Remote Sensing for Hazard Mitigation and Resource Protection in Pacific Latin America

Project Overview
Develop “great international research partnerships”

Train globally engaged workforce

Improve *internationalization* at “institutional level”

*First Announced in January 2005*
Proposal Germination

40 years of Bill Rose’s et al. volcanological research in Latin America

+ 1st year of PCMI program in Geohazards

+ fledgling interests by Aqua Terra Tech Enterprise to work internationally (starting in Boaco, Nicaragua)

+ new NSF PIRE Program Announcement

= Proposal
Proposed Collaborative Framework

- Under-graduate Remote Sensing Minor
- Principal Investigators & International Counterparts
- Aqua Terra Tech Enterprise
- Post-Docs & Traditional (MS/PhD) Graduate Students
- Masters International Program
Goals for International Hazards Work

- Advance remote sensing techniques and applications
- Develop new collaborations in Pacific Latin America
- Determine the impact on US participants
Project Particulars

• Awarded October 2005 (1st PCMI Geohaz cohort had already started service, 2nd cohort on campus)

• 5 years of funding for 1.5 post-docs, 3 Ph.D. students, 9 PCMI/yr, travel, and assessment/evaluation. Took approximately 1 year to get first post-docs and Ph.D. students

• Due to some staffing departures, we were not fully staffed until the midpoint (year 2.5); biggest impact on assessment

• Midpoint reverse site visit (more about this later)
Current Collaborative Framework

- Undergraduate Remote Sensing Minor
- Post-Docs & Traditional (MS/PhD) Graduate Students
- Peace Corps Masters International Program
- Affiliated Faculty & Graduate Students
- Undergraduate Research & UPRM Interns
- Aqua Terra Tech Enterprise
- Principal Investigators & International Counterparts
Types of MTU Participants

Faculty & Staff

Ph.D. & “regular” M.S. Students

PCMI Students (on-campus & PCVs)

Undergraduate Students (Enterprise, Research Assistants, & UPRM Summer Interns)

geo.mtu.edu/rs4hazards=>People
MTU Project Participants

- **Faculty:** 8 involved through mentoring and committees
- **Post-Doctoral Researchers:** 1 for the past year, 2 previously for 1 year each
- **PhD Students:** 5 current, all “near” completion
- **PCMI Students:** 19 participated in program, 3 graduated to date, 4 new to start F09
- **MS Students:** 9 participated in program, 6 graduated, 2 near completion, 2 new for F09
- **Undergraduate Students:** 15 participated, 4 from University of Puerto Rico--Mayaguez
# MTU Faculty/Staff Participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Primary Topical Involvement</th>
<th>Project Affiliations</th>
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</thead>
<tbody>
<tr>
<td>Dr. John Gierke</td>
<td>Water Resource Development &amp; Protection</td>
<td>Student Advisor &amp; Committee Member PI/PD</td>
</tr>
<tr>
<td>Dr. William Rose</td>
<td>Volcano Remote Sensing &amp; Hazard Communication</td>
<td>Student Advisor &amp; Committee Member, PCMI Program Coordinator, Facilitate Inter-university/agency collaborations Co-PI</td>
</tr>
<tr>
<td>Dr. Gregory Waite</td>
<td>Seismic source mechanisms, Syneruptive volcanic earthquakes and degassing</td>
<td>Student Advisor &amp; Committee Member Co-PI since Fall 2007</td>
</tr>
<tr>
<td>Dr. Jose Luis Palma</td>
<td>Volcano Remote Sensing, Digital Image Processing, &amp; Hazard Communication</td>
<td>Student Co-Advisor &amp; Committee Member, Mentor Project Students in Field Work, Data Processing, and Paper Writing Post-doc since April 2008</td>
</tr>
<tr>
<td>Ms. Essa Gross</td>
<td>Water Resource Development &amp; Protection</td>
<td>Co-PI, Assessment, Website Maintenance, Coordinate Grant Opportunities</td>
</tr>
<tr>
<td>Dr. Simon Carn</td>
<td>Volcanoes &amp; Remote Sensing</td>
<td>Student Advisor &amp; Committee Member New Faculty Fall 2008</td>
</tr>
<tr>
<td>Dr. Kathy Halvorsen</td>
<td>Social Behaviors</td>
<td>Serves on Student Committees</td>
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<tr>
<td>Dr. Ann Maclean</td>
<td>Remote Sensing &amp; Digital Image Processing</td>
<td>Serves on Student Committees and Teaches RS &amp; DIP courses</td>
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<tr>
<td>Dr. Stanley Vitton</td>
<td>Landslides</td>
<td>Student Advisor &amp; Committee Member</td>
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<tr>
<td>Dr. Paul White</td>
<td>Ethnographic Studies</td>
<td>Student Co-Advisor &amp; Committee Member</td>
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# International Collaborator Groups

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<th>Group:</th>
<th>Academic</th>
<th>Federal</th>
<th>Private</th>
<th>Domestic NGO</th>
<th>International NGO</th>
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<td>Costa Rica</td>
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geo.mtu.edu/rs4hazards=>Partners
## Project

### Counterparts in Pacific Latin America

**Guatemala**
- Instituto Simologia, Vulcanologia, Meteorologia y Hydrologia
- Coordinacion Nacional para la Reduccion de Desastres
- Universidad del Valle
- Universidad de San Carlos

**El Salvador**
- Servicio Nacional de Estudios Territoriales
- Universidad de El Salvador
- LAGEO S.A. de C.V. (Private Geothermal Company)

**Nicaragua**
- Instituto Nicaraguense de Estudios Territoriales
- Centro para la Investigación en Recursos Acuáticos de Nicaragua
- Dutch Nongovernmental Agency (SNV)
- Ometepe Biological Field Station

**Ecuador**
- Instituto Geofisico, Escuela Politecnica Nacional
- Instituto Nacional de Hidrologia y Meteorologia
- Empresa Metropolitana de Alcantarillado y Agua Potable de Quito
- Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos
- Dirección Nacional de Geologia
- Dirección Nacional de Mineria
- French Public Science and Technology Research Institute

**Costa Rica**
- Universidad de Costa Rica
- Area de Amenazas y Auscultación Sismica y Volcanica

**Panama**
- Cuerpo de Paz Panama
- Universidad de Panama
- Instituto Geografico Nacional
Mid-Project Evaluation

Reverse Site Visit

20 May 2008
NSF PIRE Program Objectives

• Research and educational excellence

• Deeper collaborations

• Research experiences for U.S. students and faculty

• Engage resources within and across institutions

• Develop new replicable models for collaborative research and education

• Raise the profile and importance of research and education in the United States
Primary Strengths & Accomplishments from the Reverse Site Visit at Project Midpoint

• Breadth and depth of the educational component, esp. Peace Corps (PCMI) component

• Activities integrate PhD/MS/BS and PCMI and use the strengths of both

• Well represented by gender and has a healthy component of Hispanic students from Puerto Rico

• Strong ties exist to some host institutions

Excerpts of Report to NSF from 5/20/08 Reverse Site Visit
Major Recommendations

- More detailed and focused research plan with measurable milestones and anticipated products
- More detailed science plan and management structure with clear timelines
- More formalized structure for contacts with international collaborators
- External assessment, perhaps an external advisory panel
Research & Educational Excellence

- Educational progress has exceeded expectations (student retention, experiences)
- Several individual research projects are well advanced but a rationalization to the goals and aims for the project is needed
- Focus and achieve depth rather than diversify
- Commit resources to web-based resources, formal publications, and presentations at conferences

Excerpts of Report to NSF from 5/20/08 Reverse Site Visit
Project Website Aim is Utility

News (aimed at increasing visibility)

People (links to PCM's blogs)

Resources (presentations, theses, papers, posters, photos & video)

Outreach materials (workshops & pre-college activities/info)

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Recommendations to Galvanize Science Strategies

• Define the science plan and clear milestones for the next 2.5 years

• Create a flow chart to track the progress of outputs from the program

• Redefine the science goals and objectives in light of the personnel changes to the program, while maintaining hazards and remote sensing foci
MTU PIRE Project Strategies

Proposal-outlined goals:

- Advancement in RS techniques and their application in Latin America
- Develop an effective new collaborative arrangement among researchers in Guatemala, El Salvador, Nicaragua, and Ecuador.
- Determine impact of the international research and educational experiences on US student (graduate and undergraduate) participants.

Inputs

- GMES Faculty/staff
- Counterpart agencies
  - Guatemala: INSIVUMEH, CONARE
  - El Salvador: SNET, Univ. del Salvador
  - Nicaragua: INETER, CIRA, SNV
  - Costa Rica: Univ. de Costa Rica
  - Panama: Univ. de Panamá
  - Ecuador: Escuela Politécnica Nacional
- Peace Corps support
  - Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Ecuador

Participation

- Undergraduates: 10 MTU, 4 Univ. Puerto Rico at Mayaguez, 1 University of Mexico
- Master's students: 9 (7 graduated)
- US Peace Corps Master's International students: 19 (3 graduated)
- PhD candidates: 5 current, 3 graduate
- Post-docs: 3 (1 current, 2 have left)
- Academic institutions (US/foreign)
  - Nicaragua: INETER, CIRA, SNV
  - Costa Rica: Univ. de Costa Rica
  - Panama: Univ. de Panamá
  - Ecuador: Escuela Politécnica Nacional
  - Panama: Instituto Geográfico Nacional
- Geoscience institutions (US/foreign)
  - Guatemala: INSIVUMEH
  - El Salvador: SNET
  - Nicaragua: INETER
  - Ecuador: Escuela Politécnica Nacional

Activities

- Define SO2 gas flux using UV and IR
- Interpret critical signals in seismo-acoustic data
- Create volcanic gas monitoring programs
- Forecast activity of open vent volcanoes
- Develop volcanic gas monitoring programs
- Map surface expressions of lineaments using satellite imagery
- Establish remote sensing-based protocol to map surface expressions of geological lineaments in non-ideal settings
- Develop a collaborative international approach to conduct research to improve knowledge of aquifer systems and establish a foundation for research and monitoring
- Conduct remote-sensing workshops on remote sensing applications to research
- Promote development of collaborative international research and education
- Offer research options with short and long term field campaigns abroad for participants
- Students more confident in applying knowledge
- Students more knowledgeable in specific knowledge
- Students more appreciative of foreign collaboration
- Students more application of foreign collaboration
- US students better prepared for careers in global
- US students better prepared for careers in global
- Education

Outcomes – Impact

- Short term
  - Develop volcanic gas monitoring programs
  - Forecast activity of open vent volcanoes
  - Develop satellite- and ground-based programs of topographic monitoring
  - Characterize eruptive history
  - Create archival database for seismo-acoustic data, gas flux, and thermal data
  - Integration of methods developed into current volcano monitoring methods by PLA volcanologists
- Long term
  - Develop a collaborative international approach to conduct research to improve knowledge of aquifer systems and establish a foundation for research and monitoring
  - Develop a collaborative international approach to conduct research to improve knowledge of aquifer systems and establish a foundation for research and monitoring
  - Development of sustainable natural hazard monitoring programs using satellite imagery and geophysics.
Flow Strategy

**Inputs**
- Goals
- PIs
- Counterparts
- Peace Corps
- NSF Funding

**Participation**
- Students
- Academic Institutions
- Government Agencies

**Activities**
- Volcanic Hazards & Gas Monitoring
- Water Resources
- Landslide Hazards
- Workshops, Communications & Data Archival
- Education

**Outcomes & Impacts**
- Short Term
- Long Term
Research Strategies: Focus & Depth

• Volcanic Hazards
• Landslide Hazards
• Water Resources
• Risk Perceptions/Crisis Management
Focus: Volcanic Hazards

• Comprehensive monitoring of volcanic activity and eruptive behaviors
• Risk Assessment/Eruption Hazards

Depth: Continued Monitoring & Repeated Field Campaigns

• Guatemala: Fuego, Pacaya, Santiaguito
• El Salvador: Santa Ana
How Fuego Works

John Lyons
Guatemala

Fuego’s Seismicity

Jemile Erdem

Fuego
Adam Blankenbicker
Guatemala
Santiaguito Dome Growth

Kyle Brill
Santiaguito Hazards
Hans Lechner
**El Congo, El Salvador**
Using GPS array to monitor Santa Ana Volcano
Focus: Landslide Hazards

• Evaluate potential
• Use remote sensing to characterize and monitor slopes and land use

Depth: Risk Perceptions

• Guatemala
• El Salvador
• ?
Focus: Water Resources

• Develop a protocol to use satellite imagery to characterize aquifer systems
• Evaluate approach by field mapping and pumping tests/hydrogeochemistry

Depth: Delineate Fracture Zones

• Nicaragua: Boaco
• Ecuador: Quito Aquifer System
Social Geology

Volcanic risk perceptions in Pacific Latin America—Kate Graves, Social Sciences MS, 2007

Community Participatory Hazards Mapping in El Salvador—Luke Bowman, Geology MS Student

Volcanic Risk & Crisis Management at Volcan de Fuego —Rudiger Escobar-Wolf, Geology Ph.D. Student
PCMI Research Project Evolution

- Students undertake preparatory activities in advance of PC service
- Country placement is made by Peace Corps and site placement by an APCD (who factors in community needs)
- Research activities depend on site placement and PC service projects
Lara Kapelancyk
Nicaragua
Ometepe Island Volcanoes
Volcán Barú
Julie Herrick
Pamama
Volcán Baru Debris Avalanche
Recommendations for Enhancing Partnerships

• Strengthen the intellectual content of the collaborations

• Establish a formal structure for regular contact with the foreign partner institutions

• Devise a plan to extend student diversity in the program to include in particular other Hispanic groups within the USA, beyond the University of Puerto Rico
Increasing Intellectual Strength of Collaborations through Workshops

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<thead>
<tr>
<th>MTU PIRE Organized</th>
<th>MTU PIRE Invited Participation</th>
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<tbody>
<tr>
<td>• July 2007 Costa Rica: Remote Sensing Applied to Volcanic Hazards</td>
<td>• November 2008 Mexico: Chemistry of Volcanic Gases Workshop</td>
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<tr>
<td>• March 2008 El Salvador: FLIR Imaging</td>
<td>• March 2009 Indonesia: Remote Sensing of Volcanic Hazards</td>
</tr>
<tr>
<td>• January 2010 Costa Rica (NSF PASI): Remote Sensing for Volcanic Hazards</td>
<td>• July 2009 Colombia: Volcanic Hazards</td>
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Collaboration with the University of Puerto Rico—Mayaguez (UPRM)

• Dr. Lizzette Rodriguez, B.S. & M.S. Geology from UPRM, Ph.D. Geology from MTU, Assistant Professor at UPRM

• Since summer of 2005, MTU has hosted 7 UPRM Geology Undergrads, MTU faculty visit annually for recruiting and discussing collaborations with faculty

• 2 new MS and 2 new PCMI's from UPRM will join project F09
Collaborative Initiatives

• MOUs
• Workshops
• Visits
  – By Counterparts
  – To Field Sites
• Joint/Exchange Degree Programs

Bill Rose will describe more
Recommendations for Project Assessment & Evaluation

• Put in place an external advisory panel for the project

• Start an external formal evaluation of the project

_Please note that the report is an excerpt from the Excerpts of Report to NSF from 5/20/08 Reverse Site Visit._

_Essa Gross will present more on the assessment on Tuesday._
# Meeting Schedule

**Monday**
- 9 am Project Overview
- 10:15 am Volcanic Processes
- Noon Lunch w/Students (Atrium)
- 1 pm Risk Perceptions
- 2:45 pm Focus Group (PhD Students)
- 3:45 pm Focus Group (PCMI Students)
- 5 pm End for the day

**Tuesday**
- 9:30 am Water Resources
- 11 am Internal Assessment
- Noon Lunch
- 2 pm Evaluators Meet
- 5 pm End for the day

**Wednesday**
- 9:30 am Report to PIs
- 11 am Depart