properties

- Fines content
- Water content
- Rate of deposition



NRC imperative: Geotechnical support of infrastructure

Why Earth-surface dynamics?

A quantitative understanding of surface dynamics is a cornerstone of environmental science and engineering

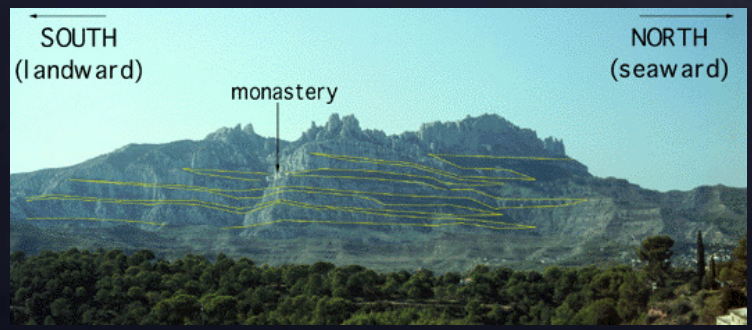
NRC imperatives:

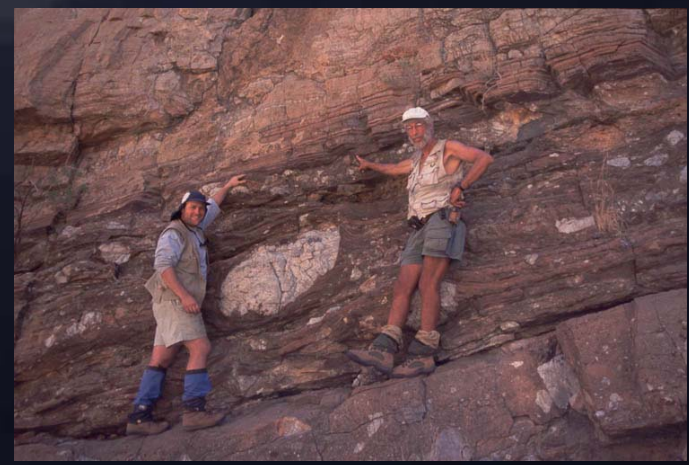
- **Stewardship of the environment**
- **Mitigation of natural hazards**
- **Geotechnical support of infrastructure**

Why Earth-surface dynamics?

Earth-surface history

- Stratigraphic record of behavior and states of the surface system
- Critical data source for model testing on planetary length and time scales





Why Earth-surface dynamics?

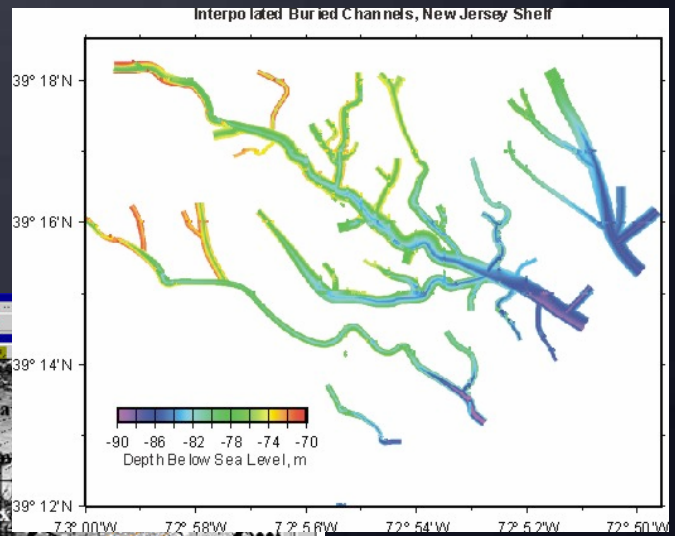
The “surface archive” is a repository of key resources: water and hydrocarbons

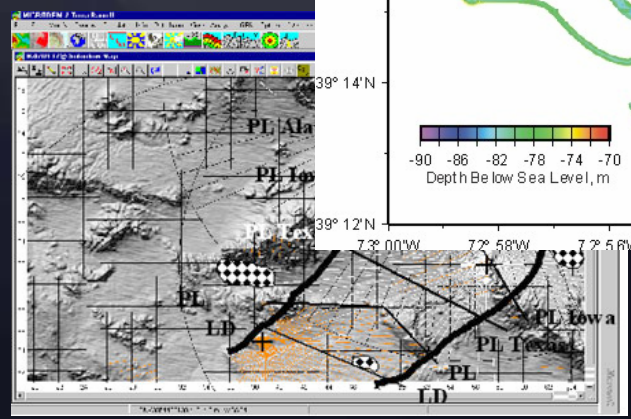
NRC imperative: Discovery, use, and conservation of natural resources

Why Earth-surface dynamics?

Surface-dynamics models can be used to estimate and model surface and subsurface terrain in inaccessible places

- ONR “Geoclutter” program
- ARO terrain analysis

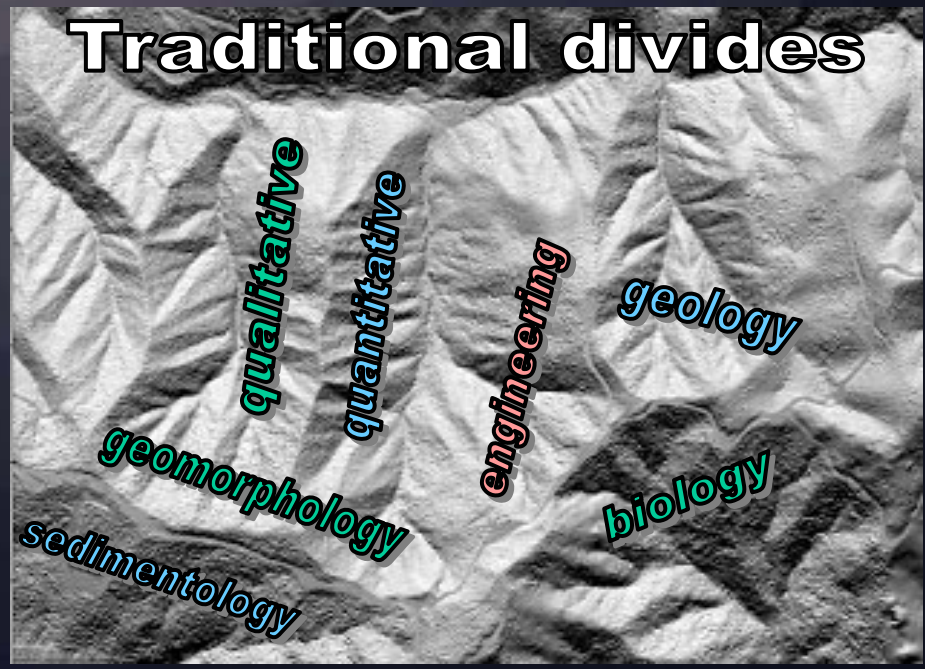




NRC imperative: Terrestrial surveillence

What's wrong with the present approach?

- Fragmentation of understanding across fields: geomorphology, sedimentology, civil engineering, oceanography, ecology, geography, physics, mathematics
- Uneven levels of understanding



How can we do better?

We need a unified, predictive science of Earth-surface dynamics

- Will require sustained, coordinated effort across a range of scientific communities
- CSDMS is a key unifying element of this effort

Why is CSDMS the Right Project?

- Because mathematics and analysis are at the heart of quantitative prediction
- Because a community model provides the best means of insuring ongoing interaction among modelers, experimentalists, and field workers

Why is CSDMS the Right Project?

- Because the surface system is sufficiently complex to require the most powerful numerical tools available
- Because effective societal applications require the most accurate predictions current science allows

Benefits

Discovery, use, and conservation of natural resources	Prediction of location and geometry of subsurface reservoirs
Characterization and mitigation of natural hazards	Quantitative estimates of hazard risk
Geotechnical support of infrastructure development	Prediction of key variables that control geotechnical properties
Stewardship of the environment	Understanding and prediction of surface arena for life
Terrestrial surveillence for global security	Estimation of inaccessible terrain and strata

Challenges and Responses

- Multiplicity of fields, scales, interests, applications
- Could stifle individual creativity
- Must deliver useful results in a timely manner

- Flexibility, adaptibility, modularity
- Toolbox rather than monolithic model
- Build on existing code

Challenges and Responses

- Complex models will be hard to test
- Complex, long-term research program requires effective management

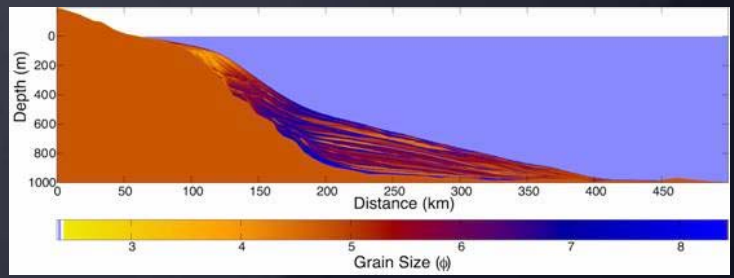
- Close ties with field and experimental programs
- Central coordinating CSDMS facility
- learn from colleagues in more mature fields

Challenges and Responses

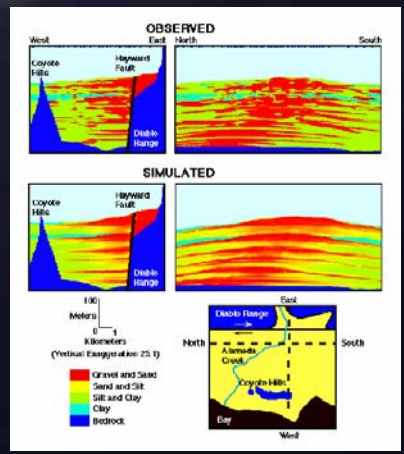
- Important processes still not understood
- Flexible, community-based approach allows for rapid assimilation and adaptation

Now is the right time

First steps toward integrated modeling have already begun:



- Stanford Sedsim series
- INSTAAR Sedflux
- USGS community shelf model
- ONR Strataform models



Now is the right time

Critical background and tools are in place:

- Graphics and visualization for large 3D datasets
- Nesting methods for systems with wide range of length scales
- Adaptive mesh-generation techniques for variable resolution
- Moving-boundary methods

Now is the right time

CSDMS has support from a network of institutions and programs:

- NCED
- INSTAAR
- Margins Source to Sink
- ONR EuroStrataform
- The broad scientific community (“full house” 2002 workshop, 6 members of writing team…)

On to my colleagues

The spirit of teamwork and cooperation that led to the workshop white paper and this presentation is representative of how CSDMS would be run…