

**Final Progress Report**  
**Sustainability Science Program**  
**Term: September 1, 2013 – August 1, 2014**

**Name:**

Fabio Farinosi

**Your fields:**

Environmental Economics; Disaster Economics; Natural Resource Management.

**Your degree program, institution and (expected) graduation date:**

PhD, Science and Management of Climate Change, Ca' Foscari University of Venice, Italy. Expected 2015.

**Faculty host(s) at Harvard name and department:**

Prof. John Briscoe, School of Engineering and Applied Sciences

Prof. Paul Moorcroft, Department of Organismic and Evolutionary Biology

**Description of SSP-related research activity:**

Extreme weather events in Sao Paulo: How changes in climate and land use in Brazil are impacting flood risk and potential for risk mitigation

**Abstract:**

The Sao Paulo Metropolitan Region (SPRM) is one of the biggest urban areas in the world lying in the Upper Tiete River Basin floodplain of Brazil. The high rate of human modification, land cover and anthropological pressure on the rivers significantly impact the frequency and magnitude of extreme events in this flood prone area. Several structural projects have been designed for mitigating flood impacts in Sao Paulo, such as the Urban Drainage Master Plans (1998, 2009 and 2014) (Braga & Porto, 2013). These include a set of interventions designed to be effective in coping with flood events with a return period of 100 years. Unfortunately, the actions implemented in the past did not effectively mitigate the problem of flood events in the RMSP. The increasing number of flood events has been traditionally explained by the massive and uncontrolled urbanization of the region. Only recently has attention been paid to the trends in precipitation and extreme precipitation events reported in literature (Silva Dias et al. 2012).

This research is aimed at understanding how much flood risk in the SPRM is driven by global (climate), regional (land use change in the Amazon area), and local (urbanization, exposure, vulnerability) changes. Patterns in local precipitations and extreme events have been analyzed in the literature and found to be driven by the variability of the main climatic variables. Little attention has been brought to the moisture advected from the Amazon and from Central Brazil – a fundamental variable determining heavy rains in Southeast Brazil, mainly in the wet season, and heavily impacted by land use change. The determinants of the evolution of the observed precipitation patterns are analyzed using a regional-scale coupled biosphere-atmosphere dynamic model designed to explore the interactions between ecosystems, hydrology, and climate in the Amazon region (ED-BRAMS). Local drivers of flood risk are mainly represented by the response of the hydrological system to the extreme precipitation events, for the hazard side, and by the main drivers in exposure and vulnerability. Variations in flood magnitude and frequency associated with specific climatic projections are assessed through the use of a hydrological model specifically calibrated for the SPRM. Expected future flood characteristics and exposure projections are used to assess the expected economic losses.

**Identification of the problem you address:**

This study analyzes flood risk in the Sao Paulo Metropolitan Region with the specific characteristics of its components: exposure, hazard and vulnerability. It analyzes the driving forces determining risk and the

possible measures aimed at achieving mitigation. The study also takes into consideration the expected evolution of risk and impacts under different climatic and land use scenarios.

**Key question asked about the problem:**

1. How climate and land use changes are expected to impact flood risk in the Sao Paulo Metropolitan Region?
2. What is the state of the art for implemented strategies aimed at addressing flood risk?
3. What is the potential for more effective risk mitigation?

**The methods by which you answered that question:**

Risk is defined as a combination of hazard, exposure and vulnerability. Methods include:

- Hydrological analysis of the return period of the extreme rainfall events and their impacts under different climate and land use scenario - their correlation with specific flood characteristics defines the hazard map.
- Exposure mapping through the study of the information obtained analyzing geo referenced information about land cover and use.
- The main sources are images of the NASA/MODIS satellite and the data collected by the IBGE (Brazilian Institute of Geography and Statistics).
- Potential economic impact assessment through the application of specific damage functions developed in the Country.
- Analysis of the regret and non-regret flood risk reduction strategies implemented in the area.

**Principle literature upon which the research drew:**

The main literature on which this study has been drawn includes several research fields:

- Disaster risk and impact assessment;
- Natural resource management;
- Climate and hydrological modeling;
- Time series analysis of extreme events;
- Geo-referenced spatial analysis.

**Empirical data acquisition description:**

Data for this study have been collected through field work activities and collaboration with local institutions and research centers. These have been integrated with:

- Past Flood events data from Dartmouth Flood Observatory, EM-DAT, SAISP – Sistema De Alerta de Sao Paulo;
- Hydrologic data from SAISP;
- Socio-economic data from IBGE, World Bank, CIESIN;
- Spatial data from SAGE, IBGE, NASA.

**Geographical region studied**

Brazil, with particular focus on the Sao Paulo Metropolitan Region

**Recommendations that might be relevant for your problem:**

NA

**A description of the final product(s) you have/are aiming to produce:**

The final product of this research activity will constitute a chapter of my PhD dissertation.

Ideally, the work conducted is expected to take the form of a peer reviewed paper in one of the main journals in the natural disaster field. Target journals could be: International Journal of Disaster Risk Science; Natural Hazards; Natural Hazards and Earth System Sciences.

**Description of major other intellectual or professional advancement activity(ies) over the past academic year:**

Beside my activities for the SSP research project, I am currently working on a statistical analysis of the impacts of climate change on the global hydropower production. The tentative title of this work is: “Climate Change Vulnerability of Global Hydropower Generation”. The study is in a quite advanced state: the statistical model has been defined based on past observations. We are currently working on the CMIP5 projections for estimating the sensitivity of the global hydropower production to the trends defined by the future climate scenarios. A draft version ready for submission to a journal will be ready in the next few months.

**Please list citations for reports, papers, publications and presentations that built on your fellowship research:**

This research project has been presented on two different occasions:

April 24th 2014 - Presentation of the study “Extreme weather events in Sao Paulo: how changes in climate and land use in Brazil are impacting on flood risk - Potentialities for risk mitigation” at “The David Rockefeller Center for Latin American Studies at Harvard University” Brazil Studies Program Seminar Series: Climate, Hydrology, and Land Use: Challenges for Brazil  
[http://drclas.harvard.edu/bsp\\_lee\\_farinosi](http://drclas.harvard.edu/bsp_lee_farinosi)

April 25th and 26th 2014 Presentation of the study “Extreme weather events in Sao Paulo: how changes in climate and land use in Brazil are impacting on flood risk - Potentialities for risk mitigation” at the “Interdisciplinary Ph.D. Workshop in Sustainable Development 2014” at The Earth Institute of the Columbia University – New York.  
[http://blogs.cuit.columbia.edu/sdds/schedule-events/ipwsd\\_2014/](http://blogs.cuit.columbia.edu/sdds/schedule-events/ipwsd_2014/)

A more substantial dissemination phase is planned for the next future.

**Please describe any collaborative activities with other SSP Fellows that you are involved with.**

I am currently collaborating with a former SSP Fellow, Angela Livino, for a study about hydropower production in Brazil.

**Principal collaborators outside Harvard:**

Prof. Ian Sue Wing – Boston University

Dr. Enrica De Cian – Fondazione Eni Enrico Mattei

Prof. Carlo Giupponi – Ca’ Foscari University of Venice

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