INCT Climate Change Phase 2

(INCT MC Phase 2)

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Year 1 Report

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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 technicians 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;
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. Modeling the earth system and production of future climate scenarios to study vulenerability, impacts, adaptattion and resilience;
3. Communication, dissemination of knowledge and education for sustainability.

This will allow the impacts of global change can be evaluated from the economic point of view, using projections of future climate to assess their potential impacts, and also allow all the results of this research can be presented and communicated to society and governments a clear and precise manner allowing a greater understanding by decision makers to propose public policies to address the current and future challenges of global change.

The most accepted definition for the terms sustainability and sustainable development is the following: is a development to meet the needs of society today without compromising the ability of future generations to meet. To be achieved, sustainable development depends on planning and recognition that natural resources are finite. This concept represents a new form of economic development that takes into account environment. The INCT MC Phase 2 provides an overview of issues related to sustainability and environmentally-responsible business in order to facilitate the participation or even the implementation of activities in different areas of the company management and their relationships with "stakeholders".

The development of the INCT MC Phase 2 scientific agenda will provide optimum conditions for the country to develop scientific excellence in various areas of global environmental change and its implications for sustainable development, especially when you consider that the economy of developing nations is strongly associated with renewable natural resources, as is strikingly the case in Brazil. 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 modeling, 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.

We use the state-of the air on climate modeling using regional and global models to generate climate change scenarios, as well as the development of impacts models to assess conseuance of

climate change of varuos key sectors in Brasil. We also use climatic, land use and socioecomic information, including economy and health, as well as experiments in the field and laboratory, all directed to assess impacts of climate in marural and human systems, and directed to the understanding of possible implications for climate change and moitigation options.

This project includes knowledge transfer using instruments that go beyond only scientific articles, but producing audiovisual, 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.

The design of the INCT MC Phase 2 is characterized by goals and targets to be achieved in the short, medium and long term, and their achievement is accomplished through well articulated, concatenated and synergistic activities, where the six main sub components are integrated by three integrative them,es economic evaluations and environmental risk, the use of state of the art in scenarios of future climate projections developed by INPE to design changes in the short, medium and long term, and communication of global environmental issues for society and government needed to define scientific and public policies for large national and international environmental debates subsidies.

Participating Brazilian institutions and centers have courses or graduate and undergraduate level, as well as technological training, or are operational centers that apply the state-of-the-art knowledge on climate change and extremes for assessments, monitoring and predictions of natural diassters and their impacts. Some of the participating institutions have the scientific and logistical skills needed to create functional networks to effectively research, where operational and research activities can be favored by the visits of researchers from international groups that are already working on issues relevant to the resarch lines of the project. For the INCT MC Phase 2 we plan to integrate national institutions with international regional and global programs of excellence in research and training matters relevant to vulnerability, impacts, adaptation, resilience and sustainability.

This new project represents a continuation of the previous INCT- MC that ended in 2017. The INCT-MC was composed by over 400 researchers from Brazil and 18 countries and interacted with several other INCTs. More information about the previous INCT- MC can be obtained at: http://inct.ccst.inpe.br/.

2. Objectives and aims

- 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 o 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

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 will be monitored by a Scientific Committee (CC), that is constituted by the coordinators of the sub components (themes) and from the cross cutting activities.

-Coordinators of each component of the INCT MC Phase 2

Duties	Coordinators (institution, state)	Activities to be developed in the Project
Coordinator	J. Marengo (CEMADEN, SP)	Coordination of the project, climate modelling, impacts and vulnerability assessments, extremes, adaptation, leader of the CG e CC.
Vice-coordinator	T.Ambrizzi (IAG USP, SP)	Vice-coordinator of the project, climatology, climate studies, water security, member of the CC and CG.

Subcomponents or cross cutting themes	Coordinators (institution, state)	Activities to be developed in the Project
Water Security*	E.Mendiondo (EESC USP, SP)	Hydrology, water security, risk assessments, subcomponent coordinator, member of the CG
	S. Montenegro (UFPE, PE)	Hydrological modelling in urban and rural areas, in the Brazilian semiarid, coordinator of sub component,
	E. S. Martins (FUNCEME, CE)	Hydrology, hydrological basin modelling and climate change, coordinator of sub component
Food Security*	E. D. Assad (EMBRAPA, SP)	Food security, agriculture modelling, coordinator of sub component
Energy Security*	R. Schaeffer (UFRJ, RJ)	Energy and climate change, coordinator of sub component and member of the CG
	E. B. Pereira (CCST INPE, SP)	Renewable energies, energy and climate change. Wind energy and solar potential scenarios, coordinator of sub component
	A. Szklo (UFRJ, RJ)	Energy and climate change, coordinator of sub component =
Human health	U. Confalonieri (UFMG-FIOCRUZ, MG)	Health and climate change, vulnerability and climate-health, coordinator of sub component, member of the CG.
	E. Rangel (UFMG-FIOCRUZ, MG)	Health and social communication, education, coordinator of sub component
Economy and impacts on key sectors *	E. Haddad (FEA USP,SP),	Economics of climate change, coordinator of cross cutting theme, member of the CG e
	S. Margulis (IPEA, DF)	Economics of climate change, coordinator of cross cutting theme,
	J. Feres (IPEA, DF),	Economics of climate change, coordinator of cross cutting theme,
Communication, knowledge diffusion and education for	A. Amorim (UNICAMP, SP)	Linguistics, scientific communication, coordinator of cross cutting theme,

sustainability *		
	S. Dias (UNICAMP, SP)	Education – knowledge and art, coordinator of cross cutting theme,
Modelling the Earth System, generation of future climate change scenarios for impacts-vulnerabiolity-adaptation studies*	P. Nobre (CPTEC INPE, SP)	Oceanic and coupled ocean-atmosphere model development, BESM-Brazilian Earth System Model, coordinator of cross cutting theme, member of the CG.
	S. Chou (CPTEC INPE, SP),	Regional climate modelling, high resolution future climate change scenarios, coordinator of cross cutting theme
	G. Sampaio (CPTEC INPE, SP)	Climate modelling, surface-atmosphere interactions, coordinator of cross cutting theme,
Natural Disasters, urban areas, physical infrastructure and urban development*	R. Alvalá (CEMADEN, SP)	Natural disasters, impacts and risk assessments, coordinator of cross cutting theme,
	R. Rodrigues (UFSC, SC)	Natural disasters, coastal regions, coordinator of cross cutting theme,
	M. Barata (FIOCRUZ, RJ)	Climate change and urban development, resilient cities, coordinator of cross cutting theme
Impacts on Brazilian ecosystems in view of changes in land use and biodiversity*	P. Artaxo (IF USP, SP)	Environmental physics, Amazonia, coordinator of cross cutting theme, member of the CG
	M. Bustamante (UNB, DF)	Greenhouse gases emission inventories, studies on the cerrado area, coordinator of sub component

*Sao Paulo based, that will be include in this report.

4. Organizational structure

Considering the objectives of the INCT-MC Phase 2, we organize the project in six thematic lines (or subcomponents):

1 Food security;
2 Water security;
3 Energy security;
4 Health;
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 crosscutting themes:

7 Economy and impacts in key sectors;
8 Modelling the earth system and production of future climate scenarios to study Vulnerability, Impacts and Adaptation-
9 Communication, dissemination of knowledge and education for sustainability.

The coordinators work is aimed at building mechanisms and interaction considering the scientific basis of the different components and crosscutting themes and scenarios and models to support the development of strategies and trajectories for adaptation, resilience and global environmental change and pathways to sustainability in Brazil. For such integration, specific activities with the coordinators of each component and each cross-theme workshops and scenarios, along with the political spheres (when appropriate) will be the responsibility of such coordination, and will be

directed to the construction in a participatory manner among different stakeholders (scientific community, decision makers) in order to promote adaptation, resilience and sustainability under environmental changes.

The purpose of the integrative themes is to work with `the different components, cross-cutting themes, and models and scenarios, aims to generating scientific information on the impacts of global environmental change on key sectors for integrated manner throughout the project (1) provide adaptive stock options; (2) pinpoint areas in sectors where policy decisions need to consider `climate change more urgently; (3) propose trajectories of adaptation in different sectors and focusing on building resilience to optimize or (4) point or map priorities for adaptive actions, helping the country in key sectors, for more resilient and adapted trajectories of climate change in order to promote sustainability on a national scale.

Global environmental changes include increased occurrence of extreme weather events such as droughts, heat waves, heavy rains, floods, storms, land-slides The extremes of climate variability poses a major challenge for society, where the unavoidable impacts hardest hit poor people living on hillsides or risk areas, or to ecosystems which have a lower capacity for adaptation. In the previous INCT-MC research experiences with traditional mixed communities in the Amazon in extreme events (drought and flood) revealed the vulnerability of this population, exacerbated by increased climate variability and uncertainty about continuity survival and maintenance of daily activities.

Each research and integrative team implement adaptive strategies in the context of environmental change. The theme, the project has a special focus to the challenges of environmental change on food security and infrastructure in coastal areas in order to better prepare the population and its institutions 'answer' to such challenges. The same can be said with respect the experiences and networks of researchers with a new global platform Earth Future, which aims to better, understand and promote global sustainability front global environmental change.

Expected that the coordination and integration activity, results proposes to run trough a series of workshops from each component and two conferences, followed by interviews and process assessments and analyses of the partial results of each component, and consecutively thereafter to be assessed and worked together between members of the INCT MC Phase 2, and some guests from government, the decision makers in such specific workshops. The results of each workshop and job analysis, they provide important subsidies the political sphere in developing appropriate adaptation measures to reality and particularities of different regions of the country.

The INCT MC Phase 2 allows that the impacts of global change can be evaluated from the economic point of view, using projections of future climate to assess their possible impacts. It will also allow that all the results of this research can be presented and communicated to society and governments in a clear and precise manner, enabling a greater understanding by decision makers, and aiming at the elaboration of public policies to address the present and future challenges of global change.

The structure of this new INCT-MC Phase 2 allows for a large universities and research institutions and national and even international institutions to collaborate and to form a virtual network. This decision has a budget justification. Whereas the financial resources to be used by a considerable number of projects are finite, most of the budget will be used to maximize the interactions between groups and institutions, fostering integrated activities. This strategy considers that there are currently funding and financing opportunities for climate and global change in Brazil: as in the Rede Clima, FAPESP Research Program on Global Change, the Science Without Borders Program of CNPq, FINEP announcements and calls for proposal on climate change at the federal level, as well as calls to fund other research projects on climate change at the state level by the sate funding agencies, providing additional resources for the implementation and completion of

the proposed research project agenda. The research network generated by INCT MC Phase 2 will certainly be more effective in finding budget resources, preparing and submitting integrated and interdisciplinary projects.

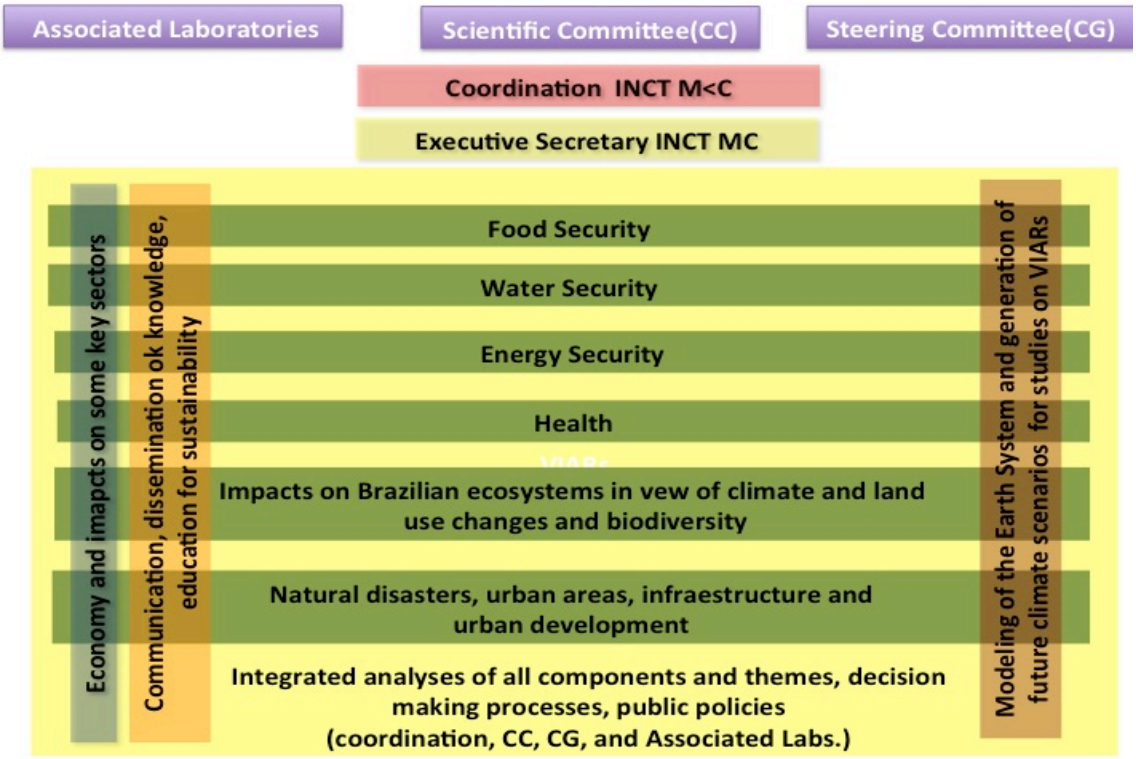


Figure 1. Structure of the new INCT MC Phase 2

This INCT MC Phase 2 represents an application of the main results of the previous INCT-MC. Among the main scientific legacies of INCT- MC we may mention the great scientific contribution to IPCC AR5 and PBMC, and also strengthening the scientific agenda of the Rede-Clima. Among the public policies generated from the findings of the INCT-MC, we can mention the creation of CEMADEN (National Centre for Monitoring and Early Warning of Natural Disasters). The INCT-MC showed that extreme rainfall events (similar to that caused floods and landslides in the mountainous region of Rio de Janeiro in January 2011) are more frequent and intense since 1950 in south-eastern Brazil, and this can increase vulnerability in areas of high population density in this region Brazil, and that this vulnerability may increase in the future if measures to reduce risks to natural hazards are not created and implemented. We expect that the legacy of the INCT MC Phase 2 will be on the same line as its predecessor INCT MC Phase 1: Contributions to the IPCC AR1.5 and IPCC AR6, the special reports of the Brazilian Panel on Climate Change on coastal cities and biodiversity, the special report of adaptation to climate change in Ibero-American countries by the RIOCC and the impacts and vulnerabilities studies for the Fourth National Communication of Brazil to UNFCCC.

The INCT MC Phase 2 is closely linked with other research networks in federal and state climate change. Firstly, is directly associated with the Rede Clima (redeclima.ccst.inpe.br), a program of MCTIC, and its structure will cover the scientific and technological aspects of interest this Network. It is also associated with several research projects in climate change, in particular the FAPESP Research Program on Global Climate Change (PFPMCG), the research networks in São Paulo INCLINE (Center for Research Support in Climate Change) and CEPED (Centre Studies and Research on Disaster) coordinated by the USP. CEMADEN has allocated a secretary in

support of the managing activities of the INCT MC Phase 2.

The development of the proposed research agenda provides optimal conditions for scientific excellence in various areas of global environmental changes presented in Figure 1 and its implications for the sustainable development of Brazil, especially when one considers that the growth in developing nations is closely related to exhaustible natural resources.

The challenge to promote interaction and integration among the 6 subcomponents and 3 cross cutting themes, involving more than 46 participant groups from 15 Brazilian states and 11 institutions from 10 countries is something to consider seriously. There is already a previous interaction among some research groups, by means of previous INCTs or by projects from FAPESP and CNPq (Figure 2). This figure was elaborated in 2014 at the time of the submission of the proposal to CNPq, and the project was formally accepted in 2016 but with a budget cut of about 40%. This determined that a number of collaborators of other regions of Brazil were not able to continue in the project. At the international level, few partners remained with the project, but their participation is very limited since budget for air fare and per diems for visits to Brazil is almost non existent.

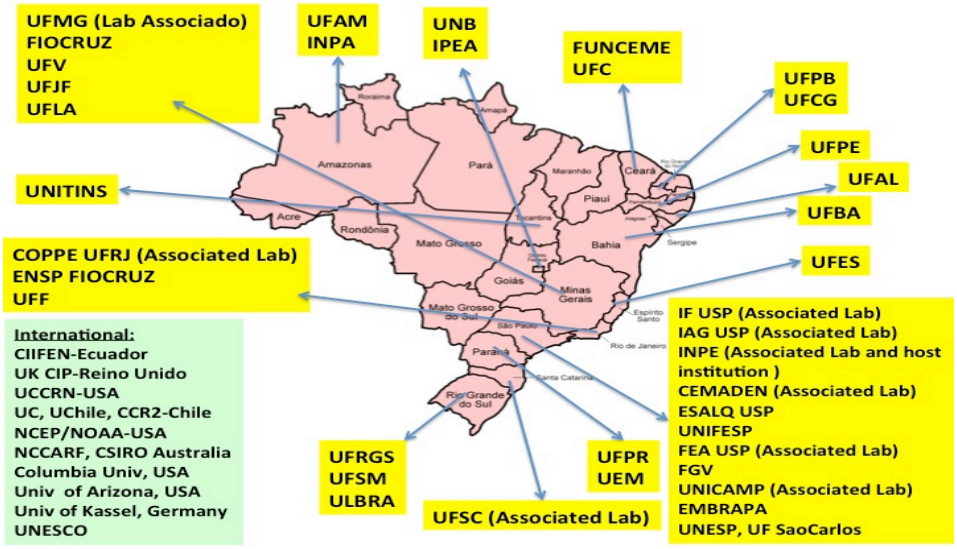


Figure 2. Research groups participating at the new INCT MC Phase 2

In the INCT MC Phase 2, CEMADEN is in the process of implement and maintain a project portal on the Internet with content specific to the various stakeholders: 1) For researchers - file publications, Discussion Forum, posting information system for reports of activities and resource management, and daily tickets and bags; 2) For students and educators - to download educational materials, interactive games, multimedia materials; 3) To the media - "press releases" on the research design, images, videos; 4) For businesses and governments - to material specific to support environmental policies.

Scientific interactions and integration of results will be obtained primarily by conducting scientific meetings of various kinds, either totally or partially dedicated to the project, or presenting the results in large events, as are the SBPC, the National Week of S & T or in the relevant project (congress SBMET, SBAgromet, ABRH etc) national scientific conferences. The Scientific Committee (CC) shall meet twice a year-up to monitor the implementation of the agenda and harmonization of scientific activities. The Scientific Committee will make recommendations to the Steering Committee (CG) on the scientific advances of the project. The Steering Committee shall meet at least once a year (in person), and can meet via Skype or webinar as many times as necessary. We met once in 2017 at the FEA USP.

Figure 3 displays the national and international scope of the project and shows that there are several groups of consolidated and unconsolidated research that will benefit by participating in this research network. Figure 3 shows that this project plans INCTs closely with other networks and national and international research related to issues of global change and sustainability, and expects to generate scientific products that can help in large studies such as IPCC and PBMC and can also help in international environmental negotiations.

The science of global change is international in nature and goes beyond the generation of scientific knowledge, reaching analyses of impacts, vulnerability, adaptation, in order to form and build resilience to global change and extreme and enable sustainable development. The INCT MC Phase 2 did seek to involve a significant number of researchers of the highest qualification of national and international centers of scientific excellence working on global change, vulnerability, adaptation, impacts, resilience and sustainable development of several countries, some from South America, and others from North America, Europe and Australia. However, this interaction has been hampered and maintained to a minimum due to budget cuts. We plan to substitute international trips to and from Brazil by using video conference and skype communication tools.

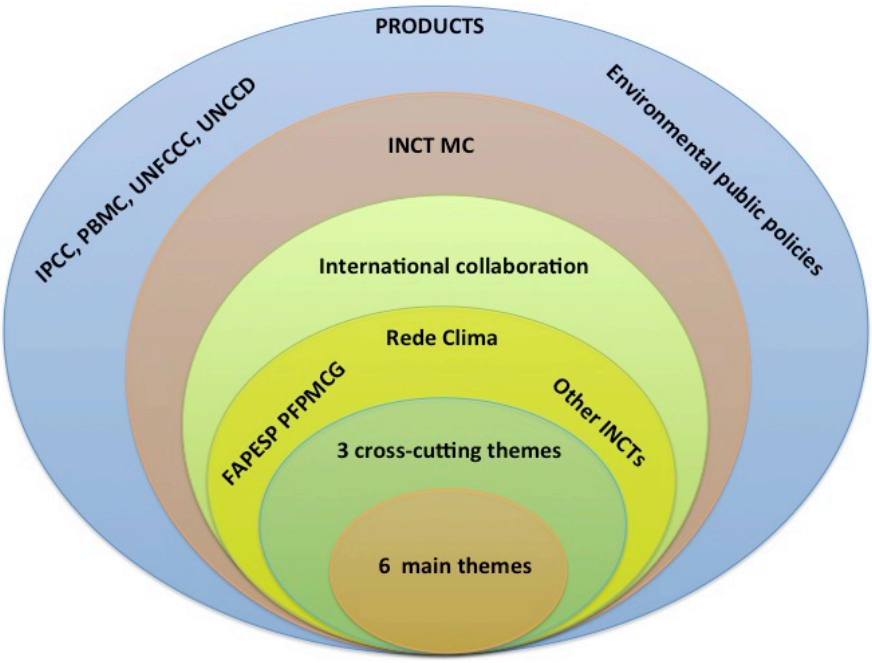


Figure 3. Scope of the INCT MC Phjase 2 at the national and international level

5. Reports by component

In the following we focus on the reports from each sub component and cross-cutting component, showing main results and activities developed in Year 1 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 1. 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 the partners located in institutions of the State of Sao Paulo that were funded by FAPESP.

5.1 Food security

5.1.1 Objective

This sub-project will be assessing issues involving the relationship between climate-livestock-economics and implications for food security, in accordance with the flowchart below (Figure 4)

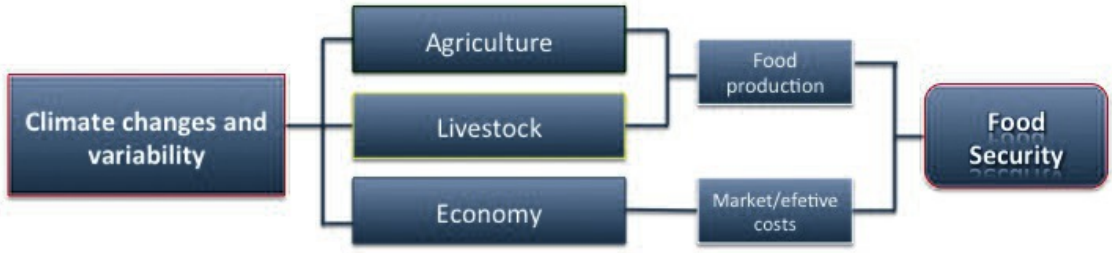


Figure 4. Flow chart of the food security sub component

When submitted in 2014, this project was lead by Drs. Flavio Justino and Luiz Claudio Costa from UFV, but once approved in 2016 they did not showed more interest on it. So, the coordination decided to invite Dr. Eduardo Assad from EMBRAPA to lead this component. He accepted and made some changes in the structure of this component and in the membership of it. The main activities planed for the project were maintained, but some goals were dropped because they were no longer relevant with the new structure of the component

-Activity 1 - Climate, agriculture and food security implications

Despite the large number of available climate projections from global and regional climate models, a great uncertainty is still present in climate projections throughout various regions of South America, and more specifically of Brazil. Some areas may exhibit more humid conditions, other is drier but the border between them is far from being well defined. In many parts of Brazil this could lead to water deficit due to precipitation decrease and/or increased evapotranspiration, conducting to an estimated reduction in water availability per capita, which can seriously result in an increase in food insecurity due to impacts on food production.

The agricultural sector is particularly sensitive to climate variability and change. Agriculture is a mainstay of the economy in Brazil providing approximately 30% of GDP, and supports the livelihoods and food security for 70-80% of the populations, particularly in rural areas.

The need for greater focus becomes urgent for the potential vulnerability to climate variability, especially in the region with the lowest income. This profit across the spectrum to investigate the impact of soil-water inter-change-environment/climate, designed on the sectors of water availability-for agricultural crops and livestock and food security, along with the consequences of these impacts and socio-economic policy options for adaptation strategies.

Goals

• Food security vulnerability Assessment due to changes induced in the farming and pasture
• Evaluation of grain quality (nutrient and protein levels) in addition to the amount (productivity) and implications for food safety

-Activity 2: Climate, economy and food security implications

Issues related to food security and climate change has been increasingly debated and analysed by researchers from different areas of knowledge. These two issues represent important challenges for the world's population and directly involve the agricultural sector and its relations with other economic sectors. As the demand for agricultural products will grow as the population and income increase in the coming decades, sectorial actions can contribute significantly to the international goals of reduction and stabilization of atmospheric concentrations of greenhouse gases – GEE. Specifically, it is consensus that, through appropriate management and regional agricultural

practices, alternatives sector agriculture, forestry and other land uses (AFOLU – Agriculture, Forestry and Other Land Use) can greatly contribute to mitigate GHG emissions.

The sustainable intensification of agricultural production passes necessarily by an integrated approach between climate change, adaptation actions and mitigation of GHG emissions. The identification of synergies between mitigation and adaptation in the AFOLU sector is essential, because the food security and the impacts of climate change on the agricultural sector requires integrated options. The combined effect of mitigation and adaptation strategies is greater than when these measures are implemented individually. Furthermore, most mitigation techniques currently used in agriculture was originally conceived as "optimal management strategies", aimed at improving the stability and resilience of farming systems in the long term, generating win-win type scenarios. For example, in the ABC Plan, it is expected for 2020 expansion of area used with Crop Livestock Integration Systems forest (iLPF) in four million hectares.

These systems make it possible, among other factors, the carbon and nitrogen fixation and thus reduced emissions of GHG 's; at the same time. Similarly, adaptive strategy is configured to provide the productivity and resilience of agricultural systems, making producers less vulnerable to climate change. In addition to the improvements of the technical issues and especially the application of technology to enhance food productivity, it is necessary to stimulate reflection on the contribution of family agriculture to guarantee food security on a global scale. As well as investigating what are the challenges in Brazil food security and nutritional sovereignty. To this end, it is necessary to enforce for the insertion of the topic on the political agenda of family farmers organizations in Brazil, through the analysis of the results of policies and programmes that aim to bring producers and consumers in the country. Moreover, investigating the tension between family farming and market price variations may contribute to reduce farmer vulnerability.

The explanation of these empirical evidences can lead to understanding of the close link between agriculture, food security and nutritional sovereignty. Hence, it is planned to examine how mitigation measures in the agricultural sector can contribute in terms of reducing vulnerability to climate change of Brazilian agriculture. In addition, to all the issues of food security and sustainable agricultural intensification, the policy analysis whose focus is the reduction of GHG is important insofar as it may affect other countries, positively or negatively, by means of international trade .

Goals:

• Build a multiregional dynamic model focusing on planned actions by Brazil for the AFOLU sector and the complex feedback effects arising there from. The idea is to perform an integrated analysis, combining biophysical and economic variables and associating climate scenarios and their socio-economic drivers.
• Investigate potential conflicts between social, economic and environmental aspects in the framework of food security;
• Evaluate climate-induced variations in the price of food products produced by family farmers.
• Investigate how adaptation measures in the agricultural sector could ensure effectively food security.

-Activity 3 Climate, livestock and food security implications

Research on food and nutritional security in Brazil is mainly made in the quality of food and the nutritional status of the population, and a little about the political, economic and social aspect. As a multidisciplinary area, investments are needed in the approach of integration.

Animal protein plays an important role in addressing macro and micronutrients deficiencies in diets in many regions of the world. The target for 2050 is 435 M tonnes of meat and 843M tons for

dairy products. The modern livestock production techniques have improved greatly the ability to provide protein for humans. However, livestock is one of the contributors to climate change and also has impacts on biodiversity and depletion of fresh water. In the particular case of small ruminants, they were resilient at high ambient temperatures for a long time. But, there is no consensus on the most effective way to address climate change in the welfare of small ruminants, whether the intensive system with high performance animals or if production of the traditional system with local breeds.

A preliminary analysis about the goat herds and precipitation in Brazil showed that there is no direct correlation, for instance, an association between extreme events and lower number of ruminants. However, physical geography and socio-economic factors could explain the oscillation of the number of goat in the northeastern region of Brazil between 1960 and 1980. Moreover, it is still unclear if there is relationship between the actual number of animals and events of severe hunger.

Goals

• Assess the relationship between climatic variables and the animal data available in a long period.
• Measure the direct and indirect impact of climate change on the cattle over time.
• Assess the impact on the cattle due to changes in the availability of pasture and implications to family farmers and global food market

The activities proposed under this component maintains synergy with cross-cutting themes of economy, and also the modelling component and generating future climate scenarios, throughout the various regions of South America, and more precisely in Brazil. This includes also consider the analysis of the uncertainty of future climate projections generated by global and regional models of INPE, analysis that will be developed by crosscutting theme of modelling.

5.1.2 Results from Year 1 of the project

-Number of fellowships (bolsas): 1 Fellowships CNPq DTI-B
-One article for Scientific American do Brazil in February-March 2018 about climate change and food security
-One workshop presentation on pricing carbon and neutral carbon meat, Campo Grande, 2018
-Updated list of participants of this component:

- Eduardo Delgado Assad (Embrapa)
- José Ruy Porto de Carvalho (Embrapa)
- Stoécio Maia (Ital Alagoas)
- Jurandir Zullo Junior (Cepagri Unicamp)
- Renata Ribeiro (Cepagri Unicamp)
- Laerte Guimarães (UFGO)
- Renata Ribeiro Unicamp
- José Ruy P. Carvalho Embrapa
- João Paulo Silva Doutorando Unicamp
- Marilia Zanetti Bolsista Cnpq
- Vanessa Pugliero Bolsista Cnpq.

To assess food security vulnerability due to climate change in agricultural activities and grassland (new production systems and intensified production), there was made an identification of main production systems in Amazonia, Cerrado and Atlantic forest and an evaluation of impacts due of the adoption of such systems.

The paper by Pugliero et al (2018) aims to obtain the environmental diagnosis in 187 municipalities fully inserted in Caatinga and São Francisco River basin using geoprocessing tools. It was mapped 24.333.158 hectares, nearly 40% of the area of the municipalities in the basin. For this it was analyzed primary and secondary spatial data. The primary data was made using Geographic Information System (GIS) and Remote Sensing resulting in land use and hydrographic mapping. From these two mapping it was possible to extract the permanent protection areas, following the forest code standards. Crossing the land use mapping with the permanent protection areas (1.281.512 ha) it was obtained 36% the environmental debt along the river. The environmental diagnosis is the first step to plain the water, energy and food security. The crossing of spatial data using GIS provided important conclusions about the transformation of land and how it could affect the sustainability in brazilian semiarid, furthermore, the municipal scale level used in this article facilitates the adoption of public policies (Figure 5).

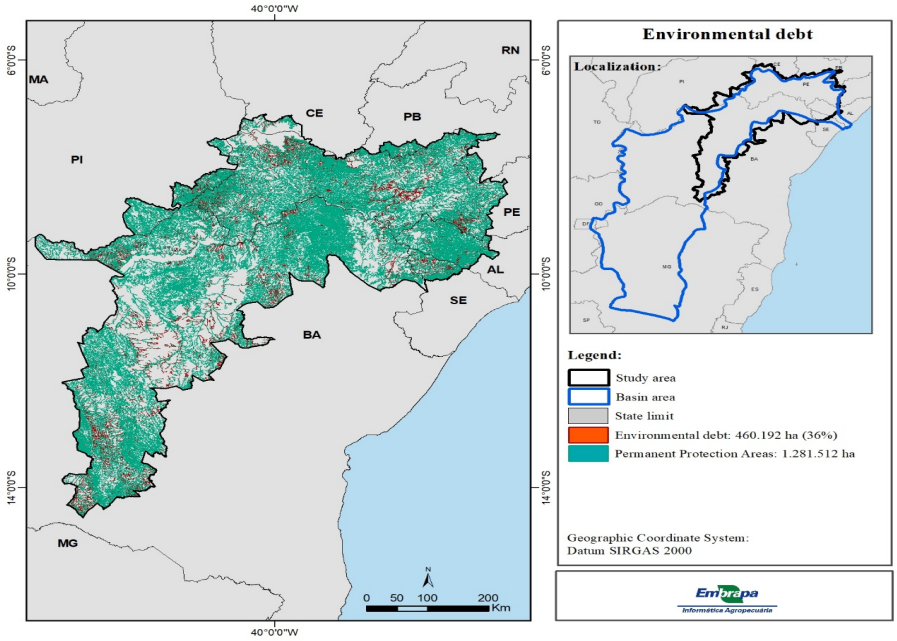


Figure 5: Environmental debt in some municipalities of Caatinga inside Basin of São Francisco (Pugliero, et al 2018)_

Also, in the first year of project, were made the land use and the hydrographic mapping of Cerrado and Mata Atlântica biome. Crossing the land use mapping with the permanent protection areas it was obtained the environmental debt along the river in Cerrado (Figure 6) and Mata Atlântica biome (Figure 7).

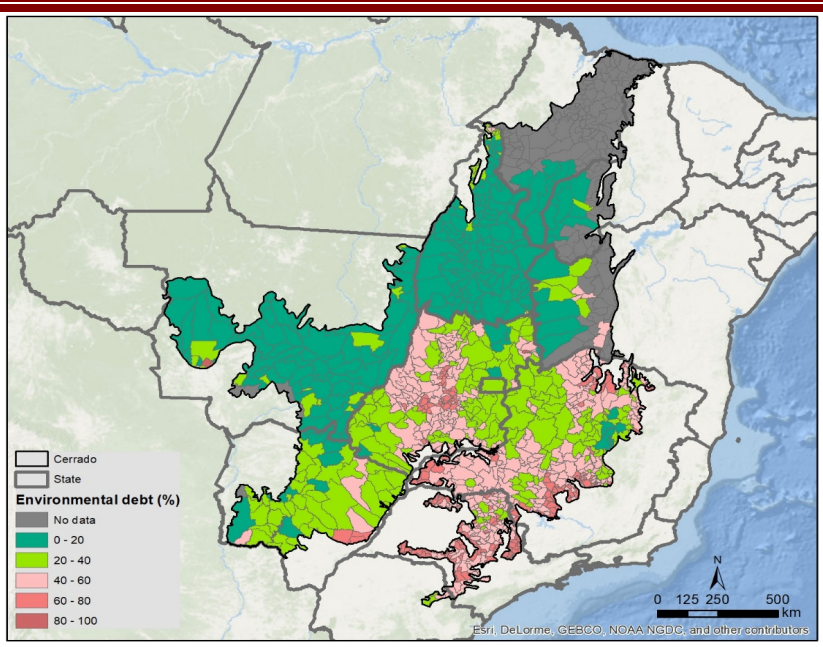


Figure 6: Environmental debt (%) in municipalities of Cerrado biome extracted in the first year of project.

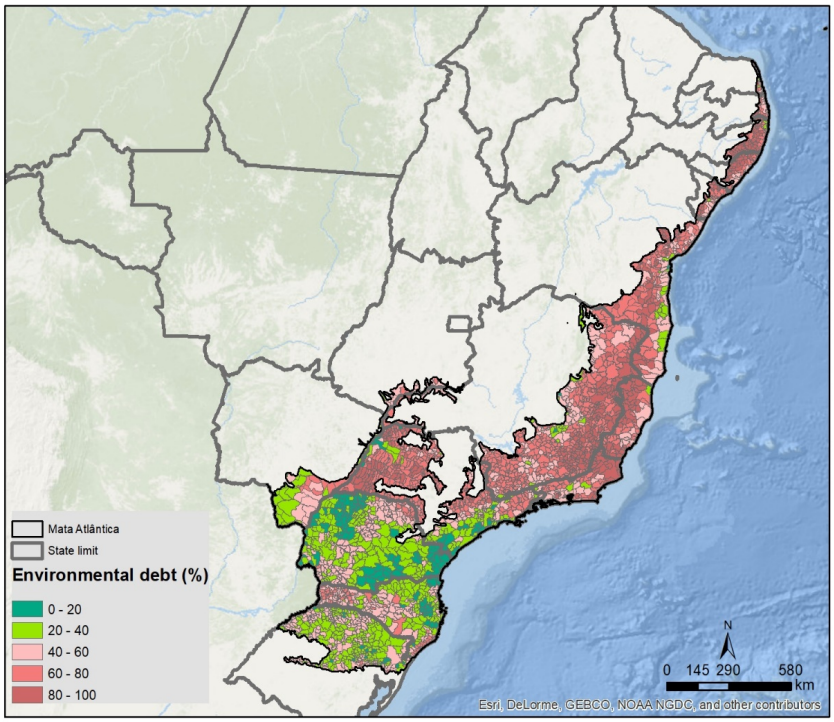


Figure 7: Environmental debt (%) in municipalities of Mata Atlântica biome extracted in the first year of project.

5.2 Water security

Water security is an interdisciplinary and multi-dimensional concept, which assesses levels of hydrological risks considered tolerable for a society under change. Water security reaches a variety of multipurpose water resources, both consumptive and non-consumptive uses that affect sustainability in general. Thus, the scenarios of climate variability under non-stationarity incorporate new challenges for evaluating indicators of water security. On the one hand, studies show that the dynamics of hydrological extremes under non-stationary conditions compromise the resilience of systems, with failures to attend specific demands. In Brazil, for example, the drought in 2013/2014 in Southeastern part produced economic losses between R$ 12-21 billion in the

hydroelectric sector, and from R$ 2.6 to 4.1 billion by the loss of ecosystem services. For water-supply purposes, lower seasonal minimum inflows in 2013/2014 had return periods above 86 years.

Some studies of water security challenges incorporate new changes in hydrological forecasts (,with assimilation of the classical steps of hydrologic modeling, calibration, validation and exploration of scenarios. In Brazil there is a good experience for hydrologic modelling applications and their couplings in all biomes: in the Northeast, in Amazonia; in the Paraná basin and Southeast Brazil.

On the other hand, new studies show that there is still no unified strategy on how to evaluate the water security of various uses and sectors, especially in basins under transposition of flows. Increasing demands promote new challenges to water security to correct the classical methods accepted in decision making for non-stationary conditions. Some methods of risk transfer are available for: agricultural harvest losses, management of urban flooding, supply failures and droughts, environmental flows, among others. These approaches have the advantage of coupling with climate and hydrological models at meso-and macro-scales.

However, it becomes evident the need to improve scientific knowledge about indicators of water security, to help with risk management. Hydroelectricity, agriculture, livestock and food production, human and industrial supply, etc. are sectors with specific characteristics of allocation of water resources. This includes methods for quantification of resiliency to decrease the vulnerability of these sectors to changes. Also, these methods should have strong fundamentals of adaptation strategies for sustainable water resources.

Thus it is necessary to overcome the challenge of how to include securitization and risk transfer methods of the most vulnerable sector users to hydrological extremes. In particular, great works of water infrastructure as transpositions of flows in various regions of Brazil do challenge the scientific community to give practical answers to society about how to evaluate the securitization. Therefore, the knowledge generated from these research surveys has become an effective tool for the management of public policies; supply chains and business plan for private companies.

Given these challenges, it is necessary a joint effort of several groups of Brazilian and foreign scientists in various fields of knowledge, to develop tools that allow to: (i) assess the safety indicators of water sectors under nonstationarity of climate and land use, (ii) clearly present indicators of securitization tools for managers of committees, agencies and consortia of river basins, and thereby adapted to local population, and (iii) support the establishment of strategies at municipal, state and regional levels to format tools of risk transfer as adaptation to social, economic and environmental appeal.

5.2.1 Main Objective

To analyse indicators of water security in major Brazilian basins associated with climate change to propose adaptation strategies that promote resilience and sustainability of user sectors of water resources.

5.2.2 Specific Objectives

1 Identification of strategic river basins in Brazil, to systematize data collection of water supply and water demand with hydro-climate models to evaluate indicators of water security for user sectors.
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 non-stationary conditions using classical indicators and new tools for risk transfer of hydrological extremes.
5 Proposition of strategies for improving water security communication among stakeholders, i.e. the scientific community, policy makers and vulnerable population to hydrological extremes

From the original proposal submitted to FAPESP (Marengo, 2014), no SP researcher abandoned the INCT MC Phase 2 Water Security subcomponent. Conversely, **new researchers** joined the INCT MC Phase 2 Water Security group, as follows:

Marina Batalini de Macedo, PhD Candidate, FAPESP Scholarship,
CV Lattes: http://lattes.cnpq.br/9996626534431250
Dr. Denise Taffarello, postdoc CAPES,
CV Lattes: http://lattes.cnpq.br/4576444154915517
César Ambrogi do Lago, PhD Candidate, CAPES,
CV Lattes: http://lattes.cnpq.br/3154830315789267
Dr Diego Guzmán, Phd Awarded in 2018, CAPES-Colciencias,
CV Lattes: http://lattes.cnpq.br/2603700060525974
Felipe de Souza, M Sc student, CAPES scholarship,
CV Lattes: http://lattes.cnpq.br/6527038185543207
Davi Gasparini Cunha, Professor,
CV Lattes: http://lattes.cnpq.br/8959063554305352
Maria do Carmo Calijuri, professor,
CV Lattes: http://lattes.cnpq.br/5354138488334805
Ana Carolina Sarmento Buarque, M Sc CAPES,
CV: http://lattes.cnpq.br/4518584779169066
Marcus Nóbrega Gómes Júnior, M Sc CAPES,
CV: http://lattes.cnpq.br/9319394097020835
Dr André de Arruda Lyra, INPE/Cachoeira Paulista
CV: http://lattes.cnpq.br/3569715659362971
Dr Sandra Furlán Nogueira, EMBRAPA Jaguariúna/SP
CV: http://lattes.cnpq.br/8230602655816897
Karina Simone Sass, Doutoranda CAPES,
CV: http://lattes.cnpq.br/4717559072743717

5.2.3 Actions and results from Year 1

We promoted synergism among researchers from Sao Paulo and from other Brazilian states participating in the INCTMC2-Water Security subcomponent. To kick-off activities, objectives and goals, this promotion was developed through several strategies with: (1) organization of national meetings, workshops and management activities, (2) support of interdisciplinary, intersectorial and interinstitutional dialogue for sharing knowledge and capacity building inside and outside the subcomponent (with other INCTMC2 groups and CEPIDs), (3) the submission and publication of co-authoring manuscripts in peer-review national and international journals with editorial boards, (4) the selection and retention of early-career scientists, explained as follows, following an internal timeplan (see Figure 8).

Cronograma Quinquenal (2018-2022) - Modelo Geral
INCT - Mudanças Climáticas - Fase II - Componente: Segurança Hídrica. Coordenadores: EESC-USP e UFPE

Participantes: CEMADEN/MCTIC, INPE/MCTIC, EMBRAPA/Jaguariúna(SP), FUNCEME/CE, IAG/USP, UFPE, UFCG, IPH/UFRGS, UFC, EESC/USP

10.2.2 Objetivo

Analisar indicadores de segurança hídrica em principais bacias brasileiras associados às mudanças climáticas para propor estratégias de adaptação que promovam a resiliência e sustentabilidade de setores usuários de recursos hídricos.

	Ano 2018	Ano 2019	Ano 2020	Ano 2021	Ano 2022
	10.2.4 Aspectos metodológicos (pág. 34 a 36)				
10.2.3 Objetivos Específicos (pag. 34)	IV-1 Coleta e sistematização de dados e de modelos hidro-climáticos e novas tecnologias de segurança hídrica.	IV-2 Calibração e validação hidrológica em bacias hidrográficas estratégicas	IV-3 Simulação de séries futuras com incertezas a partir dos modelos climáticos visando prospectar riscos e resiliência a extremos hidrológicos.	IV-4 Avaliação de estratégias de adaptação para segurança hídrica, de setores usuários em condições não-estacionárias.	IV-5 Estratégias para melhoria da comunicação de segurança hídrica entre cientificos, gestores e população.
1. Identificação de bacias hidrográficas estratégicas no Brasil, para sistematizar a coleta de dados de oferta e demanda hídrica com modelos hidro-climáticos visando avaliar indicadores de segurança hídrica para setores usuários.	**I Workshop de Segurança Hídrica (SP, 26-27 Abril, 2018): "Compartilhamento de dados" Resultados =[1., 2., 3., 5., 6., 7., 8., 9]**	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual
2. Calibração e validação hidrológica espacialmente distribuída de processos precipitaçãoevapotranspiração-escoamento, sob condições de quase-estacionariedade, em diferentes: escalas espaciais, usos do solo, demandas e biomas.	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	**II Workshop (Recife, Abril, 2019): "Compartilhamento de experiências em modelagem" Resultados =[1., 2., 3., 5., 6., 7., 8., 9]**	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual
3. Simulação de modelos calibrados, com acoplamento de modelos climáticos de médio- e longo-prazos, para prospecção de indicadores de vulnerabilidade e riscos aos extremos hidrológicos sob cenários futuros sob condições não-estacionárias	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	**III Workshop (RS, 2020): "Segurança Hídrica sob Mudanças Climáticas" Resultados =[1., 2., 4., 5., 6., 7., 8., 9]**	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual
4. Avaliação de novas estratégias de adaptação para segurança hídrica de usos múltiplos sob condições não-estacionárias com o uso de indicadores clássicos e de novas ferramentas de transferência de riscos de extremos hidrológicos. para melhoria da comunicação de segurança hídrica entre comunidade científica, gestores públicos e população vulnerável a extremos hidrológicos	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	**IV Workshop (RS, 2021): "Novos indicadores para Segurança Hídrica" Resultados =[1., 2., 4., 5., 6., 7., 8., 9]**	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual
5. Proposição de estratégias para melhoria da comunicação de segurança hídrica entre comunidade científica, gestores públicos e população vulnerável a extremos hidrológicos	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	Cada grupo preenche anualmente os objetivos, métodos e resultados esperados em workshop anual	**V Workshop (SP, 2022): "Comunicação e Divulgação de Segurança Hídrica" Resultados =[1., 2., 4., 5., 6., 7., 8., 9]**
	Ano 2018	Ano 2019	Ano 2020	Ano 2021	Ano 2022

10.2.5 Resultados Esperados (pág. 36)					
[1.] Fortalecimento de bases de informações sob clima presente e futuro em bacias estratégicas	**Ano 2018**	**Ano 2019**	**Ano 2020**	**Ano 2021**	**Ano 2022**
[2.] Consolidação de rede cooperativa de pesquisa-extensão de instituições de excelência no Brasil	**Ano 2018**	**Ano 2019**	**Ano 2020**	**Ano 2021**	**Ano 2022**
[3.] Estabelecimento de uma estratégia de adaptação "clima-água-resiliência" para desenvolvimento sustentável	**Ano 2018**	**Ano 2019**			
[4.] Subsídios para políticas públicas com estratégias de adaptação às mudanças futuras visando a mitigação da vulnerabilidade hídrica.			**Ano 2020**	**Ano 2021**	**Ano 2022**
[5.] Novas disciplinas de segurança hídrica em programas de pós-graduação, incluindo seminários e cursos de capacitação para setores público-privado.	**SHS5934 - Applied Solutions of Water Security https://uspdigital.usp.br/janus/componente/catalogoDisciplinasInicial.jsf?action=3&sgldis=SHS5934**				
[6.] Formação de pesquisadores brasileiros em segurança hídrica com ampliação da participação em projetos nacionais e internacionais, e parcerias público-privadas (PPPs).	**2 mestres, 2 doutores**	**Ano 2019**	**Ano 2020**	**Ano 2021**	**Ano 2022**
[7.] Publicação dos resultados das pesquisas em meios de comunicação acessíveis às partes interessadas, assim como em revistas internacionais de alto impacto disciplinar e interdisciplinar.	**Ano 2018**	**Ano 2019**	**Ano 2020**	**Ano 2021**	**Ano 2022**
[8.] Ampliação da participação de pesquisadores brasileiros em fóruns internacionais de inovação e soluções sobre segurança hídrica.	**Ano 2018**	**Ano 2019**	**Ano 2020**	**Ano 2021**	**Ano 2022**
[9.] Formação de redes de expertos para subsidiar o Plano Nacional de Recursos Hídricos (ANA), em conformidade com legislação vigente (leis 9.433/97, 11.445/07, 12.187/09, e 12.608/12)	**Ano 2018**	**Ano 2019**	**Ano 2020**	**Ano 2021**	**Ano 2022**

lei 9.433/97: Política Nacional de Recursos Hídricos-PNRH,
lei 11.445/07: Política Nacional de Saneamento Básico-PNSB,
Lei 12.187: Política Nacional de Mudança do Clima-PNMC, e
Lei 12.608: Política Nacional de Proteção e Defesa Civil - PNPDEC)

Figure 8. Summary of INCTMC2 Water Security scheduled activities for 2017-2023 (see number of pages of the original proposal, Marengo, 2014, FAPESP Thematic Project)

With the support of National Institute of Science and Technology of Climate Change-Phase 2 (INCT MC phase 2), through funding from CAPES, CNPq and FAPESP, and self-granted participation of the Brazilian Water Authority (Agência Nacional de Águas-ANA, Brazilian Ministry of Environment), as a policemaking partner, the group orgznized the "I Workshop revisit INCT-MC Phase 2's objectives, goals and schedule of activities related to FAPESP Thematic Project No. 2014/50848-9". This workshop promoted a synergistic, open dialogue on water security experiences, challenges and opportunities with Brazilian institutions from CEMADEN, INPE, UFPE, EESC/USP, FEA/USP, IAG/USP, EMBRAPA, UFCG and FUNCEME, all participants from two INCT-MC Phase 2's subcomponents: "Water Security" and "Economy and Impacts in Key Sectors Furthermore, the I Workshop motivated strategies of sectorial and interdisciplinary adaptation regarding the water security nexus under impacts of scenarios of climate change in Brazil, thereby addressing emerging bottlenecks and challenges in related fields of this INCT-MC Phase 2 and of other running INCTs. Thus, the participants have agreed as a main goal of this I Workshop to ensure and facilitate gathering and sharing information for the scientific, technological and social progresses around water security.

As an outlook from the Workshop, some conclusions and further recommendations for the 2nd year of INCT-MC Phase 2 subcomponent: (1) agreement with objectives listed in the original project and expected results, (2) because of financing cuts in the original proposal, total agreement with the substitution of the specific goal of "Virtual Interactive Library" (page 72), formerly expected as an unique tool, for a novel "dialogue-driven repository" of exchange information among researchers, through the running "SocioHydrological Observatory for Water Security", to be updated with the dialogues during future meetings and workshops; this observatory will be chaired by the EESC/USP, and through the CNPq Group "Water Security", created in 2014 and active in CNPq Group Directory; (3) confirmation of the specific goal "kick-off of water experts as

think tank to aid the National Plan of Water Resources", (4) promotion and participation of subcomponents members in new science proposals and calls for research funding agencies to tradeoff the non-granted activities previously requested in the INCT-MC Phase 2 original proposal, (5) stronger engagement and promotion of special activities to attract early-careers scientists at all levels (undergraduate, master, doctorate and postdocs) in future INCT-MC Phase 2 meetings, also open to other subcomponents looking forward to boosting interdisciplinary progress in this and others INCT-MC Phase 2's subcomponents, (6) motivation of new co-authored publications, attracting massive INCT-MC Phase 2 affiliated institutions, to be submitted to high-impact international journals, (7) progressive activation of INCT-MC Phase 2 granted scholarships, according to internal schedules of supervisors of each INCT-MC Phase 2's institution, and (8) start invitation to more INCT-MC Phase 2's water security researchers to participate in running courses on water security (i.e. with webinars, talks, MOOCs etc).

An study by Tafarello et al (2017) assessed ecosystem-based Adaptation (EbA) as using services on which human well-being depends to help people adapt to the impacts of climate change. Aiming at strengthening ecosystem resilience and reducing ecosystem and people's vulnerability, EbA has been encouraged worldwide as an option for climate change. Payments for Ecosystem Services (PES) are incentives offered to farmers and landowners to provide an ecological service and are currently proposed as a method for EbA and water resources sustainability on a global scale. However, organized information on PES in Brazil is limited. In this study we provide a concise review of PES initiatives in the Brazilian Atlantic Forest, where various PES projects on watershed protection (Water-PES) have been set up. We found 16 ongoing Water-PES in the Brazilian Atlantic Forest. The first initiative was launched in 2005 and since then these projects have grown rapidly. In spite of the advances made in many of these initiatives, they seldom have baseline hydrologic data and an implemented strategy for ecohydrological monitoring. Thus, we discuss how PES projects could be more effective by implementing hydrological monitoring based on ecohydrological concepts. Special attention has been given to explaining how the recent Impact-Vulnerability-Adaptation idea could be integrated into Water-PES. These projects contribute as EbA options for climate change, thereby carrying practical implications for environmental policy makers.

5.3 Energy security

Greenhouse gas (GHG) emissions increase in the recent decades has been dominated by the emerging economies, explained mainly by the growth in their economic activity. In the case of Brazil, emissions up to 2010 have been dominated by land-use CO_2 and non-CO_2 gases, pinpointing the key role played by deforestation and agriculture in the country and placing it in fourth-place when it comes to ranking national contributions to observed global warming. When accounting only for CO_2 emissions from fossil-fuel burning, cement production and gas flaring, however, Brazil is ranked as fifteenth.

In fact, according to a revision of the Second National GHG Emissions Inventory, land use, land use change and forestry (LULUCF) was the major source of GHG emissions in the country in 2010. Over 55% of total emissions came from LULUCF in that year, where land use accounted for 35% and land use change and deforestation accounted for 22%. The energy sector has increased its share in total emissions, becoming the second largest emitter in 2010, with 32% of the total.

However, because the rate of deforestation in the Brazilian Amazon (where most of the land-use change and deforestation take place) has decreased substantially in the recent years (some 77% between 2004 and 2011), assuming a direct conversion of that lost biomass into carbon suggests a drop in annual CO_2 emissions from more than 1.1 billion tonnes of CO_2 in that biome alone in 2004 to 298 million tonnes of CO_2 in 2011. This trend continued in recent years (from a 10-year deforestation average of 19,500 km^2 $year^{-1}$ through 2005 to 5,843 km^2 in 2013), meaning that the energy sector may, already or in the very near future, be the main origin of emissions in Brazil.

Brazil is in a favourable position in the global context when it comes to the use of renewable energy sources though. In 2012, nearly 46% of all primary energy produced in the country came from renewable sources. This value is relatively high when compared to the world average of around 13%. Most of the renewable sources used in the country come from sugarcane products (17% of total primary energy produced) and hydropower (14% of total primary energy produced), while wind and solar still play a small role (with less than 5% of the total primary energy produced) in Brazil.

5.3.1 Objectives

However, socioeconomic development of the country will result in higher energy use, not necessarily from renewable sources. In spite of the current high share of renewable in the Brazilian energy mix, the country faces a situation where, on one hand, it needs to increase its energy production to foster socioeconomic development, job creation and poverty alleviation. On the other hand, the country faces the near exhaustion of its environmentally feasible hydropower potential (most of the country's untapped potential are situated in the Amazon region, and therefore face severe local environmental constraints and is expected to increase its use of fossil energy, with the recent oil discoveries in the pre-salt layer and the perspectives for increased coal-fired electricity generation. Thus, it is important to assess the extent to which socioeconomic development in Brazil and the associated increase in energy use are compatible with the goals of a less-carbon-intensive and more-environmentally-sustainable economy.

5.3.2 Actions and results from Year 1

-Climatic variability and its importance in planning the expansion of the solar and wind energy in Brazil

This study began with a review on the growth projections of the solar and wind energy sources in the Brazilian electricity matrix. Recent data concerning the availability and cost of energy resources have been collected from the electricity sector. In this phase, the researchers started the development of the prediction model for the wind park expansion based on an adaptation of the LuccME modeling environment and the land use and land cover model. The importance of this study lies in the fact that despite the prospect growth of solar and wind energy share reaching 26% of the Brazilian electricity matrix in the next decade, more studies are needed to ascertain the need and alternatives to load balancing at peak times once that the increase in thermoelectric power generation can bring losses to the emissions targets and impact on the cost of energy for society.

The preliminary studies confirm that the discussion on the future scenarios for the energy sector permeates the economic, political, social and environmental spheres of society, dealing with an essentially interdisciplinary issue. Specifically considering the expansion of solar and wind generation, so far everything indicates that the availability of resources and the cost of generation are not restrictions for its growth in Brazil. Technological uncertainties regarding the limitations for the insertion of non-dispatchable energies in the electric system still remain, although evidence indicates that such constraints are much higher than the goal assumed in the current planning.

Further investigation over wind and solar variability at inter-annual time scales are ongoing. Long-term time series of gridded data from surface wind and solar radiation are being produced from a combination of atmospheric reanalysis datasets corrected by observations. The purpose is to evaluate spatio-temporal variability identifying complementary patterns over solar and wind resource that would lead to a more resilient and safe electricity matrix in Brazil.

-*Solar energy resource assessment*

With the increase and diversification of power generation plants from the solar source, the demand for surface radiation data with better temporal resolution has been increasing. Typically, the solar resource mapping is done in climatological time scale, (decades) where the average value of the statistical distribution of this resource is the most relevant variable. However, as the resource variance becomes important, it is necessary to improve this approach so that the results are representative on an intraday scale.

In this first phase of the project, we are focusing on the evaluation of the national potential for solar concentrated power generation that, due to thermal inertia, suffers the great impact of the cloud cover variability in the performance of the plant and in the design of the thermal storage. The expected product at the end of the project is the development of the numerical models to provide solar power forecasting for horizons from a few minutes to a few days.
With regard to the development of forecast capacity of the solar resource several approaches are being evaluated.

a. Numerical models: the focus in this initial phase of the project was to evaluate the results provided by two kind of numerical models the radiative transfer model BRASIL-SR and numerical weather prediction (NWP) models. At this moment, the focus was to evaluate the model skills to simulate the incident solar irradiation, especially the global horizontal and direct normal components. For that, a case study was carried out intercomparing the model outputs for the year 2014, in a portion of the Northeastern region of Brazil, based on the values of the simulations at the SONDA measurement site located in Petrolina - PE.
b. Sky imagery: during this first phase of the project a comparative study of two approaches to obtain cloud coverage information was carried out. The first, used as a reference, uses images from an all-sky imaging camera to estimate the fraction of cloud coverage, while the second uses data from the GOES-13 geostationary satellite. Under cloudy or clean conditions, the two methodologies proved to have a good agreement. The discrepancy between both methods occurs in partially cloudy sky conditions and it needs more investigation.
c. Time series: methodologies for generating medium- and long-term time series of solar radiation are being developed and how such methods can influence the various solar generation technologies. In this context, we developed an efficient method to obtain semi-synthetic hourly time series of solar irradiation from the data generated by the BRASIL-SR radiative transfer model. In this way, we can now use these time series to study the variability of solar production, which would not be possible before.

-*Wind energy resource assessment*

Although the main focus of the research was on solar energy production along the first year of the project, some important results were also obtained in wind energy resource.
Sensitivity tests were performed for the mesoscale model of WRF (Weather Research and Forecasting) configured with different physical parameterizations using wind speed data measured in automatic meteorological stations in Northeast Brazil (NEB). The model WRF was configured for a domain with the horizontal resolution equals to 5 km x 5 km over the study region. The Cluster Analysis were previously performed with wind data acquired in the period of 2008 to 2013 to establish the several domains and the model setup. The results indicate that, regardless of the parameterizations adopted, the WRF present a strong tendency to overestimate the wind speed for all 13 measurement locations used in the study.

During this first year of the project the following members actively contributed to the above results

Name	Institution
Enio B. Pereira	INPE/SJC
André Rodrigues	INPE/SP
Rodrigo Costa	INPE/SP
Francisco José Lopes de Lima	INPE/SP
Eduardo Weide Luiz	INPE/SP
Érica Ferraz de Campos	INPE/SP
Guilherme Marques Neves	INPE/SP
Fernando Ramos Martins	UNIFESP/SP

Status of equipment being imported by FAPESP for this component.

quantity	description	Status
1	spectroradiometer	purchased - waiting for delivery
2	Workstation – XEON processors	in the process of purchase
1	Storage server 18TB	in the process of purchase

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

The frequency and magnitude of extreme weather and climate events can vary according to climate change for each part of the surface. Studies show that these extremes are increasing all over the globe, including Brazil, both in terms of frequency and intensity. The impacts of these extreme events may extend to different urban aspects, such as housing, transportation, energy and public health, with significant consequences for the economy.

The most common natural disasters caused by extreme events in Brazil are due to flooding, floods, landslides and drought impacts. In urban environments, which concentrate the majority of the Brazilian population, floods and landslides of soil or rock are the events that cause the greatest number of deaths, approximately 80%. On the other hand, the drought is considered the natural disaster that can cause major economic and social losses, with the largest number of people affected, about 70% among all types of natural disasters.

The development of basic research on the occurrence of extreme events in Brazil is of great importance. One must know and understand about the main factors related to meteorological and climatic phenomena, as well as extreme hydrological and geological conditions leading to the occurrence of natural disaster, be it floods, flooding, landslides or impact of droughts. For example, the Brazilian semiarid region suffers from droughts in El Niño years (abnormal warming of waters in the tropical Pacific) and above average rainfall in La Niña years (abnormal cooling of waters in the tropical Pacific). However, recent studies showed that there was a change in the behaviour of El Niño events and La Niña, especially in the last decade. This change in behaviour has led to changes in climatic responses in several regions of the world, but mainly in the semiarid region. Such that the recent drought of 2011-2013 occurred in association with an event of La Niña and not El Niño. Understanding the mechanisms involved in this change led to the production of simple indices can predict rainfall in semiarid with 3 months in advance. Therefore, basic research may improve prediction of extremes, and hence the issue of warnings, but should be implemented by the responsible government agencies. This bridge between science and effective public policies must be strengthened.

The severity of the impacts depends not only on climate phenomenon itself, but also the vulnerability of the affected social systems, which are most vulnerable when they are already exposed to other risk factors, such as occupancy on steep slopes. In places with this characteristics, the effects of climate change on the intensification of extreme events are of more concern, as illustrated by the disaster occurred in January 2011 in the mountainous region of the State of Rio de Janeiro. Only in Nova Friburgo, three thousand landslides were recorded, 429 deaths and 3,220 homeless. Water services, energy, transport, telecommunications and health of towns in the mountainous region were affected. The occupation in areas such as this contributes to the increased vulnerability of the population and, consequently, to the aggravation of the negative impact of natural disasters.

Regarding the phenomenon of drought, the combination of climate change and competition for water resources, can lead to a potentially catastrophic crisis in the semiarid region of northeastern Brazil. These changes may affect the regional subsistence agriculture, water availability and health of the population, forcing populations to migrate, generating waves of "climate refugees" for major cities of the region or to other regions, increasing problems social already present in large cities. When it occurs in vulnerable communities with low responsiveness or adaptation, the impact of drought can be so severe that takes proportions of calamity.

In this context, there is a great demand for studies and strategies that must be implemented so that there is a reduction in the vulnerability of the population. These measures make it possible to maintain and improve the capacity of the local system to respond to the impacts of climate change and include, for example, in establishing integrated urban management for improving local health services, transportation, sanitation, housing, food and education, among others contribute to reduce the sensitivity of such systems and increase the resilience and responsiveness to citizens.

Therefore, the improvement of scientific knowledge on extreme events, risk management of natural disasters and the vulnerability of cities to climate change based prevention may led to improvement of urban management. That said, it is necessary to overcome the challenge of risk communication between the scientific community that develops research on extremes and society, so the knowledge generated in the research can be an effective tool for public management. Policymakers are faced with the need to decide on manage priorities in the present or dealing with future risks in the face of uncertainty, that may represent the impact of great magnitude to the cities and their citizens. Faced with this challenge, it is necessary a joint effort between scientists from different fields of knowledge for the development of tools that allow: (i) to submit to the managers of cities and its population clear and objective information on their climate risks, and (ii) assist in establishing strategies to prevent those risks, mitigate it and answer it with the least possible impact.

-*Objectives*

To analyse the vulnerability of municipalities with regard to natural disasters associated with climate change and extremes, so to propose adaptation strategies to promote development and urban sustainability.

-*Specific Objectives*

1. Identification of strategic areas (pilot municipalities) for the development of the associated interface between extreme events studies - risk management of natural disasters;
2. Assessment of vulnerability of the population of the pilot municipalities to major hazards and extreme events - floods, landslides and impacts of droughts;
3. Assessment of the socioeconomic and environmental impacts of extreme events in pilot municipalities;

4. Establishment of strategies (technologies and adaptation plan) and evaluation of its effectiveness for adaptation and sustainable development of cities studied;
5. Proposition of strategies to promote the improvement of risk communication between the scientific community, policy makers and the population.

5.4.1 Activities developed in Year 1 of the project

Team (CEMADEN) - Ana Paula Martins do Amaral Cunha, Gabriela de Azevedo Couto, Germano Gondim Ribeiro Neto, Karinne Reis Deusdará Leal Luz, Jose A. Marengo, Adriana Cuartas Pineda, Pedro Ivo Mioni Camarinha, Silvia Midori Saito, Sheila Santana de Barros Brito, Vanessa Canavesi, Viviana Aguilar Munoz.

In this section the main advances developed during the first year of activities is presented. The first stage was to define the pilot areas / municipalities to be studied in more detail within the scope of the project.

As an initial activity, a workshop was held with members of the three coordinating institutions of the subcomponent (CEMADEN, UFSC and FIOCRUZ), with the main purpose of defining pilot areas / municipalities to be studied in the various activities planned. The workshop held on April 10, 2017, in São José dos Campos, was attended by the coordinators and other members of the CEMADEN team involved in the subcomponent. In the morning, presentations were made of the research lines of Cemaden, Fiocruz and UFSC. Two roundtables were held in the afternoon to address (i) inter-institutions contributions to the sub-component; (ii) discussions on methodological aspects. As a result of the discussions, it was decided to address the research / studies by sub-themes of disasters, whose main aspects of research / focus areas are detailed below.

5.4.1.1 Identification of strategic regions for the development of studies associated with the interface between extreme events and risk management of natural disasters

Each disaster typology presents distinct characteristics, mainly related to the associated temporal and spatial scales. Therefore, assessments of impacts and vulnerabilities will be made in a differentiated way for each typology, taking into account socioeconomic aspects associated with disasters. It was assumed that the municipalities most vulnerable to a particular type of disaster are those that present great recurrence and magnitude of impacts over time. Environmental and social aspects were then evaluated, taking into account the already consolidated databases, which will be relevant for the implementation of the models and evaluation methods that will be proposed. In this context, the list of municipalities monitored by Cemaden, for which relevant information are available to be included into the analyses, has also been taken into account and has been included in the scope of ongoing research in the institution.

-Definition of the study area related to landslides impacts in the context of climate change

The choice of the pilot area was based on a careful analysis contemplating both the current data of the Brazilian municipalities and future climate projections. The main objective for the first year was to identify the most critical regions of the country considering the impacts caused by severe precipitation events and, consequently, the associated geohydrological processes. In this way, this item present an analysis of Brazilian municipalities using a potential impact index for landslide events (main focus) and another index for flashfloods impacts (complementary analysis). These two indexes are the result of the interaction of climatic, environmental and demographic variables.

The indexes are based on Debortoli et. al (2016) methodology. However, for the present work, some adaptations were implemented in order to improve the results obtained and present them in a

more adequate scale to subsidize the following project stages. With regard to the terminologies used, the vulnerability framework recommended by the IPCC was considered.

Under the IPCC framework, the concept of vulnerability is considered as the potential "net" impact; that is, the interaction between the vectors exposure (climate) and sensitivity results in the potential impacts, so that measures and actions that increase adaptive capacity could reduce such impacts. The final product of this interaction would be the vulnerability that, by definition of the IPCC, would be the tendency of a given element (in this case, a municipality) to be impacted by adverse factors (for example, processes associated with landslides, floods and flash floods, added to the effects of climate change). It is noteworthy that, unlike Debortoli et. al (2016), adaptive capacity is no longer an integral part of the index to be elaborated. Therefore, analyzes in the present project focused on the evaluation of the potential impacts, which will support the determination of areas that will require adaptation actions to reduce their vulnerabilities.

-The Landslide Potential Impacts Index

a) Sensibility Sub-index for Landslide impacts

The index for landslides was based on the study of Debortoli et. al (2016), which considered slope and geomorphological units in the construction of the physical-environmental dimension of vulnerability (equivalent to the sub-index of sensitivity in this study). However, the sensitivity sub-index created for this stage of the project (identification of priority areas), also incorporated urban population data, provided by Embrapa (Farias et al., 2017), using data from the 2010 Census (IBGE, 2010).

b) Exposure Sub-index for Landslides impacts

The exposure sub-index used in this study follows the same equation proposed by Debortoli et. al (2016) to determine the climate dimension of the vulnerability. The methodological difference associated with this sub-index is the average for each urban area of the Brazilian municipalities; instead of Debortoli et al. (2016) that calculated for the entire municipal territory. This sub-index is the only one that varies temporarily (the sensitivity index remain constant in the future); that is, it was calculated for both baseline (1961-1990) and the period 2011-2040, using the RCP scenario 8.5, for each of the two climate models evaluated.

c) Potential Impact Index for Landslides

The structure of the potential impact index for landslides is different from that one applied by Debortoli et. to (2016), since the relation between sensitivity and exposure sub-indexes was modified, aiming to get results more representative. Thus, in this study, sensitivity is considered as a limiting factor of the potential impacts, while the exposure vector is only capable to increase the impact condition, which is characterized by the components of the physical environment (slope and geomorphology), and induced by anthropic actions (explained by the urban population variable).

d) Criteria to define critical municipalities

This analysis is essential to define what will be the study area for the next stages of the project. Two criteria were used to define the most critical municipalities:
-Evaluating the results of each model separately - to be considered critical, the municipality must have potential impact index in the "extremely high" class (greater than 1.00) for the baseline period and also present a significant tendency to increase the impacts in future climate (that is, the increment must be positive);

-Consensual analysis - a municipality must have a potential impact index equals or higher than 0.70 ("high", "very high" or "extremely high" classes) in the reference period (1961-1990) and, for the future period, to present a positive increment, both conditions for the two climatic models.

- Results and Discussions

Due to the difference between two climatic models used (Eta-Miroc and Eta-HadGEM), the results are specific for each model and for each period analyzed (1961-1990 and 2011-2040).
The result for the period 1961-1990 is considered as a reference for the analysis of future potential impact. Figure 9 shows the Potential Impact index for each climate models, for the reference period (1961-1990), as well as the potential impact increments.

In addition, Table 1 presents the Eta-HadGem and Eta-Miroc models results, generated from the consensus analysis to identify the most critical municipalities, while Figure summarizes all the results obtained, highlighting the most critical municipalities. Considering only climate, it is noticed that it the South of Brazil is the region with greater probability and significant tendency for the intensification of the extreme events of precipitation, that potentially triggers landslides. On the other hand, this region is also characterized by to be well prepared to deal with natural hazards, especially the state of Santa Catarina, which can be considered as a reference for disaster risk management actions.

In general terms, the most critical regions are the northeast of Santa Catarina, the coast of Brazilian Northeast (mainly the states of Pernambuco and Alagoas) and the east of São Paulo state. However, considering all results and after a validation step with some Cemaden's database, the cities with highest values of indexes, as well as with considerable historical registers of impacts caused by landslides, were Maceió (AL), Blumenau (SC) and Recife (PE).

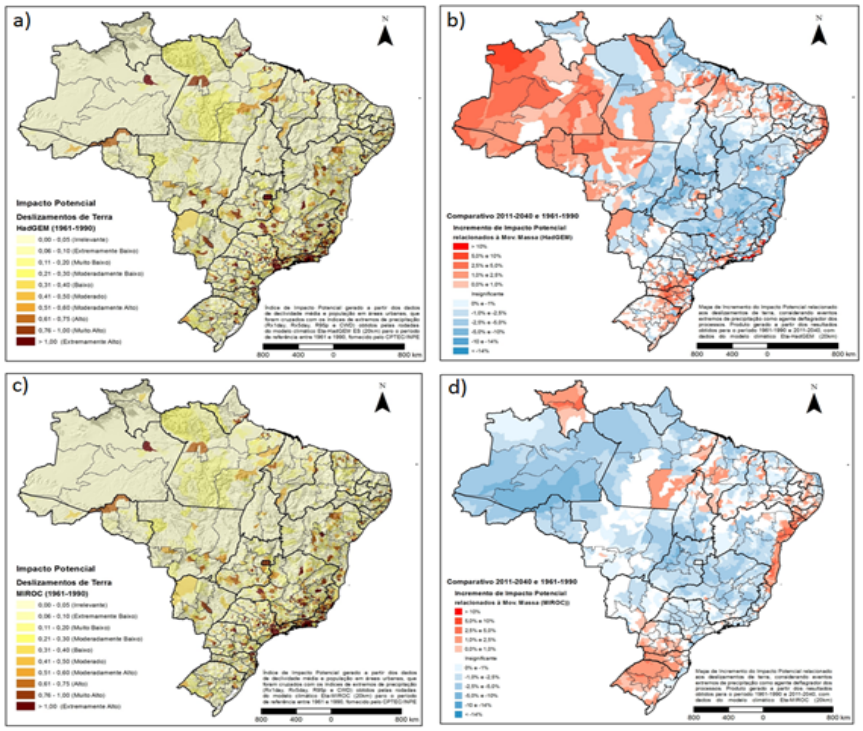


Figure 9 - At left, results for Potential Impact index using precipitation database for (a) Eta-HadGem and (c) Eta-Miroc, for 1961-1990 period. At right, the increment of potential impact index, considering the difference between the results of the future period (2011-2040) and the baseline (1961-1990), for (b) Eta-HadGem e (d) Eta-Miroc.

Table 1 - Critical municipalities indicated by consensual analysis.

UF	Município	IP_HADGEM_hist	IP_MIROC_hist	Increm_HADGEM	Increm_MIROC	Cemaden
AL	Maceió	1,5234	1,6638	0,05504	0,01397	SIM
SC	Blumenau	1,489	1,4404	0,00133	0,00073	SIM
PR	Curitiba	1,4428	1,4065	0,0371	0,00333	SIM
PE	Recife	1,3574	1,4318	0,03094	0,01041	SIM
SP	São José dos Campos	1,1466	1,1898	0,0665	0,00299	SIM
PR	São José dos Pinhais	1,0558	1,0298	0,03349	0,00117	SIM
SC	Xanxerê	0,8476	0,7602	0,00054	0,01921	SIM
PE	Jaboatão dos Guararapes	0,8372	0,8878	0,03863	0,00316	SIM
PR	União da Vitória	0,8326	0,7775	0,05001	0,0127	SIM
SC	Indaial	0,8056	0,7737	0,01564	0,00036	SIM
SC	Timbó	0,8056	0,7695	0,01503	0,00042	SIM
SE	Itabaiana	0,7842	0,8391	0,00282	0,03806	
AL	São Miguel dos Campos	0,775	0,8277	0,00956	0,01055	SIM

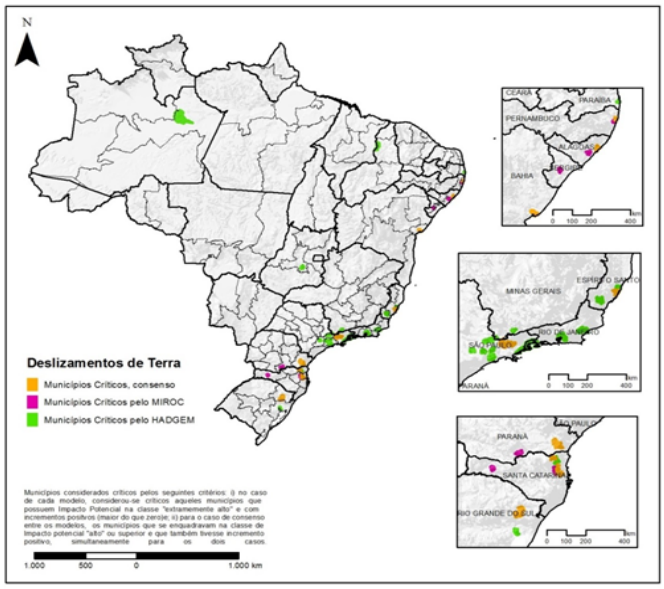


Figure 10 - Critical municipalities for landslides impacts.

-Additional contribution: analysis for the potential impact caused by flashfloods

The same methodological procedures described for landslides analysis were also carried out to evaluate the most critical municipalities for flashfloods impacts. Table 2 shows the most critical municipalities associated with this hazard, considering the consensus analysis (which takes into account the projections of both climate models used).

Table 2 - Critical municipalities for flashfloods potential impact index by the consensual analysis, considering the two climate models.

UF	Município	IP_HADGEM_Hist	INCR HADGEM	IP_MIROC_Hist	INCR_MIROC	Monitorado
SC	Blumenau	1,3731	0,0072	1,2966	0,0106	SIM
RS	Machadinho	1,3097	0,0356	1,1393	0,0051	
RS	Maximiliano de Almeida	1,2899	0,0377	1,1211	0,0040	
PE	Jaboatão dos Guararapes	1,1591	0,0411	1,2774	0,0196	SIM
SC	Rio do Sul	1,1350	0,0260	1,0017	0,0158	SIM
RS	Viadutos	1,1335	0,0307	0,9763	0,0063	
RS	Planalto	1,1076	0,0030	0,9483	0,0240	
RS	Alpestre	1,0362	0,0019	0,8903	0,0210	SIM
SC	Trombudo Central	1,0015	0,0337	0,8811	0,0163	
RS	Lajeado	1,0009	0,0204	0,8565	0,0152	SIM
SC	Imbuia	0,9852	0,0150	0,8798	0,0097	SIM
PE	Palmares	0,9813	0,0272	1,1455	0,0122	SIM
PE	Recife	0,9812	0,0424	1,0850	0,0235	SIM
SC	Jaraguá do Sul	0,9778	0,0061	0,9048	0,0134	SIM
SC	Agronômica	0,9721	0,0302	0,8550	0,0172	
SC	Caxambu do Sul	0,9622	0,0023	0,8315	0,0146	
SC	Indaial	0,9486	0,0253	0,8875	0,0002	SIM
SC	Laurentino	0,9431	0,0302	0,8295	0,0172	SIM
PE	Água Preta	0,9429	0,0289	1,0892	0,0131	SIM
SC	Atalanta	0,9427	0,0258	0,8416	0,0084	
SC	Rio do Oeste	0,9391	0,0350	0,8262	0,0158	
SC	Agrolândia	0,9372	0,0232	0,8404	0,0073	
SC	Alfredo Wagner	0,9350	0,0232	0,8449	0,0124	SIM
SC	Leoberto Leal	0,9349	0,0048	0,8464	0,0130	
AL	Campestre	0,9248	0,0284	1,0566	0,0108	SIM
AL	Jundiá	0,9215	0,0284	1,0527	0,0108	
AL	Jacuípe	0,9195	0,0284	1,0505	0,0108	
SC	Pouso Redondo	0,9190	0,0356	0,8086	0,0157	
SC	Mirim Doce	0,9147	0,0425	0,8062	0,0152	SIM
SC	Vidal Ramos	0,9138	0,0048	0,8273	0,0130	SIM
SC	Rancho Queimado	0,9006	0,0156	0,8345	0,0042	SIM
PE	Olinda	0,8605	0,0421	0,9516	0,0234	SIM
PE	Xexéu	0,8397	0,0279	0,9865	0,0097	SIM
PE	Paulista	0,8071	0,0184	0,8817	0,0176	SIM
AL	Porto Calvo	0,8056	0,0180	0,9091	0,0033	

The results of the consensual analysis indicate that the South of Brazil is the region with the greatest potential flashfloods impacts (Figure 11), especially the state of Santa Catarina. In addition, the eastern portion of Alagoas and Pernambuco states stands out, although the models' ability to represent the climate for this region is not as good as the South and Southeast regions.

It is important to emphasize that many regions indicated as critical for flashfloods impacts are also present in the analysis for landslides, mainly the metropolitan regions of Blumenau (SC) and Recife (PE). Therefore, these two cases are considered the most deserving attention, not only by the projections of the future climate but also by the already observed scenario in present time and theirs historical of related disasters in the past.

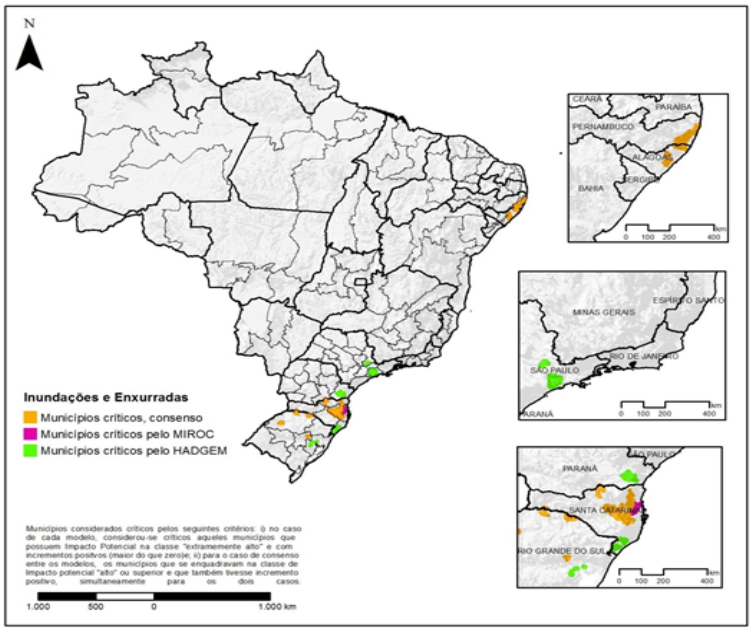


Figure 11 - Critical municipalities for flashfloods impacts.

Based on all results presented before, mainly the consensual analyzes, it was observed that Blumenau and Maceió were those municipalities considered as the most critical, both in the case of landslides and flashflood impacts. However, the uncertainties regarding the effects of climate change in the Southern region of the country, especially in Santa Catarina, are smaller than other regions. In addition, other municipalities close to Blumenau also appear with a critical high level, which further reinforces the importance of evaluating this area as one of the most priority for this issue. Thus, Blumenau was selected as pilot study area for the next stages of the project.

5.4.1.2 Delimitation of the region for the study associated with drought impacts in the semi-arid region of Brazil

Drought is considered the natural disaster that can cause economic and social losses, with the largest number of people affected directly and indirectly among all types of natural disasters (Carolwicz, 1996; IPCC, 2007). The effects of drought can persist for a long period of time, even after the event is over (Batista Júnior, 2012). In Brazil, drought is a phenomenon that occurs mainly in the Northeast Region (NEB), due to the irregular distribution (spatial and temporal) of the rains. The lack of access to water resources and the recurrent droughts have affected agroproductive activities in the semiarid for centuries, with impacts mainly on rainfed systems that depend directly on the contribution of rainfall in the region.

Future climate projections indicate risks of severe drought in the semi-arid, rainfall reductions up to 40%, and increase of consecutive dry days. In addition, more frequent and intense years of El Niño (ENSO) due to climate change may also increase water scarcity and drought risk (Alves and Repelli, 1992, Marengo, 2008).

In this context, the selection of microregions for the study associated with the impacts of droughts initially considered the criteria related with the historical recurrence of these events. Thus, the analysis was made taking into account the recurrence of drought events in the semiarid region of Brazil, between 1981 and 2016, following the methodology described in Brito et al. (2016).

However, in order to contemplate the assessment of the impacts of droughts on water resources, it was necessary to re-evaluate the previously defined area, since the impacts approach should cover

the entire contribution area (basin) of the reservoirs. It should be noted that the hydrological basin is considered the basic territorial unit for the planning and management of water resources (Law 9.433, which establishes the National Water Resources Policy). Thus, the main reservoirs (weir) whose drainage basins are located in the previously defined regions were selected, in accordance with the pilots municipalities selected for the analyses associated to the impacts of droughts.

Figure presents the new delimitation of the study area, based on recurrence of droughts and the hydrological basins of the reservoirs criteria. It is observed a high frequency of drought occurrence (more than 20 events between 1981 and 2016), mainly in the central semiarid region. In this area, 6 reservoirs (weir) for public supply were selected, whose drainage basins coincide with the regions characterized by high frequency of drought events.

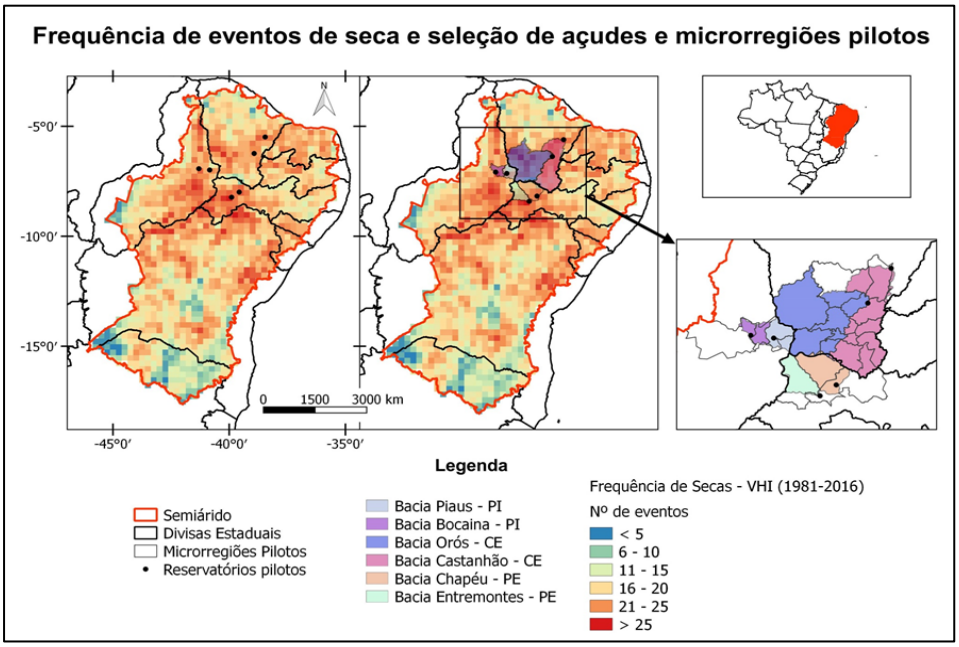
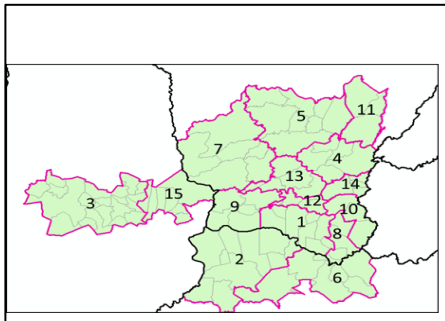


Figure 12 - Delimitation of the study area associated to the impacts of droughts.

The new delimited study area includes a total of 157 municipalities in 15 micro-regions of the Piauí, Ceará and Pernambuco states. Figure 13 shows the socioeconomic characteristics of the selected micro-regions. The estimated total population is 3,244,864 inhabitants (IBGE, 2010), with the Cariri micro-region representing the highest population density (128.4 inhabitants per km²). It is also highlighted that the Human Development Index (HDI) estimated for all micro-regions included in the study area is lower than the national average, which is 0.755 (UNDP, 2018).



N	UF	NM_MICRO	Área (km2)	Pop.	Densidade hab/km2	IDH
1	CE	CARIRI	4.115,528	528.398	128,4	0,687
2	PE	ARARIPINA	11.792	321.789	27,28	0,612
3	PI	PICOS	10.337,58	260	19,0	0,635
4	CE	IGUATU	4.762,797	219.485	46,1	0,647
5	CE	SERTÃO DE SENADOR POMPEU	9.786,680	210.032	21,5	0,610
6	CE	SALGUEIRO	8.767	170.461	0,05	0,658
7	CE	SERTÃO DE INHAMUNS	11.692,76	144.364	12,3	0,615
8	CE	BREJO SANTO	1.891,514	97.071	51,3	0,645
9	CE	CHAPADA DO ARARIPE	4.784,685	95.047	19,9	0,600
10	CE	BARRO	2.707,338	90.188	33,3	0,639
11	PI	MÉDIO JAGUARIBE	4.304,806	64.862	15,1	0,662
12	CE	CARIRIAÇU	1.300,828	63.34	48,7	0,594
13	CE	VÁRZEA ALEGRE	3.549,202	59.475	27,2	0,616
14	CE	LAVRAS DA MANGABEIRA	1.632,012	56.313	34,5	0,627
15	PE	PIO IX	4.332,926	53.059	12,2	0,586

Figure 13 - Characterization of micro-regions inserted in the study area associated to the impacts of droughts.

Figure shows the time series of the standardized precipitation index (SPI) for the study area. Positive SPI values indicate surplus water, related to rainfall above than normal average, while negative values indicate water deficit or precipitation below than normal average. It is verified the recurrence of negative values of SPI (drought condition), mainly between the years of 2005 and 2015, corroborating the criteria of study area definition.

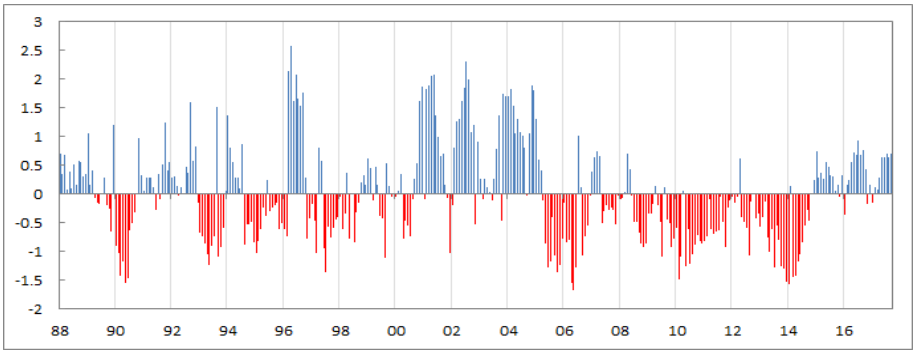


Figure 14- Time series of the SPI-6 in the study area.

Considering only the year 2016, of the 157 municipalities in the study area previously selected, 143 of them had the recognition by the federal government of emergency status, due to the drought. According to data from the Integrated Disaster Information System (S2iD, 2018), in 2016 the number of people affected by the drought in this region was approximately 1 million people. Another factor that contributed for the selection of the pilot municipalities refers to the results of Camarinha et al. (2015), who made a multidimensional analysis of the vulnerability of Brazilian municipalities to natural disasters associated with droughts. The authors evaluated the effects of climate change that may occur until the end of the 21st century, focusing on the period 2011-2040. Thus, in Figure below, reproduced from Camarinha et al. (2015), it can be noted that the eastern portion of Piauí and the northwest of Pernambuco highlight one of the vulnerable hotspots to drought-related disasters. Thus, authors had mentioned that attention needs to be put on these municipalities, especially to invest in risk management and risk reduction actions in order to reach socioeconomic development.

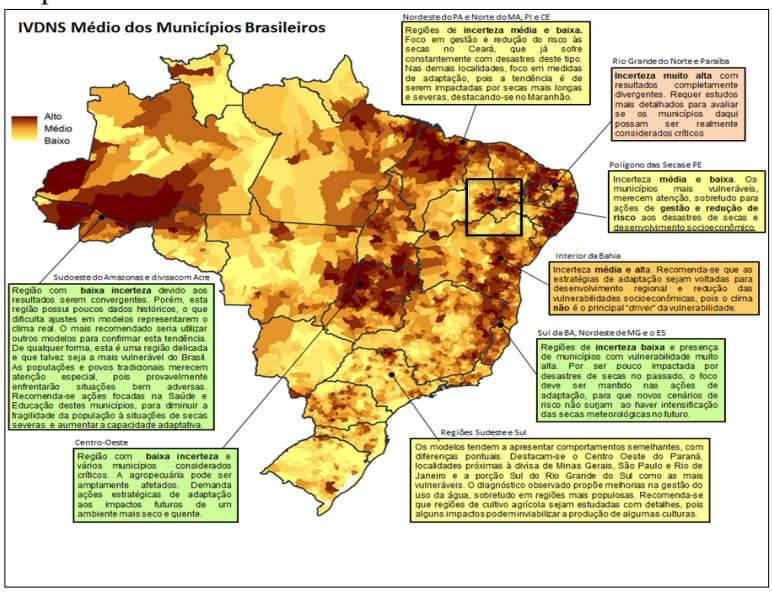


Figure 15 - Values of the average IVDNS (Drought Vulnerability Index) for Brazilian municipalities. The text boxes summarize the recommendations to support strategies focused on vulnerability reduction, taking into account all the variables related with the index and the degree of uncertainty of future climate analyzes.

The black rectangle identifies the pilot area for study of impacts associated with droughts. Source: Camarinha et al. (2015).

According to the analysis of the urban water supply, published by the National Water Agency (ANA, 2017), the selected pilot municipalities in this study showing low water security (

Figure 16), despite the water conduits in works (green highlighted in

Figure 16). Thus, the pilot municipalities of this study demanding long-term planning works and actions, i.e. structuring actions for water security that prioritize the drought coexistence, instead of fighting it (

Figure). In this sense, low or inefficient investments in water infrastructure associated with the high vulnerability due to a negative water balance (characteristic of semi-arid region), possibly enhanced by climate changes, can aggravate the situation and lead to periods of water crisis. Reactive actions may be necessary; however, it must be understood that these are emergency actions, i.e., they are not structuring for an efficient management of the water resource.

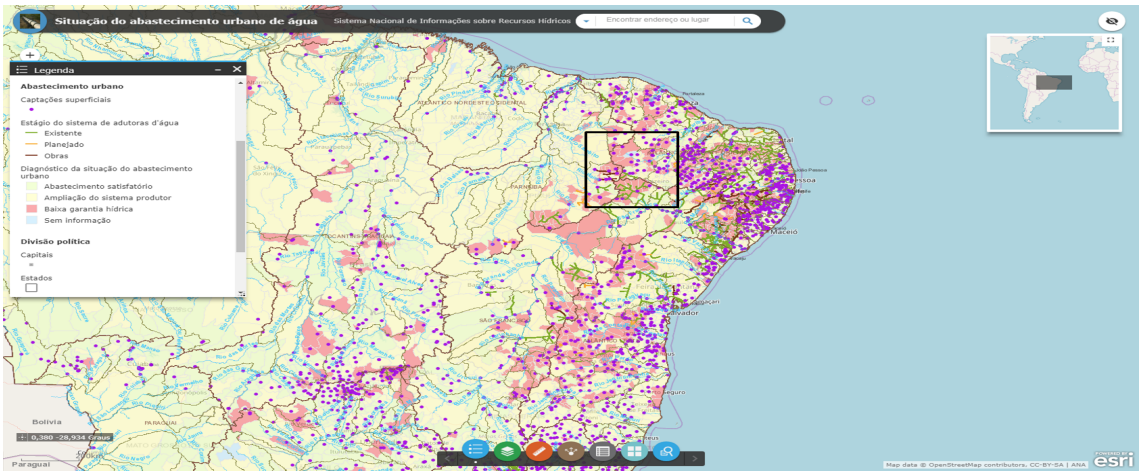


Figure 16 - Situation of urban water supply. The red color highlights the municipalities with low water security. The green lines correspond to the existing water conduits, the red lines to the water conduits in works and the orange lines to the planned ones. The black rectangle identifies the pilot area for study of impacts associated with droughts. Source: ANA, 2017.

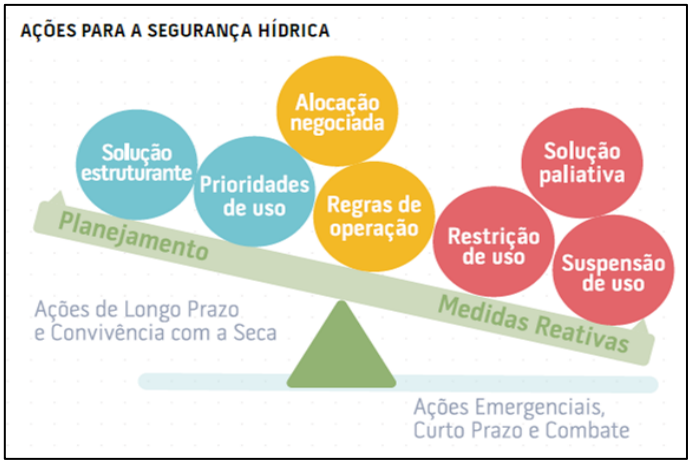


Figure 17 - Structuring actions for water security. Long-term planning actions for drought coexistence should be prioritized in relation to palliative and emergency solutions. Source: ANA, 2017b.

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

Anthropogenic greenhouse gas (GHG) emissions are driving the global carbon cycle into disequilibrium. Climate change consequences for humans and natural ecosystems are indisputable and increasing. Environmental changes are moving faster than species' ranges can adapt to new environmental conditions, causing divergences between environmental conditions and ranges.

Climate change projections indicate that many terrestrial and freshwater species should face increased extinction risk during and beyond the 21st century, especially as climate change interacts with other stressors (habitat modification, over-exploitation, pollution, and invasive species.

Anthropogenic CO_2 emissions in the last 40 years accounted for ≅ 50% of total anthropogenic CO_2 emissions between 1750 and 2010. These emissions have continued to increase over the last 40 years and highest historical levels were observed between 2000 and 2010. In 2010, total anthropogenic greenhouse gas (**GHG**) emissions reached 49 (±4.5) $GtCO_2eq$, of which CO_2 accounted for 76 % (38 ± 3.8 Gt CO_2eq) of greenhouse gas (GHG) emissions, methane (CH_4) for 16 % (7.8 ± 1.6 Gt CO_2 eq), nitrous oxide (N_2O) for 6.2 % (3.1 ± 1.9 Gt CO_2 eq), and fluorinated gases for 2.0 % (1.0 ± 0.2 Gt CO_2 eq).

The Agricultural, Forest, and Other Land Uses (**AFOLU**) sectors accounts for 25% (~ 10–12 Gt CO_2 eq/yr) of net anthropogenic GHG emissions, of which ≅ 5.0–5.8 Gt CO_2 eq/yr is from agriculture, and ≅4.3–5.5 Gt CO_2 eq/yr from forestry and other land uses. The AFOLU sector is strategic for food security and sustainable development. Climate change mitigation is just one of the many services provided by the land, and any mitigation measure (such as biomass energy production or carbon sequestration) might increase competition for resources and increase conflicts.

Deforestation and degradation of tropical forests cause great impact on terrestrial carbon balance (emissions and destruction of potential carbon sinks). On the other hand growth of primary forest under a higher CO_2 atmosphere and regrowth of secondary forests can remove considerable amount of carbon from the atmosphere. Preventing emissions from deforestation and forest degradation is an important effort to mitigate anthropogenic effects over global changes.

Accuracy in national level carbon estimates is essential for countries to develop, monitor, and assess environmental policies in compliance to international commitments and efforts, such as REDD+ initiatives, and GHG emission reports**.** The use of satellite remote sensing associated to airborne and/or field measurements stands as promising a tool for large-scale national and global assessments of carbon stocks. However, degradation of carbon stocks is more difficult to monitor than deforestation and vary widely according to the extent disturbances, such as fire or logging. Present methods cannot deliver the required precision to assess and monitor forest stocks and changes due to degradation and recovery. In fact, there is high uncertainty in global and tropical forest estimates of biomass carbon stock and fluxes.

Uncertainty in historical net AFOLU emissions is larger than for other sectors (≅ 50%). Efforts to quantify GHG emissions form above ground carbon over large areas in the tropics are full of uncertainties. Estimates of aboveground carbon stocks vary by over 100% in African forests and by 60% in Amazon forests. Fluxes form Forest and other land uses (FOLU) are dominated by CO_2. Non-CO_2 GHG from FOLU is smaller, and is mostly due to peat degradation and biomass fires. Soils contain two to three times more carbon than above ground carbon in forests, but most of it is physically and chemically protected and not easily oxidized, except, in tropical regions, for cultivation and soil exposure by plowing.

In addition to carbon dioxide uptake, other short lived climate pollutants (SLCP) such as ozone, methane, black carbon are also critically important, and direct affect ecosystem. They all have a warming effect in the climate, and because of their short lifetime, the reduction in emission of SLCP can have a quick impact on climate. SLCPs are also air pollutants, with various detrimental impacts on human health, agriculture and ecosystems. SLCPs are responsible for a substantial fraction of the climate forcing experienced to date and have a significant control over the rate or warming in the near term. Compelling scientific evidence indicates that fast and widespread action to reduce these pollutants, by implementing identified measures focusing on sources of methane and black carbon, has the potential to significantly slow down the rate of global warming, as well

as globally prevent millions of premature deaths and millions of tonnes of crop losses each year. Implementing these SLCP measures also increases the chances of staying within the 2°C target, achievement of which is contingent upon ambitious global reductions in CO_2.

It is feasible to do a global reduction of roughly 25% and 78% in methane and black carbon emissions respectively over a two-decade period, as proposed in the report by the UN Environment Programme and the World Meteorological Organization (WMO). The question is which strategy in Brazil is the most feasible and with the smallest impact on ecosystems. The calculations for Latin America can be improved with more realistic measures for reductions, specifically for our region and Brazil

Large emissions of black carbon and ozone precursors occurs as a result of land use change following biomass burning emissions in Amazonia and these emissions have strong climatic impacts not only regionally in Amazonia, but also in a continental scale and globally. The radiative forcing of these emission reductions will be calculated and optimized in terms of ecosystem impacts. Urban emissions of black carbon, methane and ozone precursors are significant in most of the large urban areas in Brazil, and we plan to investigate the ecosystem effects of these emissions, especially for the Amazonian forest, with the urban emissions of Manaus. Changes in hydrological cycle due to black carbon emissions from biomass burning and urban emissions will be investigated in Amazonia.

-*Objectives*

Monitoring the increase and decrease of carbon stocks derived from degradation or ecosystem dynamics is critical to measure, report and verify emissions reductions of carbon in forests. The project aims to bring together international researchers to present different perspectives and tools and promote advances in approaches to monitor ecosystem dynamics (growth, restoration and degradation) and its impact on climate and ecosystem functioning. The aim is to provide scientific support for the inclusion of removals (growth and restoration) and emissions (degradation) of ecosystem dynamics in the development of different national carbon accounting for the sectors of forestry and other land uses (Folu), the to support the development and implementation of public policies and policies to comply with international agreements to reduce carbon emissions.

We also plan to study strategies to reduce short-lived climate pollutants such as ozone, black carbon and methane and study the ecosystem effects of these components in the Amazonian environment. The aim is to analyse the different strategies of reducing SLCP and the different impacts on the Amazonian ecosystem, critical for net ecosystem carbon fluxes measurements.

The radiative forcing of aerosol particles including black carbon will be calculated for the Amazon region, aiming to develop strategies to minimize the ecosystem effects. The effects of aerosols on the hydrological cycle will be measured using several techniques such as remote sensing, aircraft observations and modelling.

Changes in atmospheric radiative forcing due to changes in surface albedo cause by land use change will be quantified for Amazonia. The associated changes in the clouds, precipitation and in the general hydrological cycle will also be quantified.

5.5.1 Activities of Year 1 of the project

One of the components of the INCT MC Phase 2 is the so called “Ecosystems” that deals with atmospheric processes happening in Amazonia in terms of anthropogenic and natural changes in the ecosystem functioning. In particular we are using the ATTO (Amazon Tall Tower Observatory) 325 m tower to study the atmosphere-biosphere exchange of trace gases and aerosols. This is used as a platform to unveil new processes focused on aerosols and clouds.

We are far from understanding the aerosol-cloud interactions, as well as the mechanisms of aerosol production in Amazonia. The recent finding of aerosol production at high altitudes (12-14 Km) (Andreae et al., 2017) from natural biogenic emissions is a good example on how the Amazonian atmosphere can be unique. Several key studies are already being performed at ATTO, such as optical properties, aerosol dynamics with extensive size distribution, inorganic and organic aerosol composition, biogenic aerosol, etc. With the operation of the tower, it is important that we understand how turbulence and convection affects the vertical distribution of particles of all sizes.

As part of this INCT, new studies such as detailed aerosol-cloud interaction were initiated, taking into account remote sensing measurements from space and ground. Complex problems are having a close look, such as the relationship clouds-precipitation, aerosol-radiation-carbon balance, turbulence-convection and clouds, etc. Microbiological studies in atmospheric aerosols are already being done at ATTO, and are being enhanced. Many of the microorganisms are Ice Nuclei active, as well as can act as Giant CCN, influencing directly the hydrological cycle. Studies that links the biological functioning of the forest with aerosol and aerosol precursors emissions are also important, to study the climate regulation and feedback mechanisms that could be present in Amazonia.

The proposed comprehensive set of ground-based remote sensing instruments will complement nicely the long established in-situ aerosol measurements. We are working on developing a methodology to combine aerosol remote sensing measurements with those from the vertical pointing cloud radar to study the optical and microphysical properties of mid-level mixed-phase and cirrus clouds, their lifecycle and their susceptibility to aerosol particles, linking the aerosol and cloud life cycles. Figures 18 and 19 illustrate the setup we are building up at the ATTO tower.

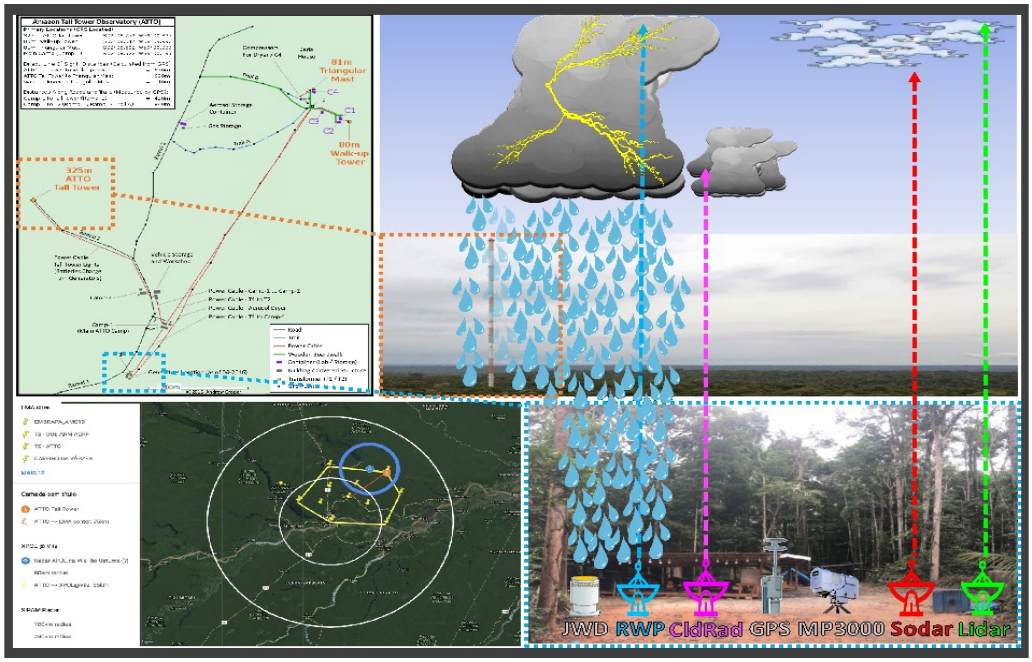

Figure 18 – Aerosol-Cloud Physics instrumentation site set-up at the "Old Generator site", containing: Joss-Waldvogel disdrometer (JWD), Radar Wind Profiler (RWP), W-band Cloud Radar (CldRad), GPS for water vapor column, MP3000, Sodar and dual-polarization Lidar. This system will allow an innovative view of precipitation formation over Central Amazonia. Figure from Rachel Albrect.

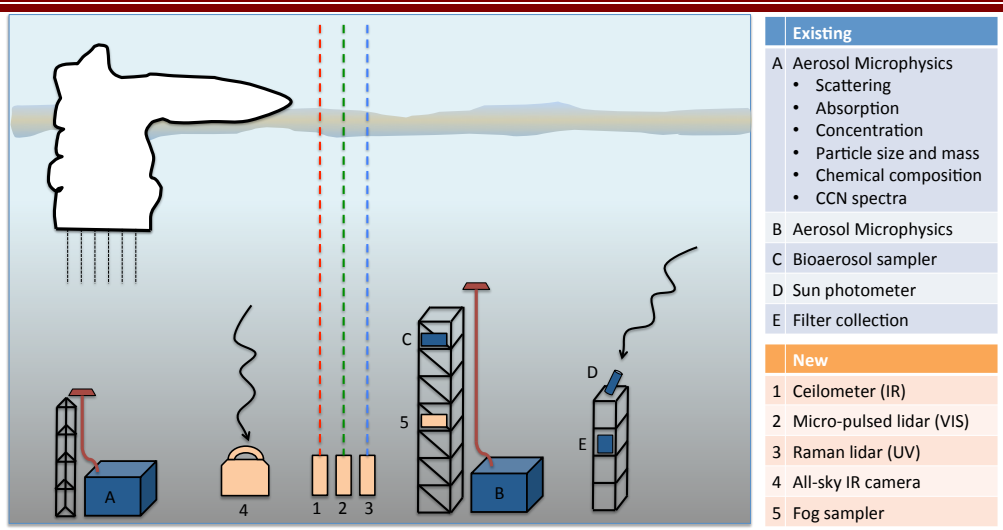

Figure 19 – Schematic view of the aerosol measurements at the ATTO site. Detailed aerosol particle microphysics measurements are already in operation at the 60 m triangular tower (A), and the 325 meters tall tower (B). Filter collection for elemental chemical composition, and organic and elemental carbon concentration (E) takes place at the walkup tower, and for analysis of fungi and spores (C), at the tall tower. New instruments will allow measuring the vertical profile of aerosol and cloud properties.

5.6 Economy and impacts in key sectors

The set of economic activities affected by climate change tends to be large, since the impacts of this phenomenon affect both directly and indirectly in economic activities. Notably, agriculture tends to be the most directly affected by climate change in Brazil, but the impact of this effect to other productive sectors (processed foods, for example) also tends to occur. Another focus is the impact on the availability of water resources, which can alter the conditions of energy production, and whose costs when transmitted to the productive system have widespread impact. Thus, systemic economic effects deserve special attention in assessing the impacts of climate change. Not only economically important sectors tend to be heterogeneously affected, directly and indirectly, since regions tend to have different impacts as well. It is noteworthy in this context that the Brazilian economy is not internally homogeneous, with large variations between sectors and regions. Therefore, it is expected that climate change show with varying intensity with its repercussions in the Brazilian interregional system being diverse.

Populations have always been exposed to hazards; these are associated with patterns of production, the form of occupation, land use and environmental resource management. Thus, climate change can be seen as an aggravator of risk situations, as it may intensify the occurrence of tropical diseases, poverty and disasters. Therefore, the population is also an essential issue of the climate change component as it may appear either as a subject that influences climate change (through emissions, land use, and consumption patters), as suffering its impacts and damage, making necessary to identify their vulnerable segments.

It is understood that one way of adaptation induced by climate change, for example in the case of agriculture, will be the development of seed and resistant cultivars, or hybrid cars as technological changes for the transportation sector, or the adequacy of living conditions in urban areas affected directly and indirectly by weather and climate extremes. The adaptation therefore involves strategies of productive sectors, consumers and governments, both to minimize damage, adverse consequences around and to create new opportunities. Some forms of adaptation are public goods that should be provided by government decisions or planning, and many of them have to be adopted in the short term (in the case of health policy and civil defence, for example).

The development of a "low carbon economy", in which favours the use of renewable fuels, "clean" production processes and sustainable consumption, has been discussed as one of the main opportunities for change in the pattern of use of natural resources, triggered by the impacts of climate change. These opportunities represent technological developments, and may represent regional development strategies or participation in external markets to favour this low carbon economy.

In this context, the cross-cutting theme "Economy and impacts in key sectors" to be developed under the INCT MC will primarily focus on (i) across other components to support the project in terms of economic analysis, and (ii) make a economic analysis of the impacts projected by different climate scenarios to climate change. It is important in this sense the competitiveness of the national economy that is heavily dependent on its natural resource base.

Studies from the cross-cutting theme "Modelling of the Earth system and production of future climate scenarios for studies on vulnerabilityimpacts-adaptation" that produces the climate change scenarios are the beginning of an integrated modelling chain developed at this INCT, directed towards the generation of indicators of climate trends that may be used in other quantitative models from other subcomponents. We believe that the crosscutting theme "Economy and impacts in key sectors" represents the end of the modelling chain. In sum, we use and develop econometric models and economic models that will generate large-scale syntheses of socioeconomic effects of climate change by means of future climate change scenarios.

The staff allocated to the development of studies related to this cross-cutting theme consists of economists with a strong background in economic theory and quantitative methods, with different experiences in the areas of applied economics associated within the six subcomponents of the INCT MC Phase 2, namely agricultural economy, natural resource economics, energy economics, health, regional and urban economics and transportation economics economy. This thematic diversity will allow a more productive integration between the subcomponents and this cross-cutting theme, since the various interdisciplinary relationships are optimized for thematic experiences that can be integrated from a line-methodological background economic modelling common to all of them.

-Objective

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 sectorial and global public policies aimed at reducing climate vulnerability.

5.6.1 Activities in Year 1 of the project

We have focused on the development of integrated modeling approaches to generate quantitative results associated with the impacts of climate change. Two areas received more attention: (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.

We have also prepared proposals for the development of specific projects within the INCT Climate Change Project. In this context, the following proposals to Fapesp should be mentioned: (i) "Urbanização e Mudanças Climáticas: Análises de Impacto na Região Metropolitana de São Paulo" (Doctorate, 2018/08833-5, under review); (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, under review); (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, under review); (v) "The Economics of

Low Carbon Markets – 2017" (Scientific Event Organization, 2017/16866-8, granted); (vi) "Assessing the Climate and Weather Effects in Brazil using Panel Data" (Fellowship Abroad, 2018/02081-1, granted).

Team members are Eduardo Haddad USP, Carlos Azzoni USP, Joaquim Martins Guilhoto USP, Andre L. S. Chagas USP. For year 2, the following members are to be included: Ariaster Baumgratz Chimeli USP, Danilo Igliori USP, Paula Pereda USP. They are all faculty at the Department of Economics at FEAUSP working with different aspects of climate change. Prof. Chimeli works with Environmental Economics and his research is closely related to different aspects of the project. Danilo Igliori is an Urban Economist and he has interest in modeling land use in urban areas. Paula Pereda has interests in assessing different impacts of climate using econometric models. Her research on climate and health is particularly important for the project. Fernando Perobelli, listed as PA, is currently Associate Professor at the Federal University of Juiz de For a (UFJF). Thus, since he is not affiliated with an institution in São Paulo, his name should be removed from the list of members from São Paulo.

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

GCMs (Global Circulation Models) can effectively address large-scale climate features such as the general circulation of the atmosphere and the ocean, and sub-continental patterns and their formal resolution (grid scale) is at best around 100–200 km. Nevertheless, the author mentions that this resolution is not adequate for regional and local climate aspects, e.g. intensive precipitation.

This component of the research proposal aims to develop a global and a regional Brazilian Earth System Modeling. Both levels of modeling will be extensively tested to operate well globally with emphasis over the continent. Models will be tested for the various processes relevant for the study of climate variability and change. Projections of future climate generated from different global earth system models, inclusive the Brazilian Earth System Model (BESM), will be downscaled by the RESM (Regional Environmental System, Model) at scales suitable for impact studies. The downscaling projections will be used in the different applications such as agriculture, megacities, and water resources. Participants from different regions in Brazil and foreign countries will also contribute in the development and evaluation of the model.

The project will be executed in 3 components: 1) Model development; 2) Climate variability and change, 3) Socio-economic impact and vulnerability studies in crosscutting issues with other project components. Workshops and group meetings are planned during all project period, as an opportunity to discuss all the activities and to promote a multidisciplinary integration among the participants. Downscaled climate change output will be distributed openly.

The Regional Earth System Model - RESM - runs is based on the Eta regional model developed at CPTEC INPE, may be used also as boundary conditions to force other types of models applied to studies in the areas of Hydrology, Glaciology, Agriculture, Hydroelectricity and occurrence of extreme events both in mesoscale (flash floods) and in the seasonal and decadal time-scale (regional floods and droughts). In all cases, the results of applying these specific models will directly impact in the assessments of risks at local scale; for example, changes in the vulnerability to flash floods in urban areas due to changes in recurrence periods, as a consequence of climate change; and at regional scale, as in the example of extended floods or droughts with serious impacts on agriculture, hydro-electrical power generation and other related activities. A second nesting to an even higher horizontal resolution, reaching about 5 km of grid size, may be applied to studies of vulnerability of megacities to climate change.

The multidisciplinary research that consider the inclusion of ocean-atmosphere interaction processes by coupling a higher resolution regional model with an ocean model, the inclusion of

biosphere-atmosphere interactions, the inclusion of a radiation scheme with more greenhouse gases and chemistry can help to better understand and simulate climate variability and climate change in Central and South America region. The results of this research, therefore, will provide support to identify the most vulnerable regions and sectors with the highest degree of reliability than that provided by global models. From historic observed records and a good evaluation of actual conditions of environmental process, relevant future scenarios can be built.

- *Objectives*

The major objective of this component of the project is the development of a global and regional earth system models, BESM-Brazilian Earth System Model and RESM-Regional Earth System Model RESM), particularly suitable for climate studies in Central and South America and its surroundings. The developments will be thoroughly tested during the project. The developed models will be used as tools to simulate global climate change scenarios as well as local scale scenarios, such as deforestation, megacities area growth, change of land-surface cover, etc. The aim is to establish a multidisciplinary network of researchers in understanding the climate variability and change in Central and South America, and to provide information at regional or local scale for the societal impact and adaptation studies.

5.7.1 Activities developed in year 1 of the project

The activities regarding this component were concentrated mainly at the CPTEC where the global BESM (Brazilian Earth System Model) and Eta regional model are being developed. Some of these activities are part of this project, while others are the model development acitivies deleiped buy INPE and with the support of the project for mobility activities (presentations and secientific events) as well as for bolsas and publication fees.

Some of these activities include:

-BESM version 2.5 experiments piControl and Abrupt4xCO2 integrations reached respectively 1,000 and 850 years of simulations in the supercomputer CRAY EX6 at INPE/CPTEC.
-Eta - Earth System Model development: update and preparation of land-use and land-cover maps for use in downscaling of urban climate change and for study of climate change impacts on the Brazilian cerrado bioma. These activities support the development of the dynamic vegetation and the urban climate components
-Eta-ESM: model modifications to incorporate the chemical species.
-Eta- 1km: long-term (6-year) integration at very high resolution, 1 km, over Amazonian deforested landscape. Land-cover evolution during the integration.
-Eta = ESM: Coupling the radiation scheme with convective clouds
These are activities that will be on-going during the whole project

5.8 Communication, dissemination of knowledge and education for sustainability.

The diagnosis and assessment will be made based on the analysis of how the 6 Sub-Project and the 3 cross-cutting themes and the integration proposed in this project are addressed in various media, and what effects would be produced on general public, managers, educators, and scientists from various fields. To this end, building a powerful conceptual network that allows to study the problematic of the existing communication dissemination will be required as well as to generate innovative links between these themes. We will involve researchers from several Brazilian research institutions coordinated by UNICAMP - who has been dedicated to the problematic of the human dimensions of climate change, and the settings of the conceptions of humanity, nature, science, culture and politics in pictures, words, sounds, signs and syntax related to the theme of climate change on various space-time and cultural artefacts.

The research will be developed within the lines of research from the Labjor-Nudecri-Unicamp: Scientific Culture; Literature, arts and communication; Information, communication, technology and society; Public Perception of Science and Technology.

In terms of education for sustainability-seeking, we shall investigate and develop strategies for on-going environmental education that promote reflection on social practices and production of meanings about the current and future context, marked by climate change and its consequences. It is intended to include a set of actors in the educational world, involving formal and non-formal education, the training of professionals in the university community and the elementary and middle school and the spaces of knowledge and culture in urban and rural environments. The emphasis is on education for sustainability is critical, innovative, interdisciplinary and committed to social change, characterized as citizenship education that problematizes the man, nature and the universe relations and human responsibility in the process of exhaustion of resources natural and environmental degradation.

Such diagnoses and evaluations subsidize the second step we propose, and what will happen with the first: the investigation of new forms-content-languages and the production of scientific artefacts and cultural dissemination involving several audiences: the researchers themselves from the Rede Clima, scientists from other areas of knowledge, artists, entrepreneurs, managers, members of social, environmental and cultural movements, teachers, students, health professionals etc. Invest in this second step to make science communication a privileged space-time connection between the natural sciences, exact sciences, humanities, philosophy, arts and other forms of knowledge, other ways of inhabitants of the world (indigenous peoples, traditional, etc.). We assume that this approach creates powerful position to address the human dimensions of climate change and at the same time, expand the capacity for dialogue with society.

-*Objective*

The main objective of this integrative component is to asses ways on how to make science communication information of climate change-a powerful tool to raise awareness and public engagement, as well as the establishment of effective public policies? We assume in this crosscutting, the answer to this question will go through two steps: 1. To diagnose and evaluate the ways in which scientific communication and dissemination have been configured in different media available now; 2. To investigate new ways to advertise by producing cultural artefacts; 3. To investigate, analyse and propose strategies for science communication and education for sustainability processes within formal and non-formal education.

5.8.1 Activities developed in Year 1 of the project

Professor Carlos Vogt, due to the need take on some new assignments, he requested to leave this project, of which he was the Principal Investigator and coordinator this Cross Cutting Theme. In view of this, and because of the non-approval of Professor Susana Dias's appointment, professor Antonio Carlos Rodrigues de Amorim, of the Faculty of Education (FE-Unicamp), was nominated and approved as the Principal Investigator and co-coordinator of this Cross Cutting Theme. Professor Amorim's appointment was made due to his extensive experience with education and science, particularly science teaching and scientific diffusion, with guidelines for undergraduate research mentorship program, master's degree, doctorate, as well as postdoctoral supervision in these areas, participation and coordination of projects with CNPq, Capes and Fapesp funding. Prof. Dr. Antonio Carlos Amorim is from the Faculdade de Educação (FE)/Universidade Estadual de Campinas (UNICAMP).

Since the beginning of the project in 2016, and considering that the proposal was submitted in 2014, some people left and others did enter in the project:

- Profa. Dra. Alik Wunder – Faculdade de Educação (FE)/ Universidade Estadual de Campinas (UNICAMP)
- Prof. Dr. Carlos Martins – Universidade Estadual Paulista (UNESP – Rio Claro)
- Profa. Dra. Carolina Cantarino Rodrigues – Faculdade de Ciências Aplicadas (FCA)/ Universidade Estadual de Campinas (UNICAMP)
- Profa. Dra. Claudia Pfeiffer – Laboratório de Estudos Urbanos (Labeurb)/ Núcleo de Desenvolvimento da Criatividade (Nudecri)/Universidade Estadual de Campinas (UNICAMP)
- Profa. Dra. Cristiane Dias – Laboratório de Estudos Urbanos (Labeurb)/ Núcleo de Desenvolvimento da Criatividade (Nudecri)/Universidade Estadual de Campinas (UNICAMP)
- Prof. Dr. Eduardo Pellejero – Universidade Federal do Rio Grande do Norte (UFRN)
- Profa. Dra. Elenise Cristina Pires de Andrade – Universidade Estadual de Feira de Santana (Uefs)
- Profa. Dra. Érica Speglich – Faculdade de Educação (FE)/ Universidade Estadual de Campinas (UNICAMP)
- Prof. Dr. Gabriel Cid Garcia – Universidade Federal do Rio de Janeiro (UFRJ)
- Profa. Dra. Isaltina Maria de Azevedo de Mello Gomes – Universidade Federal de Pernambuco (UFPE)
- Prof. Dr. Leandro Belinaso Guimarães – Universidade Federal de Santa Catarina (UFSC)
- Profa. Maria Elizabeth Vidal – Universidad Nacional de Córdoba (Argentina-Córdoba)
- Profa. Dra. Milena Serafim – Faculdade de Ciências Aplicadas (FCA)/ Universidade Estadual de Campinas (UNICAMP)
- Prof. Dr. Marcus Barbai – Laboratório de Estudos Urbanos (Labeurb)/ Núcleo de Desenvolvimento da Criatividade (Nudecri)/Universidade Estadual de Campinas (UNICAMP)
- Prof. Dr. Marko Synésio Alves Monteiro – Instituto de Geociências (IG)/ Universidade Estadual de Campinas (UNICAMP)
- Prof. Dr. Rafael Dias – Faculdade de Ciências Aplicadas (FCA)/ Universidade Estadual de Campinas (UNICAMP)
- Profa. Dra. Raquel Wiggers – Universidade Federal do Amazonas (UFAM)
- Prof. Dr. Renato Salgado de Melo Oliveira – Instituto Federal da Bahia (IFBA)
- Prof. Dr. Paulo Teles – Instituto de Artes (IA)/Universidade Estadual de Campinas (UNICAMP)
- Prof. Dr. Renzo Taddei – Universidade Federal de São Paulo (UNIFESP)
- Profa. Dra. Sandra Murriello – Universidad Nacional de Rìo Negro (Argentina-Bariloche)
- Profa. Dra. Simone Pallone – Laboratório de Estudos Avançados em Jornalismo (Labjor)/Núcleo de Desenvolvimento da Criatividade (Nudecri)/Universidade Estadual de Campinas (UNICAMP)

The registration of the following researchers was requested: PhD. Claudia Regina Castellanos Pfeiffer, PhD. Cristiane Dias and PhD. Marcos Aurélio Barbai, from the Laboratory of Urban Studies (Labeurb-Unicamp) and PhD. Carlos José Martins from the Unesp-Rio Claro Institute of Biosciences. The researchers were unable to send the documents in time in early 2017 because they were on vacation.

The activities developed by this component in Year 1 of this cross-citting theme can be summarized as:

- 03/16/2017 - General researchers' meeting of the Cross Cutting Theme of Communication at LABJOR / UNICAMP - resumption of the project proposal.
- 03/28/2017 - Participation in the general coordinators' meeting of INCT-MC in Natal-RN.
- 05/11/2017 - General researchers' meeting of the Cross Cutting Theme of Communication at LABJOR / UNICAMP - collective definition of a work agenda for 2017/2018.

- 06/23/2017 - General researchers' meeting of the Cross Cutting Theme of Communication at LABJOR / UNICAMP - presentation of the research developed by the post-doc of INCT - Climate Change PhD. Renato Salgado de Melo Oliveira on governmentality, public and scientific communication-education regarding climate change;
- 07/08/2017 - General researchers' meeting of the Cross Cutting Theme of Communication at LABJOR / UNICAMP - presentation of the research developed by PhD. Raquel Wiggers (Ufam) on traditional knowledge, anthropological approach and the Amazon forest regarding climate change; and the organization of the VII Connections Seminar and 2nd Meeting of Researchers in Communication;
- 08/31/2017 - Participation in the general coordinators' meeting of INCT-MC at USP;
- 01/09/2017 - General researchers' meeting of the Cross Cutting Theme of Communication at LABJOR / UNICAMP - Preliminary collective analysis of the last IPCC report and the first IPCC meeting focused on Communication (February 2016).
- 09/28/2017 - General researchers' meeting of the Cross Cutting Theme of Communication at LABJOR / UNICAMP - debate on the topics to be explored in the "I National Report on Communication, Education and Climate Change" that our group proposed to do and that will gather-connect-proliferate the diverse researches of each of the members of this cross cutting theme;
- 27 to 29/11/2017 - VII International Seminar Connections Deleuze whose theme was "Cosmopolitics and Radical Ecologies and New Earth and ..." which was held at the Convention Center of Unicamp and at other 5 venues (Centro Cultural Casarão, Casa do Lago, Faculdade de Educação, Labjor, Lume-Teatro and Laboratório de Genética Molecular) and received 160 research proposals and gathered 230 participants (including speakers and audience). This event was oriented by the question: What can the human in their becomings in times of catastrophe? It is perhaps the question that has oriented the actions of this group in the thinking of climate change at ClimaCom Magazine and that encouraged us to make this "VII Seminário" an experiment of being together in which the most disparate and aberrant modes and logics of thinking operate Deleuze's and Guattari's thoughts, willing to note the sparks of the ways in which a New Earth, its Cosmopolitics and Radical Ecologies. More information at: https://seminarioconexoes2017.hotglue.me;
- 11/30/2017 - 2nd. Meeting of Researchers in Communication, Education and Climate Change (Meeting on this Cross Cutting Theme of the INCT and of the Scientific Dissemination and Climate Change Subnet of the Climate Network concomitantly) at Unicamp. This meeting brought together 25 researchers from UFRN, UFPe, UFRJ, UFSC, Unesp, Uniso, Unicamp (FE, Labjor, Labeurb, IG and FCA), Universidad on Nacional de Río Negro and Universidad Nacional de Córdoba and the Guardians of the Urban Forest of Sorocaba, to share diverse researches by the group, and the lecture by professor Marko Monteiro on his research "Science and demarcation in the Amazon: ethnographic reflections on interdisciplinary cooperation".
- 15/02/2018 - Participation in the general coordinators' meeting of INCT-MC Phase 2 at USP;
- Meetings were also held to coordinate the cross cutting theme with researchers in order to evaluate the possibilities of participation with the professors: Cristiane Dias, Milena Serafim and Paulo Teles. As well as meetings with the researchers for the general organization of the VII Connections Seminar and the 10 workshops that took place there.

Some of the major results include:

Science communication-education habitually appears as a possibility of a greater social participation. Identifying the lack of access to scientific knowledge by a part of the population as the problem of the educational politics and of social inclusion.

As a result of the innovative activities and of research developed by the team of this Cross Cutting Theme, what is perceived is that the access to information does not ensure by itself the effective participation of people, but rather the construction of products and process with the active

involvement of the public, that is, with a mutual implication of people as well as of things, beings, concepts, words, images and sounds (DIAS, WIEDEMANN, 2017, 2018).

The public presents its own creativity potency and of live which resists a mere linear absorption, constituting for itself its own politics, sensibilities and strategies that define in a multiple and diversified mode the relations with the environment, society and climate changes (TADDEI, 2017).

The actions of scientific communication-education, in this way, can be comprehended as a catalyst for collaborative processes of invention of new knowledges with climate changes, and not as ultimate aims of the projects.

For this reason, in this Cross Cutting Theme we aim at potentializing the dimension of research and action in scientific communication-education of the INCT of Global Climate Changes in the relation with the public, aiming at not stabilizing the thought by the circulation of ready answers and solutions for the subjects approached.

Therefore, the public cannot be faced as the final part of communication-education, but rather as an active, creative and transformative force, not only of itself and of the social environmental conditions surrounding it, but the relations of science with the world (OLIVEIRA, 2017).

A invitation to experiment the possibility that all becomes "public". This is very noticeable in a project as the one of the nature of INCT which gathers such different researchers, practices and materials. In it we need to take seriously the challenge of producing knowledges, perceptions and modes of affecting and existing, which result in unprecedented connections and relations between the heterogeneous. Results that would being impossible to be produced isolatedly.

Climate changes themselves inspire and reclaim changes of perception that can be potentialized in the encounter of different practices: scientific, artistic, curatorial, educational, performatic, counterculture, journalistic, science dissemination, indigenous rituals and knowledges etc. Particularly, in this Cross Cutting Theme, what interests us is the relations that can be established with artistic practices. Because the manner arts experiment erasures, deletions and transformations in the habitual logics to see, to feel and to think can contribute with the production of new sensibilities in relation to the populations said more vulnerable (AMORIM, 2017).

Articulating the artistic, scientific and communication-education practices has been an interesting challenge in the experimentations conducted, which are inspired, for example, by Multispecies Studies. Rivers, clouds, soils, oceans, trees, cities etc. become copartners of research and creation, connect distinct perspectives and gain expression in sensible compositions in object-books, videos, photo-essays etc. (PEREIRA, CODES, SILVEIRA, TONON, CORSO; GUIMARÃES, 2018; DIAS, WIEDEMANN, 2017, 2018; DIAS et all, 2018).

The sort of images and texts that we produce in these experiments wish to suspend unsustainable and instrumental operations that dominate the audiovisual narratives when the subject is global warming and anthropic actions (BELINASO, 2017). Complicating the thoughts with the communication and educational processes beyond the idea of "mediation" (DIAS, WIEDEMANN, OLIVEIRA, OLIVEIRA, PONTIN, 2018).

Scientific communication-education emerges in this project as a space-time of potent creation and production for thinking about questions that cross climate changes, for example, the impotency of people and images, words and sounds (DIAS, 2017), and the fear/risk of the apocalypse (OLIVEIRA, 2017) as well as the invention of the news modes of living, acting and thinking.

5.9 Coordination

The two coordinators Jose Marengo and Tercio Ambrizzi have meet during years 1 and 2 in several occasion, one of them for few days at USP, and other during other meetings and conferences where we both were there. We have changes the way the coordination works. In the submitted project in 2014 we appointed Patricia Pinho as our liasson with the other components, but since when she left USP in 2015 and with the approval of the project we decided the make this contact directly with the leaders of each components, in meetings, by skype and by email. For the administrative issues, CEMADEN hired 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 the payments of per diem (diarias) and the issuing of air tickets for trfavel to meetings among INCT MC Fase 2 participants. Due to the delay in the decision of the approval of the project since 2014, Dr. Marcos Foliador from Way Carbon, the private organization that would work with us, left Brazil and moved to Italy and left the project and so we nave no longer collaboration with Way Carbon.

In addition we started in Year 1 contacts with other INCTs, such as Criosphere (coordinated by Dr. Jefferson Simoes) and Ethanol (coordinated by Dr. Marcos Buckeridge), and we expect a collaboration with them on issues regarding climate modelling and food security in Year 2.

6. Integration among components of the project in Year 1

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 (Stafford Smith, 2007). 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 proposed various workshops (total of six) which will lead to the preparation of documents and reports that will guide the workshops consecutively, which will involve the whole team. Due to budget constraints we decided to have 5 workshops starting on 2019 until 2022.

So far, in year 1 the workshops that took place are for the individual 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 forma approval.

7. Events organized by the components and the coordination of the project and with participation of the leaders and PIs of the project in Year 1

- "I Reunião do INCT Mudanças Climáticas Fase 2", Natal RN, 28 March 2017 (see annex for the program)
- "Primeira reuniao do CC e CG do INCT MC Fase 2", FEA-USP, 15 February 2018 (see annex for the program)
- "I Reuniao de coordenacao do INCT MC Fase 2", IAG USP, 4-6 de april 2018.
- The water security component organized the "I Workshop INCT MC2 2018: Segurança Hídrica no Brasil: Desafios e Oportunidades de Adaptação às Mudanças Climáticas" that took place at the IAG/USP, in April 26-27 2018 (see annex for the program)
- The natural disasters component organized the "I Workshop da Sub componente: Desastres Naturais, Áreas Urbanas, Infraestrutura Física, Desenvolvimento Urbano", that took place on April 10 2018 at the CEMADEN facilities in Sao Jose dos Campos, SP. (see annex for the program)
- The economy component organized the "Workshop de planejamento de atividades: subcomponente economia e impactos nos setores chave", that took place in the FEA/USP on April 13 2018. (see annex for the program)
-- Encontros Semanais do NEREUS: 09 de abril de 2018, Communication cross cutting team: Michael França – Temperature and Fertility; Bruno Souza – Mudanças Climáticas no Brasil: Efeitos Sistêmicos sobre a Economia Brasileira Provenientes de Alterações na Produtividade Agrícola; (http://www.usp.br/nereus/?p=3989)

8. Participation in scientific events with accepted abstracts or presentations

-Marengo JA (2017) Governance of water related natural disasters in Brazil, Global Forum on Science and Technology for Disaster Resilience 2017, Tokyo, Japan, 23rd – 25th, November, 2017
-Marengo JA (2017) Platform for Water and Disaster, World Bosai Forum/IDRS 2017, Sendai, Japan, 25-27 November 2017.
-Sori R, Marengo JA, Nieto, R, Drummond A, Gimeno L (2017)Drought and wet episodes in Amazonia: the role of atmospheric moisture transport,The 1st International Electronic Conference on Hydrological Cycle (CHyCle-2017), 12-16 November 2017; Sciforum Electronic Conference Series, Vol. 1, 2017
-Marengo JA (2018) Marco geográfico e sistemas naturales de Iberoamerica, Taller de Evaluación de actuaciones de adaptación al cambio climático en Iberoamérica. Galapagos, Ecuador, 12-15 Marco 2018.
-Mendiondo, E M, de Souza, F A, de Macedo, M B, Taffarello, D, Fava, M C, Guzmán-Arias, D. A, Restrepo-Estrada, C E, do Lago, C A, Abreu, F. (2017), Socio-Hydrological Observatory for Water Security (SHOWS): Examples of Adaptation Strategies With Next Challenges from Brazilian Risk Areas,Abstract [H13S-08] presented at 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec
-Taffarello, D; Guzmán-Arias, D A; Mendiondo, E M, Seguro PSA sob Mudanças: Integrando Pagamentos por Serviços Ambientais em Seguros de Riscos Hidrológicos, PAP023296, In: XXII SImp. Bras. Rec. Hídricos, Florianópolis-SC, Nov. 2017, Anais (www.abrh.org.br)
-Mendiondo, E M, Guzmán, D, Taffarello, D, de Macedo, M, de Lago, C, de Souza, F, Applied socio-hydrology using volunteer geographic information (VGI) to integrate ecosystem-based adaptation (EbA) and disaster risk reduction (DRR), In: 2017 European Geophysical Union, Vienna, 2017, No: EGU2017-18191
-Mendiondo, E M, F. de Souza, D. Taffarello, G. Mohor, L. Degrossi, D. Guzmán (2018) Citizen science for water security: First results in urban catchments under Change, In: 1st Int. Conf. Water Security, 17-20 June, 2018 Toronto, Canadá, Elsevier; Poster [P1.42] https://www.elsevier.com/__data/assets/pdf_file/0010/735616/24547_WSEC2018_Poster-Program-1st-June.pdf (presented)

-Mendiondo, E M, M. C. Fava, C.E.Restrepo-Estrada, N. Abe, F. Abreu (2018) Crowdsourcing with social media and big data for water-and-health risk reduction, In: 1st Int. Conf. Water Security, 17-20 June, 2018 Toronto, Canadá; Elsevier; Poster [P2.01] https://www.elsevier.com/__data/assets/pdf_file/0010/735616/24547_WSEC2018_Poster-Program-1st-June.pdf (presented)

-2017 Brazilian Water Resources Symposium, Florianópolis, SC, Brazil, Nov 2017: with participation of INCTMC2-Water Security institutions of EESC-USP, CEMADEN, INPE, UFPE, UFC, UFCG, UFRGS, UnB, new strategies were presented in Plenary Session Conferences of (1) "Protection of Water Supply Catchments and Water Security of Brazilian Metropolitan Regions", with case studies of São Paulo, Fortaleza, Brasília-DF and Belo Horizonte; (2) "Using Information of Climate Change in the Water Resources Planning and Management", (3) "Hydrologic Hazard Risk Reduction" and (4) " Impacts of Water Quality Uncertainties and Variabilities on Water Resources".

-2017 AGU Fall Meeting, New Orleans, USA, Dec, 2017: the Socio-Hydrological Observatory for Water Security (Mendiondo et al, 2017) was presented and discussed in terms of coping with water risks under climate change scenarios available at official link of: [https://agu.confex.com/agu/fm17/meetingapp.cgi/Paper/272306].

I INCTMC2 Workshop on Water Security, 26-27 April, 2018, Sao Paulo, Brazil: With the local support of IAG/USP INCLINE Group (Interdisciplinary CLImate iNvEstigation Centre, www.incline.iag.usp.br),; all participants represented two INCT-MC2's subcomponents: "Water Security" and "Economy and Impacts in Key Sectors", sharing their contributions in a repository.

-2018 Santa Fe Institute Workshop on Socio-Hydrological Dynamics and Water Governance, Santa Fe, NM, USA, June 2018: under invitation of the Santa Fe Institute, a representative of the FAPESP Thematic Project of the INCTMC2 was nominated and selected to discuss challenges, opportunities and limitations of the framework called Socio-Hydrological Observatory for Water Security in the context of impacts of global changes.

-1st International Conference of Water Security, Toronto, Canadá, June 2018: with the presentation of abstracts and posters related to INCTMC2 Water Security subcomponent, Sao Paulo researchers presented posters

-Gonçalves AR, Costa RS, Pereira EB, Martins FR (2018) CENÁRIOS DE EXPANSÃO DA GERAÇÃO SOLAR E EÓLICA NA MATRIZ ELÉTRICA BRASILEIRA, VII Congresso Brasileiro de Energia Solar – Gramado, 17 a 20 de abril de 2018.

-de Lima FJL, Martins FR, Costa RS, de Souza JG, Pereira SV, Pes MP, Pereira EB (2018) INTERCOMPARAÇÃO DE MODELOS NUMÉRICOS PARA ESTIMATIVA DA IRRADIAÇÃO SOLAR EM PARTE DO NORDESTE BRASILEIRO, VII Congresso Brasileiro de Energia Solar – Gramado, 17 a 20 de abril de 2018.

-Luiz EW, Martins FR, Costa RS, Gonçalves RS, de Souza JG, de Lima FJL, Pes MP, Pereira EB (2018) JG, COMPARAÇÃO DE METODOLOGIAS PARA A ESTIMATIVA DA FRAÇÃO DE COBERTURA DE NUVENS UTILIZANDO CÂMERA *ALL-SKY* E SATÉLITE-VII Congresso Brasileiro de Energia Solar – Gramado, 17 a 20 de abril de 2018.

- Neves G, Vilela W, Pereira EB, Berni LA (2018)INFLUÊNCIA DO ESPECTRO SOLAR EM MÓDULOS FOTOVOLTAICOS SOB CÉU LIMPO, CÉU PARCIALMENTE NUBLADO E CÉU NUBLADO–VII Congresso Brasileiro de Energia Solar – Gramado, 17 a 20 de abril de 2018.

-Chipponelli Pinto, LI, de Lima FJ, Martins FR, Pereira EB (2018) TESTES DE SENSIBILIDADE PARA DIFERENTES PARAMETRIZAÇÕES *CUMULUS* DO MODELO WRF PARA MELHORAR AS ESTIMATIVAS DE VENTO- VII Congresso Brasileiro de Energia Solar – Gramado, 17 a 20 de abril de 2018.

-Ambrizzi T, Marengo JA (2018) INCT for Climate Change Phase 2, CNPq – Queensland Research Workshop, Brasilia DF, 14 March 2018

- Barbosa dos Santos, R, Menezes JA, de Souza, CM, Machado SOS, Confalonieri U (2018), FLUXO DE INFORMAÇÃO EM DESASTRES E REDUÇÃO DE RISCOS PARA A SAÚDE, Seminário Internacional de Proteção e Defesa Civil, Florianopolis, 12-15 Marco 2018

-Marengo JA (2018) Discussão sobre o escopo de cada segurança: expectativas, orientações específicas, lista de impactos, recortes e tipologias., REUNIÃO TÉCNICA DA COMPONENTE DE VULNERABILIDADE E ADAPTAÇÃO, MCTIC, Brasilia 08 de maio de 2018.
-Marengo JA (2018) Discussoes do projeto Clima e Biodiversidade, 2ª REUNIÃODE AUTORES PAINEL BRASILEIRO DE MUDANÇAS CLIMÁTICAS RELATÓRIO ESPECIAL CLIMA E BIODIVERSIDADE, FBDS, Rio de Janeiro, 4 Maio 2018.
-Marengo J. A.; Alves L. M.; Alvalá, R. C. S.; Cunha, A. P. M. A.; Brito, S. S. B.; Moraes, O. L..L. Climatic characteristics of the 2010-2016 drought in the semiarid Northeast Brazil region. Annals of the Brazilian Academy of Sciences. 2017, Vol 89 (No. 3), pag XX-YY. DOI: 10.1590/0001-3765201720170206. (Printed version ISSN 0001-3765 / Online version ISSN 1678-2690, http://dx.doi.org/10.1590/0001-3765201720170206)
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-Artaxo P (2018) A componente de Amazonia e biodiversidade do INCT MC Fase 2. 1º reunião do Comitê Científico Brasileiro do ATTO São José dos Campos, SP 17-18 de maio de 2018
-Pugliero, V.S., Zanetti, M. R., Assad, E. D. (2018) DIAGNÓSTICO AMBIENTAL: QUANTIFICAÇÃO DO PASSIVO EM APP HÍDRICA NOS MUNICÍPIOS DA CAATINGA NA BACIA DO SÃO FRANCISCO, II Simpósio da Bacia Hidrográfica do Rio São Francisco – 3 a 6 de junho de 2018 - Aracaju, Sergipe
-DIAS, S. O.. Movimientos especulativos en torno de bioindicadores de comunicación y del cambio climático o de cómo dar a lo humano la más intensa potencia de existir. (26/04/2017), Universidad de San Buenaventura, Medellín, COLOMBIA (Conferência).
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-DIAS, S. O.; WIEDEMANN, S. . How to claim a new earth: Intersections between Deleuze´s Geophilosophy, Donna Haraway and the forest. 2017.(Apresentação de Trabalho/Comunicação).
-DIAS, S. O.; WIEDEMANN, S. (a)mares e ri(s)os infinitos": la catástrofe de estar juntos delante de la finitud. I Congreso Iberoamericano de Memorias del Agua y X Plenario de la Red Internacional de Universidades Lectoras, (23/03/2017 a 24/03/2017), Sevilla, ESPANHA (Comunicação vídeo)
-TADDEI, Renzo. Workshop trilateral Reino Unido-Brasil- Uruguai "How anthropology can contribute to affirmative action in South America in the fields of human rights, gender equality and environmental sustainability". Paper "The challenge of indigenous anthropologies - or, preparations for intercultural collaboration in anthropology". 21/02/2017, Montevidéu, Uruguai.
-TADDEI, Renzo. VI Congresso da Associação Latinoamericana de Antropologia. Paper "El desarrollo de la antropología de los desastres en Brasil: desafíos y perspectivas". 09/06/2017, Bogotá, Colômbia.
-TADDEI, Renzo. VI Reunião de Antropologia da Ciência e da Tecnologia. Paper "Saindo do armário ontológico". 18/05/2017, São Paulo.
-DIAS, S. O. (moderação, palestra e oficina); VI ReACT Reunião de Antropologia da Ciência e da Tecnologia, (16/05/2017 a 19/05/2017), São Paulo, SP, BRASIL, Oral: Aliar-se às nuvens para que o céu não caia.
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GUIMARÃES, L.; PELLEJERO, E.; CID, G. G. DE; MELO, I. MARTINS, C.;
MELO, S.; PAIVA, R.; OLIVEIRA, T; PONTIN, V.; VII Seminário Conexões: Deleuze e Cosmopolíticas e Ecologias Radicais e Nova Terra e...., realizado entre os dias 27 e 29 de novembro de 2017, Campinas – SP, na qualidade de organizador do evento, organizador do workshop "Imediações aberrantes".
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-SALGADO, R.; 4° Encontro de Grupos de Pesquisa em Ciência, Tecnologia e Sociedade da Unicamp, realizado nos dias 27 e 28 de setembro de 2017, Campinas - SP, com a apresentação do trabalho "O público e a população, relações entre a divulgação científica e a governamentalidade e apresentação do trabalho "Sabotagem: a guerrilha por um novo mundo".
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Lima, F. J. L., Martins, F. R., Costa, R,. S., Gonçalves, A. R., Souza, J. G., Pereira, S. V., Luiz, E. W., Pes, M. P. e Pereira, E. B. (2018) Intercomparison of numerical models for estimation of solar irradiation in part of the Brazilian northeast, VII Brazilian Solar Energy Congress, Gramado, RS.
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9. Fellowships (bolsas) granted by FAPESP in Year 1 (including students)

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-Processo 2017/25439-6, Compilation of atmospheric properties of the Amazon, aiming to analyze their impact on the ecosystem, Bolsista: Fernando Cavalcante dos Santos, period 01/03/2018 to 29/02/2020, Component Amazonia and Biodiversity, responsavel Paulo Artaxo, IF/USP. BCO - Treinamento Técnico - Fluxo Contínuo, Treinamento Técnico - TT-4
-Processo 2017/24444-6, Potential impacts of land use and land cover changes in the current and future water security of the Piracicaba-Capivari-Jundiaí Basin, Bolsista: Giane de Fatima Valles, period 01/04/2018 a 31/03/2020, Component Water Security, responsavel; Javier Tomasella, CEMADEN, BCO - Treinamento Técnico - Fluxo Contínuo, Treinamento Técnico - TT-4
-Processo2017/21392-5, Adaptation based on ecosystems through PES-Water using compensatory techniques to increase water security in urban watersheds, Young Researcher (undergraduate, IC): Joao Pedro Belini; Supervisor: E M Mendiondo (2017-2018)
-Processo2017/15614-5, Decentralized Urban Runoff Recycling Facility addressing the security of the Water-Energy-Food Nexus, Doctoral Scholarship: M B de Macedo, Supervisor: E M Mendiondo (2017-2019)
-Renata de Araújo Teixeira, Sensoriamento remoto de aserossóis e gases traços na Amazônia. Bolsista de doutordo CLIAMB, INPA-UEA. Início em Jan 2017.
-Marco Aurélio de Menezes Franco, Processos de geração, processamento e deposição de aerossóis medidos na torre ATTO, Amazonia central. Bolsista de doutorado, início abril de 2017.

On 26 March 2018, with an international and interdisciplinary board, the Doctoral Thesis titled: “Hydrological Risk Transfer Planning under the Drought Severity-Duration-Frequency Approach as a Climate Change Impacts Mitigation Strategy” was defended and approved at EESC-USP, Sao Carlos, supervised by Prof E M Mendiondo (EESC-USP) and co-supervised by Dr J Marengo (CEMADEN), and with external examinations of other INCTMC2 researchers: Prof. Eduardo Haddad (FEA/USP, “Economic Impacts”), Prof. Suzana Montenegro (UFPE, “Water Security”, Coordinator), Prof. Yosuke Yamashiki, Kyoto Univ, Japan, Prof. Tercio Ambrizzi (IAG/USP, Vice-Coordination of INCTMC2 and participant of “Water Security”), and Prof. Alberto Garrido (Univ Politécnica de Madrid, Spain).

10. List of publications

The papers published within the INCT-MC Phase 2 included in the publication list reflects the activities of the subgroups that have many different funding sources, as well as a continuous interdisciplinary work over the last years. Some of them were published with new data (collected from funds from this project this year) others contain scientific material from 2-3 years ago, that were compiled within the framework of this INCT but that started at the INCT MC Phase 1 lead by Carlos Nobre and that ended in 2017. As the new data are being collect over the duration of this INCT, the published papers will reflect more the activities of this project over the next years.

-Alvalá RC, Cunha APMA, Brito SB, Seluchi, ME, Marengo JA, Moraes OLL, Carvalho M, (2017) Drought Monitoring in the Brazilian Semiarid Region, In Press, *Annais da Academia Brasilieira de Ciencias do Brasil.*
-Marengo JA, Alves LM, Alvala, RC, Cunha AP, Brito SS, Moraes OLL (2017) Climatic characteristics of the 2010-2016 drought in the semiarid Northeast Brazil region, *Anais da Academia Brasileira de Ciências*, Online version ISSN 1678-2690 http://dx.doi.org/DOI
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-Sori R, Marengo JA, Nieto R, Drummond A, Gimeno L(2018) On the hydrological cycle at Negro and Madeira River basins in the Amazon region, submitted to *Water*
- Espinoza, JC, Ronchail J, Marengo JA, Segura H (2018) Contrasting changes in Amazon dry-day and wet-day frequency and related atmospheric features (1981-2017), Submitted to *Theoretical and Applied Climatology*
-Marengo JA, Cunha AP, Nobre CA, Magalhaes AR, Soares WR, Torres RR, Alves LM, Ribeiro-Neto G, Brito SSB, Cuartas LA,l Leal K, Álvala RCS (2018) RISK OF DROUGHT IN THE DRYLANDS OF NORTHEAST BRAZIL DUE TO REGIONAL WARMING ABOVE 4ºC, Submitted to *PNAS.*
- Lapola DM, Pinho PF, Quesada CA, Strassburg BBN, Rammig A, Kruij, Brown IF, Ometto JP, Premebida A, Marengo JA, Vergara W, Nobre CA (2018) - Living with the risk of the Amazon forest dieback while research gaps limit resilience-building action, Submitted to *PNAS.*
-Guzmán, D. A., Mohor, G. S., Taffarello, D., and Mendiondo, E. M.: Economic impacts of drought risks for water utilities through Severity-Duration-Frequency framework under climate change scenarios, Hydrol. Earth Syst. Sci. Discuss, 2017, doi: 10.5194/hess-2017-615, 2017
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-Martins, Minella A.; Tomasella, Javier; Rodriguez, Daniel A.; Alvalá, Regina C.S.; Giarolla, Angélica; Garofolo, Lucas L.; Júnior, José Lázaro Siqueira; Paolicchi, Luis T.L.C.; Pinto, Gustavo L.N. Improving drought management in the Brazilian semiarid through crop forecasting. Agricultural Systems, v.160, p.21 - 30, 2018. Doi: 10.1016/j.agsy.2017.11.002
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11 FAPESP Projects associated to the INC MC Phase 2

Process 15/24099-1
(Jovem Cientista)-Andrea Young-Titulo: Parques lineares como medidas de adaptação às mudanças climáticas: projeto piloto de requalificação urbana e prevenção a desastres ambientais
Vigência: 01 de outubro de 2016 – podendo ser renovado até 30 de setembro de 2020
(developed at CEMADEN)

Process 2017/00627-6
Pos-doc grant: Impact of global climate change on major Brazilian biomes to André de Arruda Lyra (developed at CPTEC INPE)

Process 2017/19403-9
Michael Tulio Ramos de França “Fertility and Inequality: Evidence from Brazil” Scholarships in Brazil – Doctorate Eduardo Amaral Haddad, start omn January 1 2018, end imn February 28 2019.

2014-2017. Fortalecimiento de la RED RICAC: TIC en contextos de vulnerabilidad social para la comunicación de la ciencia y el arte. (3 etapas). Coord. Elisabeth Vidal (Universidad de Córdoba-Argentina), Sandra Murriello (Universidad de Río Negro-Bariloche-Argentina) e Susana Oliveira Dias (Universidade Estadual de Campinas, Brasil). Total: $ 250.000 pesos argentinos;

2017-2018 IMEDIAÇÕES ABERRANTES: PROCESSOS DE PESQUISA-CRIAÇÃO ENTRE ARTES, CIÊNCIAS E FILOSOFIA PARA EXPERIMENTAÇÃO DA COMUNICAÇÃO COMO ECOLOGIA DOS AFETOS - PIBIC-EM 2017-2018 - Faepex e PRP - Unicamp. Coord Susana Dias. Total: 3000,00.

2016-2018. RRI Practice: Pesquisa e Inovação Responsável na Prática. Coordenador geral: Ellen-Marie Forsberg (Oslomet, Noruega); Coordenador da parte brasileira do projeto: Marko Monteiro. Comissão Europeia/H2020 e, convênio com a FUNCAMP. Total: 90.000,00 Euros.

2014-2017. Fortalecimiento de la RED RICAC: TIC en contextos de vulnerabilidad social para la comunicación de la ciencia y el arte. (3 etapas). Coord. Elisabeth Vidal (Universidad de Córdoba-Argentina), Sandra Murriello (Universidad de Río Negro-Bariloche-Argentina) e Susana Oliveira Dias (Universidade Estadual de Campinas, Brasil). Total: $ 250.000 pesos argentinos;

2017-2018 IMEDIAÇÕES ABERRANTES: PROCESSOS DE PESQUISA-CRIAÇÃO ENTRE ARTES, CIÊNCIAS E FILOSOFIA PARA EXPERIMENTAÇÃO DA COMUNICAÇÃO COMO ECOLOGIA DOS AFETOS - PIBIC-EM 2017-2018 - Faepex e PRP - Unicamp. Coord Susana Dias. Total: 3000,00.

2016-2018. RRI Practice: Pesquisa e Inovação Responsável na Prática. Coordenador geral: Ellen-Marie Forsberg (Oslomet, Noruega); Coordenador da parte brasileira do projeto: Marko Monteiro. Comissão Europeia/H2020 e, convênio com a FUNCAMP. Total: 90.000,00 Euros.

12 Financial report: Use of the RT and BC

Use of the RT:

	Valor cada Componente	Valor Gasto	Descrição	SALDO
COORDENAÇÃO	R$ 25.994,92	R$ 8.714,46	Ipad Apple, pagamento de inscrição congresso em Toquio	R$ 17.280,46
DESASTRE NATURAIS	R$ 25.994,92			
ECONOMIA	R$ 25.994,92			
SEGURANÇA ALIMENTAR	R$ 25.994,92			
ENERGIA	R$ 25.994,92			
COMUNICAÇÃO	R$ 25.994,92			
ECOSSISTEMA	R$ 25.994,92			
HIDROLOGIA	R$ 25.994,92	R$ 7.425,70	Publicação revista Copernicus	R$ 18.569,22
SAÚDE				
MODELAGEM	R$ 25.994,92			
	R$ 233.954,28			

Use of the BC: Year 2017-2018

PI	BC individual para PIs	Valor Gasto	Descrição	Saldo
JOSÉ ANTÔNIO MARENGO ORSINI	R$ 12.000,00	R$ 12.000,00	Fórum Global sobre Ciência e Tecnologia para Resiliência a Desastres 2017 -O Fórum será realizado no Conselho Científico do Japão (SCJ), em Tóquio- 20/11/2017 a 30/11/2017 - pagamento de 10 diarias US$ 400,00	0
REGINA CÉLIA ALVALÁ	R$ 12.000,00			
EDUARDO AMARAL HADADD	R$ 12.000,00			
EDUARDO D. ASSAD	R$ 12.000,00			
ENIO B. PEREIRA	R$ 12.000,00	R$ 1.800,00	Participar VII Congresso Brasileiro de Energia em Gramado de 17 a 20 de abril de 2018	

ANTONIO C RODRIGUES AMORIM	R$ 12.000,00			
EDUARDO MENDIONDO	R$ 12.000,00	R$ 1.665,00	presentar e moderar mesas sobre segurança hídrica em espaços metropolitanos no XXII Simp. Bras. Rec. Hídricos, Florianópolis-SC, de 26 a 29 de novembro.	
PAULO NOBRE	R$ 12.000,00			

Use of the BC: Year 2018 (Partial)

PI	BC individual para PIs	Valor Gasto	Descrição	Saldo
JOSÉ ANTÔNIO MARENGO ORSINI	R$ 12.000,00	R$ 6.498,00	Participar na próxima reunião do projeto RICCADAPT para a Avaliação de Atuação de Adaptação a Câmbio Climático na Iberoamérica no EQUADOR- Período 10/03/2018 a 17/03/2018- pagamento diaria - pagamento de 8 diarias US$250,00	R$ 4.932,00
		R$ 285,00	Pagamento de 1 diaria sem per noite - Participar 2º reunião de autores de relatório Especial "Clima e Biodiversidades " do painel Brasileiro de Mudanças Climáticas- Rio de Janeiro 04/05/2018	
		R$ 285,00	Pagamento de 1 diaria- sem pernoite - REUNIÃO TÉCNICA DA COMPONENTE DE VULNERABILIDADE E ADAPTAÇÃO- Brasilia 08/05/2018	

13 Plans for Year 2 and expected interaction with other INCTs

Food security:

The food security component will continue with Activities 1 and 2 and will start with Activity 3, to assess the impact on livestock / small ruminants due to changes in the availability of pasture and implications to family farmers and in the global food market. Participation un 1 international conference and 2 national conferences. These activites are planned:
-Test of dynamical multiregional models with focus on planned activities in Brazil for AFOLU sector, as well as to assess the complex mechanisms of feedback.
-Development of an integrated analysis combining biophysical and economical variables and to Interact with climate change scenarios and socioeconomically drivers (INPE, FGV, USP).
-First step of the inventory of soil occupation in Brazil. The assessment of anthropic influences in the cerrado and Atlantic forest biomes.
-Together with the Rede Clima this component is creating a database to verify relationships between water, food and energy security in a pilot Project based at the Sao Francisco River Basin in Northeast Brazil. The data is ready for sharing since March 2018 and the maintenance and continuity of this data base system depends on the continuation of the CNPq DTI B fellowship. A paper by Pugliero et al (2018) will be presented in a Conference in Aracaju SE in June 2018.

Water security:

-the Virtual Interactive Library, planned in the original proposal, will be converted into a more feasible framework of the new Socio-Hydrological Observatory for Water Security-SHOWS (Mendiondo et al, 2017), which will be established to better achieve objectives and goals of Water Security subcomponente (pages 34-72 of INCTMC2 proposal);
-the SHOWS framework will be tested in the period 2018/2019 through understanding risk perception and enigma of peoples' memory through social-hydrology (FAPESP Grant 2018/03473-0, UK Academies Call), by an UK Scholar, with a role played of visiting and starting dialogues among EESC-USP's, IAG-USP's and CEMADEN's researchers in the field of water security, sociohydrology and climate change,
-the INCTMC2-Water Security Workshop held in April 2018 recommended new co-funding initatives to help the running INCTMC2 project, especially for granting interdisciplinary research in cross-cutting fields linked with environmental, social and economic subcomponentes; one initiative will be a future School of Advanced Studies to bring co-sponsored international talks through distinguished scholars around water security and global change in SP and other INCTMC2 associated institutions in the Brazilian territory,
-FAPESP CEPID/CeMEAI-Phase 2 "Centre of Applied Maths for Industry" (2018-2023) invited INCTMC2 Water Security representative, as an Associated Researcher, to promote INCT-CEPID dialogues and talks on cutting-edge solutions of water security under climate change with high impacts in crosscutting issues of the nexus "water-energy-food-biodiversity-health",
-because budgetary restrictions to the INCTMC2 original proposal, new actions with extramurally funding for national/international research cooperation with the INCTMC2 running project are planned through submitted proposals (under review on 26 June, 2018) as follows:
--with United Kingdom: 2018-2019, São Paulo International Collaboration-FAPESP/Univ Warwick, UK-Brazil nexus water, health and urban resilience,
--with Iberoamerican Countries, 2018-2021, ERA-NET Joint Call & EU-LAC Int Cooperation/FAPESP, Int. Consortium, Design Patterns for Biodiversity and Climate Change,
--with European and Latin American countries, 2018-2022, CYTED Call 2018, Resilience of Water Resources Under Climate Change, Int. Consortium

--with Japan, 2018-2019, JSPS-FAPESP Workshop, Kyoto Univ/USP, Coping with Water-related Disasters under Changing Climate
--in the Brazilian territory, 2018-2020, CNPQ/SESCOOP Nº 07/2018, Cooperative Platform for Adapting Vulnerable Communities to Urban Flood Risks Under Scenarios of Climate Change in the Brazilian Territory,

Energy Security:

Planned activities for 2nd year

-*Vulnerability of Brazilian solar and wind power resource to climate change*

Updated solar resource maps (BRASIL-SR runs) and wind resources (exits of the Reanalysis / Mesoscale model) will be validated against surface observations of the INMET and SONDA networks in order to evaluate the uncertainties associated to the model. To evaluate future impacts on the energy sector, these maps will be used for bias removal comparing the results of the prognostic model with the rounds of climate models for the reference period (1980-2010). These statistical downscaling models will be applied to the future climate scenario to evaluate the mean trends and frequency changes of extreme events..

-*Improvements on satellite-based solar radiation model (BRASIL-SR)*

Solar radiation variability is a key factor for future energy matrix development and satellite-based models is an outstanding tool for this assessment. Improvements on BRASIL-SR model code is necessary to improve cloud detection, aerosol and direct radiation partition algorithms. Furthermore this procedure will to take advantage of new sensors and channels provided by GOES-16 satellite.

-*Long-term variability and* complementary patterns over Brazilian energy matrix

Calibrated historical datasets for daily wind speed and solar irradiation will be assessed for long term variability patterns using Principal Components Analysis (PCA) (for wind and solar separately). Combined variability (complementary) will be investigated from Canonical Correlation Analysis (CCA), identifying regions where solar and wind resource shall provide a more reliable energy supply over long periods. These results will be compared to historical time series of river outflow from main hydroelectric basins provided by Brazilian TSO (ONS) to evaluate anti-correlated regions that contribute to long term Brazilian energy matrix security.

-*C*omplementary patterns over Brazilian energy matrix

Intense drought events impacted reservoirs of major power plants in Brazil in the last decades. For example, in 2001, a combination of increased energy demand and a long and intense drought led the country to a collapse of the hydroelectric system in the Southeastern region (Kane, 2002). Similar conditions happened again in the 2013-2015 period in the Brazilian Northeastern. Preliminary studies indicated that a hybrid system, hydro-bioenergetic and/or hydro-solar, could have faced drought periods without compromising the water storage and the power generation (Pimenta e Assireu (2015); Azeredo, 2017). To evaluate what contribution such hybrid systems would bring to the Brazilian Interconnected System, a model development will be accomplished to simulate the regularization of the level of reservoirs based on the contribution of the bioenergy (algae) and solar resources running in the hydropower plants reservoirs.

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

-Creation of a preliminary database including environmental, physical, socioeconomic and historical data of occurrences of natural disasters for pilots municipalities. Environmental and physical variables: Rainfall data from Weather Forecasting and Climate Research (CPTEC/INPE) and National Centre for Monitoring and Early Warning of Natural Disasters; Vegetation Health Index (VHI) from National Oceanic and Atmospheric Administration (NOAA; available online at http://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/vh_ftp.php); Water storage information of reservoirs located in pilot municipalities from Water National Agency (ANA) and Olho n'água Program; Socioeconomic data and historical occurrences of natural disasters; BATER´s data associated with pilots municipalities from IBGE-CEMADEN; Data of occurrence of natural disasters from S2ID and from Atlas of CEPED-UFSC; Data of the "Agropecuário" Census (2017) and Demographic Census (2010); Data of occurrence of disasters from CEMADEN
-Analysis of extreme precipitation events in the pilot municipalities that lead to natural disasters: Rainfall data from Center for Weather Forecasting and Climate Research (CPTEC/INPE) will be used to calculate the Standardized Precipitation Index (SPI) to identify the extreme wet and dry events in the pilot municipalities.
-Characterization of drought events: It is important to assess the severity, duration and frequency of drought events, because it is related to the impacts on the ecosystems, agriculture/livestock and the hydrological cycle. For this purpose, the previous methodologies developed by Spinoni et al. (2014; 2015) will be adapted: Studies of impacts of extreme precipitation in the water availability of the pilots municipalities; Studies of impacts of extreme precipitation in the mass movement on slopes on pilots municipalities

In the next year we intend to assess the study area in order to investigate the better adaptation and risk reduction actions, not only from a technical point of view, but also considering their adherence to actions already in course or planned. The procedure consists in a process, step or analytical tool, to analyze a policy, plan or program, indicating the climate change risks associated to long-term development goals (OECD, 2011). The climate change risks analysis starts taking into account the potential impact index, which can also be reproduced in detail scale, if there is available data base. However, other specific analyses of sensitivity / susceptibility, including socio-economic vulnerability, also are relevant.

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

The Amazon component of the Ecosystems subproject will continue to study critical processes that control the functioning of the Amazonian ecosystem. We will conduct experiments that analyze the biogenic emissions of vegetation in terms of the so-called "primary biological particles" component, as well as the emissions of biogenic volatile organic compounds. We will also study the role of aerosols and clouds in controlling the radiation balance in central Amazonia. We will expand the area of study in Amazonia, carrying out several expeditions using boats in the western region of the Amazon, along the rivers Madeira and Solimões. We will also prepare a review paper, comparing atmospheric properties of tropical forests, and compare them with boreal forests.

Economy and impacts in key sectors:

Plans for the second year include an approximation with researchers from the subcomponent "Water Security", to develop joint projects. Moreover, the Fapesp approved scholarship abroad for Paula Pereira Pereda, to develop the project "Assessing the Climate and Weather Effects in Brazil using Panel Data" at Yale University, will provide additional incentives to integration with other areas of the INCT MC Phase 2 , mainly related to health and agriculture.

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

Coupling of Global Eta Framework – GEF to MOM6 via FMS coupler;

Performing BESM2.8.1 CMIP6 DECK, Scenarios climate change scenarios;
Upload BESM2.8.1 scenarios to ESGF/INPE distribution infrastructure;
Promoting a training school for the use of the FMS Runtime Environment (FRE) toolset;
Promoting a training school on the use of the Eta Model;
Further development of the chemistry component of the model
Perform long-term integrations at high resolution to assess the impacts of climate change on the Brazilian major biomes

Communication, dissemination of knowledge and education for sustainability:

Implementation of two DTIC scholarships aiming at:
- Identify the communication demands of the INCT Climate Change researchers through interviews;
- Make these demands available to the cross cutting theme researchers and encourage the transformation of such demands on communication in experiments to be developed in sub-projects;
- Create and implement an artifact of general communication of the INCT Climate Change which meets the interests of the INCT coordination (internal communication system, or a page etc.);
- Collaborate with the finalization of the collective production of a document of national and international impact - "I National Report on Communication, Education and Climate Change" - similar to the first Communication IPCC held in early 2016 and to the COP-21 Simulation Conference sponsored by Bruno Latour, to be launched by the cross cutting theme in 2019;
- Produce news for the Labjor-Unicamp magazines - ClimaCom, ComCiência and Ciência & Cultura - as well as other communication vehicles.
- Implementation of a scholarship for the undergraduate research mentorship program Pibic-CNPq to work the relation between scientific communication and education.
- Requesting for a scholarship for the master´s degree program to research the relation between climate change and cinema.
- Conducting meetings (face-to-face and by Skype) of researchers of the Cross Cutting Theme for: planning; analysing of documents; sharing of the research developed by each researcher in his institution; inviting the other INCT scientists to present their work and expanding the relations with the researchers of the Cross Cutting Theme;
- Producing publications (for congresses, articles, books, chapters). Already planned, we highlight the release of the books: DIAS, Susana; WIEDEMANN, Sebastian; AMORIM, Antonio C. Connections: Deleuze and Cosmopolitics and Radical Ecologies and New Earth and ..., Campinas: ALB Publishing House, 2018, 378p. (in press); DI GIUILIO, Gabriela; MONTEIRO, Marko (orgs.) Comunicação, política e representação: Interfaces com ciência, tecnologia e ambiente. SãoPaulo: HUCITEC, no prelo (in press).
- Release three new dossiers of ClimaCom magazine: "Anthropocene Dialogues", "Transdisciplinarity" and "Displacements".

15. Collaboration with other INCTs and Research networks

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

Process 465540/2014-7
INCT para Adaptações da Biota Aquática da Amazônia -ADAPTA-II
Coordinator: Adalberto Luis Val
INPA - Instituto Nacional de Pesquisas da Amazônia

Process 465680/2014-3

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

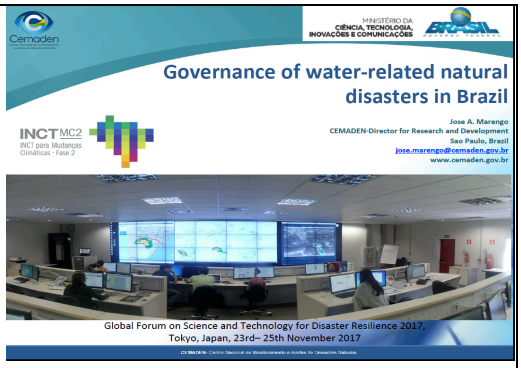
Process: 465319/2014-9
Instituto Nacional de Ciência e Tecnologia do Bioetanol
Coordinator: Marcos Silveira Buckeridge
USP - Universidade de São Paulo

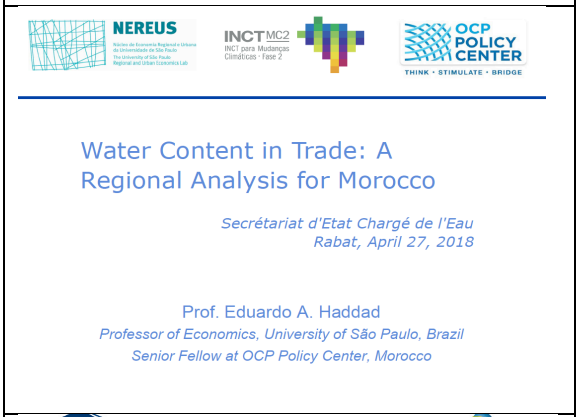
Porocess: 465583/2014-8
Instituto Geotécnico de Reabilitação do Sistema Encosta- Planície e Desastres Naturais
Coordinator: Willy Alvarenga Lacerda
UFRJ - Universidade Federal do Rio de Janeiro

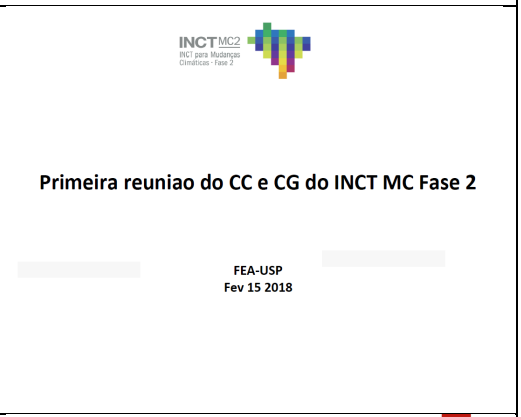
Process: 465436/2014-5
Instituto Nacional de Ciência e Tecnologia em Áreas Úmidas II (INCT-INAU II): Inovações em Pesquisa, Manejo e Políticas Públicas em Áreas Úmidas
Coordinator: Wolfgang Johannes Junk
UFMT - Universidade Federal de Mato Grosso

Annexes

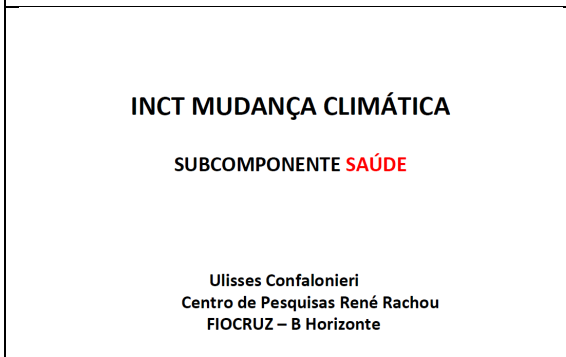
Presentations of the INCT MC Phase 2

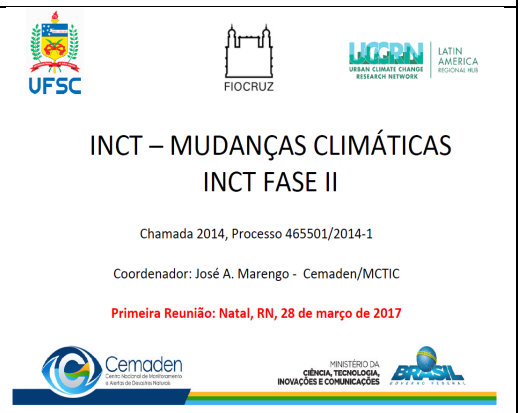


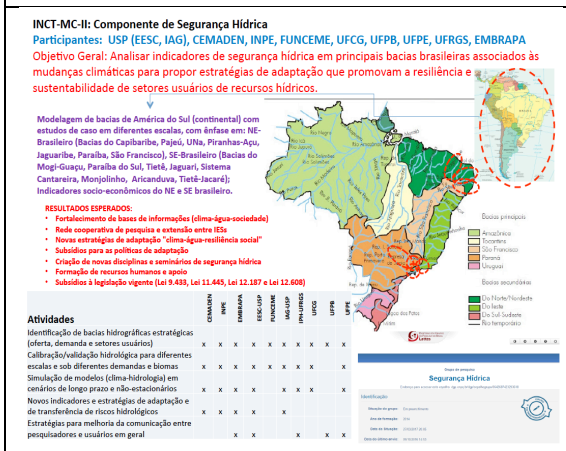


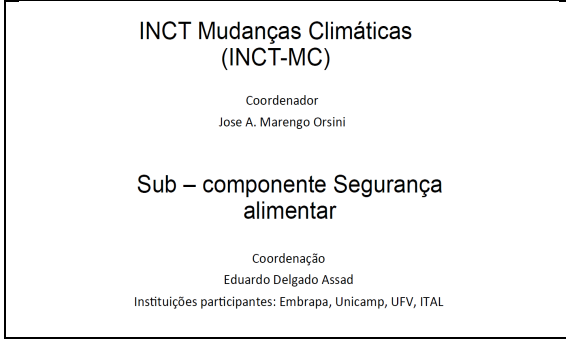


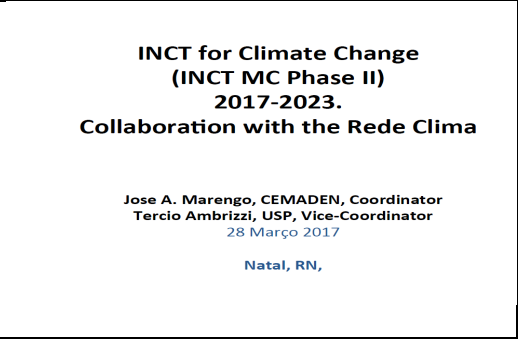
Presentations at the kick-off meeting in Natal, RN 2017

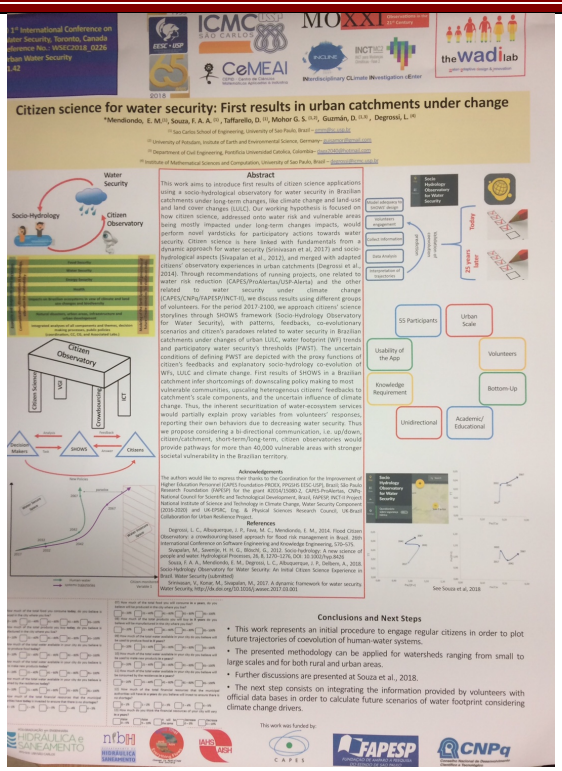











Citizen science for water security: First results in urban catchments under change
Abstract
Conclusions and Next Steps
• This work represents an initial procedure to engage regular citizens in order to plot future trajectories of coevolution of human-water systems.
• The presented methodology can be applied for watersheds ranging from small to large scales and for both rural and urban areas.
• Further discussions are presented at Souza et al., 2018.
• The next step consists on integrating the information provided by volunteers with official data bases in order to calculate future scenarios of water footprint considering climate change drivers.
This work was funded by:


Crowdsourcing with social media and big data for water-and-health risk reduction
Abstract
This work was funded by:

]

I Reunião do INCT Mudanças Climáticas Fase 2

Natal RN, 28/03/2017

9:00-9:30 am	Apresentação Geral - J. Marengo, T. Ambrizzi
9:30-10:00 am	Componente Saúde - U. Confalonieri
10:00-10:30 am	Componente Modelagem – S. Chou
10:30-11:00 am	Componente Energia – E. B. Pereira
11:30-12:30 pm	Almoço
12:30-1:00 pm	Componente recursos hídricos – S. Montenegro
1:00-1:30 pm	Componente Desastres Naturais-R. Alvala
1:30-2:00 pm	Componente Economia – J. Feres
2:30-3:00 pm	Componente Comunicações – C. Cantarino
3:00-3:30 pm	Componente Segurança alimentar - E. Assad
3:30-4:00 pm	Coffee break
4:00-5:30 pm	Discussões e interações entre componentes - J. Marengo, T. Ambrizzi
5:30-600 pm	Interações com a Rede Clima - M. Araujo

Global Forum on Science and Technology for Disaster Resilience 2017

Date: 23rd – 25th, November, 2017

Venue: Science Council of Japan and National Art Center, Tokyo, JAPAN

Organizers: Science Council of Japan (SCJ), United Nations International Strategy for Disaster Reduction (UNISDR), Integrated Research on Disaster Risk (IRDR), Public Works Research Institute (IRDR) and National Research Institute for Earth Science and Disaster Resilience (NIED)

Draft Agenda

Day 1 (Thursday, 23rd November, 2017)

8:30 - 9:30 Registration

Discussant:

- Dr. Jose Antonio Marengo, Senior Scientist / CEMADEN
- Prof. Djillali Benouar, Professor / University of Sciences & Technology Houari Boumediene (USTHB)
- Dr. Sebastian Sippel, Researcher / Future Earth Extreme events and environments – from climate to society (E3S)

INCT MC2
INCT para Mudanças Climáticas · Fase 2

I Workshop INCT MC2 2018:

"Segurança Hídrica no Brasil: Desafios e Oportunidades de Adaptação às Mudanças Climáticas"

Auditório do IAG/USP, São Paulo, 26-27 de abril de 2018

Contexto - Com apoio do Instituto Nacional de Ciência e Tecnologia em Mudanças Climáticas Fase 2 (INCTMC2), e com participação da Agência Nacional de Águas, este I Workshop retoma uma agenda de diálogo não-fragmentado sobre a segurança hídrica no Brasil. Para atender às múltiplas dimensões regionais, este I Workshop compartilha experiências de gestores públicos, tomadores de decisões e científicos do INCTMC2. São promovidas estratégias de adaptação intersetoriais e interdisciplinares em torno da segurança hídrica sob impactos de cenários de mudanças climáticas no Brasil, incluindo desafios e oportunidades com outras áreas do INCTMC2 e doutros INCTs vigentes. Os especialistas em segurança hídrica terão como meta deste I Workshop assegurar o compartilhamento de informações para progresso científico, tecnológico e social sobre segurança hídrica. Os resultados serão incorporados em relatórios técnicos e artigos de coautoria dos participantes para revistas de seletiva política editorial, sob convite de Editores de revistas internacionais.

Programa*

Dia 1, 26.04.2018: "Experiências e desafios"

8:30-9:00h, Abertura e Boas Vindas, Prof. T Ambrizzi, IAG/USP, Vice-Coordenador do INCTMC2
9:00-9:30h, Objetivos do I Workshop, Prof. S. G. Montenegro, UFPE
9:30-10:30h, Palestra: **Segurança Hídrica sob Mudanças no Brasil**, Prof. Oscar Cordeiro Neto, Diretor da Agência Nacional de Águas (ANA)
9:30-9:45h, Coffee-Break
9:45-10:30h, 1°. Diálogo: "Segurança Hídrica e Clima no Nordeste Brasileiro", Moderador: Prof. Assis Filho, UFC
Debatedores: Prof. Dr Carlos Galvão, UFCG, Profa. Dra Suzana Montenegro, UFPE, Prof Dr E. S. P. R Martins, FUNCEME
10:45-12:00h, 2°. Diálogo: "Segurança Hídrica e Clima em Amazônia Brasileira", Moderadora: Dr A Lyra, INPE
Debatedores: Dr. Javier Tomasella, CEMADEN, Apresentação 4, Prof Dr. Daniel Rodrigues, INPE/UFRJ.
11:45-14:00h, Intervalo para Almoço
14:00-14:00h, 3° Diálogo: "Segurança Hídrica e Clima no Sudeste Brasileiro", Moderador: Prof. M Mendiondo, EESC/USP
Debatedores: Dra. Adriana Cuartas, CEMADEN, Prof Dr. Humberto Rocha, IAG/USP, Dr. Ricardo Figueiredo, EMBRAPA
15:15-15:30h, Coffee-Break
15:30-17:00h, Conclusões e Recomendações do Dia 1, Moderador: Prof. E Mario Mendiondo, EESC/USP

27.04.2018, Dia 2: "Oportunidades e ações"

9:30-10:30h Palestra e Discussão: Segurança Hídrica Continental sob Mudanças, Prof. W. Collischonn, UFRGS
9:30-9:45h, Coffee-Break
10:45-12:00h, 4°. Diálogo: "Participação e Co-autoria de Artigos de Segurança Hídrica sob Mudanças Climáticas no Brasil", Moderador: Prof. E Mario Mendiondo, EESC/USP
12:00-14:00h, Intervalo para Almoço
14:00-15:15h, 5° Diálogo: "Compartilhando Dados para Atlas de Segurança Hídrica sob Mudanças Climáticas", Moderador: Prof. S. G. Montenegro, UFPE
15:15-15:30h, Coffee-Break
15:30-16:00h, Cronograma Físico e Financeiro de Segurança Hídrica/INCTMC2 2018-2022
16:00-16:30h, Conclusões e Recomendações do Dia 2. Moderador: Prof. E. M. Mendiondo, EESC-USP

Este I Workshop do INCTMC2 é apoiado por:

ANA AGÊNCIA NACIONAL DE ÁGUAS · CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico · FAPESP Fundação de Amparo à Pesquisa do Estado de São Paulo · CAPES

INCT – MUDANÇAS CLIMÁTICAS (INCT FASE II)

I Workshop da Sub componente: Desastres Naturais, Áreas Urbanas, Infraestrutura Física, Desenvolvimento Urbano

São José dos Campos, 10 de abril de 2017 (CEMADEN - Parque Tecnológico de S. J.C.)

Agenda Tentativa do Workshop

9:00 – 9:15 – INCT-II - Contextualização Geral – José Marengo (CEMADEN)

9:15 – 9:30 – Apresentação Institucional do CEMADEN – Regina Alvalá (CEMADEN)

9:30 – 9:40 – Monitoramento e Impactos Seca – Ana Paula Cunha e Sheila Brito (CEMADEN)

9:40 – 9:50 – Monitoramento e Modelagem Hidrológica da Seca – Adriana Cuartas e Karinne Leal (CEMADEN)

09:50 – 10:00 – Vulnerabilidades no contexto de DN – Pedro Camarinha (CEMADEN)

10:00 – 10:10 – Comunicação de risco de DN – Sílvia Saito (CEMADEN)

10:10 – 10:30 – Intervalo

10:30 – 11:00 – Extremos Meteorológicos e DN – Regina Rodrigues (UFSC)

11:00 -11:30 – Adaptação e desenvolvimento urbano sustentável - Martha Barata (FIOCRUZ)

11:30 – 12:00 – Vulnerabilidade Clima-Saúde – Ulisses Confalonieri (FIOCRUZ)

12:00 – 13:30 – Almoço

13:30 – 14:00 – Visita à Sala de Situação

14:00 – 15:00 – Mesa redonda: Discussões sobre contribuições interinstitucionais para o sub-projeto de DN no INCT-II – Todos

15:00 – 16:00 – Mesa redonda: Discussões sobre aspectos metodológicos do sub-projeto de DN no INCT-II

16:00 – 17:00 – Encaminhamentos

Workshop de planejamento de atividades: subcomponente economia e impactos nos setores chave

Data: 13 de junho de 2017

Horário: 14 – 18:00 hs

Local: FEA-USP

Justificativa: reunir os participantes do subcomponente "economia e impactos nos setores chave" para discussão dos diferentes modelos econômicos a serem utilizados na avaliação dos impactos das mudanças climáticas no Brasil, bem como identificar possibilidades de integração entre estes diferentes modelos. A agenda do workshop prevê ainda o planejamento de atividades para o primeiro ano de trabalho e a discussão sobre alocação das bolsas destinadas ao subcomponente.

Agenda preliminar:

14:00 hs – 15:00 hs: apresentação geral dos eixos temáticos e possibilidades de integração

- Informes gerais sobre o projeto
- "Eixo temático 1: construção, atualização e implementação de modelos EGCs aplicados às questões de mudanças climáticas globais" (Eduardo Haddad)
- "Eixo temático 2: Modelos econométricos aplicados às questões de mudanças climáticas globais" (José Féres)
- Integração entre eixos temáticos e demais subcomponentes do projeto INCT (Sérgio Margulis)

15:00 – 17:00 hs: apresentação dos temas de pesquisa

- Cada participante terá 10 minutos para expor seu tema de pesquisa

17:00 – 18:00 hs: Discussão final (moderada pelos coordenadores do subcomponente)

- Planejamento de atividades e possibilidades de integração para o primeiro ano
- Alocação de recursos de bolsa

Agenda para a reunião de lideres de componente (CC) e do CG do INCT MC Fase 2

FEA/USP
Fev 15 2018 (9 AM-4 PM)

Manha:

Para a reunião do CC-Comitê Cientifico:

a) Relatório da coordenação:
b) Relatório do tema Segurança Hídrica
c) Relatório do tema Segurança Alimentar
d) Relatório do tema Segurança energética
e) Relatório do tema Saúde
f) Relatório do tema Economia e impactos em setores chave
g) Relatório do tema Comunicação, difusão do conhecimento, Educação para sustentabilidade
h) Relatório do tema Modelagem do sistema terrestre e produção de cenários futuros de clima para estudos de IVAR
i) Relatório do tema Desastres naturais, áreas urbanas, infraestrutura física, desenvolvimento urbano
j) Relatório do tema Impactos nos ecossistemas brasileiros em vista de mudanças de uso de solo e biodiversidade
h) Discussões

Tarde:

Para a reunião do CG-comitê gestor:

a) Regras para distribuição de recursos e bolsas
b) Politica sobre pagamento para publicações e open access.
c) Politica sobre pagamento para participação em eventos nacionais e internacionais estratégia para acompanhar o desenvolvimento do projeto.
d) Interações e contatos com outros INCTs e Rede Clima
e) Conexões internacionais do INCT MC Fase 2

Some papers derived from the project

water

MDPI

Article

The Atmospheric Branch of the Hydrological Cycle over the Negro and Madeira River Basins in the Amazon Region

Rogert Sorí [1,*], José A. Marengo [2], Raquel Nieto [1], Anita Drumond [1] and Luis Gimeno [1]

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[2] National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN), São José dos Campos, São Paulo 12247-016, Brazil; jose.marengo@cemaden.gov.br
* Correspondence: rogert.sori@uvigo.es; Tel.: +34-988-387-208

Received: 6 May 2018; Accepted: 2 June 2018; Published: 5 June 2018

Abstract: The Amazon region, in South America, contains the largest rainforest and biodiversity in the world, and plays an important role in the regional and global hydrological cycle. In the present study, we identified the main sources of moisture of two subbasins of the Amazon River Basin, the Negro and Madeira River Basins respectively. The source-sink relationships of atmospheric moisture are investigated. The analysis is performed for the period from 1980–2016. The results confirm two main oceanic moisture sources for both basins, i.e., oceanic regions in the Tropical North and South Atlantic oceans. On the continents are, the Negro River Basin itself, and nearby regions to the northeast. For the Madeira River Basin, the most important continental sources are itself, and surrounding regions of the South American continent. Forward-trajectory analysis of air masses over the source regions is used to compute the moisture contribution to precipitation over basins. Oceanic (continental) sources play the most important role in the Negro River Basin (Madeira River Basin). The moisture contribution from the Tropical North Atlantic region modulates the onset and demise of the rainy season in the Negro River Basin; while the moisture contribution from the rest of the Amazon River Basin, the Madeira Basin itself, and Tropical South America leads to the onset of the rainy season in the Madeira River Basin. These regions also played the most important role in decreasing the moisture supply during most severe dry episodes in both basins. During "El Niño", generally occurs a reduction (increase) of the moisture contribution to the Negro River Basin (Madeira River Basin; mainly from April to August) from almost all the sources, causing a decrease in the precipitation. Generally, the contrary occurs during "La Niña".

Keywords: hydrological cycle; sources of moisture; moisture transport; precipitation; water level; dry episodes; Negro River Basin; Madeira River Basin

1. Introduction

The Amazon River Basin (ARB) (Figure 1) hosts the world's largest tropical rainforest and drainage basin on the planet. It is an important source of natural resources for human economic development and is characterised by large biodiversity. Its drainage area includes more than one-third of the South American continent and the discharge of the Amazon River (AR) accounts for almost one-fifth of the total discharge of all rivers of the world [1]. The ARB contains several subbasins. The most important subbasins are the Negro and Madeira River basins (NRB, MRB; Figure 1) in the north and southwest, respectively. The Negro and Madeira Rivers (NR and MR respectively) are the most important Amazonas tributaries, contributing more than one-third of the total water discharge [1]. Consequently, the ARB plays an important role in the local and regional hydrological cycle [2–4].

ARTICLE IN PRESS

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ELSEVIER

Hydrological services in the Atlantic Forest, Brazil: An ecosystem-based adaptation using ecohydrological monitoring

Denise Taffarello[a,*], Maria do Carmo Calijuri[a], Ricardo A. Gorne Viani[b], José A. Marengo[c], Eduardo Mario Mendiondo[a]

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ARTICLE INFO

Keywords:
Ecohydrology
Hydrological services
Payments for ecosystem services
Adaptive management
Climate change
Brazilian Atlantic Forest

ABSTRACT

Ecosystem-based Adaptation (EbA) involves using services on which human well-being depends to help people adapt to the impacts of climate change. Aiming at strengthening ecosystem resilience and reducing ecosystem and people's vulnerability, EbA has been encouraged worldwide as an option for climate change. Payments for Ecosystem Services (PES) are incentives offered to farmers and landowners to provide an ecological service and are currently proposed as a method for EbA and water resources sustainability on a global scale. However, organized information on PES in Brazil is limited. This paper provides a concise review of PES initiatives in the Brazilian Atlantic Forest, where various PES projects on watershed protection (Water-PES) have been set up. We found 16 ongoing Water-PES in the Brazilian Atlantic Forest. The first initiative was launched in 2005 and since then these projects have grown rapidly. In spite of the advances made in many of these initiatives, they seldom have baseline hydrologic data and an implemented strategy for ecohydrological monitoring. Thus, we discuss how PES projects could be more effective by implementing hydrological monitoring based on ecohydrological concepts. Special attention has been given to explaining how the recent Impact-Vulnerability-Adaptation idea could be integrated into Water-PES. As can be seen from the review, these projects contribute as EbA options for climate change, thereby carrying practical implications for environmental policy makers.

1. Introduction

Brazil has the largest biological diversity in the world and 35% of its biodiversity can be found in the Atlantic Forest. This biome boasts high levels of endemism, species richness, but also has high rates of devastation. Only 11–16% percent of the Brazilian Atlantic forest still remains on the coastline (Ribeiro et al., 2009; Viani et al., 2012) and a 40-50 km zone extending inland (Ab'Sáber, 2003), although there have been trends of an incipient net growth in specific areas (Molin et al., 2017).

In spite of being reduced and fragmented, the Atlantic Forest has greater plant species diversity (20,000 vascular plant species, Myers et al., 2000) than that found in North America (about 17,000 species) and Europe (around 12,500 species). Therefore, the Atlantic Forest is one of the world's most important areas for biodiversity conservation (Brazil, 2015).

Due to the global importance of this biome, because (i) it is a biodiversity hotspot (from a total of 36 hotspots on the planet) and (ii) comprises a carbon sink, the Atlantic Forest can provide an important opportunity for restoration or conservation initiatives of economic importance. One of these initiatives is the Atlantic Forest Restoration Pact (Melo et al., 2013; Rodrigues et al., 2009), which is a public-private partnership that aims to restore 150,000 km² of forest by 2050 using native species.

Moreover, the Payments for Ecosystem Services (PES) adopting incentive strategies to conserve (Buckley and Pegas, 2014; Joly et al., 2014) or restore (Banks-Leite et al., 2014; Palmer and Filoso, 2009) ecosystems offers possible solutions to prevent the degradation of water resources and related ecosystems. This procedure can be instrumental not only to reduce the risks of inadequate land use, but also to manage and adapt to climate change (Underwood, 2015; Seppelt et al., 2011).

In turn, the concept of Ecosystem-based Adaptation (EbA) as 'using biodiversity and ecosystem services to help people adapt to the adverse effects of climate change' was defined by the Convention on Biological Diversity – 10th Conference of the Parties (CoP) (CBD, 2010). According to EbA, protecting ES is required to help people and ecosystems

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ACADEMIA BRASILEIRA DE CIÊNCIAS

Drought monitoring in the Brazilian Semiarid region

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ABSTRACT

Drought is a natural and recurrent phenomenon. It is considered 'a natural disaster' whenever it occurs in an intensive manner in highly populated regions, resulting in significant damage (material and human) and loss (socioeconomic). This paper presents the efforts developed to monitor the impact of drought in the semiarid region of Northeast Brazil. In this scope, information from different sources is compiled to support the evaluation and identification of impacted municipalities, with the main objective of supporting emergency actions to mitigate their impact. In the semiarid region of Brazil there are frequent occurrences of dry periods during the rainy season, which, depending on the intensity and duration, can cause significant damage to family-farmed crops, with a farming system characterized by low productivity indices. However, rain-fed agriculture has great economic expression and high social importance due to the region is densely occupied, and contributes to the establishment of communities in the countryside. Specifically, in the present study, the methodology adopted to monitor the impact of agricultural droughts, including an analysis of the hydrological year 2015-2016, is presented, considering different water stress indicators for the identification of the affected municipalities and assessment of the methods and tools developed.

Key words: agriculture, drought impacts, drought monitoring, semiarid, dry farming, Northeast Brazil.

INTRODUCTION

During the past decades, droughts have increasingly drawn the attention of environmentalists, ecologists, hydrologists, meteorologists, agronomists, and decision makers. Generally, droughts are classified as either a meteorological drought (lack of precipitation over a region for a period of time), hydrological drought (deficiencies in surface and subsurface water supplies), agricultural drought (deficiency in water availability for crop or plant growth) or socioeconomic drought (failure of water resources systems to meet water demands, which impacts human activities both directly and indirectly) (Wilhite 2000, Yang 2010, Son et al. 2012, Udmale et al. 2014, Eakin et al. 2014). This natural and recurrent phenomenon is considered to be 'a natural disaster' whenever it occurs in an intensive manner in highly populated regions,

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ACADEMIA BRASILEIRA DE CIÊNCIAS

Climatic characteristics of the 2010-2016 drought in the semiarid Northeast Brazil region

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ABSTRACT

This study discusses the climatological aspects of the most severe drought ever recorded in the semiarid region Northeast Brazil. Droughts are recurrent in the region and while El Nino has driven some of these events others are more dependent on the tropical North Atlantic sea surface temperature fields. The drought affecting this region during the last 5 years shows an intensity and impact not seen in several decades in the regional economy and society. The analysis of this event using drought indicators as well as meteorological fields shows that since the middle 1990s to 2016, 16 out of 25 years experienced rainfall below normal. This suggests that the recent drought may have in fact started in the middle-late 1990s, with the intense droughts of 1993 and 1998, and then the sequence of dry years (interrupted by relatively wet years in 2007, 2008, 2009 and 2011) after that may have affected the levels of reservoirs in the region, leading to a real water crisis that was magnified by the negative rainfall anomalies since 2010.

Key words: drought, Northeast Brazil, rainfall, water deficit, El Nino, vulnerability.

INTRODUCTION

The first two decades of the 21st Century are being characterized by extreme climatic events that have led to natural disasters in central South America: drought in Northeast Brazil (NEB) during 2010-2016; drought in southeastern Brazil in 2014-15; droughts in Amazonia in 2005, 2010 and 2016; floods in Amazonia in 2009 and 2014; drought in Bolivia in 2016, with some of them almost synchronized, for example, intense floods in in Amazonia and drought in NEB in 2012-13. The meteorological and oceanic mechanisms that lead to circulation and rainfall changes responsible for drought in NEB have been reported elsewhere, and they refer to the occurrence of El Nino, or to an anomalously warm tropical North Atlantic, or a combination of both (Nobre et al. 2016, Coelho et al. 2012, 2015a, b, Marengo et al. 2012, 2014, 2015, 2016a, b, Silva et al. 2013, Rodrigues and McPhaden 2014).

Considering the drought as a natural disaster, its occurrence compromises water and energy

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Biomass burning in the Amazon region causes DNA damage and cell death in human lung cells

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Most of the studies on air pollution focus on emissions from fossil fuel burning in urban centers. However, approximately half of the world's population is exposed to air pollution caused by biomass burning emissions. In the Brazilian Amazon population, over 10 million people are directly exposed to high levels of pollutants resulting from deforestation and agricultural fires. This work is the first study to present an integrated view of the effects of inhalable particles present in emissions of biomass burning. Exposing human lung cells to particulate matter smaller than 10 μm (PM_{10}), significantly increased the level of reactive oxygen species (ROS), inflammatory cytokines, autophagy, and DNA damage. Continued PM_{10} exposure activated apoptosis and necrosis. Interestingly, retene, a polycyclic aromatic hydrocarbon present in PM_{10}, is a potential compound for the effects of PM_{10} causing DNA damage and cell death. The PM_{10} concentrations observed during Amazon biomass burning were sufficient to induce severe adverse effects in human lung cells. Our study provides new data that will help elucidate the mechanism of PM_{10}-mediated lung cancer development. In addition, the results of this study support the establishment of new guidelines for human health protection in regions strongly impacted by biomass burning.

Most of the overwhelming amount of research on exposure to air pollution is focused on urban centers and on the role of fossil fuels as the most important source of atmospheric pollutants. However, approximately 3 billion people in the world are exposed to air pollution from biomass burning, originating from using wood or coal as cooking fuel in simple stoves, home heating with open fires, deforestation, and agricultural practices[1].

Biomass burning emits significant quantities of known pollutants hazardous to health, including several carcinogenic compounds[2]. World Health Organization (WHO) reported that in 2012, approximately 7 million people - one in eight total global deaths - as a result of exposure to air pollution[3]. Fire is a global phenomenon, and is an integral part of the earth's ecosystem[4,5].

In particular, the Brazilian Amazon region contains world's largest tropical forest and is considered, during the rainy season, one of the continental regions least affected by human activities[6,7]. However, during the dry season, high concentrations of aerosol particles from biomass burning (mainly agricultural practices and deforestation) have been documented in this region[7,8]. The combination of forest fires and human occupation has turned biomass burning into a serious public health threat. The majority of forest fires occur in the deforestation arc, a belt in the southern and western regions of the forest, directly impacting over 10 million people in the area[9]. Many

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Atmospheric Chemistry and Physics Discussions

Long-term study on coarse mode aerosols in the Amazon rain forest with the frequent intrusion of Saharan dust plumes

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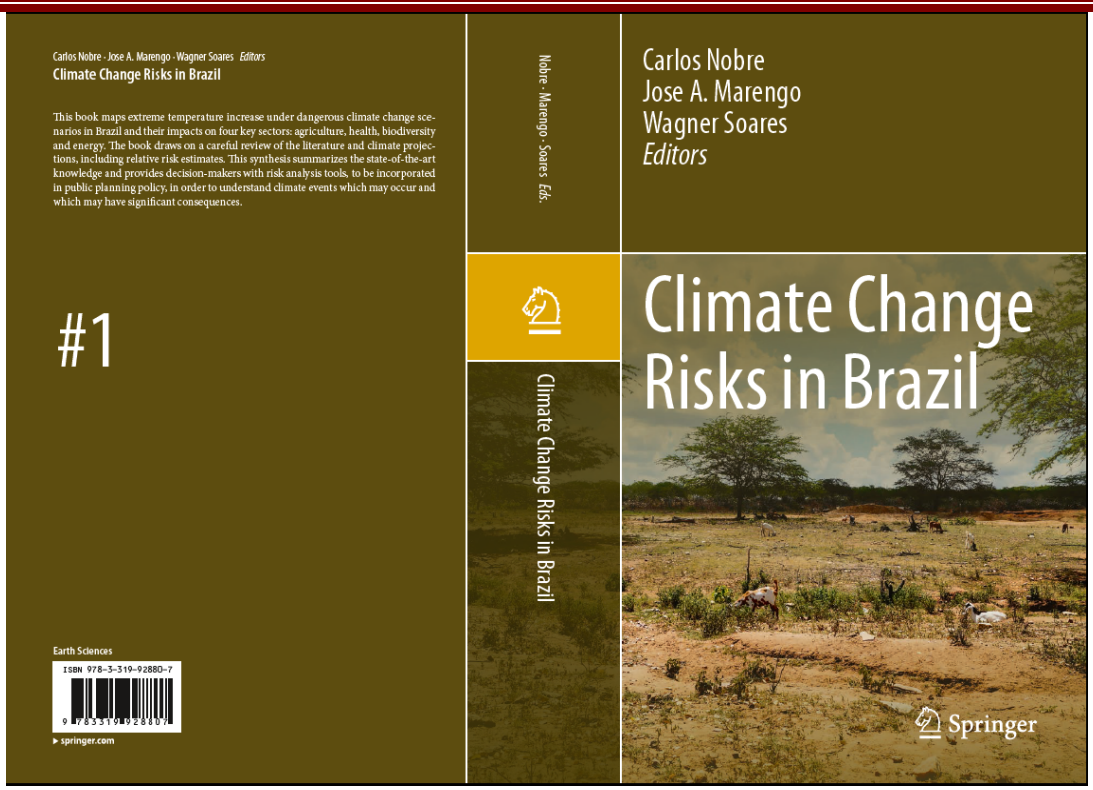
Carlos Nobre · Jose A. Marengo · Wagner Soares Editors
Climate Change Risks in Brazil
This book maps extreme temperature increase under dangerous climate change scenarios in Brazil and their impacts on four key sectors: agriculture, health, biodiversity and energy. The book draws on a careful review of the literature and climate projections, including relative risk estimates. This synthesis summarizes the state-of-the-art knowledge and provides decision-makers with risk analysis tools, to be incorporated in public planning policy, in order to understand climate events which may occur and which may have significant consequences.
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