Climate Change and Disaster Risks in Brazil

Climate Change and Disaster Risk Guide

Which climate and disaster Risks affect Brazil?

How affect climate change and disaster risks Brazil?

Marion Künzler und Evelyn Kamber

Bread for all

July 2013

BREAD FOR ALL FASTENOPFER HEKS

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Picture Front Side

Landslide in a town near Rio de Janeiro, killing at least 356 people, caused after heavy rains. Source: http://www.abc.net.au/news/stories/2011/01/14/3112590.html, Accessed March 14, 2011.

Text

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Bread for All is the development organization of the Swiss Protestant Community of Churches. The organization supports 400 development projects and programs in 57 countries in Africa, Asia, and Latin America. In addition, its development policy has the goal of creating fairer international socioeconomic structures, maintaining creation, and bringing peace.

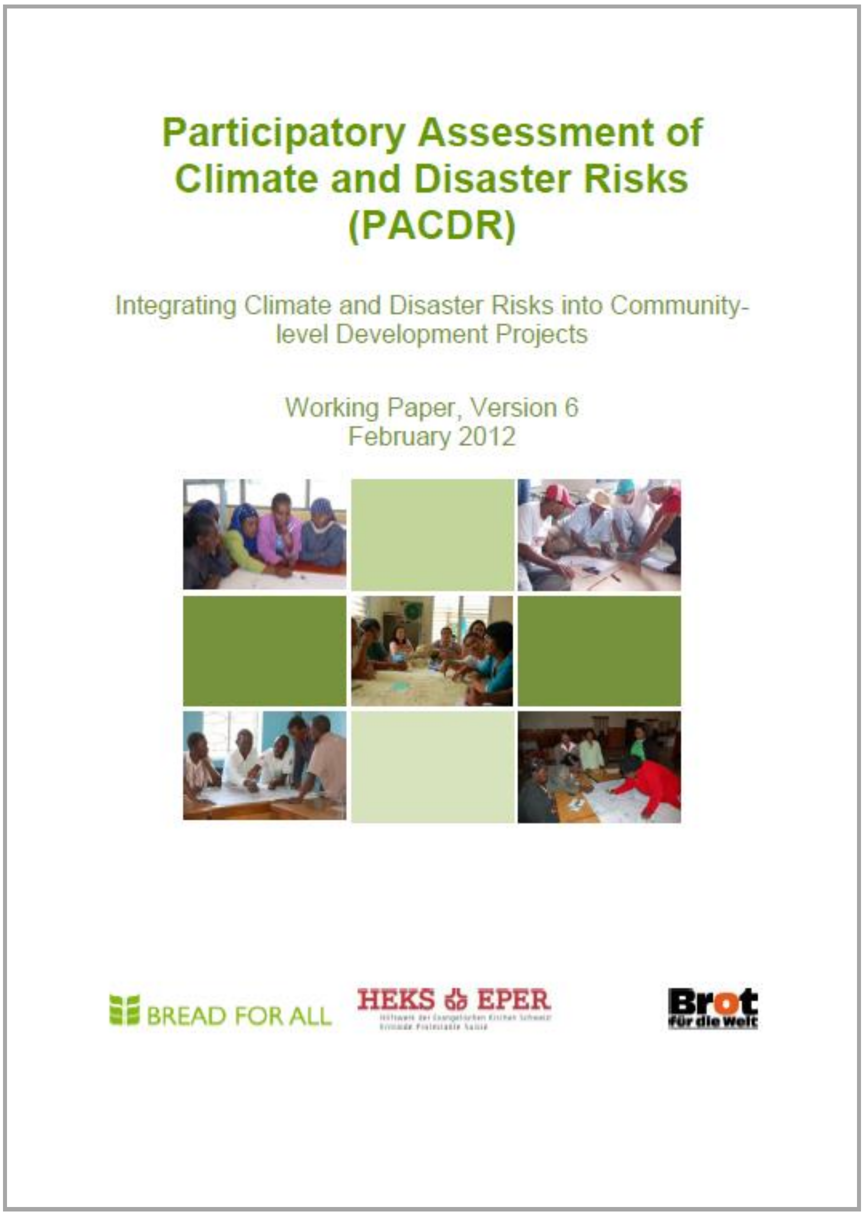
HEKS/EPER (Hilfswerk der Evangelischen Kirchen Schweiz, Entraide Protestante Suisse), campaigns for a more humane and more equitable world. HEKS gives humanitarian and emergency aid and fights the causes of hunger, injustice and social deprivation. The focus of its commitment on behalf of socially disadvantaged sections of the population is the dignity of every individual. HEKS/EPER bases its support on the resources and needs of the people concerned and works with them on the practical aspects of its projects. HEKS/EPER has a policy of working exclusively with local partner organizations and does not send Swiss people abroad. As a matter of principle, local workers are recruited to staff the coordination offices.

Fastenopfer is a Catholic aid agency in Switzerland. The slogan 'We share' describes our involvement in disadvantaged countries in the South and in Switzerland. Impact in the South: Fastenopfer supports people who take responsibility for their future. Promoting self-empowerment! Experience has shown us that a project only becomes sustainable if the community is involved and supports it. That's why Fastenopfer focuses on strengthening local village structures and other groupings in which people are involved.
Raising awareness in Switzerland: Our public information work is intended to motivate people in Switzerland to think about living conditions in the disadvantaged countries in the South. We inquire into the causes of poverty that affects large sections of the population, and see ourselves as a voice for the people in the South, including at the political level.

Contents

1 Introduction

Climate change is one of the largest problems humanity faces today. Communities in Brazil suffer now and in the future from the impacts of this global phenomenon, even though people in Brazil have contributed little to causing climate change.



Participatory Assessment of Climate and Disaster Risks (PACDR)

Integrating Climate and Disaster Risks into Community-level Development Projects

Working Paper, Version 6
February 2012

BREAD FOR ALL HEKS EPER Brot für die Welt

The first step in order to be able to cope with the adverse effects of climate change is to know about climate change and its impacts. Thus, this guide aims at providing basic information on climate change, its causes, and how it affects us. Furthermore, this guide can also be used to analyse the climate context with the *Participatory Assessment of Climate and Disaster Risks (PACDR)* developed by *HEKS*, *Bread for all and Bread for the World*.

An introduction for the terminology on climate change and disaster risk reduction can be found in the PACDR on page 7 which can be downloaded here:

www.breadforall.ch/climatetraining

2 Climate Change and Diaster Risks in Brazil

General Climate in Brazil

The Climate of Brazil varies considerably:

Southeast Region (Tropic of Capricorn)**:** The annual medium temperature ranges from 20 °C to 24 °C, while in the elevated areas the average medium temperature can be below 18 °C. In the summer (mainly January), the normal average temperatures range from 30 to 32 °C, in the winter, from 6 to 20 °C. The annual precipitation is in excess of 1,500 mm. In the elevated areas these indexes surpass 1,750 mm. The maximum pluviometric usually occurs in January and the minimum in July, while the dry period is usually concentrated in the winter, lasting from six to two months.

Northeast Region: Temperatures are high, with annual averages between 20 and 28 °C, maxima of around 40 °C. The months of winter (mainly June and July) produce minimum temperatures between 12 and 16 °C in the coastal regions and much lower temperatures of 1 °C in the plateau regions. The pluviosity of the area is complex and is source of concern: its annual totals vary from 2,000 mm to values even lower than 500 mm. In a general way, the annual medium precipitation in the northeast area is lower than 1,000 mm - interior of Paraíba was observed the smallest annual pluviometric index registered in Brazil, 278 mm /year with only two months rainy period.

South region (below the Tropic of Capricorn): The annual medium temperatures range from 14 to 22 °C and in places with altitudes above 1,100 m drops to approximately 10 °C. Some parts of the southern region also have an oceanic climate. Generally the winter (mainly July) is mild with a medium temperature between 10 and 15 °C. And the summer (mainly January) is hot with an average maximum temperature around 24 to 27 °C on the elevated surfaces of the plateau and, in the lowest areas, between 30 and 32 °C. The annual medium pluviosity oscillates from 1,250 to 2,000 mm, except along the coast of Paraná and west of Santa Catarina, where the values are in excess of 2,000 mm, and in the north of Paraná and in a small coastal area of Santa Catarina, which have lower recordings down to 1,250 mm. The maximum pluviometric indexes occur in the winter and the minimum in the summer throughout almost the whole area.

North region (great part of the Amazon Basin): The climate is hot, with annual medium temperatures ranging from 24 to 26 °C. Regarding pluviosity, there is not a homogeneity as it occur with the temperature. In the mouth of the river Amazonas, in the coast of Pará and in the western section of the area, the total annual pluviometric index exceeds 3,000 mm in general. In the direction NO-SE, of Roraima to east of Pará there is less rain, with annual totals in the order of 1,500 to 1,700 mm. The rainy period of the area occurs in summer and autumn, the exception being Roraima and of the north part of Amazonas, where the maximum pluviometric indexes occurs in winter.[1]

Middle-West region: In the north and south extremes of the region, the annual medium temperature is 22 °C and in the Chapadas it varies from 20 to 22 °C. In the spring and summer the average temperature of the hottest month varies from 24 to 26 °C. In winter low temperature occurs quite frequently. The medium temperature of the coldest month oscillates between 15 and 24 °C. The annual medium pluviosity varies from 2,000 to 3,000 mm in the north of Mato Grosso, to 1,250 mm (49.2 in) in the Pantanal mato-grossense. In spite of this inequality, the region is well provided with rain. Its seasonality is typically tropical, with maximum in the summer and minimum in the winter.

[1] http://en.wikipedia.org/wiki/Climate_of_Brazil

2.1 Past Trends of Climate Change and Disaster Risks in Brazil

Climate change is already taking place now, thus past and present changes help to indicate possible future changes. Over the last decades, temperatures generally stagnated or increased, precipitation has a spatial distribution with a decrease in Amazon and Northeast, and an increase in South-eastern and Southern Brazil in Brazil. Sea level rise ranges from 1.1-4.1 mm p.a. depending regionally in Brazil.

Temperature

IPCC 2007 states that for the century long period, warming is statistically significant over most of the world's surface. Warming is strongest over the continental interiors of Asia and North-western North America and over some mid-latitude ocean regions of the Southern Hemisphere as well as South-eastern Brazil (IPCC 2007). According to figure 3a and b, the changes of surface temperature in Brazil vary from 0-2 °C per decade (for 1901 to 2005) and 0 – 0.7 °C per decade (for 1979 to 2005) with the strongest significant warming in Southern and South-eastern Brazil.

Figure 1a: Annual surface temperature changes for 1901 to 2005 (IPCC 2007)

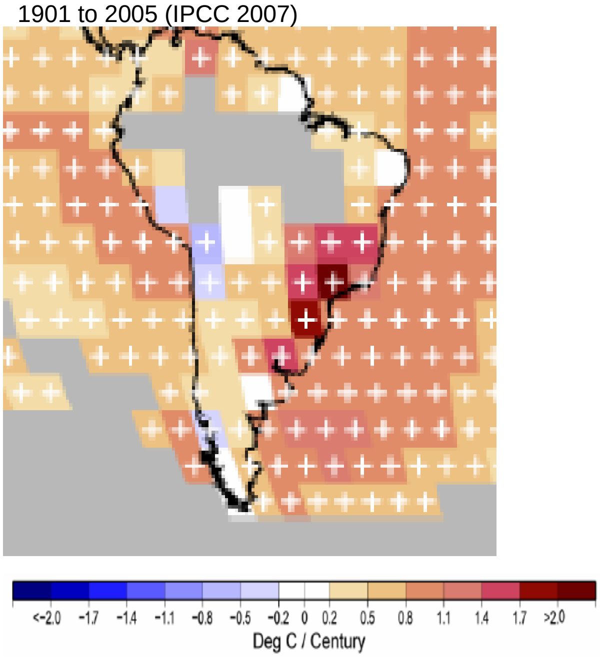
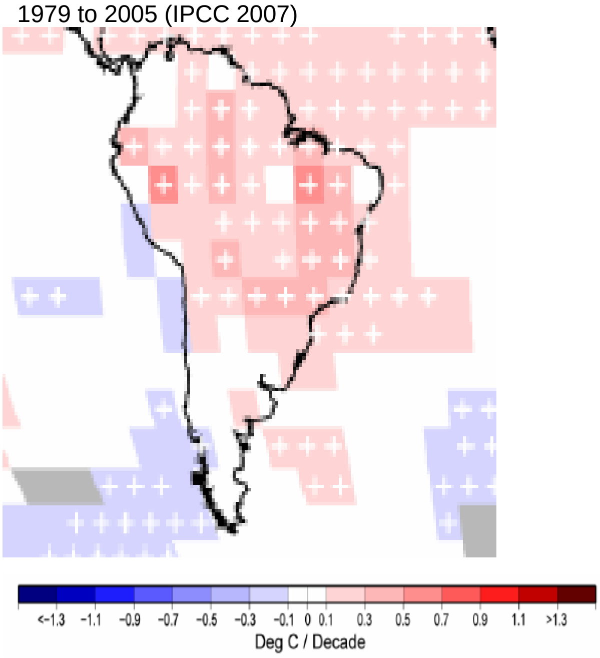


Figure 3b: Annual surface temperature changes for 1979 to 2005 (IPCC 2007)



Notes. Linear trend of seasonal MAM, JJA, SON and DJF temperature for 1979 to 2005 (°C per decade). Areas in grey have insufficient data to produce reliable trends. The minimum number of years required to calculate a trend value is 18. A seasonal value is available if there are two valid monthly temperature anomaly values. The dataset used was produced by NCDC from Smith and Reynolds (2005). Trends significant at the 5% level are indicated by white + marks.

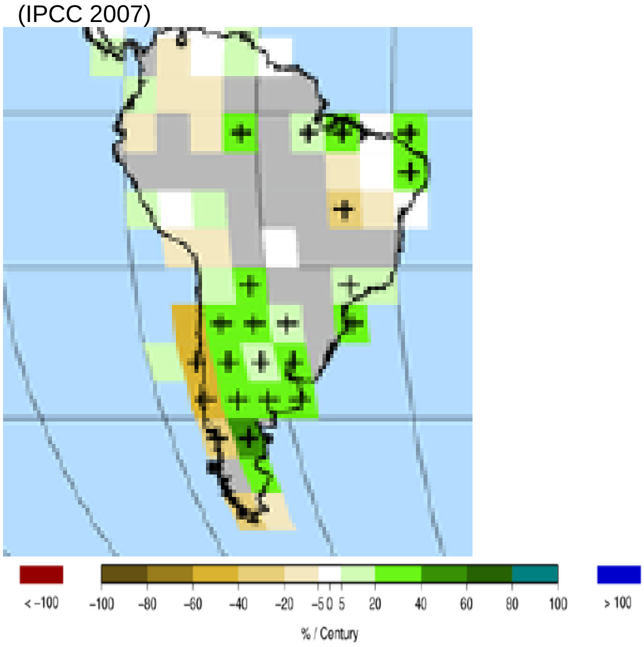
Rainfall

Accordingly to IPCC 20007, across South America, increasingly wet conditions were observed over the Amazon Basin and South-eastern South America, while negative trends in annual precipitation were observed over Chile and parts of the Western coast.

The South American Monsoon System is evident over South America in the austral summer and a key factor for the warm season precipitation regime. Over Northern and Southern Amazonia different precipitation trends have been observed, showing a dipole structure (Marengo, 2004) that indicate a southward shift of the South American Monsoon System.

The South Atlantic Convergence Zone (SACZ) is a more transient feature over and South-east of Brazil that transports moisture originating over the Amazon into the South Atlantic and it modulates the interannual variability of seasonal rainfall over Eastern Amazonia and North-eastern Brazil. Barros et al. (2000b) found that, during summer, the South Atlantic Convergence Zone was displaced northward (southward) and was more intense (weaker) with cold (warm) sea surface temperature anomalies to its South (IPCC 2007). Other studies detected in subtropical Brazil a systematic increase of very heavy precipitation since the 1950s, and in South-eastern Brazil they detected an increase in the frequency of extreme rainfall events (FBDS N.A.).

Figure 2: Trend in annual precipitation 1901 to 2005 (IPCC 2007)



Notes: Trend of annual land precipitation amounts for 1901 to 2005 (% per decade), using the GHCN precipitation data set from NCDC. The percentage is based on the means for the 1961 to 1990 period. Areas in grey have insufficient data to produce reliable trends. The minimum number of years required to calculate a trend value is 66 for 1901 to 2005 and 18 for 1979 to 2005. An annual value is complete for a given year if all 12 monthly percentage anomaly values are present. Note the different colour bars and units in each plot. Trends significant at the 5% level are indicated by black + marks.

Sea level

IPCC 2007 shows that sea level has risen by an average of 2.5 mm annually. In Brazil different studies observed sea level rise. For example the Oceanic Institute from the University of São Paulo (Instituto Oceanográfico da USP-IOUSP) confirmed an increase of 4.1 mm p.a. (1955-1990) off the coast of Cananéia (South São Paulo and an increase of 1.1 mm p.a. (1944-1989) in Santos coast. These facts demonstrate the variability of average rises in the sea level at different locations.

Extreme events

Accordingly to Prevention Web Brazil's top ten natural disasters affecting people are drought and flood. It's vulnerability and risk for drought is low, flood is low to medium and landslides is medium to high.

Intense tropical cyclone activity has likely increased in some regions all over the world since 1970. Globally, estimates of the potential destructiveness of hurricanes show a significant upward trend since the mid-1970s, with a trend towards longer lifetimes and greater storm intensity, and such trends are strongly correlated with tropical sea surface temperature. Nevertheless in March 2004 in the South Atlantic, off the coast of Brazil, the first and only documented hurricane in that region occurred (Pezza and Simmonds, 2005). This event appears to be unprecedented although records are poor before the satellite era (IPCC 2007).

El Niño-Southern Oscillation (ENSO)

The El Niño-Southern Oscillation (ENSO) is a natural fluctuation of the global climate system caused by a tendency for above-average surface atmospheric pressures in the Indian Ocean to be associated with below-average pressures in the Pacific, and vice versa. This oscillation is associated with variations in sea surface temperatures in the east equatorial Pacific. The oceanic and atmospheric variations are collectively referred to as ENSO.

An El Niño episode is one phase of the ENSO phenomenon and is associated with abnormally warm central and east equatorial Pacific Ocean surface temperatures. An El Niño episode is accompanied by drought in Amazonia and northeast Brazil, whereas southern Brazil has exhibited anomalously wet conditions.
A La Niña episode is associated with abnormally cool ocean temperatures in east equatorial Pacific. A La Niña episode is accompanied by drought in southern Brazil (IPCC 2012)

Historically, there is evidence of extensive droughts, and perhaps widespread fires, linked to paleo El Nino Southern Oscillation (ENSO) events occurred in the Amazon basin in 1,500, 1000, 700 and 400 BP, and these events might have been substantially more severe than the 1982-83 and 1997-98 events (Meggers 1994). Accordingly to the IPCC 2012, there is medium confidence in past trends toward more frequent central equatorial Pacific El Niño-

Southern Oscillation episodes, but insufficient evidence for more specific statements about observed trends in ENSO.

2.2 Projected Trends of Climate Change and Disaster Risks in Brazil

Regional climate change scenarios based on models are relatively unanimous concerning trends of the climatic changes. However, consensus and significance are less strong where regional patterns are concerned. Marengo's study (N.A.) discusses the mean climatic features of climate change projections for two different scenarios (A2 = conservative scenario and B2 = optimistic scenario of IPCC report in 2007) for 2071-2100 produced by the ensemble of three regional models.

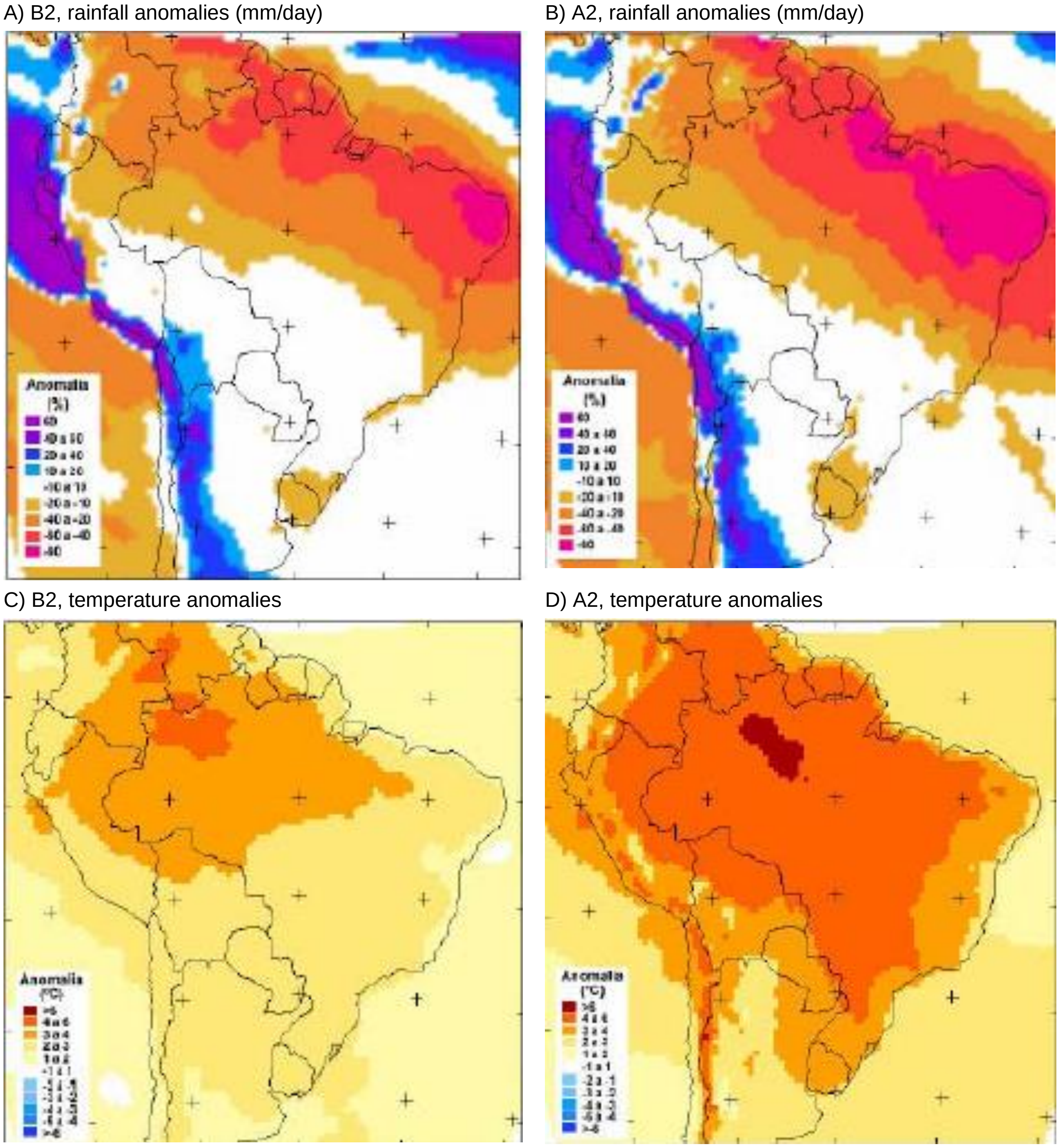


Figure 3: Projections of annual rainfall (mm/day) and air temperature anomalies (°C) for both A2 and B2 scenarios for 2071-2100 relative to 1961-90, as produced by the ensemble of the 3 regional models: Eta CCS, RegCM3 and HadRM3P regional models (Marengo N.A.)

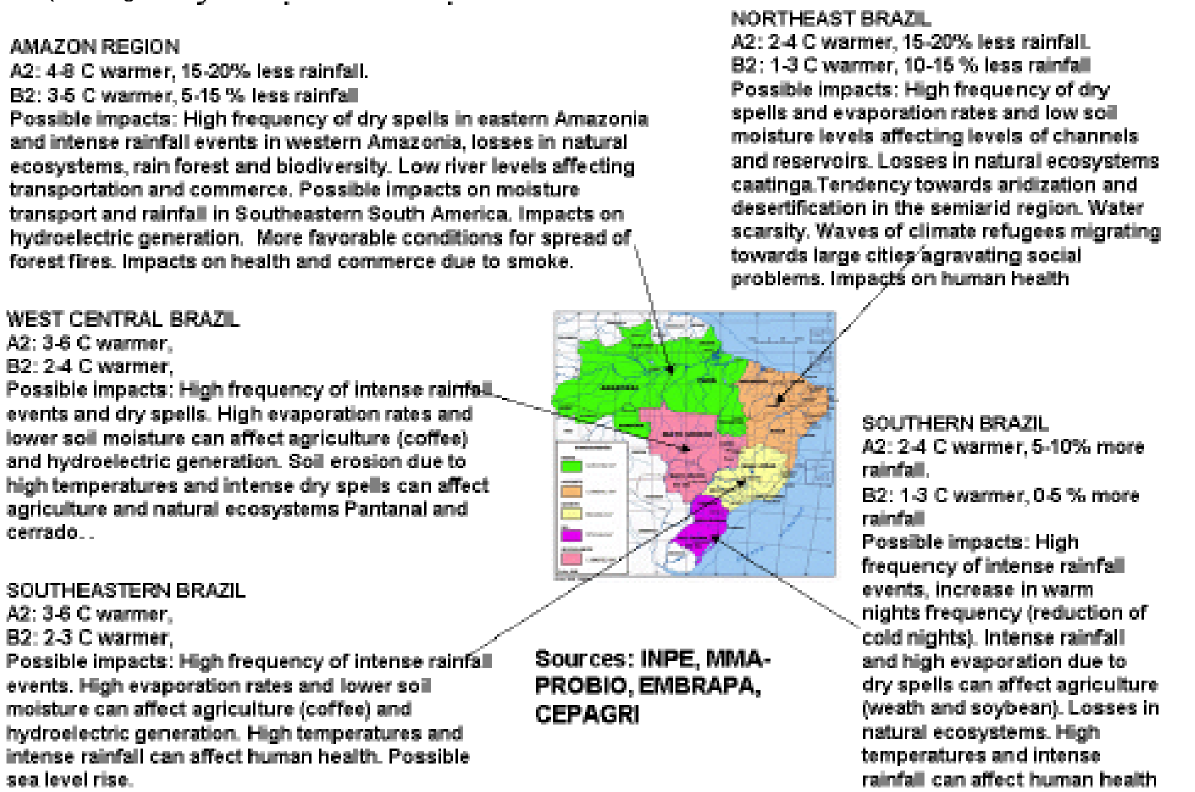
Generally the results of figure 5 indicate that

- **Temperature** increases with differences in the spatial distribution of the changes. The occurrence of warm nights is projected to be more frequent in the entire tropical South America, while the occurrence of cold night events is likely to decrease.
- **Precipitation** scenarios are less reliable. However they coincide in their estimation significant and often different changes in rainfall extremes and dry spells. Over most of South-eastern South America and Western Amazonia total rainfall increases as well as the intensity of extreme precipitation events increases. In Northeast Brazil and Eastern Amazonia total rainfall decreases, significant changes in the frequency of consecutive dry days but small or no changes in rainfall intensity are expected.
- **Sea level:** Changes in sea level will not be uniform over the world due to changes of ocean density and its circulation. Until the end of the century, sea level rises between 0.21m and 0.48m in the world average. In Northeaster and Southeaster coast of Brazil sea level is accelerated due to density and ocean circulation patterns- which are expected to be around 5cm greater than the projected world average. In Central-easter coast of Brazil sea level rise is slowed by 5cm than the projected world average (UNEP 2010).

The combined effects of higher temperatures and uneven distribution of rains could lead to serious problems in the sub-regional water balances (Marengo N.A.; GTZ 2007).

Based on Marengo's study, Figure 6 summarized possible impacts of climate change in Brazil regionally:

Figure 4: Summary of future climate change scenarios for the end of the 21st Century and possible impacts in Brazil (Marengo N.A.)



Different regions show different vulnerabilities. While in almost of Brazil the natural ecosystems would be affected, **Southern and South-eastern** Brazil seem to cope the impacts of climate change, while regions as **Northeast Brazil** would experience the highest vulnerability, especially on the social side. This region is vulnerable to the extremes of climate variability in present climates (e.g. drought during El Nino years). The different Brazilian states that are part of the Northeast region exhibit lower indicators of social and health conditions, as well as lower human development index, and in future climate a tendency for aridization would exacerbate the social vulnerability (Marengo N.A.).

Another study of PBMC 2012 shows similar but slidly different trends for the **Brazilian biomes**. For the biomes Amazônia, Caatinga, Cerrado, Pantanal and Northeastern Atlantic forest generally increasing temperatures and decreasing rainfall patterns are projected:

- **Amazônia:** A decreasing rainfall distribution (reduced by -40% to -45% in the rainy season) and temperature increase (increased by 5-6 ºC) is projected until 2071-2100. Such changes in climate may jeopardise the Amazon rainforest biome by the end of this century and increase potential for the “savannisation”, especially in the eaystern region of the Amazon. (PBMC, 2012).
- **Caatinga:** An increase of 3.5-4.5 °C in air temperature and a decrease between -40 to -50% in rainfall distribution are expected until 2071-2100, thus worsening the regional water deficit (PBMC, 2012).
- **Cerrado**: Until 2071-2100, the predicted temperature elevation reaches values from 5-5.5 °C, and the decrease in rainfall distribution is more critical, with a decrease between -35% and -45% (PBMC, 2012).
- **Pantanal:** Until 2071-2100, there will be a predominance of intense heating (temperature increase by 3.5-4.5 °C), with a marked decrease in rainfall patterns of from -35% to -45%(PBMC, 2012).
- **Northeastern Atlantic forest**: Towards 2071-2100, conditions of intense heat are expected (an increase of 3-4 °C) and a decrease of between -30% and -35% in regional rainfall patterns.

For the biomes South/Southeastern Atlantic forest and Pampas the trends show increasing temperatures as well but in contrary to the other biomes increasing rainfall patters:

- **South/Southeastern Atlantic forest:** Towards 2071-2100, temperatures are 2.5-3 °C warmer and 25% to 30% wetter.
- **Pampas:** Until 2071-2100, temperatures increase of 2.5-3 ºC and rainfall is 35% to 40% above normal (PBMC, 2012).

Extreme events

Accordingly to IPCC (2012) there is medium confidence in projected increase in duration and intensity of droughts in northeast Brazil. There is a high confidence in more frequent and/or longer heat waves and warm spells in the Amazon.

El Niño-Southern Oscillation (ENSO)

Accordingly to IPCC (2012) the model projections of changes in ENSO variability and the frequency of El Niño episodes due to climate change are not consistent.

2.3 Impacts of Climate Change and Disaster Risks in Brazil

There is little certainty on the impact of these scenarios on ecosystems and socio-economic development. However scientists tend to agree on some main thesis:

Overall, the Northeast is expected to be hit the hardest by climate change. It would experience acceleration in its problems of desertification with a tendency of becoming arid (GTZ 2007).

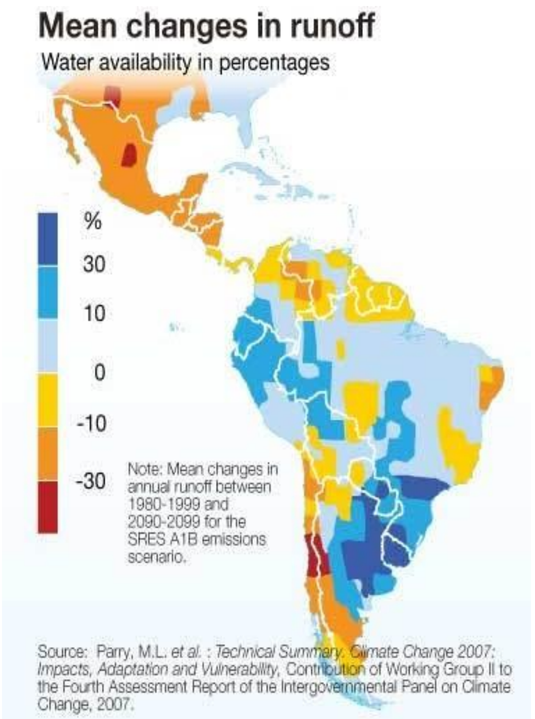


Figure 5: Mean Changes in runoff (UNEP 2010)

Water resources: Changing rainfall patterns, especially in the drought-affected North-eastern region of the country, will mean poorer water resources and a reduced water supply. Agriculture will suffer of salinization of soils through irrigation and further decrease productivity of subsistence agriculture with all the social consequences on food security, migration and poverty. Traditional mechanisms to provide fresh water for human consumption would be at risk posing additional challenges to the already difficult water management. (SCIDEV 2011, GTZ 2007).

Agriculture, Food Security: Agriculture is likely to be one of the most affected economic sectors with forced shifts in the cropping zones and severe impacts on the profitability of the main cash crops.

Accordingly to a study of of PINTO and ASSAD (2008), with the exception of Amazônia, the possible increase in the periods of dry weather should cause problems for the productivity in practically every annual and perennial crop in Brazil. Soybeans will lose the conditions to be cultivated in the South of the country, sugarcane should increase the demand for the so called “salvage irrigation” in its expansion towards Central Brazil and the subsistence crops such as beans, corn and cassava should suffer sharp drops in productivity in the North-eastern areas. Figure 10 shows the consequences on nine of the principal plants cultivated and responsible for around 85% of the Brazilian agribusiness gross domestic product.

Further some states in the Northeast such as Ceará and Piauí should lose between 70% and 80% of their agricultural land due to the increase in dry period indices between 2010 and 2050. Additionally, the use of irrigation to compensate the increases in short summers in Central Brazil and the Northeast is not recommendable in view of the increase in competitiveness between water for human consumption and agriculture. On the other hand, some areas in the East of Amazônia, with a reduction in rainfall, could develop circumstances for the cultivation of cassava and sugarcane due to the easier traffic conditions for machinery, which would enable mechanized harvesting (FBDS N.A.).

The increase in temperatures and the consequent water vapor content in the atmosphere should increase the index of disease in agricultural plants by providing better conditions for the formation of dew in the leaves and thermal comfort for the fungi. Increases in temperature induce a shortening in the reproductive cycle of fungi and insects due to a shorter period of incubation, which allows a larger number of generations of the microorganism. On the other hand, the incidence of longer intervals of dry periods, with a drop in the humidity in the air, could increase the incidence if plagues in the farms given that insects adapt themselves better to dry conditions with higher temperatures (FBDS N.A.).

Crops	Present potential area (Km²)	Year 2020 potential Model Precis A2 (Km²)	% Variation relative to present area	Year 2050 potential Model Precis A2 (Km²)	% Variation relative to present area	Year 2070 potential Model Precis A2 (Km²)	% Variation relative to present area
Cotton	4,029,507	3,583,461	-11.07	3,449,349	-14.40	3,380,202	-16.12
Rice	4,168,806	3,764,488	-09.70	3,655,029	-12.32	3,577,169	-14.19
Coffee	395,976	358,446	-9.48	328,071	-17.15	265,243	-33.01
Sugarcane	619,422	1,608,994	159.76	1,477,816	138.58	1,351,441	118.18
Beans	4,137,837	3,957,481	-04.36	3,715,178	-10.21	3,587,559	-13.30
Sunflower	4,440,650	3,811,838	-14.16	3,709,223	-16.47	3,633,928	-18.17
Cassava	5,169,795	5,006,777	-03.16	5,886,398	13.48	6,268,634	21.26
Corn	4,381,791	3,856,839	-11.98	3,716,684	-15.18	3,624,487	-17.28
Soybean	2,790,265	2,132,001	-23.59	1,837,447	-34.15	1,635,239	-41.39

Figure 6: Variation of the areas estimated by model Precis RCM, in km^2, with potential for the plantation of the principal Brazilian crops in present climatic conditions (2007/08) and also in 2020, 2050 and 2070, in the scenario IPCC – A2 (conservative scenario).

Coastal Zones: Floods, which are already a serious problem for various regions, may increase. Coastal areas, where the bulk of the population and economic activities are concentrated, will be vulnerable to rising sea levels. There is also concern that coral reefs along Brazilian coastlines could suffer from the effects of climate change (SCIDEV 2011).

Human health: Rising temperatures are expected to help organisms that act as vectors for diseases, such as mosquitoes, which transmit dengue fever and malaria, and assassin bugs, which transmit Chagas disease (SCIDEV 2011).

Biodiversity and ecosystem services: Brazil is vulnerable to climate change, not least due to its fragile, biologically diverse ecosystems, especially Cerrado and Amazon.

The *Cerrado* is one of the world's biodiversity hotspots. The Cerrado has the richest flora among the world's savannas (>7000 species) and high levels of endemism. Deforestation rates have been higher in the Cerrado than in the Amazon rainforest. Thus, in the last 35 years, more than 50% of its approximately 2 million km^2 has been transformed into pasture and agricultural lands planted in cash crops. Also conservation efforts have been modest as only 2.2% of its area is under legal protection. Numerous animal and plant species are threatened with extinction, and an estimated 20% of threatened and endemic species do not occur in protected areas. Soil erosion, the degradation of the diverse Cerrado vegetation formations, and the spread of exotic grasses are widespread and major threats (Klink and Machado 2006). Additionally to the mentioned threats is climate change accelerating the destruction. A study of Ferreira de Siqueira and Peterson, 2003 applied a series of new techniques to understand the conservation of Cerrado tree species in the face of two climate change scenario, an optimistic and a more conservative scenario.

The main results are shown in Figure 11a and b:

Figure 7a: Patterns of predicted species richness in an optimistic climate change scenario (Hadley HHGSDX50 scenario) for 144 species (Ferreira de Siqueira and Peterson 2003)

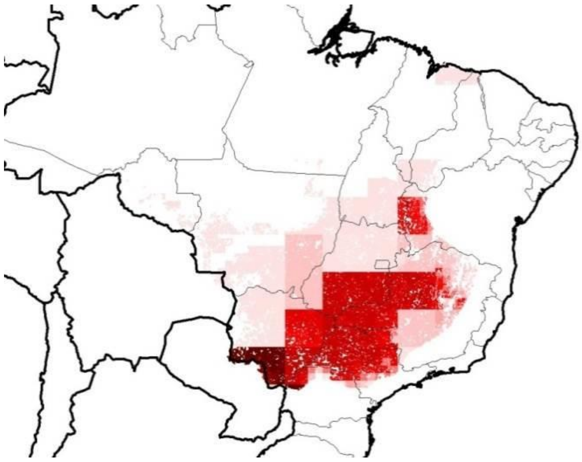
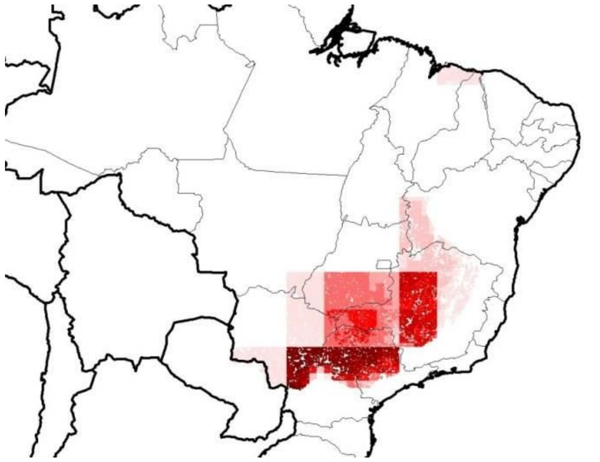


Figure 8b: Patterns of predicted species richness in a conservative climate change scenario (Hadley HHG-GAX50 scenario) for 106 species (Ferreira de Siqueira and Peterson 2003)



Most species were projected to decline seriously in potential distributional area, with both scenarios anticipating losses of more than 50% of potential distributional area for essentially all species. Indeed, out of 162 species examined, between the two climate change scenarios, 18 - 56 species were predicted to end up without habitable areas in the Cerrado region, and 91 - 123 species were predicted to decline by more than 90% in potential distributional area in the Cerrado region. These results cause for ample concern regarding Cerrado biodiversity. Since only 2.25% of the Cerrado biome is presently protected, this future scenario presents a pessimistic forecast, which would likely include widespread species loss from the biome, as well as dramatic shifts to the South and East, further complicating conservation planning efforts (Ferreira de Siqueira and Peterson 2003).

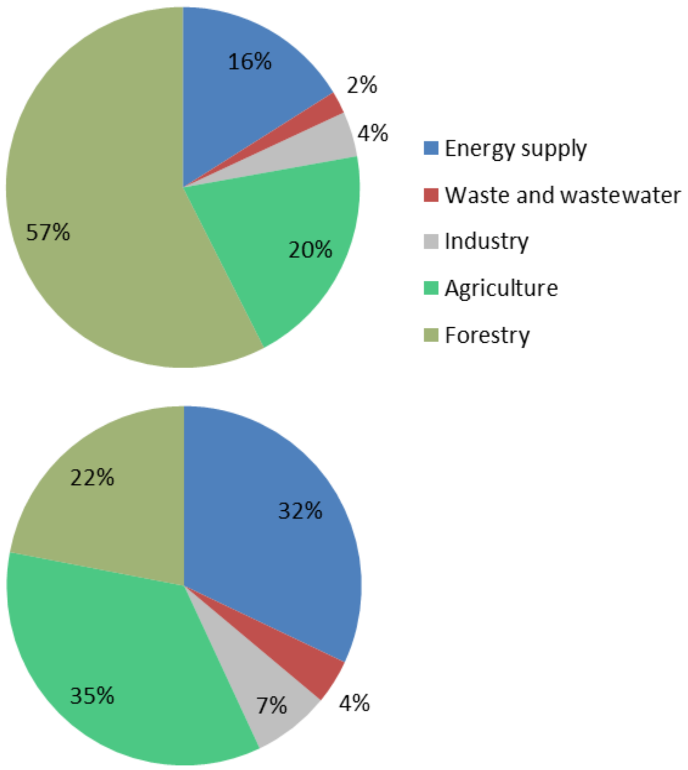
The *Amazon rainforest* is recognized as having the greatest biological diversity in the world. Besides the ongoing deforestation for e.g. livestock pasture, agricultural land for soybean endangers the Amazon rainforest biodiversity. Some studies show that, as temperatures rise, the Amazon rain forest could become dryer, making spontaneous fires more frequent and thereby accelerate deforestation. Ecosystems could be altered by reducing biodiversity leading to a “savannization” of the tropical forests. Species would change their reproduction cycles and migration patterns. Additionally those fires would release more greenhouse gases increasing their concentrations in the atmosphere, in turn raising temperatures further (SCIDEV 2011, GTZ 2007)

Energy generation: Less rain will also affect the hydropower supply, which, according to the International Energy Association, provides more than 80 per cent of the electricity Brazil generates. The major blackout crisis ever experienced in Brazil’s history in the years 2001/2002 was a consequence of a sequence of dry summers and unusually low water levels in the reservoirs. To meet Brazils’ increasing electricity demand, the pressure to build new dams is growing with all the ecological and social governance problems that follow these measures. Recent conflicts involving forest people in the context of the planned Belo Monte dam on the Amazon tributary Xingu are exemplary of the situation (GTZ 2007).

Extreme events as floods, drought and landslides cause huge economic disasters and death of people. Caused by drought, fires affected air traffic due to the closing of airports; schools and business were closed due to smoke, and many people had to be treated in hospitals due to smoke inhalation (FBDS N.A.).

3 Brazil's Contribution to Climate Change

Figure 9: CO_2e Emission in 2005 (upper) and 2010 (lower) in Brazil for sectors (RFB 2013)



Brazil plays an important and unique role in climate change. It is one of the ten largest economies in the world and — most importantly for climate change — home to one of the greatest ecosystems and forests of the planet: the Amazon. Since the last inventory in 2005, Brazil's greenhouse gas (GHG) emissions fell nearly 39% until 2010. This fall is mainly due to a reduction of deforestation with a 76% drop in cumulative emissions from deforestation. Brazil produced an equivalent of roughly 1.25 billion tonnes of carbon dioxide equivalents (CO_2e) in 2010 (in 2005 2,03 Mio CO_2e). This fall is more than 10% below the 1990 level[2] and pacing it far ahead of most major industrialized countries in terms of emissions reductions as for example, U.S. greenhouse gas emissions rose 8.5 percent between 1990 and 2010. However while Brazil's emissions from land use (including deforestation) have been falling, emissions from the energy sector have been rising rapidly[3].

More than three-quarters of the 1.25 billion ton reduction in CO_2e emissions came from a drop of **deforestation** between 2005 and 2010 which was not only in the Amazon but also in the surrounding savannahs. This is due to the governmental roll out of a plan to control Amazon deforestation since the first half of last decade. In 2010, the government announced a similar approach for the Cerrado, a woody savanna that covers 20 percent of the country and has been the target for agricultural expansion in recent years[3]. Since 2010, the rate of deforestation has even continued to fall and the country is now just shy of meeting its international commitment to reduce Amazon deforestation by 80% from 1990 levels by 2020[2].

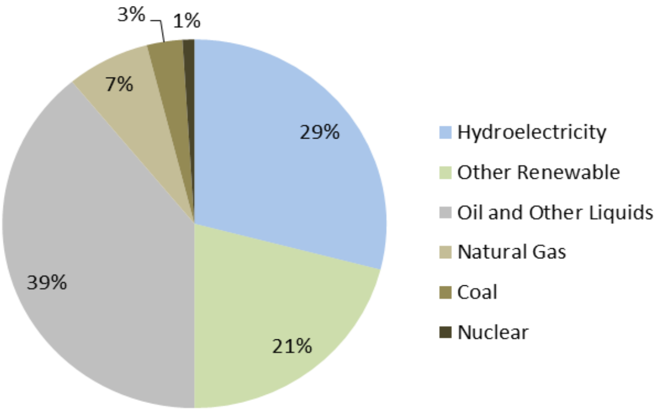
Agriculture accounts for the largest share of Brazil's greenhouse-gas output in 2010 with 35%. In terms of net emissions, the agricultural sector has systematically increased its GHG emissions over the past few years (5.2% from 2005 to 2010). Given the strong trend of emissions reductions in the forestry sector, it is obvious that the relative importance of every other sector, including agriculture, increased over the past few years. Agriculture is dominated by methane emissions from enteric fermentation of cattle (56.4%) and direct and indirect emissions of agricultural soils (35.2%).

The fastest emissions growth occurred in Brazil's **energy sector** with 21.4% between 2005 and 2010 and reached a share of 32% CO_2e. Worldwide, Brazil is the ninth largest energy consumer and the third largest in the Western Hemisphere, behind the United States and Canada (EIA 2012). Nevertheless, the share of 32% is still fare away from the share of the United States with 85,7% in 2011 or Canada with 81% in 2011 (US 2013, Canada 2013). This relative low GHG emission share is mainly due to comparative advantage with a large

[2] http://www.nature.com/news/brazil-reports-sharp-drop-in-greenhouse-emissions-1.13121
[3] http://news.mongabay.com/2013/0606-brazil-emissions.html

share of renewable energies in its energy matrix, and thus none carbon intensive energy consumption:

Figure 10: Total Primary Energy Consumption in Brazil by Type (2010)- Source: EIA



39% oil and other liquids including ethanol consumption, 29% hydroelectricity and 21% other renewables with mostly biomass (charcoal, sugarcane and biodiesel). This situation however is rapidly changing. Between 1970 and 2004 carbon emissions from fossil fuels increased 145%. Energy consumption per capita is still very low and will naturally increase with economic growth. Distribution is also very unequal. Twelve million people are estimated to have no access to electricity at all and less than 10% of all Brazilians own a car. On the other hand renewable resources are also limited leading to the "carbonization" of electricity production through thermoelectric power plants on the basis of coal, petrol and diesel.

Brazil boasts the world's most advanced bioethanol industry. Nevertheless biofuels are falling from grace around the world as critics charge that devoting millions of hectares of agricultural land to fuel crops is driving up food prices and that the climate benefits of biofuels are modest at best. But the fall has been hardest in Brazil, where government policies (as freezing the price of petrol and diesel to keep inflation under control) have compounded the effects of the global economic downturn[4].

Also hydropower is often claimed as clean energy. Neither the Brazilian government nor the companies behind the dams appear interested to discuss that the huge stretches of rain forest flooded to create dam reservoirs, often running into hundreds of square miles, rot in the water, emitting greenhouse gases. For example, the dam in Belo Monte will take 41 years before its greenhouse gas emissions break even with those of a fossil fuel plant generating the same amount of power. Indeed, Eletrobras, the state energy company with a 15 percent stake in Belo Monte, is even applying for carbon credits potentially worth hundreds of millions of dollars from the World Bank for some of its Amazonian dams based on the fact that, supposedly, they release fewer greenhouse gases than fossil fuels. Belo Monte is one of a total 60 dams the Brazilian government wants to build in the Amazon, and whose reservoirs will flood roughly 3 percent of the world's largest tropical rain forest. That forest loss, totaling 2,052 square miles, will be caused by an influx of people settling near the dam, and will result in 267 million tons of carbon emissions, Paulo Barreto, a forester at Imazon, a Brazilian nonprofit has calculated [5].

Also Brazil has increasingly turned to fossil fuels to drive an ever larger share of its economic growth in recent years. A violent surge in energy use in the transport sector (especially an increase of private cars), an increase in the gasoline consumption and an increase of amount of electricity produced by thermal power plants are responsible for the increase[6].

At the United Nations climate summit in Copenhagen in 2009, the President Lula da Silva announced that Brazil commits to reduce its greenhouse-gas emissions by 36–39% by 2020, compared to business-as-usual projections[7]. The media's judge the Brazil's track to meet these climate goals differently. Some write that Brazil is on track, others see it more critical and mention that the country will have to work on policies for other sectors soon[8].

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[4] http://www.nature.com/news/growth-of-ethanol-fuel-stalls-in-brazil-1.11900
[5] http://www.minnpost.com/global-post/2013/07/brazils-hydro-dams-could-make-its-greenhouse-gas-emissions-soar
[6] http://www.reuters.com/article/2012/12/03/brazil-greenhousegas-idUSL5E8N3FTN20121203. http://www.nature.com/news/brazil-reports-sharp-drop-in-greenhouse-emissions-1.13121
[7] http://www.nature.com/news/brazil-reports-sharp-drop-in-greenhouse-emissions-1.13121
[8] http://www.reuters.com/article/2012/12/03/brazil-greenhousegas-idUSL5E8N3FTN20121203

4 Climate Change and Disaster Risk Management Policy

4.1 Climate Change Policy

International Climate Change Policy – UNFCCC conferences and outcomes:

UNFCCC in 1992: The international political response to climate change began with the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The UNFCCC sets out a framework for action aimed at stabilizing atmospheric concentrations of greenhouse gases to avoid "dangerous anthropogenic interference" with the climate system. The Convention, which entered into force on 21 March 1994, now has 195 parties (IISD 2012).

Kyoto Protocol in 1997: In December 1997 in Kyoto in Japan, delegates to the third session of the Conference of the Parties (COP) agreed to a Protocol to the UNFCCC that commits industrialized countries and countries in transition to a market economy to achieve emission reduction targets. These countries, known as Annex I parties under the UNFCCC, agreed to reduce their overall emissions of six greenhouse gases by an average of 5.2% below 1990 levels between 2008-2012 (the first commitment period), with specific targets varying from country to country. The Kyoto Protocol entered into force on 16 February 2005 and now has 193 parties (IISD 2012).

Bali Roadmap in 2007: Negotiations resulted in the adoption of the Bali Action Plan. Parties established a working group with the mandate to focus on key elements of longterm cooperation identified during the Convention Dialogue: mitigation, adaptation, finance, technology and a shared vision for long-term cooperative action. The Bali conference also resulted in agreement on the Bali Roadmap. Based on two negotiating tracks under the Convention and the Protocol, the Roadmap set a deadline for concluding the negotiations in Copenhagen in December 2009 (IISD 2012).

Copenhagen, 2009: Disputes over transparency and processes dominated the Climate Change Conference in Copenhagen, Denmark and hindered the successful completion of the Bali Road Map. Informal negotiations of a group consisting of major economies and representatives of regional and other negotiating groups proposed "The Copenhagen Accord" which was after heavy debating "taken note of" by the plenary. In 2010 over 140 countries indicated support for the Accord in which amongst other topics the temperature limitation to 2°C, fast start finance, long term finance and scaled up, new and additional, predictable and adequate sources of funding are mentioned.

Cancun, 2010: By the end of the conference, parties had finalized the Cancun Agreements. The parties recognized the need for deep cuts in global emissions in order to limit global average temperature rise to 2°C. On finance, parties created the Green Climate Fund (GCF) and recognized the commitment by developed countries to provide US$30 billion of fast-start finance in 2010-2012, and to jointly mobilize US$100 billion per year by 2020 (IISD 2012).

DURBAN, 2011: The Climate Change Conference in Durban, South Africa was ending with outcomes, related to the Durban outcomes, covering a wide range of topics. The most notable results were the establishment of a second commitment period under the Kyoto Protocol, a decision on long-term cooperative action under the Convention and agreement on the operationalization of the GCF. Parties also agreed to launch the new ADP with a mandate "to develop a protocol, another legal instrument or an agreed outcome with legal force under the Convention applicable to all Parties." The ADP is scheduled to complete negotiations by 2015. The outcome should enter into effect from 2020 onwards. (IISD 2012)

Doha, 2012: The Conference produced a package of documents collectively titled The Doha Climate Gateway over objections from Russia and other countries at the session, The documents contained: (1) An eight year extension of the Kyoto Protocol until 2020 limited in scope to only 15% of the global carbon dioxide emissions due to the lack of participation of Canada, Japan, Russia, Belarus, Ukraine, New Zealand and the United States and due to the fact that developing countries like China (the world's largest emitter), India and Brazil are not subject to any emissions reductions under the Kyoto Protocol. (2) Language on loss and damage, formalized for the first time in the conference documents. (3) The conference made little progress towards the funding of the Green Climate Fund [9]

Brazil's Climate Change Policy (partly updated)

On the national level, Brazil is an important developing-country player in international climate change negotiations and, with China and India, one of the three largest emitters of greenhouse gases in the developing (SCIDEV, 2011). Although Brazil does not have any obligation to reduce its greenhouse gas emissions, it does have an interest in playing an active role in global efforts to tackle climate change. Brazil ratified the United Nations Framework Convention on Climate Change (UNFCC) in 1992 and ratified the Kyoto Protocol in 1994. Brazil submitted the First National Communication on Climate Change in 2004 and the Second National Communication in 2010 to UNFCCC.

Brazil maintains that yearly emissions should not be seen as a proxy for a country's responsibility for climate change. This responsibility, it argues, is more closely related to contribution to global temperature increase. Since carbon dioxide, the most important greenhouse gas, remains in the atmosphere for more than one century on average, past emissions need to be taken into account. As a result, in international negotiations, Brazil has refused to accept emission targets before the middle of the century. At that time, Brazil believes that the burden of responsibility for the total emissions present in the atmosphere would be the same for developing and developed countries (SCIDEV, 2011).

Just days after the closure of the UN Climate Change Conference in Copenhagen in 2009 President Luiz Inácio Lula da Silva signed the National Climate Change Policy (PNMC). This is a crucial part of upholding Brazil's international commitment and to make another step towards the implementation of PNMC (WRI 2011).

Most notably, law 12.187 officially adopts Brazil's voluntary national greenhouse gas reduction target of between 36.1% and 38.9% of projected emissions by 2020. This in itself is a vital step for Brazil that many doubted possible. The new law also requires Brazil's mitigation actions to be quantifiable and verifiable, meaning that international officials will be able to review and confirm whether or not emissions reductions have truly taken place. This will lay to rest doubts raised in the U.S. and elsewhere that developing countries might not allow their reductions to be subject to outside verification. Although it does not specifically address all key issues, law 12.187 fills in many gaps. It provides more details on how Brazil will finance its climate change policies. It also estimates the necessary emissions reductions per sector, and states that an executive decree will further specify reduction targets in the future. These targets will be based on the second Brazilian Greenhouse Gas Emissions Inventory (WRI 2011).

The PNMC is far-reaching and ambitious, addressing how Brazil will tackle its current and future greenhouse gas emissions and adapt to the impacts of climate change. Beyond providing an explanation of thirty-two emissions reducing activities currently being implemented in Brazil – such as the expansion of its hydroelectric power-generation capacity and the continuation of the National Ethanol Program – the PNMC also lists additional activities in the conception phase. While the plan is rather comprehensive in its economy-wide coverage, many of the proposed activities are in an early stage of development, recommended rather than mandatory, or lacking specific targets or implementation measures (WRI 2011).

Under the Kyoto Protocol, developing countries are encouraged to contribute to emission reductions through trading of emissions rights. The Clean Development Mechanism (CDM) allows mitigation projects in developing countries to earn certified emission reduction (CER)

[9] http://en.wikipedia.org/wiki/2012_United_Nations_Climate_Change_Conference

credits, which can be sold to industrialized countries to help them meet their emission targets. This mechanism aims at stimulating sustainable development and emission reductions in developing countries.

With regard to the CDM, Brazil is without a doubt one of the lead countries. The Interministerial Commission on Global Climate Change as National Designated Authority (DNA) has been established with great efficiency and the private sector has shown quick responses. The DNA is responsible for issuing approval letters to CDM project proposals that fulfil Brazil's sustainable development criteria. The commission consists of representatives of 11 ministries. So far 419 projects exist, thereof 300 are registered. The majority are in the energy sector (65 biomass energy, 75 wind energy, 111 hydro energy), followed by methane recovery in pig farms, waste management and energy efficiency. In the forest sector 3 reforestation projects have been approved (Risoe Center 2013).

4.2 Disaster Risk Management Policy

International Disaster Risk Management Policy

The **Hyogo Framework for Action (HFA)** is the key instrument for implementing disaster risk reduction, adopted by the Member States of the United Nations. Its overarching goal is to build resilience of nations and communities to disasters, by achieving substantive reduction of disaster losses by 2015 – in lives, and in the social, economic, and environmental assets of communities and countries.

The HFA offers five areas of priorities for action, guiding principles and practical means for achieving disaster resilience for vulnerable communities in the context of sustainable development. Since the adoption of the HFA, many global, regional, national and local efforts have addressed disaster risk reduction more systematically, much however, remains to be done. The United Nations General Assembly has called for the implementation of HFA, reconfirmed the multi-stakeholder ISDR System and the Global Platform for Disaster Risk Reduction to support and promote it. It is named after the Japanese prefecture of Hyogo, whose main city is Kobé and where the conference was held in 2005.

The General Assembly has encouraged Member States to establish multi-sectoral national platforms to coordinate disaster risk reduction in countries. Many regional bodies have formulated strategies at regional scale for disaster risk reduction. More than 100 Governments have designated official focal points for the follow-up and the implementation of the HFA (March 2007). Some have taken actions to mobilize political commitment and establish centres to promote regional cooperation in disaster risk reduction.

Brazil’s Disaster Risk Management Policy (Version 2011)

In Brazil, the body responsible for the coordination of the system of disaster response and disaster reduction is the National Secretariat of Civil Defense of the Ministry for National Integration. Since the mid-1990s, this system has been regulated by the “National Policy of Civil Defense”, which contains aspects later outlined in the Hyogo Framework for Action (HFA) (EIRD 2011).

Due to its geographical extension, Brazil is subject to a high number of disasters that provoke losses of lives and livelihoods. With this in mind, the Civil Defense has been working thoroughly with special emphasis on prevention, mitigation and planning, against natural and anthropogenic disasters; helping affected groups; and rehabilitating and recovering disaster scenes. Experience has shown that the Brazilian municipalities which are more resilient to calamities are the ones which have better knowledge and are able to take effective protection measures (EIRD 2011).

This system passed a severe test in 2008, when flooding’s hit hard the Brazilian state of Santa Catarina, and on the last two months as the North-eastern area was struck by severe rains. These disasters demonstrate the importance of the oceanographic monitoring of the region and the need to invest in disaster risk reduction. As part of the Federal Government’s

Growth Acceleration Program, funds have been made available to enhance drainage systems which will reduce hazards in the areas most prone to flooding (EIRD 2011).

Brazil works towards disaster risk reduction under the twin-track approach of emergency and structural actions. Part of the food stocks distributed in assistance to those affected by disasters are acquired from family agriculture. This contributes to reducing food insecurity in vulnerable population touched by emergencies as well as to strengthening rural livelihoods, as part of the “Zero Hunger” strategy. If on the one hand investment in disaster risk reduction is important, on the other hand it is also necessary a strong commitment to development policies which respect local priorities. Both perspectives must be under the framework of international solidarity and sustainable humanitarian assistance, which Brazil has diligently pursued. In an effort to help mitigate disasters abroad, Brazil inaugurated the International Humanitarian Depot, in the city of Rio de Janeiro. The Rio Depot can rapidly supply food items to countries of Latin America, the Caribbean and Africa which ask for emergent support (EIRD 2011).

In the Summit of the Caribbean and Latin America on Integration and Development (2008) all Heads of States of the region agreed to seek ways to ensure the coordination of mechanisms for DRR and disaster response, in coordination with international and subregional organisms and committees (EIRD 2011).

Brazil’s Hyogo Framework for Action (HFA) includes:

- HFA P1 - Institutional and legal framework: Establishment of a national risk management center. Prevention and preparedness program for emergencies and disaster to support the creation and implementation of provincial and municipal civil defense agencies, coordinated with the national civil defense system. The decree n.5.736 (17 February, 2005) to the agencies and entities of the federal public administration of the States. The Federal district and the cities, the private entities and the community, responsibilities for the actions of civil defense in all the domestic territory. The Decree n.26 (September 2005), institutes the national week of reduction of disasters
- HFA P2 - Risk identification and Early Warning System: Extensive risk mapping initiative. Enhancement of the Early Warning System
- *HFA P3 - Knowledge and education:* Continued education program led by civil defense.
- HFA P4 - Risk applications: Family basket program that benefits families in poverty conditions in hazardous areas (with monthly income for person of R$60.01 R$120,00) and extreme poverty (with monthly income for person of until R$60,00)
- HFA P5 - Preparedness and response: Capacity building for emergencies and disaster relief operations in the Amazonas.

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