AN INTEGRATED SYSTEM FOR ANALYSIS OF ENVIRONMENTAL DISASTERS AND RISK ASSESSMENT

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Motivation

In response to catastrophic occurrences frequently observed in densely populated regions in Brazil, researchers from The Institute of Geosciences (IGEO) at The Federal University of Rio de Janeiro (Universidade Federal do Rio de Janeiro, UFRJ) are working towards an integrated system for the analysis of environmental disasters, and vulnerability and risk assessments (The SAnDRA Project).
General Mission

The integrated modeling approach aims the development of a system for decision-making regarding environmental disasters caused by extreme events via coordinated projects, research and activities of the Departments of Geography, Geology and Meteorology at IGEO-UFRJ.
LANDSLIDE OCCURRENCES ARE MOSTLY DRIVEN BY EXTREME METEOROLOGICAL EVENTS IN BRAZIL

Caraguatatuba, SP (1967)  
Cubatão, SP (1985)  
Timbé do Sul, SC (1995)  
Nova Friburgo, RJ (2011)

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LANDSLIDE OCCURRENCES ARE MOSTLY DRIVEN BY EXTREME METEOROLOGICAL EVENTS IN BRAZIL

Rio Vieira (Teresópolis), RJ (2011)
Flux of Information

METEOROLOGIA

Regionalização da Previsão climática
Ex.: Precipitação abaixo, na média ou acima da média

GEOGRAFIA

Gestão Territorial
Identificação da possibilidade do desastre, alvos e vulnerabilidade socioambiental

GEOLOGIA

Mapeamento Geológico
Geração de informações geológicas e ambientais

Análise de Risco

Boletim para Imprensa

Informações de Risco
Cartas de Suscetibilidade e Sensibilidade

WEB

Banco de dados

Pilot Area

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TEAM EXPERTISE

PhD: 31; MSc: 6

Weather and Climate Modeling, Geomorphology, Mesoscale Meteorology, Micrometeorology, Hydrometeorology, Geographic Information System (GIS), Cartography, Geography, Paleoecology, Paleoclimatology, Geotechnical Engineering, Geology and Environmental Engineering, Geophysics, Hydrogeology, Computational Intelligence, Oceanography.
Multi-scale Approach
Deterministic Models

AOGCM or Reanalysis

Regional Model

Mesoscale Model

Geomorphological Model
MODELING COMPONENT

FAPERJ 09/2011

PREVER Project

✓ Mathematical Modeling Applied to Risk Assessment over Catastrophic Landslide Areas of the State of Rio de Janeiro
The Prever Project

Meteorological, geological and geographical datasets will be integrated into mathematical models in order to make predictions of natural disasters.
PREVER

Modelo Digital de Elevação MDE

Mapa de Uso e Cobertura do Solo

Caracterização das Propriedades do Solo

Simulações da Suscetibilidade a Deslizamentos

Dados Meteorológicos Reanálises

Simulações das Condições Atmosféricas Regionais

Mapeamento da Ocupação

Mapa de Risco

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The landslide modeling will apply physically based numerical models that include advanced hydrology and slope stability, among other combinations.

Predictions of areas susceptible to mass movements will be made through the combination of prediction models of mass movements (e.g., SHALSTAB and TRIGRS models for shallow landslides) with a propagation model for debris flow (model FLO-2D).
Forecasts of occurrence of landslides, and extent and thickness of the deposits of debris flow.
It might be associated with SALLJ.
<table>
<thead>
<tr>
<th>Global Reanalysis</th>
<th>Res.</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCEP-DOE R2</td>
<td>~200 km</td>
<td>28 sigma-layers; coupled to the OSU1 LSM; R2 provides 6-hly boundary conditions to the RSM experiments.</td>
<td>Kanamitsu et al. 2002</td>
</tr>
<tr>
<td>NCEP Climate Forecast System Reanalysis (CFSR)</td>
<td>~38 km</td>
<td>64 layers; 4-layer Noah LSM; coupled to ocean.</td>
<td>Saha et al. 2010</td>
</tr>
<tr>
<td><strong>Satellite-based Products</strong></td>
<td><strong>Res.</strong></td>
<td><strong>Description</strong></td>
<td><strong>Reference</strong></td>
</tr>
<tr>
<td>CMAP</td>
<td>2.5°</td>
<td>Standard version (satellite and gauge), monthly means of precipitation</td>
<td>Xie and Arkin 1997</td>
</tr>
<tr>
<td>1DD-GPCP</td>
<td>1°</td>
<td>One-degree daily precipitation from version 1.1</td>
<td>Huffman et al. 2001</td>
</tr>
<tr>
<td>CMORPH (RAW/CRT)</td>
<td>25 km</td>
<td>From satellite; 3-hly precipitation assimilated by RSM/Gauge-corrected</td>
<td>Joyce et al. 2004</td>
</tr>
<tr>
<td><strong>Station dataset</strong></td>
<td><strong>Res.</strong></td>
<td><strong>Description</strong></td>
<td><strong>Reference</strong></td>
</tr>
<tr>
<td>GTS</td>
<td>0.5°</td>
<td>Daily precipitation analyses from global gauges</td>
<td>WMO</td>
</tr>
<tr>
<td>GPCC V6.0</td>
<td>0.5°</td>
<td>Monthly land-surface precipitation from gauges built on GTS-based and historic data</td>
<td>Schneider et al. 2011</td>
</tr>
</tbody>
</table>
Comparisons with station data from Brando et al., PNAS 2010.
Dynamical downscaling assimilating satellite-based data (CMORPH_CRT) into a numerical modeling system (RSM+PA+SSBC).
Neutral Conditions: 2004

(i) Precipitation analysis (mm/day) for: (a) CMAP; (b) IDD-GPCP; (c) GTS; CMORPH V1.0; and (ii) Precipitation (mm/day) for: (a) R2; (b) SSBC; (c) PA only; PA+SSBC. Displayed: January 2004.

(iii) Near-surface temperature (°C) and (iv) Near-surface specific humidity (g/kg) for: (a) R2; (b) SSBC; (c) PA only; PA+SSBC. Displayed: January 2004.

(v) Latent Heat Flux (W/m²) and (vi) Near-surface wind (m/s) for: (a) R2; (b) SSBC; (c) PA only; (d) PA+SSBC. Displayed: January 2004.
Extreme Event: Catarina, March 2004
Precipitation (mm/3hr)

Regional Spectral Model (RSM) ~ 40 km

Modified Scale-Selective Bias Correction (Kanamitsu et al., JGR 2010) & Precipitation Assimilation (PA; Nunes and Roads, JHM 2007)

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Adaptive modeling based on neural network methodology for the nowcasting of severe weather events.
HYBRID PROFESSIONALS???
Concluding Remarks

All proposed modeling experiments, as well as essential datasets, will be used in the refinement of the modeling systems, providing better predictions and projections to model areas susceptible to landslides.

This combined modeling effort will also contribute to the understanding of regional climate variability and change; and will support better mitigation and adaptation decisions at local scales.

An interdisciplinary approach will emerge together with new research initiatives and trained specialists.
Acknowledgments

• CMAP data were provided by the NOAA Office of Oceanic and Atmospheric Research Earth System Research Laboratory Physical Sciences Division at: http://www.esrl.noaa.gov/psd/;

• 1DD data were provided by the NASA/Goddard Space Flight Center’s Laboratory for Atmospheres, which develops and computes the 1DD as a contribution to the Global Precipitation Climatology Project (GPCP) - GEWEX;
• NOAA/NCEP/National Weather Service provided the R2 and CFSR data sets;
• MERRA data sets were obtained from the Modeling and Assimilation Data and Information Services Center (MDISC), managed by the NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC).
We thank all those who contributed to make the “Sistema de Análise de Desastres e Riscos Ambientais” (SAnDRA) project possible.
PILOT AREA

The State of Rio de Janeiro’s mountain region (slopes) and surroundings.