ASSESSING THE RISK OF AMAZONIAN FOREST DIEBACK: AN ASSESSMENT FROM THE WORLD BANK

Jose A. Marengo [(1)], Carlos A. Nobre [(1)], Walter Vergara[(2)], Sebastian Scholz[(2)], Alejandro Deeb[(2)], Peter Cox[(3)], Wolfgang Lucht [(4)], Hiroki Kondo[(5)], Lincoln Alves [(1)], Jose Pesquero [(1)]

[1]Centro de Previsão de Tempo e Estudos Climáticos - CPTEC, Instituto Nacional de Pesquisas Espaciais- INPE, Cachoeira Paulista- SP, Brasil, marengo@cptec.inpe.br, Carlos.Nobre@inpe,br, lincoln@cptec.inpe.br, pesquero@cptec.inpe.br, [2] World Bank, Latin America Environment Department, 1850 I st NW-Washington DC, 20433, USA, Wvergara@worldbank.org, adeeb@worldbank.org, sscholz@worldbank.org, [3]School of Engineering, Computing and Mathematics, University of Exeter, Exeter, EX4 4QF, UK, P.M.Cox@exeter.ac.uk, [4]Potsdam Institute for Climate Impact Research (PIK) Telegraphenberg A 3114473 Potsdam Germany, Wolfgang.Lucht@pik-potsdam.de, [5]Frontier Research Center for Global Change (FRCGC) Japan Agency for Marine-Earth Science and Technology (JAMSTEC) 3173-25, Showa-machi, Kanazawa-ku, Yokohama, 236-0001 Japan hkondo@jamstec.go.jp

RESUMO: Apresentamos o projeto Assessing the Risk of Amazonian Forest Dieback, financiado pelo Banco Mundial, e que inclui cientistas do Brasil, Estados Unidos, Reino Unido, Alemanha e Japão. Este projeto apóia analise de opções e ações de longo prazo que seriam necessárias para manter a integridade da floresta Amazônica, e o principal objetivo é de ajudar no entendimento dos processos e da dinâmica do Amazon Dieback e as suas conseqüências.

ABSTRACT: We introduce the project on Assessing the Risk of Amazonian Forest Dieback, funded by the World Bank, which includes scientists from Brazil, United States, United Kingdom, Germany and Japan. This project support the analysis of long-term options that would be required to maintain the integrity of the basin, and the main objective is to assist in understanding the process and dynamics of Amazon Dieback and its implications.

Palavras-Chave: Climate change, Amazon Dieback, climate modeling

1. INTRODUCTION

The Amazon rainforest plays a crucial role in the climate system. It helps to drive atmospheric circulations in the tropics by absorbing energy and recycling about half of the rainfall that falls upon it. Furthermore, the region is estimated to contain about 10% of the carbon stored in land ecosystems, and to account for 10% of global net primary productivity (Melillo et al., 1993). Despite large-scale human-deforestation, it seems likely that the region is currently acting as a net sink for anthropogenic CO_2 emissions (Tian et al., 2000). The resilience of the forest to the combined pressures of deforestation and climate change is therefore of great concern, especially since some major climate models predict a severe drying of Amazonia in the 21st century leading to the possibility of catastrophic rainforest dieback (Cox et al., 2000; Cox et al., 2004).

The potentially catastrophic impacts of Amazonian Forest dieback make it vital for us to properly assess the risk of such an event under scenarios of future climate change. Unfortunately, global climate models currently differ significantly in their predictions of regional climate change over Amazonia (Li et al., 2006), but there is a major opportunity to reduce the uncertainties through a more rigorous comparison of models with long-term observational data. One of the most profound predicted impacts of climate change into the 21st Century is the impact on ecosystem integrity of the large Amazonian basin. Temperature increases and disruption in precipitation cycles have the potential to seriously hamper the workings of the Amazon as a forest ecosystem, reducing its capacity to retain carbon, increasing its soil temperature and eventually forcing the Amazon through a gradual process of savannization. The issue of Amazonian dieback leapt from computer predictions to global environmental concern with the unexpected Amazonian drought of 2005 (Marengo et al. 2008a, b, Cox et al 2008).

A preliminary analysis of the potential of biome alterations in the Amazon in response to the family of IPCC AR4 climate scenarios has shown that eastern Amazon is the most vulnerable area (Salazar et al., 2007). Climate change due to global warming is happening concurrent with regional climate change due to rapid land use change and recent calculations indicate that for deforestation rates in excess of 40%, there is an increased risk of savannization (Sampaio et al., 2007). There is therefore an urgent need to assess the risk and implications of significant changes of the Amazon forest. This can be done by conducting a risk assessment of the reduction of rainfall in the basin with several modeling tools. In parallel, the risk analysis should be complemented with improved land cover modeling and the application of earth simulator data to the basin. Together, these three approaches would strengthen the quality of the results.

The Amazon is critical to global climate because it helps regulate the amount of carbon dioxide in the global atmosphere by locking away vast quantities of carbon into rainforest trees. It is also an ”engine” of the global atmospheric circulation that affects rainfall patterns in places as far away as Europe and Central Asia. Through the recycling of rainwater back into the atmosphere, the rainforests also influence their own unique regional climate, which provides a home to a quarter of the world's biodiversity and many indigenous peoples. Moisture injected by the Amazon ecosystem into the atmosphere, also plays a critical role in the precipitation patterns in the region. Serious disruptions in the volumes of moisture coming from the Amazon basin could also trigger a process of desertification over vast areas of Latin America. Amazon dieback is probably the most serious climate change impact in Latin America, yet its prospects are poorly understood.

The Amazon rainforest is currently suffering multiple pressures, most notably from deforestation and climate change. Even in the absence of anthropogenic deforestation, some climate projections indicate a risk of climate change-driven rainforest dieback. This document discusses this phenomenon and introduces a World Bank funded study designed to assess the risk of Amazon forest dieback in the 21st century.

2. STUDY DEVELOPMENT OBJECTIVE

The World Bank administers this assessment to assist in understanding the risk (likelihood), process and dynamics of abrupt changes of Amazon forests and its implications. The task would also support the analysis of long-term options that would be required to maintain the integrity of the basin. The task is intended to make use of the Bank's Climate Change and Clean Energy grant resources and collaboration with the Meteorological Research Institute (MRI) of Japan, the National Institute for Space Research (INPE) from Brazil, the University of Exeter in the UK, and the Potsdam Institute for Climate Change and Impacts (PIK) from Germany.

The study development objective is to assist in understanding the process and dynamics of Amazon dieback and its implications. The project would also support the analysis of long-term options that would be required to maintain the integrity of the basin and assess the economic consequences of Amazon dieback. The task is intended to make use of the World Bank's Climate Change and Clean Energy.

3. TASK COMPONENTS AND ACTIVITIES

These are the activities that are being developed by all the partner institutions involved on the project:

a) Risk analysis of Amazon Dieback or development of a probability density function (PDF) for future Amazon rainfall as a function of the level of greenhouse gases in the atmosphere. It will utilize the range of results from the climate models used in the 4th Assessment Report of the Intergovernmental panel on Climate Change (IPCC) and weight these through comparison to the climatic anomalies observed in the long-term records of rainfall and sea-surface temperature (SST).

b) Download of Earth Simulator data at a 20 by 20 km resolution for end of century scenario A1B. This entails access to ES data, compilation and analysis with environmental parameter models that may be useful to characterize the prospects of Amazon dieback and provide resilience to the analysis under a).

c) Develop a version of the PIK´s LPJ (carbon-water vegetation-soil dynamic model) vegetation model specifically for the Amazonian region, to get improved predictions. This concerns

tree parameterization, drought stress reactions, and the occurrence of fires. All of these are relevant for potential forest type change, and forest die-back. An LPJ model would reduce uncertainties concerning biomass response to the reduced rainfall and increased soil temperature.

d) Assess possible regional and transboundary impacts of Amazon die back and connectivity analyses to see if the die back may results on desertification or changes in extreme events (rainfall and dry spells) in other adjacent (e.g. Nordeste and the La Plata Basin) and remote regions.

e) Estimate the economic implications of Amazon dieback and identify development options to locally address the impacts.

4. EXPECTED OUTCOMES

This project will utilize results from global climate models used in the IPCC AR4, from regional climate models for South America (CREAS Project), and from high resolution simulations of the Earth Simulator to study changes in frequencies of extreme climate events over Amazonia. Additionally, the project will study some potential driving mechanisms for forest collapse of die-back (global warming, deforestation). Some of the expected outcomes are:

(a) Risk analysis of Amazon Dieback

(b) Simulation through the earth simulator of late 21st century climate in the Amazon

(c) Improved the LPJ vegetation model specifically for the Amazonian region, to get improved predictions.

(d) better understanding of the process and dynamics of Amazon dieback and its implications

(e) assessment of implications on overall hydrology and on precipitation patterns in the Andes

f) identification of development options to locally address or delay the impacts of Amazon dieback

g) most importantly, the project is expected to result in an increased level of dialogue with Brazilian development authorities and planners on the issue of Amazon dieback.

The project is part of the World Bank project on ***Identification of regional implications of Amazon dieback induced by climate change*** and will complement the work being undertaken with the Earth Simulator in the region and the portfolio of conservation activities in the Amazon rainforests. The project will also be linked to the earlier activities of the newly-established Center for Earth System Science at INPE (CCST). This research center has a focus on climate change studies for South America, including scenarios, adaptation and mitigation.

The project will benefit from the existing partnership between the Brazilian Space Research Institute (INPE) and the Hadley Centre for Climate Prediction and Research, and from the proposed partnerships with the Earth Simulator in Japan on predictions of future climate in the region

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