INCT Climate Change Phase 2
(INCT MC Phase 2)

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Year 3 Report

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CEMADEN

SUMMARY

1. Overview

The INCT for Climate Change Phase 2 (INCT MC Phase 2) aims to implement and develop a comprehensive network of interdisciplinary research on global change and sustainability, and is based on the cooperation between about 30 research groups from all regions of Brazil and 4 international research groups, involving in its entirety over approximately 350 researchers, students and collaborators and establishing itself as one of the largest networks of environmental research developed in Brazil.

The program consists of six thematic lines (or subcomponents):

1. Food security;
2. Water security;
3. Energy security;
4. Health and climate change;
5. Natural disasters, impacts on physical infrastructure in urban areas and urban development;
6. Impacts on Brazilian ecosystems in view of changes in land use and biodiversity.

All these components are connected via 3 integrative themes or cross cutting themes:

1. Economy and impacts in key sectors;
2. Modelling the earth system and production of future climate scenarios to study vulnerability, impacts, adaptation and resilience;
3. Communication, dissemination of knowledge and education for sustainability.

So far the INCT MC Phase 2 scientific agenda has been developed as planned, providing scientific excellence in various areas of global environmental change and its implications for sustainable development. The emphasis on the impacts of global climate change on agriculture, health, renewable energy, urban development, and natural disasters such as central themes integrated with environmental modelling, the economics and the communication of these impacts to the public, scientific community and academic sector, industry business and government can contribute to maintain excellence in activities in Science & Technology & Innovation as the axis of sustainable environmental development, with an integrative and innovative character. This project includes knowledge transfer using instruments that go beyond only scientific articles, but producing audio-visual, web tools, and other outlets that allow a scientific education of the population, improving the impact of Brazilian science and also a greater international integration of Brazil in environmental negotiations.

Different from the Report of Year 1, where only FAPESP funded components were explained, in Years 2 and 3 we decided to include all components of the project, that include contributions of the UFMG and FIOCRUZ in MG, and partnerships with UFSC, UFRJ, IPEA, and other institutions outside of the State of Sao Paulo. This provides a better holistic view of the project and its components.

Since March 2020, due to the covid-19 pandemics, many meetings, conferences has been cancelled or moved to 2021, and participation in some international and national gatherings were cancelled because either the meeting were moved to 2021 or cancelled. In any case, participation in meetings and seminars by means or virtual platforms (Zoom, Goto Meeting, etc) made possible the interaction among participants. The scientific production and publication activities did not stop and continue as planned. Participation in many national and international meetings after March 2020 were in the form of Webinars, Lives, and other using the virtual platforms due to the impossibility to travel imposed by the pandemics.

Outside the scope of the initial project, there is a proposal to include the in the Health Component theme COVID-19, since this condition has generated major social, economic, environmental changes, i.e., global and planetary changes, which can generate impacts on the results analyzed (See Annexes). Considering this context, it is possible that the seasonality of the new coronavirus (SARS-COv-2) may also rest in climatic aspects, given that its seasonality in the world and in Brazil is still practically unknown, but it can share similarities with other vARIS. Obviously, human behavior, globalization and control measures (ie wearing masks, social isolation, lockdown, among others) are non-climatic factors that, in fact, seem to have the greatest impact on the epidemiology of SARS-VOC-2, but the climatic factors should be better analyzed in the Brazilian context to help understand the epidemic in the country. This understanding can benefit both from vulnerability assessments that allow identifying the territories most susceptible to localized outbreaks, and from the climate approach in epidemiological models that provide a holistic view of the behavior of the new pathogen.

Therefore, the introduction of the COVID-19 theme in the Health component of the INCT is justified, as this condition has generated major social, economic, and environmental changes, specifically for the following reasons:

- Brazil is the second country in the world in absolute number of cases of the disease, with about 1,150,000 records (6/25/2020);
- Preliminary data indicate that climatic factors may play a role in modulating the transmission of SARS-Cov2;
- 3-Its social importance, being the most severe pandemic in 100 years, with serious impacts on the health of communities and on the economy;
- The importance of evaluating the impact of the SARS-COV-2 surveillance and control of other diseases, related to the State and Municipal Health Departments, as well as population well-being;
- The expertise of the researchers involved will allow a broad approach to COVID-19 in Brazil, with the analysis of climatic, social, environmental and health system factors, bringing important proposals to the health decision-making agencies.

The COVID-19 is also considered as a research activity in the components of energy and natural disasters.

2. Objectives and aims

The objectives of the INCT MC Phase 2 have not changed:

- To implement and develop a comprehensive network of interdisciplinary research on global environmental change and sustainability
- To develop actions aimed at assessing adaptation to environmental changes and the transformation to sustainability, to reflect the vulnerabilities and resilience trajectories and propose ways in adapting to these changes, especially in relation to decision in the political sphere.
- To merge science with education from primary to the post-graduate levels.
- To provide an overview of issues related to sustainability and environmental-social-corporate responsibility, in order to facilitate the participation or even the implementation of activities in different areas of management of public and private institutions and their relationships with stakeholders.
- To maintain excellence in activities in Science & Technology & Innovation as the structural axis of sustainable environmental development, with an integrator and innovative character.
- To transfer knowledge using instruments that go beyond only scientific articles, but producing audio-visual material, web tools, and other outlets that allow the development of a scientific culture in society, improving the impact of Brazilian science and enabling increased international insertion of Brazil in environmental negotiations.
- To develop a research agenda in global change to identify and understand the current impacts

of climate variability on natural and human systems in Brazil;

- To enhance and expand the scope of studies on global changes and their impacts on important sectors to the economy of Brazil.
- To engage and educate society, aiming to increase the resilience of these sectors.
- To sensitize the public perception of science and technology in relation to global change and impacts on society.
- To contribute prominently in the research and development of the National Plan on Climate Change and the National Adaptation Plan to Combat Drought and Desertification, in partnership with federal, state and international research programs on global change
- To produce publications and model data that can be used to provide scientific contributions for the IPCC AR6, special reports of the Brazilian Panel of Climate Change and the Fourth National communication of Brazil to UNFCCC.

3 Coordination

Coordinator: Jose A. Marengo, Researcher, Level 1 A-CNPq classification, CEMADEN, Sao Paulo
Vice-Coordinator: Tercio Ambrizzi, Researcher, Level 1 A-CNPq classification, IAG USP, Sao Paulo

-Steering Committee

Name	**Field of work**	**Institution**	**e-mail**
Jose Antonio Marengo Orsini	Project's coordinator. Climate modelling, impacts and vulnerability assessments	CEMADEN	jose.marengo@cemaden.gov.br
Tercio Ambrizzi	Vice-coordinator, Climatology, climate studies, water security	IAG USP	ambrizzi@model.iag.usp.br
Paulo Nobre	Oceanic and coupled atmosphere-ocean modelling	CPTEC INPE	pnobre@cptec.inpe.br
Roberto Schaeffer	Energy and climate change	COPPE UFRJ	roberto@ppe.ufrj.br
Paulo Eduardo Artaxo Neto	Environmental physics, Amazonia, and climate change	IF USP	artaxo@if.usp.br
Eduardo Mario Mendiondo	Hydrology and water security	USP EESC	emm@sc.usp.br
Ulisses E C Confalonieri	Health and climate change	CEDEPLAR UFMG e FIOCRUZ	uconfalonieri@gmail.com efrangel@ioc.fiocruz.br
Eduardo Haddad	Economy of climate change	FEA USP	ehaddad@usp.br

All members of the Steering Committee (CG) are also coordinators of the Associated Laboratories. The Federal University of the Sate of Santa Catarina (UFSC) and the State University of Campinas (UNICAMP) are also Associated Laboratories. Associated Laboratories are those centers whose members are part of the CG but are not part of the group that is submitting the proposal. The progress of the Project is monitored by a Scientific Committee (CC), that is constituted by the coordinators of the sub components (themes) and from the cross cutting activities. We have meet virtually in March to see the progress of the project.

We have to inform that FAPESP approved the Report of Year 2. After the III Seminário de Avaliação dos INCT in Brasilia en November 2019, CNPq approved the Report of Years 1 and 2 with some suggestions, that we are following (see annex).

4. Reports by component

In the following we focus on the reports from each sub component and crosscutting component, showing main results and activities developed in Year 2 of the project. We also include information on new team members coming into the project, explain some changes in the coordination of the components if that is the case and plans for Year 2. All information on scientific production and activities from each of the components (workshops, publications, participation in events, use of the BC and RT, fellowships [bolsas]) are listed in upcoming sections. The report is from activities developed by all components of the project.

4.1 Coordination

The two coordinators Jose Marengo and Tercio Ambrizzi have meet during year 3 in several occasions, some of these meetings took place USP, and other during other meetings and conferences where we both were there. We have changed the way the coordination works. For the administrative issues, CEMADEN hired Ms. Josiane Rosa, who is working part-time dedicated to this project. Ms Rosa helps the coordination with the procedures to indicate *bolsas* to CNPq, CAPES and FAPESP, with payments, meetings organization and air travel arrangements for participant scientists to meetings among INCT MC Phase 2 participants.

In addition to administrative activities, the coordinators together with their students, bolsistas and Post-doctoral have developed a scientific agenda on investigation of observed climate variability and change, with focus on extremes in regions such Amazonia, Northeast Brazil major cities, such as Sao Paulo. Ans some paper have been produced as well as reports in various journal, magazines and the Revista Pesquisa FAPESP. This is being done since the beginning of the project and constitutes a background fall all components.

Dr. Marengo participated in the review of FAPESP Research Program on Global Climate Change (PFPMCG) for the period 2020-2030. This plan implements a scientific agenda aimed at understanding the processes associated with climate change and assessing its causes and impacts, providing scientific support to find solutions and support public policies based on scientific evidence and generate knowledge.

Present and future climate extremes imply adverse impacts, and therefore often pose severe societal challenges across a range of sectors and might even exacerbate or trigger human conflict. About 90% of all disasters are caused by weather-related hazards, such as floods, storms, extreme temperatures, and droughts. A combination of these hazards, either sequentially such as a tropical cyclone followed by a heatwave, or a concurrent compounding of hazardous factors such as heat and drought can be even more disastrous than a single hazard. Moreover, not only the interdependence between hazards but also interactions between hazards, ecosystem or societal responses, and vulnerabilities can amplify the risk. Extreme event impacts are increasingly recognized, methodologies to address such impacts and the degree of our understanding and prediction capabilities, however, vary widely among different sectors and disciplines. Moreover, traditional climate extreme indices and large-scale multimodel intercomparisons that are used for future projections of extreme events and associated impacts often fall short in capturing the full complexity of impact systems.

4.1.1 Weather and climate extremes in the Metropolitan Region of Sao Paulo: Intense rainfall episodes in Summer of 2020

Floods and flash floods in Sao Paulo are no news, they have been detected in the past, and with the population relatively lower and the urbanization as not as big as now they still constituted a major problem in the past (Figure 4.1). A review of the most updated literature on rainfall and extremes in the MASP shows a significant increase in the total volume of rainy-season rainfall during the last seven decades (Marengo et al 2020). While there were practically no days with

heavy rain (more than 50 mm) in the 1950s, these days have been occurring two to five times a year in the last 10 years. This, together with the inappropriate occupation of risky areas, such as slopes and banks of water- courses, leads to inundation, flooding, and landslides. Changes in extremes can be partly due to natural climate variability but can also be related to global warming and/or urbanization. There is ample evidence of an increasing risk of rainfall-related hazards in the MASP. This is particularly so for landslides in vulnerable areas. Exposure will continue to lead to risk increases. This calls for significant improvement in climate and disaster risk reduction and management efforts in the MASP region. (Figure 4.2).

The floods and landslides in southeastern Brazil in 2020 started on January 17, 2020 as a result of heavy rains, causing major damage in municipalities in the state of Espírito Santo. In the following days, disasters of the same nature occurred in the states of Minas Gerais and Rio de Janeiro. By February 10 intense rainfall affected São Paulo. The volume of rain of February 10 2020 in São Paulo is the 2nd largest for the month of February in 77 years. In the capital of São Paulo, the strongest rain started in the late afternoon of Sunday (9) and remains steady this Monday (10). Considering all months of the year, this was the eighth largest accumulated in 24 hours in the entire history of Inmet measurements.

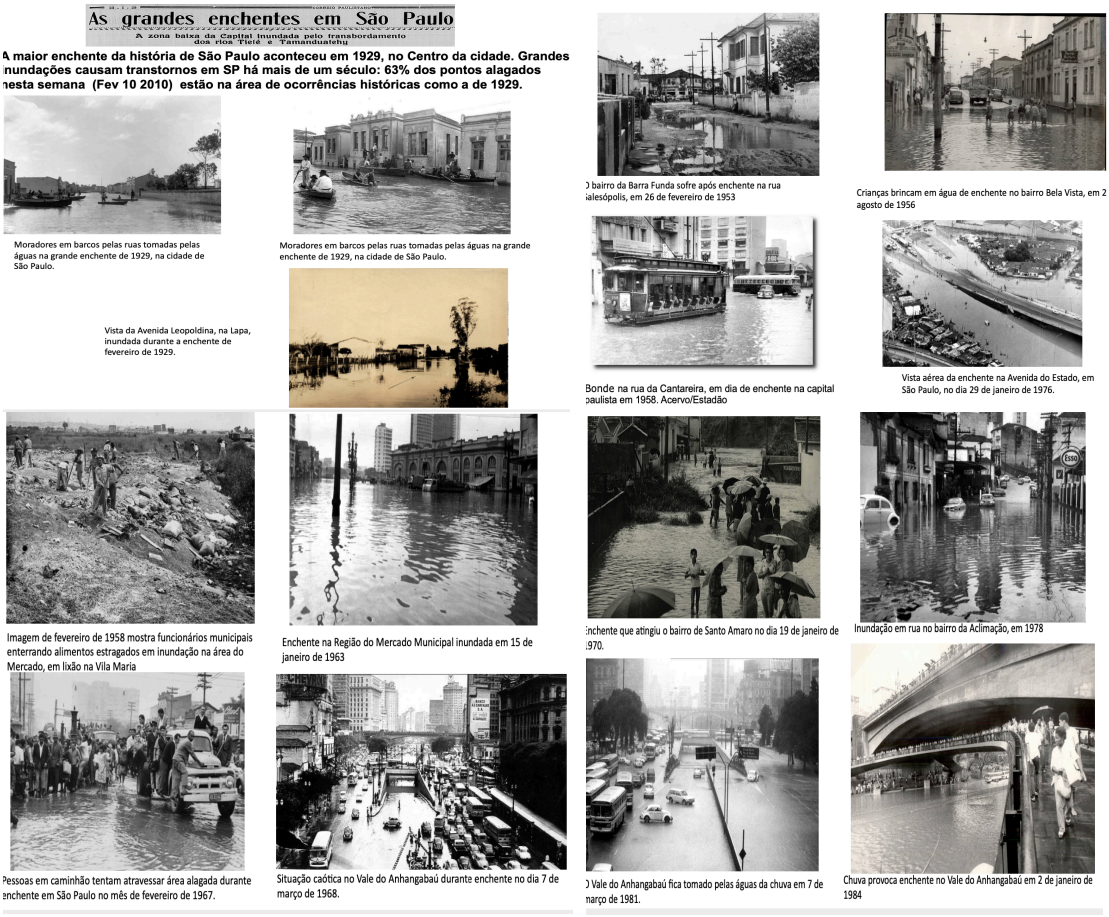

Figure 4.1. Historical floods events in the city of Sao Paulo.

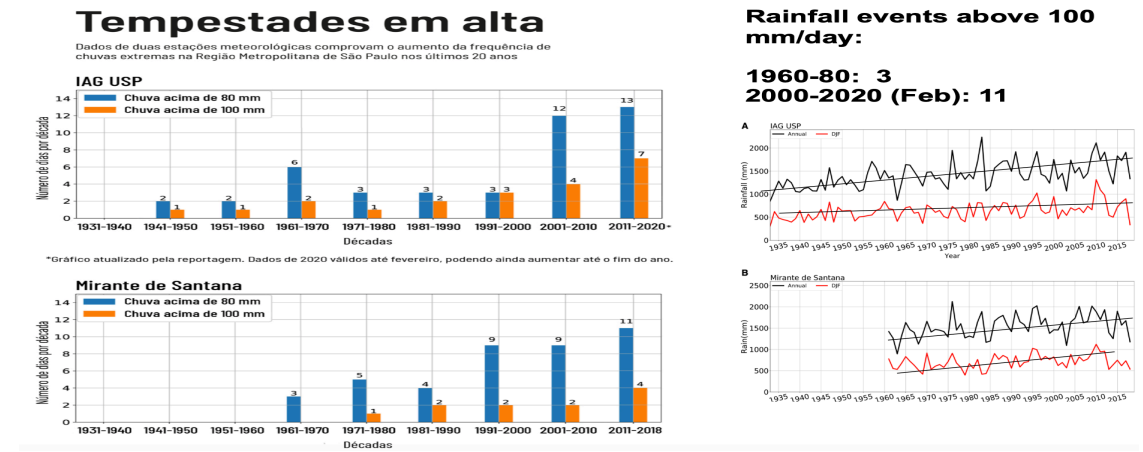

Figure 4.2. Sources: Marengo et al (2020; http://agencia.fapesp.br/numero-de-dias-com-chuva-forte-cresceu-em-sao-paulo-nas-ultimas-sete-decadas/32683/

As of February 9, 2020, torrential rains began to hit São Paulo and its regions, at dawn the next day, a strong storm hit Greater São Paulo and the Coast, and this left the affected locations in chaos and in a situation of emergency for landslides and overflowing rivers, most classes in schools and jobs were suspended on February 10. In just 11 days, rainfall in the city of São Paulo exceeded the historical average for February by 37.2%. According to the National Institute of Meteorology (Inmet), it rained 342.6 mm this month, and the average recorded between 1981 and 2010 was 249.7 mm. Several cities in São Paulo faced total chaos and the Greater São Paulo had a record of rain with 140.8 mm of rain on the day, making this the second rainiest day since the beginning of the measurements and the biggest rain since December 21, 1988, almost all regions of São Paulo were under water, certain places even registered rainfall above 200 mm, as was the case on the coast of São Paulo

The volume of rain in SP February is the 2nd largest for February in 77 years. In the capital of São Paulo, the strongest rain started in the late afternoon of Sunday (9) and remained steady by Monday (10). Considering all months of the year, this was the eighth largest accumulated in 24 hours in the entire history of Inmet measurements The heavy rain that hit São Paulo from the end of this Sunday afternoon (9) caused destruction and chaos. The storm caused rivers to overflow, caused dozens of floods, landslides and blocked the city. According to the city managers, the storm gained strength from 1 am on Monday (10). The volume of water recorded in the 24-hour interval was the highest for a month of February in 37 years, reported the National Institute of Meteorology (Inmet). The Tietê and Pinheiros rivers overflowed, which had not occurred since March 2016. According to the State Secretariat for Infrastructure and Environment, since 2005 Pinheiros did not overflow in the integrity of its extension. Two marginals roads were left blocked.

The circulation of public transport (buses, subways and trains) was compromised, and the city government suspended the rotation of vehicles, a measure that will continue to be valid throughout Tuesday (11). The Companhia de Entrepostos e Armazéns Gerais de São Paulo (Ceagesp) and Campo de Marte, an airport in the North Zone of the capital, were flooded. After a chaotic morning, São Paulo reached 161 points of flooding during this second. Until the last update of this report, 19 remained active, according to the City's Emergency Management Center (CGE). At around 10 pm, the city still had impassable spots. (Figure 4.3)

Figure 4.3. Damages due to the intense rainfall of February 10 2020 in the city of Sao Paulo.

4.1.2 **Changing Trends in Rainfall Extremes in the Metropolitan Area of Sao Paulo: Causes and Impacts**

This study analyses observed trends in extreme rainfall events in the Metropolitan Area of São Paulo (MASP). Rainfall data sets with more than 60 years of record in MASP are used. In MASP, extreme rainfall events represent hydro meteorological hazards that trigger flash floods and landslides. Changes in rainfall extremes can be partly due to natural climate variability. In addition, it can also be related to global warming and/or urbanization. Total annual precipitation and the number of days with precipitation of 20 mm exhibit the largest significant increase during 1930-2019. This is better noticed during summer. This tendency is also noticed in the number of days with precipitation of 100 mm or more. Therefore, the positive trend in annual precipitation is mainly due to an increase in the frequency of extreme precipitation events. On the other hand, our analysis shows that the number of consecutive dry days increased. Though these results appear to be contradictory, they indicate an important climate change in recent times. Intense precipitation is concentrated in few days, separated by longer dry spells. The focus is on how atmospheric circulation variations are contributing to these changes. During 1960-2019 the South Atlantic Subtropical Anticyclone has intensified and slightly moved southwestward of its normal position. This change influences the transport of humidity and therefore impact precipitation. This can explain the increase in the precipitation extremes in the MASP. However, other atmospheric systems may also be important.

Observed trends of rainfall extreme indices at the IAG-USP and the Mirante de Santana stations are shown in Figure 4.4. This analysis has been updated until 2019. Total precipitation in both stations has been increasing steadily, with a pronounced interannual variability. The rate is +53 mm/10 year at Mirante de Santana and at IAG-USP the change is about +55 mm/10 year, and those trends reach statistical significance as shown by the Mann-Kendall test. CDD shows almost no significant change since the beginning of the records in both stations. However, in the last 20 years CDD featured positive trends (Figure 4.4a, b), i.e., the number of consecutive dry days is increasing, from 30 in 200 to 50 between 2019. R95p and Rx5D (Figure 4.4c, d) show a steady increase, being statistically significant for R95p. Changes in CDD and Rx5D are not significant in both stations. We found that the most significant linear trends were for increases in R95P until 2019. One conclusion from Figure 4.4 is that there are signals of change in the rainfall pattern. The increase in total precipitation is accompanied by more intense rainfall episodes. These heavy precipitation events occur with long dry spells in between

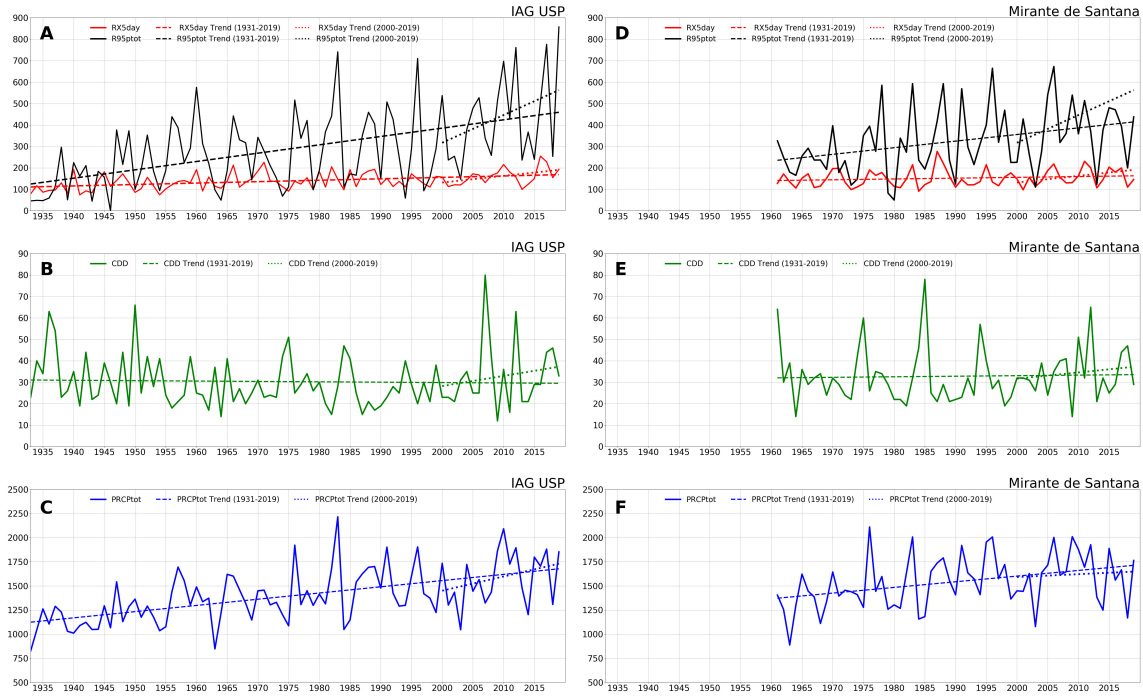

Figure 4.4. Time series of heavy precipitation (R95P); 5 days accumulated precipitation (R5xD); consecutive dry days (CDD) and total annual precipitation (PRECTOT) during 1931-2019 for IAG-USP (a-c) and Mirante de Santana during 1961-2019 (d-f). Linear trends are shown with full (since 1961) and broken (200-2019) lines.

Tendencies in rainfall extremes at Mirante de Santana and IAG-USP stations are shown in Figure 4.5a-f. The number of days with precipitation from 10 to 50 mm (R10 to R50) has been increasing. The largest values are shown after 2000 in both Mirante de Santana and IAG-USP. The number of days with R10 at Mirante de Santana and IAG-USP varied from 40 to 60 during the last 20 years. It shows a positive significant trend. R20 and R25 also show positive trends (statistically non-significant) and with a strong interannual variability. The figure shows a positive non-significant trend in R30, and during the last 20 years, it has varied between 10 and 20 days, as compared to 5 to 10 days in 1940−1960. There is a positive and significant trend in R50 (Figure 5b, e) but perhaps the most important feature is the relatively large number of days with R80 and R100 from 2000 to 2019 as compared to the 1960's (Figure 4.3c and f). It can be concluded that all climate indices had increasing trend across the whole period of study. The results also have shown non-significant trends for most of the climate indices at recent period (2000 – 2019), despite rising trends observed in RX5day for IAG-USP and R80 for Mirante de Santana. Overall these trend results reveal the increasing tendency in heavy precipitation.

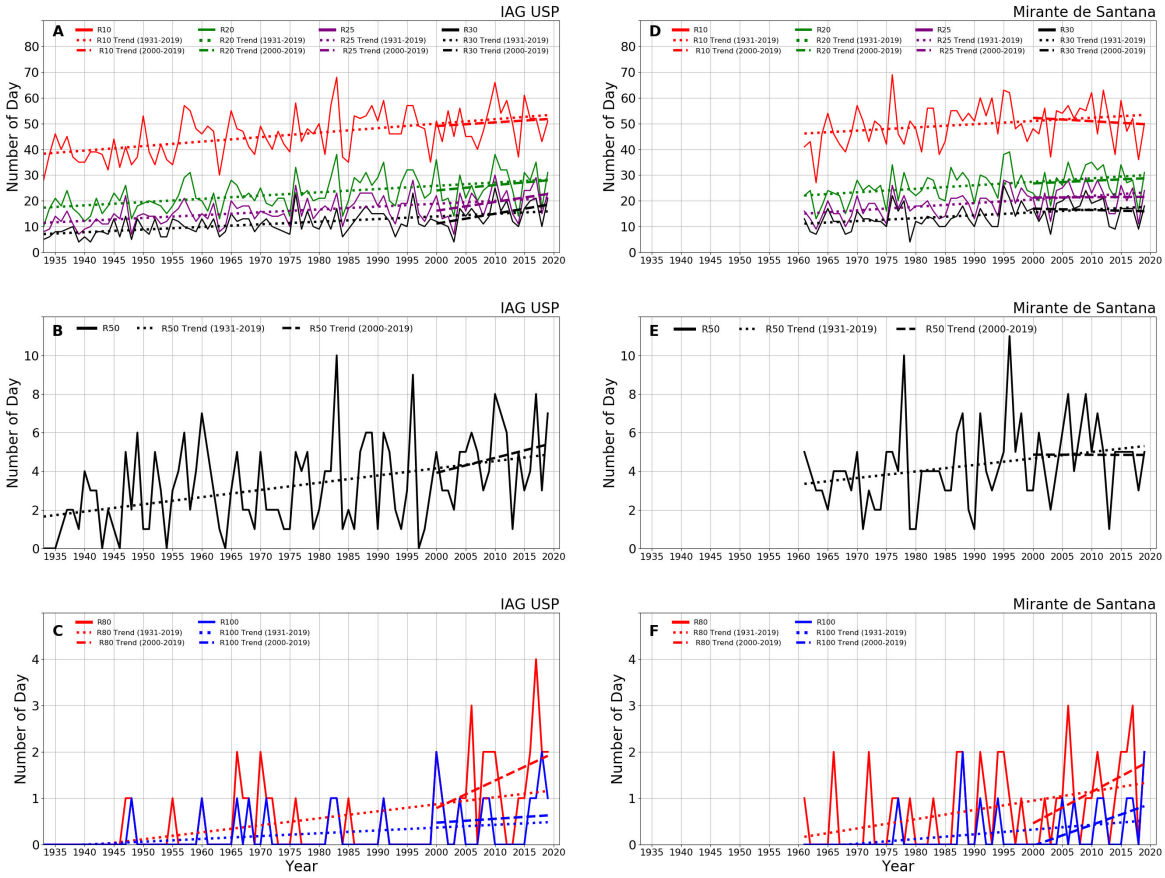

Figure 4.5. Time series of numbers of days with precipitation above 10 mm (R10), 20 mm (R20), 25 mm (R25), 30 mm (R30), 50 mm (R50), 80 mm R80) and 100 mm (R100) for IAG-USP during 1931-2019 (a-c) and Mirante de Santana during 1961-2018 (d-f). Linear trends are shown with full (since 1961) and broken (200-2019) lines. Linear trends are shown with full (since 1961) and broken (200-2019) lines.

There is an observed increase in number of days with precipitation above 80 mm and 100 mm in the last 2 decades. These changes are statistically significant at 95% level. Marengo et al. (2020) show that for both stations the number of days with rainfall above 80 and 100 mm has increased by a factor of four during the last 20 years as compared to 1940-1960. Between 1960-80 the number of days with precipitation above 80 mm/100 mm was 9/3 at IAG USP and 8/1 for Mirante de Santana. For the period 2001-2019, these numbers were 25/11 and 20/6. Two events with rainfall above 100 mm were detected in January and February 2020 at the IAG USP station.

The results from Vemado and Pereira Filho (2016) show that the warmer urban environment in MASP produces a UHI effect that interacts with the sea breeze. This intensifies thunderstorms that lead to flash floods and landslides. Therefore, the increase in rainfall extremes can be explained by the UHI and by changes in atmospheric circulation (see section 4).

In sum, we can affirm that:

- Total precipitation and frequency of days with extreme rainfall values are increasing
- There is a small negative trend of the number of days with light precipitation from the beginning of the 2000's.
- The number of days 80 and 100 mm has almost doubled in 2011-2019 as compared to 1971-80, mainly in DJF.
- It is also worth mentioning that the precipitation above 80mm/100mm started to be observed after the 2000's during austral winter (JJA)

J. Marengo and T. Ambrizzi were interviewed by Elton journalist of the Agencia FAPESP about this paper and these rainfall extremes and this is listed in the Annex. On another interview, Carlos Fioravanti from Revista Pesquisa FAPESP interviewed them about warming trends in Brazil, and some parts of its are also listed in the Annex section.

4.2 Food security

In the activity developed by the INCT Project in the Amazon Biome, were collected the primary data systems of crop-livestock (ILP) and livestock-forest (IPF), both systems adopted on farms in the Paragominas region, Pará. The data collection was made through interviews with producers and farm managers who adopt these integrated systems, aiming at the description of the technical production itinerary and its economic evaluation. The collected data were treated and are in the validation phase.The activity developed in the Cerrado Biome characterized two systems in integration in the regions of Maracaju and Três Lagoas, south-central Mato Grosso do Sul. The data collection was done by technical panels (focus groups) with producers, local technicians and researchers specialized in integration systems. In the Maracaju region were made available the rsults for systems of crop-livestock (ILP).

With respect to market prices, the results show great technical and economic viability of the ILP system under analysis (soybeans, followed by off-season corn and livestock for two years). In the Tres Lagoas region, the ILPF system are formed by eucalyptus for the production of wood for celulose, this system is more complex and its analyse for economic viability are being made. The Project has data from specialized about beef cattle and soybean systems, representative of production in monoculture systems. The data for “single” beef cattle were collected under the Pecus Research Network for Brazilian biomes and have already been made available in the project.

The scientific activities developed in the climatic scope aimed at estimating the projected productivity for rice, beans, corn and soybean crops through the CROP WATER STRESS INDEX and the IBGE data. And to analyze the resilience of different types of beef cattle breeders to the impacts of climate change in the Atlantic Forest, Cerrado and Amazon biomes. Single, integrated and diversified production systems will be compared as units of analysis in soy planting and beef cattle activities.

Two databases for climate were used to estimate the productivity for Brazil, are XAVIER (2015) and the global climate model ETA-HadGEM2 ES. The both contains 11.299 points gridded in 0,25° and its important is in the daily information about climate parameters as maxima temperature, minimum temperature and rainfall.

4.2.1 Methodology for calculating present and future productivity

Actual productivity (Yp) is estimated from relative water deficiency [1 - (Er / ETP)], weighted by a crop sensitivity factor to water deficit (ky), according to Doorenbos & Kassam (1979):
Yr / Yp = 1 - ky [1- (Er / ETP * Kc)] (equation 1)

Where:

• Yr is the estimated productivity;
• Yp is the potential productivity;
• Er is the actual evapotranspiration of the culture;
• ETP is the potential evapotranspiration of the crop, estimated by the method of Thornthwaite (1948);
• Kc is the culture coefficient for each phenological phase;
• ky is the coefficient of productivity penalty for water deficit, variable with the phenological phase of the crop. In the case of soy, ky is equal to 1.

The ETP * ks ratio is called ETC (culture evapotranspiration).

Despite the great scientific advances in the use of the geoprocessing of satellite images, in estimating the area of agricultural crops, there is still no operational method and of low cost, for national estimate of the planted area of soybeans. Alternatively, in order to estimate the national harvest, in addition to the productivity estimate, the system incorporates a module to access a database, based on surveys carried out by the Brazilian Institute of Geography and Statistics (IBGE), on a municipal scale. The system points to the crops producing municipalities and associates to each of them their fraction relative to the total area of crop produced. At the state scale, data on planted area are used, derived from surveys carried out by the National Supply Company (CONAB), which are converted into municipal areas, multiplying the relative fraction of the municipality by the total area of the State.

The following parameters of crops are used:

-Vegetative cycle length: subdivided into phenological phases, by identification of critical periods (stages), such as initial period, crop development, mid-season, and late season;
-Kc (crop coefficient): as method for definition of the plant water demand;
-Root system depth: The root system depth is particularly important to estimate the available water capacity (AWC). Considering the depth of the tobacco root system in the zone where nutrients are mostly available, in this Study, it was considered 30 cm as the standard depth of the roots and where was calculated / estimated the AWC.
Um schematic summary of the methodology and the flow of data calculation is presented below.
-Vegetative cycle length: subdivided into phenological phases, by identification of critical periods (stages), such as initial period, crop development, mid-season, and late season;
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An schematic summary of the methodology and the flow of data calculation is presented below (Figure 4.6, 4.7).

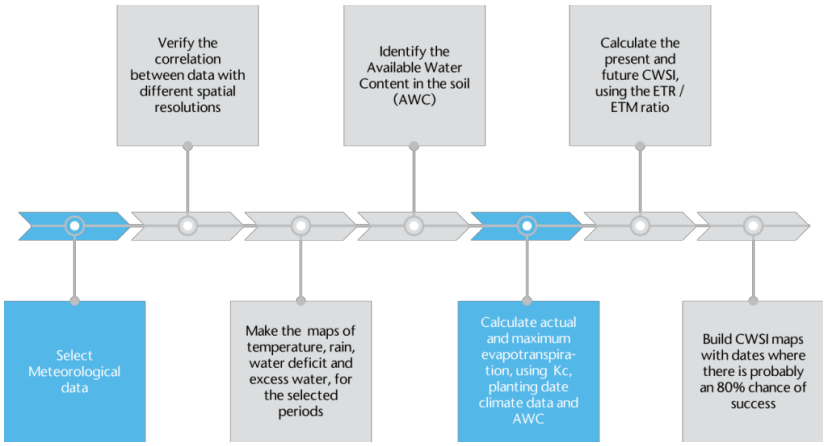


Figure 4.6 . Schematic summary of the methodology and the flow of data calculation.

And finally, the steps of calculation the relation ETR/ETC are:

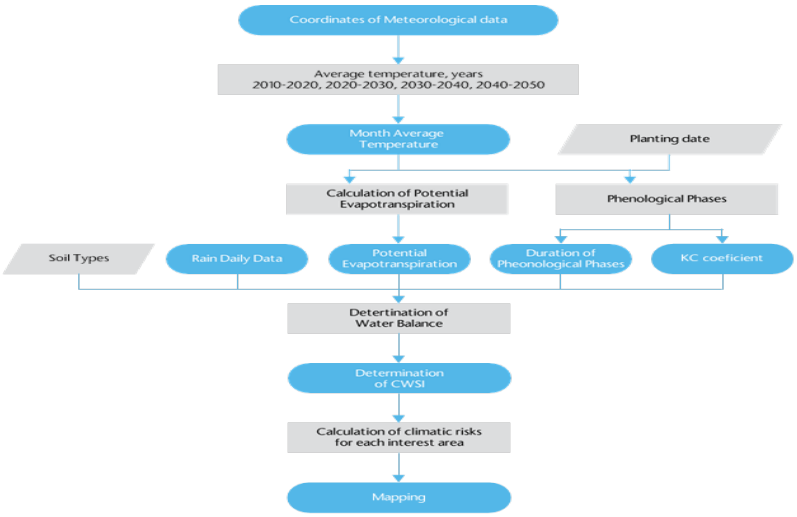
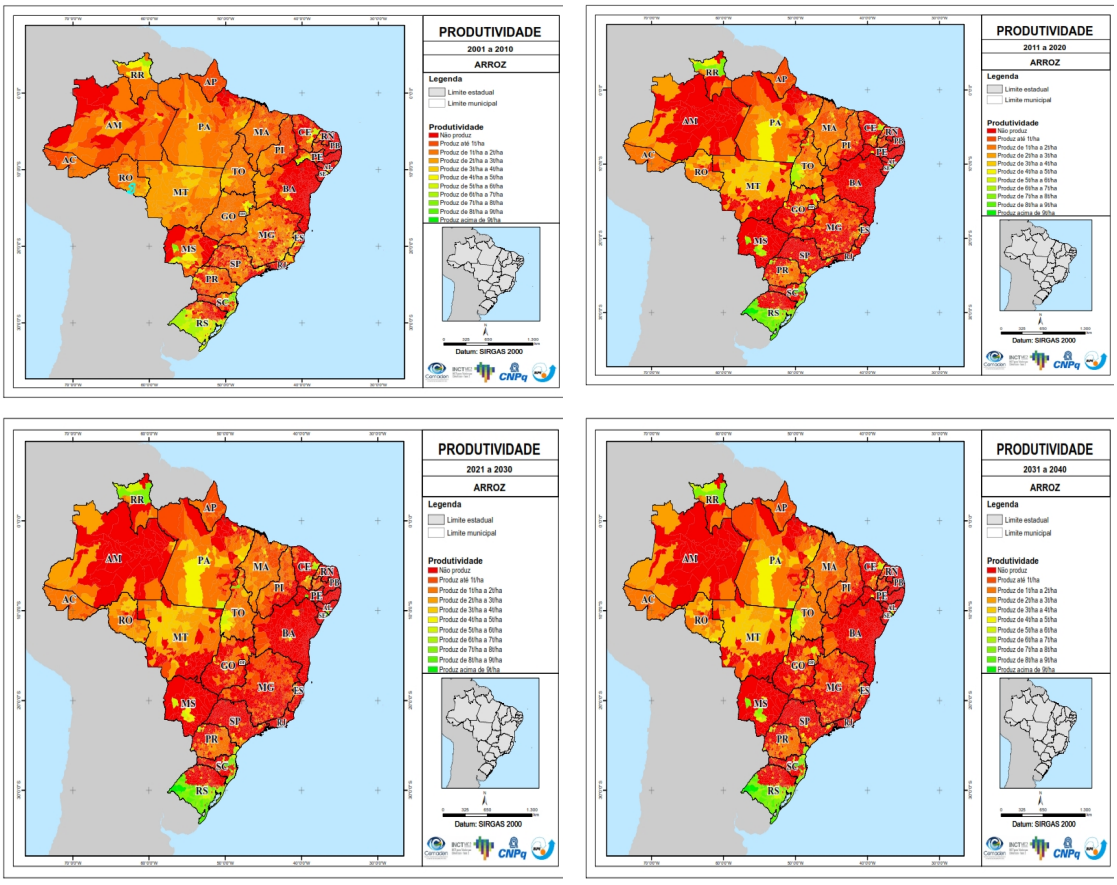


Figure 4.7. Schematics of calculation the relation ETR/ETC

4.2.2 Simulations and projections of spatial variation of productivity for the different cultures

The following maps show the spatial variation of productivity for the different cultures studied and the future impacts from the analysis made with the results of the Eta-Hadgem 2 ES model (Figures 4.8-4.11).



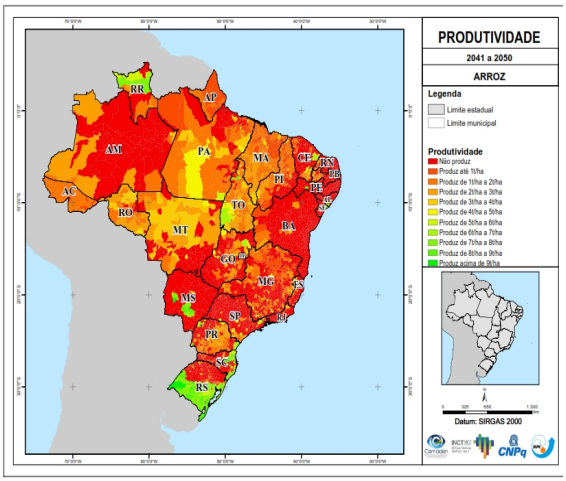
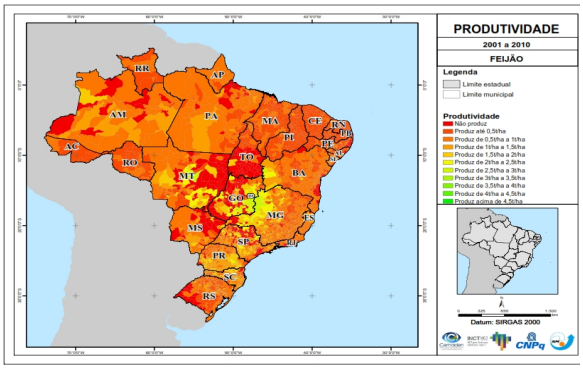
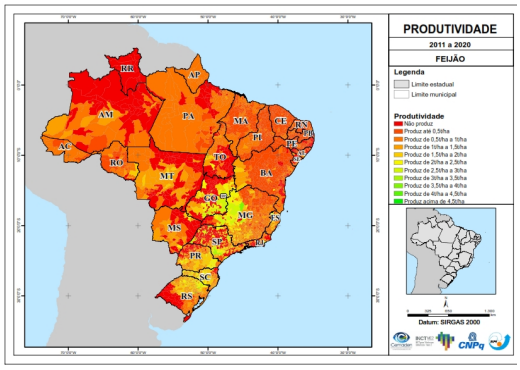
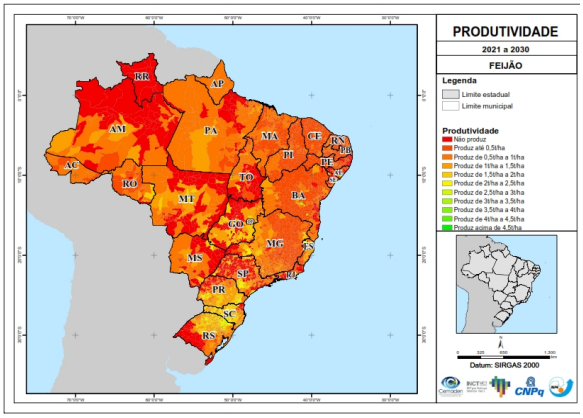
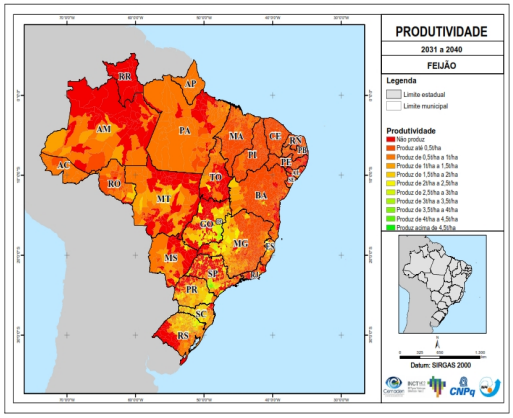


Figure 4.8: Simulation and projections of rice productivity from 2001 to 2010 to 2050









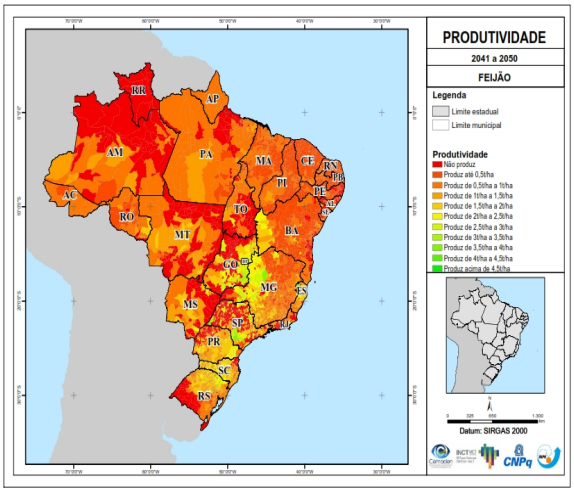
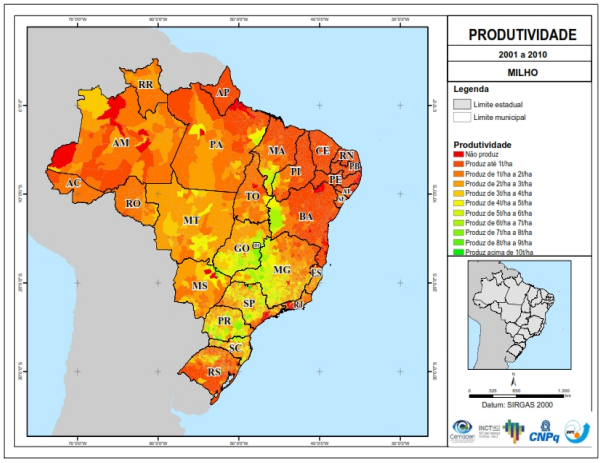
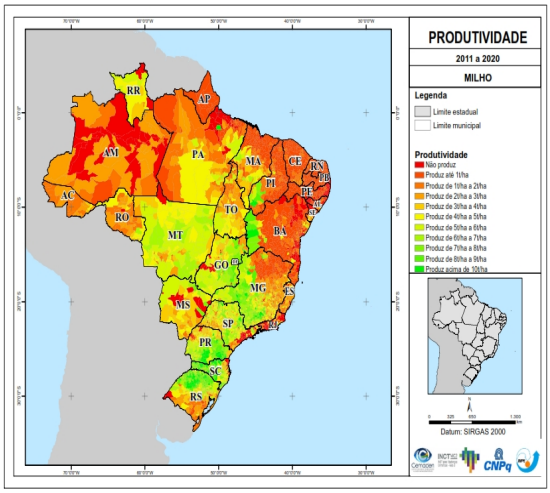
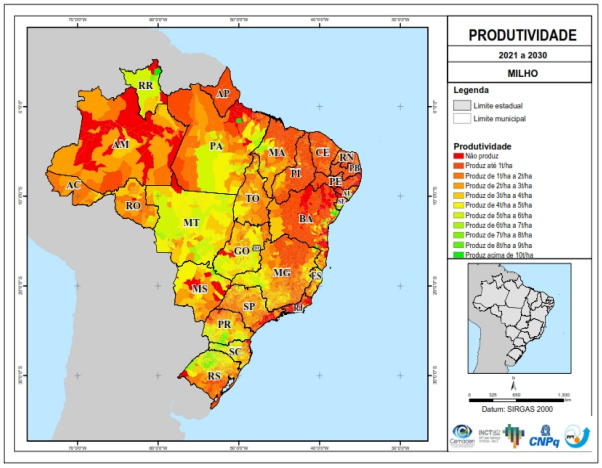
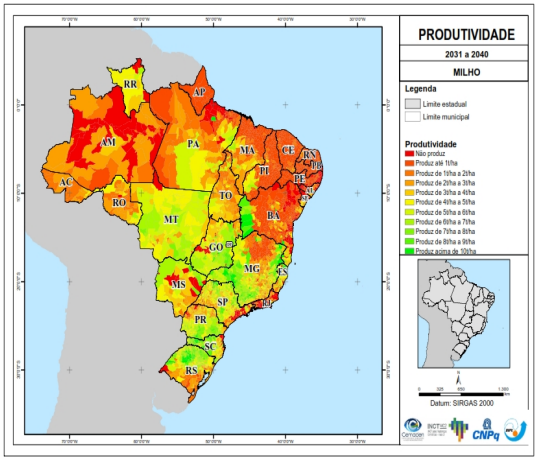


Figure 4.9. Simulation and projections of beans productivity from 2001 to 2010 to 2050









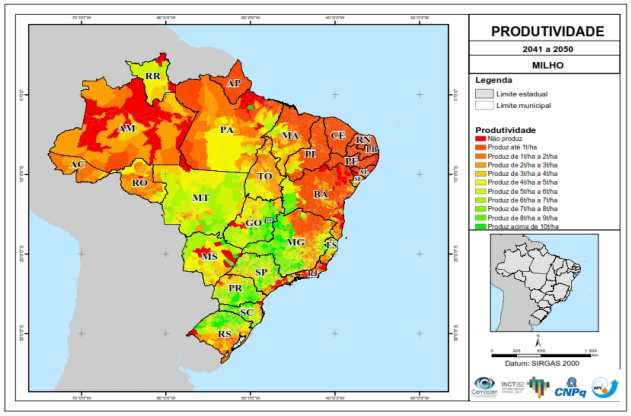


Figure 4.10. Simulation and projections of maize productivity from 2001 to 2010 to 2050

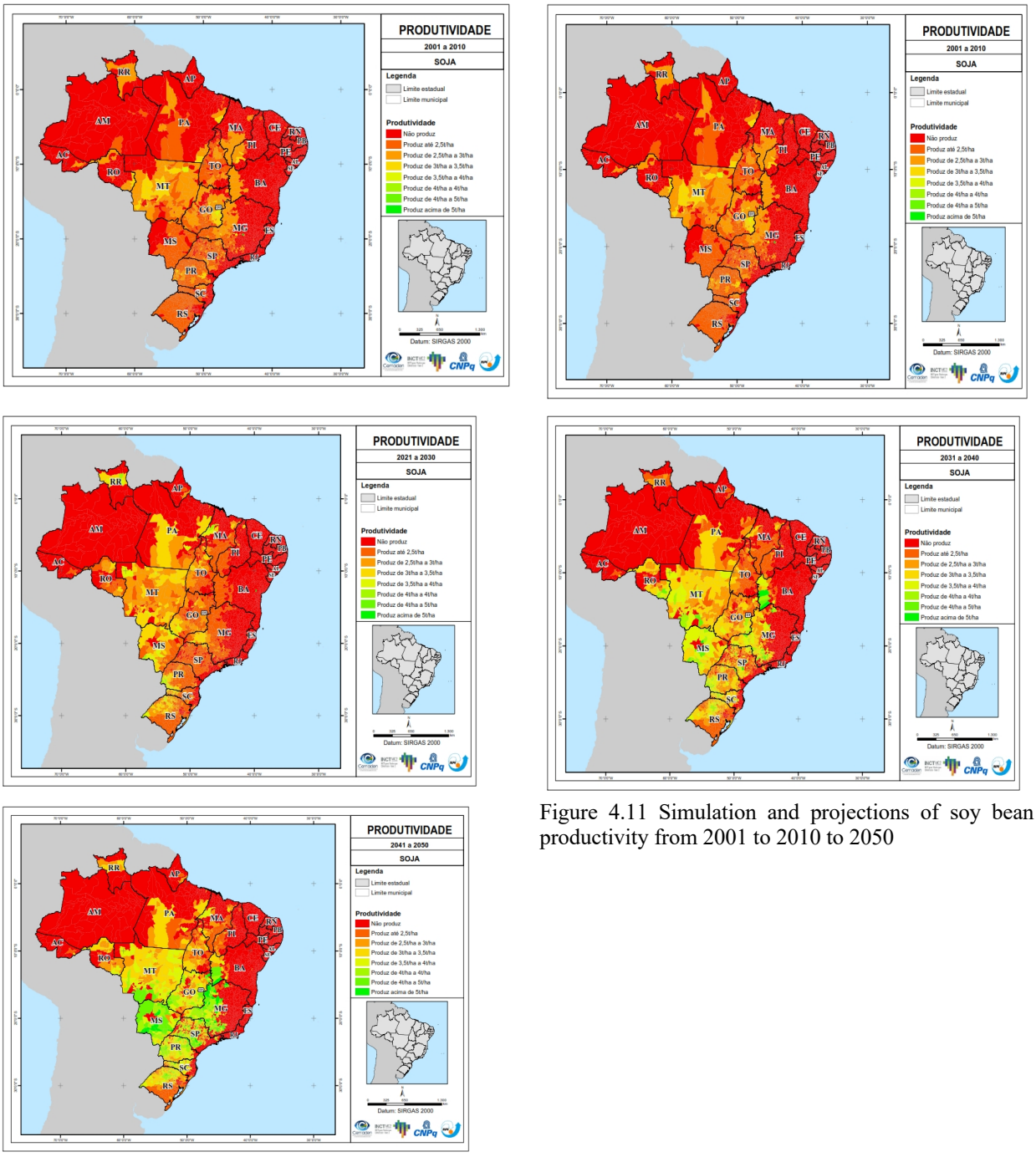


Figure 4.11 Simulation and projections of soy bean productivity from 2001 to 2010 to 2050

Table 4.1 shows the average values of impacts on productivity, extracted from the maps presented. It identify for all biomes there will be a reduction in productivity for all crops. The productivity of corn, which shows a reduction of more than 30% in the next decade . According to the simulated results, there will be a strong reduction in productivity in the next ten years, which may be eased in the period 2031-2040. In this specific stage of this research, we do not present the tabulated data for the period 2041-2050, as some inconsistencies were detected in the results obtained by the ETA-HADGEM 2 ES model. For the purposes of methodology, in the next steps, the results of the CIMP5 models will be compared with the Cmip6 models. In all cases, the scenario chosen was RCP 8.5. In terms of food supply, if the production systems are not changed, to sustainable agricultural production systems, the food supply may have a significant reduction with respect to maize (39% reduction), rice (28% in the cerrado and 17% in the Atlantic Forest - in the area of greatest production, the southern region will not change, as rice is irrigated) and beans (38% in the cerrado and 17% in the Atlantic forest). In the specific case of the caatinga,

projections for soy were not considered, as the municipalities that produce soy in that biome (14), represent 1.2% of the total, which is not significant. The approach taken so far is to offer food. It is about presenting possible risks, as has been done in the past. In 2007 , after analyse the climate change scenarios for 2020, losses of more than 5 billion reais were expected due to extreme events. In the 2019/2020 harvest the amount lost was R$ 15 billion. All losses can be reduced or minimized with the adoption of more balanced systems of agricultural production.

Table 4.1. Average values of impacts on productivity, extracted from the maps presented.

		Productivity kg/ha				
Biome		2011/2020	2021/2030	DIFFERENCE	(%)	2031/2040
Amazon	Soy	3.078	2.815	264	9	2.968
	Maize	2.543	2.465	78	3	2.495
	Rice	1.917	1.849	68	4	1.893
	Bean	678	671	7	1	674
Savanna	Soy	3.244	2.202	1.043	32	2.923
	Maize	4.331	2.630	1.701	39	4.152
	Rice	2.105	1.525	580	28	1.748
	Bean	1.179	733	446	38	942
Atlantic Forest	Soy	3.349	2.377	972	29	3.066
	Maize	4.818	3.051	1.768	37	4.597
	Rice	3.542	2.926	617	17	3.169
	Bean	1.171	972	199	17	1.051
Pampa	Soy	2.458	2.122	336	14	2.397
	Maize	3.812	2.538	1.274	33	3.670
	Rice	7.337	7.331	6	0	7.337
	Bean	1.030	1.030	-	-	1.030
Caatinga	Soy	-	-	-	-	-
	Maize	660	699	- 39	- 6	686
	Rice	1.604	1.648	- 43	- 3	1.265
	Bean	321	338	- 17	- 5	272

4.3 Water security

4.3.1 Highlights

The noteworthy results achieved by the group during the third year of the project were the continuous promotion of INCT MC Phase 2 water security goals on (see Figure 4.12 and Table 4.2, with a Summary and Appendix enclosed):

- methods of communication among scientists, policy makers and society,
- new scientific tests on water security at several spatiotemporal scales, and
- novel alliances for co-financing research with policy impacts.

These achievements were developed through strategies of:
(1) organization of international courses, workshops and seminars,
(2) new funding of grant projects for interdisciplinary, intersectorial and interinstitutional dialogue for sharing knowledge around INCT MC PHASE 2's goals,
(3)optimization of capacity building inside and outside the INCT MC PHASE 2 subcomponents with other INCT MC PHASE 2's groups, FAPs and CEPIDs,

(4)submission of new grant proposals and publication of co-authoring manuscripts in peer-review, high-impact journals with editorial boards,
(5)identification, selection and retention of early-career scientists promoting INCT MC Phase 2' s objectives and action plan,
(6) following and updating the INCT MC Phase 2 water security timeplan (see Table 1).

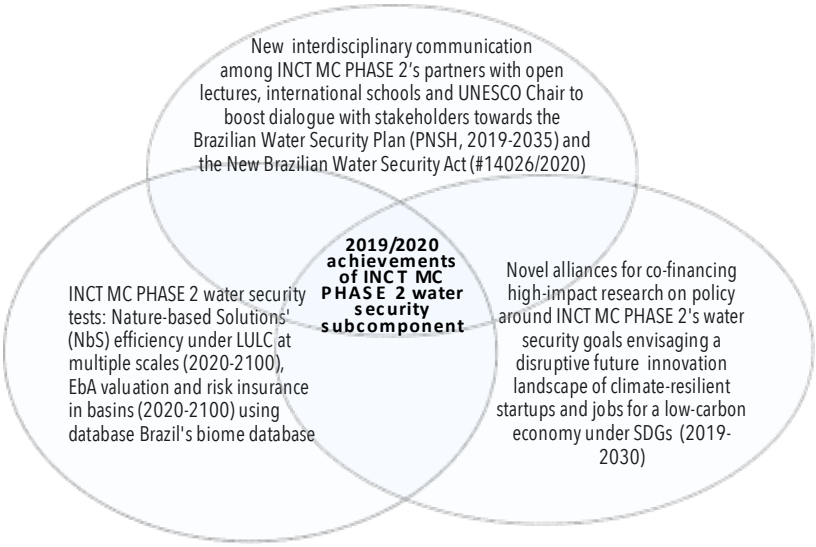


Figure 4.2. Summary of achievements of the INCT MC Phase 2 water security in the period 2019/2020.

Table 4.2. Objectives and goals of INCT MC Phase 2-Water Security (adapted from Marengo, 2014)

	executed activities			planned activities		
10.2.3 Main objectives (page 34)	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
1. Identification of strategic river basins, to systematize data collection of water supply and demand with hydro-climate models to evaluate indicators of water security for users.	👍	👍	👍	✓		
2. Calibration and validation, spatially-distributed, of hydrological processes, i.e. rainfall- evapotranspiration, and runoff, under conditions of quasi-stationarity for several spatial scales, land uses, demands and biomes.	👍	👍	👍	✓		
3. Simulation of calibrated models, coupling with climate models of medium-and long-term, for prospecting indicators of vulnerability and risk of hydrological extremes under future scenarios and non-stationary conditions	👍	👍	👍	✓	✓	
4. Evaluation of new adaptation strategies for water security for multiple uses under nonstationary conditions using classical and new tools for risk transfer of water extremes.	👍	👍	👍	✓	✓	✓
5. Proposition of strategies for improving water security communication among stakeholders, scientific community, policy makers and vulnerable population to hydrological extremes		👍	👍	✓	✓	✓
10.2.5 Expected Goals (page 36)						
[1.] Strengthening information and databases for present and future climate-hydrology information in strategic basins under growing risks of hydrological extremes.	👍	👍	👍	✓	✓	✓
[2.] Consolidation of a cooperative research network from institutions of excellence in Brazil to evaluate the water security to the extremes of floods and droughts.	👍	👍	👍	✓	✓	
[3.] Promotion of adaptation strategy of climate-water-resilience for sustainable development in Brazilian watersheds.		👍	👍	✓	✓	✓
[4.] Providing technical tools for policies with strategies of adaptation to future changes aimed at mitigating hydrological vulnerability.		👍	👍	✓	✓	✓

[5.] New courses of water security in graduate programs, including interdisciplinary seminars and crosscutting training courses for public-and-private sectors.	👍	👍	👍	✓	✓	✓
[6.]Postgraduate Award of Brazilian researchers on the subject of water security with increased participation in national and international projects, and with public-private partnerships (PPPs).	👍	👍	👍	✓	✓	
[7.] Publication of research results in media accessible to interested parties, as well as in international journals of high impact and across disciplines.	👍	👍	👍	✓	✓	✓
[8.] Expansion of participation of Brazilian researchers in international forums for innovation and solutions on water security.	👍	👍		✓	✓	✓
[9.] Promotion of a network of experts to collaborate with the Brazilian Water Resources Plan (ANA), under the legal framework (i.e.. Law. 9.433/97, the Braz. Water Resources Act; Law 11.445/07, the Braz. Act on Sanitation, law 12.187/09: the Braz. Climate Change Act, and law 12.608/12, the Braz. Civil Defense Act).	👍	👍	👍	✓	✓	✓

4.3.2 Scientific and Management Activities.

This part outlines a summary of activities developed by INCT MC Phase 2's water security affiliated institutions, i.e. UFPE, UFCG, USP, UFCG, UFRGS, CEMADEN, INPE, FUNCEME and EMBRAPA. Scientific and management activities are subdivided into sections of advances in water security at local scales, climate change and trends in selected urban scales, temporal stability of soil moisture in agricultural lands and other strategies at local scales of selected basins.

-Advances in Water Security at Multiple Scales

In this 2019/2020 period, research groups of INCT Phase 2-Water Security for local scales provide advances. They are based on the use of geotechnologies and hydrological models to represent the hydrological cycle and to estimate the flow in river basins, as well as on the identification and projection of anomalies in the hydrological variables under different climatic and land use scenarios, to subsidize actions in water management that provide better quality of life for the local and regional population. These surveys associated with the analysis of extreme drought and flood events in local watersheds, specifically at Brazilian Northeast and Southeast regions. Also the occurrence of floodings in urbanized areas has represented new insights for understanding the climatic factors acting on local and regional hydrology. The results generated by the research included in the project and in the water security axis allow us to establish a picture of the possible impacts caused by climate change on local and regional water resources, and, consequently, on the population's quality of life. In this context, the concept of water security is followed to guide future research actions and projects. According to the United Nations, water security is "the ability of a population to guarantee sustainable access to adequate quantity and acceptable quality for their livelihood, human well-being and socioeconomic development, to ensure protection against pollution and water-related disasters, and for preservation of ecosystems in a condition of peace and political stability" (UN-Water, 2013).

-Adaptation Measures of Water Security in Northeast Brazil

Under the supervision of Prof Suzana G Montenegro and Prof A Ribeiro, a new study analysed adapting measures, both structural and non-structural, in the Rio Capibaribe and Rio Ipojuca basinsto coping with climate change (*PhD student: Luiz Gustavo Costa Ferreira Nunes)* The objective of the research aims to propose an adaptation plan to face climate change, listing mitigating measures to the different uses of water, considering the non-stationarity of hydrological and meteorological variables. Analyzing, through modeling, the vulnerability of the existing water infrastructure to future scenarios, in addition to simulating various mitigating measures, both structural and non-structural. Briefly, the methodology is divided into: (a) analysis and considerations about current flow and precipitation trends (diagnosis) and future scenarios

(prognosis); (b) applying a rain-flow model (MODHAC) and then (c) allocating water; where, the vulnerability of the existing water infrastructure and the implementation of various adaptive measures in an isolated and combined manner will be considered; finally, based on these results, (d) an adaptation plan will be proposed listing the priority and most effective measures for tackling climate change.The data used were extracted from CMIP5, model HadGEM2-ES. This data set of climatic variables comprises the period from 1850-2100. However, this study must evaluate two distinct periods of 30 years: a base period (1981-2010) and a medium-long term future period (2051-2080), for the RCP8.5 scenario. The calibration and validation of MODHAC for the Capibaribe River and Ipojuca River Basin is described in Ribeiro Neto et al. (2014). The allocation model that will be used will be AcquaNET. The initial results showed that the best performance of the RCP8.5 model for the study basins was r1, with NSE = 0.22, NMRSE = 9.98% and PB = -13.31%; considered excellent by NMRSE (less than 10%) and satisfactory by BP (between –25 and + 25%). Figure 4.13a illustrates the observed precipitation and the historical base period of RCP8.5 in the contribution basin of the Poço Fundo reservoir. The trend analysis was performed using the Mann-Kendall test and found changes in the trend for the future period in the sub-basins: Goitá (Capibaribe), Tapacurá (Capibaribe), Várzea do Una (Capibaribe) and Foz (Ipojuca). In all cases, the change occurred between the years 2055 and 2056. No trend changes were found in the observed period. Figure 4.13b illustrates the intersection of the two statistical curves, U (tn) and U * (tn), corresponding to the location of the approximate point of trend change for the Tapacurá sub-basin.

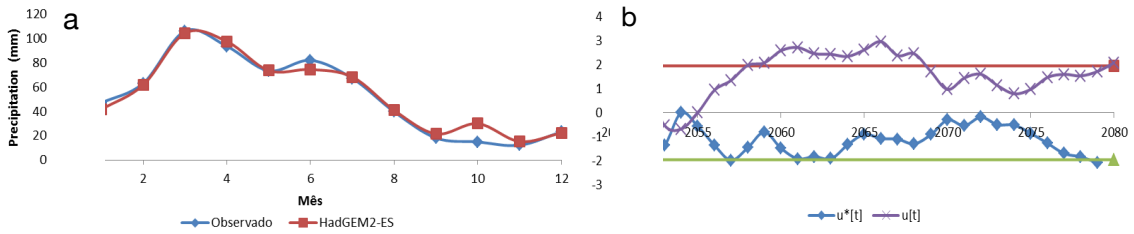


Figure 4.13. (a) Precipitation in the Poço Fundo sub-basin; (b)Trend Change in the Tapacurá sub-basin (Capibaribe)

4.3.3 Climate change and trends of the rainfall of the city of Recife-PE

Subject of major discussions, recent climate changes show the impact and magnitude of anthropic actions in the natural environment. The magnitude of the impacts caused by the changes reflects not only the major disasters caused by extreme events, but also the economic and social spheres, as these changes trigger an imbalance in ecosystems, as well as in climate configuration and hydrological regimes. Therefore, this study aims to analyze the transformations of rainfall over time by detecting trends in time series of hydrological data. The trends and fluctuations of the climatological variables, referring to the precipitation series obtained from 4 rainfall seasons located in Recife-PE, were analyzed by the Mann-Kendall test. According to the Mann-Kendall sequential test, there was a period of significant increase in rainfall that may have its occurrence related to extreme events in the region. Thus the results express a non-significant reduction in rainfall patterns in Recife (Figure 4.14).

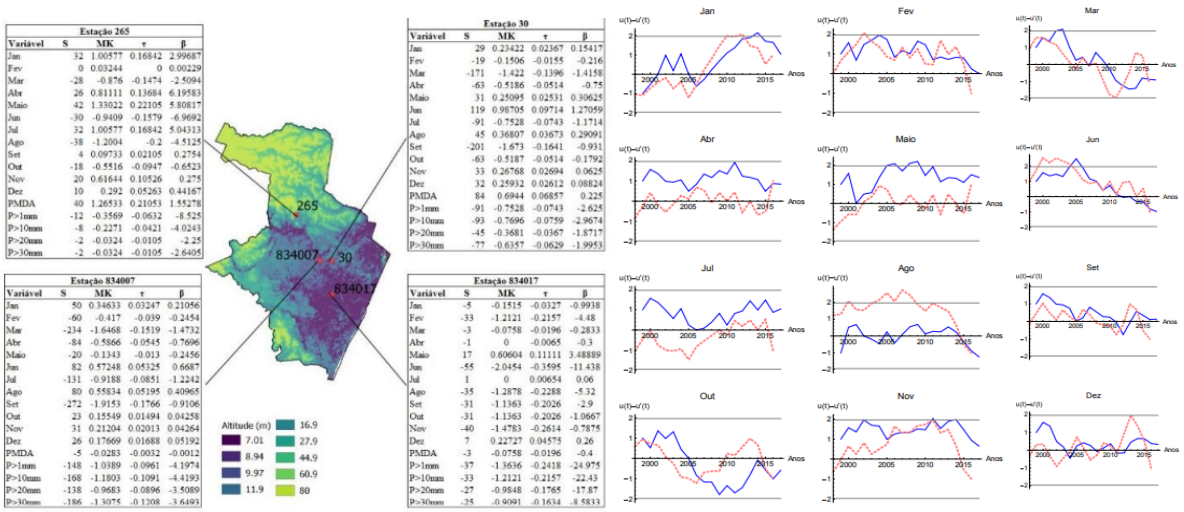


Figure 4.14. Details of the Mann-Kendall statistical analysis; The SQ-MK test for the Brazilian high station (265). The gray horizontal straight lines indicate the lower limit and the upper limit of the 95% confidence interval.

4.3.4 Soil Moisture Dynamics in Cropping Area in the Brazilian Semiarid

Soil moisture is essential for agricultural production. Knowledge on its spatial-temporal variability is indispensable to support agriculture, and it is strongly influenced by cultural practices, soil cover conditions and irrigation methods. Thus, this study aimed to evaluate the temporal stability and spatial distribution of soil moisture as a function of the use of banana leaves as soil cover in a plot under conventional sprinkler irrigation and cultivated with banana in the Brazilian semiarid region. The study area was divided in two sectors, with and without covering using banana leaves. Soil moisture was monitored before and after irrigation, at 16 times, using FALKER HidroFarm sensors installed on a transect with 11 units spaced by 8 m, in each sector. The data were analyzed using descriptive statistics, temporal stability and Spearman correlation test. The morphology of the banana leaves and the irrigation system used contributed to lower soil moisture in the covered sector at all monitoring times. Variations in the physical-hydraulic properties of the soil promoted variations in soil moisture with the position of the sensors in the ground. The temporal stability technique allowed the identification of points that represent the mean behavior of soil moisture throughout the area. The use of banana leaf residues caused less soil wetting using sprinkler irrigation, indicating the need to pregrind the material or use localized irrigation systems, practices that are not very accessible to small farmers (Figure 4.15).

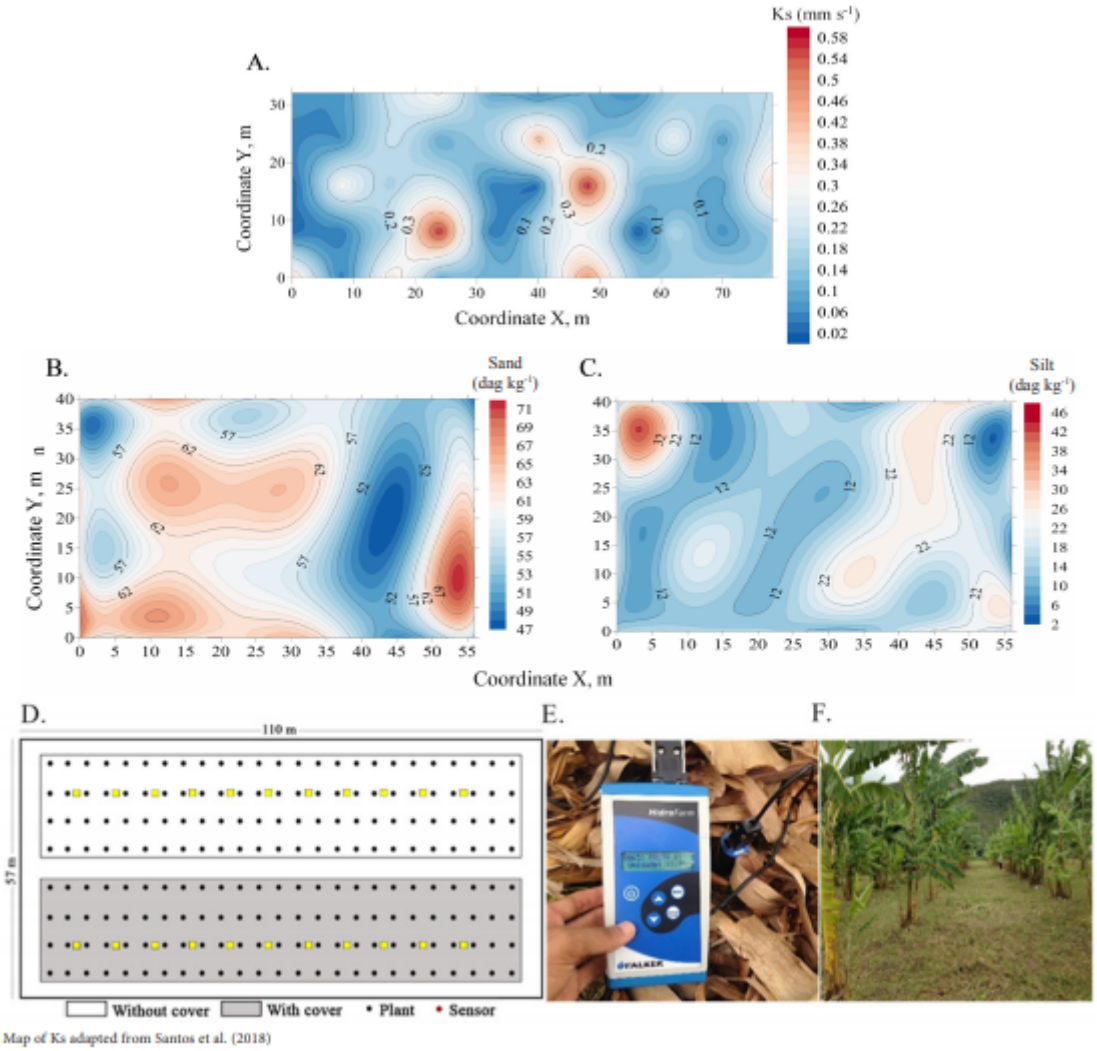


Figure 4.15. Kriging maps of the variables hydraulic conductivity (A), sand (B) and silt (C), as well as experimental area (D), highlighting the sensor model used (E) and view of the banana plantation (F)

4.3.5 Alternative Water Security Strategies at Mid-size Municipalities

Water security metrics are scale-dependent, highly non-stationary and policy-correlated with the Brazilian changing legal framework, progressively redefined by enactments # 9433 (year 1997), # 11445 (year 2007) and #14026 (year 2020). Hence, INCT MCPhase 2 has explored how water security metrics rely on water quality standards, citizen engagement, social awareness and economic private-public partnerships (PPPs) tradeoffs, especially in Brazilian mid-scales (ca. 1,300 to 2,800 km^2) where most changes are expected (ANA, 2019). At these medium scales, future LULC scenarios project: grey water footprint (*WFGrey*) for 2020-2100, i.e. from waste solids' pollutants (Fig 4.16), stormwater efficiency of Nature-based Solutions (*NbS*) (Fig. 4.17), social memory for climate-driven floods (Fig 4.18) and increasing long-term climate insurance premiums for water supply utilities from mid-size catchments to metropolitan areas (Fig. 4.19).

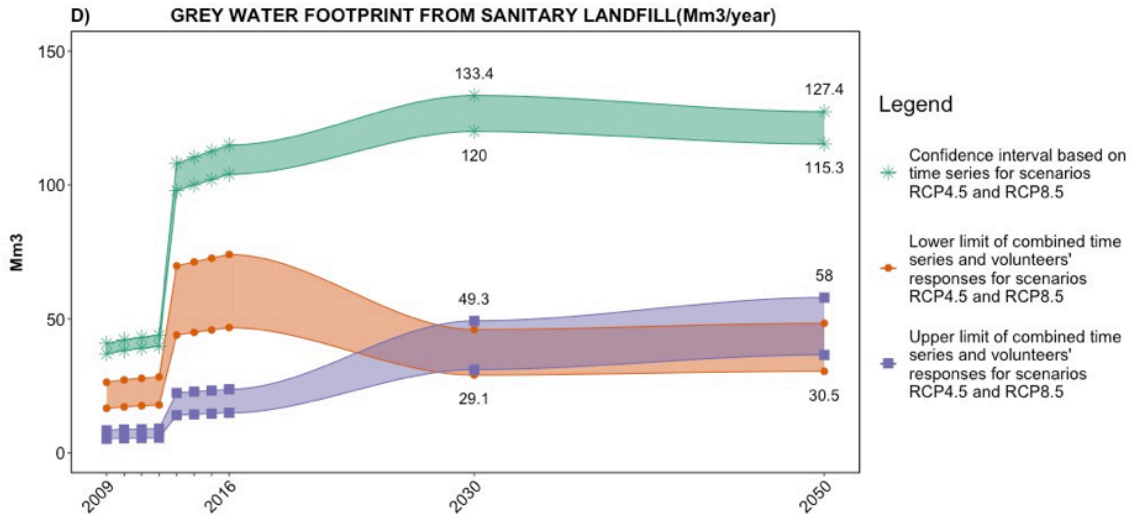


Figure 4.16. Citizen-science awareness discrepancy about of landfill solid waste *WFGrey* accounting in a Brazilian mid-size municipality throughout the aggregated 2009-2050 period. The 2009-2016 $WFGrey_{SolidWaste}$ time series is aggregated with the 2020-2050 RCP 4.5 & RCP 8.5 climate change scenarios and volunteer participatory perceptions. Source: Souza et al (2020).

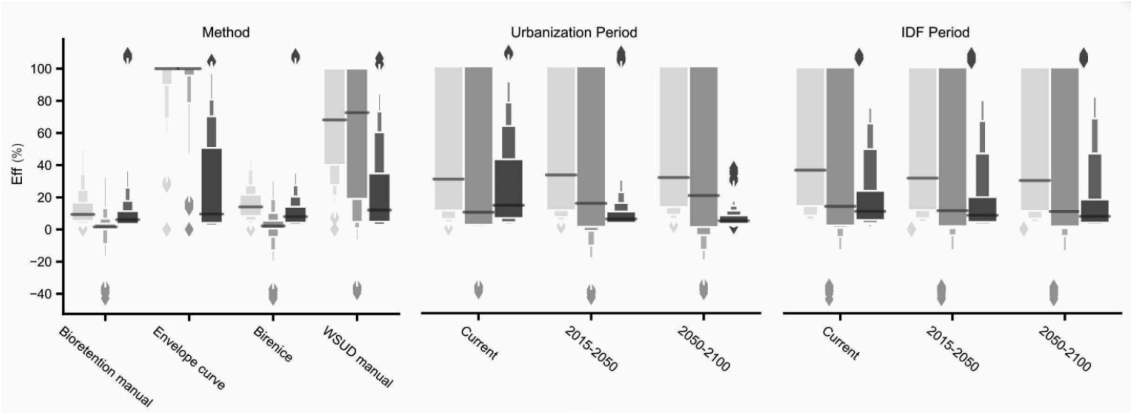


Figure 4.17: Climate change-driven sensitivity analysis of NbS efficiency in a Brazilian mid-size municipality for the period 2000-2100. Diamond plots and color tones are related different variables of runoff volume retention (light grey), maximum runoff peak mitigation (mild grey) and water reuse potential (dark grey). Left side: models of NbS sizing and operation ("Method"); Central side: land use and land cover change scenarios (LULC, "Urbanization Period"); Right side: non-stationarity impacts due to changing precipitation intensity, duration and frequency curve ("IDF period), under RCP 4.5 & RCP 8.5. Source: de Macedo et al (2020).

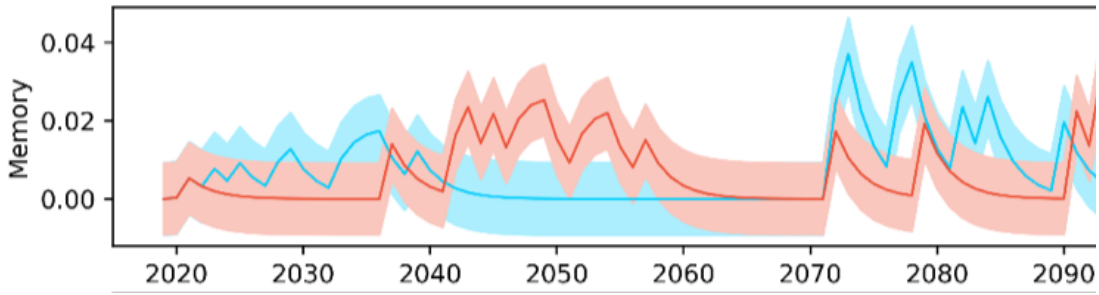


Figure 4.18: Continuous modeling of nondimensional weighting factors of social memory to flood impacts for 2020-2100 climate change scenarios under RCP 4.5 and 8.5 runs in a Brazilian mid-size municipality (230,000 inhab., 1,300 km^2 area). Source: Sarmento-Buarque et al (2020).

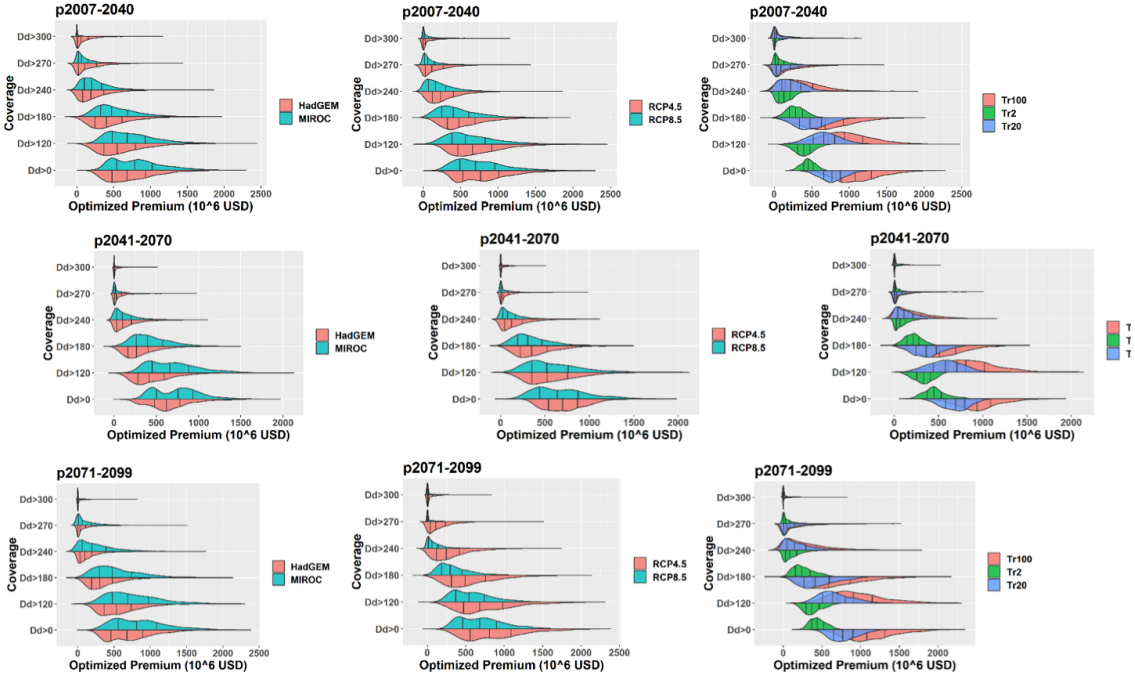


Figure 4.19. Risk-averse sensitivity analysis through probability violin plots (vertical axis) of long-term climate insurance premiums (horizontal axis) of water supply utilities with surface withdrawals from donor mid-size catchments (2,800 km2) to a Brazilian metropolitan area (ca. 9 million inhabitants). Adaptation strategies are accounted for changing drought periods of 2007-2100, using RCP 4.5 and RCP 8.5, from HadGEM and MIROC outputs, under different return period of droughts and variable risk insurance coverage of unattended water demand duration. Source: Guzmán et al (2020).

4.3.6 Partnership Projects and Cofunding Activities on Water Security

PEGASUS/CNPq - Integrated Research to Guarantee Water, Food and Energy Sustainability in the Caatinga Biome. Period of validity: 2017 to 2020. *Integrated research for long-term monitoring, field experimentation and climate, hydrological, agricultural and biogeochemical modeling to develop sustainable technologies for increasing water, food and energy security and adaptation to climate changes in the Caatinga Biome. The proposal brings together several research groups dedicated to topics related to sustainability in the Caatinga Biome of the main research institutions in the Northeast of Brazil. The proposal also includes the main group of researchers from the National Observatory of Water and Carbon Dynamics in the Caatinga Biome (ONDACBC).*

Universal Call - MCTI/CNPq Nº 28/2018 - Study of hydrological attributes to support the management of water resources in the state of Pernambuco, Brazil. Period of validity: Feb. 2019 to Feb. 2022. *Scientific and technological advances regarding distributed hydrological processes, with the improvement of remote sensing techniques, which favors the provision of subsidies for management strategies, decision making and the establishment of public policies related to the conservation of water resources. In addition, the project innovates by providing farmers, through an application, the maps resulting from the studies, such as maps of precipitation, evapotranspiration and soil moisture in the evaluated basins. It will also contribute to the dissemination of knowledge and training of human resources.*

CNPq/BRICS-STI-2 Call - Integrated water management model for BIS countries under climate change scenarios. Period of validity: Aug. 2018 to Aug. 2021. Q*ualitative and quantitative impacts on water resources under different climate change scenarios for selected basins in BIS countries (Brazil, India and South Africa) and to develop an Integrated Water Resource Management (IWRM) model as a political tool for decision-making. The project is developed in collaboration with two foreign institutions: the National Institute of Technology Warangal - NITW, India, and the Durban University of Technology - DUT, South Africa, as well as two national co-executing institutions: the Federal Rural University of Pernambuco - UFRPE and the Brazilian Agricultural Research Corporation - EMBRAPA.*

SMART Control (FACEPE) - SMART Framework for Real-Time Monitoring and Control of Subsurface Process in Managed Aquifer Recharge Applications. Period of validity: 2019 to 2021. *Reduce risks in the application of sustainable groundwater management techniques by developing an innovative real-time monitoring and control system, in combination with risk assessment and management tools. The improvement of groundwater recharge, storing excess water underground in times of high availability, followed by recovery in times of high demand, represents a low-cost technology that increases the resilience of the water supply infrastructure for extreme hydroclimatic events. This technique, known as Managed Aquifer Recharge (MAR), represents a viable adaptation solution for the sustainable management of water resources, while reducing the impact of water scarcity.*

DIGIRES (CNPq) - Digital-enabled green infrastructure for sustainable water resources management. Period of validity: 2019 to 2021.*The main objective of the project is the development and use of ICT-based tools, together with citizen observations of science for the design and implementation of Managed Aquifer Recharge (MAR) as a nature-inspired component for sustainable management of water resources in the LAC region (Latin America and the Caribbean). The efficiency of the proposed solutions will be demonstrated through success stories, by demonstrating MAR's efficiency through ICT-based tools and implementing small-scale MAR schemes with active stakeholder participation and capacity building for sustainable urban development. In this project, the Managed Aquifer Recharge (MAR) is proposed to replace the traditional water infrastructure with greener and nature-inspired solutions, which allow a more equitable water supply.*

Climate change impacts in hydrological extremes: droughts and floods (2016-2021). Funding by CAPES and ANA. Partner institutions: UFC (Coordinator), UFCG, UnB.

Water, food and energy security in the extended São Francisco river basin (2018-2021). Funding by CNPq. Partner institutions: UFC (Coordinator), UFCG, UnB, EMBRAPA.

Metropolis and the right to the city: INCT Metropolis Observatory (2016-2022). Funding by CNPq and FAPERJ. Partner institutions: UFRJ (Coordinator) and a wide institutional network under INCT Program.

Water governance: analysis and assessment in multiple scales and domains (2018-2021). Funding by CNPq. Partner institutions: UFCG (Coordinator), UFPB, IFPB, UPE.

New Generation of Nature-based Solutions for Water-Energy-Food Nexus Under Climate Change, FAPESP, 2018/04527-2, 2019-2020. Partner Institution: USP.

Social Memory for Water Security and Socio-Hydrology, FAPESP, 2018/03473-0, 2019-2020. INstitutions: USP and Univ of Chester (UK)

Center for Artificial Intelligence/Agriculture and Environmental Systems, Funding: FAPESP (2019-2029). Partner Institutions: USP (coordinator), IBM, Unicamp, Embrapa

Center of Applied Maths for Industry, Funding: FAPESP (2019-2023). Coordinator: ICMC/USP

Water-Health-Data Resilience Nexus, Funding: SPRINT UK/BR, Partners: USP and Univ of Warwick (UK) (2018-2020),

School of Adv Stud. Water & Society Change, Funding: CAPES, 2019-2020, Partner Institutions: USP, UFPE, UFCG, ANA

Observatório Sócio Hidrológico de Segurança Hídrica (SHOWS) para Redução de Riscos de Enchentes e Aumento da Resiliência Comunitária sob Cenários de Mudanças e de COVID-19, Funding: Pró-Reitoria de Pesquisa, USP, 2020-2022.

4.4 Energy security

4.4.1 Impacts of climate change on wind and solar potential

The analysis of the effects of climate change on solar and wind energy resources requires an assessment of the uncertainties of the numerical models used by the research teams LABREN/INPE and IM/UNIFESP. This required extensive work of validation and quality control of wind and solar radiation data from different bases, such as the SONDA, EPE Network, airport data (METAR) and public databases such as INMET and INPE.

These data were used to correct the bias of a climatological database, which in turn served as a basis for correcting the simulations of the historical period of two climate models nested in the regional ETA model (HadGEM2-ES and MIROC5) - considering different emission scenarios associated with Climate Change. From this point on, a bias correction of the results of future climate simulations was carried out using a robust methodology, which involved statistical refinement to eliminate systematic errors.

The results of the analysis of the solar resource identified three main spatial patterns, which are repeated in the climate projections of the models and scenarios. The first of them is a reduction of 5% to 10% of the solar resource in the north and northeast coast (with peaks of up to 20% in isolated points) that were presented in the projections for DJF and SON for almost all periods for the HadGEM2-ES and MIROC5 models in RCP4.5 and almost all periods of MIROC5 in RCP8.5. The second pattern is a reduction of 5% to 10% in RS (and in points in the South region) for JJA and SON for all future periods projected by HadGEM2-ES in RCP4.5 and for SON in RCP 8.5 for the middle and century by both models. The last general pattern observed is

for a transversal band from the Amazon to the Southeast region, projecting an increase of 5% to 10% in the solar resource for DJF in all future periods in RCP4.5 and RCP8.5. The global irradiation difference maps between historical periods and the model projections in RCP8.5 are shown in Figure 4.20.

The analysis of the wind resource indicated changes not only in the spatial pattern, but in the seasonality of the resource itself. Relevant changes were observed in seasonal wind patterns, such as an anticipation of maximum annual values of wind intensity from 30 to 60 days before the month of occurrence in the historical period.

Both agree with a reduction in the scale parameter cover NEB in January, with a progressive increase in future periods. MIROC5 projects a much larger area for the reduction of the parameter, reaching the -20% mark across the NEB, with regions more located on the interior and its north coast showing a reduction of 30 to 40% in parameter *C* maps (scale factor). The HadGEM2ES projects a 20% increase in parameter *C* between the state of São Paulo (SP) and Paraná (PR), even at the beginning of the century.

The models project a 20% increase in wind intensity over the northern portion of the Amazon, and the HadGEM2ES model indicates this increase from the Midwest to the Western Amazon. For April, HadGEM2ES projects an increase of 20% over some locations in the north of the country and MIROC5 projects an increase of 20% over NEB, from the middle to the end of the century. The months of July and October are similar to the month of April considering the changes presented by the HadGEM2ES model, while there are no relevant changes for the period in the MIROC5 model simulations. Figure 4.21 shows the intensity difference maps (*C*) between historical periods and the projections of the models in RCP8.5.

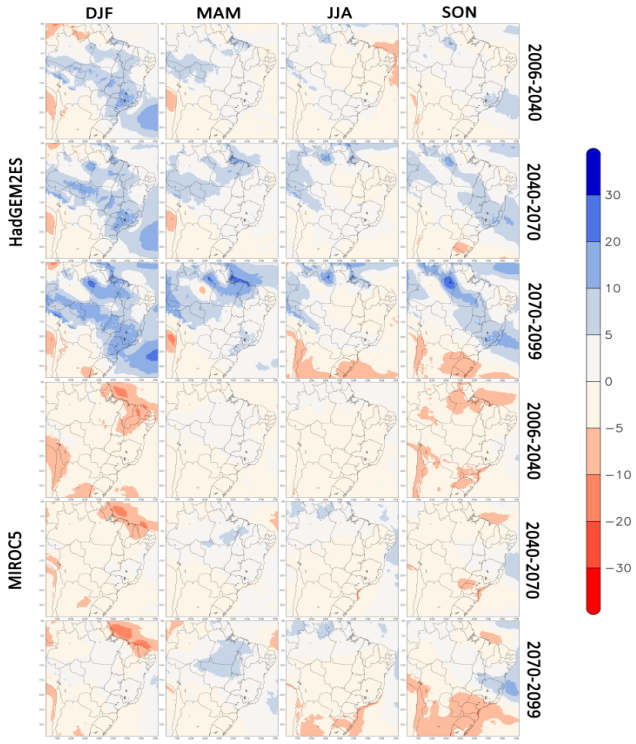


Figure 4.20 - Maps of percentage difference between the historical period and the projections of the seasonal average of the Daily Total of the Global Horizontal Irradiation, simulated by the Eta-HadGEM2-ES and Eta-MIROC5 models, in the scenario RCP8.5.

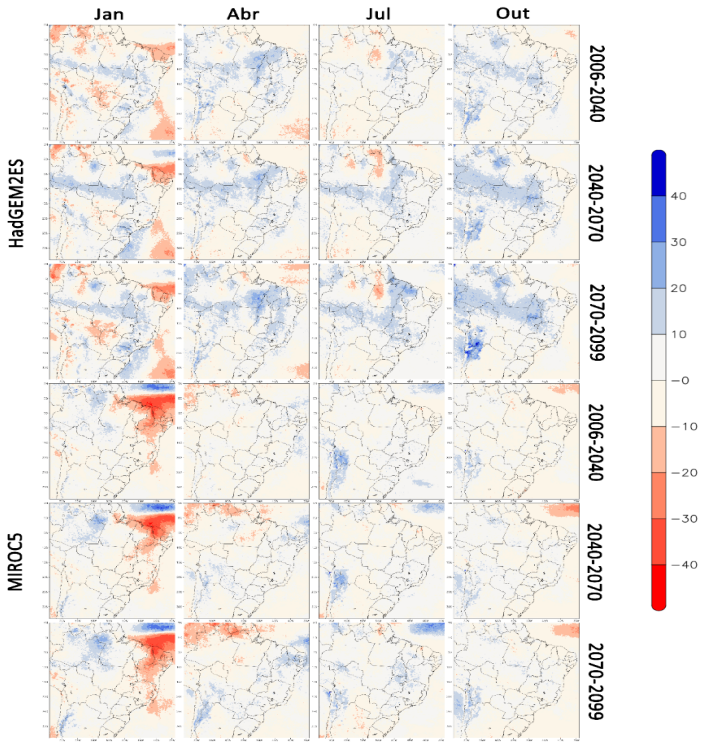


Figure 4.21 - Percentage difference maps between the historical period and the scale factor c projections, simulated by the Eta-HadGEM2-ES and Eta-MIROC5 models, in the RCP8.5 scenario.

4.4.2 Climate Services and risk analysis in transmission line infrastructures

Extreme wind events cause various damage to society and, among many, damage to power transmission towers. Quantifying the future risk that extreme winds may cause to the energy sector, specifically over transmission lines, involves better understanding the relationships between climate projections and the behavior of the wind over our territory. This study aimed to carry out a mapping of extreme winds and the implications for climate change scenarios, which would contribute to the planning of current and future investments in Transmission Lines, especially in the state of Santa Catarina. Simulations of the historical period and projections of the Eta-HADGEM2-ES and Eta-MIROC5 climate models were used.

This study included the validation of historical rounds, correction of the model bias, adjustment of a relationship between the average wind and the gust of wind, distribution of extreme events and statistical adjustment method. A preliminary statistical relationship was verified between the average wind and the gust, which made it possible to estimate more intense values and consequently allowing a more realistic calculation of the simulated return period by the model. The projections showed an increase in the maximum burst in the west of the state, where the Ita Salto Santiago line is located, and a decrease in the east, where the Biguaçu Blumenau line is located. The increase was confirmed by the FAR, P99 indices and the frequency of the gust of the wind. Maps of the probability classification that represent the probability of occurrence of a climatic event above a limit, 20 m/s, were generated to assess the risks to climatic conditions.

4.4.3 Thermal comfort and energy efficiency in urban areas

Global warming can increase people's vulnerability to heat and change the pattern of energy consumption in cities. In this sense, it is necessary to develop urban policies that focus on the use of green, blue and gray infrastructure to promote the negative feedback of the urban climate system naturally. The objective of this research is to develop a methodology to produce diagnostics at different urban scales, considering the distribution of surface temperature and

landscape patterns; and providing information for the development of urban policies for adaptation and heat resilience. The method contemplates the use of Landsat-8 images, to estimate and map the surface temperature and its spectral characteristics (albedo, emissivity, vegetation cover fraction and humidity index by normalized difference), the integration of data in a georeferenced cell space , exploratory analyzes, clustering of surface temperature clusters and identification of local climatic zones. The study area is São José dos Campos, SP, Brazil, where the local climate zone 3, with small compact constructions is predominant. In the study area, the difference in surface temperature reached 12 °C and occurred between areas where permeable and shaded surfaces are observed, associated with the presence of trees and vertical buildings, called “heat sinks”, and areas composed of extensive constructions on fully waterproofed surfaces with intense production of anthropogenic heat, called “hot spots”.

The analyzes allowed to infer the spatial dependence of the surface temperature, despite the seasonal variability and can be used as an indicator of the thermal and energy performance of urban areas. The mapping of the surface temperature and the unit index by normalized difference allowed to identify the factors that influence the negative and positive feedback processes of the urban climate system, associated local climatic zones, and to assess the impact of policies aimed at promoting adaptation and urban resilience to heat. At UNIFEI, this component is in progress in the form of an academic master's degree that should be completed by the end of August 2020, with the title "Contribution of green roof coverage in the municipality of São Paulo to regularize the level of the Itumbiara reservoir" conducted by student Grazielle Gonçalves Inocêncio, in the graduate program in Environment and Water Resources at UNIFEI. The work evaluates the energy savings that could be achieved considering the scenario of installing a green roof in every available roof area in the city of São Paulo. The savings resulting from the thermal comfort generated by such vegetated cover and the consequent non-use of equipment to cool the internal environment were measured. It was possible to verify that with the studied technique it is possible to save with air conditioning values that reach dozens of TW.

The present study is based on the results of a dissertation defended at USP in 2012 that experimentally quantified the electric energy savings used for internal artificial conditioning from one type of coverage to another. For this, the calculation of the total thermal load was carried out, according to NBR 16401-1: 2008, taking into consideration in the research, the penetration of heat by conduction, convection and radiation, ignoring the contribution of heat from people and equipment . The calculation of the thermal load was performed for the representative summer and winter days of both prototypes, being performed for the internal temperature found and for a temperature of 24 °C, which is the comfort reference indicated by NBR 6401/08. After the calculations, graphs were generated where the difference between the thermal load curve required to maintain the building and the curve obtained with the collected temperature results in energy savings for heating or cooling.

In order to estimate the available roof area in the city of São Paulo, a methodology based on Geographic Information System was used. To quantify the energy saved in air conditioning due to the installation of the green roof, the thermal load saved by the construction of the green roof at work was analyzed. Climatology was based on 30 years (1989 to 2018) of dry bulb temperature data for the city of São Paulo, made available by the IAG. This information will feed a hybrid model in order to convert the energy saved by the lower use of air conditioning into a corresponding level of water saved in the pilot reservoir.

4.4.4 Modeling of solar irradiation applied to energy

The main focus of this work was to improve the modeling of radiative transfer processes in South America using the Brazil-SR model. Specifically, it was proposed to improve the estimate of the cloud cover coefficient, being validated from the proof of improved performance of the Brazil-SR model for the dry and wet seasons. In calculating the effective cloud cover of the model, the radiance associated with overcast conditions is often estimated as the maximum radiance at the

me for a given period - usually, in the Brazil-SR model, one month. However, this condition is problematic in two situations: a) clouds with intense vertical development and b) dry periods of the year. Bypassing the deficiencies of this estimate, an approach was sought that combines direct surface installation and satellite data to manage a contingency table to identify cases of overcast sky, identifying True Positive, False Positive, True Negative and False Negative.

The results obtained indicated that the introduction of an intermediate threshold for the parameterization of cloudiness obtained by the satellite improved the results for the dry and wet seasons in tropical regions such as Brazil.

4.4.5 Influence of spectral distribution on photovoltaic production

Photovoltaic modules are marketed under their efficiency measured under standard test conditions (Standard Test Conditions), considering a 1000 Wm2 irradiance, 25 °C and the spectrum AM 1.5G standard, described in ASTM G173 an d. IEC 60904-3. Despite standardizing the evaluation method and allowing the comparison between different technologies, the STC is not representative for the conditions that occur in the field, since the spectral distribution of solar radiation varies in me and space due to atmospheric parameters, which may affect the energy production of the modules.

In the last year, spectral measurements of solar radiation were obtained, with a temporal resolution of 1 min. These data have been used in the spectral characterization of a city in the state of São Paulo, comparing it with the solar spectrum measured in other regions of the planet, such as Spain, Italy, Japan and Germany. In addition to understanding the impacts caused on photovoltaic devices, the relevance of this work is in generating information for investors and engineers, evaluating the results in photovoltaic projects.

4.4.6 Solar energy and the Nexus water, energy and food: case studies

The systems dihydro-solar hybrid adopted in large scale tanks have the potential to alter the water-NEXUS-energy food. The availability of water in large-scale reservoirs provides control over electricity generation and represents an important water resource for consumption and public services, such as agriculture. However, multiple uses of water compete for access, especially during water scarcity events. In addition, evaporative losses deduct relevant volumes of water. In this study, we analyzed the benefits of introducing solar electricity generation at the Sobradinho hydroelectric plant, complementary to hydroelectricity , during the 2009-2016 dry period in the Brazilian semiarid region. The WEAP software (Water Evaluation and Planning System) was used to model the reference scenario and quantify the results in water, energy and food security.

The Sobradinho hydroelectric plant is an emblematic case. The 34 billion m³ reservoir is located near Petrolina-Juazeiro, in the Brazilian semiarid region, and is fed by the flow of the São Francisco River. In this semi-arid region, the water deficit is estimated at 1,000 mm and the dry periods last from 7 to 8 months. During the last severe drought (2010-2016), control of water for electricity generation in Sobradinho was no longer possible. The volume of water dropped to less than 2% of capacity in December 2015 and November 2017. As outlets were gradually reduced over the years, electricity generation dropped from 5,113 in 2007 to 1,162 GWh in 2017. In this context, combining hydroelectric and solar generation is an alternative to provide electricity and reduce water dependence on the energy sector in this region critical to water resources.

The adoption of solar photovoltaic systems has potential in several aspects. Evaporation showed lower results than years of complete reservoir, as it depends on the lake's flooded area, but a water loss of 4.4 billion m³ per year was estimated. This volume of water is equivalent to 9.5% of the electricity generated during the study period and compared to the water needed for fruit

production, it represents about 2 years of removing water from Sobradinho for use in irrigation, based on National Water Agency authorizations.

4.4.7 Lake breeze and hydro-solar complementarity

Brazil has dozens of hydroelectric reservoirs with vast extension capable of influencing the local climate through the lake breeze mechanism. The change in heat flows on the surface caused by the flooding of large areas triggers the circulation of the lake breeze and affects the hydrological cycle, the energy balance and the local cloudiness. In this way, the reservoirs can induce areas of less cloudiness over the lake, creating a spatial pattern of complementarity between solar and hydraulic generation.

In this research we describe the predominant breeze mechanism in the Serra da Mesa hydroelectric reservoir, located in central Brazil, and evaluate its impact on the local cloudiness and on the surface solar radiation using GOES-16 satellite images and surface measurements. We evaluated the frequency of cloud cover assuming two different perspectives: i) spatial, comparing cloud cover over the water surface and areas close to its margins; ii) temporal, comparing cloudiness before and a after the construction of the reservoir.

The results indicated that the average daily cloudiness increases as we move away from the reservoir in any of the four main directions. The same pattern can be observed when observing the cloudiness in the afternoon (14h to 16h BRT). This reduction in cloudiness starts at 4% in summer (DJF) and can reach values of up to 8% during autumn (MAM) and spring (SON). It has been proven that local cloudiness can cause a systematic increase in solar irradiance over the flooded area compared to the external areas of the reservoir. Comparing the external areas, the average increase in irradiance on the water surface was about 1.75% for the daily average (from 7 am to 5 pm BRT) and 4.59% for the interval of 2 pm to 4 pm BRT.

These studies indicate that floating photovoltaic plants (FPV) in hydroelectric dams can be an excellent alternative to integrate renewable energy resources in a hybrid energy generation due to the high solar irradiance in the Brazilian territory combined with the prevailing breeze mechanism in large water reservoirs tropical.

4.4.8 Integrated Assessment Modelling tools improvements and advances

The Integrated Assessment Models (IAMs) developed and used by the team at COPPE are continuously being improved, opening new possibilities of analyses and scenarios. The Brazil Land-Use and Energy Systems (BLUES), the Total Economy Assessment (TEA) and the Computable Framework for Energy and the Environment (COFFEE) models are constantly being reviewed for the introduction of new features that allow a better representation of the sectors and, consequently, more detailed results. Currently, new modules are being introduced to better represent materials, industry and transport sectors, among others.

In that sense, sectoral-specific technical the analyses are being developed to feed IAMs with well-based information. In the last year, for instance, studies for a diverse range of sectors, such as households, biofuels and biorefining, oil refining and the electric system were performed, with the results not only being published in important scientific journals, but also being incorporated as parameters in the IAMs.

Moreover, new projects and partnerships in the IAM global community occurred in the last year. Three new projects for the development of IAMs took place: Next Generation of Advanced Integrated Assessment Modelling to Support Climate Policy Making (NAVIGATE) project, that aims to improve the technical capability of integrated assessment models by evaluating current model flaws and working on them, providing new insights to match long term climate goals with short term policy actions; the Exploring National and Global Actions to Reduce Greenhouse Gas

Emissions (ENGAGE) project, which intends to explore the feasibility of pathways that can meet the objectives of Paris Agreement; and the Climate pOlicy assessment and Mitigation Modeling to Integrate national and global Transition pathway (COMMIT) project, that aims to improve modeling of national low carbon emission pathways and analysis of country contributions to the global ambition of Paris Agreement. These will certainly allow further advancements in the area of Integrated Assessment Modelling for the energy security team.

4.5 Natural disasters, impacts on physical infrastructure in urban areas and urban development

In the third year of the project, the efforts were to prioritize the following proposed activities: **(i)** detailed analysis of extreme precipitation and streamflow in pilot municipalities that lead to natural disasters, especially for Itajaí Açu River in the South region; **(ii)** For drought events, it was assessed the severity, duration and frequency of droughts, and its impacts on the water resources and ecosystems for whole Brazil, as well for the whole domain of the study area, as defined previously during the year 1 of the project. **(iii)** Determine frequency, intensity and duration of land heatwaves and their impacts on human health and marine heatwaves in the western South Atlantic and their impact on marine ecosystem, which in turn can affect fisheries and food security. **(iv)** Development a risk indicator that addresses the physical-environmental (susceptibility), socio-economic, and demographic dimensions of vulnerability, which subsidize the proposition of adaptation measures at the local level. **(v)** Create a complete historical disaster database, from 1970 to 2016 period, for the critical municipalities considered in the scope of the project, in DesInventar System. **(vi)** Interaction with the team of the Economy and Impacts in Key Sectors sub-project, for advances in the integration of studies / products of droughts (generated in CEMADEN / MCTI) with economic models.

As previously highlighted in the year 1 report, the objective of the subcomponent "Natural Disasters, urban areas, infrastructure, and urban development" of the INCT-Phase II project - FAPESP is to analyze the vulnerability of Brazilian municipalities in relation to natural disasters associated with climate change, in order to propose a methodology for adaptation strategies to promote urban development and sustainability. Therefore, it is hoped to contribute to improving scientific knowledge on extreme events, disaster risk management and vulnerability of cities, as strategies for mitigation and adaptation to climate change.

This report integrates and summarizes the researches/contributions conducted during year 3 by the groups from (i) National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN), coordinated by Dr. Regina Célia dos Santos Alvalá; (ii) Federal University of Santa Catarina, coordinated by Dr. Regina Rodrigues Rodrigues and (iii) Oswaldo Cruz Foundation (FIOCRUZ), coordinated by Dr. Martha Barata. Additionally, the schedule for the year 4 is presented, in order to achieve the general objective of the sub-component.

4.5.1 Analysis of extreme events and consequences for urban areas

The research conducted during year 3 focus on compound extreme events in Brazil that has devastating socioeconomical consequences, in particular, for urban areas. Compound extreme events are the combination of events that occur simultaneously and lead to several serious impacts at the same time. In the southeast and south of Brazil the anomalously dry year of 2013/14 was a compound event that led not only to a severe drought in the south and southeast of Brazil, but also to land heatwaves and marine heatwaves in the South Atlantic (Rodrigues et al., 2019). Additionally, in most of the country, the 2014/15 hydrological year stands out due to the higher occurrence of severe and moderate droughts (Cunha et al., 2019a; Deusdará-Leal et al., 2020). As previously highlighted by Cunha et al. (2019b) in Brazil, droughts are widespread and recurrent in the semiarid region, mainly due to its water vulnerability. Approximately 28 million people live in this region, which concentrates the highest proportion of people living in poverty in Brazil.

If drought occurs intensively and extensively in densely populated areas, it can result in disaster when local capacities are insufficient to avoid significant damage. The risks associated with drought are related to the natural hazard, local vulnerabilities, response capacity, and mitigation policies.

Therefore, the drought-related disaster risk, is associated, for example, to the socioeconomic impacts from water and power shortages in southeast Brazil, a region that is heavily populated, home to more than 80 million people (Cunha et al., 2019b; Rodrigues et al., 2020). And, also, related to the reduced Brazilian crop production, such as soy, coffee, and sugarcane production, impacting food supplies globally and increasing worldwide prices.

The impacts from drought and land heatwaves and marine heatwaves events (compound event) included the decreased the production of oysters and the catch of some commercially important fish species, while decimating clams along the southern coast of Brazil. Besides, this event was also responsible for a dengue fever outbreak that tripled the usual number of fatalities. In addition, compound events like this have a disastrous impact on ecosystem degradation and loss of land and marine biodiversity. In summary (Figure 4.22), this compound event affected Brazil's Water, Food, and Energy Security (FAO Water-Energy-Food Nexus) and human health (increasing infectious diseases, heat stress and vector-borne diseases) in large urban areas of Brazil, including the study area of this component, Itajaí Açu River region.

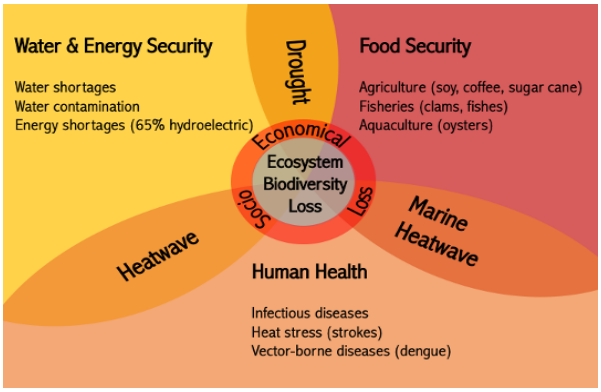


Figure 4.22: Schematic of the impacts of compound extreme events, droughts – land heatwaves – marine heatwaves, that frequently occur in Brazil during austral summer (adapted from Rodrigues et al., 2020).

The work developed during year 3 also analyzed the time evolution of compound events for the period of 1982-2016 and preliminary results have shown that their frequency, intensity and duration have increased during this period. Moreover, their occurrence is also expected to increase in the future using Sustainable Socioeconomical Paths 3 and 5 scenarios, respectively medium and high emissions scenarios, in simulations of the Coupled Model Intercomparison Project – Phase 6 (CMIP6). The physical drivers of these events have also been investigated to propose predictability index and help Brazil to prepare and avoid disastrous consequences in urban areas, such as in the study area of Itajaí Açu River region. In particular, land heatwaves were identified for the period of 1980-2019 (Figure 4.23). These heatwaves (Fig. 23a) are linked to droughts (Fig. 23b) that are caused by atmospheric blocking (Fig. 23c).

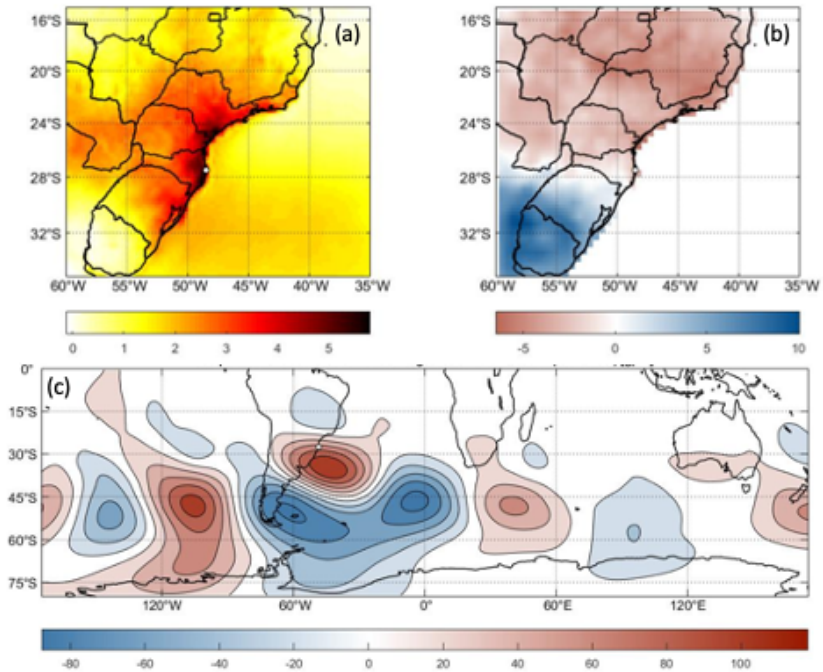


Figure 4.23: Heatwaves in southern Brazil (centered around the study area of the Itajaí Açu River) for the period of 1980-2019: (a) Air temperature anomalies (°C) during heatwave days; (b) precipitation anomalies (mm/day) during heatwave days; (c) 200hPa geopotential height anomalies (m) during heatwave days. Positive geopotential height anomalies over southeast South America represent anti-cyclonic circulation linked to atmospheric blocking. The latter cause droughts (negative precipitation anomalies in b) and heatwaves (positive air temperature anomalies in a).

In addition to the aforementioned, most of extreme events that lead to natural disasters in Brazil in urban areas are associated with the El Niño – Southern Oscillation (ENSO). During year 3, the drivers and impacts of ENSO in South America were reviewed (Cai et al., 2020). It was concluded that in spite of improvements of our understanding of ENSO–South America relationships, with implications for prediction and projection, uncertainty remains in regard to the robustness of the impacts, inter-basin climate interactions and interplay with greenhouse warming. The study recommend that a coordinated international effort is, therefore, needed to close the observational, theoretical and modelling gaps currently limiting progress, with specific efforts in extending palaeoclimate proxies further back in time, reducing systematic model errors and improving simulations of ENSO diversity and teleconnections.

Finally, regional research of the study area of Itajaí Açu River was conducted and the results provided recommendation for infrastructure projects in urban areas, which is the main objective of this INCT component. Trends in extreme precipitation events were identified for the Itajaí Açu River through Intensity-Duration-Frequency (IDF) curves (Chaffe et al., 2019a). Uncertainties related to IDF curves using stationary and non-stationary models have shown that the stationary model, often used, underestimates the precipitation intensities for all durations and return periods. However, the differences between the stationary and non-stationary models are significant only for small return periods (5-10 years). The results also show that the uncertainties grow proportionally with the return period, which suggests caution in the use of IDF curves for infrastructure projects that take into account large return periods (Anzolin et al. 2019). In addition, analysis of the skill of CMIP5 in simulating the precipitation regime and extremes has been conducted for the south of Brazil including the study area of the Itajaí Açu River (Pereima et al. 2020). For future projections (2081-2100), most models show an increase in the precipitation over the study area, after taking into account bias correction. Without the correction, most models project a decrease in precipitation.

In addition, a new approach to define flood probability was used as a function of sea and river water levels coastal area of the Itajaí Açu River basin (Chaffe et al. 2019b). The reasoning behind this is that when storm surge and intense precipitation co-occur, the probability of coastal floods are generally higher than if they occurred independently. Moreover, coastal infrastructure, in particular, is more susceptive to coastal flooding due to a combination of hazards (i.e. extreme discharge, precipitation, storm surges or wind) that may happen in several temporal and spatial scales. By using an impact centered methodology (Multivariate Copula Analysis Toolbox), we analyzed processes that control the occurrence of compound events in the Santa Catarina coastal area of the Itajaí river basin by combined data of precipitation, discharge and sea water level for the period of 1979-2010. The combination patterns between extremes of precipitation, streamflow and tides were determined to provide risk assessment for urban infrastructures in the Itajaí river basin.

4.5.2 Assessment of severity, duration and frequency of droughts from 2011 to 2019

The combination of remote sensing and ground-based precipitation measurements in a drought indicator enables joint assessment of the precipitation component (precipitation deficit as a driver of drought) and the surface response to water deficit (vegetation index and land temperature surface). Thus, from the scope of a study conducted by Cunha et al., 2019a, the drought assessment over Brazil from 2011 to 2019 using the Integrated Drought Index (IDI), which combines meteorological drought information (Standardized Precipitation Index -SPI) and remote sensing data (Vegetation Health Index – VHI), showed that throughout the last 8 years (2011–2019), drought events were recorded in all Brazilian territories. From 2011 to 2019, excluding the south region, the other Brazilian regions have been exposed to the most severe and intense drought events almost the last 60 years.

The SPI stratified by region shows that from 2011 to 2019, the most severe drought event (–102.9) occurred in the northeast region (Figure 4.24c) and the most intense (–2.3, recorded in January 2015) in the southeast region (Figure 4.24d). In terms of severity, the central west (–91, from 2012 to 2018) and the southeast (–86) were in second and third position, respectively. On the other hand, in terms of intensity, the northeast (–2.2, recorded in February and March 2013) and the north region (–2.0, recorded in December 2015) were in second and third position, respectively.

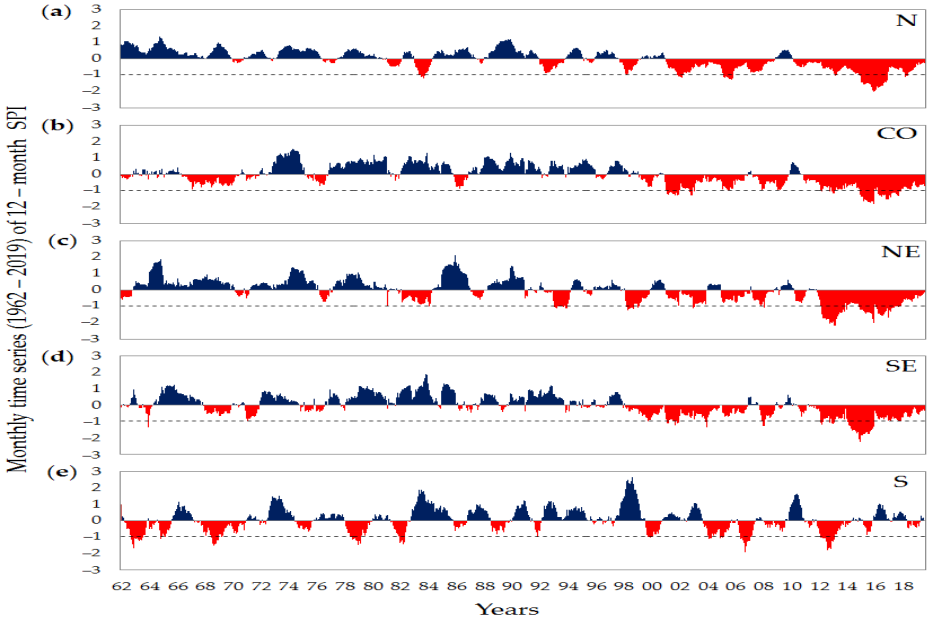


Figure 4.24: Temporal pattern of the SPI-12, calculated based on the months' time scale, per Brazilian region from 1962 to 2019. (a) N: North; (b) CO: Central west; (c) NE: Northeast; (d) SE: Southeast, and (e) S: South. (Source: Cunha et al., 2019a).

In addition, the 2015/2016 drought in the Amazon was considered the most severe and widespread in the last 100 years. Similarly, the multiyear drought of (2011–2017) in the northeast was the most extreme in decades. By evaluating the frequency of drought occurrence over Brazilian territory, the 2014/2015 hydrological year stands out due to the higher occurrence of extreme and severe droughts, which corresponds to an area of approximately 3 million km2 (34% of Brazilian territory) and 60% of this area corresponds to drought in the north region (Cunha et al., 2019a).

4.5.3 **Drought characterization and impact assessments for the whole domain of the study area, defined previously during the year 1 of the project.**

The exposure and affected areas by drought can be assessed by the IDI, that as mentioned before, combines the lack of precipitation and the surface response to water stress. Figure 4.25 shows IDI calculated to hydrological years from 2011 to 2018 over microregions of the study area. The hydrologic cycle, for most parts of Brazil, is from 1 October to 30 September.

Especially from 2011 to 2018, droughts affected most parts of the study area. Considering this period, the microregions of Araripina (Pernambuco state), Picos and Pio IX (Piaui state) were those with the highest intensity of drought, varying between abnormally dry and extreme drought. The highest drought intensities were observed in 2011/2012 and 2012/2013.

As shown in previous studies, the recurrent drought events recorded from ending 2011 to 2017 at NE were considered more intense in terms of duration, severity, and recurrence for at least the last 30 years. According to Cunha et al., 2019a, this severe drought was associated with an unusual combination of factors. First, an abnormal upward motion, apparently induced by the active La Niña during November–December 2011, counter-induced a severe subsidence over Northeastern Brazil. This mechanism was so intense that it was related to the unprecedented flood of the Amazon River in 2012. Later, during March–May 2012, cold surface waters in the South Atlantic configured the so-called negative Atlantic Dipole, which is known to be associated with dry conditions over Northern Northeast Brazil. In 2015/2016, a strong El Niño event increased and prolonged the effect of the drought over NE. The 2015/2016 El Niño was one of the strongest on record, comparable to the 1982/1983 and 1997/1998. Although the large majority of severe drought events in the NEB is associated with the occurrence of El Niño, this is not always the case, as in the beginning of the multiyear drought in the NE.

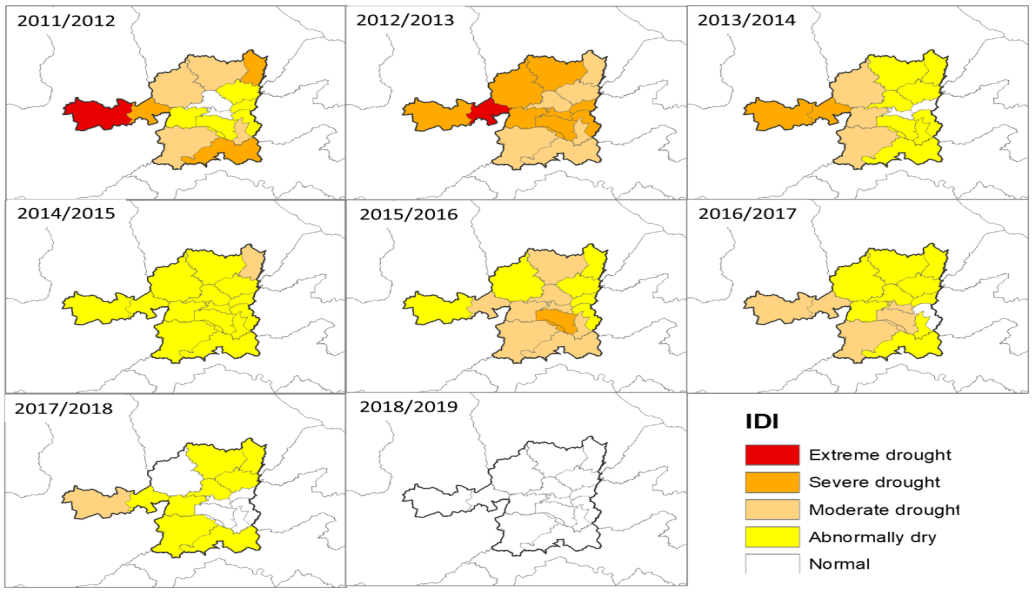


Figure 4.25: Integrated Drought Index (IDI) calculated to the 2011–2018 hydrological years (from October to September) for the study area.

4.5.4 Assessing drought in the drylands of northeast Brazil under regional warming exceeding 4 °C

Concerning to the semiarid region of Northeast Brazil (NEB), a study was conducted to assess changes in vegetation stress hazard observed in the present and projected for future climate change scenarios (Marengo et al., 2020). Drought impacts on vegetation were assessed in recent decades and also projected for future using CMIP5-Coupled Model Intercomparison Programme Version 5 model projections. It is important to evaluate in detail the risk of water stress and drought impacts in the region, both for the present and for the future, given the expected anthropogenic climate change. The analyses presented in the study focused on changes in vegetation stress hazard (vegetative drought) associated with changes in exposure under projected changes in local or regional climate extremes. Other publications to describe future climate change scenarios in NEB and to detail and update the methods and data used for the assessments of vegetation stress in the present and future (Marengo et al., 2019; Cunha et al., 2019a) were considered. A permanent drier climate state in a regional warming above 4 °C scenario can exacerbate the aridization, that together with land degradation may lead to desertification in the near future in developing countries (Vieira et al. 2016; Huang et al. 2017). In the study it was considered regional and not global warming of 4 °C because the impacts would be higher on water stress and vegetation in the region.

The study highlighted that, historically, during periods of extreme drought, food security in the drylands of the NEB is under severe risk due to agricultural collapse. The drought that started in 2012 continues to highlight the vulnerability of this region, and arid conditions have been detected during the last years mainly in the central semiarid region, covering almost 2% of the NEB. Climate projections showed an increase in the area under water stress condition, covering 49% and 54% of the NEB region by 2070 and 2100, respectively, with a higher likelihood with warming above 4 °C (Figure 4.26).

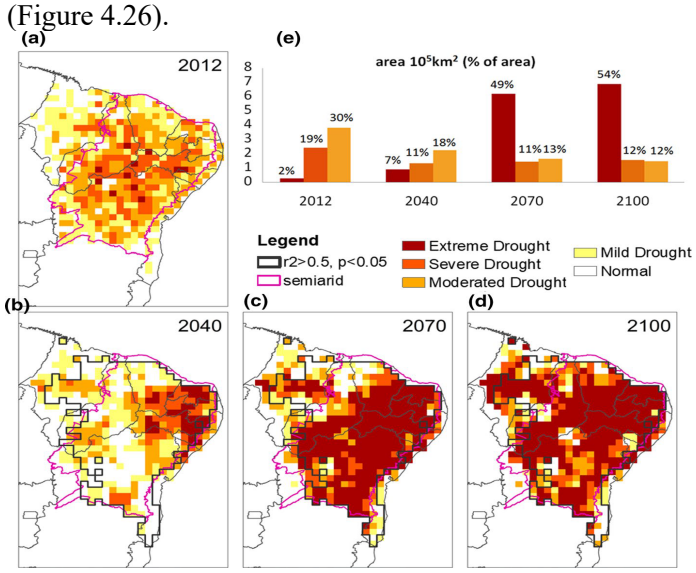


Figure 4.26: Spatial distributions of area with mild, moderate, severe and extreme drought according to vegetation health index (VHI) for a 2012; b projected for 2040 c projected for 2070, d projected for 2100 from an ensemble of CMIP5 models for the RCP8.5 projections. The black contour denotes regions with the coefficient of determination greater than 0.5 and 95% significance level. The area (km^2) is shown in bar diagrams at bottom (e), with the colors identifying the levels of drought: yellow-mild, light orange-moderate, dark orange-severe and brown-extreme. (Source: Marengo et al, 2020).

The projections of vegetative stress conditions derived from the empirical model for Vegetation Health Index (VHI) are consistent with projections from vegetation models, where semi-desert types typical of arid conditions would replace the current semiarid bushland vegetation ("caatinga") by 2100. Due to the impacts of the 2012–2017 drought, public policies have been

implemented to reduce social and economic vulnerability for small farmers but are not enough as poor population continues to be affected. In the long term, to make the semiarid less vulnerable to drought, strengthened integrated water resources management and a proactive drought policy are needed to restructure the economy. Integrating drought monitoring and seasonal climate forecasting provides means of assessing impacts of climate variability and change, leading to disaster risk reduction through early warning. Lastly, there is an urgent need for integrated assessments because the possibility that under permanent drought conditions with warming above 4 °C, arid conditions would prevail in NEB since 2060.

4.5.5 Water resources management scenarios for water availability under drought conditions.

In the context of crisis management, as we are currently experiencing due to the coronavirus pandemic, knowing the past, assess the causes of the crisis and its impacts is of fundamental importance. Bringing this crisis reality to the INCT-MC II project, in southeastern Brazil, between the years 2014 and 2016, we experienced an extremely unfavorable period in terms of water reserves. This drought event was severe enough to pumping the dead volume from the Cantareira system in order to continue water supplying the Metropolitan Region of São Paulo (MRSP) population. Nevertheless, extraction flow decreased from 29.6 $m^3 s^{-1}$, in the pre-crisis period, to 16.2 $m^3 s^{-1}$, during the crisis. As a result, water was lacking to supply part of the largest metropolitan region in Latin America. After crisis, two new mitigation policies were implemented: a water extraction Resolution (in 2017) and a Resolution for water reallocation from another basin (in 2018). In this context, a study was conducted during year 3 of the INCT project (Deusdará-Leal et al., 2020) in order to providing a novel investigation of the Cantareira System water crisis by assessing the mitigation policies impacts on storage level dynamics. The system storage level was evaluated using the reservoir simulation module of PDM-CEMADEN hydrological model, assuming the new policies had already been implemented prior to the crisis. A control simulation was run with observed in- and outflow and operationally-practiced extraction flow. The storage level dynamics impacts were evaluated under 4 water mitigation policies scenarios varying the policies implementation starting date, the extraction flow range and including the water reallocation variable.

Results showed that pumping volume would only need extraction during a short period (scenarios I, III and IV, Figure 4.27), and considering the water reallocation, pumping volume extraction would not have been necessary (Scenario II). Although the pumping volume would still have been extracted during a short period, water shortage impact would have been lessened, had the policies been already implemented before the crisis. The water mitigation policies implementation supports the reservoirs storage management but do not guarantee that MASP water demand is fully met. Therefore, in order to effectively improve water security, further policies and practices to reduce water demand and enhance supply should be considered. Policies and practices could shift from water-supply to demand-management approaches contributing to water security improvement. An implemented practice example was the temporarily incentive to reduce consumption applied during the crisis. Actions should also address reducing leakages from water supply distribution network and enhance sewage collection and treatment and also the public participation for future water management. Managing crises in real time is challenging because we do not know how long the unfavorable situation will last. Concepts learned in other areas of knowledge can be valuable for managing the current health crisis. This study allowed to understand the importance of considers water management policies in the context of mitigation and adaptation to the present and future drought events.

4.5.6 **Historical disaster database – DesInventar System.**

A database of drought-related disasters, using the conceptual tool and computational platform for data systematization and support for risk and disaster research, named DESINVENTAR - Disaster Inventory System (https: //online.desinventar.org/) was elaborated. This tool was created in the

1990s by professionals and institutions linked to the Red of Social Studies in Disaster Prevention in Latin America (LA RED), given the demand for detailed data for the analysis of vulnerability in studies risk and disaster.

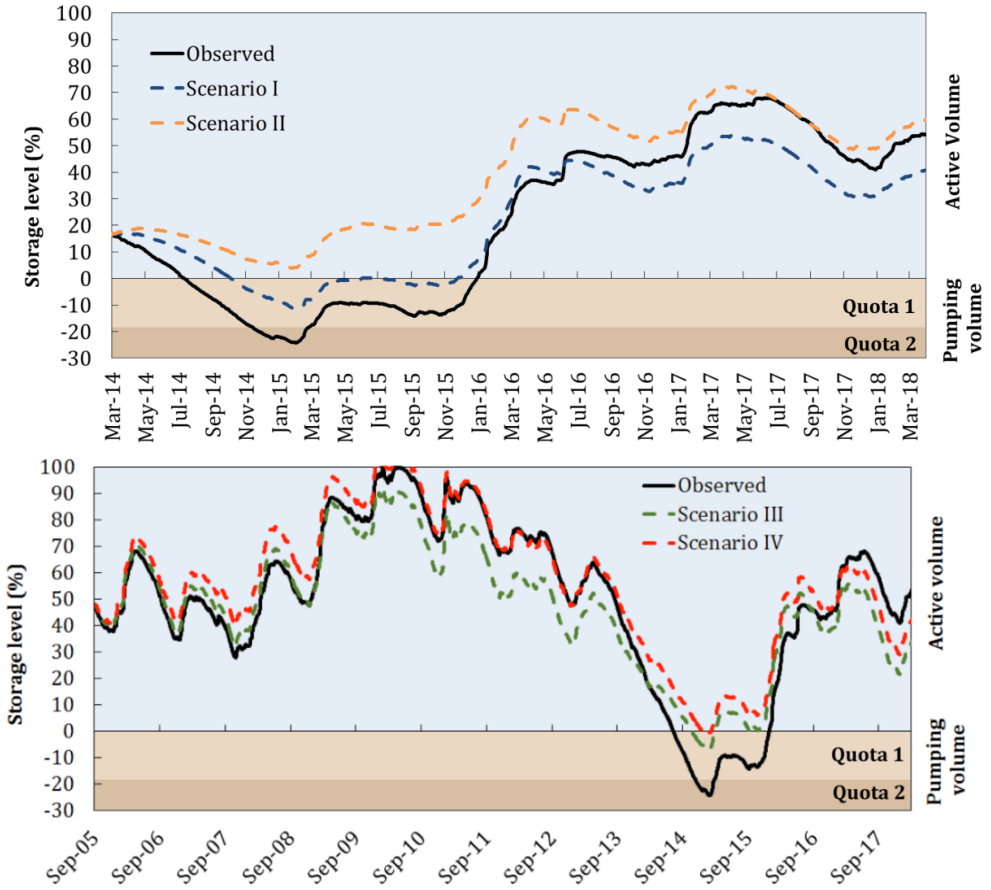
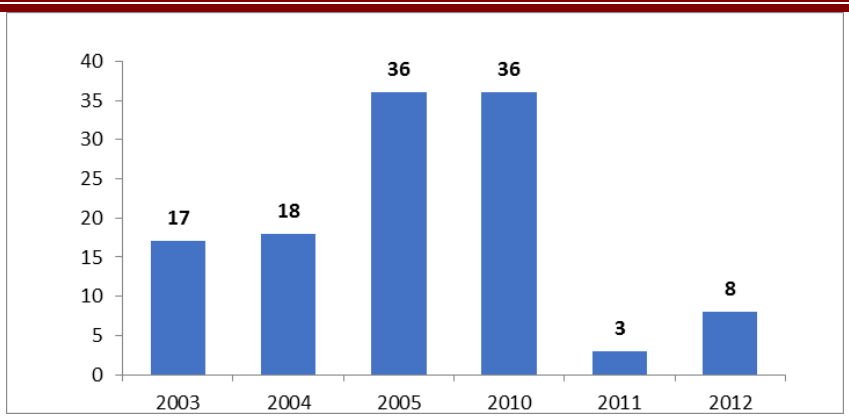


Figure 4.27: Cantareira System 4 (2014-2018; upper) and 13-years (2005-2018; lower) storage level simulations under four water mitigation policies scenarios. Black line refers to observed data; pale blue, light brown and dark brown background areas depictions, respectively, active volume, pumping volume quota 1 and 2. (Source: Deusdará-Leal et al., 2020).

Initially, this platform was filled with information about drought events and impacts registered in municipalities in the State of Piauí, focusing on 53 municipalities in the semi-arid region of Piauí, located in the portion of the state with the greatest historical recurrence of drought events since the 1980s, according to Brito et al. (2017). This information was extracted from the AVADAN (Damage Assessment) and FIDE forms (Disaster Information Form) from S2ID (Integrated Disaster Information System).

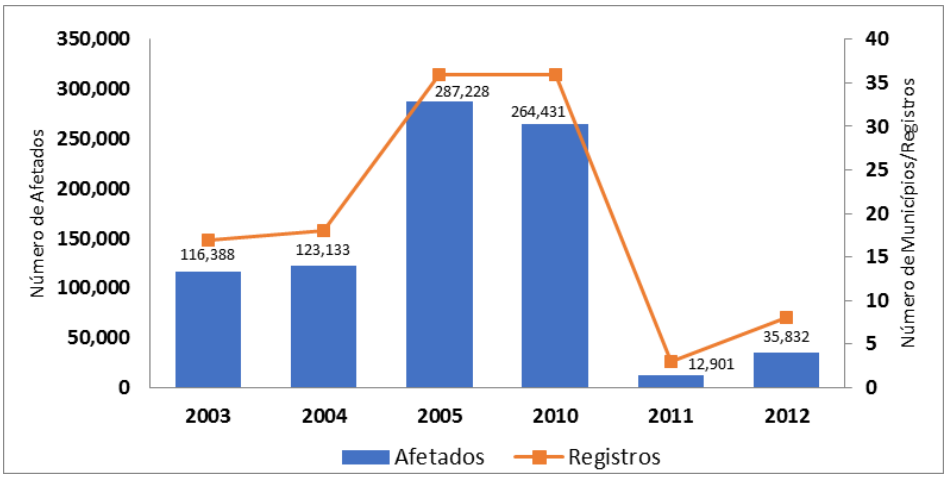
In DESINVENTAR, individual forms have been created for the storage of all information from each municipal record of "Estiagem" (14110) and Drought (14120), based on the availability of data of S2ID platform. AVADANs referring to these records are provided from the year 2002, for the State of Piauí, and from 2003, for the study area. The AVADAN dataset from 2002 to 2005 and from 2010 to 2012 has been included in the platform. Priority has been given to the inclusion of data from the last decade (until 2016), as this corresponds to the period in which occurred longest, recurrent, and severe droughts events in the region (Brito et al., 2017). In the first phase, 122 forms were included in DESINVENTAR, corresponding to the municipal records of "Estiagem" and Drought in Piauí, with 118 forms referring to the municipalities located in the portion of the state with the greatest historical recurrence of drought events (Figure 4.28).



* 2012: Partial data.

Figure 4.28: Municipalities in the study area with records of "estiagem" and drought, from 2003 to 2005 and from 2010 to 2012, included in DESINVENTAR.

Preliminary results showed that 839,913 people were affected by drought in the municipalities of Piauí, between 2003 to 2005 and 2010 to 2012 (Figure 4.29).



* 2012: Partial data; Nº of registers = Nº of municipalities.

Figure 4.29: Affected by drought in the municipalities in the study area according to the reports from 2003-2005 and 2010-2012.

Regarding the reported impacts, the main sectors affected were agriculture and livestock, in 100% of the municipalities and for all periods, followed by water supply, as shown in Table 4.3. While the main affected crops corresponded to the beans and corn, in every year.

Table 4.3 - Main sectors affected

Year	Agriculture and livestock	Water supply	Others
2003	100%	100%	-
2004	100%	94%	33%
2005	100%	33%	-
2010	100%	92%	31%
2011	100%	100%	33%
2012	100%	88%	25%

* Percentage of municipalities cited, in relation to the total of municipalities.

4.5.7 Risk management and sustainable urban development

There is a consensus among scientists in the Research Network on Urban Climate Change, regarding the effective management of climate risks in cities. The management should jointly contemplate the establishment of planning strategies for disaster risk reduction and adaptation to climate change (Rosenzweig, C; Solecki, W., 2018). Based on this approach, a study was carried out for the city of Rio de Janeiro, which has a strategy to reduce landslides risk, considering projections obtained by climate models (Barata et all, 2020). In general terms, the results generated by three different methods projected an increase of warm days and nights and a decrease of cold days and nights. Although the directions of change are the same from the three methods, the magnitude differs when considering warm and cold nights. Therefore, the information is relevant to support different strategies of city managers / decision makers, making it possible, for example, to consider distinctly what level of risk they are willing to bear in the future. The availability of future climate projections at the city scale, and the adoption of clear communication and interactive process between scientists and stakeholders, are essential subsidies for proposing adaptation strategies for the entire city and for specific uses in different sectors, as well as to promote governance of urban climate risks.

Looking for the improvement of scientific knowledge about extreme events, disaster risk management and sustainable urban development, in accordance with the objectives of the project, Blumenau, SC, was selected as a case study. The rainfall and landslide risk assessment established during the 3 initial years of the project highlighted Blumenau, state of Santa Catarina, as a municipality with high risk of landslide. Nowadays they are implementing strategies for disaster risk reduction, as well as accepted to be partner of our research, looking for the definition of adaptation strategies to improve their climate risk management.

Thus, a climate-related landslide risk assessment for the city is in development, in order to propose adaptation strategies that should improve its sustainable development and resilience. For that, the approach for urban vulnerability and risk assessment developed at UCCRN ARC3-2 (Rosenzweig et al, 2018) is been adjusted.

Also, contact with partners from the Blumenau city was made. The local Secretary of Civil Defense is the focal point. The needed information and data for the construction of the vulnerability index for Blumenau, Santa Catarina are been collected and assessed. At the same time, the geological, geomorphological and land use data to generate a new susceptibility map for the municipality are been organized and weighed. This step will be carried out using the Fuzzy Gamma technique and, later, it will be combined with the vulnerability analysis mentioned above aiming to generate a new and improved landslide risk index.

It is also highlighted that during year 3 of the project, efforts were made in order to establish rainfall thresholds that trigger landslides, and mapping landslide susceptibility. In this context, two studies were conducted at the Department of Earth Sciences, University of Florence, Italy. The first one was leaded by a researcher from the University (Dr Ascanio Rosi) and co-leaded by a researcher from CEMADEN's team (Dr. Vanessa Canavesi), while the second study was coordinated by Dr. Canavesi. Both studies (Landslides in the Mountain Region of Rio de Janeiro: A Proposal for the Semi-Automated Definition of Multiple Rainfall Thresholds – Rossi et al., 2019; Different Approaches to Use Morphometric Attributes in Landslide Susceptibility Mapping Based on Meso-Scale Spatial Units: A Case Study in Rio de Janeiro (Brazil) – Canavesi et al., 2020) focused evaluation for the Mountain Region of Rio de Janeiro and the methodologies will be extrapolated for Blumenau, SC, There is a consensus among scientists in the Research Network on Urban Climate Change, regarding the effective management of climate risks in cities. The management should jointly contemplate the establishment of planning strategies for disaster risk reduction and adaptation to climate change (Rosenzweig, C; Solecki, W., 2018). Based on this approach, a study was carried out for the city of Rio de Janeiro, which has a strategy to reduce

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4.5.8 Characterization of exposed population to landslides, floods and flashfloods in Brazil

Three studies were published over the last year exploring the Statistical Territorial Base of Risk (BATER) database, produced in the scope of IBGE & CEMADEN partnership, which are relevant in the context of the INCT's project. The first one (Souza et al., 2019) presents the methodology developed to define the BATER delimitation, as well as an analysis of potential applications. For instance, the cross-correlation to another existent databases (i.e. subnormal agglomerates, urban typologies).

The second study (Alvalá et al., 2019) provided a contribution for the comprehension of the conditions of at-risk population at an intra-urban scale and the potential application in the Brazilian early warning system. Through an integration of demographic data and landslide and flood risk mappings of 825 municipalities historically affected by disasters in Brazilian territory, an estimation of 8,266,566 people and 2,470,506 households was achieved. This result indicates that for every 100 inhabitants, 9 lived in disaster risk areas in Brazil.

Saito et al. (2019) conducted a study in order to analyze the exposure conditions of the population groups at disaster risk areas in 479 Brazilian municipalities. The results showed that the largest number of people exposed was in the Southeast region of the country, although, in proportional terms, in the Northeast region 15 out of every 100 people lived in risk areas.

Considering the efforts into to develop vulnerability indexes, especially in the context of climate change, a vulnerability population index (InOV) to support monitoring and issuing early warnings for disaster risk in Brazil related to landslides was developed (Assis Dias et al., 2020). Thus, an InOV, based on the database generated in the scope of IBGE and CEMADEN partnership, was proposed and validated. The purpose of the InOV developed is for use into the operational activities in the context of the early warning, to identify areas that concentrate large number of populations exposed to the landslides risk areas. The InOV is based on indicators that characterize physical exposure conditions of residents, as well as population responsiveness to recover themselves post disaster. Thus, the InOV can subsidizes the identification of priority areas providing additional information about vulnerable populations and helps to identify critical areas in the municipality that are under risk of hydro meteorological disaster when critical rainfall thresholds are surpassed. Although the developed InOV has focused on application for use in early warnings, it can also be useful to subsidize the proposition of adaptation measures at the local level.

4.5.9 Interaction with Economy and Impacts in Key Sectors sub-project

In order to advances in the integration of studies / products of droughts (generated in CEMADEN / MCTI) with economic models, interaction with experts from INCT project were prioritized. Thus, the Integrated Drought Index (IIS) previously mentioned was calculated for all municipalities inserted into the semiarid region from January 2012 to December 2018. These data were made available to the INCT's Economy and impacts in Key Sectors sub-project to assess the socioeconomic impacts of drought in the semiarid region.

There was a meeting between the INCT project coordinator and the subproject coordinators, held on 10/03/2019, via skype. The aim of the meeting was to prioritize the axes of research (Urban Development and Adaptation; Hydrology/Hydrological Modeling/Water Shortages/ Vegetative Drought; and Risk Communication), as well the contributions of each institution involved.

4.6 Impacts on Brazilian ecosystems in view of changes in land use and biodiversity.

During this period, we focused on the support to the preparation of the 4th National Inventory of Greenhouse Gases coordinated by the Brazilian Ministry of Science, Technology, and Innovation and in partnership with the Rede Clima (Projeto BRA/16/G31 – Quarta Comunicação Nacional e Relatório de Atualização Bienal à Convenção do Clima (UNFCCC).

4.6.1 Biomass and carbon stocks

The activities included the organization and review of biomass and carbon stocks in the different compartments (living aboveground biomass - trees, palm trees, and lianas; living belowground biomass –roots; dead organic matter - fine litter and dead wood; and soil

carbon) according to vegetation types of the Brazilian Biomes. We also contributed to the development and updating of estimates and uncertainties of anthropogenic emissions by sources and removals by sinks of greenhouse gases associated with land cover and land-use change for the Amazon, Cerrado, Caatinga, and Atlantic Forest (including the growth of secondary and primary vegetation in managed areas).

In particular, for the Cerrado, a new biomass map was prepared for the 4th National Communication to the UNFCCCC. The compiled values were organized in a database that will be made public by the Brazilian Ministry of Science, Technology, and Innovation. The technical report (Reference Report of the Sector Land Use, Land Use Change, and Forests of the Fourth National Inventory of Greenhouse Gas Emissions and Removals (1990 - 2016) was submitted to public consultation for comments in June 2020, and the final version will be published after the completion of this process.

Also, between 2017 and 2019, Mercedes Bustamante coordinated the as Lead author the chapter on the Impacts, vulnerability, and adaptation to climate change of Terrestrial and freshwater ecosystems with a focus on the Iberoamerican countries. This effort was support by the Red Iberoamericana de Oficinas de Cambio Climatico (RIOCC).

4.6.2 Amazonia

The activities in Amazonia focused in continuous measurements of trace gases and aerosols at the ATTO tower, as well as the continuous operation of the NASA/AERONET network of sun-photometers. We also worked on several projects looking at carbon balance in Amazonia, and particularly the effects of radiation, clouds and aerosols on forest carbon uptake.

We have used regional models such as the WRF-Chem as well as several global coupled model such as the Met Office Hadgem2 . Different biomass burning scenarios were used, and the impact on aerosol optical depth and cloud condensation nuclei concentrations were calculated. A time series of 2002 to 2016 was analyzed and we obtained total BB aerosol radiative forcings of –0.2 W m–2 and 1.5 W m–2, respectively, showing that the influence of BB aerosols on the regional energy balance can range from modest cooling to strong warming. In all scenarios, BB aerosols led to a decrease in the frequency of occurrence and rate of precipitation, caused primarily by ACI effects at low aerosol loading and by ARI effects at high aerosol loading. The dependence of precipitation reduction on BB aerosol loading is more remarkable in strong convective regime than in weak convective condition (Liu et al., 2020). Overall, our results show that Aerosol-Cloud-Interactions (ACI) tend to saturate at high aerosol loading, whereas the strength of Aerosol-Radiation-Interactions (ARI) continues to increase and plays a more important role in highly polluted episodes and regions. This should hold not only for BB aerosols over the Amazon, but also for other light-absorbing aerosols such as fossil fuel combustion aerosols in industrialized and densely populated areas. The importance of ARI at high aerosol loading highlights the need for accurately characterizing aerosol optical properties in the investigation of aerosol effects on clouds, precipitation, and climate, as well as on carbon balance.

Biomass burning (BB) is a large source of atmospheric reactive trace gases and aerosol yielding substantial impacts on surface air quality (AQ) in the region and also trough long range transport. Long-term (2005-2016) trends in satellite observed fire activity in eastern

Brazil, during the BB season (August-September-October), coincide with significant increases in satellite retrieved tropospheric column nitrogen dioxide (TCNO2). Simulations from the well evaluated TOMCAT 3D-global chemistry transport model highlight this degradation in regional AQ as surface NO2 and O3 concentrations have increased at a rate of over 0.1 and 1.0 ppbv/year, respectively. This long-term BB originated fire-O3 exposure can induce premature mortality from Chronic Obstructive Pulmonary Disease (COPD), which we show has resulted in up to an extra 118 deaths over the time period. However, years with intense BB seasons yield the largest health impacts leading to between 28 and 187 premature deaths per year in eastern Brazil. For surface O3, positive significant trends peaked at over 1 ppbv/year yielding an increase of over 10 ppbv (i.e. ~40%) over the time period, while NO2 increased by over 1.0 ppbv (i.e. ~100%). The health burden from long-term fire-sourced O3 exposure-induced COPD ranged from 77 to 121 (28-119, 45-187) deaths in extreme drought/anomalous fire (ED-AF) years in the East Amazon, with O3 sourced predominately from Cerrado-emitted ozone precursor pollutants. The long-term COPD mortality trend from fire-O3 exposure resulted in approximately an extra 30-118 deaths over the time period in Amazonia. Therefore, these findings suggest that increases in surface O3 from changes in the Cerrado fire activity (i.e. greater burning of savannah grass lands) are a substantially increasing risk factor to human health in the eastern Amazon (Pope et al., 2020).

4.6.3 Impact of fires in air quality

The impact of fires in air quality was also studied in the Butt et al., 2020 manuscript. Vegetation fires across the tropics emit fine particulate matter (PM2.5) to the atmosphere, degrading regional air quality and impacting human health. Extensive vegetation fires occur regularly across the Amazon basin, but there have been no detailed assessments of the impacts on air quality or human health. We used updated exposure-response relationships and a regional climate-chemistry model, evaluated against a comprehensive set of observational data, to provide the first in-depth assessment of the potential public health benefits due to fire prevention across the Amazon Basin. We focused on 2012, a year with emissions similar to the 11-year average (2008 to 2018). Vegetation fires contributed >80% of simulated dry season mean surface PM2.5 in the western Amazon region particularly in Bolivia and Brazilian states of Rondônia, Acre, and Mato Grosso. We estimate that the prevention of vegetation fires would have averted 16 800 (95UI: 16 300 – 17 400) premature deaths and 641 000 (95UI: 551 900 – 741 300) disability adjusted life years (DALYs) across South America, with 26% of the avoided health burden located within the Amazon Basin. The health benefits of fire prevention in the Amazon are comparable to those found in Equatorial Asia (Butt et al., 2020).

We also dedicated lots of effort in understanding the role of the Biogenic Volatile Organic Compounds (BVOC) emissions and its links with the aerosol-climate-carbon connections. BVOCs play important roles at cellular, foliar, ecosystem, and atmospheric levels. The Amazonian rainforest represents one of the major global sources of BVOCs, so its study is essential for understanding BVOC dynamics. It also provides insights into the role of such large and biodiverse forest ecosystem in regional and global atmospheric chemistry and climate. We review the current information on Amazonian BVOCs and identify future research priorities exploring biogenic emissions and drivers, ecological interactions, atmospheric impacts, depositional processes, and modifications to BVOC dynamics due to changes in climate and land cover. A feedback loop between Amazonian BVOCs and the trends of climate and land-use changes in Amazonia is then constructed.

Satellite observations and model simulation time series demonstrate the validity of the proposed loop showing a combined effect of climate change and deforestation on BVOC emission in Amazonia. A decreasing trend of isoprene during the wet season, most likely due to forest biomass loss, and an increasing trend of the sesquiterpene to isoprene ratio during the dry season, suggest increasing temperature stress induced emissions due to climate change. Figure 4.30 bellow shows schematically the BVOCs dynamic in Amazonia. Figure 4.31 shows the potential climate feedbacks from deforestation mediated by changes in BVOCs emissions in Amazonia (Yanez et al., 2020).

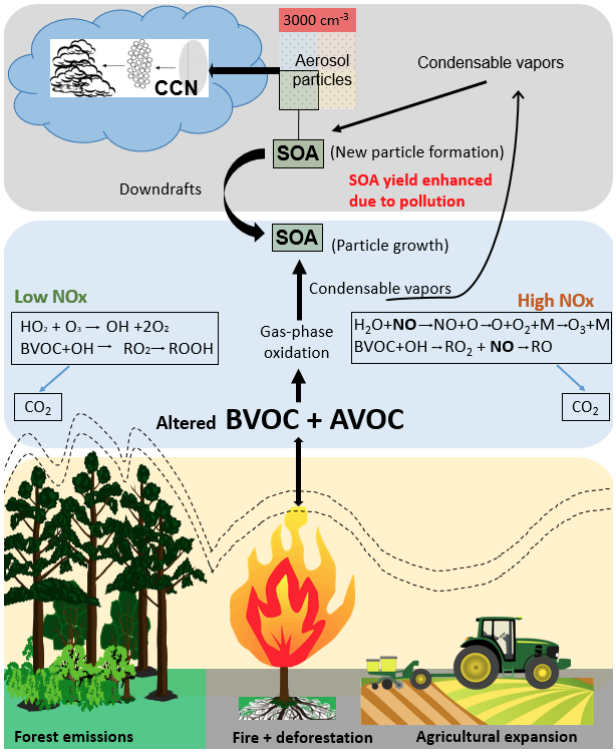

Figure 4.30 - Schematic showing BVOC dynamics in a polluted Amazonian atmosphere, including BVOC sources and interactions, interaction with anthropogenic volatile organic compounds (AVOCs), BVOC oxidation in the atmosphere, and subsequent aerosol and cloud dynamics. CCN stands for cloud condensation nuclei and SOA stands for secondary organic aerosol

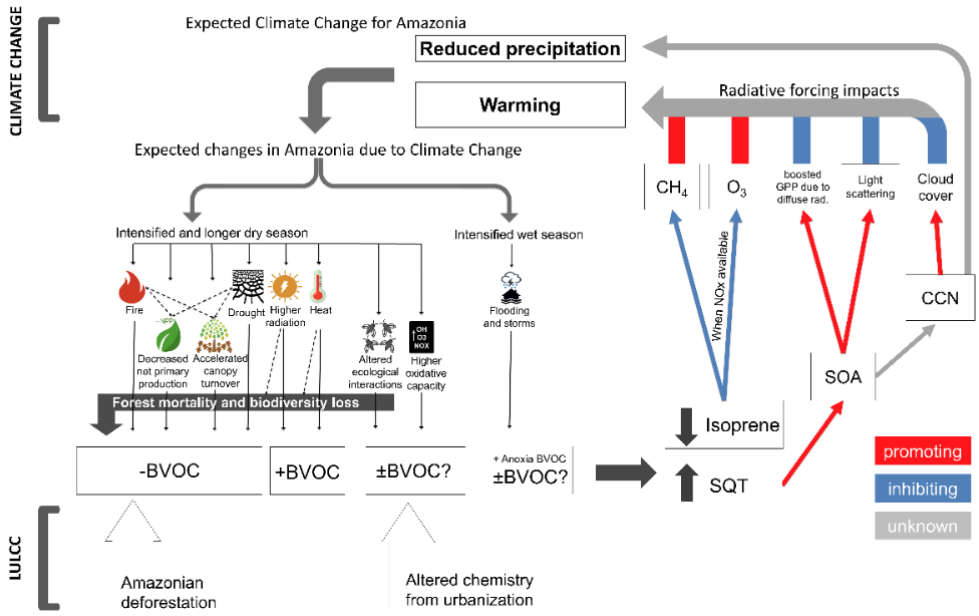

Figure 4.31- Proposed feedback loops for the impacts of climate and land-use changes in Amazonian BVOCs and how these impacts will feed back into the system. The dashed arrows represent the situation where threshold limits are reached (i.e. heat can stimulate BVOC emissions until the point where heat is detrimental to plant fitness, thereby decreasing BVOC emissions). Red colour stands for promoting and blue colour for inhibiting. Grey arrows indicate inconclusive/unknown effects. LULCC stands for Land Use Land Cover Change.

4.7 Health and climate change

4.7.1 Analysis of the results for each vector species

Brazil, a country with a tropical climate, is particularly vulnerable to the increased incidence of vector-borne diseases in the context of global climate change. It is estimated that such events may have a particular impact on geographical distribution, population density, seasonality, prevalence of infection and parasitic vector load. In Brazil, the eco-epidemiology of leishmaniasis is extremely complex, considering that different species of vectors, parasites and hosts participate in the transmission cycle, in restricted ecological niches. According to the World Health Organization (2010, 2011), the policies for the surveillance / control of neglected diseases must be aligned with agendas committed to the assessment of climate and environmental changes.

During year 1 of the Fiocruz / RJ group project, Health sub-component, projections of the distribution of 04 vectors of American Tegumentary Leishmaniasis - ATL (Lutzomyia flaviscutellata, L. whitmani, L. intermedia and L. neivai) were produced in climate change scenarios. At the end of the second year of the project, these projections for other vector species L. wellcomei, L. complexa, L. umbratilis, L. migonei, L. longipalpis and L. cruzi were concluded, the last two being important vectors of American Visceral Leishmaniasis. During year 3, the results of the climate suitability scenarios for the vectors studied individually were explored, as well as their associations with the distribution of the respective diseases ATL and AVL. The project has also been evaluating further (started in year 2), the potential distribution of L. longipalpis, the most important AVL vector in the American continent, focusing on the state of Rio de Janeiro, as well as the municipal vulnerability to the occurrence of the disease, the databases have been updated and new analyzes will be carried out, with the inclusion of important information on canine cases for AVL.

In the analysis of the results for each vector species, it was possible to identify areas of the country most vulnerable to their expansion in climate change scenarios. Spatial overlapping areas of the

potential distribution of human cases of ATL and AVL with their respective vectors were also identified, which allowed the suggestion of locations for surveying new occurrences of phlebotomine sand flies, especially the vectors. Figures 4.32, 4.33 and 4.34 show the climate variables used in the ecological niche models, in the current time cut (1960-1990) and future time cut (2041-2060), RCP 4.5 scenario, and RCP 8.5 scenario. In figures 4.35 and 4.36, the frequency of TSS (True Skill Statistic) values obtained for replicas of ecological niche models, and TSS values obtained for replicas of ecological niche models of the ten species of leishmaniasis vectors studied

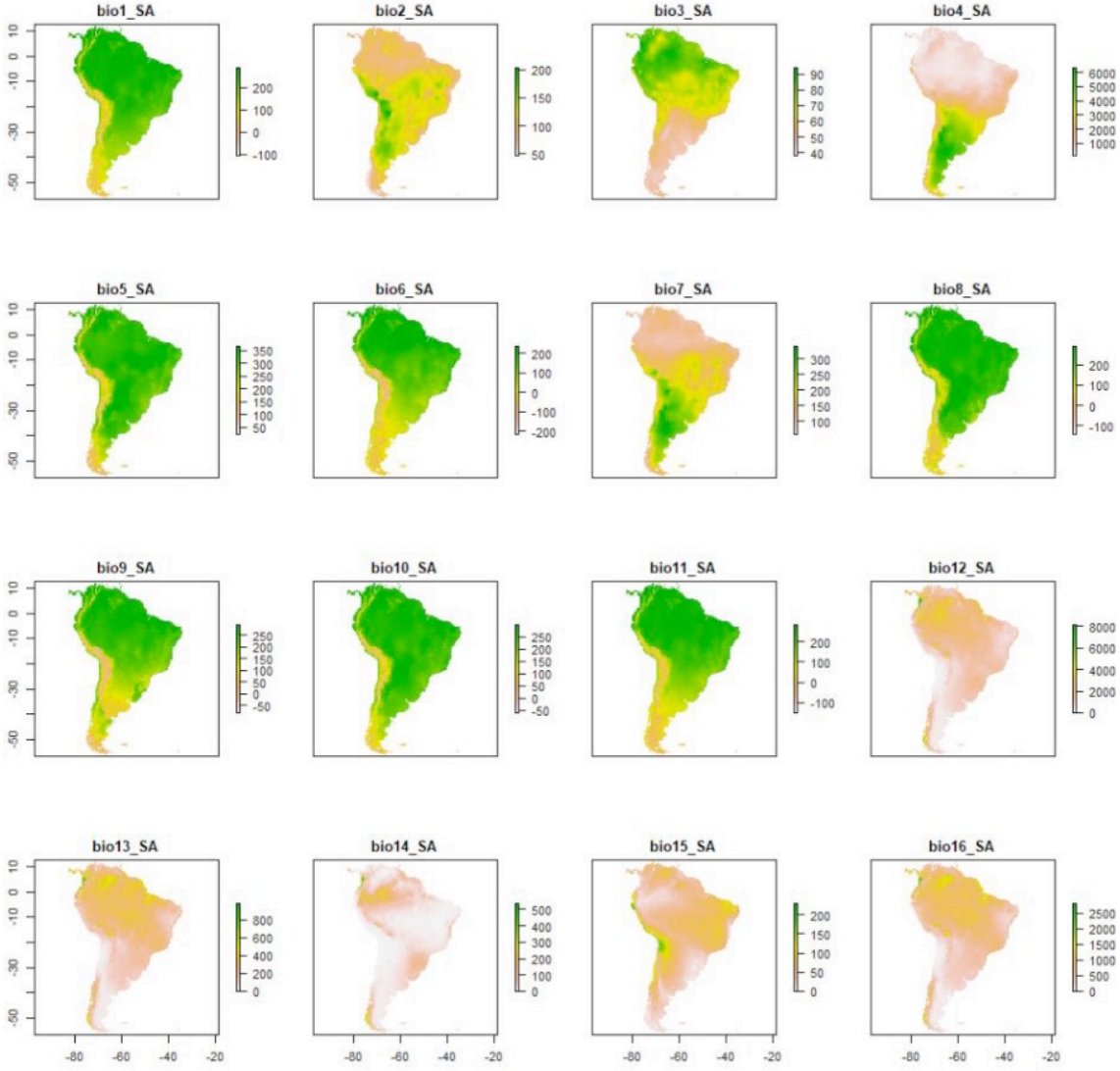

Figure 4.32: Climate variables used in ecological niche models, in the current time cut (1960-1990). Codes: bio1: average annual temperature; bio2: average daytime, temperature variation (monthly average (max. temp - min. temp)); bio3: isothermality; bio4: temperature seasonality (standard deviation); bio5: maximum temperature of the warmest month; bio6: minimum temperature of the coldest month; bio7: annual temperature range; bio8: average temperature of the wettest quarter; bio9: average temperature of the driest quarter; bio10: average temperature of the warmest quarter; bio11: average temperature of the coldest quarter; bio12: annual precipitation; bio13: precipitation in the wettest month; bio14: precipitation in the driest month; bio15: precipitation seasonality (coefficient of variation); bio16: precipitation in the wettest quarter; bio17: precipitation in the driest quarter; bio18: precipitation in the warmest quarter; bio19: precipitation in the coldest quarter.

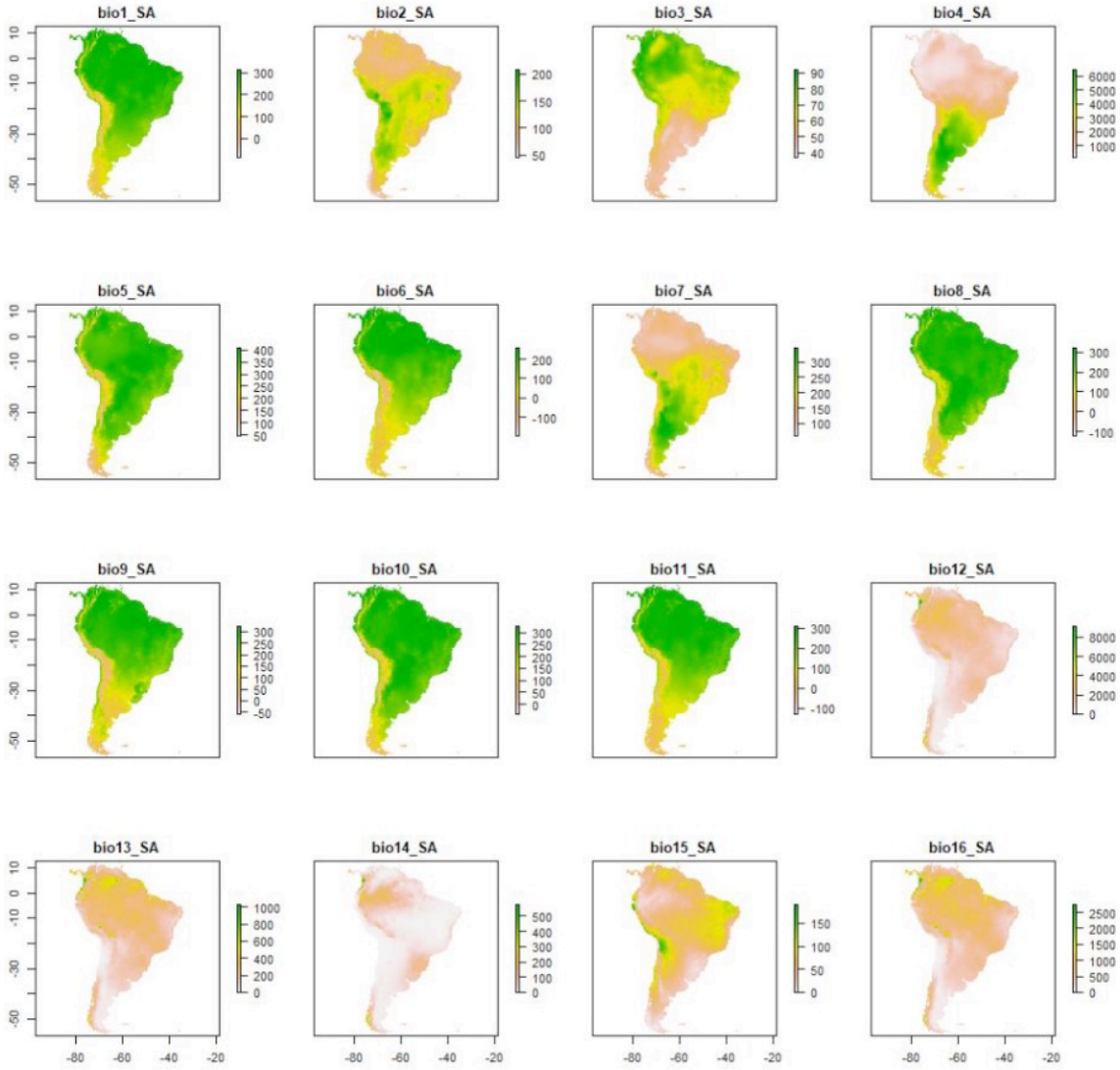

Figure 4.34: Climate variables used in ecological niche models, in the future time cut (2041-2060), RCP 4.5 scenario. Codes: bio1: average annual temperature; bio2: average daytime temperature variation (monthly average (max. temp - min. temp)); bio3: isothermality; bio4: temperature seasonality (standard deviation); bio5: maximum temperature of the warmest month; bio6: minimum temperature of the coldest month; bio7: annual temperature range; bio8: average temperature of the wettest quarter; bio9: average temperature of the driest quarter; bio10: average temperature of the warmest quarter; bio11: average temperature of the coldest quarter; bio12: annual precipitation; bio13: precipitation in the wettest month; bio14: precipitation in the driest month; bio15: precipitation seasonality (coefficient of variation); bio16: precipitation in the wettest quarter; bio17: precipitation in the driest quarter; bio18: precipitation in the warmest quarter; bio19: precipitation in the coldest quarter.

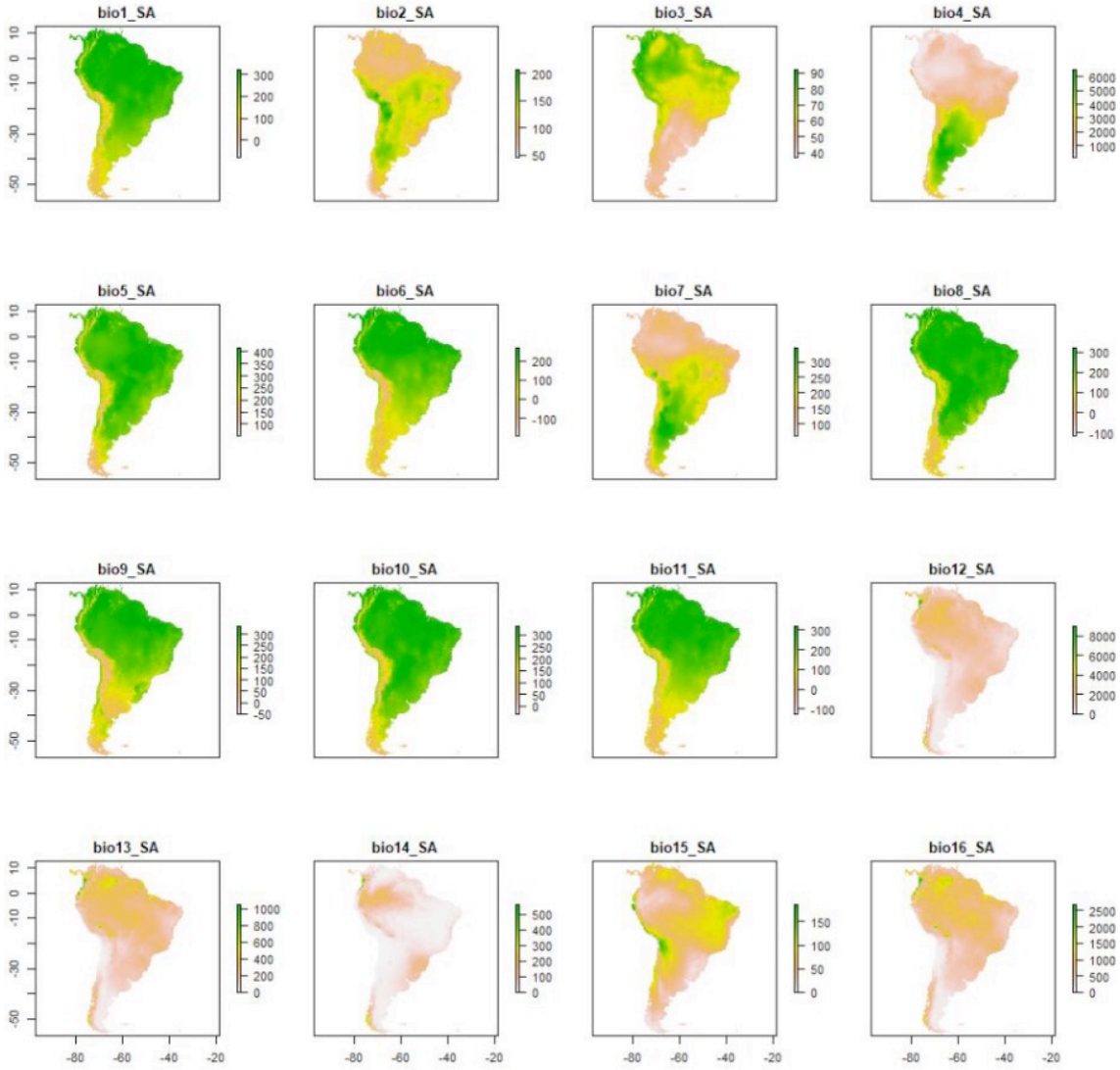

Figure 4.35: Climate variables used in ecological niche models, in the future time cut (2041-2060), RCP 8.5 scenario. Codes: bio1: average annual temperature; bio2: average daytime temperature variation (monthly average (max. temp - min. temp)); bio3: isothermality; bio4: temperature seasonality (standard deviation); bio5: maximum temperature of the warmest month; bio6: minimum temperature of the coldest month; bio7: annual temperature range; bio8: average temperature of the wettest quarter; bio9: average temperature of the driest quarter; bio10: average temperature of the warmest quarter; bio11: average temperature of the coldest quarter; bio12: annual precipitation; bio13: precipitation in the wettest month; bio14: precipitation in the driest month; bio15: precipitation seasonality (coefficient of variation); bio16: precipitation in the wettest quarter; bio17: precipitation in the driest quarter; bio18: precipitation in the warmest quarter; bio19: precipitation in the coldest quarter.

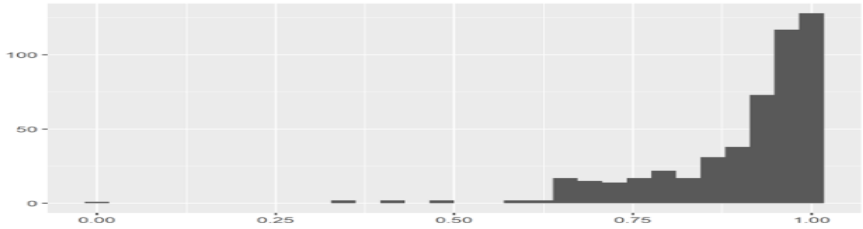

Figure 4.36: Frequency of TSS (True Skill Statistic) values obtained for replicas of ecological niche models.

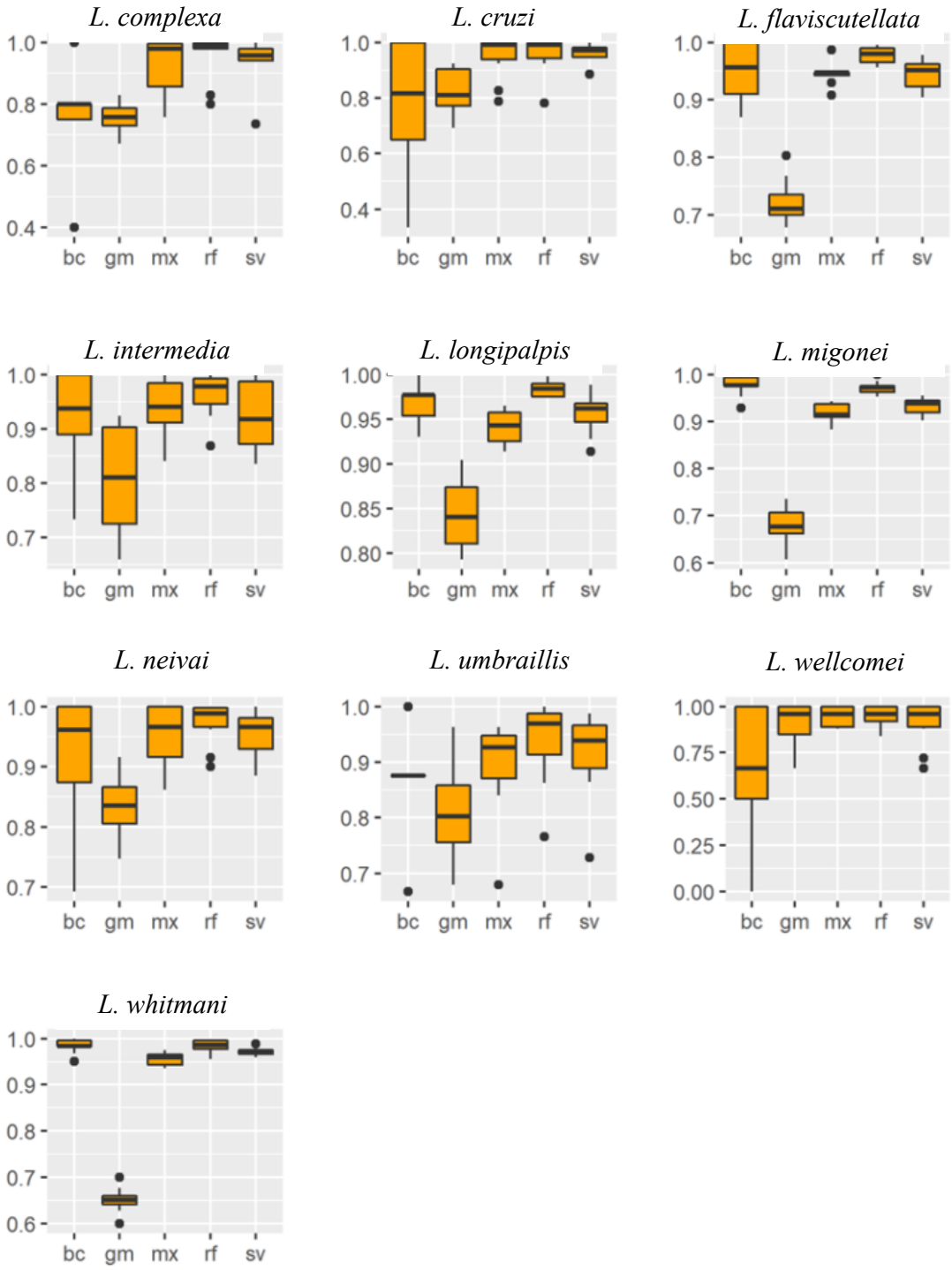

Figure 4.37: TSS (True Skill Statistic) values obtained for the replicas of the ecological niche models of the ten species of leishmaniasis vectors studied.

The vector species studied can expand their areas of occurrence in Brazil in the face of climate changes. In this context, important vectors of ATL stand out, such as L. flaviscutellata and L. whitmani and the main vector of AVL, L. longipalpis (Figures 4.38 and 4.39, Tables 4.4 and 4.5).

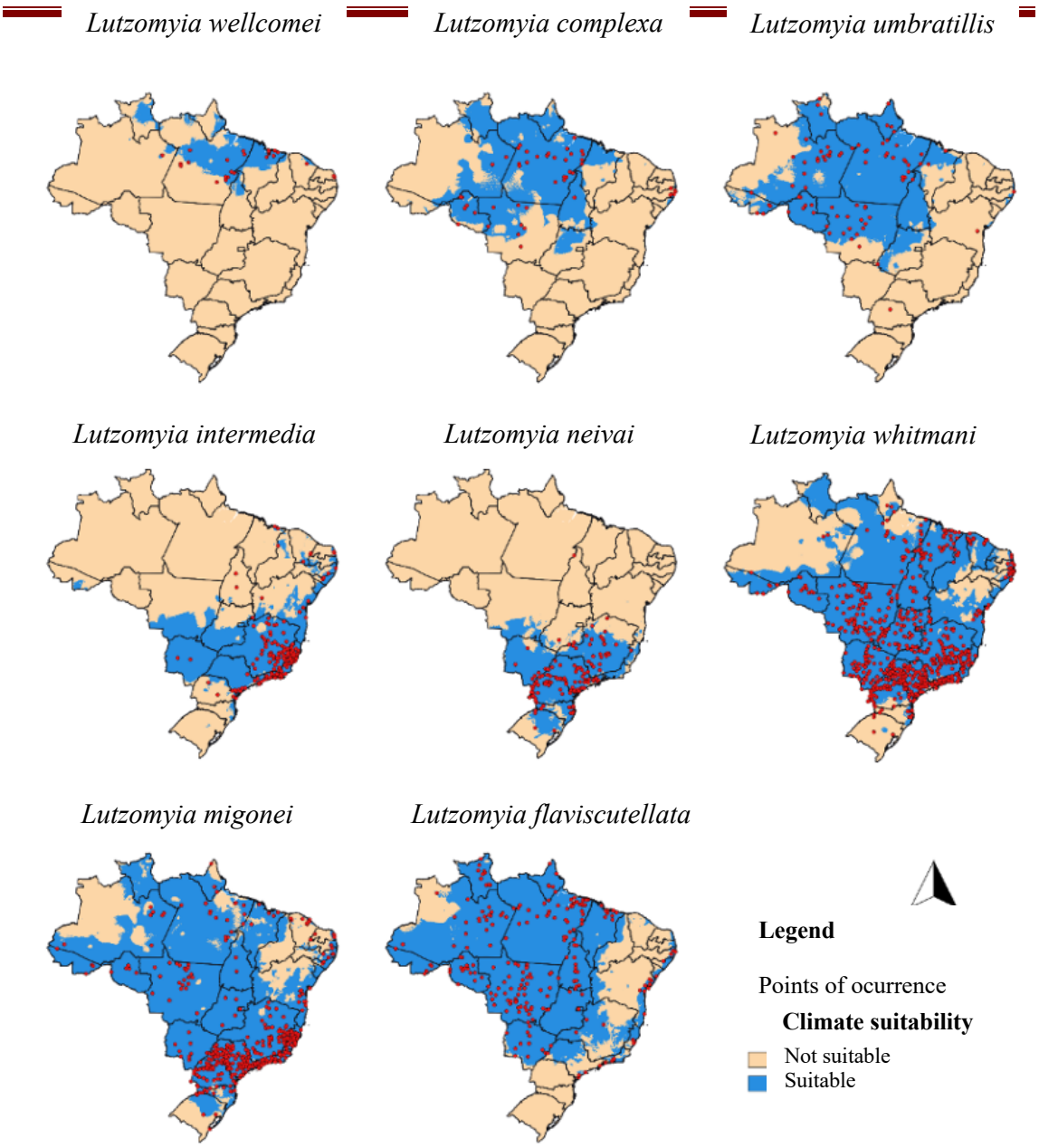

Figure 4.38: Climate suitability for vectors of American Visceral Leishmaniasis - AVL, in the current time cut (1960-1990).

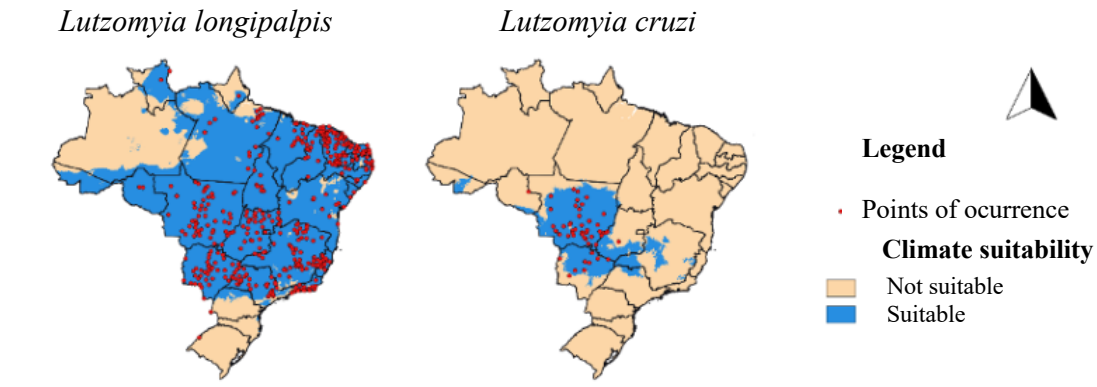

Figure 4.39. Climate suitability for vectors of American Visceral Leishmaniasis - AVL, in the current time cut (1960-1990).

Table 4.4: Total area of climate suitability estimated through ecological niche modeling for the ten species of leishmaniasis vectors studied in climate change scenarios.

Species	Estimated area (km²) 1960-1990 (Baseline)	2041-2060 RCP 4.5	2041-2060 RCP 8.5
Lutzomyia complexa	899,690	424,875	299,870
Lutzomyia cruzi	375,560	559,305	620,780
Lutzomyia flaviscutellata	2,149,845	1,577,500	1,536,715
Lutzomyia intermedia	656,425	458,995	422,080
Lutzomyia longipalpis	1,984,990	1,974,875	2,008,830
Lutzomyia migonei	2,196,705	1,190,185	1,161,065
Lutzomyia neivai	474,605	307,870	306,070
Lutzomyia umbratilis	1,361,825	1,273,630	1,129,875
Lutzomyia wellcomei	243,535	91,360	66,595
Lutzomyia whitmani	1,925,000	1,698,545	1,729,120

Table 4.5: Estimated altitude values (meters above sea level) for the ten species of leishmaniasis vectors studied in climate change scenarios.

Species	Duration	Estimated altitude (m) Minimum	Medium	Maximum
Lutzomyia complexa	1960-1990 (Baseline)	0	198.51	1,809
	2041-2060 RCP 4.5	0	205.44	2,189
	2041-2060 RCP 8.5	0	209.12	2,214
Lutzomyia cruzi	1960-1990 (Baseline)	88	365.85	979
	2041-2060 RCP 4.5	71	429.11	2,374
	2041-2060 RCP 8.5	99	427.79	2,349
Lutzomyia flaviscutellata	1960-1990 (Baseline)	0	276.68	1,809
	2041-2060 RCP 4.5	0	364.92	2,486
	2041-2060 RCP 8.5	0	374.51	2,465
Lutzomyia intermedia	1960-1990 (Baseline)	0	475.41	2,142
	2041-2060 RCP 4.5	0	572.21	2,656
	2041-2060 RCP 8.5	0	596.33	2,535
Lutzomyia longipalpis	1960-1990 (Baseline)	0	340.05	1,912
	2041-2060 RCP 4.5	0	361.46	2,656
	2041-2060 RCP 8.5	0	365.40	2,684
Lutzomyia migonei	1960-1990 (Baseline)	0	344.82	2,479
	2041-2060 RCP 4.5	0	515.01	2,907
	2041-2060 RCP 8.5	0	523.75	2,911
Lutzomyia neivai	1960-1990 (Baseline)	0	505.68	2,302
	2041-2060 RCP 4.5	0	597.05	2,546
	2041-2060 RCP 8.5	0	597.91	2,689
Lutzomyia umbratilis	1960-1990 (Baseline)	0	217.79	2,030
	2041-2060 RCP 4.5	0	249.99	2,187
	2041-2060 RCP 8.5	0	266.74	2,484
Lutzomyia wellcomei	1960-1990 (Baseline)	0	122.57	1,820
	2041-2060 RCP 4.5	0	153.82	3,089
	2041-2060 RCP 8.5	0	98.31	3,244
Lutzomyia whitmani	1960-1990 (Baseline)	1	352.68	2,398
	2041-2060 RCP 4.5	0	390.01	2,838
	2041-2060 RCP 8.5	0	403.46	2,940

L. flaviscutellata, vector of *Leishmania amazonensis*, currently has a wide distribution in the country, with records of occurrence in the Amazon, Cerrado, and Atlantic Forest. Scenarios for 2050 indicate an increase in its area of climate suitability, especially in the Southeast Region and western Amazon (Figure 4.40).

Lutzomyia flaviscutellata

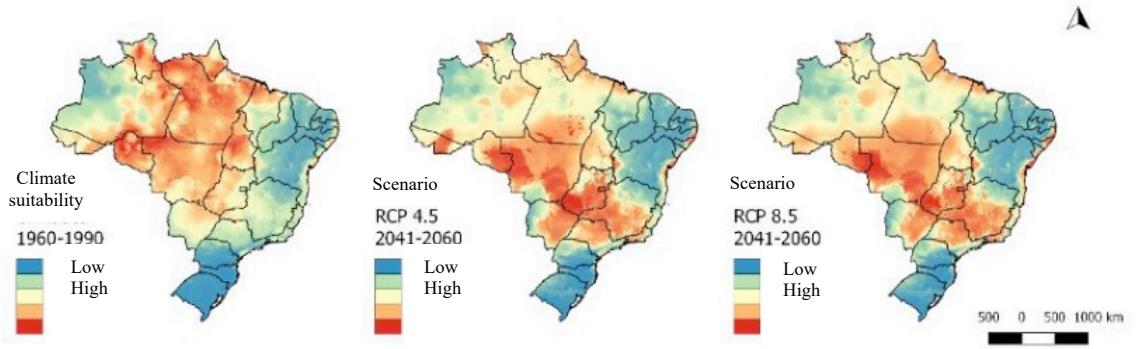

Figure 4.40: Climate suitability of *Lutzomyia flaviscutellata* in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

L. whitmani, the main vector of ATL in Brazil, involved in the transmission of two dermotropic leishmanias, is currently distributed in all Brazilian biomes. Scenarios for 2050 indicate an increase in its area of climate suitability, mainly in the northern and southern portions of its current distribution area. The same scenarios indicate a potential for expansion of this vector into the interior of the Amazon (Figure 4.41).

Lutzomyia whitmani

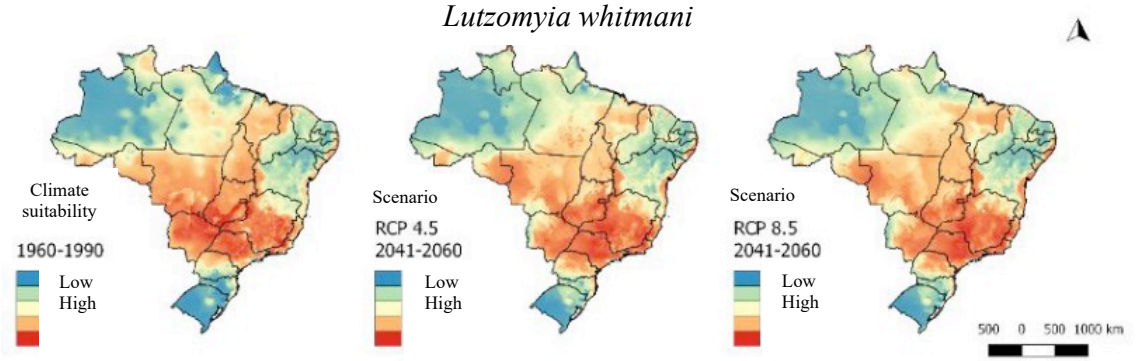

Figure 4.41: Climate suitability of Lutzomyia whitmani in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

Lutzomyia intermedia and *L. neivai*, both vectors of *Leishmania braziliensis* (ATL), are species distributed essentially in areas of Atlantic Forest, with a few records in the Cerrado. For *L. intermedia*, future scenarios indicate a reduction in its area of climate suitability, with a potential shift in the northeast direction from its current distribution more concentrated in the Southeast region. For *L. neivai*, the scenarios indicate an increase in the area climatically favorable to its occurrence, with potential expansion towards the south. By combining the scenarios of both species, it was possible to notice that the current area of sympatry of the two species (interior of SP, MG, and MS) can be reduced under the impact of climate change (Figures 4.42 and 4.43).

Lutzomyia intermedia

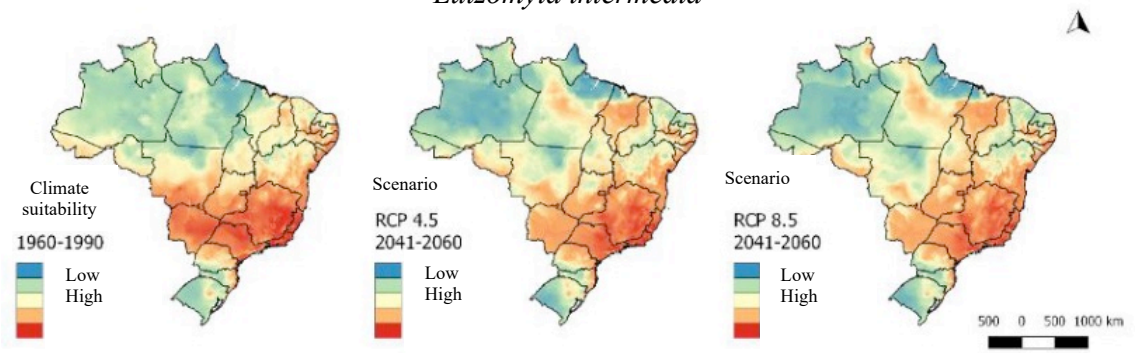

Figure 4.42: Climate suitability of *Lutzomyia intermedia* in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

Lutzomyia neivai

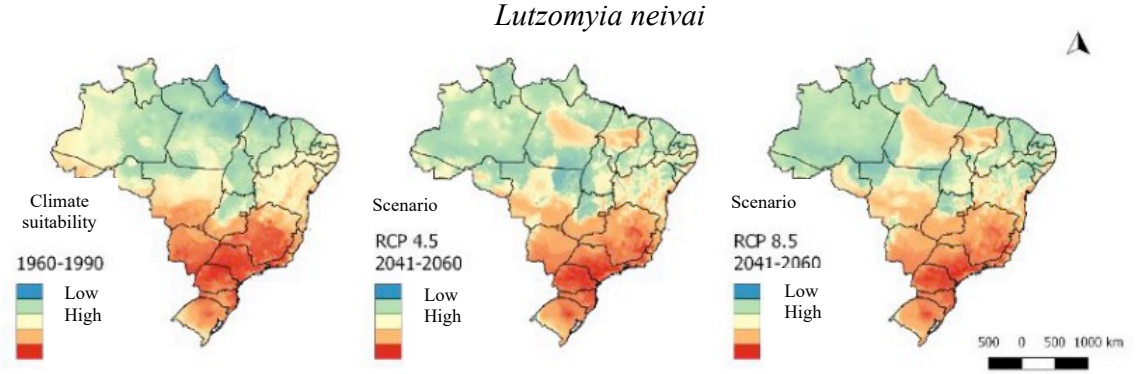

Figure 4.43: Climate suitability of *Lutzomyia neivai* in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

Regarding *Lutzomyia (Psychodopygus) wellcomei* and *L. (P.) complexa*, species evolutionarily close to ATL vectors, the climate and other environmental changes can affect their roles as vectors of *Leishmania (Viannia) braziliensis* in Brazil. *L. complexa* shows tolerance to a wider range of temperatures than *L. wellcomei*, while *L. wellcomei* occurs in areas with less precipitation than areas of occurrence of *L. complexa*. Preliminary results of ecological niche models in a climate change scenario (RCP 8.5, 2050) point to the expansion of the climate suitability areas of *L. complexa* towards the western Amazon, while *L. wellcomei* will have more favorable climate conditions towards the north and the northeast coast of the country (Figures 4.44 and 4.45).

Lutzomyia complexa

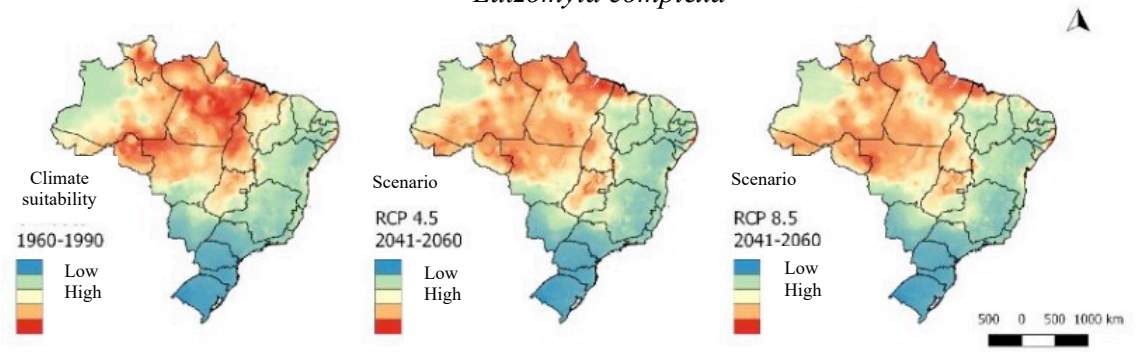

Figure 4.44: Climate suitability of *Lutzomyia complexa* in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

Lutzomyia wellcomei

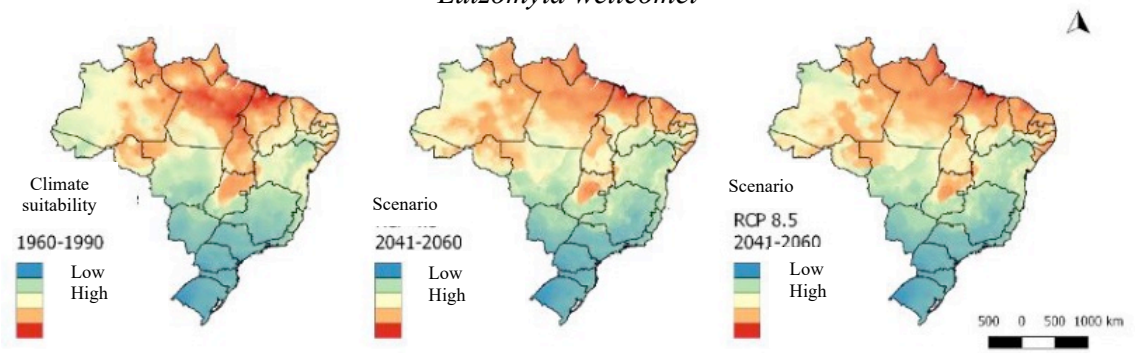

Figure 4.45: Climate suitability of *Lutzomyia wellcomei* in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

Lutzomyia migonei secondary vector of ATL in the Southeast, but also with evidence of transmission of AVL only in the state of Pernambuco, has distribution in several states (Figure 4.465).

Lutzomyia migonei

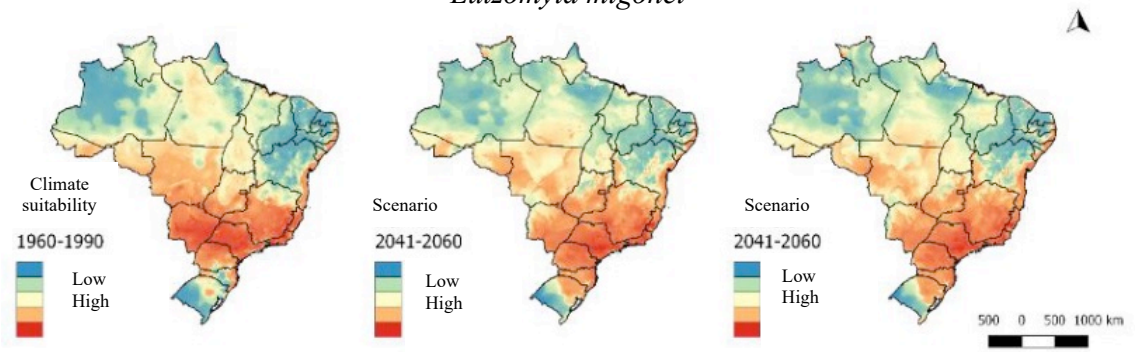

Figure 4.46: Climate suitability of *Lutzomyia migonei* in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

Lutzomyia umbratilis LTA vector, in Northern Brazil, transmitting *Leishmania (V.) guyanensis*, responsible for the clinical form with multiple lesions (Figure 4.47).

Lutzomyia umbratilis

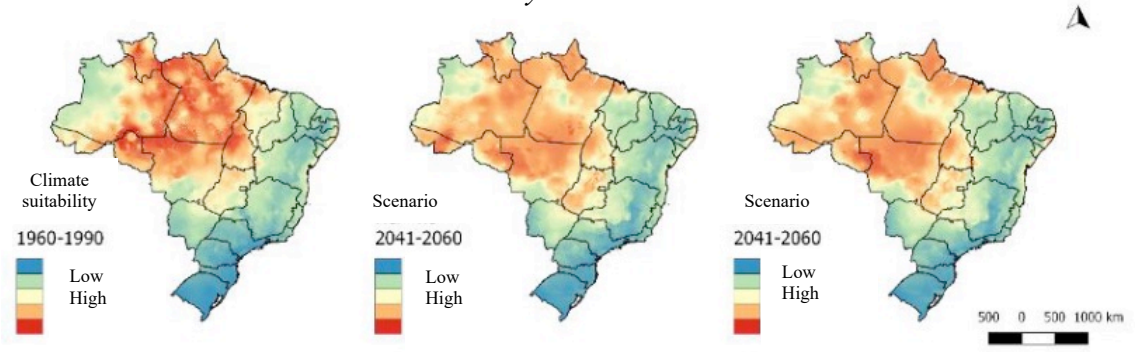

Figure 4.47: Climate suitability of *Lutzomyia umbratilis* in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

L. longipalpis, the main vector of *Leishmania infantum chagasi* in the Americas, has a wide distribution in all regions of Brazil. Scenarios for 2050 indicate that its area of climate suitability will remain stable in most of the country, with expansion mainly in the South and contraction in the western Amazon. The potential distribution of *L. cruzi*, a secondary vector of LVA, was also

evaluated using models combining climate and vegetation cover at multiple spatial scales (Figures 4.48 and 4.49).

Lutzomyia longipalpis

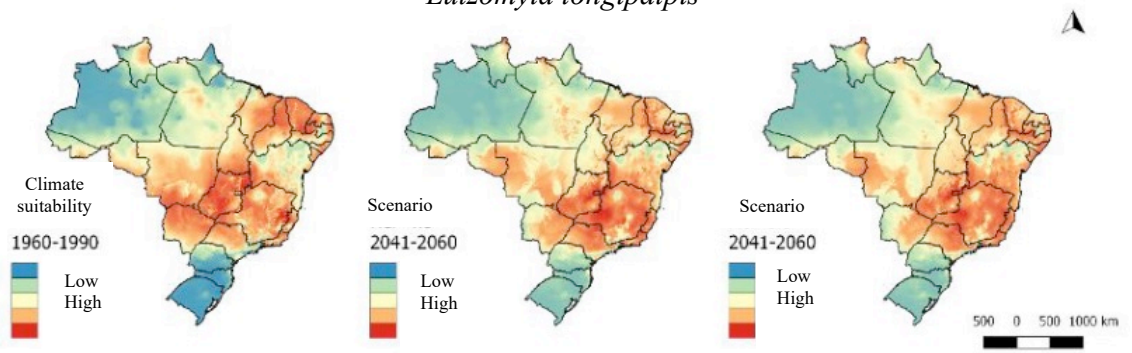

Figure 4.48: Climate suitability of *Lutzomyia longipalpis* in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

Lutzomyia cruzi

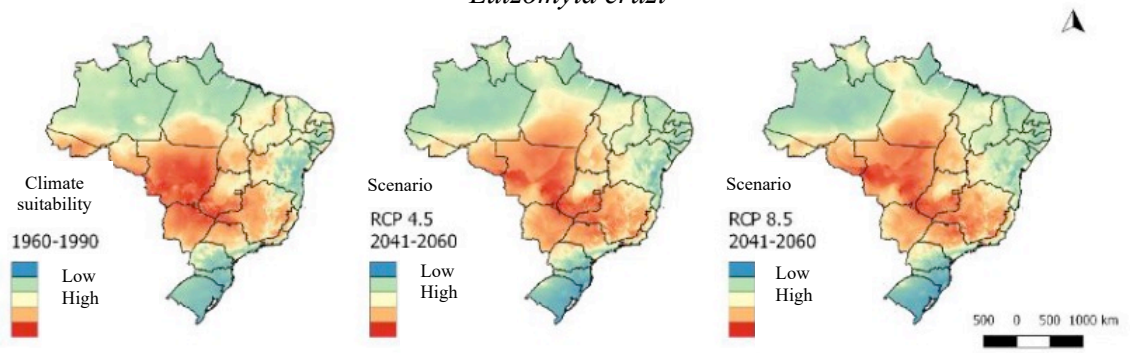

Figure 4.49: Climate suitability of *Lutzomyia cruzi* in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

The control of visceral and cutaneous leishmaniasis has been a major challenge for the Ministry of Health. The goals of reducing the lethality of AVL and the incidence of ATL have not advanced and the scenario that we have today is the expansion and increase in the number of human cases. The actions currently recommended, when the outbreak is already installed, have been ineffective. Therefore, it is necessary to think about alternative planning proposals in the short and medium term, identifying areas vulnerable to the occurrence of these diseases, working with surveillance as a tool that promotes health. Projections of vector distribution (Figure 4.50), associated with socioeconomic variables and incidence of leishmaniasis, will serve as a basis for calculating vulnerability indexes by municipality (next stage of the project). The results disaggregated and analyzed per municipality are important products to subsidize the National Leishmaniasis Control Program and the State and Municipal Health Secretariats of Brazil, in the planning of surveillance and control actions. In addition, the information may support the adaptation measures and integrate the National Plan for Adaptation to Climate Change.

Predicting regions of occurrence of vectors is a complex exercise that the technicians of the leishmaniasis surveillance and control programs face, in the design of a more effective intervention planning. In view of the complexity and challenge posed by the control of these diseases in Brazil, the indication of future risk scenarios for epidemic outbreaks, can optimize costs and facilitate the planning of well-targeted actions with a focus on permanent monitoring and surveillance in areas of environmental impacts.

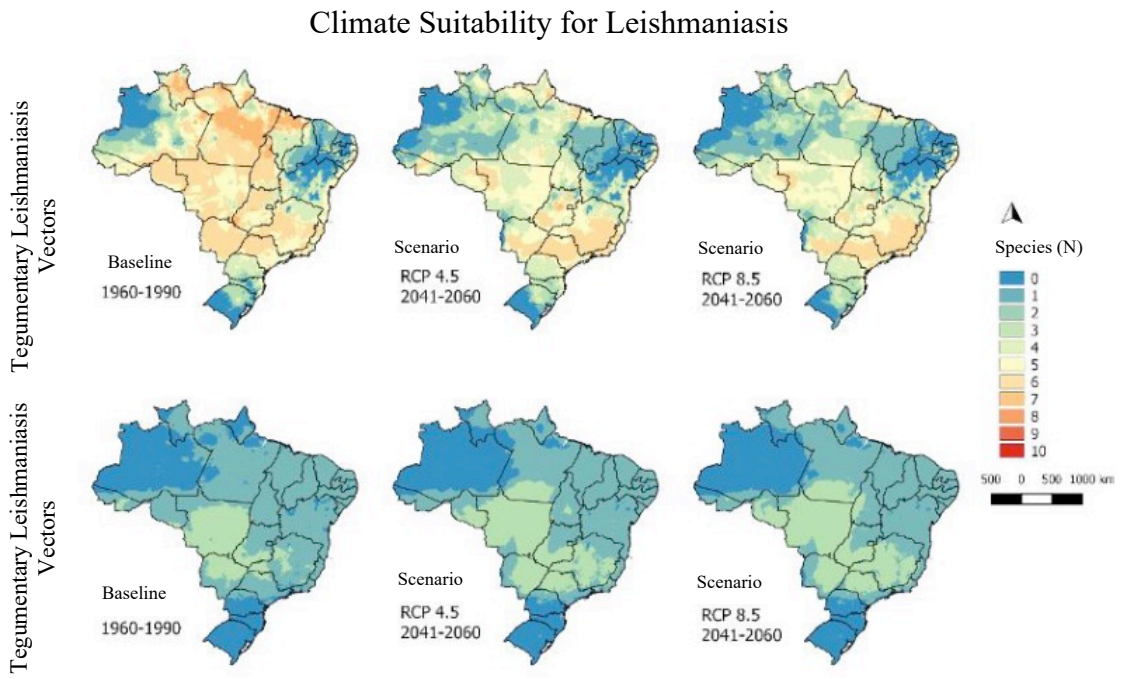

Figure 4.50: Climate suitability of cutaneous leishmaniasis vectors (above) and visceral leishmaniasis vectors (below) in Brazil in the current (1960-1990) and future (2041-2060) time cuts in the climate change RCP 4.5 (stabilization) and RCP 8.5 (high increase) scenarios.

4.7.2 Health-Drought Index

Minas Gerais is the state with the highest number of occurrences of natural disasters between the years 1991 to 2012, in the southeast region, and the second largest in the country (5,086 occurrences). For the year 2013/2014 alone, the state recorded a total economic loss caused by the rainfall of R$2,138,704,613.73, with 237,266 human damages. Despite the great impacts caused by natural disasters in Minas Gerais, the flow of health information related to these events is still not well established. Therefore, initiatives capable of stimulating discussions on this theme contribute to the knowledge of the gaps that exist in this process and prove to be of value in improving the quality of the records.

As important as knowing static situations, such as the number of deaths and evacuated people, is to understand the context in which disaster information is generated, since the quality of the information is directly related to the quality of the data collected.

An explanatory and integrated case study was used. The unit of analysis was the municipality (two small municipalities, two medium-sized municipalities and two large municipalities) and four other sub-units of analysis (epidemiological surveillance, environmental surveillance, civil defense, and fire brigade). Face-to-face surveys were conducted using a guiding script. Figure 4.51 is a generic macroscopic view of the information flow identified, in the vast majority of cases analyzed.

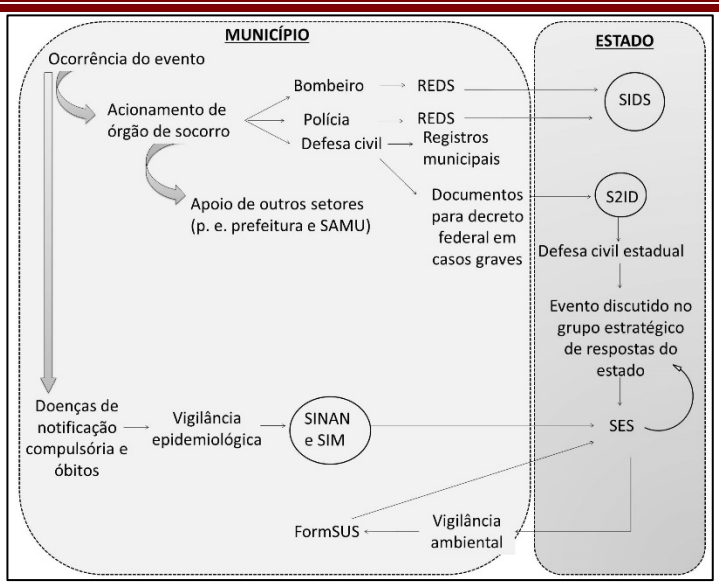

Figure 4.51- Macroscopic representation of information flow in disasters in Minas Gerais municipality, 2019.

It is noticed the absence of a flow of information on disasters previously established in most of the institutions and municipalities surveyed, where the exchange of information happens only in the response stage. There is no prior communication of risk in the stages that precede the event, which could help to minimize the impacts on the population.

Although Vigidesastres began to be discussed almost two decades ago, this is still an unusual area among workers in the sector. It is reiterated that the involvement of health surveillance in the risk management is of paramount importance in all stages of the process and must occur more incisively, coordinated with the various levels of health care, inter and intraorganizational, in order to reduce and control the impacts of disasters on public health.

The main limitations listed are related to human capital and could be mitigated with non-structural actions that encourage teamwork, the qualification of people involved in the collection, storage, processing, and dissemination of information. Such limitations are summarized in table 4.6.

Table 4.6- Limitations and strategies related to the flow of information in disasters.

Limitations	Strategies
• inaccuracy about what a disaster is; • the lack of information on the topic; • the lack of coordination between the institutions involved in a disaster situation; • interference from political issues; • the lack of trained professionals for the positions they occupy; • the lack of integration between civil defense and the community; • the vision of health in a biomedical sense; • absence of a previously established information transmission network.	• advances in the discussion of the theoretical field for institutional practices; • the training of professionals; • improve intra and inter-institutional articulation; • spaces for discussion to exchange information - (for example, periodic meetings with groups of managers); • encourage popular participation in civil defense and protection actions through campaigns in schools and the creation of civil defense centers in the community; • integration of different information systems.

As advances in the flow of information, the research identified the Integrated Disaster Information System - S2ID, which, although underutilized, is an important instrument that shortened the distances between the municipal and state civil defense, since before the bureaucratic procedures - now carried out through the system - they were in the mail with physical documents sent.

The importance of socioeconomic status and other underlying living conditions of the population has been considered relevant to public health policies and the reduction of health inequalities worldwide, especially after the Commission on Social Determinants of Health established by the World Health Organization in 2005 (Lucyk & McLaren, 2017; Pedrana, Pamponet, Walker, Costa, & Rasella, 2016; Rasella et al., 2016; World Health Organization, 2008). This approach recognizes the interaction between social, economic, cultural, ethnic, psychological, environmental, and behavioral factors that influence the occurrence of health problems and their risk factors in the population, generating health inequities among different strata. Recently, these determinants have been analyzed from the perspective of disaster risk reduction, since they influence and overlap the different elements that make up the risk, such as vulnerability, exposure and adaptation, affecting the outcomes related to disasters and health of the population (Gray, 2017; Lindsay, 2003; Nomura et al., 2016).

Understanding how possible interactions between drought and health take place at the regional level is then essential to map risks and vulnerabilities, assisting in the agreement on adaptation and preparedness measures that contribute to reducing future risks from disaster and climate change to human health (Obermaier & Rosa, 2013; Sena, Ebi, Freitas, Corvalan, & Barcellos, 2017; Wilhite, Sivakumar, & Pulwarty, 2014). Thus, this study aims to understand, from a multidimensional perspective, the health-drought process in the Brazilian Semiarid municipalities, a region considered the most inhabited semiarid area on the planet (more than 22 million people).

The results indicated four main factors emerging from the health-drought relationship in the Semiarid: health and its determinants, rural economy and access to water, health outcomes and

infrastructure, and rural structure and social capital. In general, it was observed a differentiation between ruralized municipalities, in which predominated family farming conditions, low access to piped water, low income, recurrent droughts, and agricultural workforce, while municipalities with commercial agriculture (more urbanized) had higher average income, higher distribution of beds and health professionals, less dry periods, and greater access to water and sanitation.

The grouping of these characteristics in an index, named as Health Vulnerability Index (HVI), allowed the identification of hotspots in the Semiarid region where life and health conditions are less developed, requiring greater application of human and financial resources to enable municipalities to mitigate the adverse effects of droughts. The HVI represents the grouping of the four factors observed for the region, ranging from 0 (least vulnerable) to 1 (most vulnerable) (Fig. 4.52). There was a grouping of highest values of the index in the midwestern portion and other clusters in the northeast and southern portions of the region. These are the places that need the most attention regarding the drought-health relationship in the Semiarid and which may become even more vulnerable under the current/future climate hazards. This is because the changes in the average annual temperature are projected higher for the Brazilian Northeast than for other parts of the world, demonstrating that the local impacts can be much stronger, which may in turn exacerbate vulnerability scenarios in the near future (Marengo et al., 2019).

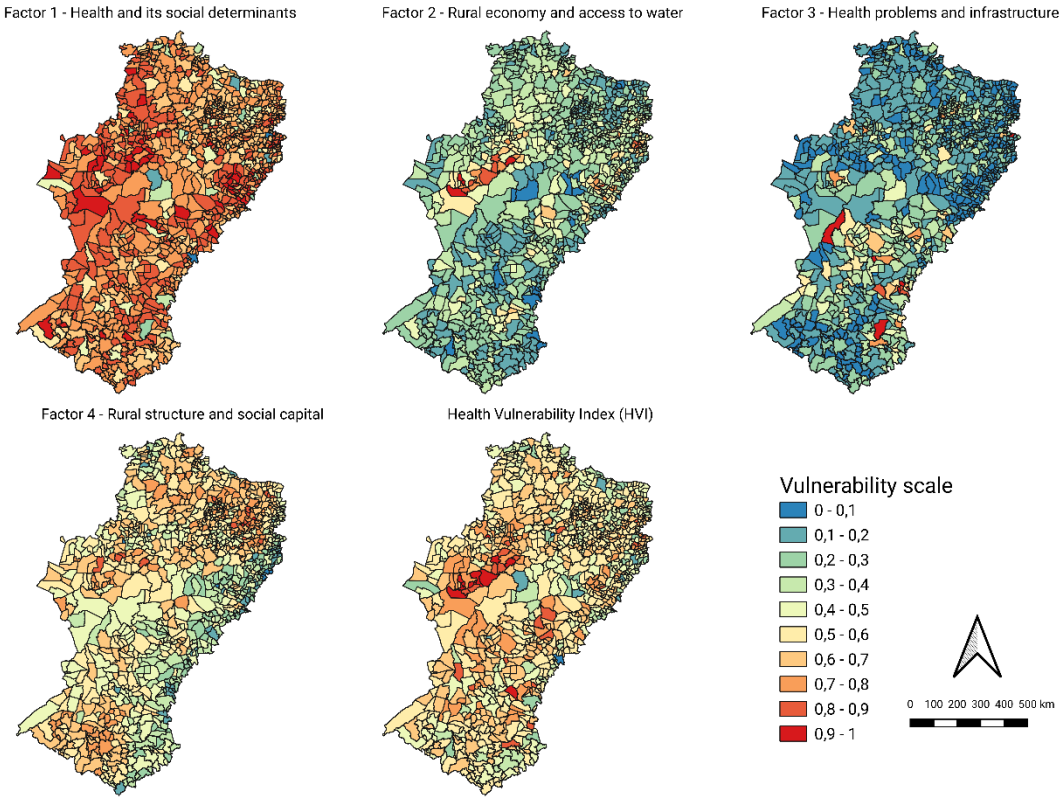

Figure 4.52. Distribution of vulnerabilities across the Semiarid area for each factor identified.

4.7.3 Studies on COVID-19- Epidemiological evaluation, environmental and climatic factors

In December 2019, clusters of patients with pneumonia of an unknown etiology were described in Wuhan, China. The outbreak was further associated to a novel coronavirus (CoV), the SARS-CoV-2. The fast viral dissemination through continents led the World Health Organization to declare the COVID-19 pandemics. In July 2020, 13.150.645 COVID-19 cases were confirmed, with 574.464 reported deaths, worldwide. Presently, Brazil figures among the leading epidemic countries, with more than 2.000.000 cases and more than 75.000 reported deaths. Pandemic response is extra challenging in a continental country like Brazil, with massive regional variations

in socioeconomic inequalities, population density and climate, which effectively contribute to unpaired levels of viral dissemination among municipalities. COVID-19 pandemics undoubtedly amplified our public health and socioeconomic gaps and concerns. SARS-CoV-2 presents a high transmissibility and is mainly spread by infected droplets released by infected subjects. Recently, viral dissemination by air has also been argued. Increasing evidence support a putative role of fecal-oral transmission, since viable viruses were already isolated in faeces of COVID-19 patients.

SARS-CoV-2 is shed in different human excreta and coronaviruses remain infectious in water and sewage for days to weeks. To date, there is no evidence of viral transmission through water, wastewater or food. However, viral RNA has been detected in raw sewage, sludge, treated wastewater, surface water and soil and only few studies reported viral isolation trials. The introduction of contaminated wastewater into natural aquatic environment is a common scene in low and middle-income countries like Brazil. Despite the short viral survival at the environment, this practice can pose a potential risk for wildlife hosts.

The effects of weather variables on COVID-19 context is still controversial and under debate. Some authors point to an impact of temperature, humidity and pressure on viral circulation. However, despite the climatic differences among Brazilian regions (from temperate to tropical patterns), all states were virtually affected by this first pandemic wave, although in distinct periods. Given the significant weather specificities among geographical regions, Brazil is a suitable scenario to investigate putative influence of these variables onto viral circulation, especially considering the contrasts between the Northern (tropical) and South (temperate).

In this new objective, we propose to investigate, with emphasis in the Northern and Southern Brazilian regions: i. the putative impact of climate variables on viral circulation and mortality; ii. the presumed future seasonal patterns of viral circulation in the country; iii. SARS-CoV-2 viability and circulation in polluted surface water, considering the different seasons of the year.

Thus, we propose to enhance knowledge on the role of climate variables on SARS-COV-2 circulation among humans and in the environment. Furthermore, we intend to contribute to SARS-CoV-2 surveillance in our country, which should be implemented under a One Health perspective.

Due to the extension of the Brazilian territory, the intention is to use the state of Minas Gerais as a proxy for the possible socioeconomic and climatic relations that can be observed in other regions of the country with regard to the coronavirus epidemic. The state has 853 municipalities with very different human, economic, and climatic conditions, ranging from places such as the Jequitinhonha Valley and North region (semi-arid), with a hot, dry climate and greater human poverty, to the Triângulo Mineiro and Alto Paranaíba, with better living conditions and subtropical climate. The objective of the work will be i) to survey social and health system vulnerabilities in the municipalities of Minas Gerais and ii) to study climatic patterns that may be related to the SARS-COV-2 epidemic in the state during the first year of registered cases (March 2020 - February 2021).

4.8 Economy and impacts in key sectors

The most important result achieved by the group during the third year of the project is related to the use of a unique database at the municipality level -- developed during the second year of the project -- by various modeling initiatives related to some of the ongoing projects. Different interregional input-output systems for various regional settings in Brazil have been used to calibrate CGE models. Such databases were used, for instance, to calibrate a model for Brazil's semiarid, a model for the Brazilian watersheds, and a model for São Paulo Metropolitan Region. In the first case, a study on the economic impacts of droughts has been concluded (Pimenta, 2020 -- Master thesis) with the participation of researchers from CEMADEN related to the sub-

component "Natural Disasters, Urban Areas, Infrastructure, and Urban Development" of the INCT MC Phase 2; in the other two cases, researchers are working on the model integration with hydrological models developed in collaboration with the subcomponent "Water Security".

The regionalization method had been tested and implemented in different countries, such as Angola, Chile, Greece and Mexico. In this third year, it has also been implemented in Colombia, to develop studies such as the first version of the paper "Boiling Hot! Economy-wide Impacts of Climate Change on Colombian Coffee Yields".

Finally, it should be mentioned that the modeling expertise and the tools developed in the context of the INCT were very successfully used to give prompt responses to policymakers in the context of the COVID-19 crisis control and monitor, especially providing elements to the State Government of São Paulo to develop its "São Paulo Plan", and officers from the MCTIC (Brazil), the Policy Center for the New South -- PCNS (Morocco), and the Banco de la República (Colombia).

4.8.1 Summary of activities

The objective of the subcomponent remains the same:

"To provide policymakers and society in general with quantitative results of rating studies of the economic costs associated with impacts of climate change, to subsidize a more systematic way, the design of sectoral and global public policies aimed at reducing climate vulnerability."

Activities of Work Package # 1 (Integrated modeling) have focused on the development of integrated modeling approaches to generate quantitative results associated with the impacts of climate change. We continued to focus on two areas that received more attention in years 1 and 2: (i) dealing with uncertainty in agriculture productivity models and the implications for economy-wide impacts; and (ii) exploring the effects of climate on demographic variables, mainly fertility rates and, now, health.

We have also added other two key areas, which includes: (i) the water and economic modeling integration; and (ii) modeling uncertainty and risk assessment in the context of unexpected events. In the letter case we have teamed up with colleagues from the Civil Engineering Department at UNAM (Mexico), led by Prof. Mario Ordaz, to devise alternative methodological approaches to integrate risk assessment models and CGE models. Using modeling of earthquakes in Chile, this partnership will be relevant for bringing additional insights and understanding of the economic consequences unscheduled events. We hope to learn from this modeling experience to better inform groups from the INCT and elsewhere dealing with the economic impacts of sea-level rise.

During the third year of INCT MC Phase 2, the activities related to Work Package #2 (Econometric modelling of climate-related economic issues) have been focused on three main themes: (i) development of land use models for assessing the potential for land use intensification in the Brazilian Legal Amazon; (ii) development of econometric models to assess adaptation to climate shocks through rural labor market reallocations and (iii) severe droughts and their impacts on rural school students.

4.8.2 Projects developed

We have also started the development of specific projects within the INCT Climate Change Project, complementing the funding received. In this context, the following projects funded by Fapesp should be mentioned: (i) "Urbanização e Mudanças Climáticas: Análises de Impacto na Região Metropolitana de São Paulo" (Doctorate, 2018/08833-5, granted); (ii) "Agricultural and Agro-Industrial Sustainability in Chile: Modeling the Impacts of Climate Change and Natural Disasters in an Integrated Framework" (CONICYT - Regular Research Project, 2018/08337-8,

granted); (iii) "Fertility and Inequality: Evidence from Brazil " (Fellowship Abroad, 2018/06782-4, granted); (iv) "Uma Análise Espacial de Impacto da Acessibilidade à Água na Produção Agropecuária do Semiárido Brasileiro" (Scientific Initiation, 2018/11799-3, granted); (v) "The Economics of Low Carbon Markets – 2018" (Scientific Event Organization, 2018/17781-9, granted); (vi) "Assessing the Climate and Weather Effects in Brazil using Panel Data" (Fellowship Abroad, 2018/02081-1, granted); (vii) "The Economics of low Carbon Markets" -- 2019 (Scientific Event Organization, 2019/13756-2, granted)

We have also succeeded in receiving additional funding from Instituto Escolhas for master and Ph.D. students: (i) "O impacto da crise hídrica no sistema público de saúde da Região Metropolitana de São Paulo", Tales Rozenfeld (Ariaster Chimeli); (ii) "Transição florestal e instituições: evidências dos últimos 50 anos no estado de São Paulo", Keyi Ando Ussami (Ariaster Chimeli); (iii) "Choque China: efeitos sobre saúde e meio ambiente no Brasil", Victor Simões Dornelas (Ariaster Chimeli); and (iv) "Mudanças Climáticas e Secas no Brasil: Uma Análise Espacial Integrada a partir de Modelos IEGC e Monitoramento Climático no Semi-Árido Brasileiro", Bruno Proença Pacheco Pimenta (Eduardo A. Haddad). Since January 2020, there is a member of the group with a Capes doctoral scholarship (88887.493251/2020-00): "Modelagem Integrada de Sistemas Econômicos e Hidrológicos com Base nas Unidades de Planejamento Hidrográfico do Brasil", Ademir Antônio Moreira Rocha (Eduardo A. Haddad). Finally, in the context of Rede CLIMA and the INCT MC Phase 2, we are concluding the process to receive a grant from FInep involving collaboration/integration of researchers from FIOCRUZ, USP, UFMG, UFPR, UFJF and UFBA related to Economy and Health ("Saúde, Economia e Clima frente à COVID-19 no Brasil: Impactos Socioeconômicos e o Papel da Mitigação de Emissões de GEE na Recuperação Econômica")

We have organized a workshop in Colombia together with colleagues from Banco de la República (Banrep), in Cartagena, on "International Workshop on Interregional Economic Modeling: Applications for the Colombian Economy". The workshop was supposed to take place on March 19-21 (http://www.usp.br/nereus/?p=7396) but it had to be postponed due the COVID-19 pandemic. The project with Banrep is partially linked to our INCT and proposes to replicate some of the INCT-MC features in the Colombian case. Given the focus of the project, planned to be published as a book, we plan to adapt one of its transversal themes ("economy and impacts on key sectors") to Colombia. During the next year, we plan to address issues related to structural features of the Colombian regional system using the tools box developed in this project.

4.8.3 Land use models and potential land use intensification in the Brazilian Legal Amazon (BLA)

Improving land use efficiency to cope with increasing food demand requirements can be an effective strategy to avoid further deforestation in BLA. In order to assess the potential for land use intensification, José Féres teamed up with Marcelo Ferreira from Universidade Federal de Goiás to estimate land use efficiency in BLA agricultural establishments. The researchers applied a stochastic production frontier model based on data from the 2006 Agricultural Census. The authors have been calibrating the econometric model since 2018 (second year of the project) and they have obtained robust results during 2019-2020.

Land use efficiency estimates suggest that there is plenty of room for agricultural land intensification: farmers could reduce agricultural land use by 87.4 % and produce the same output quantity while holding other input quantities constant. This means that, in this region, it is possible to achieve expressive reductions in land use without decreasing agricultural production. This finding also indicates that agricultural production could increase without resulting in further deforestation pressures.

The authores observed a "U-shaped" relationship between farm size and land use efficiency: land use efficiency initially decreases as farm size increases, but after a certain size this relationship is

reversed. However, land use efficiency reached its minimum level at approximately 8,000 ha, which is far above the typical size for agricultural establishments in the Brazilian Amazon. For practical purposes, our estimates are in line with previous results that found a negative relationship between farm size and land productivity.

Land concentration in the Brazilian Amazon has been intensifying since the 1980s. This trend raises social inequality concerns. Our results suggest that, in addition to socioeconomic issues, policymakers should also be concerned with the environmental effects of land concentration, since it may put additional pressure on deforestation.

The paper was submitted for *Land Use Policy*, an international and interdisciplinary journal concerned with the social, economic, political, legal, physical and planning aspects of rural land use. The paper was accepted for publication in June 2020 and it is already available on the journal website (https://www.sciencedirect.com/science/article/abs/pii/S0264837719311123). The first page of the paper entitled "*Farm Size and Land Use Efficiency in the Brazilian Amazon"* may be found in the Annex to this report.

During the fourth year of the project, the estimated land use efficiency parameters will be plugged in the CGE model of work package #1 to simulate the socioeconomic impacts of land use intensification.

4.8.4 Climate change adaptation through rural labor market adjustments

The second research theme has dealt with rural labor supply responses to weather shocks. In a context where irrigation and genetically improved seed are unavailable, drought shocks are likely to negatively affect agricultural productivity, most notably causing lower yields of subsistence crops and reduce income from cash crops. As a result, households could have incentives to increase labor supply to hedge against declining agricultural profitability and smooth consumption. For instance, families may reduce income volatility by increasing the number of hours worked in non-agricultural activities in periods of unfavorable weather conditions. In addition, taking a second job out of agriculture could help keep farmers in rural areas and not to abandon agricultural production. Documenting the quantitative importance of labor supply and other behavioral household responses are crucial for policy design intended to alleviate the adverse consequences of weather shocks.

Understanding the rural labor supply responses to weather shocks is particularly relevant in developing countries. Since these countries are located in warmer areas, they are expected to experience a disproportionate share of extreme weather events in the future. Moreover, these countries have limited social safety nets, limited access to credit markets, and irrigation and genetically improved seed are not always available, restricting the portfolio of available adaptation strategies to weather events.

José Féres teamed up with Danyelle Branco from University Federal de Pernambuco in order to examining how household adjust their allocation of labor in response drought shocks in Northeastern Brazil. The focus on Northeastern Brazil provides a compelling setting to investigate this question for several reasons. First, it is the driest Brazilian region and it has long been subject to harsh climatic conditions, with recurrent events of drought.

The authors found that negative rainfall shocks are associated with greater likelihood of holding more than one job, reduced share of farm activities, and a higher share of secondary non-agricultural job. These effects tend to be stronger among households residing in municipalities with lower per capita income. This heterogeneity is consistent with the idea that households with limited social safety nets and potentially limited access to alternative short-run mitigation sources are more likely to adjust their labor supply to cope with adverse income shocks.

The authors submitted a paper to the *American Journal of Agricultural Economics.* The manuscript entitled "Weather Shocks and Labor Allocation: Evidence from Rural Brazil" is currently in the second revision round.

The impact of labor market adjustments to weather shocks will be further investigated by integrating the labor responses in the CGE model. These activities are predicted to take place during the fourth year of INCT MC2.

4.8.5 Severe droughts and their impacts on rural school students

A number of studies have documented the detrimental effects of extreme weather events on sectors such as agriculture, energy generation, infrastructure and human health. However, little attention has been devoted to the relationship between extreme events and educational outcomes.

Of particular interest are the potential negative impacts of droughts on student achievement in rural schools located in low-income regions. In Northeastern Brazil, there is plenty of anecdotal evidence that schools in rural semiarid areas are forced to temporarily cease activities due to lack of water storage infrastructure. It is estimated that approximately 40.5% of all public schools have no water storage devices such as water tanks and cisterns. The "Articulação Semiárido Brasileiro" (ASA), an association representing more than 1,000 NGOs engaged in regional development actions in the Brazilian semiarid, have been constantly denouncing that schools without cisterns are forced to close during severe drought periods. Such disruptions may contribute to poor student achievement and high school evasion rates.

In addition to the lack of water storage facilities, two more underlying mechanisms could explain the relationship between drought periods and poor school performance. Due to the decrease in agricultural income, parents may employ child labor as a substitute to adult labor in household activities or farm work during severe drought periods. Other potential channel is through health. Lack of safe drinkable water can directly lead to increased incidence of infectious diseases, such as diarrhea, affecting young children. Both mechanisms could prevent children from attending school and provide incentives for school dropout. The impacts for long-term human capital accumulation could be substantial. This is particularly critical since the Northeastern semiarid is one of the least developed Brazilian regions. All municipalities located in the Brazilian semiarid region present human development index levels below the national average

José Féres teamed up with Danyelle Branco to assess the impact of drought shocks on student performance in rural schools located in the Brazilian Northeast. Specifically, the authors were interested in answering the following questions: Are drought periods associated to lower student achievement levels? What are the mechanisms underlying the relationship between droughts and poor school performance? Could investments in the construction of cisterns be an effective way to mitigate the negative effects of droughts on student performance?

Results show that drought shocks are associated to lower scores on both Mathematics and Portuguese exams. By investigating the potential transmission mechanisms underlying the relationship between weather shocks and school performance, we observe that exposure to a negative rainfall shock increase the hospitalization rate among children. In addition to that, severe droughts are also associated to higher probability of child work. Both health- and job-market related effects may be associated to lower school attendance and therefore contribute to poor student achievement.

Results also provide suggestive evidence that drought tends to be more harmful to children that study in schools without cistern or other water storage devices. Therefore, investing in basic infrastructure like cisterns is a low-cost policy strategy that may offset the negative effects of droughts, considerably improving school performance in Brazilian semiarid rural areas.

In a broader perspective, this result highlights the importance of investing in rural school infrastructure. Much of government efforts in Brazil are devoted to "urban education issues", such as enhancing teaching quality. Little attention is devoted to rural education issues, where critical problems like the provision of adequate infrastructure have not been properly addressed.

The first draft of the paper entitled "*Drought Shocks and Student Achievement in Brazilian Rural Schools"* has been presented at the 24th Annual Conference of the European Association of Environmental and Resource Economists in Manchester, UK (presentation cover in the Annex). The event took place between 26 and 29 June, 2019.

During the fourth year of the project, the authors intend to submit the paper to the *Journal of Development Economics*, a leading journal in the field of Development Economics.

4.9 Modelling the earth system and production of future climate scenarios to study Vulnerability, Impacts and Adaptation

4.9.1. BESM Global Model

During this period, BESM2.5 piControl and Abrupt4xCO2 runs 1,000+ years of integration were analysed and converted into a manuscript, to be submitted. The analyses revealed the whole of Arctic sea ice melting as a potent trigger of the Atlantic Meridional Overturning Circulation (AMOC) strength reduction, at the same time that revealed the atmospheric driven ocean-atmosphere fluxes, which eventually led to the re-establishment of the AMOC.

Four articles were published, two of them in the prestigious Geoscientific Modeling Development (GMD) about BESM CMIP5 global scenarios, documenting BESM model Historical run (Veiga et al. 2019b) and the Abrupt4xCO2 scenarios results (Capistrano et al. 2020), one in the Atmospheres journal on the representation of Atlantic meridional mode in BESM historical simulation (Veiga et al. 2019a) and one on paleoclimatic aspects in the Global and Planetary Change journal (Venancio et al. 2020).

Two manuscripts are under peer review, covering the aspects of polar amplification under Abrupt4xCO2 scenario for both CMIP5 and CMIP6 models runs (Casagrande and Nobre, 2020), and Southern Hemisphere sea level rise under RCP 8.5 climate change scenarios (Giarolla et al., 2020 - accepted for publication on July 15, 2020).

There are five other manuscripts in preparation, which encompasses: (i) BESM RCPs scenarios contrasted with other CMIP5 and CMIP6 scenarios (e.g. Figure 4.53a.1.1 below); (ii) the anticipated changes of the hydrological cycle over Brazil and (iii) tropical Atlantic warming and water masses formation; (iv) sea ice extent intercomparison among CMIP5 and CMIP6 model simulations when average global warming under RCPs 4.5 and 8.5 reach 1.5, 2.0, and 3.0 degrees Celsius above each model's piControl run; in addition to (v) the impacts of the combined effects of global warming and Amazon deforestation on human health in Brazil.

In terms of modeling tools for global climate change scenario computations with the BESM model, INCT-MC2 Modeling Component counted with the work of a FAPESP fellowship in high performance computing, which developed automation tools for model integration and analyses for both BESM and the Eta models. During the test integrations of BESM2.9 for the generation of CMIP6 scenarios, two major happenings were detected. One, that the new version of the model corrects a radiative imbalance still present in the previous version of the model. Two, the now improved radiative code generates an spurious sea ice over the polar latitudes of the globe, creating an anomalous equatorward expansion of the Arctic/Antarctic sea ice. Such sea ice anomalies, on the other hand, prevent the formation of North Atlantic Deep Water (NADW), with impacts on the AMOC circulation.

Also, in the period of this report, the Brazilian Earth System Model, coupled ocean-atmosphere-cryosphere-biosphere (BESM-OA2.9) has been migrated to CPTEC's CRAY XC-50 supercomputer, which represents a 5-fold increase in the speed of model integration, now integrating up to 10 years of model simulation per 24h of CPU time, using mere 300 cores processing units, to generate climate change long runs. In terms of reaching out for societal impacts, the members of the Modeling Component of INCT-MC2 have been involved in seminars and talks. One lecture was delivered by Paulo Nobre at a live-lecture at the Federal University of Rio de Janeiro (UNIRIO) on the impacts of the COVID-19 lockdown worldwide on the environment, in April 2020, which has reached some 400 persons online. The recorded lecture can be reached at: https://youtu.be/dUENyRD2FCg

Another presentation was delivered by Paulo Nobre at the Dresden Nexus Conference. Paper titled "The Project Ecolume: the abundance paradigm in living along with the semiarid climate in the Brazilian Northeast" oral presentation under Session 16 (Circular economy and social inclusion: Participatory and Equitable Approaches for Sustainable Resource Management). Thursday, 04.06.2020, from 3.30pm-5.00pm. The recorded lecture can be reached at: https://www.dropbox.com/s/viuiuebylq0qg99/Lacerda_Nobre_DNC2020.mov?dl=0

4.9.3 RESM Eta based regional model

Modular new version: The Eta model code has been modified by removing all common blocks and replaced by module calls. This new version of the model enables easier coupling of new physics processes. This version of the model has been tested for long integration and has reproduced the results of the previous version. New version with restart function: The restart functionality of the model is revisited in order to operate with the FMS coupler. This will enable the coupling with the MOM5 ocean model and to run in a research controlled environment.

The previous GFDL radiation scheme was replaced by the RRTMG radiation scheme. The RRTMG was initially tested in cloud free sky. Recently, the evaluation for cloudy sky for a domain that covers the entire South America and Central America has been carried out for a long integration. A paper is being prepared on this evaluation. The RRTMG scheme is further coupled with the convection scheme (Figure 4.54).

The previous NOAH land-surface scheme is replaced by the NOAH-MP scheme (Figure 4.55). The version is modified to contain 8 soil layers and improved the surface fluxes in the Eta/Noah-MP model. The depth of the soil layers are: 0.1, 0.4, 1, 2, 3.5, 5.6, 8.4 and 12 meters. This version has run long term simulations. The replacement of the land-surface from NOAH to NOAH-MP scheme still requires some fine tuning of the land-surface properties. Precipitation evaluation against observations (GPCP) shows larger underestimate, in the entire domain.

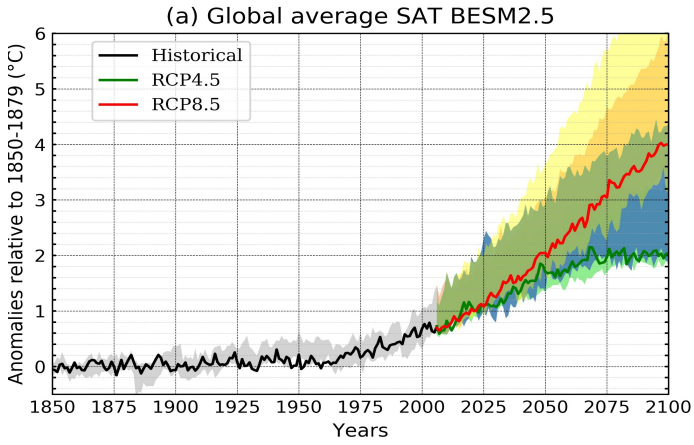

Figure 4.53 – 1850-2100 BESM 2.5 simulations under Historical radiative forcing protocol (1850-2005) and under RCPs 4.5 and 8.5 protocols for the period 2005-2100. The shaded areas under the black, green and red curves represent the span of temperature for CMIP5 and CMIP6 model runs. Source: Veiga et al (2020, in preparation).

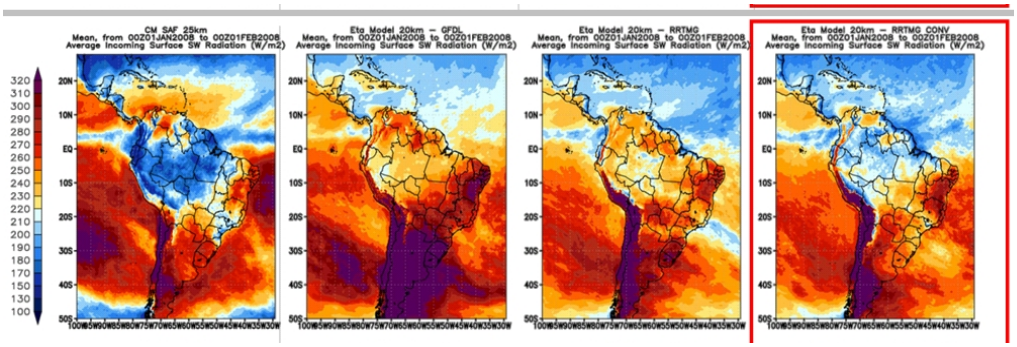

Figure 4.54– January mean Incoming shortwave radiation at the surface (W/m²). From left to right: CMSAF estimate (a), simulated by the Eta-GFDL (b) simulated by the Eta-RRTMG, and simulated by Eta-RRTMG_with coupling with convection . Values are averaged between 01/01/2008 and 01/02/2008.

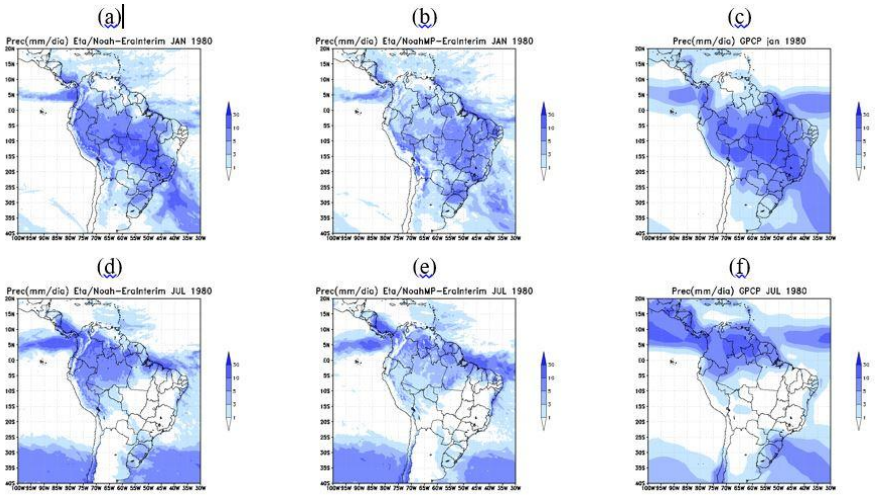

Figure 4.55 – Precipitation (mm/day) simulated in January by (a) Eta-NOAH; (b) Eta-NOAH-MP; (c) GPCP; and simulated in July Eta-NOAH; (g) Eta-NOAH-MP; (f) GPCP

4.10 Communication, dissemination of knowledge and education for sustainability.

The Cross Cutting Theme Communication of the INCT (National Institute of Science and Technology) MC2, during the period of this report, deepened theoretically, aesthetically, and in practical actions the ideas that communicating is: promoting meetings between the heterogeneous (DIAS, 2020); creating new modes of being together, living together (DIAS & PENHA, 2019); constituting a common which keeps lines of variation (AMORIM, 2020); paying attention to the multidimensionality involved in climate change and in the ways they affect the subjectivities, that is, the ways of living, thinking and existing (MORENO & MARTINS, 2020; taking nature – winds, rains, rivers, mushrooms, trees, forests... –, like partners of thought, research and creation, as scientists do (CHIODI, 2020; DIASb, 2020; DIAS & PENHA, 2020); opening humans to the cosmos, allowing an understanding of the allied humans and settled by non-humans (DIAS; AMORIM, SPEGLICH, 2019; DIAS, PENHA, 2019).

With regard to the products of the researches, three dossiers of the ClimaCom journal were published with the themes "The language of contingency", "Peoples hear: the courage of shame" and "Forests". This production makes it possible to understand communication as a kind of laboratory-atelier, where researchers of several components and Cross Cutting Themes of this INCT MC Phase 2participate in articles, essays, subscribed columns, news, reports, photo essays, workshops etc.

Among the collective publications, the book Conversas infinitas: divulgação científica, educação, mudanças climáticas e…, ["*Infinite conversations: scientific dissemination, education, climate change and…*"] (DIAS; OLIVEIRA, PESTANA, 2020) stands out. It gathered studies by 20 researchers of the humanities and arts from different regions of the country and from Argentina - who are part of this Cross Cutting Theme Communication. Its contribution goes toward highlighting: the human dimensions of climate change; the various functionings of the negationism/denialism and the end of the world narratives; the reflections around the archiving attitude of science and communication: the challenges of the composition of common causes and worlds before the Anthropocene, among other themes.

The texts of this book elucidate the relations between scientific dissemination, education and climate change in several narrative dimensions which are little effective to generate new sensibilities to the questions related to the changes in the planet's climate, such as:

- those of fear, which aim to comply with the norm (ANDRADE & OLIVEIRA);
- the simplistic and instrumental ones, which emphasize the traditional executive management (MORENO & MARTINS);
- the ones which focus solely on the dimensions of the opportunity and the progress of the technosciences (DIASc, 2020);
- the ones which show the "inability to manage the environmental problem and its implications" (MORENO & MARTINS, 2020);
- the ones which denote the impotency of the dominant modes of perceiving, thinking and narrating (DIAS, 2020; ANDRADE, OLIVEIRA, 2020).

In this sense, the book points out that: "the uncertainties should not operate as fear agents, but rather as cracks of possibilities" (ANDRADE & OLIVEIRA, 2020); that the wild dimension of life (OLIVEIRA JR.) and the challenge that scientists, writers, filmmakers, journalists face... of entering into communication with all alive worlds, in constant movement and formation, marked by uncertainties (DIAS, 2020), need to gain affirmative expressions that constitute new problematic fields.

The research presented in the book aim at moving thoughts and actions around a communication and education which: a) investigate the layers of meanings that coat the names nature, culture,

science, scientific dissemination (GARCIA, 2020); b) pay attention to the vibrations that affect the bodies and metamorphose the practices (OLIVEIRA JR., 2020; DIAS, 2020); c) recognize the countless other legitimate uses of climate information (TADDEI, 2020); d) welcome the potency of poetry (QUEIROZ FILHO, 2020) and fiction (GARCIA, 2020; BELINASO & GOMES, 2020, CHIODI, 2020; ANDRADE & OLIVEIRA, 2020, OLIVEIRA, 2020; DIAS, 2020; DIAS & PENHA, 2020); e) make visible what is on the borders and escapes the anthropo and logocentric perspectives, welcoming the need to problematize the habitual logics of dissemination and experiment new modes of dissemination (DIAS; AMORIM, OLIVEIRA, 2019; GARCIA, 2020; BELINASO & GOMES, 2020, CHIODI, 2020; ANDRADE & OLIVEIRA, 2020, OLIVEIRA, 2020; DIAS, 2020; DIAS & PENHA, 2020); f) combat the communicating xenophobia which hugely affects the communication and the education of themes like climate change (DIAS; AMORIM, OLIVEIRA, 2019).

Another research product is the photobook Forest² (DIAS & PENHA, 2019), an example of an attempt to experiment what a communication can do when thought in alliance with the forests. The book seeks to gather and connect, in unprecedented ways, people, practices, thoughts and materials collected and produced in a forest reserve, an urban quilombo, the laboratory of Embrapa of Unicamp (which coordinates the food security subcomponent of this INCT), a classroom and a square of Unicamp and provide a cheerful clarity for the encounters with science, arts and philosophies concerning climate change.

4.10.1 Results from interviews

The work by Allison Almeida was done by interviewing researchers linked to all sub-components and cross-cuting themes of INCT aiming to produce journalistic material (news, interviews, story, etc.) both to ClimaCom Journal and INCT sites. The interviews were conducted with:

-Eduardo Assad from the Food Security component in the interview "O problema da fome no Brasil não decorre da produção de alimentos, mas sim da distribuição" (Available from: http://climacom.mudancasclimaticas.net.br/entrevistaeduardoassad/)
-José A. Marengo, coordinator of INCT-MC2, in the interview "A comunidade científica brasileira não permitirá que a reflexão sobre as mudanças climáticas estacione" (Available from: http://climacom.mudancasclimaticas.net.br/entrevista-jose-a-marengo-a-comunidade-cientifica-brasileira-nao-permitira-que-a-reflexao-sobre-as-mudancas-climaticas-estacione-por-allison-almeida/)
-Enio Pereira Bueno, from the Energy Security componente in the interview "Ciência é aliada vital na produção de energia limpa do Brasil" (Available from: http://climacom.mudancasclimaticas.net.br/entrevista-enio-pereira-bueno-ciencia-e-aliada-vital-na-producao-de-energia-limpa-do-brasil-por-allison-almeida/)
-Paulo Nobre, from the Cross-Cutting Earth System Modelling, in the interview "Modelagem climática, sistemas caóticos e incertezas" (Available from: http://climacom.mudancasclimaticas.net.br/entrevista-paulo-nobre-modelagem-climatica-sistemas-caoticos-e-incertezas-por-allison-almeida/)
-Paulo Artaxo, from the Ecosystems and Amazonia component in the article "Monitorar a Amazônia e o cerrado é um gesto vital para proteção dos ecossistemas e geração de novas compreensões climatológicas" (Available from: http://climacom.mudancasclimaticas.net.br/monitoramento-da-amazonia-e-cerrado-e-vital-para-proteger-ecossistemas-e-gerar-novas-compreensoes-climatologicas/)
-Marko Monteiro, Elenise Andrade, Gabriel Cid, Sandra Murriello, Isaltina Gomes, Renzo Taddei, Claudia Pffeifer e Leandro Belinaso, from the Cross-Cutting Theme Communication, in the interview "Mudanças climáticas e divulgação científica em multientrevista, pluriolhares, poliescutas…" (Disponível from: http://climacom.mudancasclimaticas.net.br/mudancas-climaticas-em-multi-entrevista-pluri-olhares-poli-escutas/) and the mew "Abusar da pulsão de vida diante das mudanças climáticas, pandemia e negacionismo" (Available from: http://climacom.mudancasclimaticas.net.br/allison-almeida-abusar-da-pulsao-de-vida-diante-

das-mudancas-climaticas-pandemia-e-negacionismo/).
-And Regina Alvalá, whose interview will be published soon in ClimaCom Journal.

4.10.2 Publications in Clima.com Journal

Gláucia Perez has already done the follow journalistic subjects for *ClimaCom* Journal:

-Interview with José Marengo in order to write the note "Não é eficaz pensar na seca como um fenômeno genérico e abstrato" (Available from: http://climacom.mudancasclimaticas.net.br/seca-fenomeno-abstrato-estudo-de-caso/). The new is concerned to the paper "Extreme Drought Event over Brazil from 2011 to 2019" de Ana Paula M. A. Cunha, Marcelo Zeri, Karinne Deusdará Leal, Lidiane Costa, Luz Adriana Cuartas, José Antônio Marengo, Javier Tomasella, Rita Marcia Vieira, Alexandre Augusto Barbosa, Christopher Cunningham, João Victor Cal Garcia, Elisangela Broedel, Regina Alvalá e Germano Ribeiro-Neto; "Diante do Antropoceno, tecer um rio voador para comunicar" (Available in : http://climacom.mudancasclimaticas.net.br/diante-do-antropoceno-tecer-um-rio-voador-para-comunicar-claudia-tavares/); "Escrita e fungos: o que pode essa relação?" (Available in: "http://climacom.mudancasclimaticas.net.br/escritaefungos/) e "E quando o corpo (não) comunica? Artista Lerato Shadi dá a pensar as relações entre corpo e Antropoceno" (Available from: http://climacom.mudancasclimaticas.net.br/e-quando-o-corpo-nao-comunica-artista-lerato-shadi-da-a-pensar-as-relacoes-entre-corpo-e-antropoceno/). The last three pieces are related to invited people who participated of *Simbioses* event.

We have organized and launched three dossiers of ClimaCom Journal - "A linguagem da contingência" (ago 2019); "Povos ouvir: a coragem da vergonha" (dez 2019) and "Florestas" (jun 2020), cointaining papers, essas, reviews, com artigos, ensaios, resenhas, signed column, News, interviews, reports and cultural and artistic productions. We have started the Seminars Cicle "SIMBIOSES: encontros de artes, ciências, filosofias e mudanças climáticas" and have done two encontres wtih these thematic:

-"Água, matéria viva", with participation of Eduardo Mário Mendiondo (coordinator of the Water Security component, Ernesto Bonato (visual artist, Master of Univeristy of São Paulo), Carolina Rodrigues (social science of FCA-Unicamp) and Susana Dias (coordinator of Cross Cutting Theme Communication) (Available from: http://climacom.mudancasclimaticas.net.br/satelite/primeiro-encontro-simbioses-agua-materia-viva-acontece-na-unicamp-nesta-sexta/);
-"Refúgios para espantar o Antropoceno", with Claudia Tavares (visual artist and PhD of UERJ), Antonio Carlos Amorim (coordinator of Cross Cutting Theme Communication) and Vitor Chiodi (anthroplogist and PhD student of IFCH-Unicamp);

We keep stimulating the researchers from other components and Cross Cutting Themes to publish papers into the Section Signed Column of ClimaCom Journal. We got these papers:
-*Coronavírus e clima* por Ulisses Confalonieri, Elizabeth Rangel, Maria de Lourdes Oliveira, Júlia Menezes e Rhavena Santos, da Sub-componente Saúde (Available from: http://climacom.mudancasclimaticas.net.br/ulisses-confalonieri-elizabeth-rangel-maria-de-lourdes-oliveira-julia-menezes-e-rhavena-santos-coronavirus-e-clima/) and
-*2019, o ano líquido que não acabou* por Eduardo Mario Mendiondo da Sub-componente Segurança Hídrica (Available from: http://climacom.mudancasclimaticas.net.br/eduardo-mario-mendiondo-2019-o-ano-liquido-que-nao-acabou/);

4.10.3 Results from scientific divulgation activities

We have finished the National Report of Communication and Climate Changes in this book layout: "Conversas infinitas: divulgação científica e mudanças climáticas e…" organizado por Susana Dias, Renato Oliveira e Fernanda Pestana. The book is in the final step of edition (cover and summary are attached) and approach themes like climate change sckepticism, public

participation, human dimensions, common world, among others. Focusing on climate changes in the perspective of human sciences, philosophy and arts.

We have launched the photobook *Floresta* edited by Susana Dias and Alessandra Penha and that took together researchers from Sub-Component Food Security coodinated by Professor Eduardo Assad of Embrapa-Unicamp Campinas, the Comunity of Jongo Dito Ribeiro of urban quilombo and Culture House e Casa de Fazenda Roseira, artists of Campinas and São Paulo, and biologists of Mata Santa Genebra.

The public survey "Cambio climático en Bariloche: una encuesta de percepción pública" was posted through the web and local medium. The results were analysed by the student Laura García Oviedo as part of her Master dissertation named "Percepción publica del cambio climático", da Maestría en Ciencia, Tecnología e Innovación da UNRN, supervised by Profa. Dra. Sandra Murriello.

Prof. Dr. Leandro Belinaso has finished one e-book which includes five interviews with environmental educators with wise expertise in Brazil . The book is in the edition phase (for summary and cover see annexes). To cope with climate change, the environmental education focus in the ways of how cultural and historically we have engaged, as human and no-human, and gets an unquestionable political pertinence and actuality. Besides interviews, the book contains an extensive list of commented references from literature, movies and musical that will contribuite to the reflection about socioambiental relationships that constitute ourselves, opening space to think ways of existence that face the climate change problematic.

Dr. Carlos Queiroz, from UFES, was a Visiting Professor in February 2020 at the School of Architecture, Planning and Environmental Policy and Earth Institute, at University College Dublin, Ireland, where I collaborated on the project "Coastal Communities Adapting Together" (CCAT), funded by the EU as part of the Ireland Wales program. The Irish Sea and its coastal communities are directly affected by climate change. The CCAT operation aims to respond, helping to build resilience (adaptive capacity for change), facilitate marine and climate citizenship and realize the potential of the Irish Sea region in connecting coastal communities with their place and their coastal systems dynamic. Queiroz received the "Small Responsive Funding Scheme" Award, from the Earth Institute, University College Dublin - UCD, dedicated to supporting research, technical visits and lectures/conferences by visiting research professors at the institution.

Drs. Simone Pallone and Susana Dias have got one Fapesp Mídia Ciência Scholarship assigned to the student Camila Ramos to produce podcasts for the Section Escuta Clima of *ClimaCom* Journal and to produce texts for the Journalism Section of ClimaCom and Comciência Journals, involving all Sub-Components and Cutting Themes INCT-MC2. The student has already done her first program, a podcast about Energy Security with participation of Roberto Shaeffer and André Gonçalves. The publication of jounalistic materials will be happen when three episodes are finished. Camila Ramos produced those journalistic material:

-Coprodução e a natureza especulativa das modelagens computacionais nas pesquisas em mudanças climáticas. Available from: http://climacom.mudancasclimaticas.net.br/coproducao-camila-ramos/

-Quarentena reduz poluição atmosférica, mas impactos das mudanças climáticas são tímidos. Available from: http://climacom.mudancasclimaticas.net.br/camila-ramos-quarentena-clima/

Prof. Dr. Susana Dias together with Allison Almeida and Gláucia Perez have done field work in the laboratory coordinated by Mario Mendiondo, leader of Water Security component, collecting statements in audio and video of many researchers that work in the INCT about the thematic of water and security.

5 Integration among components of the project in Year 3

As previously described in the sub components and cross-cutting themes, there is convincing evidence that our climate is changing, and that emissions of greenhouse gases from human activities are partly responsible for these changes and decisions in different sectors of society. The economy will need to take into account and manage the risks associated with climate change. It is also known that climate change is also a source of uncertainty for decision makers, due to the limitations of our scientific knowledge about the dynamics of the Earth system and how the climate will respond to anthropogenic forces at different scales. At the same time, there are trends and evidence of global environmental changes exceeding the limits of the planet, with increased risk for society to advances in the science of climate change models and allow us to be sure to present and future modifications.

So the challenge of the INCT MC Phase 2 will be to provide an integration of all six components and three cross-cutting themes through dialogue and workshops, for a better understanding of the impacts and benefits arising from current climate variability, and help to think of ways to reduce the uncertainty surrounding the consequences of future climate change scenarios.

The new observations and projections of climate models and future scenarios of climate change should be placed in the context of these established thresholds and integrated assessment of adaptation options and pathways.

This task of coordination can help decision makers to recognize and assess the risks arising from a change in climate, making the best use of available information on climate change, its impacts and appropriate adaptive responses as a project of true integration. In the initial proposal we planned various workshops (total of six), which will lead to the preparation of documents and reports that to guide the upcoming workshops. Due to budget constraints we decided to have 5 workshops starting on 2019 until 2023.

The database generated by the natural disasters component subsidized the development of a Master research, titled “Mudanças Climáticas e Secas no Brasil: Uma Análise Espacial Integrada a partir de Modelos IEGC e Monitoramento Climático ao Semiárido Brasileiro”. This research is been conducted by Bruno Proença Pacheco Pimenta, a Master's student of the Postgraduate Program in Economics at USP, and guided by Dr. Eduardo Amaral Haddad. Dr Ana Paula Cunha was invited as an external member of the examiner committee.So far, in year 2 various workshops took place among individual components and collaboration between two or more sub components to adjust to the reality of a budget cut, and in some cases to redefine the specific objectives, with some new people coming and other leaving the project due to retirement, changing institution or to inability to wait for almost 3 years since the time of submission to the time of the formal approval.

The natural disasters and health componentes of the Project did meet at the Gestão do Risco da Mudança do Clima para a Saúde Urbana - Construindo Cidades Resilientes. 2019. This meet counted with the participation of researchers engaged in the project, (Martha Barata, Emilio La Rovere Diana Marinho, Maria Fernanda Lemos, Felipe Vommaro, Pedro Camarinha and Karinne Reis Deusdará Leal, among others). The meeting also counted with the participation of colleagues engaged in the health component of INCT MC Phase 2. One of the aims of the meeting was analyze the vulnerability of Brazilian municipalities with regard to natural disasters associated with climate change to propose methodology for adaptation strategies that contribute to urban development and sustainability (urban resilience). Other target was to integrate Brazilian researchers engaged in urban climate disaster risk reduction, as well as, the ones working with urban climate change risk assessment and adaptation.

Following-up on the INCT MC Phase 2 meeting hosted at FEAUSP, on November 30, 2018, when we moved on to enhance interactions with the "Natural Disasters" subcomponent on issues related to urban mobility. After a meeting hosted by CEMADEN on February 26, 2019, we have agreed to collaborate on a study using the Uber database, and on the study on drought in the Brazilian semiarid, which have been developed during this third year.

Plans for the fourth year include further approximation with researchers from the subcomponents "Natural Disasters" and "Water Security", to further develop joint projects. Moreover, as pointed in the second year report, the Fapesp granted scholarship abroad for Paula Pereira Pereda, to develop the project "Assessing the Climate and Weather Effects in Brazil using Panel Data" at Yale University, has provided additional incentives to integration with other areas of the INCT, mainly related to health and agriculture. Finally, an array of recent FIPE's projects with Uber has granted us access to the Uber Movement database stimulating the integration with the subcomponent "Natural Disasters". The protocol between NEREUS and Uber to have access to the data has finally been signed. In addition to researchers at USP, researchers at CEMADEN will have access to the data to write a collaborative paper on the effects of climate on urban mobility and the associated economic costs.

The component of communications held three meetings in the second half of 2019 to address: 1) the launch of new dossiers; 2) the organization of the Symbiosis events; 3) the organization of the book "Conversas infinitas: scientific dissemination, education, climate and change. Pepole from the other components of the INCT MC Phase 2 were invited.

Lastly, Prof. Jailson Andrade from the UFBA came with the initiative of having Meetings of Coordinators of INCTs, to discuss synergies, collaboration and also problems related to logistics and procedures with the funding agencies. The first meeting took place in October 2018 in Brasilia. These meetings will take place once a year.

6 Plans for Year 4 of the project

6.1 Health and climate change

1. To evaluate the relationship between the occurrence of leishmaniasis vectors and impacts in climate change associated to land use in the country (in progress).
2. To estimate the municipality vulnerability to the occurrence of leishmaniasis in Brazil in climate change scenarios (in progress).
3. Modeling of recent and future bioclimatic niches of two species evolutionarily close to ATL vectors, *Lutzomyia (Psychodopygus) wellcomei* and *L. (P.) complexa*, and to predict how climate and other environmental changes may affect the role of both in transmission *Leishmania (Viannia) braziliensis* in Brazil (in progress).
4. Surveillance and Control of American Visceral Leishmaniasis in the State of Rio de Janeiro: spatial distribution and analysis of municipal vulnerability (in progress).
5. Evaluation of "Sentinel Units" for monitoring environmental changes in the face of climate impacts in the municipality of Barbalha, State of Ceará, Brazil. Pilot project for the Northeast.
6. Participation in technical meetings to discuss and disseminate the results.

Acute viral infections of the respiratory tract (vARIs) are responsible for a high burden of acute diseases in all age groups and their association with local weather patterns in various parts of the world has long been demonstrated (Chadha et al., 2020; Li et al., 2019; Moura, Perdigão, & Siqueira, 2009; Shek & Lee, 2003; Stewart, 2016). The most common viral types are Influenza, an important cause of morbidity and mortality in humans and responsible for seasonal, pandemic and zoonotic outbreaks (e.g. H2N2, H3N2, H1N1, H5N1, H5N9). However, other non-influenza respiratory viruses have recently emerged or were detected such as the coronaviruses of severe acute respiratory syndrome (SARS-CoV and SARS-CoV-2) and of the Middle East respiratory syndrome (MERS-CoV), adenovirus type 14 (Ad14), human rhinovirus C (RV-C) and human bocavirus species (Dunn & Miller, 2014).

In general, a fundamental role of temperature is observed in the seasonality of these viruses, including the frequent migration of influenza viruses from warmer to colder geographical regions. (Li et al., 2019; Sundell, Andersson, Brittain-Long, Lindh, & Westin, 2016). In fact, almost all vARIs share the same seasonality in temperate regions, where cases are more prevalent in winter, while there is greater temporal diversity in the tropics. (Li et al., 2019; Stewart, 2016). However, the timing of vARI epidemics varies between and within countries (Bloom-Feshbach et al., 2013). Regarding coronaviruses, a study found that SARS-Cov probably behaved in a seasonal manner in China, appearing initially between late autumn and early spring, times when temperature, relative humidity and wind speed were the main meteorological factors affecting its transmission (Yuan et al., 2006). Sun et al. (2020) report that in the past 17 years two generalized SARS epidemics have occurred in China caused by the coronavirus, and that some general patterns related to the epidemic are noticeable such as: the two epidemics appeared in the winter season, when a favorable condition for the survival of the virus is observed , and both occurred in times of severe drought, rare conditions in the locations where the epidemic broke out.

6.2 Energy Security

During this period, research on the impact of climate change on solar and wind resources in Brazil is expected to continue, deepening the analyzes initiated with the sets of projections from the CMIP6. This activity will be supported by the FAPESP Technical Training scholarship as provided for in the Work Plan approved at the beginning of the project. In addition, the analysis of wind extremes must be expanded to the entire Brazilian territory indicating the future risk of occurrences of damage caused by extreme gusts.

In the area of energy complementarity, the intention is to deepen the analyzes of hydro-solar complementarity through a mapping of offshore solar potential for dozens of Brazilian hydroelectric reservoirs. As for solar-wind complementarity, spatial analyzes are foreseen based on reanalysis data and models mapping regions where the pattern of synergy between solar and wind generation on an hourly, daily and interannual scale.

It is also planned to include a new parameterization of aerosols for the BRAZIL-SR radio transmittance model, and its adaptation for better resolution of the GFPES-16 satellite, improving the estimates of surface solar resources.

6.3 Natural disasters, impacts on physical infrastructure in urban areas and urban development

-To continue to collect and to assess the needed information and data initiated in year 3 to subsidize the proposition of adaptation measures at the local level. In this scope, will be constructed the landslide risk index for Blumenau, SC, which will incorporate the city exposition and vulnerability to the climate related disaster of landslide. The Blumenau landslide risk index generated will be presented and evaluated with local stakeholders, in order to prepare the adaptation strategy proposal for the city, which will be discussed with local stakeholders to support its implementation in year 5. Also, during the year 4 the development of the climate change risk indicator and the adaptation strategies for Blumenau will be conducted, as well as the evaluation of applying the same methodology for other Brazilian municipalities.

- Historical disaster database – DesInventar System - For the next step, activities such as the end of the inclusion of data from 2012 to 2016, as well as the inclusion of data from 2006 to 2009, with a focus on all municipalities affected by drought in the study area, are planned. This database will support the socioeconomic analysis of impacts of extreme weather events in the municipalities included in the study area, as defined in year 1.

-To continue the research developed in Year 3. In particular, continue the analysis in more detail of extreme precipitation and streamflow in pilot municipalities that lead to natural disasters: Itajaí Açu River in the south. For drought events, we will assess severity, duration and frequency of droughts, and its impacts on Brazil's water, food and energy security. Also continue investigating the characteristics (frequency, intensity and duration) of land heatwaves and their impacts on human health and of marine heatwaves in the western South Atlantic and their impact on marine ecosystem in coastal urban areas, which in turn can affect fisheries and food security.

-To assess socioeconomic and environmental impacts of extreme events in pilot municipalities: present and future. The future changes of the aforementioned extremes using CMIP6 simulations to provide risk assessment for stakeholders to elaborate public policies of mitigation and adaptation in urban areas.

-To propose strategies to promote the improvement of risk communication among the scientific community, public managers and the population. In this phase of the project, two activities are planned to be developed with the scientific community, public managers and the population of the selected municipalities (Blumenau and a municipality of the Northeast region): i) consultation with public managers using an online questionnaire about the comprehension of the results of scientific researches; ii) focus groups formed by stakeholders aiming to collect the feedbacks on the proposal to disseminate the results of this research. This stage, which depends on interaction with local partners, is conditioned to the end of the Covid-19 pandemic.

6.4 Food security

-In the next phase, data collected of ILP and ILPF will be validated.
-Each spreadsheet will be organized and therefore the future impact in livestock production will be estimated considering the climate changes simulations.

6.5 Communication, dissemination of knowledge and education for sustainability

- We will request our second TT3 scholarship from Fapesp so that a scholarship holder can produce material from the papers produced by the researchers of the various components of the INCT, conducting interviews with the authors and other researchers for the ClimaCom magazines and the INCT website. The materials can be produced in different formats, from news, to interviews, reports, even podcasts, videos, among others. In parallel with the production, collaborative readings and analyzes of problems involving communication and climate change will be made. The idea is that the problems to be worked on investigating the relationship between researchers at this INCT, the production of materials and the proposed bibliographies. Through these relationships, we intend to explore and broaden the understanding of the effectiveness and effectiveness of climate change communication. We assume that a dialogue with the philosophy of science and the social studies of sciences, especially with the works of Bruno Latour, Isabelle Stengers and Donna Haraway, is fruitful for this project.

- As part of the fellowship's actions, promotional materials (reporting and video) will be produced with the testimonies collected in the laboratory coordinated by Mario Mendiondo, coordinator of the water security sub-component. The idea may be made with other researchers, but it will have to be adapted to a pandemic context.
- We will continue the cycle of seminars "SIMBIOSES - sciences, philosophies, arts and climate change" through virtual platforms due to the pandemic, with the same idea of bringing together researchers from the different sub-components and transversal themes of this INCT and other guests. The seminars will be aimed at university students and teachers and students from the state and municipal education systems of Campinas and region.
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the water security sub-component. The idea may be made with other researchers, but it will have to be adapted to a pandemic context.
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- Three new ClimaCom dossiers will be launched with articles, essays, journalistic materials and artistic productions. The participation of researchers from the various components of the INCT in the journal will be stimulated with the production of texts, interviews, participation in news etc.
- Profa. Dr. Simone Pallone from Labjor-Unicamp will coordinate the production of a series of radio programs (podcasts) to be done with the nine INCT groups (sub-components and cross-cutting themes).
- Prof. Dr. Gabriel Cid de Garcia will launch the book Science in Focus, vol. 3: Cinema, culture and thought, Garamond publisher and will make II Cycle (Im) permanences - Dialogues between arts, climate change and humanities, FE / UFRJ, depending on the isolation measures imposed by the context of the Covid-19 pandemic; The production of videos from the Pedagogias da Imagem project, with testimonials from researchers, for broadcasting on the project's social networks and production of episodes of the UFRJ Faculty of Education Podcast may happen if there are scholarship holders and production conditions;
- This master's dissertation will be defended in 2021: "Public perception of climate change". Master in Science, Technology and Innovation scholarship - SECTYP Secretariat of Research, International and Postgraduate, National University of Cuyo - research by Laura García Oviedo. Supervisor: Sandra Murriello of the National University of Río Negro, Argentina.

6.6 Modelling the earth system and production of future climate scenarios to study Vulnerability, Impacts and Adaptation

For the Year 4 of the project it is planned to complete the generation suite of the CMIP6 SSP's scenarios protocol, encompassing the period of 1985-2100 with the BESM model.
- Continued development of the Coupled Eta based model with MOM5 ocean model (RESM – Eta Model);
- Finish Coupling and evaluation of the Radiation-Convection scheme in the RESM (Eta Model)
- Finish Coupling and evaluation of the Lightning-precipitation and NOx production schemes in the RESM (Eta Model)
- Finish Coupling and evaluation of the dynamic vegetation + Carbon cycle in the RESM (Eta Model)
- Conclude evaluation with the new model version of the Eta Model
- Generation of projections using new model version and new SSP's emission scenarios.

6.7 Economy and impacts in key sectors

Plans for the fourth year include further approximation with researchers from the subcomponents "Natural Disasters" and "Water Security", to further develop joint projects. Moreover, as pointed in the second year report, the Fapesp granted scholarship abroad for Paula Pereira Pereda, to develop the project "Assessing the Climate and Weather Effects in Brazil using Panel Data" at Yale University, has provided additional incentives to integration with other areas of the INCT, mainly related to health and agriculture. Finally, an array of recent FIPE's projects with Uber has granted us access to the Uber Movement database stimulating the integration with the subcomponent "Natural Disasters". The protocol between NEREUS and Uber to have access to the data has finally been signed. In addition to researchers at USP, researchers at CEMADEN will have access to the data to write a collaborative paper on the effects of climate on urban mobility and the associated economic costs.

6.8 Impacts on Brazilian ecosystems in view of changes in land use and biodiversity

We plan to continue the process of quantification of the feedback loops between Amazonian forest emissions, climate variables and carbon cycling. This is being done with field measurements as well as model studies. In April 2021 we should perform the Café-Brazil aircraft campaign in Amazonia, studying the connections between large scale forest emissions, aerosols, trace gases and climate. The CAFÉ-Brazil experiment was supposed to be run at May 2020, but the COVID-19 made it impossible. We are also continuing the long-term trace gases and aerosol observations at the ATTO tower, with high precision CO2, CH4, O3, VOCs as well as an extensive set of aerosol measurements. This is being done win partnership with the Max Planck Institute. We also plan to continue measurements of aerosol optical thickness with the NASA/AERONET network of sun-photometers.

In the Cerrado, we will continue the work on the linkage between biodiversity and climate change.

6.9 Water security

After COVID-19 pandemic impacts endured in mid 2020, social distancing, travelling restrictions and temporary closing of research labs did impose a new adaptation effort to INCT MC Phase 2 water security tasks. Notwithstanding, either objectives or goals are maintained and rescheduled. Hence, in the fourth year, INCT MC Phase 2 water security scientists will promote actions for :

- rescheduling remote workshops with key partners like CEMADEN and INPE, especially revisiting and updating database of river catchments of flood risk prone areas; this activity has started in the period 2016/2017, but temporary paused because of changing workforce and other INCT MC Phase 2 priorities;
- developing core activities on water security indices in key basins for ANA/PNSH, with main focus on uncertainty analysis in prospective water infrastructure systems, linked to the new sanitation framework (Act # 14.026),
- enhancing new science-and-policy cross-partnership among Brazilian state agencies, i.e. APAC in Pernambuco, FUNCEME in Ceará, and statewide climate-and-resilience science groups, i.e. University of Sao Paulo's INCLINE (Center for Interdisciplinary Climate Investigation) and CEPED/SP (Center for Education and Research in Disasters),
- outreaching stronger communication activities on "water security and climate change", in partnership with INCT MC Phse 2's scientists from UFPE, UFC, UFPB, UFCG, USP and UFRGS, through the Brazilian Water Resources Association Education Technical Commission (ABRHidro/Ensino) linked to the UNESCO Chair on Water Security,
- coauthoring new original papers with more INCT MC PHASE 2's affiliated institutions,
- leading webinars with other INCT MC PHASE 2's subcomponents, especially around the water-energy-food-biodiversity nexus addressing the integration of SDG's, DRRs and COP/IPCC's recommendations,
- managing integrated activities with the Center of Applied Maths for Industry (CeMEAI) and the Center for Artificial Intelligence (C4AI) to optimize startups and spinoffs using large scale of database and modelling demands of climate change scenarios at the Brazilian selected river basins,
- merging new insights of INCT MC PHASE 2 water securrity with worldwide initiatives like the Global Climate Research Program (WMO/UNESCO/ISC) the UNEP World Water Quality Alliance, and Future Earth,
- promoting new Regional Centers of Global Water Security e-Courses in Brazil, in partnership with other UN Water Learning Centers, to boost interdisciplinary training using INCT MC PHASE 2's experiences and lessons learnt.

7 Events organized by the INCT MC Phase 2 and its components with interaction among sub components of the project in Year 2

1. Meeting (via skype) of the project INCT MC Fase 2 component natural disasters, urban areas, infrastructure, and urban development, Regina Alvala, Jose Marengo, Martha Barata, 03/10/2019.
2. III Seminário de Avaliação dos INCTs, Brasilia, Novembro 2019.
3. Eventos Extremos: Tendências Globais e Impactos Locais. Ciclo UrbanSus, Jose Marengo, Tercio Ambrizzi, IEA USP, Nov 2019
4. Reuniao com o Vice coordenador do projeto INCT MC Fase 2 Tercio Ambrizzi, 19-21 Novembro 2011, USP Sao Paulo.
5. Amazonia em Foco, São Jose dos Campos, 19 setembro 2019.
6. Reuniao de coordenadores de Componentes do INCT MC Fase 2, USP, 2-3 Outubro 2019.
7. Reuniao com o Vice coordenador do projeto INCT MC Fase 2 Tercio Ambrizzi , 2-5 marco 2020.
8. COVID-19, emergencia climatica e questoes socio ambientais, Tercio Ambrizzi, Webinar, 3/06/2020.
9. Aquecimento Global: Fatos e Mitos, Jose Marengo, Live, 18/06/2020
10. Impactos das Mudanças Climáticas na Sociedade Brasileira:A ciência focada em soluções produzida pela cooperação FAPESP-Belmont Forum, Jose Marengo, Webinar, 16/06/2020.
11. *Gestão do Risco da Mudança do Clima para a Saúde Urbana – Construindo Cidades Resilientes. Workshop do Núcleo Latino Americano da Rede de Pesquisa Global em Mudança do Clima e Cidades* (Urban Climate Change Research Network - UCCRN).
12. *Impacto das mudanças climáticas na distribuição de vetores de leishmanioses do Brasil.* Instituto Oswaldo Cruz/FIOCRUZ, Rio de Janeiro / RJ, 10.2019
13. *XII Jornada de Ciência & Tecnologia: Bioeconomia Diversidade e Riqueza para o Desenvolvimento Sustentável.* Centro Universitário da Zona Oeste/ UEZO, Rio de Janeiro, October/2019.
14. *Distribuição espacial da leishmaniose visceral e avaliação da vulnerabilidade municipal.no Estado do Rio de Janeiro, Brasil.*

8 Participation in scientific events relevant to the INCT MC Phase 2 with accepted abstracts or presentations

1. **ANZOLIN, G.,** OLIVEIRA, D.Y., **CHAFFE, P.L.B.,** 2019: Incerteza na determinação das curvas IDF na bacia do Itajaí. In: XXIII Simpósio Brasileiro de Recursos Hídricos, Foz do Iguaçu, 24–28/11/2019.
2. **CHAFFE, P.L.B.,** OLIVEIRA, D.Y., BARTIKO, D., CHAGAS, V.B., 2019a: Prediction of extreme flood events in Brazil: accounting for uncertainty and (non)stationarity. In: IUGG, Montreal, 8–18/07/2019a.
3. **CHAFFE, P.L.B.,** SILVA, P.G., DAVID, P.C., FILHO, A.F.H.F., MENDEZ, F.J., KLEIN. A.H.F., 2019b: Uso de cópulas e *weather types* para análise de eventos compostos de cheia da bacia do Itajaí. In: XXIII Simpósio Brasileiro de Recursos Hídricos, Foz do Iguaçu, 24–24–28/11/2019b.
4. **PEREIMA, M.F.R.,** BORGES, P.A., BRIGHENTI, M.T., **RODRIGUES, R.R., CHAFFE, P.L.B**., 2020: How well does climate model perform for southern Brazil? In: European Geophysical Union General Assembly Online, 03–08/05/2020.
5. **PEREIMA, M.F.R.,** BORGES, P.A., **RODRIGUES, R.R., CHAFFE, P.L.B.,** 2019: Análise e correção de viés da precipitação de modelos de circulação geral do CMIP5 do sul do Brasil. In: XXIII Simpósio Brasileiro de Recursos Hídricos, Foz do Iguaçu, 24–28/11/2019.
6. **RODRIGUES, R.R.,** TASCHETTO, A.S., SEN GUPTA, A., FOLTZ, G., 2020a: Common cause for severe droughts in South America and marine heatwaves in the South Atlantic. In: Ocean Sciences Meeting, San Diego, 16–21/02/2020.

7. **RODRIGUES, R.R.,** TASCHETTO, A.S., SEN GUPTA, A., FOLTZ, G., 2020b: From severe droughts in South America to marine heatwaves in the South Atlantic. In: European Geophysical Union General Assembly Online, 03–08/05/2020.
8. TASCHETTO, A.S., UMMENHOFER, C.C., STUECKER, M.F., DOMMENGET, D., ASHOK, K., **RODRIGUES, R.R.,** YEH, S.-W., 2020: Revisiting ENSO Atmospheric Teleconnections and Challenges. In: European Geophysical Union General Assembly Online, 03–08/05/2020.
9. BARATA, M. M. L.; ROVERE, E. L. L. ; LEMOS, M. F. C. ; MARINHO, D. P. ; MELLO-SILVA, C. C. ; MACHADO, C. . Gestão do Risco da Mudança do Clima para a Saúde Urbana - Construindo Cidades Resilientes. 2019. (Outro).
10. TAGOMORI et al, 2019. Assessment of Negative Emissions Technologies (NETs) for Brazil. https://www.iamconsortium.org/wp-content/uploads/2020/03/Tagomori.pdf, 12th IAMC Annual Meeting (Tksuba, Japão)
11. ANGELKORTE et al, 2019. Better Representing Land-Use Technologies in National IAM. https://www.iamconsortium.org/wp-content/uploads/2020/03/1_rochedo.pdf,l 12th IAMC Annual Meeting (Tksuba, Japão)
12. CUNHA et al, 2019. The Opportunity Cost of the Refusal to a Global Dietary Change. https://www.iamconsortium.org/wp-content/uploads/2020/03/46_rochedo-1.pdf, 12th IAMC Annual Meeting (Tksuba, Japão):
13. ROCHEDO; ROCHEDO, 2019. Estimating the radiological impact to the public in long-term energy scenarios in an Integrated Assessment Model. https://www.iamconsortium.org/wp-content/uploads/2020/03/Rochedo.pdf, 12th IAMC Annual Meeting (Tksuba, Japão)
14. DIAS, S. O.; AMORIM, A. C. R. de; SPEGLICH, E. Cosmic becoming: new sensibilities for to think the human in catastrophes times. 12th Annual Deleuze & Guattari Studies Conference. July, 1-5, 2019.
15. DIAS, S. O.; AMORIM, A. C. R. de; OLIVEIRA, R. S. de M. The "Elemental" Potency of Climate to Think Communication in the Anthropocene. 4S 2019 New Orleans. Elements: Thinking our Present Elementally. Coord. Courtney Addison, Victoria University of Wellington Timothy Neale, Deakin University Thao Phan, University of Melbourne, Australia. September, 4-7, 2019.
16. DIAS, S. O.. ECOLOGIAS DE DEVIRES: DO CHAMADO A FAZER-PERCEBER FLORESTA. 2019. (Apresentação de Trabalho/Comunicação).
17. GARCIA, Gabriel Cid de. I Simpaex – Simpósio das Ações de Extensão da Faculdade de Educação da UFRJ, dezembro de 2019, apresentando o trabalho 'Cultura, pensamento e educação: os projetos de extensão do SECULT da FE/UFRJ'.
18. VIDAL, Liz. COPUCI 2019 - Congreso de Comunicación Pública de la Ciencia (COPUCI) - "Pensemos y hagamos comunicación pública de la ciencia y la tecnología", de 2 a 4 de outubro de 2019, em Córdoba-Argentina.
19. DIAS, Susana. O.. 1o. Simbioses - Água, matéria viva (Encontros entre artes, ciências, filosofias e mudanças climáticas). 2019. (Outro).
20. DIAS, Susana. O.. 2o. Simbioses - Refúgios para espantar o Antropoceno (Encontros entre artes, ciências, filosofias e mudanças climáticas). 2019. (Outro).
21. GARCIA, Gabriel. Sessões mensais do projeto de extensão Pedagogias da Imagem - cineclube da Faculdade de Educação da UFRJ, com exibição de filmes seguida de palestra e debate com pesquisadores: dia 20/8/19, exibição do filme 'Elefante' (Elephant - E.U.A., 2003), de Gus Van Sant, seguido da palestra 'Adolescência hoje: qual o lugar para o mal-estar na escola?', com a convidada Cristiana Carneiro (FE/UFRJ); dia 10/09/19, exibição do filme 'Nietzsche Sils Maria Rochedo De Surlej' (Brasil, 2019), de Julio Bressane, Rosa Dias e Rodrigo Lima, seguido da palestra 'O fugitivus errans em Sils-Maria', com a convidada Rosa Dias (Filosofia, UERJ); dia 29/10/2019, exibição do filme 'Rocky Horror Picture Show' (Reino Unido/E.U.A., 1975), de Jim Sharman, seguido da palestra 'Dissidências após a meia-noite e as estratégias da estranheza', com o convidado Diego Paleólogo (ECO/UFRJ); dia 12/11/2019, exibição do filme 'Paterson' (França/Alemanha/E.U.A., 2016), de Jim Jarmusch, seguido da palestra 'A poesia e a ideia da repetição em Jim Jarmusch', com o convidado Paulo Domenech Oneto (ECO/UFRJ).

22. DIAS, S. O.; WUNDER, M. ; MELO, S. ; BERNARDES, C. ; AMARANTE, A. . SÉRIE DE ENCONTROS Ecologia de devires | ENCONTRO 2 - Devir planta-casa-cosmos. 2019. (Outro).
23. DIAS, S. O.; RODRIGUES, R. ; COPETTI, A. ; TANAKA, M. . SÉRIE DE ENCONTROS Ecologia de devires | ENCONTRO 1 - Devir criança-animal-elemental-traidor. 2019. (Outro).
24. DIAS, S. O.; RODRIGUES, C. C. ; RIBEIRO, A. ; MONTEIRO, C. ; TAMIRES, F. ; RIBEIRO, B. L. ; BATISTA, P. . SÉRIE DE ENCONTROS Ecologia de devires | ENCONTRO 5 - ENCONTRO 5 - Devir negro-cura-música-festa. 2019. (Outro).
25. DIAS, S. O.; OLIVEIRA, T. ; FUREGATTI, S. . SÉRIE DE ENCONTROS Ecologia de devires | ENCONTRO 4 - Devir linha-ar-luz. 2019. (Outro).
26. DIAS, S. O.; PENHA, A. ; ROMAGUERA, A. . SÉRIE DE ENCONTROS Ecologia de devires | ENCONTRO 3 - NCONTRO 3 - PASSAGEM ARTÍSTICA, CIENTÍFICA E CULTURAL PELA MATA SANTA GENEBRA. 2019. (Outro).
27. DIAS, S. O.; OLIVEIRA, Renato Salgado de Melo ; SCARTEZINI, C. . SÉRIE DE ENCONTROS Ecologia de devires | ENCONTRO 6 - Devir rio-mulher-mar. 2019. (Outro).
28. Water-Energy-Food Nexus scenarios provided by the hybrid power generation at Sobradinho hydropower reservoir. Érica Ferraz de Campos, André Rodrigues Gonçalves, Rodrigo Santos Costa, Fernando Ramos Martins, Pieter van Oel , Enio Bueno Pereira. XII Brazilian Congress on Energy Planning - Foz do Iguaçu, 9 to 11 September 2020.
29. The SONDA network for solar and wind energy resource data. Marcelo Pizzuti Pes , Enio Bueno Pereira, Fernando Ramos Martins, Silvia Vitornio Pereira, André Rodrigues Gonçalves, Rodrigo Santos Costa, Guilherme Bággio Martins Machado, Filipe Loyola Lopes. XII Brazilian Congress on Energy Planning - Foz do Iguaçu, 9 to 11 September 2020.
30. Impacts of Climate Change on the availability of solar energy resources. Rodrigo Santos Costa, Graziela Luzia da Costa, Francisco José Lopes de Lima, André Rodrigues Gonçalves, Fernando Ramos Martins, Enio Bueno Pereira, Madeleine Sánchez Gácita Casagrande. XII Brazilian Congress on Energy Planning - Foz do Iguaçu, 9 to 11 September 2020.
31. Impacts of Climate Change on the future availability of the wind resource. Rodrigo Santos Costa, Graziela Luzia da Costa, Francisco José Lopes de Lima, André Rodrigues Gonçalves, Fernando Ramos Martins, Enio Bueno Pereira, Madeleine Sánchez Gácita Casagrande. XII Brazilian Congress on Energy Planning - Foz do Iguaçu, 9 to 11 September 2020.
32. Enhancement of the incoming solar irradiance over a large tropical reservoir in Brazil. Fernando Ramos Martins, André Rodrigues Gonçalves, Madeleine Sánchez Gácita Casagrande, Rodrigo Santos Costa, Francisco José Lopes de Lima, Marcelo Pizzuti Pes , Enio Bueno Pereira. XII Brazilian Congress on Energy Planning - Foz do Iguaçu, 9 to 11 September 2020.
33. Study of the complementarity profile between wind and solar generation in the Brazilian semiarid region. André Rodrigues Gonçalves, Rodrigo Santos Costa, Madeleine Sánchez Gácita Casagrande, Fernando Ramos Martins, Marcelo Pizzuti Pes , Enio Bueno Pereira. XII Brazilian Congress on Energy Planning - Foz do Iguaçu, 9 to 11 September 2020.
34. Variations in the frequency of extreme winds and their impact on the energy sector. Francisco José Lopes de Lima, André Rodrigues Gonçalves, Rodrigo Santos Costa, Fernando Ramos Martins, Enio Bueno Pereira. XII Brazilian Congress on Energy Planning - Foz do Iguaçu, 9 to 11 September 2020.
35. Energy Transition - Case Studies in Brazil - Enio Bueno Pereira. Invited lecture given as part of a technical visit (annexes: certificates of lectures given) to the National Energy and Geology Laboratory (LNEG), in the city of Lisbon, and to the Geosciences Center of the University of Coimbra (CEO), in the city of Coimbra , both in Portugal.
36. Complementarity of Solar and Wind Energy Sources in Brazil . Enio Bueno Pereira, André Goncalves, Rodrigo Santos Costa, Fernando Ramos Martins (Poster Presentation), Dresden Nexus Conference - DNC 2020, 3-5 June 2020, Dresden, Germany (Online).
37. Can solar energy change the Water, Energy and Food Nexus at Juazeiro- Petrolina ? Erica Ferraz Campos, André R. Goncalves, Rodrigo S. Costa, Fernando R. Martins, Pieter van Oel , Enio B. Pereira (Poster Presentation), Dresden Nexus Conference - DNC 2020, 3-5, June 2020, Dresden, Germany (Online).

38. 6th INTERNATIONAL CONFERENCE ENERGY & METEOROLOGY - ICEM 2019, 24-27 June 2019, Copenhagen . "Improvements in the estimation of the solar energy resource in tropical regions from satellite data: a statistical approach." Madeleine Sanchez Gacita Casagrande, André Goncalves, Fernando Ramos Martins, Rodrigo Santos Costa, Jefferson Gonçalves de Souza and Enio Bueno Pereira.
39. Solar World Congress 2019 - Innovation in Transforming Energy Systems and Markets to 100% Renewable Energy - November 2019, SWC-ISES, Santiago, Chile. (poster presentation) "Seasonal Variability of the surface solar installation in Northeastern region of Brazil." Francisco JL Lima, Fernando R. Martins, André R. Gonçalves, Rodrigo S. Costa, Enio B Pereira.
40. Academic Congress of the Federal University of São Paulo. São Paulo Brazil. "Comparison of Databases of the Solar Energy Resource in the Brazilian Territory." Giovanna M. Bonafé , Fernando R Martins, Francisco JL Lima, André Rodrigues Gonçalves, Rodrigo S. Costa and Enio B. Pereira.
41. Carvalho, BM; Rangel, EF. *Impacto das mudanças climáticas na distribuição de vetores de leishmanioses do Brasil Evento: Gestão do Risco da Mudança do Clima para a Saúde Urbana – Construindo Cidades Resilientes. Workshop do Núcleo Latino Americano da Rede de Pesquisa Global em Mudança do Clima e Cidades* (Urban Climate Change Research Network - UCCRN). 2019.
42. Costa, LH; Afonso, MMS; Carvalho, BM; Dias, CMG; Rangel, EF; Figueiro, R. *Distribuição espacial da leishmaniose visceral e avaliação da vulnerabilidade municipal no Estado do Rio de Janeiro, Brasil.* In: *XII Jornada de Ciência & Tecnologia: Bioeconomia Diversidade e Riqueza para o Desenvolvimento Sustentável*, Rio de Janeiro. UEZO, 2019.
43. NEREUS at FEAUSP hosts a weekly seminar, on Mondays, during the academic year. In 2019-2020, there were different presentations on topics related to the INCT-MC. The full program with the names of the presenters and titles of the presentations can be accessed at (http://www.usp.br/nereus/?p=3989)
44. May 14-16 - Lecture at the event *Sustainable Development Objectives*, at the Magna meeting of the Brazilian Academy of Sciences, Rio de Janeiro.
45. September 4 - Keynote lecture -International Long Term Ecological Research Network 2nd Open Science Meeting, Leipzig, Germany.
46. October 8 - Lecture at the event *Agenda 2030,* at State University of Rio de Janeiro (UERJ), Rio de Janeiro.
47. October 10 – Presentation at Roundtable on Nexus between Mitigation and Adaptation in the IX National Meeting of the National Association for Postgraduate Studies and Research in Environment and Society (ANPPAS), Brasília.
48. December 13 – Presentation at Roundtable on Amazon Fires in the Fall Meeting of the American Geophysical Union, San Francisco, United States.
49. Artaxo, P., Climate change and sustainable developmemnnt goals. Reunião Magna 2019 da Academia Brasileira de Ciências. Museu do Amanhã, Rio de Janeiro, 14-16 de maio de 2019.
50. Artaxo, P., The future of Amazonia. Worksho Amazonia and our planetary furures, a conference on Climate change. Harvard University, May 7-8, 2019.
51. Artaxo, P., Urban air pollution and climate change. Klimapolis workshop, IAG-USP, São Paulo, 21-24 de Maio de 2019.
52. Artaxo, P., Mudanças climáticas, governança e direito internacional. 24 Congresso Brasileiro de Direito Ambiental, São Paulo, 25 a 29 de Maio de 2019.
53. O. Lauer, D. Rosenfeld, R. Braga, Y. Zhu, Y. Zheng, E. Hashimshoni, F. Ditas, M. O. Andreae, P. Artaxo, H. M. J. Barbosa, J. Brito, S. Carbone, A. Efraim, B. Holanda, M. A. Pinsky, C. Pöhlker, A. P. Khain, T. Klimach, O. Krüger, B. Nillius, M. Praß, J. Shpund, D. Walter, S. Wolff, U. Pöschl,. M. L. Pöhlker and the ATTO and MPIC Multiphase team. Detection of secondary droplet activation and differentiation of microphysical zones in deep convective cumulus clouds over the Amazon rainforest using satellite imaging. 8th COAA International Conference on Atmosphere, Ocean, and Climate Change (ICAOCC), Nanjing, China, July 10-12, 2019.

54. Artaxo, P., Why we are discussing geoengineering? International Symposium on Climate Geoengineering, Academia Brasileira de Ciências, Rio de Janeiro, 10-11 junho de 2019.
55. Rahul Zaveri, Paulo Artaxo et al., Growth of Urban Ultrafine Aerosols and Their Impact on Shallow Clouds and Precipitation in the Amazon Rainforest. DoE ASR Science Team Meeting. Bethesda North Marriott Hotel and Conference Center in Rockville, Maryland, USA, June 10 to 13, 2019.
56. Shrivastava, M., Artaxo, P., and others. Using the Amazon as a natural laboratory to understand anthropogenic enhancement of biogenic SOA. DoE ASR Science Team Meeting. Bethesda North Marriott Hotel and Conference Center in Rockville, Maryland, USA, June 10 to 13, 2019.
57. Arthur Dias Freitas, Ednaldo Carvalho Guimarães, Luciana Varanda Rizzo, Paulo Artaxo, Samara Carbone. IDENTIFICAÇÃO DE PICOS NA CONCENTRAÇÃO DE MP1 NA BACIA CENTRAL DA AMAZÔNIA DURANTE A ESTAÇÃO CHUVOSA DE 2015 (ATTO). Paper numero 160496. XVII ENEEAMB e V Forum Latino Americano de Engenharia e Sustentabilidade, João Pessoa, Paraiba, 22-26 de Julho de 2019.
58. Artaxo, P., The impacts of climate change on our planet Earth. FAPESP-UNICAMP, Cardiff Workshop on Environment and Development: Shared 21st Century Sustainability Challenges, UNICAMP, Campinas, 15-19 July 2019.
59. Artaxo, P., Os impactos das mudanças climáticas no nosso planeta Terra. CAEB Congresso Aberto aos estudantes de biologia, UNICAMP, Campinas, 15 a 19 de julho de 2019.
60. Artaxo, P., Mudanças climáticas e o ciclo hidrológico. II Fórum Brasil de Gestão Ambiental, Centro de Convenção de Campinas, Campinas, Brasil, 25 a 28 de Junho de 2019.
61. Artaxo, P., Climate change as a nonlinear process. ICTP-SAIFR Conference on perspectives in nonlinear dynamics. Instituto de Física Teórica, UNESP São Paulo, 16-19 de Julho de 2019.
62. Artaxo, P., The impacts of climate change on our planet Earth. UNICAMP-Cardiff Bi-lateral workshop: Environment and Development: Shared 21st Century Sustainability Challenges, Campinas, 15-19 July 2019.
63. Janaina Mayara Pinto Nascimento, Bruno Meller, Megan Bela, Sameh Adib Abou Rafee, Angel Liduvino Vara Vela, Luciana Varanda Rizzo, Samara Carbone, Henrique Barbosa, Michael Trainer and Paulo Artaxo. Aerosols from Anthropogenic and Biogenic Sources: Optical Properties and their Interactions over the Amazon Rainforest [GoAmazon2014/15 Experiment]. Gordon Research Conference on Atmospheric Chemistry, July 28, 2019 - August 02, 2019 at Grand Summit Hotel at Sunday River in Newry, ME, United States.
64. Artaxo, P., The science and engineering challenges of global climate change. Grand Challenges Scholar Program Workshop-Brasil. 5-8 de Agosto de 2019, UFMG, Belo Horizonte, Brasil.
65. P. Artaxo, R. M. Santos, L. V. Rizzo, H. M. J. Barbosa, M.O. Andreae, C. Pohlker. Long term observations of Sahara dust in Central Amazonia at the ATTO and ZF2 towers. Paper 2019001044 Goldschmidt Barcelona 2019 Conference. 18-23 August 2019.
66. D. Guinoiseau, S.J.G. Galer, A.G. Kral, J. Saturno, F. Ditas, P. Artaxo, C. Pöhlker, W. Abouchami & M.O. Andreae. Identification of African dust sources in the Amazon Basin. Goldschmidt Barcelona 2019 Conference. 18-23 August 2019.
67. M. Praß, F. Ditas, I. Hrabe de Angelis, B. Holanda, O. Lauer, L. A. Kremper, O. Krüger, A. Kunert, B.Weber, J. Fröhlich, P. Artaxo, E. Thines, B. M. Fuchs, M. O. Andreae, J. Fröhlich, U. Pöschl, C. Pöhlker. Quantification of bioaerosol classes in the Amazon rain forest. European Aerosol Conference EAC 2019, Gothenburg, Sweden, 25-20 August 2019.
68. Hans Christen Hansson, P. Artaxo, Atmosphere-Forest Interaction, A Review Comparing the Tropical and the Boreal Forest. European Aerosol Conference EAC 2019, Gothenburg, Sweden, 25-20 August 2019.
69. L. A. Kremper, E. Bernikola, J. Pfisterer, M. Praß, F. Ditas, D. Walter, B. Holanda, S. Carbone, O. Lauer, M. L. Pöhlker, P. Artaxo, U. Pöschl, K. F. Domke, C. Pöhlker. Chemical characterization of ultrafine aerosol particles from the Amazon by surface-enhanced Raman spectroscopy. European Aerosol Conference EAC 2019, Gothenburg, Sweden, 25-20 August 2019.

70. Paulo Artaxo, Henrique Barbosa, Luciana Rizzo, Samara Carbone, Marco A. Franco, Fernando G. Morais, Urban air pollution and climate change in Amazonia. IUAPPA 18 World Clean Air Conference WCAC 2019, 23-27 September, Istanbul, Turkey.
71. Artaxo, P., Agriculture and Climate Change: Emissions, mitigations and needs. Invited talk for the World Science Forum, Hungarian Academy of Sciences, Budapest, Hungary, 20-23 Nov 2019.
72. Artaxo, P., Impacts of deforestation in Amazonian climate. Symposium "Amazonian Leapfrogging," Princeton University (Princeton, New Jersey), October 17-18, 2019
73. Artaxo, P., Impacts of climate change in Amazonia. FAPESP Week Paris, Université Diderot, Paris, França, 25-27 November 2019.
74. Artaxo, P., Amazon and Climate Research. FAPESP Week Lyon, University of Lyon, Lyon, França, 21-22 November 2019.
75. Artaxo, P., The scientific challenge of climate change in Latin America. 22nd TWAS LACREP Young Science Conference. Academia Brasileira de Ciências, Rio de Janeiro, 27-29 de Novembro de 2019.
76. Paulo Artaxo, Hans Christen Hansson, Christopher Pöhlker, and Meinrat O Andreae. Comparison of atmospheric composition and properties over boreal and tropical forests ecosystems. Paper A51B-06. AGU 100 Fall Meeting, San Francisco, California, USA, 9-13 December 2019.
77. Artaxo, P., Biomass burning in Amazonia degrading air quality over large areas of South America. Paper AGU Session U51B – Amazon fires provoke attacks on science. AGU 100 Fall Meeting, San Francisco, California, USA, 9-13 December 2019. AGU 100 Fall Meeting, San Francisco, California, USA, 9-13 December 2019.
78. Djacinto Monteiro dos Santos Jr, Samara Carbone, Luciana V. Rizzo, Paulo Artaxo. Relationships between secondary organic aerosol and physical properties of submicron particles over the Sao Paulo macro metropolis, Brazil. Paper AGU A23K-2922. AGU 100 Fall Meeting, San Francisco, California, USA, 9-13 Dec. 2019.
79. Fernando Morais, Eduardo Landulfo, Paulo Artaxo, Marco Aurélio Franco. Long Term Characterization of Brown Carbon in Amazonia using AERONET and in situ Measurements. Paper AGU A13S-3172. AGU 100 Fall Meeting, San Francisco, California, USA, 9-13 December 2019.
80. Rahul A Zaveri, Jian Wang, Jiwen Fan, Yuwei Zhang, John Shilling, Alla Zelenyuk, Fan Mei, Rob K Newsom, Mikhail S Pekour, Jason M Tomlinson, Jennifer M Comstock, ManishKumar Shrivastava, Edward Fortner, Luiz Machado, Paulo Artaxo and Scot T Martin. Rapid growth of urban ultrafine aerosols and their impact on shallow clouds and precipitation in the Amazon rainforest. Paper AGU A12B-07. AGU 100 Fall Meeting, San Francisco, California, USA, 9-13 Dec. 2019.
81. Matthew W Fraund, Daniel Bonanno, Jay Mendoza Tomlin, Kevin A Jankowski, Benny Wong, Peiwen Wang, Don Pham, Josette Elizabeth Marrero, Gourihar Kulkarni, Joseph C. Charnawskas, Tristan Harder, Daniel Veghte, Joel Brito, Suzane S de Sá, Samara Carbone, Swarup China, Christopher Pöhlker, Bingbing Wang, Paulo Artaxo, Meinrat O Andreae, Josephine Y Aller, Scot T Martin, Jian Wang, Alexander Laskin, Daniel Alexander Knopf, Mary Gilles and Ryan Moffett. Mixing State and Composition of Aerosol Particles Collected During the GoAmazon2014/15, HI-SCALE, and ACE-ENA Field Campaigns. Paper AGU A53M-2941. AGU 100 Fall Meeting, San Francisco, California, USA, 9-13 December 2019.
82. Marco Aurélio Franco, Paulo Artaxo, Luciana Varanda Rizzo, Henrique M Barbosa, Fernando Morais, Samara Carbone, Christopher Pöhlker, Bruna Amorim Holanda, Florian Ditas and Meinrat O Andreae, Vertical Variability of Aerosol Physical Properties at the Central Amazonia ATTO Tower in the Wet Season. Paper AGU A11S-2812. AGU 100 Fall Meeting, San Francisco, California, USA, 9-13 December 2019.
83. Paulo Artaxo, Henrique Barbosa, Luciana Rizzo, Samara Carbone. The close links between the biological functioning of Amazonian forest and climate. Invited paper 365410-3B2, 100th AMS Annual Meeting, 22nd Conference on Atmospheric Chemistry Special Conference Sessions on Amazonian Weather and Climate: 40 years of research. Boston, USA, 12–16 January 2020.

84. Manishkumar Shrivastava, M. O. Andreae, P. Artaxo, H. M. J. Barbosa, L. K. Berg, J. Brito, J. Ching, R. Easter, J. Fan, J. D. Fast, Z. Feng, J. Fuentes, M. Glasius, A. H. Goldstein, E. G. Alves, H. Gomes, A. Guenther, S. H. Jathar, S. Kim, Y. Liu, S. Lou, S. T. Martin, V. F. McNeil, A. medeiros, J. Shilling, S. Springston, R. A. F. Souza, J. A. Thornton, G. I. VanWertz, L. D. Yee, R. Ynoue, R. A. Zaveri, A. Zelenyuk, C. Zhao, S. S. de Sá, and D. Gu. Urban Pollution Greatly Enhances Formation of Natural Aerosols over the Pristine Amazon (Invited Presentation). 100th AMS Annual Meeting, 22nd Conference on Atmospheric Chemistry Special Conference Sessions on Amazonian Weather and Climate: 40 years of research. Boston, USA, 12–16 January 2020.
85. Hans-Christen Hansson, Paulo Artaxo, Meinrat O. Andreae, Markku Kulmala. Composition and Properties of the Natural Aerosol over the Boreal and Tropical Forests. EGU2020-11662 - Session AS3.7 – Natural Aerosols in Climate Change. EGU General Assembly 2020, Vienna, 3-8 May 2020.
86. Manishkumar Shrivastava, M. O. Andreae, P. Artaxo, H. M. J. Barbosa, L. K. Berg, J. Brito, J. Ching, R. Easter, J. Fan, J. D. Fast, Z. Feng, J. Fuentes, M. Glasius, A. H. Goldstein, E. G. Alves, H. Gomes, A. Guenther, S. H. Jathar, S. Kim, Y. Liu, S. Lou, S. T. Martin, V. F. McNeil, A. Medeiros, J. Shilling, S. Springston, R. A. F. Souza, J. A. Thornton, G. I. VanWertz, L. D. Yee, R. Ynoue, R. A. Zaveri, A. Zelenyuk, C. Zhao, S. S. de Sá, and D. Gu.Urban Pollution Greatly Enhances Formation of Natural Aerosols over the Pristine Amazon. abstract (ID: 3399054), Pacifichem 2020: A Creative Vision for the Future, Honolulu, Hawaii, 15-20 December 2020.
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90. June 5 - Participation in the Seminar on "Climate Change Mitigation and Adaptation Measures," House of Representatives, Environment and Sustainable Development Commission, Brasília.
91. July 9 - Presentation at the Technical Debate on climate protection, forests, and sustainable agriculture during the visit of Minister Dr. Gerd Muller, with experts from Brazil and Germany, Brasília.
92. September 11 - Roundtable on The Contributions of Peoples and Communities to the Conservation of the Cerrado, Chamber of Deputies, Environment, and Sustainable Development Commission, Brasília.
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9 List of publications (Articles, books, book chapters)

The papers published within the Year 3 of the INCT-MC Phase 2 included in the publication list reflects the activities of the subgroups that have funding other than FAPESP, as well as a continuous interdisciplinary work over the last years.

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7-DIAS, Susana. In: STALLONE, Julia. Os devires de um mundo todo vivo: a autocompostagem de Agnès Varda, Pedagogias da imagem, 20 de jul. 2019.. Disponível em: https://cineclubepedagogiasdaimagem.wordpress.com/
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11-Event: René Rachou Institute Quality, Biosafety and Environment Week
Theme: Health surveillance and natural disasters: actors and roles (Rhavena Barbosa dos Santos).
Date: 06/13/2019
12-Event: Pathogens transmitters class – René Rachou post-graduation program (Júlia Alves Menezes)Title: Global environmental change and human health, Date: 15/10/2019
13-Meeting with researchers from the Center for studies and research in emergencies and health disasters (CEPEDES) / Fiocruz. October 22-23, 2018.
14-Meeting with researchers from the Center for studies and research in emergencies and health disasters (CEPEDES) / Fiocruz. May 21 and 22, 2019.
15-Technical meeting with researchers from the Center for studies and research in emergencies and health disasters (CEPEDES) / Fiocruz. November 11, 2019.
16-Internal discussions and interactions for the development of the BESM-GEF global climate model continued throughout the year, among both BESM and GEF developers at CPTEC.

17-Meetings with the State of Sao Paulo Secretariat of Environment to support the development of the Ecological-Economic Zoning of the State.

During the third INCT MC PHASE 2 year, the Water Security Subcomponent has strongly promoted open science outreach and a wide popularization of international and interdisciplinary talks and lectures. With worldwide and distinguished visiting professors co-granted through partnered initiatives, INCT MC PHASE 2-water security scientists have fostered an School of Advanced Studies on Water & Security under Change, with an open repository of syllabi, knowledge and thinking evolution available to support water literacy, social empowerment and policy making towards a low carbon, more sustainable and resilient society

Joint FAPESP UK & EAE-CAPES/SASW&SC Waters Workshop
Prof. N Bhattacharya-Mis, Univ Chester: https://youtu.be/wRl-Z1dRunw (31')
Dr D Green, Univ of Chester, UK: https://youtu.be/muUaNRtgNtI (45')
Dr F Chen, Univ of Ningbo/Univ Leeds: https://youtu.be/GG61Ny3RyZg (53')
Dr A Miles, Univ of Chester, UK: https://youtu.be/ZmT1aq-4bxQ (46')
Dr B Montz, East Caroline University, USA: https://youtu.be/tZR8rspHigA (57')
Dr O Dubovyk, Univ of Bonn, Germany: https://youtu.be/MmgwCjZLVRs (45')
Dr V, Odongo, Uppsala Univ, Sweden: https://youtu.be/EK4imCIhM30 (53')
Dr M Mis, University of Derby, UK: https://youtu.be/gGsl8ev7NQc (52')
Dr S Miller, Univ of Chester, UK: https://youtu.be/a7SbkweMHbw (36')
Dr S Forest, UK, https://youtu.be/RPeWdxmMoAI (49')
Group Presentation: https://youtu.be/CmJTRaN3CZw (77')
Total duration of open science lectures and talks free of charge: 544'

Challenges in Sanitation Processes
Prof. Nicholas Hankins, Univ of Oxford, UK, Prof M Giacomoni, UTSA, USA, Dr E Rangel, & Dr B Carvalho, FIOCRUZ, Brazil
The Clean Water Challenge: https://youtu.be/b59SKUv9KYE (89')
Part 1: https://youtu.be/rs3kCoZkzWQ (72')
Part 2: https://youtu.be/hbDMR2RV1wo (46')
Part 3: https://youtu.be/0a_UZmqkgIc (60')
Part 4: https://youtu.be/FV3fHZ8Bp_4 (74')
Part 5: https://youtu.be/B5JTb_sAww4 (103')
Water-Health-Resilence Workshop I: https://youtu.be/PRAJXguke_4 (146')
Water-Health-Resilence Workshop II: https://youtu.be/AnEGRLcK6Vw (46')
Water-Health-Resilence Workshop III: https://youtu.be/YmSlgN3z0VI (73')
Total duration of open science lectures and talks free of charge: 709'

Modelling and Measuring Hydrologic Systems
Prof Dimitri Solomatine, IHE-Delft & TU Delft, The Netherlands
Open Lecture: https://youtu.be/5wyydVXYRwQ (52')
Part 1: https://youtu.be/sIOKpenTlFY (51')
Part 2: https://youtu.be/XmVN9qI1fJA (59')
Part 3: https://youtu.be/UdusKXLGZhE (45')
Part 4: https://youtu.be/2sc2JG-Dl2o (55')
Part 5: https://youtu.be/DN6qCIKxfJc (42')
Part 6: https://youtu.be/R5SuTcj5BHQ (46')
Part 7: https://youtu.be/zAgtq-ULr8w (43')
Part 8: https://youtu.be/-c8Spi0iZC8 (38')
Part 9: https://youtu.be/-c8Spi0iZC8 (32')
Part 10: https://youtu.be/U7RX1CFANRk (58')
Part 11: https://youtu.be/8qZNcSZK7K8 (51')
Part 12: https://youtu.be/PaC41_2GgD0 (45')
Part 13: https://youtu.be/r7WqzTfkZC0 (89')

Total duration of open science lectures and talks free of charge: 706'

Infrastructure Systems under Changing Climate
Prof Slobodan Simonovic, Western University, Canada, Dr J Tomasella, CEMADEN & Dr S Ayrimoraes, ANA, Brazil
Part 1: https://www.youtube.com/watch?v=yJ9rPX7rgk8&feature=youtu.be (97')
Part 2: https://youtu.be/IcMQ65KtQcI (68')
Part 3: https://youtu.be/FpSm1fsyDVk (45')
Part 4: https://youtu.be/VR5NbWBDt2A (85')
Part 5: https://youtu.be/CJQ0_DaMJbc (58')
Part 6: https://youtu.be/xFSgzAuTWtE (80')
Part 7: https://youtu.be/ndHfsP7pb10 (46')
Part 8: https://youtu.be/YPM5Qr5Hb7A (38')
Part 9: https://youtu.be/h6PIWq5svNU (55')
Part 10: https://youtu.be/_nul5o_TlEo (57')
Total duration of open science lectures and talks free of charge: 572'

SWAT applied to Water Security under Climate Change
Prof. R Srinivasan, Texas A&M Univ, USA & Prof D Bressiani, UFPel, Brazil
Part 1: https://youtu.be/4kbUkathSMg (93')
Part 2: https://youtu.be/ab-UIPcmFYI (66')
Part 3: https://youtu.be/wUb5yaNJOKk (87')
Part 4: https://youtu.be/3j88BRv0-4Y (77')
Part 5: https://youtu.be/wSCHMyBwIzA (50')
Part 6: https://youtu.be/txpugJ4LOfw (70')
Part 7: https://youtu.be/8IeNYKFpt3Q (88')
Part 8: https://youtu.be/XaZjcRv6EZ8 (70')
Part 9: https://youtu.be/VYenk8EKdwg (77')
Part 10: https://youtu.be/YQMTSHtzi8U (120')
Part 11: https://youtu.be/EjdE1OYeEXM (74')
Part 12: https://youtu.be/7SaDHeo7qxg (84')
Total duration of open science lectures and talks free of charge: 956'

Sedimentation Engineering
Prof Marcelo Garcia, Illinois University at Urbana-Champaign, USA
Part 1: https://youtu.be/bFmHe-RrdBM (73')
Part 2: https://youtu.be/Gazv6Vm2lgg (93')
Part 3: https://youtu.be/_neoJ0xjr-Q (73')
Part 4: https://youtu.be/CVe4cgN5TyA (74')
Part 5: https://youtu.be/WxXmemdj6kY (49')
Part 6: https://youtu.be/Vc6Wh5XGtBY (64')
Total duration of open science lectures and talks free of charge: 426'

Water Resources Management in Societies Under Change
Profa. P Gober, Arizona St Univ, Prof H Weather, Univ Saskatchewan/Imperial College London, Dr. J Tundisi, IIE/Sao Carlos Municipality, Eng. B Rodrigues, Consultant on Water Security and Sanitation, Brazil
Part 1: https://youtu.be/Hmz6J9aNlGI (33')
Part 2: https://youtu.be/Sgf8RILz-jk (107')
Part 3: https://youtu.be/rfLnn3p-Fxg (83')
Part 4: https://youtu.be/o2OXSAZNcpQ (20')
Part 5: https://youtu.be/L3xQSK9mEL4 (87')
Part 6: https://youtu.be/BCfejwg1-6s (77')
Part 7: https://youtu.be/aD53T3kZ4RY (92')
Part 8: https://youtu.be/3iVwCjQ3zMQ (68')

Part 9: https://youtu.be/eLnLV3t0VwI (105')
Part 10: https://youtu.be/iZbD-9lzQn0 (79')
Total duration of open science lectures and talks free of charge: 751'

Hydro-Social Systems
Prof. Günther Blöschl, Tech Univ. Vienna, Austria
Part 1: https://youtu.be/-yl57r9ukzQ (71')
Part 2: https://youtu.be/t62IJpKtTl4 (93')
Part 3: https://youtu.be/rKXeq5ynZxI (85')
Part 4: https://youtu.be/5mzq9pZTsCA (106')
Part 5: https://youtu.be/c_big0aqLpM (90')
Part 6: https://youtu.be/RYTghs9ay8Q (78')

11 Fellowships (bolsas) granted by FAPESP and other funding agencies in Year 3 (including students)

1. Title: A second year of fellowship, extending it until 30 April 2020 was submitted.
Bolsista: Manoel Batista da Silva Jr.,
Orientador: Paulo Nobre
Tipo de bolsa: FAPESP fellowship for technical training, for the period May 1st, 2018 to April 30th, 2019.
2. Titulo: Coupling MOM5 ocean model to the Eta Framework model.
Bolsista: Luís Thiago Lucci Correa Paolicchi
Orientador: Sin Chan Chou
Tipo de bolsa: CNPq DTI-A fellowship, from March 2018 until February 2020.
3. Title: On the climate variability and impacts on major Brazilian Biomes
Bolsista: André Lyra,
Orientador: Sin Chan Chou
Tipo de bolsa:FAPESP pos-doc fellow.. Period: 01/09/2017 and 31/08/2019. A request for extension is being prepared.
4. Title: Impacts of different deforestation scenarios on the projections of climate change over the Plata river basin
Bolsista: Isabel Pilotto,
Orientador: Sin Chan Chou
Tipo de bolsa:FAPESP pos-doc fellow on the. Period: 01/08/2018 a 31/07/2020
5. TITLE: Downscaling de Modelos Climáticos na Bacia do Rio Itajaí e eventos extremos
NAME: Maria Fernanda Rodrigues Pereima
Orientador: Regina Rodrigues
MASTER – CAPES, PROCESS NUMBER: 88887.318111/2019-00, PERIOD: 01/03/2019-28/02/2021
6. TITLE: Incerteza e Não Estacionariedade na Análise de Frequência de Precipitação Máxima Anual na Bacia do Itajaí
NAME: Gabriel Anzolin
Orientador: Regina Rodrigues
MASTER – CAPES, PROCESS NUMBER: 88887.477406/2020-00, PERIOD: 01/03/2020-28/02/2022
7. Title: Propostas de adaptação da indústria brasileira de carvão a um mundo de baixo carbono
Name: Fábio Teixeira Ferreira da Silva
Orientador: Roberto Schaeffer
Ph.D – CAPES, processo 88887.137891/2017-00, period 01/03/2017 até 28/02/2021
8. Title Incorporação e Aprimoramento do Nexo Água-Uso da terra a um Modelo Energético – Estudo de Caso Brasil
Name: Fabio Amendola Diuana
Orientador: Roberto Schaeffer

Ph.D – CAPES, processo 88887.137141/2017-00, 01/03/2017 até 28/02/2021

9. Pos Doutorado, Gabriela dos Santos Eusébio, UNICAMP since april 2019 until march 2020, FAPESP.

10. Title: *Projeções futuras da distribuição geográfica dos vetores de Leishmaniose Visceral Americana no Brasil* [Future projections of the geographic distribution of American Visceral Leishmaniasis vectors in Brazil]
Name: Margarete Martins dos Santos Afonso,
Proceeding: 88887.136402/2017-00/ CNPq

11. Title: *Projeções futuras da distribuição geográfica dos principais vetores de Leishmaniose Tegumentar Americana na Amazônia brasileira* [Future projections of the geographical distribution of the main vectors of American Tegumentary Leishmaniasis in the Brazilian Amazon´]
Name: Bruno Moreira de Carvalho, Post-doctorate, 06/01/2018 to 05/31/2019.
Post-doctorate, 03/01/2018 to 02/28/2019.
CAPES 88887.169731/2018-00/ CNPq

12. Pos Doutorado, Andrea F. Young, CEMADEN, until September 2020, FAPESP

13. Title– Divulgação jornalística do INCT Mudanças climáticas – 2ª fase

14. Bolsista - Allison Eduardo da Silva Almeida
Orientadores – Antonio Carlos Amorim e Susana Oliveira Dias (Unicamp)
Tipo de bolsa: Bolsa TT3 FAPESP/ Duração – 1 ano, ended in May 2020

15. Margarete Martins Afonso dos Santos, PhD. Research collaborator. FIOTEC/ FIOCRUZ, Project: *Sustentabilidade e melhoria contínua dos Laboratórios de Referência do Instituto Oswaldo Cruz, para atendimento às demandas de Vigilância e Saúde* [Sustainability and continuous improvement of the Reference Laboratories of the Oswaldo Cruz Institute, to meet the demands of Surveillance and Health]. Sub-project: *Vigilância e o Controle da Leishmaniose Visceral Americana no Estado do Rio de Janeiro: distribuição espacial e análise de vulnerabilidade municipal* [Surveillance and Control of American Visceral Leishmaniasis in the State of Rio de Janeiro: spatial distribution and analysis of municipal vulnerability].

16. Simone Miranda da Costa, PhD. Research collaborator. FIOTEC/ FIOCRUZ,
Sub-project: *A importância de "Áreas Sentinelas" associadas às mudanças climáticas no contexto da vigilância epidemiológica da Leishmaniose Tegumentar Americana, no Brasil* [The importance of "Sentinel Areas" associated with climate change in the context of the epidemiological surveillance of American Tegumentary Leishmaniasis, in Brazil]

17. Pos-doctoral – CNPQ
Title: A saúde em situações de seca para o Semiárido brasileiro – a proposta de um índice de vulnerabilidade da saúde em situações de seca (fase I)
Name: Júlia Alves Menezes
Period: 01/02/2018 -31/01/2019

18. Scientific and Technological Development (DTI-A) - CNPQ
Title: A saúde em situações de seca para o Semiárido brasileiro – a proposta de um índice de vulnerabilidade da saúde em situações de seca (fase II)
Name: Júlia Alves Menezes
Period: 01/05/2019 -30/04/2020

19. Francisco Agustinho Neto, Doctoral Student developing Antarctic Ice modeling studies with BESM. Advisor: Paulo Nobre.

20. Diego de Andrade Campos, Doctoral Student. Coupling Radiation-Convection in the Eta Model. Advisor: Sin Chan Chou

21. José Davi de Moura, Doctoral Student. .Parameterization of lightning in the Eta Model. Advisor: Sin Chan Chou

22. Manoel Baptista da Silva Jr., FAPESP fellowship for technical training, for the period May 1st, 2018 to April 30th, 2019. A second year of fellowship, until 30 April 2020.

23. Luís Thiago Lucci Correa Paolicchi,. CNPq DTI-A fellowship, from March 2018 until February 2020. Coupling MOM5 ocean model to the Eta Framework model

24. "Assessing the climate and weather effects in Brazil using panel data"
Scholarships abroad – Research; Paula Carvalho Pereda

Link: https://bv.fapesp.br/en/bolsas/179293/assessing-the-climate-and-weather-effects-in-brazil-using-panel-data/
25. Michael Tulio Ramos de França, "Fertility and Inequality" Scholarships abroad - Research Internship – Doctorate Columbia University in the City of New York (United States) Eduardo Amaral HaddadLink: https://bv.fapesp.br/en/bolsas/177969/fertility-and-inequality/
26. Michael Tulio Ramos de França"Fertility and inequality: evidence from Brazil"Scholarships in Brazil - DoctorateEduardo Amaral Haddad, Link: https://bv.fapesp.br/en/bolsas/174909/fertility-and-inequality-evidence-from-brazil/
27. Eduardo Amaral Haddad "Agricultural and agro-industrial sustainability in Chile: modeling the impacts of climate change and natural disasters in an integrated framework" Regular Research Grants Eduardo Amaral Haddad Link: https://bv.fapesp.br/en/auxilios/102276/agricultural-and-agro-industrial-sustainability-in-chile-modeling-the-impacts-of-climate-change-and/
28. François Claude Prado Boris "A spatial impact analysis of water accessibility on farming in the Brazilian semiarid" Scholarships in Brazil - Scientific Initiation Eduardo Amaral Haddad Link: https://bv.fapesp.br/en/bolsas/181818/a-spacial-impact-analysis-of-water-accessibility-on-farming-in-the-brazilian-semiarid/
29. Karina Simone Sass "Urbanization and climate change: impact evaluation in the Metropolitan Region of São Paulo" Scholarships in Brazil – Doctorate Eduardo Amaral Haddad Link: https://bv.fapesp.br/en/bolsas/183721//
30. Inácio Fernandes de Araújo Junior "Agricultural and agro-industrial sustainability in Chile: modeling the impacts of climate change and natural disasters in an integrated framework" Scholarships in Brazil - Technical Training Program - Technical Training Eduardo Amaral Haddad Link: https://bv.fapesp.br/en/bolsas/184227/agricultural-and-agro-industrial-sustainability-in-chile-modeling-the-impacts-of-climate-change-and/
31. Luís Romero Barbosa. Period: 2020/2021. Federal University of Pernambuco. Funding agency: National Council for Scientific and Technological Development. In progress.
32. Jussara Freire de Souza Viana. Period: 2019/2021. Federal University of Pernambuco. Funding agency: Foundation for the Support of Science and Technology of the State of Pernambuco. In progress.
33. Ana Claudia Villar e Luna. Period: 2017/2022. Federal University of Pernambuco. Funding agency: CAPES/Foundation for the Support of Science and Technology of the State of Pernambuco. In progress.
34. Francine Modesto dos Santos. 2020. Universidade Federal de Campina Grande, Conselho Nacional de Desenvolvimento Científico e Tecnológico. INCT Grant (CAPES)
35. ROCHELE SHEILA VASCONCELOS. 2019. Universidade Federal de Campina Grande, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior.
36. Denise Taffarello. Period 2019. Supervisor: Prof. Davi G F Cunha. Title: Ecosystem service valuation method through grey water footprint in partially-monitored subtropical watersheds. Funding: CAPES, EESC/USP.
37. Diego Cezar dos Santos Araújo. Aplicação do modelo SWAT como ferramenta complementar para a gestão dos recursos hídricos: avaliação dos processos hidrossedimentológicos em bacias hidrográficas do estado de Pernambuco. Grant type: Technological and Industrial Development - DTI/B–CNPq (2019/2020).

12. Changes in Personnel

Food Security

Ms. Gabriela Eusébio left the staff of INCT-MC, in the form post-doctoral Internship of Campinas State University, until 31/03/2020.
Ms. Vanessa Pugliero left the staff of INCT-MC. She had a CNPq DTI-B scholarship until 31/03/2020.

Natural disasters, impacts on physical infrastructure in urban areas and

urban development

A researcher from the CEMADEN team left the project (Germano Gondim Ribeiro Neto. Insertion of a researcher in the CEMADEN team (Dr. Daniela de Azeredo França).

The student João Lucas Eberl Simon (UFSC) finished his MSc and is no longer working in this project. Professor Nádia B. Bonumá also left the project team because is on medical leave since 2019.

Insertion of the following researchers int the FIOCRUZ team: Maria Fernanda Campos Leme, Felipe Vommaro, Frederico Tosta.

Economy and impacts in key sectors

In year 3, the following member was included: Inácio Ferreira de Araújo Jr., USP

Dr. Araújo is a post-doctoral researcher at the Department of Economics at FEAUSP working with different aspects of large-scale economic modeling.

13. FAPESP Projects associated to the INC MC Phase 2

1) DIAS, S.; AMORIM, A. C.. "Sensitive Forest: Images, Writings and Climate Change". Workshops approved by EDUCA SP PROGRAM of the Secretary of Education of the State of São Paulo. with students from the state of São Paulo. 60 students are expected and R$500,00 of financial support are expected for each student.

2) GARCIA, G. Cid de. Pedagogias da imagem - contemplado com duas (2) bolsas para estudantes de graduação do Programa Institucional de Bolsas de Iniciação Artística e Cultural - PIBIAC/PR-1/UFRJ.

3) GARCIA, G. Cid de. Podcast Faculdade de Educação da UFRJ - projeto aprovado e periodicamente renovado nos editais RUA (Registro Único de Ações de Extensão), PR-5/UFRJ.

4) 2017-2020 - "For a new ecology of emissions and disseminations: how can communication modulate the human´s most intense potency of existing in face of climate changes?" Productivity scholarship - CNPq - research by Susana Oliveira Dias at Labjor-Unicamp.

5) 2019-2020 - "Science communication of INCT Climate Change - 2nd phase". Technical Training Scholarship - Fapesp TT3 - research by Allison Eduardo da Silva Almeida. Supervisors: Susana Oliveira Dias and Antonio Carlos Rodrigues de Amorim of the Labjor-FE-Unicamp.

6) 2018-2019 - "Public perception of climate change". Master in Science, Technology and Innovation scholarship - SECTYP Secretaría de Investigación, Internacionales y Posgrado, Universidad Nacional de Cuyo - research by Laura García Oviedo. Supervisor: Sandra Murriello of the Universidad Nacional de Río Negro, Argentina.

7) DIAS, S.; AMORIM, A. C.. "Sensitive Forest: Images, Writings and Climate Change". Workshops approved by EDUCA SP PROGRAM of the Secretary of Education of the State of São Paulo. with students from the state of São Paulo. 60 students are expected and R$500,00 of financial support are expected for each student. (Os recursos não foram liberados até o momento e não sabemos se serão);

8) GARCIA, G. Cid de. Pedagogias da imagem - contemplado com duas (2) bolsas para estudantes de graduação do Programa Institucional de Bolsas de Iniciação Artística e Cultural - PIBIAC/PR-1/UFRJ.

9) GARCIA, G. Cid de. Podcast Faculdade de Educação da UFRJ - projeto aprovado e periodicamente renovado nos editais RUA (Registro Único de Ações de Extensão), PR-5/UFRJ.

14 Financial report: Use of the RT and BC (summary)

Use of the RT:

	Valor cada Componente	Valor Gasto	Descrição	SALDO
COORDENAÇÃO	R$ 30.000,00	R$ 29.439,27	- Compra Ipad - Compra de	R$560,73

			Macbook e Adaptador - Compra de microcomputador Dell All in one Inspiron	
DESASTRE NATURAIS	-	-	-	-
ECONOMIA	-	-	-	-
SEGURANÇA ALIMENTAR	-	-	-	-
ENERGIA	-	-	-	-
COMUNICAÇÃO	-	-	-	-
ECOSSISTEMA	-	-	-	-
HIDROLOGIA	-	-	-	-
SAÚDE	-	-	-	-
MODELAGEM	-	-	-	-

Use of the BC: Year 2019-2020

PI	BC individual para PIs	Valor Gasto	Descrição	Saldo
JOSÉ ANTÔNIO MARENGO ORSINI	R$24.000,00	R$16.856,35	- Ministração de Palestra Natal-RN; - Pagamento de Inscrição evento em São Francisco E.U.A; - Diária evento em São Francisco- E.U.A; - Pagamento de Uber ao Aeroporto	R$ 7.143,65
REGINA CÉLIA ALVALÁ	R$24.000,00	R$ 1.999,54	- Publicação Scientific Research Publishing Limited	R$ 22.000,46
EDUARDO AMARAL HADADD	R$ 24.000,00	-		R$ 24.000,00
EDUARDO D. ASSAD	R$24.000,00	-		R$ 24.000,00
ENIO B. PEREIRA	R$ 24.000,00	R$ 20.543,12	- Pagamento de diárias visitas técnica ao laboratório Nacional de Energia e Geologia Barcelona; - Pagamento Seguro Viagem; - Pagamento Passagem; - Pagamento publicação Revista Elsevier	R$3.456,88
ANTONIO C RODRIGUES AMORIM	R$24.000,00	R$ 13.541,48	- Pagamento de diária Apresentação The "Elemental" Potency of Climate to Think Communication in the Anthropocene; - Pagamento Passagem; - Pagamento Inscrição para participação do evento;	R$10.458,52

			-Pagamento de Diagramação do PDF do livro Conexões: Deleuze e Cosmopoliticas e Ecologias Radicais e Nova Terra - 430 páginas	
EDUARDO MENDIONDO	R$ 24.000,00	R$9.466,75	- Pagamento de diária participação evento na Austrália -Pagamento de passagem para representar INCT evento em Brasília - Pagamento de Diária evento em Brasília - Pagamento de diária para Congresso Recursos Hídricos em Foz do Iguaçu	R$14.533,25
PAULO NOBRE	R$ 24.000,00	R$16.446,66	- Pagamento INVOICE-MDPI Atmosfere 585962 - Pagamento INVOICE-Copernicus Gesellscaft; - Pagamento IOF do artigo	R$7.553,34

Use of the BC: Year 2020 (Partial)

PI	BC individual para PIs	Valor Gasto	Descrição	Saldo
JOSÉ ANTÔNIO MARENGO ORSINI	-	-		-

The BC was used by the Communications component. The participation in the 2019 Annual Meeting of the Society for Social Studies of Science, held in New Orleans, Louisiana from September 4-7, one of the most important and internationally prominent in the field of social studies in science and technology, was due to the oral presentation of the work The Elemental Potency of Climate to Think Communication in the Anthropocene. The summary of the work is transcribed below. This paper was presented: Paper title: The Elemental Potency of Climate to Think Communication in the Anthropocene Authors: Susana Dias, University of Campinas; Antonio Carlos de Amorim, University of Campinas; Renato Oliveira, Institute Federal Baiano.

For the energy security component, during the period of validity of this report, a technical visit was made (a attachments: certificates of lectures given) to the National Energy and Geology Laboratory (LNEG), in the city of Lisbon, and the Center for Geosciences of the University of Coimbra (CGeo) in the city of Coimbra , both in P Portugal . The purpose of the trip was to carry out a technical visit to two selected Portuguese instructions in order to establish future scienfic partnerships in the area of Energy Meteorology in the context of climate change and sustainable development. The Brazil, and Portugal, two important countries of the Portuguese - speaking community, ratified the Paris agreement fixing their emission reduction targets. These goals have strong connections with national energy sector strategies. In this context, Portuguese research instructions present themselves as important partners since they have knowledge about the use of renewables in a climate region different from that prevailing in Brazil. The issue of energy use is strongly linked to the development scenarios of each country, which leads us to the Water-Energy-Food Nexus, which is the focus of the INCT-MC Phase 2 energy security subproject mission, in which INPE is one of the focal points of this subproject. During the visit, lectures (annexes) and interviews were held addressing specific topics within the context of decarbonization of the energy matrixes of the two countries in order to open possible lines of collaboration with exchanges of researchers and students from both instructions and seeking to attract Portuguese students for graduate studies. of INPE .

15 Collaboration with other INCTs, projects and Research networks

This INCT MC Phase 2 works very closely with the Rede Clima, the Brazilian Panel on Climate Change PBMC, and the INCLINE program at USP. We are already interacting or plan to interact with these INCTs and projects due to common interests and collaboration:

Process 465680/2014-3
Instituto Nacional de Ciência e Tecnologia da Criosfera
Coordinator: Jefferson Cardia Simões
UFRGS - Universidade Federal do Rio Grande do Sul

Process: 465319/2014-9
Instituto Nacional de Ciência e Tecnologia do Bioetanol
Coordinator: Marcos Silveira Buckeridge
USP - Universidade de São Paulo

Process: 2015/03804-9
Project MacroAmb-Environmental Governance in São Paulo Macro Metropolis in a climate variability context
Coordinator: Pedro R. Jacobi
USP - Universidade de São Paulo

UK-CSSP Climate Service Science Project
Newton Fund UK
CEMADEN, INPE, INPA, UKMO, Univ of Leeds.

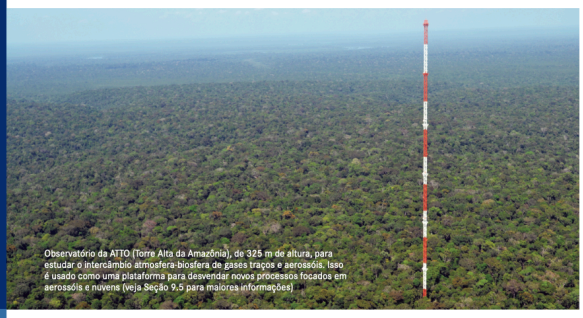
Annexes

Report of Years 1 and 2 of the project

2017.2019 | RELATÓRIO DE ATIVIDADES

Instituto Nacional de Ciência Tecnologia para Mudanças Climáticas Fase 2 (INCT MC Fase 2)

CNPq 465501/2014-1
FAPESP 2014/50848-9
CAPES 88887.136402-00INCT



Observatório da ATTO (Torre Alta da Amazônia), de 325 m de altura, para estudar o intercâmbio atmosfera-biosfera de gases traços e aerossóis. Isso é usado como uma plataforma para desvendar novos processos focados em aerossóis e nuvens (veja Seção 9.5 para maiores informações)

INCT para Mudanças Climáticas Fase 2

INCT PARA MUDANÇAS CLIMÁTICAS FASE 2
2017.2019 | RELATÓRIO DE ATIVIDADES | BRASIL

Novembro 2019

INCT MC2
INCT para Mudanças Climáticas · Fase 2

INCT para Mudanças Climáticas Fase 2 – Relatório de Atividades 2017-2019

Coordenação Geral
Jose A. Marengo

Vice Coordenação Geral
Tercio Ambrizzi

Organização, elaboração, revisão e didática de textos
Josiane Rosa, Ana Paula Soares

Editoração Eletrônica
Magno Studio

Pesquisadores líderes
Jose A. Marengo, CEMADEN
Tercio Ambrizzi, IAG USP
Alexandre Szklo, COPPE UFRJ
Antonio Amorim, UNICAMP
Eduardo Assad, EMBRAPA
Eduardo Mendiondo, EESC USP
Eduardo Haddad, FEA USP
Elizabeth Rangel, FIOCRUZ
Ênio B. Pereira, CCST INPE
Jose Feres, IPEA
Marta Barata, UFMG
Mercedes Bustamante, UnB
Paulo Artaxo, IF USP
Paulo Nobre, CPTEC INPE
Roberto Schaeffer, COPPE UFRJ
Regina Alvala, CEMADEN
Regina Rodrigues, UFSC
Sergio Margulis, IPEA, Way Carbon
Sin C. Chou, CPTEC INPE
Susana Dias, UNICAMP
Ulisses Confalonieri, UFMG, FIOCRUZ

Sede
Centro Nacional de Monitoramento e Alerta de Desastres Naturais-CEMADEN

Estrada Dr Altino Bondesan Nº. 500
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www.cemaden.gov.br

Apoio

Parcerias

Approval of Relatório Parcial Anos 1 e 2 of the INCT MC Phase 2 by CNPq

[465501/2014-1] III Seminário de Avaliação dos INCT - Relat...

Subject: [465501/2014-1] III Seminário de Avaliação dos INCT - Relatório Parcial Aprovado
From: seminarioinct@cnpq.br
Date: 30/03/20 16:43
To: jose.marengo@cemaden.gov.br, jose.marengo@pq.cnpq.br
CC: Usuario Assinatura Planilha <efomento@cnpq.br>, Seminario INCT <seminarioinct@cnpq.br>

Senhor Pesquisador Jose Antonio Marengo Orsini,

Comunicamos que o seu relatório técnico parcial, apresentado para o III Seminário de Avaliação dos INCTs, foi aprovado por este Conselho.

Adicionalmente, informamos abaixo os pareceres exarados em virtude do seu relatório/apresentação durante o evento:

1. O INCT para Mudanças Climáticas, de acordo com a documentação apresentada pelo coordenador do Instituto, tem tido execução extremamente satisfatória e recomendo sua aprovação nesta avaliação parcial.

2. Intensificar a viabilização da tradução do conhecimento adquirido neste excelente INCT para a sociedade e governantes.

3. Este INCT desenvolve múltiplas linhas de pesquisa com abordagem multidisciplinares sobre mudanças climáticas, segurança hídrica, social e desastres ambientais com potencial aplicação em políticas públicas no país. A produção científica qualificada, bem como a formação de recursos humanos, merece destaque. Recomenda-se que este INCT busque a transferência de conhecimento para o setor produtivo e subsídio para as políticas públicas no país. Concluindo, recomenda-se a aprovação do relatório parcial avaliado por esta comissão.

Atenciosamente,

Leila de Morais
Especialista em Políticas Públicas e Gestão Governamental
Coordenadora Geral

1 of 2 02/06/20 09:31

Presentations of the INCT MC Phase 2 at meetings and conferences (presential and virtual)

WATER, HEALTH AND URBAN RESILIENCE

30/09/2019 - 9:30-12:00H – ANFITEATRO DO SHS

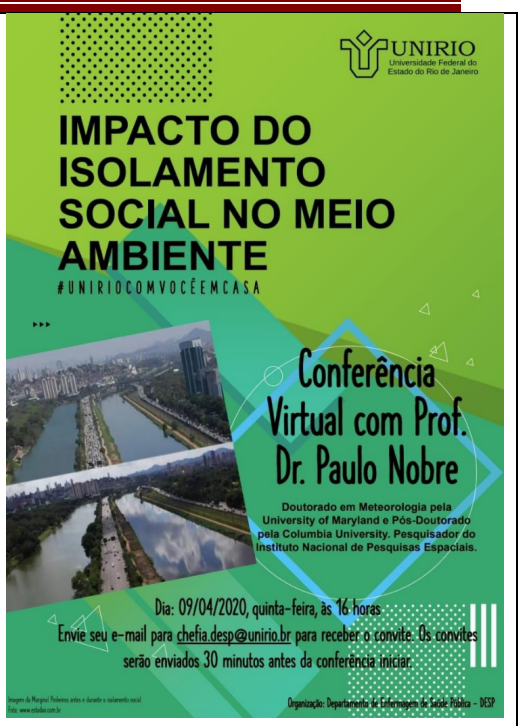
COOPERAÇÃO INTERNACIONAL

Participe dia 30 de setembro de 2019 do International Workshop on 'Water, Health and Urban Resilience', parte do projeto SPRINT FAPESP: '2018/08413-6 UK-Brazil collaboration for investigating the nexus between water, health and urban resilience', baseado nos Objetivos de Desenvolvimento Sustentável e iniciativas internacionais IAHS-Panta Rhei e IAHS-MOXXI . Este Workshop integra o ciclo de palestras internacionais 2019 International Water Lectures, com apoio CAPES/PROEX do Programa de Pós-Graduação em Engenharia Hidráulica e Saneamento (PPGSHS) da Escola de Engenharia de São Carlos (EESC), Universidade de São Paulo (USP), se associa a iniciativas interdisciplinares de: (1) Subcomponente de Segurança Hídérica do Instituto Nacional de Ciência e Tecnologia em Mudanças Climáticas-Fase 2 (INCTMC2) coordenado pelo CEMADEN/MCTIC, (2) Subprojeto de Recursos Hídricos e Mudanças Climáticas do Interdisciplinary Climate Investation Centre (INCLINE), (3) Centro de Ciências Matemáticas Aplicadas à Indústrica (CEPID/CeMEAI) e (4) CAPES/USP/ALERTA do Centro de Educação e Pesquisa em Desastres, CEPED/USP, via Programa CAPES Pró-Alertas.

PROGRAMA PRELIMINAR - 30/09/2019 - 9:30-12:00H – ANFITEATRO DO SHS

- ***How Digital Water Shape Resilient Infrastructure, AI-based Health and Insurance Industry in Scenarios After Brexit and Amazon Fires?*** (9:30-10:00h): Prof. E M Mendiondo, FAPESP/SPRINT Coord. (USP, Brazil)
- ***Brazilian Citizen-based Technologies for the Water-Health-Resilience Nexus*** (10:00-11:00h): Felipe A A Souza, USP (BR), Dr M C Fava, USP (BR), Dr L Degrossi, USP (BR), Prof H Lombardi, UFSCar (BR), Prof J Estrella, USP (BR), Eng H Pimentel-Fialho, USP (BR)
- ***The Water-Health-Resilience Nexus at the Municipality Scale*** (11:00-11:30h): Prof Dr J G Tundisi, Municipality Secretary on Science, Technology and Innovation of Sao Carlos (BR), Nominated UNESCO Chair on Urban Waters
- Conclusions and Recommendations (11:30-12:00h)

Inscrições: Vagas gratuitas e limitadas. Enviar email para emm@sc.usp.br e realizar a inscrição na Secretaria do Programa de Pós Graduação em Engenharia Hidráulica e Saneamento. **Mais informações:** www.eesc.usp.br/ppgshs

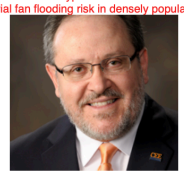


The CAPES/PROEX PPGSHS EESC/USP, in association with Federal University of Pernambuco and Federal University of Campina Grande, hosts at CETISC, USP São Carlos, 14-18 Oct., 2019:

The SCHOOL OF ADVANCED STUDIES OF WATER AND SOCIETIES UNDER CHANGE:

Sedimentation Hazards Engineering to Reduce Flooding Risk by Natural and Manmade Phenomena:

from water floods and landslides to hyperconcentrated floods, mudflows, debris flows and alluvial fan flooding risk in densely populated areas



Prof Marcelo Horacio Garcia

University of Illinois, USA, Director of Ven Te Chow Hydrosystems Lab

Biography - Marcelo Horacio Garcia, is an Argentinian water resources engineer from Universidad Nacional del Litoral, Santa Fe, Argentina. Educator and consultant, his achievements include development of the first model for sediment mixtures transport by turbidity currents in the ocean. Prof Garcia is recipient of several outstanding distinctions: Karl Emil Hilgard hydraulics Prize from American Society of Civil Engineers, New York City, The Alvin Anderson Award from University of Minnesota, Minneapolis. He is named Distinguished Visiting Professor University Genoa, Italy, has the M.T. Geoffrey Yeh Endowed Chair in Civil Engineering and is the recipient of the 6th M. Selim Yalin Lifetime Achievement Awardby the International Association for Hydro-Environment Engineering and Research (IAHR). He is a Fellow of ASCE's Environmental Water Resources Institute. In addition, Garcia has received many awards including the National Award for Scientific Contributions to Science and Technology from the National Secretariat for Science, Technology and Innovation of Panama and the Hunter Rouse Hydraulic Engineering Lecture Award. He teaches courses on water resources engineering and hydraulic engineering, environmental hydrodynamics, sediment transport, river mechanics and open-channel hydraulics. Prof Garcia is the Director of the Ven Te Chow Hydrosystems Laboratory at Univ of Illinois, Urbana-Champaign.

Context: The 2019 CAPES School of Advanced Studies of Water & Society under Change (SASW&SC) encompasses different modules. SASW&SC's modules share interdisciplinary objectives and crosscutting issues related to running initiatives of: IAHS Panta Rhei Everything Flows, the National Institute of Science and Technology on Climate Change-Phase 2 (INCTMC2), the Interdisciplinary Centre for Climate Investigation (INCLINE), the Center for Education and Research on Disasters (CEPED/SP), and the FAPESP Research and Innovation Center of Applied Maths for Industry (CEPID/CeMEAI), developed by local and international institutions. All CAPES SASW&SC visiting professors are worldwide experts allocated through a mix of open talks, lectures, workshops and seminars, according to their experiences and recent published articles in journals. In this new SASW&SC module, sedimentation hazards engineering is addressed to reduce flooding risk by natural and manmade phenomena, of central interests to either the Brazilian System of Civil Protection, Braz. Act # 12.608 and the UN Sendai Disaster Risk Reduction (DRR) Framework. Thus, the research alliance among EESC-USP, UFPE and UFCG, promotes this 2019 SAWS&SC module to discuss and develop these pathways under private-public partnership, a stewardship step to disaster risk reduction.

The CAPES/PROEX PPGSHS EESC/USP, in association with Federal University of Pernambuco and Federal University of Campina Grande, will host the CAPES School of Advanced Studies of Water & Societies under Change at the

Anfiteatro do CETISC (USP São Carlos) 02/December – 06/December

SCHOOL OF ADVANCED STUDIES OF WATER AND SOCIETIES UNDER CHANGE BY

PATRICIA GOBER
ARIZONA STATE UNIVERSITY

Patricia Gober is a research professor in the School of Geographical Sciences and Urban Planning at Arizona State University as well as professor of Public Policy in the Johnson-Shoyama Graduate School of Public Policy at the University of Saskatchewan and affiliated faculty in the Global Institute for Water Security at the University of Saskatchewan.

XIMING CAI
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAING

Professor Cai's research areas include coupled human-natural system analysis with an emphasis on human interferences in hydrological processes, water-energy-food system modeling especially in dry areas, and sustainable water resources management particularly in developing countries. He has been named a 2019 Fellow of the American Geophysical Union AGU.

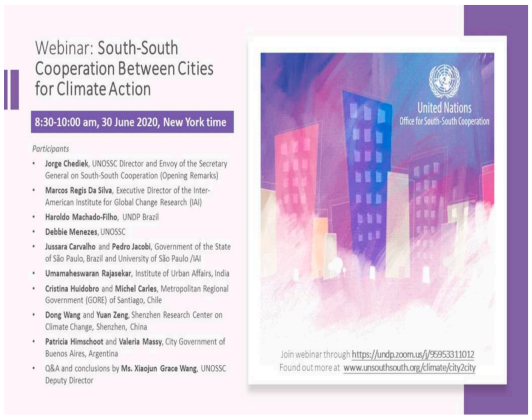
HOWARD WHEATER
IMPERIAL COLLEGE LONDON
UNIVERSITY OF SASKATCHEWAN

Howard Wheater is a researcher in the Global Institute for Water Security at the University of Saskatchewan and emeritus professor at Imperial College London. Dr. Wheater also is a Canada Excellence Research Chair in Water Security and a world-leading expert in hydrology and sustainable water resource management.

MAARTEN KROL
UNIVERSITY OF TWENTE

Maarten Krol joined the University of Twente in 2003 and since contributed to research in integrated water modelling. He worked as a researcher at the National Institute of Public Health and the Environment (RIVM, Bilthoven, Netherlands), the Potsdam Institute for Climate Impact Research (PIK, Potsdam, Germany) and the Universidade Federal do Ceará (UFC, Fortaleza, Brazil).

Registration: Free-of-charge, limited positions. Send email to felipeaas@usp.br and emm@sc.usp.br. **Live Streaming:** e.usp.br/cetisc-aovivo. **Credits:** only for enrolled participants. Registration at the graduate programs of EESCP-USP, UFCG and UFPE. **More information:** www.eesc.usp.br/ppgshs


Webinar: South-South Cooperation Between Cities for Climate Action
8:30-10:00 am, 30 June 2020, New York time
Participants
Jorge Chediek, UNOSSC Director and Envoy of the Secretary General on South-South Cooperation (Opening Remarks)
Marcos Regis Da Silva, Executive Director of the Inter-American Institute for Global Change Research (IAI)
Haroldo Machado-Filho, UNDP Brazil
Debbie Menezes, UNOSSC
Jussara Carvalho and Pedro Jacobi, Government of the State of São Paulo, Brazil and University of São Paulo /IAI
Umamaheswaran Rajasekar, Institute of Urban Affairs, India
Cristina Huidobro and Michel Carles, Metropolitan Regional Government (GORE) of Santiago, Chile
Dong Wang and Yuan Zeng, Shenzhen Research Center on Climate Change, Shenzhen, China
Patricia Himschoot and Valeria Massy, City Government of Buenos Aires, Argentina
Q&A and conclusions by Ms. Xiaojun Grace Wang, UNOSSC Deputy Director
United Nations
Office for South-South Cooperation
Join webinar through https://undp.zoom.us/j/95953311012
Found out more at www.unsouthsouth.org/climate/city2city


AMS100
American Meteorological Society
100th AMS Annual Meeting
Boston, 14 January 2020
INCT MC2
Amazonia, climate and biomass burning in a changing world
Paulo Artaxo, Samara Carbone, Luciana Rizzo, Henrique Barbosa
University of São Paulo, Brazil
Artaxo@if.usp.br


"Ciência Cidadã" para subsidiar modelagem do risco de colapso de safras de agricultura familiar
Agri Support
Ana Paula Cunha*, Carlos A. Nobre, Regina Alvalá*
1. Introdução
O que é?
Ferramenta que permite o envolvimento direto do agricultor no monitoramento da seca agrícola
Como?
Coleta e envio de informações agrícolas incluindo manejo por meio de dispositivo móvel
Qual a finalidade?
Ciência Cidadã compreende a participação da comunidade na coleta e envio de informações relevantes para subsidiar projetos científicos de interesse social. No presente projeto, informações específicas sobre o cultivar e manejo agrícola integrarão um banco de dados que será utilizado para subsidiar o Sistema de Previsão de Risco de Colapso de Safras na Agricultura Familiar do Semiárido do Brasil (em desenvolvimento no CEMADEN/MCTI). Considerando que o foco principal do projeto é a proteção da produção agrícola familiar no semiárido, o sistema de previsão auxiliará no planejamento e tomada de decisão com a finalidade de minimizar os impactos de quebras de safra e prejuízos sociais decorrentes.
2. Metodologia
Funcionalidades
Seleção do cultivar:
Principais culturas de subsistência do semiárido do Brasil: Feijão, Milho, Sorgo, Mandioca, Algodão, Arroz, Batata, Frutas, Hortaliças.
Informações: Manejo
•Informação da propriedade
•Data de plantio
•Data e colheita
•Estimativa área plantada
•Estimativa área colhida
•Preparo do solo
•Uso de fertilizante orgânica
•Qualidade da semente
•Número de sementes por cova
•Espaçamento entre mudas
•Ocorrência de pragas ou doenças
3. Resultados
4. Conclusão: Aplicação
Este projeto é uma contribuição do Instituto Nacional de Ciência e Tecnologia (INCT) para Mudanças Climáticas, financiado pelo projeto CNPq Processo 573797/2008-0 e FAPESP Processo 2008/57719-9.


III SEMINÁRIO sobre DESASTRES NATURAIS
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ABJICA
SÃO PAULO GOVERNO DO ESTADO
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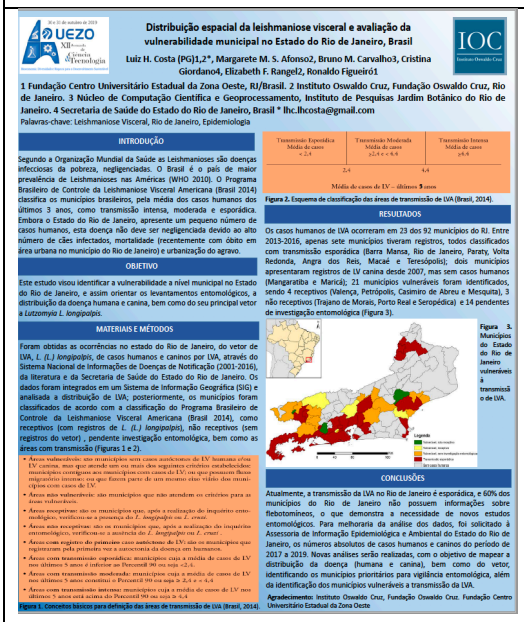
MACCAFERRI
Cartões Digitais Interativos


INCT para Mudanças Climáticas Fase 2
(INCT MC Fase 2)
CNPq 465501/2014-1
FAPESP 2014/50848-9
CAPES 88887.136402-00INCT
INCT MC2
INCT para Mudanças Climáticas Fase 2
Coordenador: Jose A. Marengo-CEMADEN
Vice-Coordenador: Tercio Ambrizzi-IAG USP
inct
cgee
CNPq


30
VEGETATION STRESS HAZARD IN THE DRYLANDS OF NORTHEAST BRAZIL (NEB) UNDER REGIONAL WARMING EXCEEDING 4oC
Introduction
Future drought scenarios, impacts in vegetation and drought risk in NEB
Public policies, adaptation and drought
Drought in Northeast Brazil
Final thoughts, References and Acknowledgements


Ministério da Saúde
Fundação Oswaldo Cruz
Instituto René Rachou
Programa de Pós Graduação em Saúde Coletiva
FLUXO DE INFORMAÇÕES DE SAÚDE EM DESASTRES DECORRENTES DE INUNDAÇÕES E ENXURRADAS NO ESTADO DE MINAS GERAIS - LIMITAÇÕES, AVANÇOS E CONTRIBUIÇÕES.
Aluna: Rhavena Santos
Orientação: Dr. Ulisses Confalonieri
Coorientação: Dr. Carlos Freitas e Dr. Carina Margonari


INCT MC2
Ministério da Saúde
Fundação Oswaldo Cruz
Instituto René Rachou
Programa de Pós Graduação em Saúde Coletiva
Vigilância em saúde e desastres: atores e papéis
Aluno: Rhavena Santos
Belo Horizonte, 13 de junho de 2019


Distribuição espacial da leishmaniose visceral e avaliação da vulnerabilidade municipal no Estado do Rio de Janeiro, Brasil
Luiz H. Costa (PG)1,2*, Margarete M. S. Afonso2, Bruno M. Carvalho3, Cristina Giordano4, Elizabeth F. Rangel2, Ronaldo Figueiró1
1 Fundação Centro Universitário Estadual da Zona Oeste, RJ/Brasil. 2 Instituto Oswaldo Cruz, Fundação Oswaldo Cruz, Rio de Janeiro. 3 Núcleo de Computação Científica e Geoprocessamento, Instituto de Pesquisas Jardim Botânico do Rio de Janeiro. 4 Secretaria de Saúde do Estado do Rio de Janeiro, Brasil * lhc.lhcosta@gmail.com
Palavras-chave: Leishmaniose Visceral, Rio de Janeiro, Epidemiologia
INTRODUÇÃO
OBJETIVO
MATERIAIS E MÉTODOS
RESULTADOS
CONCLUSÕES


8º Congresso Brasileiro de Ciências Sociais e Humanas em Saúde
UM ÍNDICE DE VULNERABILIDADE EM SITUAÇÕES DE SECA PARA MUNICÍPIOS DO SEMIÁRIDO
Júlia Alves Menezes[1]; Rhavena Barbosa dos Santos[1]; Isabela de Brito Duval[1], Pedro Regoto[2]; Ana Paula Madureira[3]; Martha Barata[4]; Carina Margonari[1]; Ulisses Confalonieri[1]
[1]Instituto René Rachou, Fiocruz Minas; [2]Universidade Federal do Rio de Janeiro; [3]Universidade Federal de São João Del Rei; [4]Escola Nacional de Saúde Pública Sérgio Arouca, Fiocruz.
INTRODUÇÃO
MÉTODOS
RESULTADOS
CONCLUSÕES


DIVULGAÇÃO CIENTÍFICA E MUDANÇAS CLIMÁTICAS
MENU
VII Seminário Conexões
Deleuze e Cosmopolíticas e Ecologias Radicais e Nova Terra e...
Deleuze and Cosmopolitics and Radical Ecologies and New Earth and...
Deleuze y Cosmopolíticas y Ecologías Radicales y Nueva Tierra y...
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GRUPO
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Objetivos
Resultados
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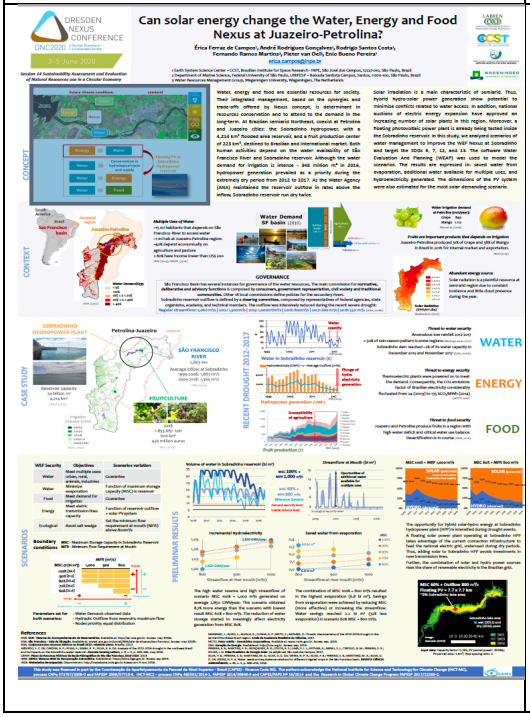
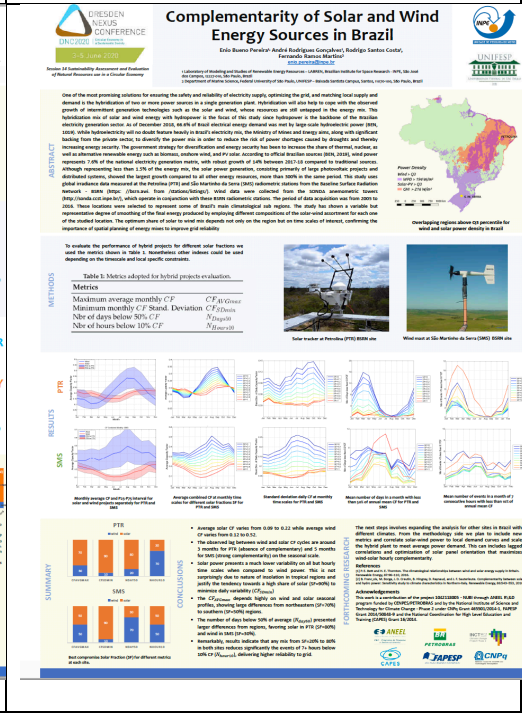
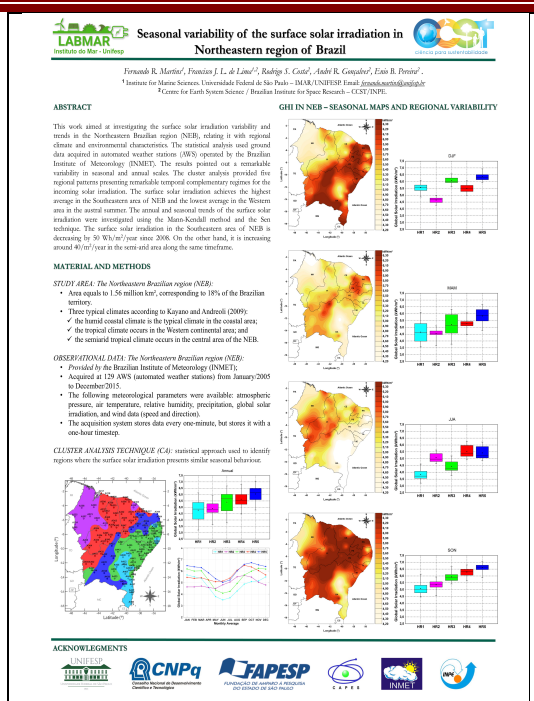
Quinta-feira
18/06
Às 11:00 hs
Prof. PhD Nereu Streck
Coordenador Equipe FieldCrops
Dr. José Antônio Marengo
CEMADEM, São Paulo
Field Crops
Cemaden


Apresentação
Base de
Dados de
Satélite da
EMBRAPA
Eduardo Assad
José Ruy Carvalho
Mariela Almeida
Vanessa Pugliero
PROJETO SHAE-SF
NEXUS ÁGUA, ENERGIA
E ALIMENTO


Resiliência Econômica e
Ambiental dos Sistemas
Integrados e Diversificados
da Bovinocultura de Corte
Projeto de Pesquisa Embrapa - NEA
Supervisor: Alexandre Gori Maia
Adamara S. G. Felício
Gabriela Eusébio
Embrapa
UNICAMP
NEA


DRESDEN NEXUS CONFERENCE
DNC2020
5-5 June 2020
Can solar energy change the Water, Energy and Food Nexus at Juazeiro-Petrolina?
Érica Ferraz de Campos¹, André Rodrigues Gonçalves², Rodrigo Santos Costa³, Fernando Ramos Martins⁴, Pieter van Oel⁵, Enio Bueno Pereira⁶
erica.campos@inpe.br
CONCEPT
CONTEXT
CASE STUDY
RESULTS
SCENARIOS
PRELIMINAR RESULTS
WATER
ENERGY
FOOD
GOVERNANCE
RECENT DROUGHT 2012-2017


DRESDEN NEXUS CONFERENCE
DNC2020
5-5 June 2020
Complementarity of Solar and Wind Energy Sources in Brazil
Enio Bueno Pereira¹, André Rodrigues Gonçalves², Rodrigo Santos Costa², Fernando Ramos Martins³
ABSTRACT
METHODS
RESULTS
PTR
SMS
CONCLUSIONS
SUMMARY
FORTHCOMING RESEARCH



Seasonal variability of the surface solar irradiation in Northeastern region of Brazil

Fernando R. Martins[1], Francisco J. L. de Lima[1,2], Rodrigo T. Costa[1], André R. Gonçalves[1], Enio B. Pereira[2] .
[1] Institute for Marine Sciences. Universidade Federal de São Paulo – IMAR/UNIFESP. Email: fernando.martins@unifesp.br
[2] Centre for Earth System Science / Brazilian Institute for Space Research – CCST/INPE.

ABSTRACT

This work aimed at investigating the surface solar irradiation variability and trends in the Northeastern Brazilian region (NEB), relating it with regional climate and environmental characteristics. The statistical analysis used ground data acquired in automated weather stations (AWS) operated by the Brazilian Institute of Meteorology (INMET). The results pointed out a remarkable variability in seasonal and annual scales. The cluster analysis provided five regional patterns presenting remarkable temporal complementary regimes for the incoming solar irradiation. The surface solar irradiation achieves the highest average in the Southeastern area of NEB and the lowest average in the Western area in the austral summer. The annual and seasonal trends of the surface solar irradiation were investigated using the Mann-Kendall method and the Sen technique. The surface solar irradiation in the Southeastern area of NEB is decreasing by 50 Wh/m²/year since 2008. On the other hand, it is increasing around 40/m²/year in the semi-arid area along the same timeframe.

GHI IN NEB – SEASONAL MAPS AND REGIONAL VARIABILITY

MATERIAL AND METHODS

STUDY AREA: The Northeastern Brazilian region (NEB):

- Area equals to 1.56 million km², corresponding to 18% of the Brazilian territory.
- Three typical climates according to Kayano and Andreoli (2009):
  - ✓ the humid coastal climate is the typical climate in the coastal area;
  - ✓ the tropical climate occurs in the Western continental area; and
  - ✓ the semiarid tropical climate occurs in the central area of the NEB.

OBSERVATIONAL DATA: The Northeastern Brazilian region (NEB):

- *Provided by* the Brazilian Institute of Meteorology (INMET);
- Acquired at 129 AWS (automated weather stations) from January/2005 to December/2015.
- The following meteorological parameters were available: atmospheric pressure, air temperature, relative humidity, precipitation, global solar irradiation, and wind data (speed and direction).
- The acquisition system stores data every one-minute, but stores it with a one-hour timestep.

CLUSTER ANALYSIS TECHNIQUE (CA): statistical approach used to identify regions where the surface solar irradiation presents similar seasonal behaviour.

ACKNOWLEGMENTS

Mudanças Climáticas e Zonas Costeiras

Jose A. Marengo
CEMADEN/MCTIC
São José dos Campos, SP, Brazil
www.cemaden.gov.br

1º Seminário Capixaba sobre Mudanças Climáticas do IEC-UFES
Julho 2020

Impacto das mudanças climáticas na distribuição de vetores de leishmanioses do Brasil

INCT Mudanças Climáticas
Subcomponente Saúde

Bruno Carvalho (Instituto Nacional da Mata Atlântica, MCTIC)
Elizabeth Rangel (Instituto Oswaldo Cruz, FIOCRUZ, INCT Mudanças Climáticas)

1

The Water, Food, Energy Nexus & Climate Change
in the Semiarid Northeast Brazil

Francinete Francis Lacerda, Dr.
Agronomic Institute of Pernambuco - IPA
Paulo Nobre, Ph.D.
National Institute for Space Research – INPE

Dresden Nexus Conference, 4 June 2020.

Impacto do isolamento social no meio ambiente

Paulo Nobre, Ph.D.
Instituto Nacional de Pesquisas Espaciais – INPE

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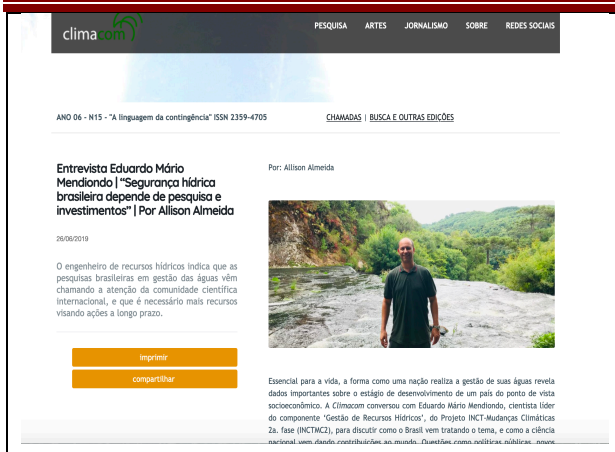
9 de abril de 2020!

Reports, interviews and press communications where results of the INCT MC Phase 2 were mentioned



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PESQUISA ARTES JORNALISMO SOBRE REDES SOCIAIS

ANO 06 - N15 - "A linguagem da contingência" ISSN 2359-4705 CHAMADAS | BUSCA E OUTRAS EDIÇÕES

Entrevista Eduardo Mário Mendiondo | "Segurança hídrica brasileira depende de pesquisa e investimentos" | Por Allison Almeida

26/06/2019

O engenheiro de recursos hídricos indica que as pesquisas brasileiras em gestão das águas vêm chamando a atenção da comunidade científica internacional, e que é necessário mais recursos visando ações a longo prazo.

imprimir

compartilhar

Por: Allison Almeida

Essencial para a vida, a forma como uma nação realiza a gestão de suas águas revela dados importantes sobre o estágio de desenvolvimento de um país do ponto de vista socioeconômico. A *Climacom* conversou com Eduardo Mário Mendiondo, cientista líder do componente 'Gestão de Recursos Hídricos', do Projeto INCT-Mudanças Climáticas 2a. fase (INCTMC2), para discutir como o Brasil vem tratando o tema, e como a ciência nacional vem dando contribuições ao mundo. Questões como políticas públicas, novos

clima com

PESQUISA ARTES JORNALISMO SOBRE REDES SOCIAIS

ANO 06 - N16 - "Povos ouvir - a coragem da vergonha" ISSN 2359-4705 CHAMADAS | BUSCA E OUTRAS EDIÇÕES

Entrevista José A. Marengo | A comunidade científica brasileira não permitirá que a reflexão sobre as mudanças climáticas estacione | Por Allison Almeida

25/12/2019

José A. Marengo, pesquisador no Centro Nacional de Monitoramento e Alertas de Desastres Naturais, coordenador do INCT-MC2, afirma que, mesmo no cenário atual de incertezas políticas relacionadas a investimentos na área de ciência, a climatologia brasileira manterá o padrão de qualidade e continuará engajada na busca de soluções diante dos desafios trazidos pelas mudanças climáticas.

imprimir

Por Allison Almeida

Cortes em orçamentos para a ciência, declarações negacionistas de Ministros de Estado, aumento do número de queimadas nos principais biomas nacionais. Todos esses fenômenos mostram que 2019 será marcado como um período complicado para trabalhar com climatologia no Brasil. Apesar das dificuldades, a área tem conseguido bastante destaque por seus trabalhos relacionados às mudanças climáticas. O interesse vai além do círculo acadêmico e vem aumentando exponencialmente, pois a manutenção de serviços ecossistêmicos como a Amazônia e o Cerrado são essenciais para o equilíbrio da Terra.

A **Climacom** convida José A. Marengo, coordenador do Instituto Nacional de Ciência e Tecnologia - Mudanças Climáticas Globais - 2a. fase (**INCT-MC2**), principal consórcio brasileiro de estudos relacionados às mudanças climáticas para uma conversa sobre climatologia, ciência e política. Além de uma panorama sobre os trabalhos realizados durante uma década no INCT, o físico, membro titular da Academia Brasileira de Ciências abordou temas como aumento das queimadas no Brasil, a onda internacional de negacionismo vinculado às mudanças climáticas e os erros que o governo brasileiro cometeu no que se refere à preservação.

Sobre o futuro da climatologia, apesar do cenário atual, José A. Marengo é confiante. "Com toda experiência que já temos e massa crítica de pesquisadores dificilmente vamos parar ou perder todo conhecimento que foi aprendido. Não voltaremos à estaca zero. Estamos em turbulência neste momento, mas ela irá acabar e voltaremos a fazer

climacom

PESQUISA ARTES JORNALISMO SOBRE REDES SOCIAIS

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Coronavírus e clima | Ulisses Confalonieri, Elizabeth Rangel, Maria de Lourdes Oliveira, Júlia Menezes e Rhavena Santos

10/04/2020

Pesquisadores da Fiocruz, que fazem parte do INCT Mudanças Climáticas - 2a fase, apresentam relações entre a transmissão do COVID-19 e o clima

Por: Ulisses Confalonieri [1], Elizabeth Rangel [2], Maria de Lourdes Oliveira [2], Júlia Menezes [1] e Rhavena Santos [1]

Em dezembro de 2019 foram relatados clusters de pacientes com pneumonia de origem desconhecida, epidemiologicamente relacionados a um mercado de frutos do mar em Wuhan, na província de Hubei, China (Wu *et al.*, 2020; Zhou *et al.*, 2020). Esses casos estavam associados à infecção por um novo coronavírus, denominado SARS-CoV-2 (Coronaviridae Study Group of the International Committee on Taxonomy of Viruses, 2020).

Este vírus, causador da Covid-19, faz parte de um grupo grande de vírus que infectam vários animais e o homem, não apenas no sistema respiratório. Junto com os vírus da influenza, tem sido os principais responsáveis pelas epidemias e pandemias de infecções respiratórias em populações humanas. Apesar da gripe (influenza) ser mais frequente e estudada, os coronavírus têm, nas últimas décadas, causado importantes epidemias, com maior ou menor disseminação regional/global.

No homem, os coronavírus causam doença respiratória, gastrointestinal, hepática e desordens neurológicas (Corman, Muth, Niemeyer, & Drosten, 2018). Os vírus SARS-CoV, (originado na China, em 2003); MERS-CoV (originado na Arábia Saudita, em 2012) e SARS-CoV-2 podem ocasionar doenças graves, ao passo que o HKU1, NL63, OC43 e 229E co-circulam normalmente com outros vírus respiratórios e encontram-se associados a um quadro clínico mais brando em indivíduos imunocompetentes, acometendo principalmente o trato respiratório superior (Corman, Muth, Niemeyer, & Drosten, 2018; Forni, Cagliani, Clerici, & Sironi, 2017; Cui, Li, & Shi, 2019).

O que atualmente causa a pandemia (SARS Cov-2) foi conhecido somente em janeiro passado e muito pouco é conhecido sobre sua história natural. Mas a sazonalidade observada com outras viroses respiratórias pode nos dar uma boa orientação, em relação às suas possíveis relações com os fenômenos climáticos.

Viroses respiratórias epidêmicas

De maneira geral, observa-se um papel fundamental da temperatura na sazonalidade desses vírus, sendo apontada inclusive a migração frequente dos vírus influenza de regiões geográficas mais quentes para as mais frias •(Li *et al.*, 2019; Sundell, Andersson, Brittain-Long, Lindh, & Westin, 2016)□. De fato, quase todos os vARIs compartilham a mesma sazonalidade em regiões temperadas, onde os casos são mais prevalentes no inverno, enquanto há maior diversidade temporal nos trópicos •(Li *et al.*, 2019; Stewart, 2016)□. A temporalidade das epidemias de vARIs varia entre e dentro de cada país •(Bloom-Feshbach *et al.*, 2013)□.

Para a influenza, os padrões sazonais são parecidos, o que permite haver sobreposição de picos entre os dois grupos virais. A atividade mais frequente do influenza está associada ao período de inverno nos países temperados, enquanto nas áreas tropicais podem ser observados os seguintes padrões: i) infecções o ano todo com picos nas estações das chuvas; ii) infecções o ano todo com picos semestrais associados à estação das chuvas e aos meses de inverno; e iii) infecções sem clara sazonalidade •(Moura *et al.*, 2009; Shek & Lee, 2003)□. De fato, a temporalidade das epidemias parece ser mais variável e menos sazonal à medida que se aproxima do equador •(Bloom-Feshbach *et al.*, 2013)□. •Lobato-Cordero *et al.* (2019)□ estudando moradias sociais em 1040 paroquias no Equador, revelaram que a transmissão da gripe e da pneumonia viral foram favorecidas por locais com temperaturas e umidade relativa mais baixas. Já •Murtas & Russo (2019)□, ao estudar o excesso de mortalidade na região metropolitana de Milão em 2016-2017, associaram este excesso à epidemia de gripe e a exposições ambientais concomitantes, especificamente, o efeito combinado da poluição do ar e baixas temperaturas. •S. Sun *et al.* (2019)□, ao avaliarem a

Some papers and other publications derived from the project

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REVIEW

Trends in extreme rainfall and hydrogeometeorological disasters in the Metropolitan Area of São Paulo: a review

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Our paper reviews recent progress in the study and understanding of observed trends in extreme rainfall events in the Metropolitan Area of São Paulo (MASP). These are discussed in relation to hydrometeorological hazards that trigger natural disasters, such as flash floods, landslides, and droughts, that affect the population and local economies. A review of the most updated literature on rainfall and extremes in the MASP shows a significant increase in the total volume of rainy-season rainfall during the last seven decades. While there were practically no days with heavy rain (more than 50 mm) in the 1950s, these days have been occurring two to five times a year in the last 10 years. This, together with the inappropriate occupation of risky areas, such as slopes and banks of watercourses, leads to inundation, flooding, and landslides. Changes in extremes can be partly due to natural climate variability but can also be related to global warming and/or urbanization. There is ample evidence of an increasing risk of rainfall-related hazards in the MASP. This is particularly so for landslides in vulnerable areas. Exposure will continue to lead to risk increases. This calls for significant improvement in climate and disaster risk reduction and management efforts in the MASP region.

Keywords: climate extremes; natural disasters; climate change; disaster risk reduction; metropolitan area; São Paulo

Introduction

Extreme weather and climate events have received more and more attention owing to increasing numbers of disasters with large loss of human life in the last decades. Through models developed by the climate research community, it has been concluded that human activities are changing the Earth's climate and increasing the risks that make the residents of cities progressively more vulnerable.[1]

Anthropogenic changes have led to significant modifications in climate and weather systems in cities,[2] and their citizens have already begun to experience effects of unprecedented magnitude, including floods and landslides caused by heavy rainfall, as well as record-breaking droughts,[2–4] and dry spells.[5–7] As a consequence, populations are more vulnerable to disasters of natural hydrometeorological origin, such as floods, landslides, and severe droughts.

Changes in the total amount of rainy-season precipitation can be manifested in different ways. There can be variations in the number of wet days or heavy precipitation, or both.[8] Changes in extremes are generating concern over the environmental security of urban areas, which is where people and assets are concentrated, and in high-risk areas where vulnerable people live. The effects of climate-related disasters are often exacerbated in cities, owing to interactions with urban infrastructure systems, growing population, and certain economic activities.[9] Countries all over the world have been affected by the growing number of these disasters, and climate change is expected not only to affect the intensity and frequency of extreme events, but

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The role of nature-based solutions in disaster risk reduction: The decision maker's perspectives on urban resilience in São Paulo state

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ABSTRACT

This paper presents the co-learning process outcomes based on Ecosystem-based Adaptation (EbA) and Nature-based Solutions (NbS) for Disaster Risk Reduction (DRR). EbA principles are directly associated with resilience improvement that depends on NbS for change of patterns and actions. Basically, we expected to explore how urban systems can be improved avoiding environmental degradation (i.e. waste ecosystem services and their benefits). Therefore, distinct scenarios were proposed with specific objectives: (1) identification of barriers and challenges; (2) identification of opportunities for NbS implementation. Throughout a workshop, we had chance to discuss knowledge gaps and potential emerging research such as: (1) synergies between DRR and EbA; (2) a long-term perspective of ecosystem management; (3) dynamic of DRR and the natural processes involved considering the complexity of NbS. We conclude that existing measures are limited in their ecological focus regarding to DRR and benefits they address. For this reason, a more comprehensive approach to support NbS and its systematic mainstreaming is required.

1. Introduction

This paper presents the results from co-learning process based on Ecosystem-based Adaptation (EbA) and Nature-based Solutions (NbS) for Disaster Risk Reduction (DRR). We applied knowledge maps as one of the main tools to identify current practices in São Paulo state. In addition, we explore some techniques of representation and suggest a roadmap with some directions to build a proposal of development based on nature that we called Nature-based Development (NbD).

We discussed the operationalization of DRR by improving knowledge on how ecosystem-based approaches can be considered in decision making process through the Workshop Mobilization for Organization and Feasibility of Resilient Urban Spaces (MOVER), held on August 21–24, 2018, organized by Brazilian National Center of Monitoring and Early Warning of Natural Disasters (Cemaden) and the municipality of São Jose dos Campos, in Sao Paulo, Brazil.

We focused on the necessity of an integrated program of actions in urban areas based on the potential linkages between DRR and NbS. The aim was to encourage a discussion on urban resilience to address contemporary disaster risk management. We emphasized not only aspects on how to achieve the DRR but also how to incorporate the ecosystems services in decision making.

It is recognized that over the last decade, hydrometeorological extremes have become more frequent and intense in Brazil [1,2], with records of significant socioeconomic impacts and losses of human lives in Brazil [3], leading to the need of strengthening of disaster risk management at local levels.

In 2010, the number of people affected by natural disasters in Brazil was about 96 million in contrast to recently period, when approximately 123 million were affected by direct or indirect damages. During the last decade, more than half a million people have been made homeless by landslides and floods mainly. An expressive part of affected people is in the Southeast region, which accounts approximately 66% of the total disasters occurred in the country [3]. In terms of cost, events such as landslide in Rio de Janeiro (e.g. mountain range in 2011) totaled approximately US 2 billion with at least 780 million for rebuilding [4].

Concerning this critical situation around the world, highlighting developing countries, the Sendai Framework for Disaster Risk Reduction (SFDRR) emphasized the urgency of national plans implementation to effectively protect the population [5].

The importance of improved understanding on DRR in all its

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RESEARCH ARTICLE

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The role of ENSO flavours and TNA on recent droughts over Amazon forests and the Northeast Brazil region

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Abstract

Amazon tropical forests and the semiarid Northeast Brazil (NEB) region have registered very severe droughts during the last two decades, with a frequency that may have exceeded natural climate variability. Severe droughts impact the physiological response of Amazon forests, decreasing the availability to absorb atmospheric CO_2, as well as biodiversity and increasing risk of fires. Droughts on this region also affect population by isolating them due to anomalous low river levels. Impacts of droughts over NEB region are related to water and energy security and subsistence agriculture. Most drought episodes over Amazonia and NEB are associated with El Niño (EN) events, anomalous warming over the Tropical North Atlantic (TNA), and even an overlapping among them. However, not all the dry episodes showed a large-scale pattern linked to a canonical EN event or warm TNA episodes. For instance, dry episodes linked to EN events present distinct spatial patterns of precipitation anomalies depending on EN type (Central-Pacific vs. Eastern-Pacific EN), and NEB region experienced a severe drought in 2012 that is not attributed to EN or warm TNA events. Even in the case of the strong EN in 2015/16, some regional impacts have not been explained by EN contribution. This paper discusses the effects of CP and EP EN events, and the role of warm TNA events on tropical Walker and Hadley circulation leading to drought over Amazonia and NEB regions.

KEYWORDS

Amazonia, drought, ENSO, Northeast Brazil, precipitation, TNA

1 | INTRODUCTION

Together with global and regional warming, the last two decades have experienced three major droughts in the Amazon region (2005, 2010, 2016) and a large-scale drought affecting Northeast Brazil (NEB) since 2012 (Alvala *et al.*, 2019; Aragao *et al.*, 2018; Marengo *et al.*, 2018a; 2018b and references quoted in). This raises concerns about the resilience of tropical forests in the Amazon and semiarid biome in NEB to extreme droughts. The occurrence of these droughts leads to socio-economical impacts over these regions because drought conditions severely disrupt the livelihood of riverine, urban population, and the ecological functioning of the forest in the Amazon and the semiarid region population.

Earlier studies documented negative rainfall anomalies in Amazonia and NEB during El Niño (EN) (Ropelewski

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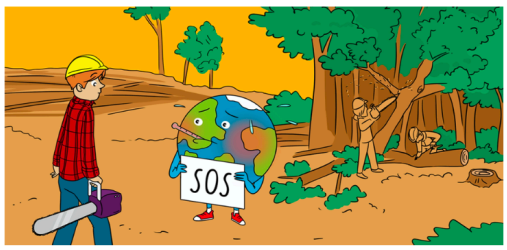

DROUGHT, FLOODS, CLIMATE CHANGE, AND FOREST LOSS IN THE AMAZON REGION: A PRESENT AND FUTURE DANGER?

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YOUNG REVIEWERS:


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GWEN
AGE: 12

The Amazon is the world's largest rainforest and it plays an important role in global and regional climate, including the exchange of water between the rainforest and the atmosphere. Extremes of climate, such as droughts or floods, can be dangerous for both humans and natural systems. Droughts and floods may alter the moisture exchange between forests and the atmosphere and can affect the survival of the Amazon forest. Actions to avoid or to reduce global warming and forest loss are discussed in this article.

WHY SHOULD WE CARE ABOUT THE AMAZON RAINFOREST?

When people think about the Amazon rainforest, they often consider it to be the lungs of the planet, removing carbon dioxide (CO_2) from the air and releasing oxygen for animals, including humans, to breathe. People also think about snakes, monkeys, spiders, orchids,

REVIEWS

Climate impacts of the El Niño–Southern Oscillation on South America

Wenju Cai[1,2]✉, Michael J. McPhaden[3], Alice M. Grimm[4], Regina R. Rodrigues[5], Andréa S. Taschetto[6], René D. Garreaud[7,8], Boris Dewitte[9,10,11,12], Germán Poveda[13], Yoo-Geun Ham[14], Agus Santoso[2,6], Benjamin Ng[2], Weston Anderson[15], Guojian Wang[1,2], Tao Geng[1,2], Hyun-Su Jo[2], José A. Marengo[16], Lincoln M. Alves[17], Marisol Osman[18,19], Shujun Li[1,2], Lixin Wu[1], Christina Karamperidou[20], Ken Takahashi[21] and Carolina Vera[18,19]

Abstract | The climate of South America (SA) has long held an intimate connection with El Niño, historically describing anomalously warm sea-surface temperatures off the coastline of Peru. Indeed, throughout SA, precipitation and temperature exhibit a substantial, yet regionally diverse, relationship with the El Niño–Southern Oscillation (ENSO). For example, El Niño is typically accompanied by drought in the Amazon and north-eastern SA, but flooding in the tropical west coast and south-eastern SA, with marked socio-economic effects. In this Review, we synthesize the understanding of ENSO teleconnections to SA. Recent efforts have sought improved understanding of ocean–atmosphere processes that govern the impact, inter-event and decadal variability, and responses to anthropogenic warming. ENSO's impacts have been found to vary markedly, affected not only by ENSO diversity, but also by modes of variability within and outside of the Pacific. However, while the understanding of ENSO–SA relationships has improved, with implications for prediction and projection, uncertainty remains in regards to the robustness of the impacts, inter-basin climate interactions and interplay with greenhouse warming. A coordinated international effort is, therefore, needed to close the observational, theoretical and modelling gaps currently limiting progress, with specific efforts in extending palaeoclimate proxies further back in time, reducing systematic model errors and improving simulations of ENSO diversity and teleconnections.

El Niño and La Niña events denote sea-surface temperature (SST) conditions in the tropical Pacific that are, respectively, warmer and colder than average[1]. Collectively, these events are referred to as the El Niño–Southern Oscillation (ENSO), which, owing to scientific breakthroughs from the 1960s, are now widely known to arise from coupled atmosphere–ocean interactions that, in most cases, involve the entire Pacific basin[2,3]. However, the scientific understanding of ENSO has historically been deeply rooted in South America (SA). For example, El Niño was first described by Peruvian fishermen in the nineteenth century as a warm current appearing around Christmas time along the coast of Ecuador and Peru, disrupting local fisheries and bringing torrential rains to the normally arid coastal plane[4].

Yet, ENSO's effects extend far beyond the coastal regions of Ecuador and Peru, with substantial and regionally varied climatic effects observed throughout the entire SA continent[5–9], as well as globally[1,10,11]. Within SA, changes in temperature and precipitation can be linked to both direct (for instance, coastal warming along Peru[12]) and indirect (for instance, atmospheric teleconnections from the Pacific[13]) forcings, which, in turn, can have marked socio-economic, ecological and environmental impacts. ENSO impacts are felt through agricultural production[14], fisheries[15], malaria occurrence and public health[16,17], wildfire frequency[18], and droughts and floods[18–20]. For example, drought linked to the 1877–78 El Niño led to crop failures, starvation and disease that killed hundreds of thousands in north-eastern Brazil, with similar disruption over the Central Andes[5]. The early 1925 coastal-warming event induced catastrophic floods in the northern region of Peru and Ecuador[12,20], and the ensuing 1925–26 El Niño generated a severe summer drought in the Amazon region, causing deadly fires and the loss of thousands of lives[21]. See BOX 1 for further discussion of ENSO's socio-economic impacts in SA.

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Article

Extreme Drought Events over Brazil from 2011 to 2019

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Abstract: Drought-related disasters are among the natural disasters that are able to cause large economic and social losses. In recent years, droughts have affected different regions of Brazil, impacting water, food, and energy security. In this study, we used the Integrated Drought Index (IDI), which combines a meteorological-based drought index and remote sensing-based index, to assess the drought events from 2011 to 2019 over Brazil. During this period, drought events were observed throughout the country, being most severe and widespread between the years 2011 and 2017. In most of the country, the 2014/15 hydrological year stands out due to the higher occurrence of severe and moderate droughts. However, drought intensity and observed impacts were different for each region, which is shown by the different case studies, assessing different types of impacts caused by drought in Brazil. Thus, it is fundamental to evaluate the impacts of droughts in a continental country such as Brazil, where a variety of vegetation, soil, land use, and especially different climate regimes predominate.

Keywords: drought assessment; hydrological drought; agricultural drought; SPI; VHI; Brazil

1. Introduction

The frequency of extreme weather and climate events has increased in recent years, with events showing greater intensity and duration. This favors the occurrence of natural disasters, particularly those associated with flood and severe drought [1–5].

Drought events have increased in frequency and intensity in several regions of the planet in recent decades [1–11]. According to [12], while droughts represented only 4% of total economic losses (US$124 billion) in the period of 1998–2017, research conducted by Centre for Research on the Epidemiology of Disasters (CRED) in 2011 [13] related to 2481 disasters where information was available, when considering the impact of disasters according to their type, found that droughts cause significantly greater losses on national economies than other types of disasters, with almost 40% of droughts studied provoking damage equal to or greater than 0.5% of the gross domestic product (GDP) of the country where they occurred. As highlighted by [12], the level of 0.5% of GDP losses is the International Monetary Fund's threshold for a major economic disaster. Thus, as a natural disaster, drought is

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Assessing the performance of climate change simulation results from BESM-OA2.5 compared with a CMIP5 model ensemble

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Abstract. The main features of climate change patterns, as simulated by the coupled ocean–atmosphere version 2.5 of the Brazilian Earth System Model (BESM), are compared with those of 25 other CMIP5 models, focusing on temperature, precipitation, atmospheric circulation, and radiative feedbacks. The climate sensitivity to quadrupling the atmospheric CO_2 concentration was investigated via two methods: linear regression (Gregory et al., 2004) and radiative kernels (Soden and Held, 2006; Soden et al., 2008). Radiative kernels from both the National Center for Atmospheric Research (NCAR) and the Geophysical Fluid Dynamics Laboratory (GFDL) were used to decompose the climate feedback responses of the CMIP5 models and BESM into different processes. By applying the linear regression method for equilibrium climate sensitivity (ECS) estimation, we obtained a BESM value close to the ensemble mean value. This study reveals that the BESM simulations yield zonally average feedbacks, as estimated from radiative kernels, that lie within the ensemble standard deviation. Exceptions were found in the high latitudes of the Northern Hemisphere and over the ocean near Antarctica, where BESM showed values for lapse rate, humidity feedback, and albedo that were marginally outside the standard deviation of the values from the CMIP5 multi-model ensemble. For those areas, BESM also featured a strong positive cloud feedback that appeared as an outlier compared with all analyzed models. However, BESM showed physically consistent changes in the temperature, precipitation, and atmospheric circulation patterns relative to the CMIP5 ensemble mean.

1 Introduction

The effects of increased atmospheric CO_2 concentrations on the climate system have been studied over the last 120 years (Arrhenius, 1896; Callendar, 1938; Plass, 1956; Kaplan, 1960; Manabe and Wetherald, 1967, 1975; Manabe and Stouffer, 1980; IPCC, 2007, 2013; Pincus et al., 2016; Good et al., 2016, and many others). The human-induced increase in atmospheric greenhouse gas (GHG) concentrations, sometimes given as the CO_2-equivalent concentration, contributes to a radiation imbalance at the top of the atmosphere (TOA) that causes less outgoing radiation to leave the Earth system. The trapping of infrared radiation results in a temperature rise at the lower levels of the troposphere and an increase in ocean heat content. In addition, the increased GHG concentration can trigger climate feedback processes that either amplify or damp the initial radiative perturbation (Cubasch and Cess, 1990). Earth system models (ESMs) are the most advanced tools available for analyzing the coupled climate system (atmosphere, ocean, land, and ice) physical processes and their interactions, although even these models still ex-

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Analyzing the influence of the North Atlantic Ocean variability on the Atlantic Meridional Mode on decadal time scales

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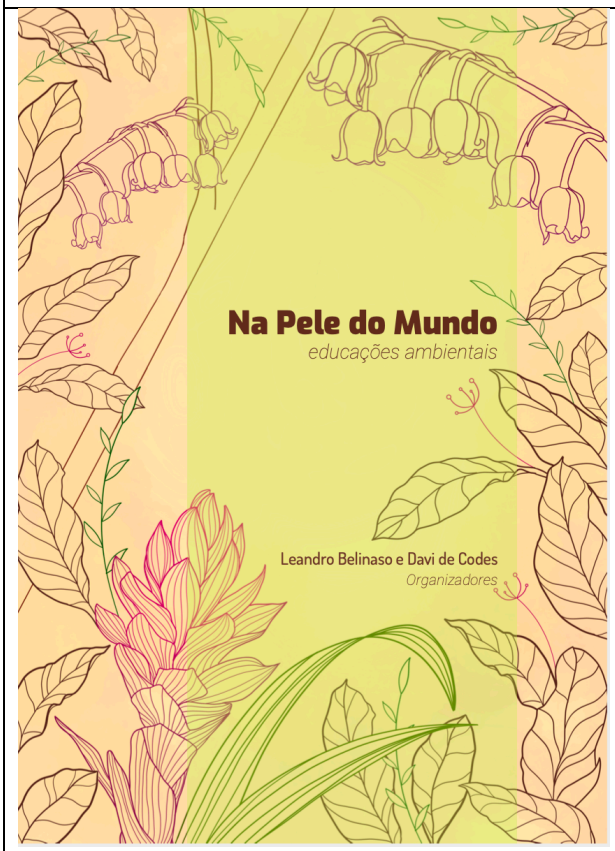
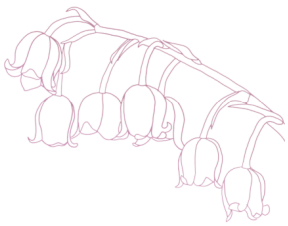
Abstract: Important features of the Atlantic Meridional Mode (AMM) remain to be fully understood, from what determines its dominant decadal variability to the complex physical processes that sustain it. Using Reanalysis datasets, we investigated the influence of the North Atlantic Ocean variability on the dominant decadal periodicity that characterizes the AMM. Statistical analyses demonstrated that the correlation between the sea surface temperature decadal variability in the Atlantic Ocean and the AMM time series characterizes the Atlantic Multidecadal Oscillation (AMO). This corroborates those of previous studies that demonstrated that the AMO precedes the AMM. A causal inference with a newly developed rigorous and quantitative causality analysis indicates that the AMO causes the AMM. To further understand the influence of the subsurface ocean on the AMM, the relationship between the ocean heat content (0–300 m) decadal variability and AMM was analyzed. The results show that although there is a significant zero-lag correlation between the ocean heat content in some regions of the North Atlantic (south of Greenland and in the eastern part of the North Atlantic) and the AMM, their cause-effect relationship on decadal time scales is unlikely. By correlating the AMO with the ocean heat content (0–300 m) decadal variability, the former precedes the latter; however, the causality analysis shows that the ocean heat content variability drives the AMO, corroborating several studies that point out the dominant role of the ocean heat transport convergence on AMO.

Keywords: Atlantic Meridional Mode; Atlantic Ocean variability; ocean-atmosphere interaction; decadal variability

1. Introduction

The last four decades of climate research have revealed the influence of the ocean-atmosphere coupled system variability within the tropical Atlantic basin on the observed climate conditions in the adjacent continental regions [1–6]. Recent studies have also shown that atmospheric perturbations generated by the ocean-atmosphere coupled variability in this region act as forcing conditions on the El Niño-Southern Oscillation (ENSO) [7–10], Pacific Meridional Mode [11], North Atlantic Oscillation (NAO) [10,12] and Indian monsoon [13,14]. Therefore, a more accurate understanding of the tropical Atlantic variability could help to improve climate prediction over the adjacent regions, benefiting their populations, and, from a broader perspective, it could deepen our understanding of the interactions between the tropical Atlantic variability and diverse large-scale phenomena.





Um livro em que diferentes gerações se encontram. Uma abertura para vivermos, enquanto leitores e educadores, mundos distintos que se cruzam, se relacionam, se distanciam, se reaproximam. Ana Godoy. Cátia Hansel. Davi de Codes. José Douglas Alves dos Santos. Isabel Carvalho. Leandro Belinaso. Marcos Reigota. Maria Lúcia Wortmann. Marina Lopes e Gomes. Valdo Barcelos. Victor Anselmo Costa. Na pele do mundo, educações ambientais emergem e se desfazem, nascem e renascem. Nos fortalecem para os embates cotidianos às mudanças climáticas e às virulências do tempo presente. Brotam contaminadas com livros, músicas, filmes, histórias, lugares, lutas, conversas, encontros, amores, afetos. Na pele crispada e sensível do mundo, educações ambientais podem ser os poros por onde também se respira.

INCT Mudanças Climáticas Fase 2

Abril 9 2020

CORONAVIRUS E CLIMA

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INTRODUÇÃO

Em dezembro de 2019 foram relatados clusters de pacientes com pneumonia de origem desconhecida, epidemiologicamente relacionados ao um mercado de frutos do mar em Wuhan, na província de Hubei, China (Wu et al., 2020; Zhou et al., 2020). Esses casos estavam associados à infecção por um novo coronavirus, denominado SARS-CoV-2(Coronaviridae Study Group of the International Committee on Taxonomy of Viruses, 2020).

Este vírus, causador da Covid-19, faz parte de um grupo grande de vírus que infectam vários animais e o homem, não apenas no sistema respiratório. Junto com os vírus da influenza, tem sido os principais responsáveis pelas epidemias e pandemias de infeções respiratórias em populações humanas. Apesar da gripe (influenza) ser mais frequente e estudada, os coronavirus tem, nas últimas décadas, causado importantes epidemias, com maior ou menor disseminação regional/global

No homem, os coronavirus causam doença respiratória, gastrointestinal, hepática e desordens neurológicas (Corman, Muth, Niemeyer, & Drosten, 2018). Os vírus SARS-CoV, (originado na China, em 2020); MERS-CoV (originado na Arábia Saudita, em 2012) e SARS-CoV-2 podem ocasionar doença grave, ao passo que o HKU1, NL63, OC43 e 229E co-circulam normalmente com outros vírus respiratórios e encontram-se associados a quadro clinico mais brando em indivíduos imunocompetentes, acometendo

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Implications of the new operational rules for Cantareira water system: re-reading the 2014-2016 water crisis

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Abstract

During the 2014-2016 water shortage crisis, the Metropolitan Area of São Paulo (MASP) water supply system extracted pumping volume from the Cantareira System. Before the crisis, between 1984 and 2013, the reservoirs average water extraction flow was 29.6 $m^3 s^{-1}$. During the period of pumping volume usage, the average extraction flow was 16.2 $m^3 s^{-1}$. Following the crisis, two new mitigation policies were implemented: a water extraction Resolution (in 2017) and a Resolution for water reallocation from another basin (in 2018). This study provides a novel investigation of the Cantareira System water crisis by assessing the mitigation policies impacts on storage level dynamics. The system storage level was evaluated using the reservoir simulation module of PDM-Cemaden hydrological model, assuming the new policies had already been implemented prior to the crisis. A control simulation was run with observed in- and outflow and operationally-practiced extraction flow. The storage level dynamics impacts were evaluated under 4 water mitigation policies scenarios varying the policies implementation starting date, the extraction flow range and including the water reallocation variable. Results showed that pumping volume would only need extraction during a short period (scenarios I, III and IV), and considering the water reallocation, pumping volume extraction would not have been necessary (Scenario II). Although the pumping volume would still have been extracted during a short period, water shortage impact would have been lessened, had the policies been already implemented before the crisis. The water mitigation policies implementation supports the reservoirs storage

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XXIII SIMPÓSIO BRASILEIRO DE RECURSOS HÍDRICOS

DETECÇÃO DE MUDANÇAS DE USO E COBERTURA DA TERRA NA BACIA HIDROGRÁFICA DO RIO SÃO MATEUS

Yan Breno Azeredo Gomes da Silva [1];Rochane de Oliveira Caram[2]; Felix Carriello[1]

RESUMO – Buscar entender o ambiente em que o homem em sociedade está envolvido é de grande importância, portanto, analisar e extrair informações de uso e a cobertura do solo possui grande relevância na elaboração de dados que possam auxiliar na tomadas de decisões no manejo do ambiente. Utilizando técnicas de sensoriamento remoto e geoprocessamento, o objetivo deste trabalho foi detectar as mudanças de uso e cobertura do solo, nas classes utilizadas na classificação, ocorridas entre os anos de 1985 e 2017, na região da bacia hidrográfica do Rio São Mateus. Os resultados mostram que grande parte do uso e cobertura do solo da bacia é a pastagem, correspondendo a 72% e 71% da área total da bacia, nos anos de 1985 e 2017, respectivamente. Além disso, os resultados evidenciaram que a dinâmica acelerada das relações socioambientais a partir das atividades econômicas como a silvicultura, a pecuária, e a agricultura colaboraram para o processo indiscriminado de desmatamento ao longo dos anos. Espera-se com este estudo, que a caracterização do uso e da cobertura do solo auxilie na avaliação do nível de pressão sobre os recursos hídricos, assim como uma avaliação da disponibilidade quali-quantitativa desses recursos em trabalhos futuros.

ABSTRACT – To understand the environment in which the man in society is involved is of great importance, therefore, to analyze and extract information of use and the ground cover has great relevance in the elaboration of data that can help in making decisions in the management of the environment. Using remote sensing and geoprocessing techniques, the objective of this work was to detect changes in land use and cover, in the classes used in the classification, between 1985 and 2017, in the São Mateus River basin region. The results show that a great part of the land use and cover of the basin is pasture, corresponding to 72% and 71% of the total area of the basin, in the years of 1985 and 2017, respectively. In addition, the results showed that the accelerated dynamics of socio-environmental relations from economic activities such as forestry, livestock, and agriculture have contributed to the indiscriminate deforestation process over the years. The aim of this study is to characterize soil use and land cover in assessing the level of pressure on water resources, as well as assessing the qualitative and quantitative availability of these resources in future works.

Palavras-Chave – Geoprocessamento, Sensoriamento Remoto, Uso e Cobertura do Solo

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XXIII SIMPÓSIO BRASILEIRO DE RECURSOS HIDRÍCOS

SIMULAÇÃO HIDROLÓGICA NA BACIA DO RIO SAPUCAÍ COM O MODELO HIDROLÓGICO DISTRIBUÍDO UTILIZANDO PRECIPITAÇÃO OBSERVADA E DADOS DO PRODUTO MERGE

Ana Carolina Nascimento Santos[1]; Javier Tomasella[1]; Rochane de Oliveira Caram[1]

RESUMO – A Bacia Hidrográfica do rio Sapucaí apresenta longo histórico de ocorrência de inundações. Nesse contexto, a aplicação de modelos hidrológicos propicia importante ferramenta para prevenção de desastres naturais. Entretanto, o desempenho de um modelo hidrológico é dependente da qualidade das informações e dados que são fornecidos como entrada do modelo, sendo a precipitação a variável meteorológica que apresenta maior variabilidade espaço-temporal. Dessa forma, o objetivo deste trabalho foi comparar o desempenho do MHD-INPE (Rodriguez; Tomasella, 2015) na bacia do rio Sapucaí, quando alimentado com o MERGE, que é um produto que combina as estimativas de precipitação por satélite com as observações de superfície e com a base de dados pluviométricos. Os resultados da aplicação do modelo à bacia do rio Sapucaí indicam que o MHD-INPE representou satisfatoriamente os processos que compõem o ciclo hidrológico na transformação da chuva em vazão. Além disso, observa-se que o ajuste na etapa de calibração utilizando os dados do produto MERGE é melhor que quando se utiliza a precipitação observada, para maioria das sub-bacias. No entanto, o mesmo não ocorre na etapa de verificação.

ABSTRACT– The Sapucaí Basin has a long history of flooding. In this context, the application of hydrological models is a valuable tool for preventing natural disasters. However, the performance of a hydrological model depends on the quality of the information and data used as input, being precipitation the meteorological data with the largest spatial-temporal variability. The objective of this study was to compare the performance of the MHD-INPE in the Sapucaí basin, using as input data interpolated rainfall gauges and MERGE, which is a product that combines the satellite precipitation with surface observations. Results of the application to the Sapucaí river basin indicate that the MHD-INPE provided a good representation of the hydrological process responsible for the transformation of rainfall into flow. For most sub-basins, the performance in the calibration using the MERGE product data as input is better than when the observed precipitation is used. However, the same was not verified in the verification step.

Palavras-Chave – Bacia Hidrográfica, Modelagem Hidrológica, MERGE

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Abstract: IUGG19-4656

Prediction of extreme flood events in Brazil: accounting for uncertainty and (non)stationarity

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Recent climate change and the development of non-stationary models for flood frequency analysis has prompted several discussions on under what circumstances those models should be applied when a trend is detected. Our objective was to compare the use of Akaike and Bayesian information criteria (AIC e BIC) to a Bayesian framework that accounts for uncertainty in parameter inference when selecting stationary or non-stationary models. We analyzed annual floods from 275 catchments across Brazil with a complete 40-year record (1976 – 2015). While Brazil has one of the greatest flood loss potential among the emergent countries, flood studies in the country are still scarce. We used the first 30 years of record to fit a GEV distribution and the subsequently 10 years for model testing. In the fitting period, we found that the non-stationary model would be preferred 142 (82 negative and 60 positive trends) when using AIC and 42 time with BIC (42 negative and 11 positive trends). In the validation period, 28 out of the 60 models selected by AIC would actually be non-stationary; and 10 out of the 11 models selected by BIC would be non-stationary. When using a Bayesian framework for the consideration of uncertainty in parameter inference, 146 models would be non-stationary with 47 of them with a positive trend. Out of this 47, 27 would support an updated stationary thesis and 20 a non-stationary. Overall, we found that floods are becoming more intense in wetter regions and less intense in drier ones.

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How well does climate model perform for southern Brazil?

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Southern Brazil is in a transitional zone between tropical and extratropical climates. The rainfall regime in such transitional zones can be rather sensitive to climate change and related expansion of the tropics in the Southern Hemisphere. It is expected that rainfall will increase up to 30% over this area in the next decades. It is important, however, to investigate if the mechanisms that generate rainfall are simulated correctly in the models to know when downscaling and bias correction methods should be applied. The objective of this study is to evaluate the performance of the CMIP5 climate models in terms of precipitation in southern Brazil. This study addresses fundamental aspects of model evaluation and aims to give guidance on the proper use of climate model outputs for southern Brazil. We use 41 historical climate simulations and 22 RCP8.5 future climate simulations for the periods of 1980-2005 and 2070-2100, respectively. We compare the historical simulations with an interpolated product database obtained from ground stations. To evaluate the model performance regarding its marginal distribution, we use the following metrics: annual rainfall, variance, skewness, dry day fraction, wet day fraction, high percentiles and similarity of distributions (trough Kolmogorov-Smimov test). There is a negative bias in all of them except for wet day fraction. All metrics of temporal aspects such as Markham's seasonality index, autocorrelation, time of the annual maxima, dry spell average and maximum lengths, wet spell average and maximum lengths show a positive bias, apart from the time of annual maxima. Overall, annual rainfall is expected to increase in southern Brazil. Spatial patterns of annual rainfall are similar in the RCP 8.5 future pathways to the ones found in the historical period, with wetter areas expanding toward the north. However, the spatial pattern of observed rainfall is not captured by climate models. They simulate smaller volumes of precipitation in the southern border. A similar pattern was found in extreme precipitation, with bias almost twice as large than the one found in annual rainfall. Furthermore, the models do not properly represent the seasonal cycle, the Markham's seasonality index reached four times the observed in some areas. Given the poor performance in the area, the use of future simulations in impact studies should be done carefully once the direct use of climate model precipitation in hydrological studies could result in misleading conclusions.

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From severe droughts in South America to marine heatwaves in the South Atlantic

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In 2013/14 eastern South America experienced one of its worst droughts, leading to water shortages in São Paulo, the world's fourth most populated city. This event was also responsible for a dengue fever outbreak that tripled the usual number of fatalities and reduced Brazilian coffee production leading to a global shortages and worldwide price increases. The drought was associated with an anomalous anticyclonic circulation off southeast South America that prevented synoptic systems reaching the region while inhibiting the development of the South Atlantic Convergence Zone and its associated rainfall. A concomitant and unprecedented marine heatwave also developed in the southwest Atlantic. Here we show from observations that such droughts and adjacent marine heatwaves have a common remote cause. Atmospheric blocking triggered by tropical convection in the Indian and Pacific oceans can cause persistent anticyclonic circulation that not only leads to severe drought but also generates marine heatwaves in the adjacent ocean. We show that increased shortwave radiation due to reduced cloud cover and reduced ocean heat loss from weaker winds are the main contributors to the establishment of marine heatwaves in the region. The proposed mechanism, which involves droughts, extreme air temperature over land and atmospheric blocking explains approximately 60% of the marine heatwave events in the western South Atlantic. We also identified an increase in frequency, duration, intensity and extension of marine heatwave events over the satellite period 1982–2016. Moreover, surface primary production was reduced during these events with implications for regional fisheries.

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Revisiting ENSO Atmospheric Teleconnections and Challenges

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The warming of the equatorial Pacific associated with the El Niño–Southern Oscillation (ENSO) causes profound impacts on rainfall and temperature in the tropics and extratropics. El Niño drives changes in the Walker and Hadley circulations, warms the tropics and affects the neighboring ocean basins, favoring a short-term rise in global temperatures. We will present an overview of the atmospheric teleconnections driven by ENSO and its diversity focusing on the impacts over land and remote ocean basins. During El Niño, dry conditions are generally observed in the Maritime Continent, northern South America, South Asia and South Africa, while wet weather typically occurs in southwestern North America, western Antarctica, and east Africa. Global effects during La Niña are overall the opposite to El Niño, however this assumption is not true for all regions. ENSO atmospheric teleconnections are non-linear in part due to different locations of the anomalous equatorial warming (Eastern versus Central Pacific events) superimposed on the Pacific mean state, as well as interactions with the annual cycle, off-equatorial regions, remote ocean basins, and other modes of climate variability. Adding to this complex behavior, ENSO teleconnections are non-stationary either due to deterministic low-frequency modulations or stochastic variability, the latter being a factor generally overlooked in the literature. As the world warms in response to greenhouse gas forcing, ENSO atmospheric teleconnections are expected to change, despite large uncertainties in ENSO projections. We will discuss the limitations of climate models in representing realistic teleconnections from the tropical Pacific to remote regions and some of the challenges for future projections.

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https://doi.org/10.5194/gmd-13-2277-2020

Geoscientific Model Development

Assessing the performance of climate change simulation results from BESM-OA2.5 compared with a CMIP5 model ensemble

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Abstract. The main features of climate change patterns, as simulated by the coupled ocean–atmosphere version 2.5 of the Brazilian Earth System Model (BESM), are compared with those of 25 other CMIP5 models, focusing on temperature, precipitation, atmospheric circulation, and radiative feedbacks. The climate sensitivity to quadrupling the atmospheric CO_2 concentration was investigated via two methods: linear regression (Gregory et al., 2004) and radiative kernels (Soden and Held, 2006; Soden et al., 2008). Radiative kernels from both the National Center for Atmospheric Research (NCAR) and the Geophysical Fluid Dynamics Laboratory (GFDL) were used to decompose the climate feedback responses of the CMIP5 models and BESM into different processes. By applying the linear regression method for equilibrium climate sensitivity (ECS) estimation, we obtained a BESM value close to the ensemble mean value. This study reveals that the BESM simulations yield zonally average feedbacks, as estimated from radiative kernels, that lie within the ensemble standard deviation. Exceptions were found in the high latitudes of the Northern Hemisphere and over the ocean near Antarctica, where BESM showed values for lapse rate, humidity feedback, and albedo that were marginally outside the standard deviation of the values from the CMIP5 multi-model ensemble. For those areas, BESM also featured a strong positive cloud feedback that appeared as an outlier compared with all analyzed models. However, BESM showed physically consistent changes in the temperature, precipitation, and atmospheric circulation patterns relative to the CMIP5 ensemble mean.

1 Introduction

The effects of increased atmospheric CO_2 concentrations on the climate system have been studied over the last 120 years (Arrhenius, 1896; Callendar, 1938; Plass, 1956; Kaplan, 1960; Manabe and Wetherald, 1967, 1975; Manabe and Stouffer, 1980; IPCC, 2007, 2013; Pincus et al., 2016; Good et al., 2016, and many others). The human-induced increase in atmospheric greenhouse gas (GHG) concentrations, sometimes given as the CO_2-equivalent concentration, contributes to a radiation imbalance at the top of the atmosphere (TOA) that causes less outgoing radiation to leave the Earth system. The trapping of infrared radiation results in a temperature rise at the lower levels of the troposphere and an increase in ocean heat content. In addition, the increased GHG concentration can trigger climate feedback processes that either amplify or damp the initial radiative perturbation (Cubasch and Cess, 1990). Earth system models (ESMs) are the most advanced tools available for analyzing the coupled climate system (atmosphere, ocean, land, and ice) physical processes and their interactions, although even these models still ex-

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Geoscientific Model Development

The Brazilian Earth System Model ocean–atmosphere (BESM-OA) version 2.5: evaluation of its CMIP5 historical simulation

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Abstract. The performance of the coupled ocean–atmosphere component of the Brazilian Earth System Model version 2.5 (BESM-OA2.5) was evaluated in simulating the historical period 1850–2005. After a climate model validation procedure in which the main atmospheric and oceanic variabilities were evaluated against observed and reanalysis datasets, the evaluation specifically focused on the mean climate state and the most important large-scale climate variability patterns simulated in the historical run, which was forced by the observed greenhouse gas concentration. The most significant upgrades in the model's components are also briefly presented here. BESM-OA2.5 could reproduce the most important large-scale variabilities, particularly over the Atlantic Ocean (e.g., the North Atlantic Oscillation, the Atlantic Meridional Mode, and the Atlantic Meridional Overturning Circulation), and the extratropical modes that occur in both hemispheres. The model's ability to simulate such large-scale variabilities supports its usefulness for seasonal climate prediction and in climate change studies.

1 Introduction

Climate models, which have recently been expanded into Earth system models via inclusion of biogeochemical cycles, are key tools for investigating climate phenomena that significantly influence human societies (e.g., von Storch, 2010; Flato, 2011). Since 2008, the Brazilian climate community has been engaged in setting up the Brazilian Earth System Model (BESM; Nobre et al., 2013; Giarolla et al., 2015). This major scientific task has been carried out by Brazilian scientific institutions and highlights the critical need to produce reliable future climate projections and to understand their potential impact, particularly over South America. The primary objective of this effort was to assemble the scientific expertise capable of developing and maintaining a state-of-the-art Earth system model. Such an achievement would represent a significant step forward in establishing a scientific tool that can be used in different types of research activities. The importance of such an undertaking lies in the need to understand the physics of the Earth system to produce and lend credibility to studies that explore the impacts of climate change on different areas of great importance, such as food and water security, tropical ecosystems, and natural disasters. One of the fundamental aims of the BESM project is to participate in the Coupled Model Intercomparison Project's sixth phase (CMIP6; Meehl et al., 2014).

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Article

Analyzing the influence of the North Atlantic Ocean variability on the Atlantic Meridional Mode on decadal time scales

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Abstract: Important features of the Atlantic Meridional Mode (AMM) remain to be fully understood, from what determines its dominant decadal variability to the complex physical processes that sustain it. Using Reanalysis datasets, we investigated the influence of the North Atlantic Ocean variability on the dominant decadal periodicity that characterizes the AMM. Statistical analyses demonstrated that the correlation between the sea surface temperature decadal variability in the Atlantic Ocean and the AMM time series characterizes the Atlantic Multidecadal Oscillation (AMO). This corroborates those of previous studies that demonstrated that the AMO precedes the AMM. A causal inference with a newly developed rigorous and quantitative causality analysis indicates that the AMO causes the AMM. To further understand the influence of the subsurface ocean on the AMM, the relationship between the ocean heat content (0–300 m) decadal variability and AMM was analyzed. The results show that although there is a significant zero-lag correlation between the ocean heat content in some regions of the North Atlantic (south of Greenland and in the eastern part of the North Atlantic) and the AMM, their cause-effect relationship on decadal time scales is unlikely. By correlating the AMO with the ocean heat content (0–300 m) decadal variability, the former precedes the latter; however, the causality analysis shows that the ocean heat content variability drives the AMO, corroborating several studies that point out the dominant role of the ocean heat transport convergence on AMO.

Keywords: Atlantic Meridional Mode; Atlantic Ocean variability; ocean-atmosphere interaction; decadal variability

1. Introduction

The last four decades of climate research have revealed the influence of the ocean-atmosphere coupled system variability within the tropical Atlantic basin on the observed climate conditions in the adjacent continental regions [1–6]. Recent studies have also shown that atmospheric perturbations generated by the ocean-atmosphere coupled variability in this region act as forcing conditions on the El Niño-Southern Oscillation (ENSO) [7–10], Pacific Meridional Mode [11], North Atlantic Oscillation (NAO) [10,12] and Indian monsoon [13,14]. Therefore, a more accurate understanding of the tropical Atlantic variability could help to improve climate prediction over the adjacent regions, benefiting their populations, and, from a broader perspective, it could deepen our understanding of the interactions between the tropical Atlantic variability and diverse large-scale phenomena.

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Research article

Changes in surface hydrography at the western tropical Atlantic during the Younger Dryas

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ABSTRACT

During the Younger Dryas (YD), paleoceanographic proxies indicate a weakening of the Atlantic Meridional Overturning Circulation (AMOC) resulting in a widespread surface cooling of the North Atlantic and a southward displacement of the Intertropical Convergence Zone (ITCZ). In the western tropical Atlantic, competing ocean and atmospheric processes may result in contrasting surface hydrography scenarios north and south of the equator during the YD. Based on new and compiled data, we provide an up-to-date model-data comparison of changes in western tropical Atlantic surface hydrography during the YD. We show that both transient model simulations and proxy results indicate warming of sea surface temperatures (SST) in the western tropical South Atlantic, but disagree for the SST in the western tropical North Atlantic. Proxies also reveal a complex spatial pattern in surface salinity in the western tropical Atlantic, while a broad negative anomaly is observed in the model output. By comparing planktonic foraminiferal Ba/Ca records from different records in the western tropical Atlantic we constrain ITCZ shifts from the YD to the early Holocene. Based on the Ba/Ca records, the ITCZ reached its southernmost position between 13 and 11.8 ka and started to move northward reaching its northernmost position between 10.8 and 9.7 ka.

1. Introduction

Over the course of the last deglaciation, the warming trend in the North Atlantic was discontinuous due to the occurrence of abrupt cooling events such as the Younger Dryas (YD) (12.9–11.6 ka) (Carlson, 2013). Several mechanisms such as reduced solar activity (Renssen et al., 2000) and an extraterrestrial impact (Firestone et al., 2007) may have caused the YD and promoted its global climate signal (Renssen et al., 2015). However, the most accepted cause of the YD is the drainage of Lake Agassiz, which increased freshwater discharge to the North Atlantic and, consequently, abruptly reduced the strength of the Atlantic Meridional Overturning Circulation (AMOC) (Johnson and McClure, 1976; Rooth, 1982; Broecker et al., 1985).

During the YD, Greenland ice cores (NGRIP members, 2004) and sea surface temperature (SST) records from the northeastern North Atlantic (Bard et al., 2000) reveal an abrupt cooling. In the western tropical Atlantic, the scenario is more complex (Carlson, 2013). SST records show a warming of the Caribbean, Tobago Basin and off northeastern Brazil (Schmidt et al., 2004; Rühlemann et al., 1999; Weldeab et al., 2006), while cooling is indicated at Barbados, Cariaco and Guiana Basins (Guilderson et al., 2001; Lea et al., 2003; Rama-Corredor et al., 2015).

Paleoclimate proxies from the western tropical Atlantic provide evidence for a southward shift of the Intertropical Convergence Zone (ITCZ) during the YD (Haug et al., 2001; Wang et al., 2004; Portilho-Ramos et al., 2017; Bouimetarhan et al., 2018; Reißig et al., 2019). This should have lead to an increase in sea surface salinity (SSS) over the western tropical North Atlantic and a decrease in the western tropical South Atlantic, as pointed out by Wan et al. (2010). However, positive SSS anomalies have been reconstructed for the northern and southern western tropical Atlantic during the YD (Schmidt et al., 2004; Weldeab et al., 2006; Hoffmann et al., 2014). Thus, additional factors forcing the changes in surface hydrography (SST and SSS) in the western tropical Atlantic are required during the YD.

Here we investigate changes in surface hydrography during the YD in the western tropical Atlantic. Specifically, our goals are to: (1)

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ORIGINAL PAPER

Assessing drought in the drylands of northeast Brazil under regional warming exceeding 4 °C

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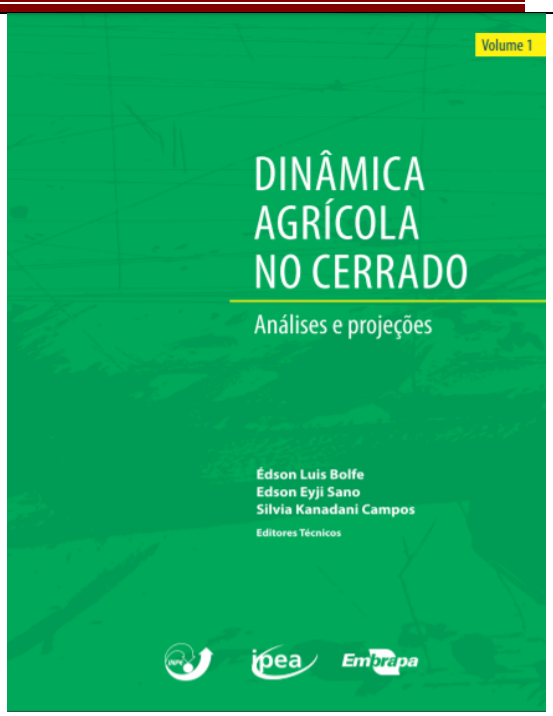
Received: 28 December 2019 / Accepted: 30 May 2020

Abstract
Historically, during periods of extreme drought, food security in the drylands of the semi-arid region of Northeast Brazil (NEB) is under severe risk due to agricultural collapse. The drought that started in 2012 continues to highlight the vulnerability of this region, and arid conditions have been detected during the last years mainly in the central semiarid region, covering almost 2% of the NEB. Climate projections show an increase in the area under water stress condition, covering 49% and 54% of the NEB region by 2700 and 2100, respectively, with a higher likelihood with warming above 4 °C. The projections of vegetative stress conditions derived from the empirical model for Vegetation Health Index (VHI) are consistent with projections from vegetation models, where semi-desert types typical of arid conditions would replace the current semiarid bushland vegetation ("caatinga") by 2100. Due to the impacts of the 2012–2017 drought, public policies have been implemented to reduce social and economic vulnerability for small farmers but are not enough as poor population continues to be affected. In the long term, to make the semiarid less vulnerable to drought, strengthened integrated water resources management and a proactive drought policy are needed to restructure the economy. Integrating drought monitoring and seasonal climate forecasting provides means of assessing impacts of climate variability and change, leading to disaster risk reduction through early warning. Lastly, there is an urgent need for integrated assessments because the possibility that under permanent drought conditions with warming above 4 °C, arid conditions would prevail in NEB since 2060.

Keywords Vegetation stress hazard · Climate change · Caatinga · Northeast Brazil · Climate change impacts · Risk of aridization



Capítulo 7

Efeito das mudanças climáticas na agricultura do Cerrado[1]

Eduardo Delgado Assad
Daniel de Castro Victoria
Santiago Vianna Cuadra
Vanessa Silva Pugliero
Marília Ribeiro Zanetti

Introdução

Em 2015, o quinto relatório do Painel Intergovernamental sobre Mudanças Climáticas (do inglês, Intergovernmental Panel on Climate Change – IPCC) deixa claro que

> [...] o aquecimento do sistema climático é inequívoco, e desde os anos 1950, muitas das alterações observadas não têm precedente nas últimas décadas e milênios. A atmosfera e oceano aqueceram, a quantidade de neve e gelo diminuíram, e os níveis dos oceanos aumentaram[2].

O mesmo relatório também aponta que

> [...] a influência humana no sistema climático é clara, e as recentes emissões antropogênicas de gases de efeito estufa são as maiores na história. Mudanças climáticas recentes têm amplos impactos nos sistemas naturais e antrópicos[1].

Tais alterações climáticas terão amplos efeitos no Brasil e no mundo, atingindo áreas diversas, como recursos hídricos, agricultura, energia, infraestrutura urbana e costeira, transportes e saúde, dentre outras. Este capítulo trata dos efeitos que tais alterações no clima podem ter sobre a agricultura no bioma Cerrado, identificando os principais impactos nas culturas agrícolas e elencando algumas alternativas para adaptação da produção.

[1] O presente trabalho foi realizado com a colaboração de bolsistas de Desenvolvimento Tecnológico Industrial (DTI) do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) vinculados à Rede Clima – Projeto nº 40.18.00.059.00.01.001.

[2] Tradução livre a partir do texto original em inglês.

Capítulo 8

Potencialidades para expansão e diversificação agrícola sustentável do Cerrado

Daniel de Castro Victoria
Édson Luis Bolfe
Edson Eyji Sano
Eduardo Delgado Assad
Ricardo Guimarães Andrade
Daniel Pereira Guimarães
Elena Charlotte Landau

Introdução

O bioma Cerrado possui em torno de 29,5% da sua área total ocupada com pastagens plantadas, 11,7% com áreas agrícolas (culturas anuais e perenes) e 1,5% com silvicultura (Brasil, 2015). A expansão agrícola em curso gera a necessidade de fortalecimento de atividades de planejamento para uso sustentável dos recursos naturais, melhoria de infraestrutura, investimentos em pesquisa e crédito agrícola. Aspecto relevante nesse contexto é a análise das potencialidades agropecuárias associadas aos processos de intensificação e diversificação agrícola. Essa análise é favorecida quando são incorporados os fatores relacionados à sustentabilidade e ao planejamento estratégico das fronteiras agrícolas brasileiras.

A Aliança pelo Clima e Uso da Terra Consulting – Clua (CEA Consulting, 2016) destacou que a melhoria da sustentabilidade e produtividade de terras agrícolas e pastagens existentes no Cerrado passa pelo estímulo da intensificação sustentável de pastos, incorporação de práticas agrícolas de baixo carbono, expansão e adoção de outras práticas sustentáveis e apoio aos produtos da agricultura tradicional. Faleiro e Farias Neto (2008) destacaram que pesquisas envolvendo o bioma Cerrado são essenciais para subsidiar o equilíbrio entre sociedade, agronegócio e recursos naturais. Temas como caracterização, conservação e uso da biodiversidade; uso e conservação do solo e da água; produção agropecuária e florestal; impactos dos sistemas de produção e estratégias de mitigação; commodities agrícolas e valoração socioambiental; biotecnologia, transgênicos e biossegurança; agroenergia; sistemas alternativos e diversificados para produção; agricultura familiar; agricultura de precisão, zoneamento agroambiental e modelagem; e políticas públicas e perspectiva mundial para as savanas são de grande

A PRODUÇÃO AGRÍCOLA BRASILEIRA PODE SER SUSTENTÁVEL?

EDUARDO DELGADO ASSAD[1], PELERSON PENIDO DALLA VECCHIA[2], ROBERTO STRUMPF[3], SUSIAN MARTINS[4]

A Fazenda Roncador, no município de Querência-MT, mudou o sistema de produção passando a adotar práticas de baixa emissão de carbono. Como resultado, foi possível aumentar a produtividade sem a necessidade de expandir as áreas de produção, ou seja, sem desmatar. Além disso, a carne produzida pela Fazenda possui um saldo positivo na captura de carbono.

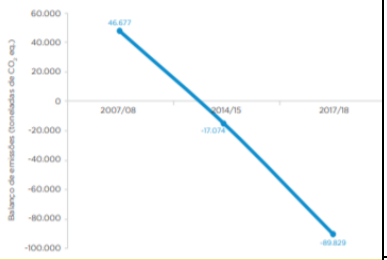
DADA A relevância do setor agropecuário para a economia do Brasil, a transição do modelo de produção agrícola tradicional para um modelo de baixa emissão de carbono é necessária. A produção de alimentos é absolutamente prioritária para a sociedade, e, portanto, ao se mitigar a mudança climática, também se tem o interesse estratégico de promover a segurança alimentar. É preciso, então, fortalecer a agricultura de baixa emissão de carbono (ABC) no Brasil. O uso de fazendas para capturar e armazenar mais carbono no solo está cada vez mais difundido. O esforço feito pelo Brasil desde 2010 na implementação da ABC tem sido intenso, e, segundo o último relatório feito pelo Ministério da Agricultura, Pecuária e Abastecimento (MAPA), já foram atingidos quase 13 milhões de hectares utilizando técnicas de baixa emissão. Um número crescente de agricultores está explorando o potencial de capturar e armazenar maiores quantidades de dióxido de carbono (CO_2) no solo como forma de combater as mudanças climáticas e aumentar sua produtividade. Nos EUA, essa prática já é conhecida como *carbon farming*. Exemplos não faltam no Brasil.

Pioneira desde a safra 2007/08, a administração da Fazenda Roncador, que fica no município de Querência-MT, decidiu mudar o sistema de produção. Veja, na

MUDANÇA DE USO DO SOLO NA FAZENDA RONCADOR

USO DO SOLO	Área (hectares)		
	2007/08	2014/15	2017/18
Pecuária	59.313	40.459	29.005
Degradada	26.550	16.900	10.700
Início da recuperação	21.737	-	-
Recuperada	11.026	23.559	18.305
Integração lavoura-pecuária	-	9.744	24.600
Agricultura	687	9.400	7.060
Eucalipto	-	400	400
TOTAL	60.000	60.003	61.065

MUDANÇA NO BALANÇO DE EMISSÕES NA FAZENDA RONCADOR AO LONGO DE DEZ ANOS DE IMPLEMENTAÇÃO DE SISTEMAS INTEGRADOS DE PRODUÇÃO AGRÍCOLA E RECUPERAÇÃO DE PASTAGENS



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Current Opinion in Environmental Sustainability

The socio-ecological Nexus+ approach used by the Brazilian Research Network on Global Climate Change

Moacyr Araujo[1,5], Jean Ometto[2,5], Saulo Rodrigues-Filho[3,5], Marcel Bursztyn[3,5], Diego P Lindoso[3,5], Gabriela Litre[3,5], Larisa Gaivizzo[3,5], Julia L Ferreira[3,5], Rafael M Reis[3,5] and Eduardo Assad[4,5]

The Brazilian Research Network on Global Climate Change (Rede CLIMA) is an interdisciplinary network composed of 16 research groups, which interact in different levels and programs. This work aims at building climate change cause-effect research from a 'Nexus+' perspective, considering the added value of flexibility and adaptability of the concept. The article draws on the Nexus literature alongside a case study in São Francisco River Basin, Northeast Brazil. An additional pillar to the Nexus approach is proposed here, the socio-ecological security, which can be defined as a political-territorial dimension of coupled social and ecological systems. A collaborative research-practice frame was applied to the study region, a hotspot of climate vulnerability in Brazil. Our results highlight the need for this fourth component to address socio-ecological sustainability into context.

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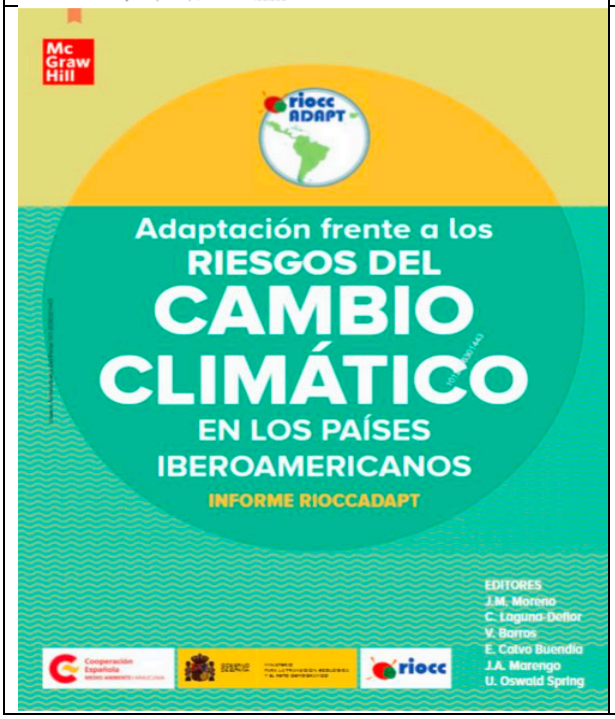
Introduction

In response to the urgency that the challenge of global climate change imposes on society, and the critical need for high quality and relevant scientific knowledge to support public policies focusing on these issues, the Federal Government of Brazil established in 2008 the Brazilian Research Network on Global Climate Change – Rede CLIMA. The Rede CLIMA (RC) is a network of 16 interdisciplinary research groups, which interact in different levels and programs, through inter and transdisciplinary approaches. The RC's research activities have been progressively prioritizing the use of interdisciplinary and transdisciplinary methods to address the causes and effects of global climate change at national and regional levels.

Promoted by United Nations (UN) agencies as a key approach to the implementation of the Sustainable Development Goals (SDG), the Nexus approach has found obstacles to be applied where, at first, it is most needed: in low and middle income countries. The widely disseminated Nexus approach is based on the argument that the limited emphasis on the interfaces of water, energy, and food (WEF) securities commonly leads to contradictory interventions and the inefficient use of natural resources [1].

Populations whose livelihoods are directly impacted by climate change, such as traditional populations and family farmers, particularly in low income countries, are among the most vulnerable due to their high climate sensitivity, and low institutional capacity to minimize risks and to respond to negative impacts through informed decision-making at different scales [2–5]. This means that social vulnerability (including the institutional one) and climate sensitivity are intertwined: therefore, this relationship has to be acknowledged for a genuinely holistic Nexus approach. In this sense, public management has the challenge of internalizing actual problems, such as climate change, in a transversal way, crossing the various sectors involved with adaptive capacity building.

Climate vulnerability is a broad concept used to express the propensity of a system – social, ecological or socio-ecological – to be adversely affected by climate hazards,



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Solar smart grid as a path to economic inclusion and adaptation to climate change in the Brazilian Semiarid Northeast

Paulo Nobre, Enio Bueno Pereira, Francinete Francis Lacerda, Marcel Bursztyn, Eduardo Amaral Haddad and Debora Ley
(Author affiliations can be found at the end of the article)

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Abstract

Purpose – This study aims to exploit the abundance of solar energy resources for socioeconomic development in the semi-arid Northeastern Brazil as a potent adaptation tool to global climate change. It points out a set of conjuncture factors that allow us to foresee a new paradigm of sustainable development for the region by transforming the sun's radiant energy into electricity through distributed photovoltaic generation. The new paradigm, as presented in this essay, has the transformative potential to free the region from past regional development dogma, which was dependent on the scarce water resource, and the marginal and predatory use of its Caatinga Biome.

Design/methodology/approach – The research uses a *pre ante* design, following the procedures of scenario building, as an adaptation mechanism to climate change in the sector of energy generation and socioeconomic inclusion.

Findings – The scenarios of socioeconomic resilience to climate change based on the abundance of solar radiation, rather than the scarcity of water, demonstrates its potential as a global adaptation paradigm to climate change.

Research limitations/implications – The developments proposed are dependent on federal legislation changes, allowing the small producer to be remunerated by the energy produced.

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Erratum: It has come to the attention of the publisher that the article, Paulo Nobre, Enio Bueno Pereira, Francinete Francis Lacerda, Marcel Bursztyn, Eduardo Amaral Haddad and Debora Ley, "Solar smart grid as a path to economic inclusion and adaptation to climate change in the Brazilian Semiarid Northeast" published online in *International Journal of Climate Change Strategies and Management*, had some mislabeled and incorrectly cited figures. This error was introduced in the editorial process and has now been corrected in the online version. The publisher sincerely apologises for this error and for any inconvenience caused.

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Data in brief

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Data Article

Data generated by evaluating the seasonal variability and trend analysis of the solar energy resource in the Northeastern Brazilian region

Fernando Ramos Martins [a, *], Francisco José Lopes de Lima [a, b], Rodrigo Santos Costa [b], André Rodrigues Gonçalves [b], Enio Bueno Pereira [b]

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ABSTRACT

The solar radiation is the primary energy resource for several human activities. Nowadays, the environmental issues and climate concerning are boosting the substitution of fossil fuel resources by renewable energy resources, including the adoption of solar energy for power generation. Although the solar power stands for 0.2% of the Brazilian electricity mix, the solar energy resource in the Northeastern Brazilian region (NEB) is higher than in countries where the solar energy market is already consolidated. Nowadays, it is crucial to deepen the comprehension of solar resource time and spatial variability in NEB to support and promote the solar energy market and save water to other purposes than power generation. The paper presents the data generated by Lima et al. (2019). The database, based on meteorological observations at 129 automated weather stations, provides reliable information on the spatial and seasonal variability of the incoming solar irradiation in NEB.

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The seasonal variability and trends for the surface solar irradiation in northeastern region of Brazil

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ABSTRACT

Earlier studies have demonstrated that the Northeastern Brazilian region (NEB) has the most abundant solar energy resource of the Brazilian territory due to its geographical location, and its environmental characteristics. However, the spatial and seasonal variability was little evaluated. This work investigated the surface solar irradiation variability and trends based on a statistical analysis of the ground data acquired in automated weather stations operated by the Brazilian Institute of Meteorology. A data quality control procedure was accomplished according to WMO criteria to avoid suspicious data. The results pointed out a remarkable variability in seasonal and annual scales. The cluster analysis provided five regional patterns presenting quite interesting temporal complementary regimes for the incoming solar irradiation. The surface solar irradiation achieves the highest values in the Southeastern area of NEB and the lowest in the Western area during the austral summer. The annual and seasonal trends of the surface solar irradiation were investigated using the Mann-Kendall method and the Sen technique. The surface solar irradiation in the Southeastern area of NEB is decreasing by 50 Wh/m^2/year since 2008. On the other hand, it is increasing around 40 Wh/m^2/year in the semi-arid area at the same time-frame.

Introduction

The study of the incoming solar radiation has direct implications on the meteorology, especially on the climate variability [20]. The solar radiation is the energy resource for every physical and biological process regulating the life on Earth including the diurnal and seasonal cycles of temperature and the photosynthesis [16]. The evapotranspiration is intrinsically related to the Earth's energy balance, and the solar energy data allows to quantify the energy allocated to heat soil and atmosphere [44]. The surface solar radiation is essential for carbon assimilation by canopies and, consequently, in the ecosystem productivity [37,3,8,42,45]). In addition, the solar radiation also has an important role in several human activities with important environmental and socioeconomic consequences like agriculture, architecture, energy generation and consumption and other sectors [32].

The Brazilian energy mix is based on mostly hydroelectric and thermoelectric power plants [33]. The hydropower is around 64% of the total installed power capacity in Brazil, but the climate variability is affecting the power generation due to more frequent and extreme drought events as occurred in 2001–2002 and 2013–2015. As a response to the climate variability and increasing energy demand, the thermal power generation based on fossil fuels has increased over the last years. The consumption of fossil fuels releases greenhouse gases into the atmosphere, especially carbon oxidesSPS:refid:.bib7.

The solar and wind power generation are valuable alternatives, not only because of the inherent advantages related to energy matrix diversification but also there will be great worldwide pressure to stabilize carbon emissions rate in the atmosphere through reducing the consumption of fossil fuels. Although Brazil has a vast potential for solar energy usage, some studies are pointing the technological issues related to the solar irradiation intermittency in time and space, and dependence on weather conditions as significant barriers to the growth of the participation of solar energy in the Brazilian electricity mix [48,19,49]. Besides that, the investment to install and operate solar power plants is still larger than for the conventional hydropower and thermal power plants [34]. Thus, the solar energy resource will not replace fossil fuels or hydroelectric power in the current Brazilian scenario, but it will be gradually added to complement the existing resources through hybrid and distributed generation systems. The current limitations on solar energy exploitation tend to be reduced or even eliminated, mainly in

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Comparing Solar Data from NWP Models for Brazilian Territory

F. Lima, R. Costa, A. Gonçalves, M. Pes, E. Pereira, and F. Martins

***Abstract*—Brazil is experiencing continuous growth in the solar energy market over the last years, and it is expected that solar power plants will have a significant contribution to the Brazilian energy matrix soon. The solar irradiance variability is an important issue due to its impact on electricity distribution systems. However, solar energy variability has not been comprehensively evaluated in Brazil. The study aimed to assess the capacity of two numerical models of mesoscale in simulating the solar radiation conditions in the Northeastern region of Brazil. For this, a case study was conducted comparing the surface solar irradiation data acquired in 41 automated weather stations operating in the study area and managed by the Brazilian Institute of Meteorology with estimates provided by two weather mesoscale models BRAMS and WRF. The study indicated that the difference between the model's uncertainties is small (typically less than 5%) when evaluating the entire region of the Brazilian Northeast. However, local comparisons may show more notable discrepancies reflecting uncertainties in the estimates produced by the models.**

***Index Terms*—Solar energy resource assessment, Numerical modeling, Seasonal patterns, Northeastern Brazilian region.**

I. Introdução

O aproveitamento da energia a partir da radiação solar incidente na superfície é uma alternativa para complementar a matriz energética brasileira, que nos dias atuais é primariamente baseada em plantas hidroelétricas e termelétricas alimentadas com uso de combustíveis fósseis. Os entraves tecnológicos e econômicos para crescimento da participação da energia solar tendem a ser reduzidos ou até mesmo eliminados com o tempo, principalmente em resposta à evolução do nível de maturidade tecnológica, à consolidação do mercado internacional, e ao crescimento da demanda energética mundial associado ao desenvolvimento socioeconômico de países emergentes [1], [2]. Contudo, existem desafios ainda não solucionados, relacionados à variabilidade de oferta e dependência das condições de tempo e clima [3], [4].

A participação da energia solar na matriz elétrica nacional está crescendo rapidamente com a implementação de sistemas híbridos e de sistemas de geração distribuída [5], [6] e, assim, vem contribuindo para complementar as fontes de energia convencionais em uso na atualidade. Apesar do fato que o potencial solar está descrito para o território brasileiro com base em dados satelitais [7], [8], a disponibilidade de dados confiáveis coletados em estações de superfície ainda é escassa no país. Estudos anteriores enfrentaram muitas limitações em função da baixa densidade de estações de coleta de dados radiométricos de classe 1 (no padrão internacional) ao investigarem a disponibilidade e a variabilidade da irradiação solar no território brasileiro [7], [9]–[11].

O conhecimento e previsão do potencial disponível de energia solar tem um papel extremamente importante no apoio ao setor energético, no que se refere ao planejamento de operação tanto do sistema elétrico do País quanto de plantas de geração solar fotovoltaicas (PV) e as heliotérmicas (CSP) [9], [12]–[14]. Atualmente, há uma gama de modelos numéricos de alta resolução espacial e temporal capazes de simular os processos radiativos que ocorrem na atmosfera. No entanto, é de suma importância conhecer as incertezas associadas aos resultados destes modelos numéricos para subsidiar a tomada de decisões no setor elétrico nacional, principalmente com relação aos aspectos relacionados à sustentabilidade econômica dos empreendimentos.

A irradiância solar no Nordeste do Brasil possui algumas características peculiares, como discutido por Lima et al. [9]. Sua distribuição espaço-nazonal mostra que os maiores valores ocorrem durante a primavera austral e os menores valores são verificados no outono e inverno, período chuvoso em grande parte da região. Neste contexto, o presente trabalho avalia e compara o desempenho de dois modelos numéricos de mesoescala - o BRAMS (Brazilian Developments on the Regional Atmospheric Modeling System) e WRF (Weather Research and Forecasting) - para a previsão da irradiação solar global incidente na superfície no Nordeste do Brasil (NEB). Os dois modelos atmosféricos são amplamente utilizados pela comunidade acadêmica brasileira em aplicações abrangentes como previsão de temperatura, precipitação e vento mas poucas informações estão disponíveis sobre seu uso em previsões de irradiação solar destinadas especificamente para atender o setor de energia. Os resultados mostram as limitações e diferenças entre os modelos sendo esta a principal contribuição do estudo. Além disso, pretende-se que o estudo possa contribuir para orientar o desenvolvimento de serviços de meteorologia aplicada para suporte da operação de plantas de geração solar no Nordeste do Brasil tanto sob o ponto de vista do empreendedor do setor elétrico quanto do Operador Nacional do Sistema elétrico brasileiro (ONS).

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II. Materiais e Métodos

A. Área de Estudo

O estudo em questão compreende a porção norte da região Nordeste do Brasil (NEB) sujeita a uma diversidade de aspectos climatológicos e fatores antrópicos. A Fig. 1 mostra

RIOCC ADAPT

1

Marco conceptual y contexto regional

José M. Moreno (España), Clara Laguna-Defior (España), Vicente Barros (Argentina), Eduardo Calvo Buendía (Perú), José A. Marengo (Brasil) y Úrsula Oswald Spring (México).

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ARTICLE

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Why do extreme events still kill in the São Paulo Macro Metropolis Region? Chronicle of a death foretold in the global south

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ABSTRACT

This paper contributes to the study of climate change and environmental justice with a particular focus on a Global South case-study in the São Paulo Macro Metropolis of Brazil. We also aim to contribute to mandatory critical dialogue between (anticipatory) governance and environmental justice. This study focuses on the rainy seasons from 2016 to 2019. We examine the incidence of 61 extreme precipitation events, as well as 47 deaths caused by rain events, considering their location based on vulnerability indicators. The correlations among these data allow us to reveal the socio-environmental patterns within the relationships between social vulnerability and deaths caused by general rainfall and, more specifically, extreme events. Based on this, we demonstrate that current infrastructure or its lack is one of the reasons why death tolls remain due to the absence of anticipatory governance.

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KEYWORDS
Macro metropolis; São Paulo; climate change; environmental justice; anticipatory governance

Introduction

The debate on justice and social inequalities related to climate change has intensified throughout the past decade, mainly due to the growing incidence of extreme climate events, as suggested by evidence for global warming published in the latest IPCC report (IPCC 2018). This debate tends to expand, exposing unequal territorial cartographies of those most impacted by these events (Birkland and Waterman 2008; Shi et al. 2016; Anguelovski et al. 2016; Bell et al. 2018; Pelling and Garschagen 2019).

For small oceanic islands that have begun to disappear, underscoring the process of immigration and climate refugees from areas devastated by hurricanes, floods, and droughts has increasingly exposed the reality of the social and environmental inequalities present in the contemporary production of space.

In Brazil, ~85% of natural disasters are related to rainfall or a lack of it. Flash floods, landslides (usually caused by soil saturation), and prolonged droughts produce events that have resulted in more than 10,000 deaths in the last five decades (Pivetta 2016). With climate change, such events tend to increase in frequency and spatial scope. Climate scenarios for 2100 indicate that in the state of São Paulo, either there may be a 10% increase in torrential rainfall or a decrease in total rainfall (Marengo 2007).

In the state of São Paulo, as in other parts of the world, especially in the Global South, tragedies are already a certainty when discussing extreme events. This study aims to address the following question: 'Why do extreme events still kill in the São Paulo Macro Metropolis (SPMM)?' (Figure 1). Macro Metropolis is a specific terminology coined by the São Paulo State Government, based on previous

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Distribuição espacial da leishmaniose visceral e avaliação da vulnerabilidade municipal no Estado do Rio de Janeiro, Brasil

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Palavras-chave: Leishmaniose Visceral, Rio de Janeiro, Epidemiologia

Introdução

Segundo a Organização Mundial da Saúde as Leishmanioses são doenças infecciosas da pobreza, negligenciadas. O Brasil é o país de maior prevalência de Leishmanioses nas Américas[1]. O Programa Brasileiro de Controle da Leishmaniose Visceral Americana[2] classifica os municípios brasileiros, pela média dos casos humanos dos últimos 3 anos, como transmissão intensa, moderada e esporádica. Embora o Estado do Rio de Janeiro, apresente um pequeno número de casos humanos, esta doença não deve ser negligenciada devido ao alto número de cães infectados, mortalidade (recentemente com óbito em área urbana no município do Rio de Janeiro) e urbanização do agravo. Desta forma, este estudo visa identificar a vulnerabilidade a nível municipal no Estado do Rio de Janeiro, e assim orientar os levantamentos entomológicos, a distribuição da doença humana e canina, bem como do seu principal vetor a *Lutzomyia L. longipalpis*.

Material e Métodos

Foram obtidas as ocorrências no estado do Rio de Janeiro, do vetor de LVA, *L. (L.) longipalpis*, de casos humanos e caninos por LVA, através do Sistema Nacional de Informações de Doenças de Notificação (2001-2016), da literatura e da Secretaria de Saúde do Estado do Rio de Janeiro. Os dados foram integrados em um Sistema de Informação Geográfica (SIG) e analisada a distribuição de LVA; posteriormente, os municípios foram classificados de acordo com a classificação do Programa Brasileiro de Controle da Leishmaniose Visceral Americana[2], como receptivos (com registros de *L. (L.) longipalpis*), não receptivos (sem registros do vetor) ou pendente investigação entomológica.

Resultados

Os casos humanos de LVA ocorreram em 23 dos 92 municípios do RJ. Entre 2013-2016, apenas sete municípios tiveram registros, todos classificados com transmissão esporádica (Barra Mansa, Rio de Janeiro, Paraty, Volta Redonda, Angra dos Reis, Macaé e Teresópolis); dois municípios apresentaram registros de LV canina desde 2007, mas sem casos humanos (Mangaratiba e Maricá); 21 municípios vulneráveis foram identificados, sendo 4 receptivos, 3 não receptivos e 14 pendentes de investigação entomológica.

Conclusões

Atualmente, a transmissão da LVA no Rio de Janeiro é esporádica, e 60% dos municípios do Rio de Janeiro não possuem informações sobre flebotomíneos, o que demonstra a necessidade de novos estudos entomológicos. Para melhoraria da análise dos dados, será solicitado à Assessoria de Informação Epidemiológica e Ambiental do Estado do Rio de Janeiro, os números absolutos de casos humanos e caninos do período de 2017 a 2019. Novas análises serão realizadas, com o objetivo de mapear a distribuição da doença (humana e canina), bem como do vetor, identificando os municípios prioritários para vigilância entomológica, além da identificação dos municípios vulneráveis a transmissão da LVA.

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ESTIMATIVAS DE TEMPERATURA SUPERFICIAL POR SATÉLITE E ANÁLISE CLIMÁTICA EM MUNICÍPIO DE GRANDE PORTE NO BRASIL.

Fabiana Lourenço e Silva Ferreira

Tese de Doutorado do Curso de Pós-Graduação em Ciência do Sistema Terrestre, orientada pelo Dr. Ênio Bueno Pereira, aprovada em 05 de maio de 2020.

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RESEARCH Open Access

The Grand Tour: Keynes and Goodwin go to Greece

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Abstract

The impact of the crisis in the Greek economy was not uniform among the regions, threatening socioeconomic cohesion. In this paper, we explore the concept of the income multiplier in a multi-regional input–output setting, in the context of the Greek recession, showing empirical evidence for the increasing magnitude of the multiplier during the recession period. The main results reveal a complex system of interregional relations on some of whose structural characteristics the cyclical reaction paths of the regions depends. In this case, the use of fiscal instruments to stimulate local activity in the regions may bring about important implications for regional inequality in Greece.

Keywords: Interregional input–output analysis, Keynesian multiplier, Recessions, Greece, Austerity policy, Countercyclical regional policy

JEL Classifications: E12, E62, R11

1 Introduction

Robert Solow (2015) has recently commented on Richard Goodwin's article 'The Multiplier as a Matrix' (Goodwin 1949) recalling the analogy between the Leontief-like matrix multiplier and the Kahn–Keynes multiplier.[1] By including households as one of the sectors, Goodwin's multi-sectorial approach has paved the way to replicate Kahn–Keynes by calculating an aggregate national income multiplier as a weighted average of all sector multipliers.

Having Wassily Leontief as its most influential source of inspiration, the quest for relaxing the aggregative nature of the Keynesian system has nudged not only Goodwin's initial scientific accomplishments, but also other early authors, especially Chipman (1950), who developed, at the same time as Goodwin, the notion of sector multipliers. The idea that a net increase in the rate of home investment (and other autonomous injections) propagates in the entire system generating higher-order effects is even more appealing in a multi-sectorial context. Rather than attempting to create a complete model of the economy, the main interest was to trace some of the effects of such injections in the system (Solow 2015).

[1] Kahn (1931) and Keynes (1936).

The Case for Regional Policy: Design and Evaluation

Carlos R. Azzoni and Eduardo A. Haddad

Contents

Abstract

Is regional policy necessary? If so, under what circumstances? The first part of the chapter discusses the rationale behind the existence of (or the need for) regional policies in general. Cases in which excessive concentration or inequality hinders national economic growth are natural candidates for regional policies. If concentration and inequality favor national growth and competitiveness, regional interventions call for a different sort of argument, such as national unity or cohesion. Any regional policy has sectoral and national consequences, as well as any sectoral or national policy has regional consequences. Should public authorities engage in explicit regional policies (place-based) or in sectoral or social policies (people-based) with desirable regional implications? Finally, if regional policies are implemented, how to evaluate them? The chapter discusses these topics.

Keywords

Regional inequality · Regional policy · Regional identity · Policy justification · Policy evaluation

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Water content in trade: a regional analysis for Morocco

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ABSTRACT

This paper aims at evaluating the virtual water content in trade in an intra-country perspective and discussing potential tradeoffs between the use of natural resources and value added creation. We develop a trade-based index that reveals the relative water use intensities associated with specific interregional and international trade flows. The index is calculated considering the measures of water and value added embedded in trade flows associated with each regional origin-destination pair using an interregional input-output matrix for Morocco together with information on sectorial water use. We add to the literature on virtual water by encompassing the subnational perspective in a country that shows a clear 'climate divide'. Furthermore, we contribute to the literature by proposing an index that may be applied to different economies to evaluate multidimensional trade-offs associated with the pressure of specific economic flows to the use of natural resources relative to its economic relevance.

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Water accounting; integrated ecologic-economic modelling; interregional input–output

JEL
Codes: Q25; Q56; C67; D57; R15

1. Introduction

Considered as one of the most poorly endowed countries in water resources, Morocco has intimately linked its economic and social development to the control of its natural resources. The country has developed strategies and policies aiming at the best management and valorization of such resources. It has built, in the last decades, a large system of hydropower infrastructure consisting of approximately 139 large dams, with a storage capacity of more than 17 billion m^3, and several transfer systems that allow the physical transposition of water to the driest areas (Court of Audit, 2018).

These strategies have played a key role in food, water, and energy security for the population, particularly through improved access to drinking water and hydroelectric power, as well as protection against floods and droughts. Nevertheless, good governance of water resources requires continuing attention in Morocco, especially in the face of a significant increase in the demand for water and its multiple uses in the context of a growing population and an expanding economy (Global Nexus, 2017). Moreover, adding to the long-term changes to recent dry conditions in Morocco, global climate change is projected to increase

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Impacts of Royalties on Copper Miners in Chile

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Abstract. We evaluate the effects of a recent proposal to raise an additional royalty payment for copper miners operating in Chile. We use a computable general equilibrium (CGE) model calibrated for the Chilean economy. Results show that GDP would decrease if we considered only the effects of the additional royalty payments. However, recycling the revenue into the economy through government expenditures and allowing real factor income to affect household consumption would make GDP to increase. This difference is mainly due to the very inelastic nature of both the demand and the supply curves for copper.

Keywords: Taxation; CGE models; Chile; Copper; Impact analysis

JEL Classification Number: C68; H20; Q38

1. Introduction

The extraction of non-renewable natural resources has the potential to generate income to finance government activities. Rent capturing through taxation may enhance the public sector ability to harness the potential of natural resources to sustain a broad-based development. Chile, the largest copper producer and exporter in the world, is one of the few nations that have succeeded in this endeavour (Collier and Venables, 2011). The country's strategy is grounded on stabilization funds, fiscal discipline and complementary policies, such as trade openness, to avoid Dutch disease (Fuentes, 2011).

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Mobility in cities: Distributional impact analysis of transportation improvements in São Paulo Metropolitan Region

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1. Introduction

Good connectivity within cities is an essential input for productivity and livability in cities, but the distributive impacts of improvements in within-city mobility are not well understood. This work aims at filling this gap by exploring the impacts of alternative infrastructure investments and mobility policies on economic growth, income distribution of households and internal distribution of economic activity.

This paper focuses on the estimation of the impacts of transportation investments/policies using a spatial computable general equilibrium (SCGE) model integrated to a travel demand model, following the methodology presented in Haddad et al. (2015). In order to enhance our understanding of the distributional impacts of transportation improvements in Brazilian cities, we simulate the impact of different types of mobility investments in the São Paulo Metropolitan Region (SPMR). To explore further the income effects of infrastructure investments, we also conduct microsimulation exercises integrated to the SCGE results.

We look at ten different scenarios, which are divided into two main categories: ranging from a series of infrastructure-related interventions on the mass-transit, and policies that create disincentives to the use of private cars. In the first group, the expansion of transportation infrastructure tends to reduce the average travel time in public transportation, representing a reduction in the generalized cost[1] of public transportation to individuals. Therefore, travelers gain an incentive to substitute away from private modes, potentially reducing congestion. The second group of interventions relates to policies that restrict car access to the city, increasing the generalized cost of individual transportation. In such cases, potential mode switch away from cars also tends to reduce congestion. The simulations results suggest potential trade-offs between efficiency and equity in the case of policies that restrict cars' access to the city. However, infrastructure-related interventions, not surprisingly, are associated with increases in GRP (Gross Regional Product) and, while their impacts on income distribution are relatively more modest, they suggest that improvements in the overall economy brought by transportation investments are not coming at the expense of lower-wage workers.

In what follows, we discuss the motivation for this study in section 2. We then discuss the main methodological aspects of the integrated modeling system in section 3, with emphasis on the microsimulation module that adds to the original work in Haddad et al. (2015). Results for the mobility scenarios derived from simulations using the integrated modeling framework are presented and discussed in section 4. Section 5 concludes.

2. Motivation and background

Cities come in different sizes and forms. However, cities that have been able to grow large and remain productive and competitive such as London, Singapore and New York, all have one thing in common: good connective infrastructure that has allowed all areas of the city to remain connected. Thus, connectivity made it possible for these cities to grow as single entities.

Connectivity is essential for the success of a city for several reasons. First, firms benefit from good links to their input and output markets. A well-connected city provides firms with a larger pool of labor and bigger markets to sell their products. Second, households also benefit from good connections in a city. They can reach more opportunities in shorter times, and have access to larger pools of goods, including housing, to choose from. When households and firms are well connected, productivity and livability can be higher (Fernald, 1999; Ghani et al., 2012; Rosguhé and Selod, 2006; Gobillon et al., 2007; Gobillon and Selod, 2014; Cao and Pan, 2016).

Improvements to connectivity can be achieved in at least two ways. First, by reducing the cost of transportation per unit of distance

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[1] The term "generalized cost" refers to the weighted sum of the monetary and non-monetary costs of a journey.

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Non-deforestation drivers of fires are increasingly important sources of aerosol and carbon dioxide emissions across Amazonia

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Deforestation rates have declined substantially across the Brazilian Legal Amazon (BLA) over the period from 2000–2017. However, reductions in fire, aerosol and carbon dioxide have been far less significant than deforestation, even when accounting for inter-annual variability in precipitation. Our observations and analysis support a decoupling between fire and deforestation that has exacerbated forest degradation in the BLA. Basing aerosol and carbon dioxide emissions on deforestation rates, without accounting for forest degradation will bias these important climate and ecosystem-health parameters low, both now and in the future. Recent increases in deforestation rate since 2014 will enhance such degradation, particularly during drought-conditions, increasing emissions of aerosol and greenhouse gases. Given Brazil's committed Nationally Determined Contribution under the Paris Agreement, failure to account for forest degradation fires will paint a false picture of prior progress and potentially have profound implications for both regional and global climate.

Amazonia is one of the world's most important tropical regions and is suffering substantial pressures from human occupation, expansion of agricultural activities and climate change. The biological functioning of the forest is being altered by smoke from biomass burning, changes in precipitation patterns and extreme events such as frequent intense droughts[1]. The majority of Amazonia is located in Brazil, demarcated as the Brazilian Legal Amazon (BLA). Tropical moist broadleaf forest covers 81% of the area, with tropical grasslands, savannah and shrublands composing 16%[2]. The majority of BLA states are dominated by tropical forests, with Cerrado (savannah-like areas) also present in significant portions of Mato Grosso, Tocantins and Maranhão.

Large-scale deforestation of the BLA to clear vegetation and maintain agricultural lands has been recorded as a regular annual occurrence since the 1970s. As of 2018, approximately 800,000 km^2 of the BLA has been deforested[3,4], which represents close to 20% of the original area of the Amazon rainforest in the BLA. Since 2004, official figures for the BLA produced by the Brazilian National Institute for Space Research[5] have shown a significant decline in annual deforestation[6,7]. International and national policy interventions have been identified as being major drivers of the observed reductions[8–11]. The primary means of clearing an area is through so-called 'slash-and-burn' agriculture, where the forest is cut and subsequently burned[12]. The cutting and burning stages are usually separated as the fallen wood is given time to dry due to very high moisture. Deforestation peaks in June/July, approximately three months after the peak in the rainy season, while biomass burning peaks in September when fire counts reach their maximum[13]. The annual burning season typically runs from August to October, with the associated fires producing large amounts of gas and particulate phase material that have a range of environmental and health consequences.

Biomass burning aerosol is a global phenomenon that represents a significant uncertainty in assessments of the impact of atmospheric aerosol on the Earth System. Biomass burning aerosol impacts global climate and the hydrological cycle in tropical and savannah environments, as well as boreal regions. Biomass burning aerosol-radiation interactions are very poorly constrained with the global radiative forcing central estimate spanning positive and negative values due the uncertain balance between scattering organic aerosols and absorbing

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RESEARCH LETTER
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Substantial Increases in Eastern Amazon and Cerrado Biomass Burning-Sourced Tropospheric Ozone

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Key Point:
- Savannah-type fires in the Cerrado, northeastern Brazil, have increased emissions of ozone precursor gases degrading air quality

Supporting Information:
- Supporting Information S1

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Abstract The decline in Amazonian deforestation rates and biomass burning activity (2001–2012) has been shown to reduce air pollutant emissions (e.g., aerosols) and improve regional air quality. However, in the Cerrado region (savannah grasslands in northeastern Brazil), satellite observations reveal increases in fire activity and tropospheric column nitrogen dioxide (an ozone precursor) during the burning season (August-October, 2005–2016), which have partially offset these air quality benefits. Simulations from a 3-D global chemistry transport model (CTM) capture this increase in NO_2 with a surface increase of ~1 ppbv per decade. As there are limited long-term observational tropospheric ozone records, we utilize the well-evaluated CTM to investigate changes in ozone. Here, the CTM suggests that Cerrado region surface ozone is increasing by ~10 ppbv per decade. If left unmitigated, these positive fire-sourced ozone trends will substantially increase the regional health risks and impacts from expected future enhancements in South American biomass burning activity under climate change.

1. Introduction

Fire is a widely used method for land clearance in the tropics, allowing rapid conversion of regions of natural vegetation to agricultural land (Cochrane, 2003). In the Amazon, these deforestation practices led to a 15–20% decrease in forest cover between 1976 and 2010 (Aragão et al., 2014; Davidson et al., 2012; Hansen et al., 2013). Vegetation fires are a large source of reactive trace gases and aerosol to the Amazon atmosphere (Bela et al., 2015; Hodgson et al., 2018; Sena & Artaxo, 2015; Ward et al., 1992), especially during the dry season, with substantial impacts on the atmospheric radiation balance (Kolusu et al., 2015; Scott et al., 2018; Sena & Artaxo, 2015; Thornhill et al., 2018) and surface air quality (Artaxo et al., 2013; Johnston et al., 2012; Jacobson et al., 2014; Reddington et al., 2015; Pacifico et al., 2015).

Over the period 2001 to 2012, deforestation rates in Brazil decreased by ~40% (Hansen et al., 2013) leading to improvements in particulate air quality (Reddington et al., 2015). These decreasing deforestation rates correlated with reductions in satellite-observed aerosol optical depth (AOD) over the Amazon, which were attributed to significant reductions in surface emissions of aerosol from deforestation fires (Reddington et al., 2015). Reductions in surface $PM_{2.5}$ (mass of particulate matter with diameter less than 2.5 μm) concentrations, resulting from the reduction in fire emissions, were estimated to prevent 400–1,700 premature deaths annually in South America. The reduction in fire activity is particularly evident in the arc of deforestation, around the southern edge of the Amazon Basin, where the majority of Amazon deforestation fires occur (van der Werf et al., 2017). Satellite-observed fire-burned area (FBA) in this region has decreased by 0.25–0.5%/year between 1998 and 2015 (Andela et al., 2017). Despite these reductions in the arc of deforestation, FBA in northeastern Brazil has increased by 0.5–1.0%/year, resulting in increased regional pollutant emissions (Andela et al., 2017; Chen et al., 2013). This region represents the transition biome between the eastern Amazon, the Cerrado grasslands, and the Caatinga desert vegetation (Santo et al., 2017). However, this region is predominantly covered by savannah grasslands, and hereafter, we refer to it as the

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Urban pollution greatly enhances formation of natural aerosols over the Amazon rainforest

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One of the least understood aspects in atmospheric chemistry is how urban emissions influence the formation of natural organic aerosols, which affect Earth's energy budget. The Amazon rainforest, during its wet season, is one of the few remaining places on Earth where atmospheric chemistry transitions between preindustrial and urban-influenced conditions. Here, we integrate insights from several laboratory measurements and simulate the formation of secondary organic aerosols (SOA) in the Amazon using a high-resolution chemical transport model. Simulations show that emissions of nitrogen-oxides from Manaus, a city of ~2 million people, greatly enhance production of biogenic SOA by 60–200% on average with peak enhancements of 400%, through the increased oxidation of gas-phase organic carbon emitted by the forests. Simulated enhancements agree with aircraft measurements, and are much larger than those reported over other locations. The implication is that increasing anthropogenic emissions in the future might substantially enhance biogenic SOA in pristine locations like the Amazon.

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Chemical composition of ultrafine aerosol particles in central Amazonia during the wet season

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Abstract. Central Amazonia serves as an ideal location to study atmospheric particle formation, since it often represents nearly natural, pre-industrial conditions but can also experience periods of anthropogenic influence due to the presence of emissions from large metropolitan areas like Manaus, Brazil. Ultrafine (sub-100 nm diameter) particles are often observed in this region, although new particle formation events seldom occur near the ground despite being readily observed in other forested regions with similar emissions of volatile organic compounds (VOCs). This study focuses on identifying the chemical composition of ultrafine particles as a means of determining the chemical species and mechanisms that may be responsible for new particle formation and growth in the region. These measurements were performed during the wet season as part of the Observations and Modeling of the Green Ocean Amazon (GoAmazon2014/5) field campaign at a site located 70 km southwest of Manaus. A thermal desorption chemical ionization mass spectrometer (TDCIMS) characterized the most abundant compounds detected in ultrafine particles. Two time periods representing distinct influences on aerosol composition, which we label as "anthropogenic" and "background" periods, were studied as part of a larger 10 d period of analysis. Higher particle number concentrations were measured during the anthropogenic period, and modeled back-trajectory frequencies indicate transport of emissions from the Manaus metropolitan area. During the background period there were much lower number concentrations, and back-trajectory frequencies showed that air masses arrived at the site predominantly from the forested regions to the north and northeast. TDCIMS-measured constituents also show distinct differences between the two observational periods. Although bisulfate was detected in particles throughout the 10 d period, the anthropogenic period had higher levels of particulate bisulfate overall. Ammonium and trimethyl ammonium were positively correlated with bisulfate. The background period had distinct diurnal patterns of particulate cyanate and acetate, while oxalate remained relatively constant during the 10 d period. 3-Methylfuran, a thermal decomposition product of a particulate-phase isoprene epoxydiol (IEPOX), was the dominant species measured in the positive-ion mode. Principal component analysis (PCA) was performed on the TDCIMS-measured ion abundance and aerosol mass spectrometer (AMS) mass concentration data. Two different hierarchical clusters representing unique influences arise: one comprising ultrafine particulate acetate, hydrogen oxalate, cyanate, trimethyl ammonium and 3-methylfuran and another made up of ultrafine particulate bisulfate, chloride, ammonium and potassium. A third cluster separated AMS-measured species from the two TDCIMS-derived clusters, indicating different sources or processes in ultrafine aerosol

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Implications of the New Operational Rules for Cantareira Water System: Re-Reading the 2014-2016 Water Crisis

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Abstract

During the 2014-2016 water shortage crisis, the Metropolitan Area of São Paulo (MASP) water supply system extracted pumping volume from the Cantareira System. Before the crisis, between 1984 and 2013, the reservoir's average water extraction flow was 29.6 $m^3 s^{-1}$. During the period of pumping volume usage, the average extraction flow was 16.2 $m^3 s^{-1}$. Following the crisis, two new mitigation policies were implemented: a water extraction Resolution (in 2017) and a Resolution for water reallocation from another basin (in 2018). This study provides a novel investigation of the Cantareira System water crisis by assessing the mitigation policies impacts on storage level dynamics. The system storage level was evaluated using the reservoir simulation module of PDM-Cemaden hydrological model, assuming that the new policies had already been implemented prior to the crisis. A control simulation was run with observed in- and out-flow and operationally-practiced extraction flow. The storage level dynamics impacts were evaluated under 4 water mitigation policies scenarios varying the policies implementation starting date, the extraction flow range and including the water reallocation variable. Results showed that pumping volume would only need extraction during a short period (Scenarios I, III and IV), and considering the water reallocation, pumping volume extraction would not have been necessary (Scenario II). Al-

Segurança e vulnerabilidade hídrica: evoluções conceituais à luz da Gestão Integrada e Sustentável

Water Security and Vulnerability: Conceptual Evolution in the Integrated and Sustainable Management

Seguridad y vulnerabilidad del Agua: Evolución Conceptual a la Luz de la Gestión Integrada y Sostenible

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Resumo

MOURA, M. R. F. de; SANTOS, F. M. dos; GALVÃO, C. de O.; MONTENEGRO, S. M. G. L.; SILVA, S. R. da. Segurança e vulnerabilidade hídrica: evoluções conceituais à luz da Gestão Integrada e Sustentável. ***Rev. C&Trópico***, v. 44, n. 1, p. 100-120, 2020. DOI: https://doi.org/10.33148/cetropicov44n1(2020)art6

O gerenciamento integrado da água, com premissas baseadas na Sócio-hidrologia, direciona os sistemas socioecológicos à sustentabilidade. O presente artigo apresentou um Mapa Conceitual para compreensão de evoluções conceituais relativas à segurança e à vulnerabilidade hídrica na perspectiva da Sustentabilidade Global. Para isso, realizou-se uma revisão de literatura para o desenvolvimento de uma estrutura teórica que relaciona conceitos-chave fundamentais para análise e discussão interdisciplinar do gerenciamento sustentável da água. Observa-se que existem evoluções conceituais no campo dos recursos hídricos que passaram a contemplar abordagens interdisciplinares que, por muito tempo, foram negligenciadas. O Mapa Conceitual mostrou ainda que há múltiplos focos no conceito e no estudo da Segurança Hídrica, de modo que esta pesquisa manteve o foco na Vulnerabilidade e na Sustentabilidade, entendendo que estes são elementos relevantes para consolidar a prática da Gestão Integrada de Recursos Hídricos em prol da garantia da Segurança Hídrica.

Palavras-chave: Segurança Hídrica. Gestão Integrada de Recursos Hídricos. Vulnerabilidade Hídrica. Sustentabilidade.

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PAPER

Governance of alluvial aquifers and community participation: a social-ecological systems analysis of the Brazilian semi-arid region

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Abstract

Small and shallow alluvial aquifers in arid and semi-arid regions compose an important water system that smallholder farmers rely on for irrigation and livestock feeding. Geological settings and the small scale of these aquifers suggest the need for governance at the local level, but research supporting its development is still scarce. Treating a case of alluvial aquifers exploited by smallholder farmers located in the Brazilian semi-arid region as a common pool resource (CPR), this paper analyses the governance of a social-ecological system (SES) for which an alluvial aquifer is an essential source of water. The paper applies the SES Framework to analyse the SES in light of Ostrom's principles for sustainable CPR management to answer the questions: (1) can the governance arrangements support sustainable common pool resource management of the alluvial aquifers? (2) what opportunities are there to make the management of the aquifer more sustainable through community-based governance? (3) can Ostrom's design principles lead the transition to more sustainable governance of alluvial aquifers? Despite a water policy aiming for decentralisation and participatory governance, gaps in the implementation of these policies are identified. Taking into account the challenges imposed by the aquifer characteristics to impact efficient groundwater exploitation, equity in water distribution and conservation of the CPR, the analysis reveals opportunities to improve CPR management by supporting the community to increase participation in the governance of the aquifer in coordination with existing policies. This work concludes with suggestions that could empower community progress towards more sustainable governance of the aquifer.

Keywords Groundwater management · Brazil · Arid regions · Alluvial aquifers · Socio-economic aspects

Introduction

Water scarcity, which can be defined as the imbalance between the water supply availability and the demands for meeting the needs of ecosystems and people in a given area, is a global concern that affects the livelihoods of people on different spatial and temporal scales (UNDP 2013). It is a problem faced by 4 billion people in the world for at least 1 month of the year (Mekonnen and Hoekstra 2016) and is exacerbated by population growth and climate change. Climate change is expected to be a "poverty multiplier", with impacts on agriculture being one of the main drivers "to force more than 3 million to 16 million people into extreme poverty" (Hoegh-Guldberg et al. 2018, p. 244) and part of this is due to increased risk of water scarcity. However, recent research has argued that water scarcity in many areas is much more a water governance issue than a biophysical one (Pahl-Wostl and Kranz 2010; OECD 2011; Silva et al. 2015), focusing the attention of the scientific community and decision makers on analysing how to improve the governance of water systems (Tan et al. 2012; Durán-Sánchez et al. 2019; OECD 2015).

Groundwater has become an increasingly important source of water over the past century, now representing approximately one third of water consumed in the world (UN Environment 2019) and the imbalance between water extraction and aquifer recharge has been causing aquifer depletion globally (Wada

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10040-020-02160-8) contains supplementary material, which is available to authorized users.

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journal homepage: www.elsevier.com/locate/fgcs

BioClimate: A Science Gateway for Climate Change and Biodiversity research in the EUBrazilCloudConnect project

Sandro Fiore [a,*], Donatello Elia [a], Ignacio Blanquer [b], Francisco V. Brasileiro [c], Alessandra Nuzzo [a], Paola Nassisi [a], Iana A.A. Rufino [c], Arie C. Seijmonsbergen [d], Niels S. Anders [d], Carlos de O. Galvão [c], John E. de B.L. Cunha [c], Miguel Caballer [b], Mariane S. Sousa-Baena [e], Vanderlei P. Canhos [e], Giovanni Aloisio [a,f]

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[b] Universitat Politecnica de Valencia, Valencia, Spain
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HIGHLIGHTS

- Climate and biodiversity systems are closely linked across a wide range of scales.
- User-centric research environment built on top of a federated cloud infrastructure.
- A multi-scale, integrated approach to investigate the climate-biodiversity system.
- The BioClimate Science Gateway represents the high-level interface for scientists.
- BioClimate supports different kinds of scientific data analysis.

ARTICLE INFO

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Science gateways
Scientific data management and analytics
Biodiversity and climate research

ABSTRACT

Climate and biodiversity systems are closely linked across a wide range of scales. To better understand the mutual interaction between climate change and biodiversity there is a strong need for multidisciplinary skills, scientific tools, and access to a large variety of heterogeneous, often distributed, data sources. Related to that, the EUBrazilCloudConnect project provides a user-oriented research environment built on top of a federated cloud infrastructure across Europe and Brazil, to serve key needs in different scientific domains, which is validated through a set of use cases. Among them, the most data-centric one is focused on climate change and biodiversity research. As part of this use case, the BioClimate Science Gateway has been implemented to provide end-users transparent access to (i) a highly integrated user-friendly environment, (ii) a large variety of data sources, and (iii) different analytics & visualization tools to serve a large spectrum of users needs and requirements. This paper presents a complete overview of BioClimate and the related scientific environment, in particular its Science Gateway, delivered to the end-user community at the end of the project.

1. Introduction

Climate and biodiversity systems are closely linked across a wide range of scales. To predict the effects of climate change on the biodiversity system, which is essential towards sustainable landscape and eco-services management, there is a need to further investigate the interaction between the climate system and biodiversity. Presently, researchers and professionals are burdened by scattered data sources, wealth of analysis tools to master and implement, and computational limitations to upscale their analysis.

The "*EU-Brazil Cloud infrastructure Connecting federated resources for Scientific Advancement*" (EUBrazilCloudConnect) [1] is a project funded under the third EU-Brazil coordinated call. It is a preliminary step towards providing a user-oriented environment for scientific research communities to test the execution of

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journal homepage: www.elsevier.com/locate/hydroa

Research papers

Can regional to continental river hydrodynamic models be locally relevant? A cross-scale comparison

Ayan Fleischmann *, Rodrigo Paiva, Walter Collischonn

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ARTICLE INFO

Article history:
Received 8 November 2018
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1D hydrodynamic modeling
Regional scale
Continental scale modeling
Cross-scale comparison
HEC-RAS

ABSTRACT

Regional to global river hydrodynamic models are now a reality, and have largely improved in the recent years due to increasing computation power, remote sensing datasets and new modeling methods. It is fundamental then to understand to which extent these models can provide locally relevant estimates of variables as discharge and water levels. It is addressed here by setting up three different versions of the large scale MGB hydrologic-hydrodynamic model with increasing spatial scale (global, regional and local), based on different topography datasets, cross section parameterization and reach lengths. These model versions are then compared to a detailed HEC-RAS model, set up with >620 locally surveyed cross sections in the Itajaí-Açu basin in Brazil. All models are run with calibrated rainfall-runoff parameters, so that effects of non-calibrated runoff fields or uncertain forcing data are not taken into consideration. To assist interpretation, three main requirements to define estimates from a river hydrodynamic model as locally relevant are defined: the model errors should be equal or smaller (i) than the accuracy requirement for a particular application and location, (ii) than typical local, reach scale models' errors, and (iii) than observation uncertainties. Results then indicate that the regional and local MGB versions (and to a lesser extent, the global one) could estimate locally relevant discharges and water level anomalies for many parts of the basin. For absolute water levels, all models failed to provide RMSE smaller than 0.4 m basin-wide, although the local MGB model yields an average 2.1 m RMSE, in comparison to 4.4 m (regional) and 26.1 m (global). For flood extent, all model versions generally yielded unsatisfactory results with average Fit metric values smaller than 65%. Lastly, different setups of the regional MGB model were run to investigate the role of different factors in improving model estimates. Results showed that a coarse reach length (15 km) is unable to capture flood dynamics and water level variations in the basin, while a smaller 1 km long reach improves discharges, water level and flood extent. A locally derived DEM did not lead to significant improvements in relation to a global DEM. In turn, the smallest water level errors would be attained by using information from the in-situ cross sections in the regional models. This study's outcomes are encouraging for the future development of regional to global hydrodynamic models, with new remote sensing techniques and higher computational power improving cross section estimation and model discretization.

1. Introduction

Large scale river hydrodynamic models are powerful tools for water resources studies related, for example, to flood risk assessment and flood forecasting, and have been recognized as fundamental to yield satisfactory discharge, water level and flood extent model estimates (Dottori et al., 2016; Hirabayashi et al., 2013; de Paiva et al., 2013; Sampson et al., 2015; Schumann et al., 2013; Trigg et al., 2016a; Yamazaki et al., 2011; Zhao et al., 2017). Improvements in computational power, remote sensing datasets and modeling frameworks have allowed the development of several regional hydrodynamic models in the last years moving toward hyperresolution spatial resolution, i.e. 100 m–1 km (Bates et al., 2018; Bierkens et al., 2015; Hodges, 2013; Wood et al., 2011). Today, application scales range from thousands to millions of square kilometers (Fleischmann et al., 2018; Lai et al., 2013; Miguez-Macho and Fan, 2012; de Paiva et al., 2013) and extend to continents (Schumann et al., 2016; Siqueira et al., 2018; Trigg et al., 2016b; Wing et al., 2017) and even to the whole globe (Dottori et al., 2016; Sampson et al., 2015; Yamazaki et al., 2013; Zhao et al., 2017). These models have also been coupled to

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Urban expansion and its impact on water security: The case of the Paraíba do Sul River Basin, São Paulo, Brazil

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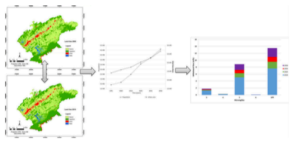
[b] *Federal University of Rio de Janeiro (UFRJ), Brazil*
[c] *National Center for Monitoring and Early Warning of Natural Disasters (Cemaden), Brazil*
[d] *Federal Fluminense University (UFF), Brazil*

HIGHLIGHTS

- To estimate water consumption, we integrated LUCC scenarios with demographic data.
- Results showed good agreement of the estimation of urban sprawl and water consumption.
- The main driver of urban sprawl expansion is the access to the transportation network.
- LUCC scenarios indicate a 38% growth in consumption and withdrawal flows by 2050.

GRAPHICAL ABSTRACT



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Editor: Jurgen Mahlknecht

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Water supply
Urbanization
Population growth
Land use modelling

ABSTRACT

Increasing demand for water is one of the most challenging problems that human societies face today and has encouraged new studies to examine water security and water management. Seeking to discuss this important issue in the Brazilian context, we analyzed the impacts of urban expansion on water security in a basin located in the most populated region of Brazil. To quantify increased water demand, we combined urban sprawl and regional population increase projections. In this context, our study contributes to discussions on water security by addressing the importance of integration between water and urban planning. Simulations indicate good performance in reproducing actual water system conditions. The finding demonstrates that urban expansion in the region is mainly driven by road proximity. Urban occupation is projected to increase in 1701 by 2050, increasing water demands for domestic use in 38%. Results indicate the feasibility of including landscape and socioeconomic constrains in order to obtain potential domestic water demand scenarios by using land use and land cover change modelling to assess urban expansion and population growth. For the study region, our findings suggest that although urban sprawl increases water demand, urban supply will not be compromised given the large volume of available water in the basin. However, the indirect consequences of urban sprawl, such as industrialization and agricultural intensification, may compromise the quality of this resource and require better water use management in the region.

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0048-9697/

Join activities with other INCTs

Ao Ilustríssimo Ministro da Ciência, Tecnologia, Inovações e Comunicações
Astronauta Marcos Pontes

Cumprimentamos V. Excelência pelo agendamento da reunião do Conselho Deliberativo do FNDCT, programada para o dia 25 de março de 2020, na qual serão definidos os destinos dos 600 milhões de Reais que poderão ser usados neste ano. Gostaríamos de ressaltar que as demandas do CNPq (apresentação do presidente do CNPq em reunião recente na SBPC) são referentes aos compromissos já assumidos pela Agencia com o Edital Universal (de 2018), Institutos Nacionais de Ciência e Tecnologia (INCTs), PROANTAR e ARC que totalizam 78 milhões de Reais. Estes recursos, são fundamentais para manter atividades de alto impacto na Ciência, Tecnologia e Inovação do Brasil, além de contribuir fortemente na formação de recursos humanos altamente qualificados.

Com relação aos INCTs, a segunda fase foi iniciada em 2014 e formalizada em 2016, com liberação de recursos em dezembro de 2016. Atualmente, são 102 INCTs com presença em todas as regiões do País atuando em áreas altamente estratégicas tais como: Saúde, Ecologia e Meio Ambiente, Ciências Exatas e Naturais, Ciências Humanas e Sociais, Ciências Agrárias, Engenharia e Tecnologia da Informação, Energia e Nanotecnologia.

Ressaltamos que, neste momento de crise sem precedentes, devido à chegada da pandemia de COVID-19 nas Américas, mais que nunca precisaremos de recursos humanos e financeiros nas mais diversas áreas necessárias ao enfrentamento desta situação única, urgente e que trará graves prejuízos econômicos e sanitários. O programa INCT, pela atuação comprovada não só na saúde mas em diversas outras áreas das ciências necessárias ao combate ao coronavirus - epidemiologia, desenvolvimento tecnológico, ensaios pré-clínicos e clínicos de novos fármacos, vacinas, kits diagnósticos, estatística, modelagem, saúde pública, gestão, logística, demografia, saneamento básico etc. - precisa ser financiado, mobilizado e convocado para nestes próximos meses estar na linha de frente do combate a esta devastadora pandemia.

Nesse sentido, os Coordenadores dos INCTs manifestam-se pela priorização e aprovação pelo CD FNDCT da demanda do CNPq (78 milhões de Reais).

Enfraquecer o CNPq significa comprometer o FUTURO do BRASIL!!!

Assinam o Manifesto os Coordenadores dos Institutos Nacionais de Ciência e Tecnologia.

Adalberto Val, INCT Adapta
Afonso Luis Barth,- INCT – INPRA
Alvaro Toubes Prata, INCT-Refrigeração e Termofísica
Amauri Alcindo Alfieri, INCT - Leite

Anderson Gomes, INCT Fotônica
Antonio Carlos Campos de Carvalho - INCT-REGENERA.
Antonio Martins Figueiredo Neto, INCT de Fluidos Complexos
Augusto Cesar Alves Sampaio, INCT de Engenharia de Software (INES)
Belita Koiller, INCT de Informação Quantica
Carlos A. L. Chernicharo - INCT Estações Sustentáveis de Tratamento de Esgoto
Carlos Morel, INCT-IDPN
Celio Pasquini, INCTAA – INCT de Ciências e Tecnologias Analíticas Avançadas
Charbel El-Hani, INCT IN-TREE
Carisi A Polanczyk, INCT para Avaliação de Tecnologias em Saúde
Deisy de Souza, INCT-ECCE
Diogo Souza - INCT Doenças Cerebrais, Excitotoxicidade e Neuroproteção
Edgar Carvalho, INCT-DT (Doenças Tropicais)
Elibio Leopoldo Rech Filho, INCT Biologia Sintética
Eliezer J. Barreiro, INCT INOFAR
Evaldo Mendonça Fleury Curado, INCT-SC
Fabio Kon, INCT da Internet do Futuro para Cidades Inteligentes
Fernando Galembeck, INCT Inomat
Fernando José Gomes Landgraf, INCT Terras Raras
Fernando Lázaro Freire Junior, INCT Engenharia de Superfícies
Helio Leães Hey, INCT Geração Distribuída de Energia Elétrica
Henrique Krieger, INCT sobre Epidemiologia da Amazonia
Hernandes F Carvalho, INCT-INFABiC
Hugo Gallardo, INCT Catálise em Sistemas Nanoestruturados
Jailson Bittencourt de Andrade, INCT de Energia e Ambiente
Jefferson Cardia Simões, INCT da Criosfera
Jerson Silva, INCT de Biologia Estrutural e Bioimagem
João B. Calixto, INCT-INOVAMED
José Krieger, INCT-MACC
José Luiz Rezende Pereira, INCT de Energia Elétrica - INERGE
José Marengo, INCT Mudanças Climáticas Fase 2
José Maria Landim Dominguez, INCT AmbTropi
Jorge Elias Kalil Filho, INCT de Investigação em Imunologia
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Luiz Nicolaci da Costa, Coordenador INCT do e-Universo
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Marcos Buckeridge, INCT do Bioetanol
Marco Henrique Terra, INCT - Sistemas Autônomos Cooperativos
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Maria Fátima das Graças Fernandes da Silva, INCT-CBIPF
Maria Fatima Grossi de Sá, INCT - Plant Stress Biotech
Maria Valnice Boldrin, INCT-DATREM
Mario Saad INCT - obesidade e diabetes
Mauro Teixeira, INCT em Dengue
Mayana Zatz, INCT Envelhecimento e Doenças
Milton Porsani, INCT de Geofísica do Petróleo
Niro Higuchi, INCT - Madeiras da Amazônia
Otavio Franco, INCT Bioinspir
Paulo Arruda - INCT- Centro de Química Medicinal de Acesso Aberto
Paulo Teixeira de Sousa Júnior, INCT-Áreas Úmidas
Pedro Lagerblad de Oliveira, INCT Entomologia Molecular
Poli Mara Spritzer, INCT em Hormônios e Saúde da Mulher

Reinhardt Fuck, INCT Estudos Tectônicos
Renato Boschi, INCT PPED
Ricardo Coutinho INCT-Pro-Oceano
Ricardo Gazzinelli, INCT-Vacinas
Roberto Kant de Lima, INCT – InEAC
Roberto Lent, INCT - Neurociência Translacional
Roberto Mendonça Farias, NCT de Eletrônica Orgânica
Rochel Montero Lago, INCT Midas
Sebastião C. Velasco e Cruz, INCT Ineu, Estudos sobre os Estados Unidos
Sebastião Valadares, INCT de Ciência Animal
Sergio de Azevedo, INCT Observatório das Metrópoles.
Takeshi Kodama, INCT-FNA, Física Nuclear e Aplicações
Vanderlan Bolzani, INCT BioNat
Vanderlei S. Bagnato - INCT em Óptica Básica e aplicada as ciências da vida
Vilma Regina Martins, INCT de Oncogenômica e Inovação Terapêutica
Wilson Gomes, INCT de Ciência & Tecnologia em Democracia Digital
Wilson Savino, INCT de Neuroimunomodulação

Pesquisa FAPESP – Interview with Marengo and Ambrizzi

assine boletim

Pesquisa FAPESP

EDIÇÃO IMPRESSA
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Ciência Saúde Política C&T Tecnologia Humanas Ética Ambiente Entrevistas Carreiras Dados Vídeos Podcasts

Republicar

CLIMATOLOGIA

2019 foi o ano mais quente já registrado no Brasil

Temperaturas máxima e mínima anuais sobem de modo contínuo desde 1961

Carlos Fioravanti

13:59
10 mar 2020

Atualizado em
17 mar 2020

Ambiente
Ciênc. Atmosféricas
Saúde Pública

O ano de 2019 foi o mais quente já registrado no país, com uma média de temperatura máxima (diurna) de 31,05 graus Celsius (°C), de acordo com dados divulgados em fevereiro pelo Instituto Nacional de Meteorologia (Inmet), órgão do Ministério da Agricultura, Pecuária e Abastecimento (Mapa), que acompanha a variação diária da temperatura no país desde o final do século XIX. O ano de 2015 foi o segundo mais quente, com 31,02 °C. A média da temperatura mínima também foi a mais alta em 2019, 20,04 °C, depois de 2015, com 19,93 °C.

O Brasil segue a tendência mundial, principalmente no inverno, com pequenas diferenças. Em janeiro de 2020, a Organização Meteorológica Mundial (OMM) anunciou que 2016 foi o ano mais quente na média global e 2019 foi o segundo mais quente desde 1850, quando as medições começaram a ser feitas.

"A circulação atmosférica no Brasil em parte compensou a variação do clima verificada em outros países", comenta o meteorologista Marcelo Schneider, do Inmet de São Paulo. Segundo ele, a variabilidade natural do clima, o aquecimento global e a ação humana, com a maior emissão de gases do efeito estufa, principalmente o dióxido de carbono (CO_2) e o metano (CH_4), a expansão urbana e agrícola e o desmatamento, são as principais razões da contínua elevação de temperatura no país e no mundo. "Somente o El Niño [aquecimento das águas do Pacífico equatorial] não explica sozinho o aumento da temperatura em 2019, porque no Brasil seu efeito foi fraco e limitado aos meses de maio a julho."

No estado de São Paulo

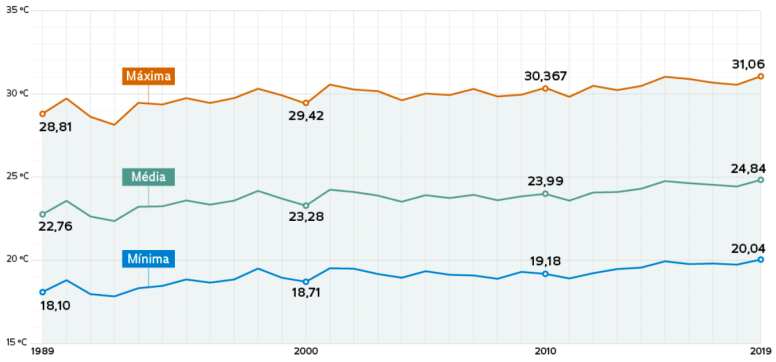
Na cidade de São Paulo, o ano de 2019 foi o segundo mais quente desde 1943, com média de 27,0 ºC, depois de 2014 e 2002, que registraram a média de 27,1 ºC, de acordo com o Inmet. A média de temperatura mínima também foi a segunda maior em 2019, com 17,4 ºC, só perdendo para 2015, com 17,5 ºC. "A altitude, a latitude mais baixa e a proximidade com o Atlântico explicam por que as temperaturas da cidade de São Paulo em geral são mais baixas que a média nacional", comenta Schneider.

Os modelos climáticos sugerem que a urbanização de áreas cobertas por vegetação natural pode causar um aumento de temperatura média anual de 3,5 ºC, menos noites frias e mais dias quentes na Região Metropolitana de São Paulo (RMSP), de acordo com um artigo publicado em fevereiro na revista científica *Annals of the New York Academy of Sciences*.

Os efeitos da urbanização e a variabilidade da temperatura da superfície do mar se somam para explicar a oscilação extrema nos índices de pluviosidade. De acordo com o estudo coordenado pelo meteorologista José Marengo, do Centro Nacional de Monitoramento e Alertas de Desastres Naturais (Cemaden), com a participação de Ambrizzi, na década de 2020 a temperatura média anual da RMSP deve aumentar entre 0,9 ºC e 1,7 ºC, e a pluviosidade variar entre cair 31% e aumentar 43%, concentrando-se em poucos dias, como ocorreu em janeiro de 2020. "Essa variação grande é uma resposta extrema da atmosfera ao aquecimento global que estamos vivendo", diz Abrizzi.

Um Brasil mais quente

Temperaturas máximas, médias e mínimas sobem desde 1989



FONTE INMET

Consequências

Já em 2006, estudos do Instituto Nacional de Pesquisas Espaciais (Inpe), com base em modelos climáticos regionais, haviam delineado a tendência de temperaturas mais altas e umidade mais baixa nos anos seguintes, com impactos que vão além do desconforto causado pelos dias tórridos.

Projetos
1. INCT 2014: INCT para Mudanças Climáticas (INCT-MC) (nº 14/50848-9); **Modalidade** Programa de Pesquisa sobre Mudanças Climáticas Globais; **Pesquisador responsável** José Antonio Marengo Orsini (Cemaden); **Investimento** R$ 699.115,21.
2. Governança ambiental da macrometrópole paulista em face da variabilidade climática (nº 15/03804-9); **Modalidade** Programa de Pesquisa sobre Mudanças Climáticas Globais; **Pesquisador responsável** Pedro Roberto Jacobi (USP); **Investimento** R$ 298.437,75.

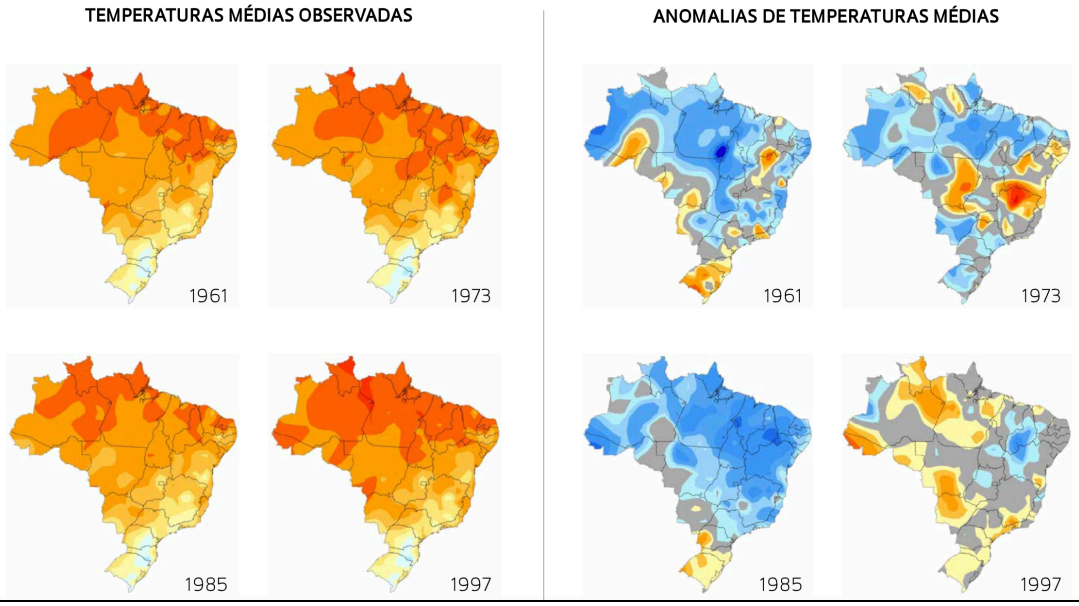
Artigos científicos
ABREU, R. C. de *et al.* Attribution of detected temperature trends in southeast Brazil. **Geophysical Research Letters**. v. 46, n. 14, p. 8407-14. 28 jul. 2019.
MARENGO, J. A. *et al.* Trends in extreme rainfall and hydrogeometeorological disasters in the Metropolitan Area of São Paulo: A review. **Annals of the New York Academy of Sciences**. (on-line). 13 fev. 2020.
CARVALHO, A. A. de *et al.* Trends of rainfall and temperature in Northeast Brazil. **Revista Brasileira de Engenharia Agrícola e Ambiental**. v. 24, n. 1, p.15-23. jan. 2020.

MUDANÇAS CLIMÁTICAS | CLIMATOLOGIA

Republicar

58 anos de calor crescente

As temperaturas médias e as anomalias (variações sobre a média local) desde 1961 mostram que o Brasil está mais quente a cada ano



REUNIÃO PREPARATÓRIA PARA O 3º SEMINÁRIO DE AVALIAÇÃO DOS INSTITUTOS NACIONAIS DE CIÊNCIA E TECNOLOGIA

ATA-EXECUTIVA

Data: 26/09/2019

Local: Auditório do CNPq – Brasília/DF

Horário início: 13h **Horário Término**: 18h

Coordenação: CGNAC e COAPI

Objetivo: A reunião teve o objetivo de compartilhar informações sobre os preparativos para a realização do 3º Seminário de Avaliação dos INCTs, com apresentação do formato proposto para o evento, permitindo captar sugestões acerca de como aproveitar a oportunidade para iniciar um processo cumulativo de construção de experiências de divulgação do Programa INCT e, bem como dar maior visibilidade aos 105 INCTs (Chamadas 16/2014 e 71/2010) e a seus respectivos resultados.

PARTICIPANTES

Presidente do CNPq, Diretor de Cooperação Institucional, Coordenadora Geral de Cooperação Nacional, Coordenador e equipe técnica de Apoio a Parcerias Institucionais do CNPq, representantes do Centro de Gestão e Estudos Estratégicos/CGEE, representante do SEBRAE e coordenadores e representantes de 34 dos 105 Institutos Nacionais de Ciência e Tecnologia aprovados nas Chamadas Públicas 71/2010 (INCT-Mar) e 16/2014 (INCT temas prioritários), além de representantes de INCTs que acompanharam via transmissão da RNP.

PROGRAMAÇÃO:

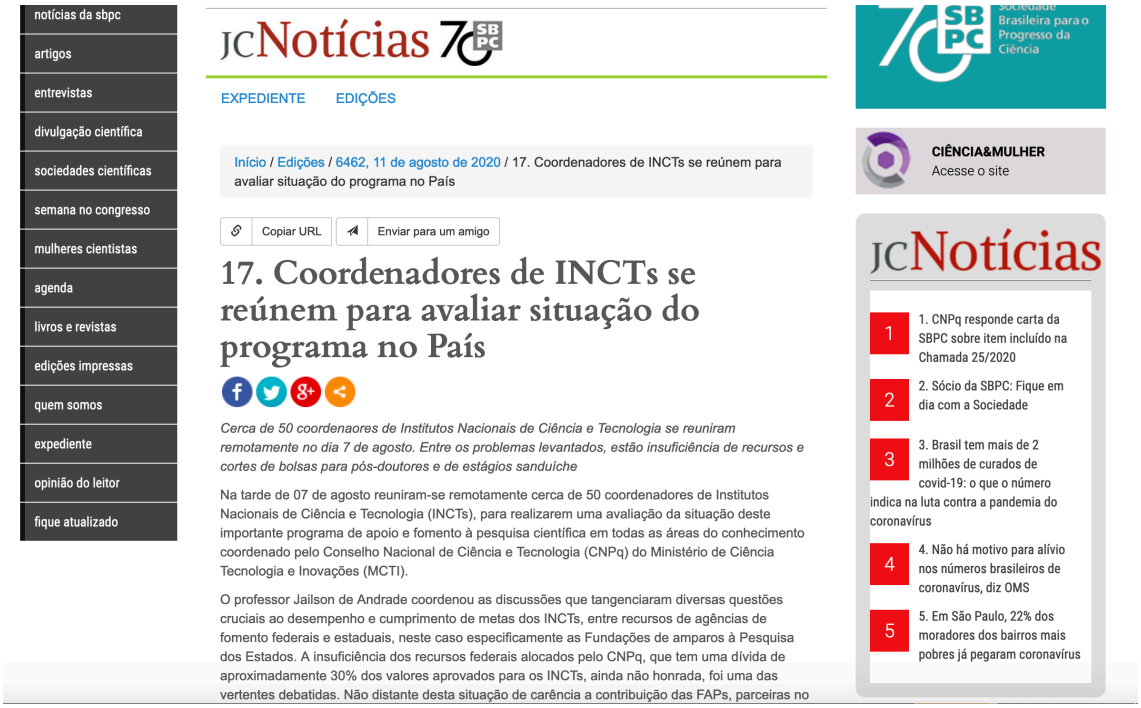
13h às 13h30: Boas Vindas e abertura

- Dr. João Luiz Filgueiras de Azevedo – Presidente do CNPq

- Vilson Rosa de Almeida – Diretor de Cooperação Institucional

13h30 às 14h: Apresentação dos objetivos e da proposta de estruturação do 3º Seminário

1	Coordenação de Apoio a Parcerias Institucionais – COAPI/CGNAC/CNPq seminarioinct@cnpq.br



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EXPEDIENTE EDIÇÕES

Início / Edições / 6462, 11 de agosto de 2020 / 17. Coordenadores de INCTs se reúnem para avaliar situação do programa no País

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17. Coordenadores de INCTs se reúnem para avaliar situação do programa no País

Cerca de 50 coordenaores de Institutos Nacionais de Ciência e Tecnologia se reuniram remotamente no dia 7 de agosto. Entre os problemas levantados, estão insuficiência de recursos e cortes de bolsas para pós-doutores e de estágios sanduíche

Na tarde de 07 de agosto reuniram-se remotamente cerca de 50 coordenadores de Institutos Nacionais de Ciência e Tecnologia (INCTs), para realizarem uma avaliação da situação deste importante programa de apoio e fomento à pesquisa científica em todas as áreas do conhecimento coordenado pelo Conselho Nacional de Ciência e Tecnologia (CNPq) do Ministério de Ciência Tecnologia e Inovações (MCTI).

O professor Jailson de Andrade coordenou as discussões que tangenciaram diversas questões cruciais ao desempenho e cumprimento de metas dos INCTs, entre recursos de agências de fomento federais e estaduais, neste caso especificamente as Fundações de amparos à Pesquisa dos Estados. A insuficiência dos recursos federais alocados pelo CNPq, que tem uma dívida de aproximadamente 30% dos valores aprovados para os INCTs, ainda não honrada, foi uma das vertentes debatidas. Não distante desta situação de carência a contribuição das FAPs, parceiras no

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1. CNPq responde carta da SBPC sobre item incluído na Chamada 25/2020
2. Sócio da SBPC: Fique em dia com a Sociedade
3. Brasil tem mais de 2 milhões de curados de covid-19: o que o número indica na luta contra a pandemia do coronavírus
4. Não há motivo para alívio nos números brasileiros de coronavírus, diz OMS
5. Em São Paulo, 22% dos moradores dos bairros mais pobres já pegaram coronavírus