

# Integrated Research and Capacity Building in Geophysics

**Raymond J. Willemann, IRIS Consortium**

**Andrew Nyblade, Pennsylvania State University**

**Arthur Lerner-Lam, Columbia University**

- There have been special opportunities over the past several years to improve the ways that newly-constructed geophysical observatories in Southeast Asia and the Americas are linked with educational and civil institutions.
- Because these opportunities have been only partially fulfilled, there remains the possibility that new networks will not fully address desired goals or even lose operational capabilities.
- In contrast, the AfricaArray project continues to progress towards goals for linkages among education, research, mitigation and observatories.



# A Consortium of 109 US Universities

Operating Facilities for Seismic Data Acquisition & Distribution

IRIS Members comprise virtually all US universities with research programs in seismology - and include a growing number of educational & international affiliates.



IRIS Board of Directors member Brian Stump makes field notes of a mine blast.



IRIS Board of Directors member Anne Sheehan surveying aquifer properties in El Salvador.

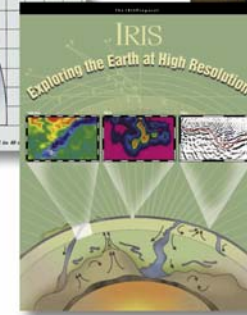
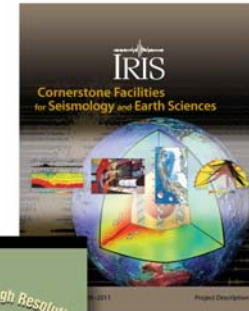


IRIS Board of Directors member Don Forsyth on a research cruise in the Pacific



# For 24 Years, Partner with the US National Science Foundation

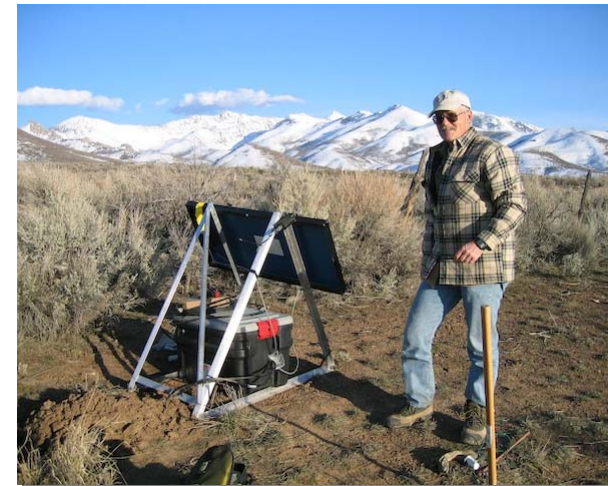
Facilities built and operated by IRIS have secured a critical role for NSF-funded earth scientists in national and international research



Continuous cooperative agreements with the US NSF since 1984.



The Global Seismographic Network station in Patinga, Brazil, is part of a societal resource for earth observations, monitoring, research, and education.

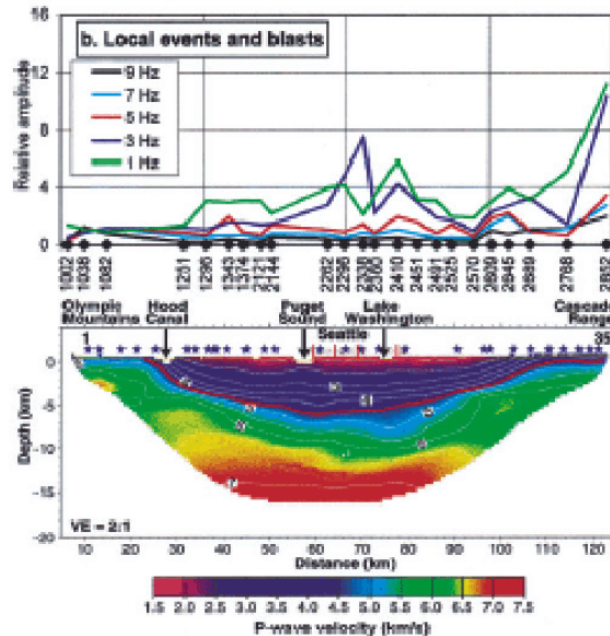


Dozens of field projects around the world each year rely on IRIS services & instruments

# IRIS Facilities Enable Discoveries about Faults, Rupture, and Earthquake Hazard

Research activities include:

- Detecting previously unsuspected rupture modes.
- Rapid deployments to measure stress changes while



IRIS facilities allowed rapid quantification of the devastating Sumatra-Andaman earthquake and tsunami of 2004.  
*Graphic by S. Lombeyda*

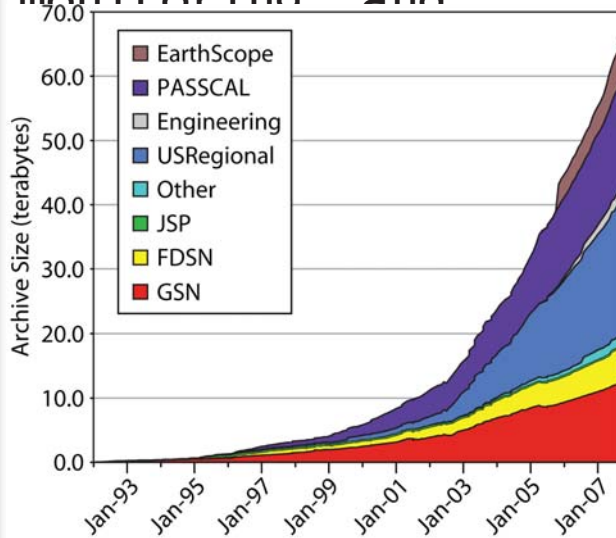
*V. Hjorleifsdottir, J. Tromp, and R. Aster.*

Observed amplification of strong ground motion from one earthquake (top) varies with frequency and location in the Seattle Basin. 3-D basin structure from seismic experiments (bottom) can be used to compute amplification from other scenario earthquakes

# Committed to Open Data Exchange

Seismology has become one of the most open sciences

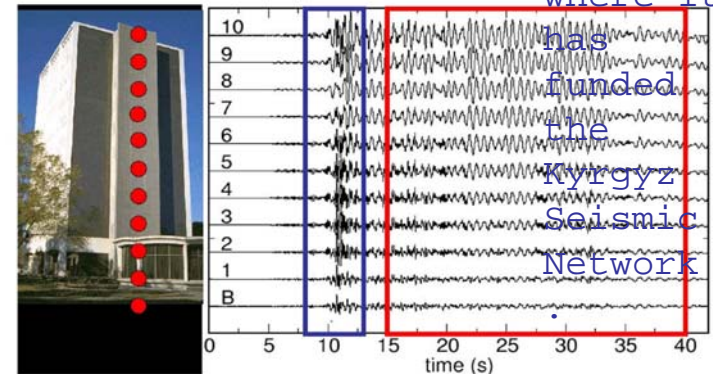
Open access facilitates ever-greater returns from data acquired for research, earthquake and explosion monitoring and



IRIS archives data from around the world and responds to millions of data requests each year.



IRIS helps open data access to stations in many areas, including Kyrgyzstan, where it



has funded the Kyrgyz Seismic Network.

Open policies are now being adopted more widely, even from previously proprietary accelerometers in the built

# Contributing to Science Education, Scientific Literacy, and Public Understanding

IRIS Education & Outreach provides products and programs for

- The general public,
- K-12 students and teachers,
- Post-secondary students.



▪ IRIS Summer Intern Program sends university students to the field to learn how to deploy seismic equipment and interpret the data.



Scientist uses data and educational resources from IRIS Web site to introduce earth



The Active Earth Display is an interactive, computer-based display for small museums, visitor

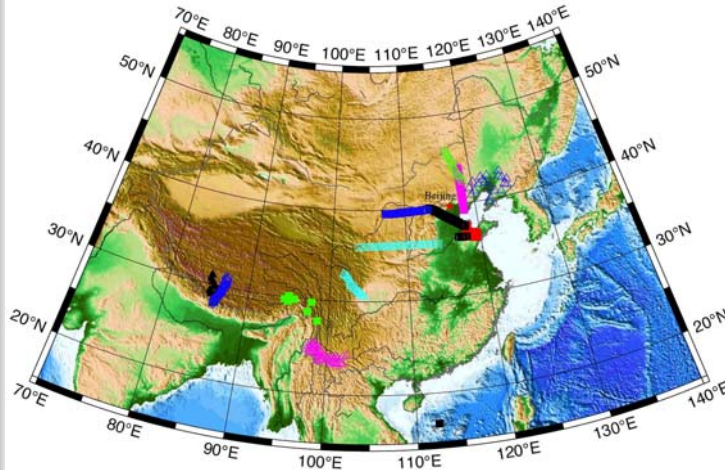
# Global Revolution in Seismology

A global perspective is indispensable to seismology

Imaging earth's interior needs worldwide data.

Monitoring nuclear tests needs near-site instruments.

Tsunami warning needs cooperation among many nations.



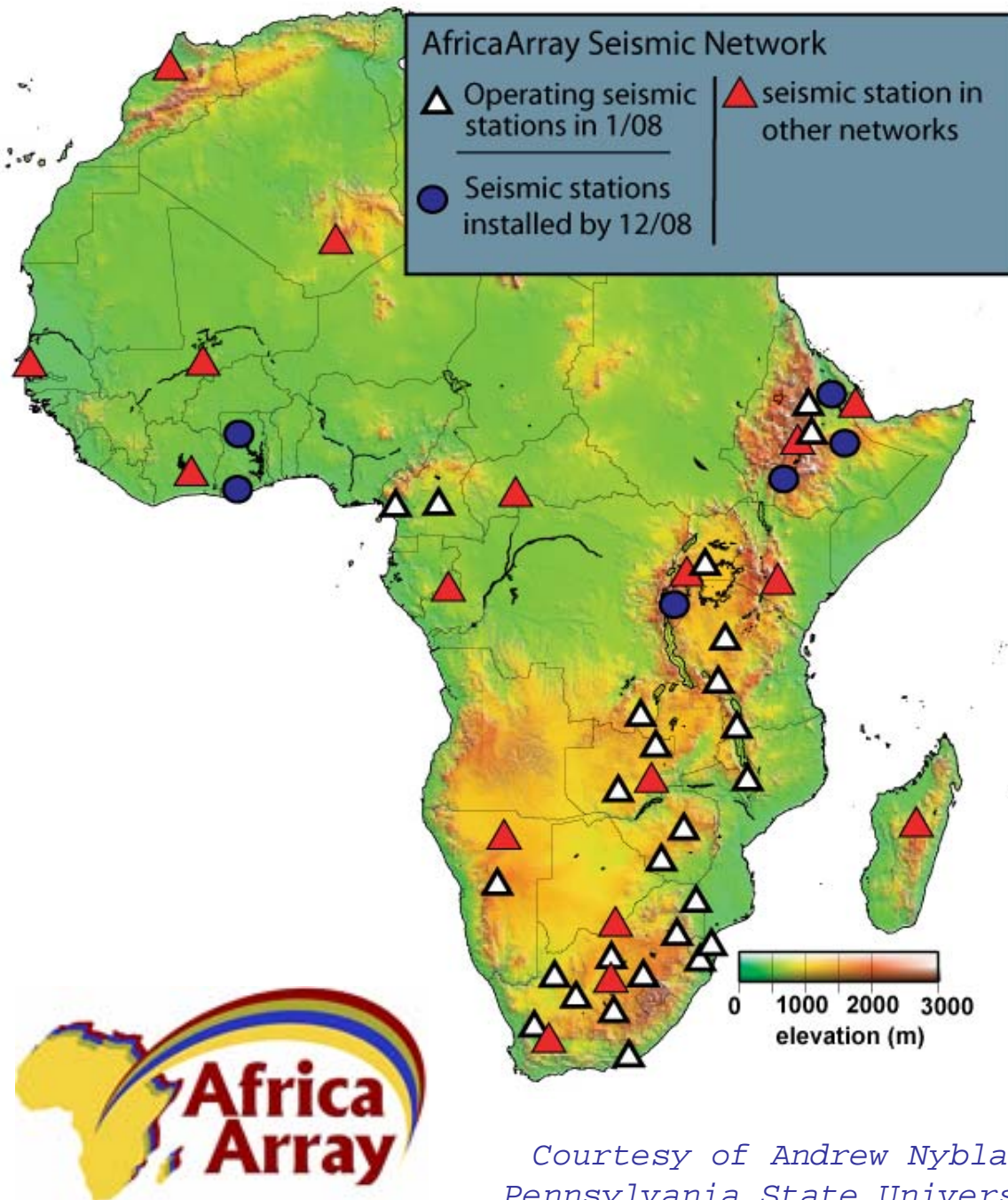
The Chinese Academy of Sciences (CAS) operates portable broadband seismometers, similar to IRIS's, and uses IRIS software



GEOSCOPE is a global digital seismographic deployed by France participates with IRIS in an international federation. *Photo courtesy of*

## A public-private partnership supporting capacity building and research linked to Africa's natural resource sector

- To support in-situ training and research programs to help build a scientific workforce - initially in geophysics
- As part of the training and research programs, create a network of shared scientific observatories (initially broadband seismic stations) to promote education, research, and community building
- Arrays of
  - + training programs
  - + research projects
  - + partnerships
  - + science observatories



*Courtesy of Andrew Nyblade  
Pennsylvania State University*



IRIS

# Building Capacity Around the World

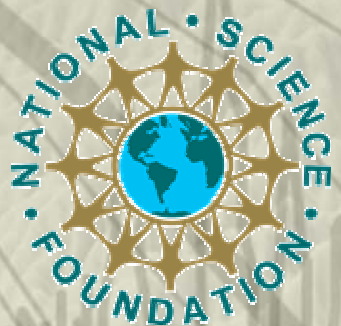
## *Workshop Goals*

*Enumerate leading regional science objectives* that require long time series of high-fidelity seismological waveform records.

*Identify broader regional social benefits* from improved seismological capacity and sophisticated data products.

*Suggest mechanisms for assessment* of technical capacities and performance of new and existing regional and national networks.

*Introduce development experts and aid providers* to the need for integrated network solutions.





## *Workshop Participants: 50 Seismologists*

- US academics with extensive experience in temporary deployments around the world.
- University-based seismologists – generally with operational responsibilities – from Africa, Southeast Asia, South America, and Middle America.
- Students and post-docs at US universities, primarily from other countries.



# Summary Recommendations

From the Draft Report

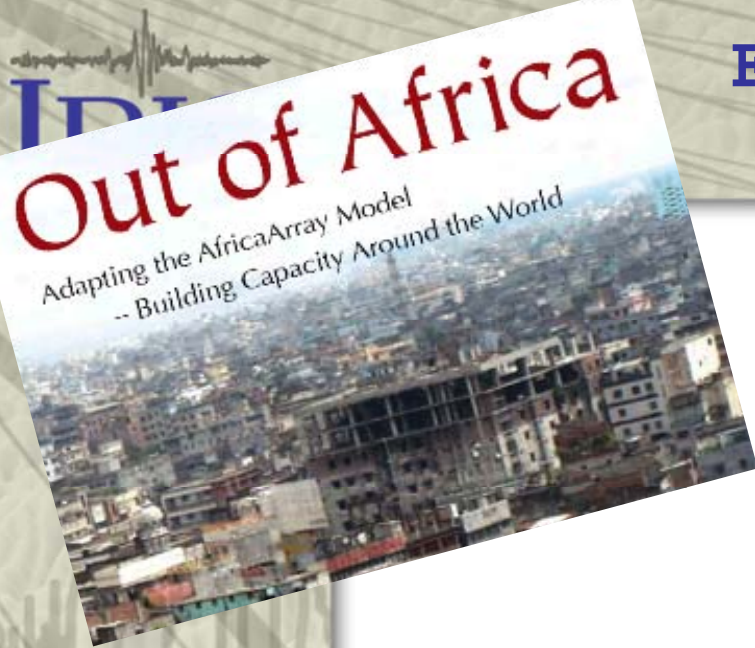


## Out of Africa

Adapting the AfricaArray Model  
-- Building Capacity Around the World

- Geophysicists must be “densified” through more education and training.
- New instruments are needed, but must be coupled to effective capacity building.
- Software and instruments must be adapted for local requirements.
- Regional data centers and confidence building measures are needed to move towards open data.





# Education Recommendations

From the Draft Report

*Intergovernmental organizations or development banks* should fund expansion of strong educational programs, to include students from other countries.

*Universities in Middle America & South America* should establish geophysical summer field courses, with US students and faculty.

*US universities* should

- allow students to make several visits of one or two semesters while earning an advanced degree in their home country.
- engage in “cluster” admissions to create a “critical mass” of young, educated geophysicists – complemented by US foreign aid to facilitate research by post-doctoral scientists.
- partner with the USGS and mining and oil companies for internships to teach applied skills while students earn credit towards post-graduate degrees.



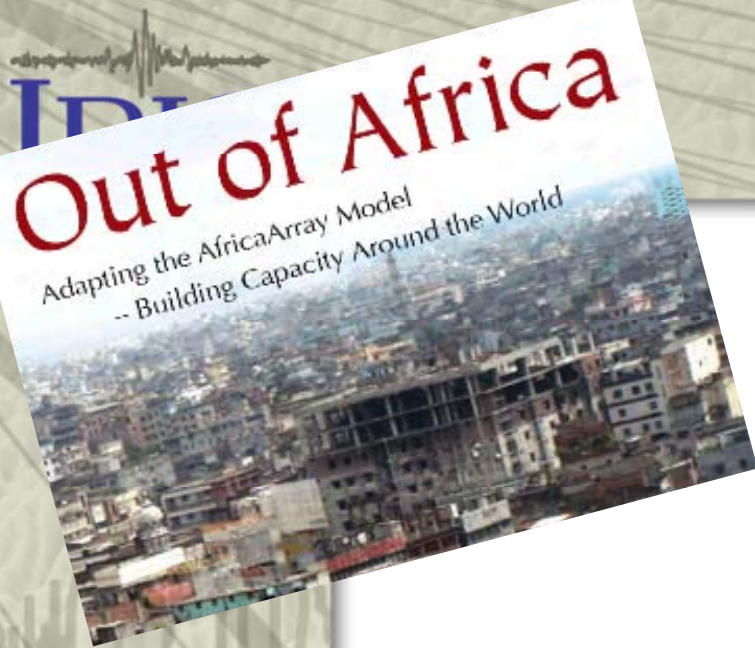


# Education Recommendations

## Establish Summer Field Courses in the Americas

*That is, create an international version of the “Summer of Applied Geophysical Experience” (SAGE) program, in which*

- Advanced undergraduates and graduate students are introduced to geophysical exploration and research, going beyond a standard classroom-based curriculum.
- Students combine geophysical data that they acquire with geological information for integrated subsurface interpretations.
- Modern field equipment and vehicles are provided by various academic institutions and industrial affiliates.
- Processing and modeling of data use state-of-the-art software.



# Training Recommendations

From the Draft Report

- *Organizations that operate international training programs* should meet bi-annually to compare the objectives and content of the different programs. Where possible, they should plan complementary courses in selected geographic regions that cumulatively build capacity toward clearly stated goals, with objective metrics of success.
- *International regional seismological organizations (such as MIDAS in Middle America and CERESIS in South America)* should conduct detailed surveys of existing capabilities and publish summaries of regional training requirements.

# Out of Africa

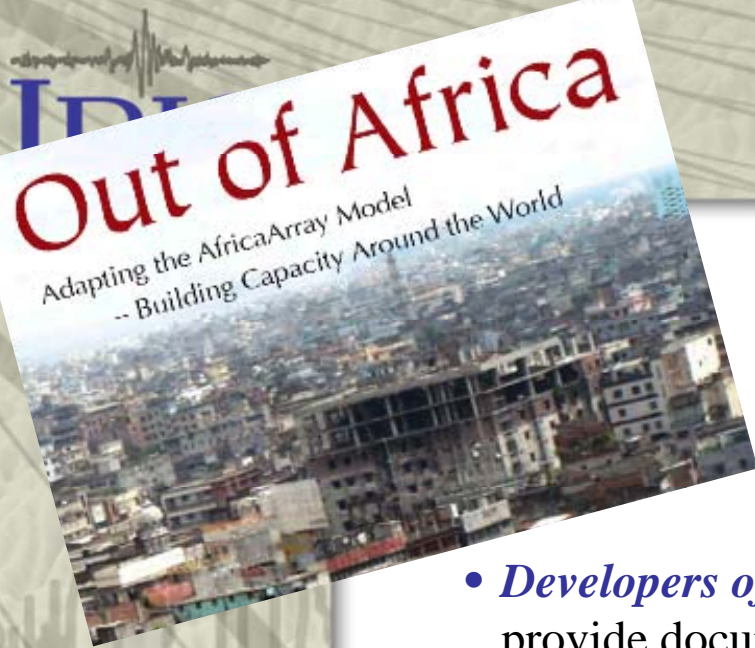
Adapting the AfricaArray Model  
-- Building Capacity Around the World

## Instrument Recommendations

From the Draft Report

- ***High-income countries*** should offer standardized sets of instrumentation to low- and middle-income countries, coupled to cooperation in training, education, research, and open data commitments.
- ***IRIS*** should produce a summary of existing sensors, digitizers, power systems and telemetry, including features that them make suitable for particular environments.
- ***Regional development agencies*** should fund projects to develop versions of sensors, digitizers, power systems and telemetry that would perform more reliably in different environmental conditions, such analogous to the US program to develop cold systems for the International Polar Year.



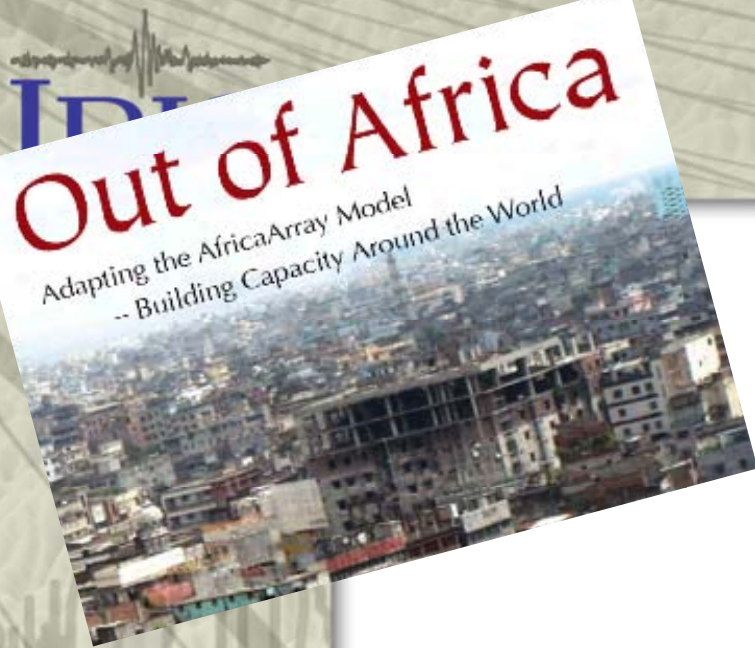


# Software Recommendations

From the Draft Report

- *Owners of proprietary software* should provide no-cost or low-cost licenses to users in low- and middle-income countries.
- *Developers of both proprietary and open-source software* should provide documentation on what fields in data formats need to be filled in order to perform specified analyses. Translators between data formats should be open-source and run under widely available operating systems, and should to be developed jointly by the two organizations owning the data analysis programs between which the translation is done.
- *Documentation writers for a specialized products* should include advice on using their computer programs with different network processing packages.





# Data Recommendations

From the Draft Report

- *An international seismological organization representing consensus among network operators in each of South America, Middle America, and Southeast Asia* should propose confidence building measures for archiving data at the IRIS Data Management Center that address the risks of complacency and a slippery slope.
- *Seismological network operators within each of South America, Middle America and Southeast Asia* should make plans for a regional data management center, possibly comprised of geographically distributed nodes.





New Slide

