Inria-Brasil Workshop on Digital Science and Agronomy

September 10, 2024

The BI0S Research Center

Projects under development and planned in the areas of Agriculture, Health and Method

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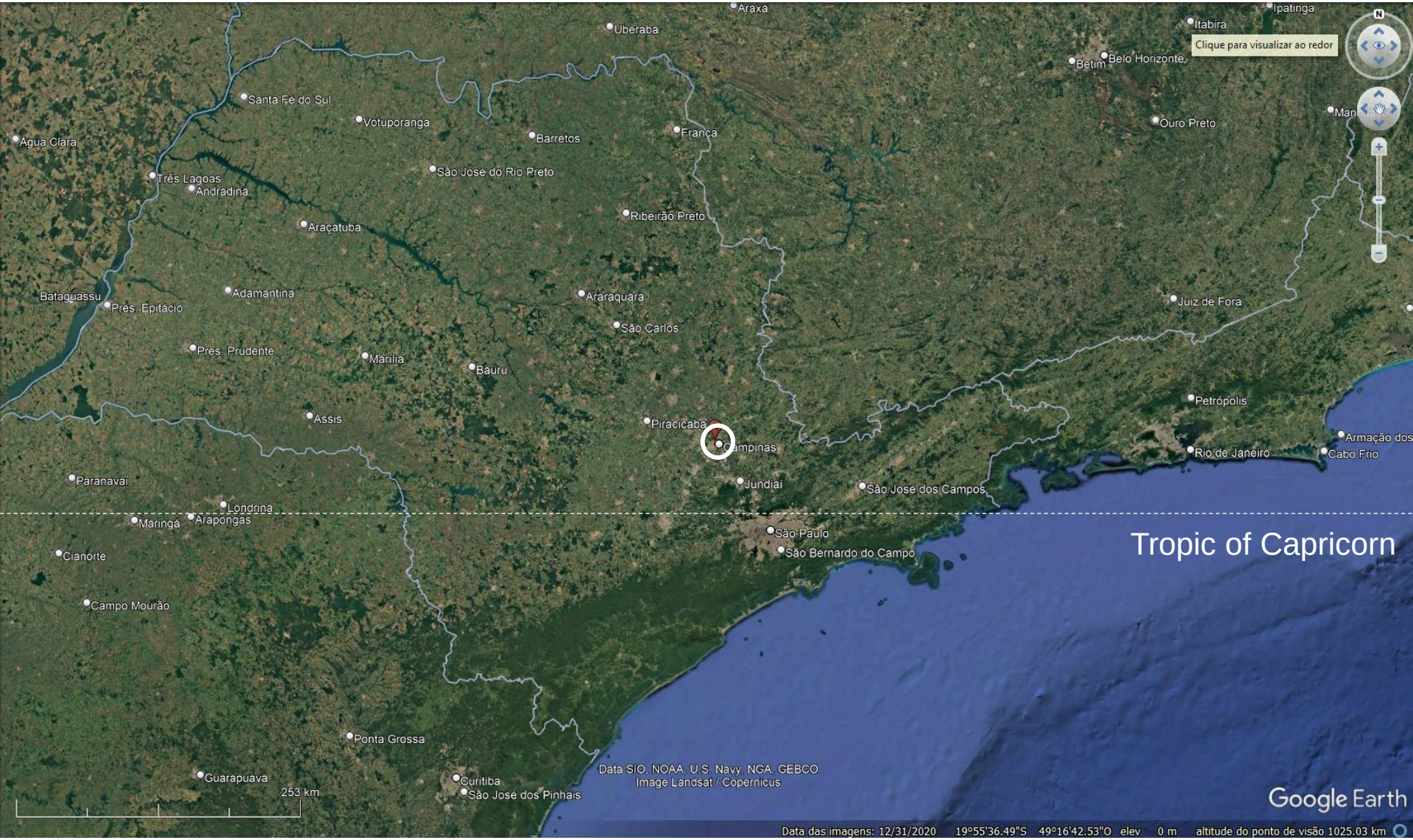
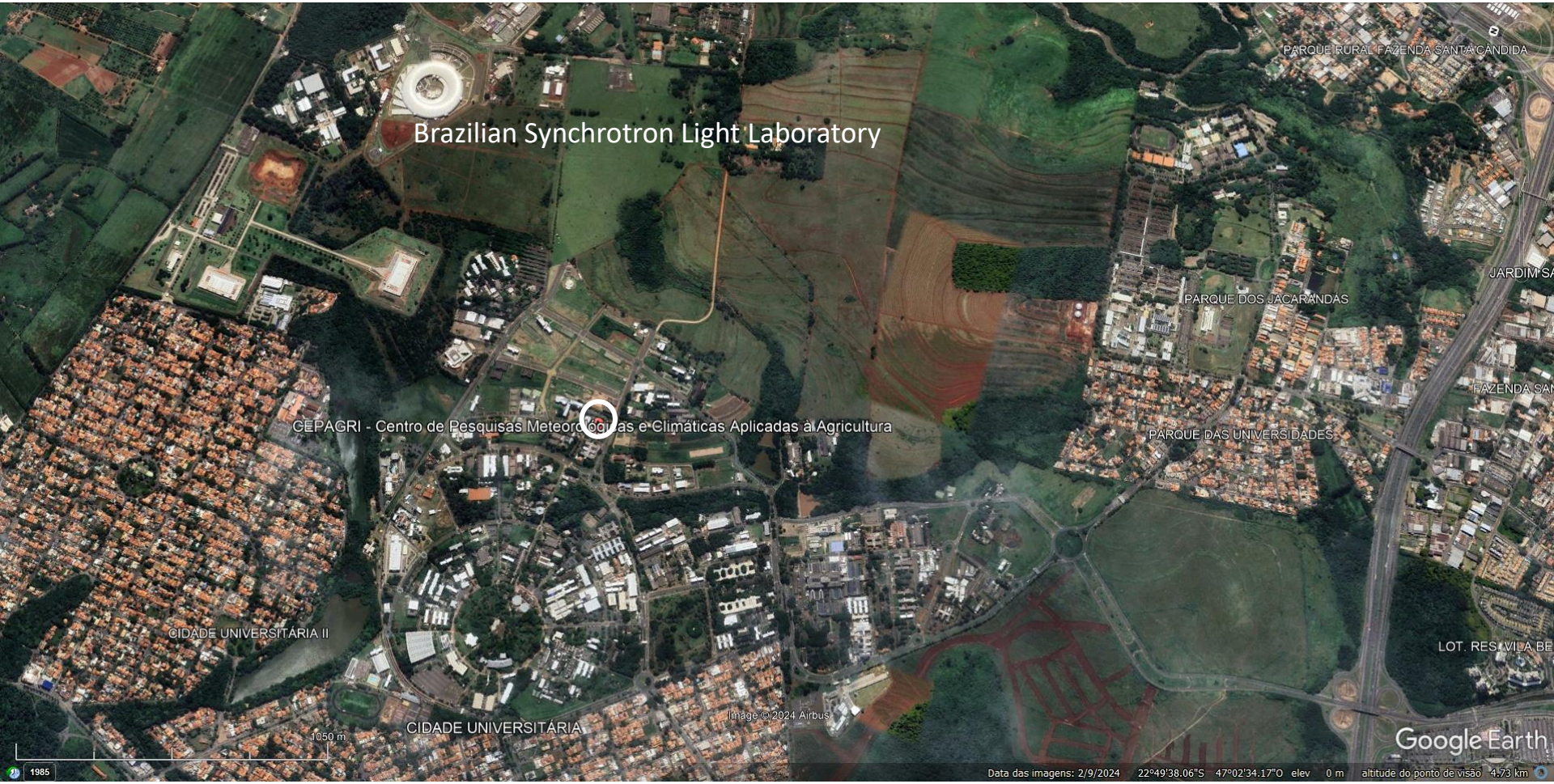
Where we are – Cepagri in Brazil

Where we are – Cepagri in SP



Where we are – Cepagri at UNICAMP



Where we are – Cepagri at UNICAMP

Unicamp in numbers

1.697

Professors

16.229

Postgraduate students

40%

21.390

Undergraduate Students

53%

2.983

Students in Technical Education

7%

6.845

Staff

60.089

Surgeries/Year

31.884

Admissions/Year

968

Hospital beds

22
Centers & Nuclei

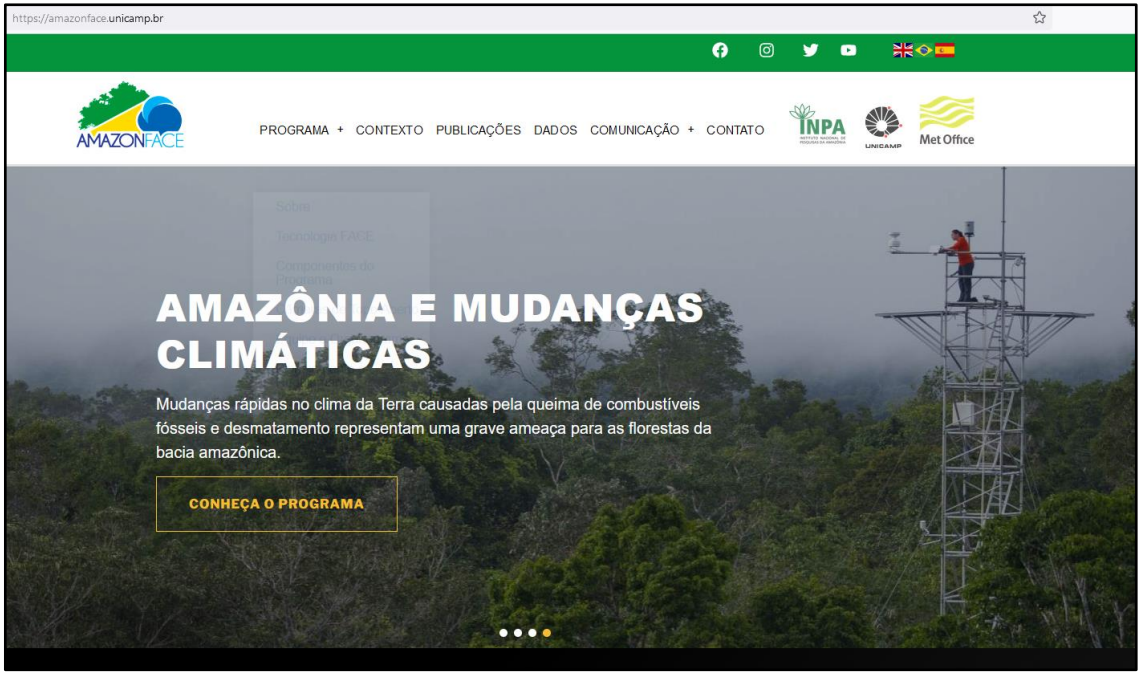
737
Staff

85
Researchers

8
Libraries

INTERDISCIPLINARIDADE COCEN

Cepagri - Present and Future



Cepagri - Present and Future

CEPAGRI
TEMPO E CLIMA UNICAMP

Technical and Administrative Team

Brazilian Institute of Data Science (BI0S)

Research center based in the University of Campinas (UNICAMP) with the purpose of contributing to scientific, technological and social development in two strategic areas: *Health* (main track) and ***Agriculture*** (*Agro*, secondary track).

National Public Call by FAPESP (São Paulo Research Foundation), MCTI (Brazilian Ministry of Science Technology and Innovation) and CGI.br (Internet Steering Committee in Brazil

Investment: US$ 2 million (50% from public transfers and 50% from partnerships with the private sector) over a 5-year period (can be renewable for another 5 years)

Agro track: the main objective is to increase the availability and quality of information to assist decision making at **local**, **regional** and **global** scales, to develop solutions for precision agriculture and to address central problems such as the impacts of climate change and harvest forecasting and monitoring.

Important Dates

Scientific Team

- 102 researchers (engineers, mathematicians, computer scientists, statisticians, medical doctors, agronomists and economists, among other areas of expertise)

- Researchers come from 13 faculties and schools at UNICAMP, and 7 partner institutions (FITEC, UFABC, ITA, UFAM, CPQD, FIOCRUZ and USP-RP)

Leadership

João Marcos Travassos Romano
Principal Investigator

Henrique Sá Earp
Executive manager

Rodolfo Pacagnella
Health Track

Jurandir Zullo Jr
Agro Track

Leonardo Tomazeli
Method Track

Patrícia Gestic
TT Coordinator

Cristiano Torezzan
TT Scientific Manager

Victor Vicente
EKD Coordinator

Leandro Tessler
EKD Scientific Manager

Jorge Moreira
Partner companies

Ricardo Suyama
ICTs Partners

Herman Bessler
Business Coordinator

Gustavo Joppert
Templo Representative

BIOS Tracks

BRAZILIAN INSTITUTE OF DATA SCIENCE BIOS

HEALTH

S.1 Axis: AI-healthcare interactions at the Individual level

S.1.1 Line: Risk prediction and pattern recognition based on data analysis
S.1.2 Line: Image-based diagnostic support
S.1.3 Line: Human-machine interfaces

S.2 Axis: AI-healthcare interactions at the Community level

S.2.1 Line: Decision support for health systems
S.2.2 Line: Drug discovery

S.3 Axis: AI-healthcare interactions at the Populational level

S.3.1 Line: Epidemiological modeling
S.3.2 Line: Health planning

T.1 Axis: Transversal axis

T.1.1 Line: Pollution
T.1.2 Line: Climate change
T.1.3 Line: Food Traceability
T.1.4 Line: Ecosystem services
T.1.5. Line: Exposome

METHOD

M.1 Axis: *Cutting-edge AI*

M.1.1 Line: Machine learning for signal and image processing
M.1.2 Line: Machine learning and operations research
M.1.3 Line: Advanced mathematical and statistical tools for AI

M.2 Axis: Ethical AI and interfaces with society

M.2.1 Line: Fairness, Accountability, Transparency, and Ethics (FATE) in AI
M.2.2 Line: AI and society

AGRO

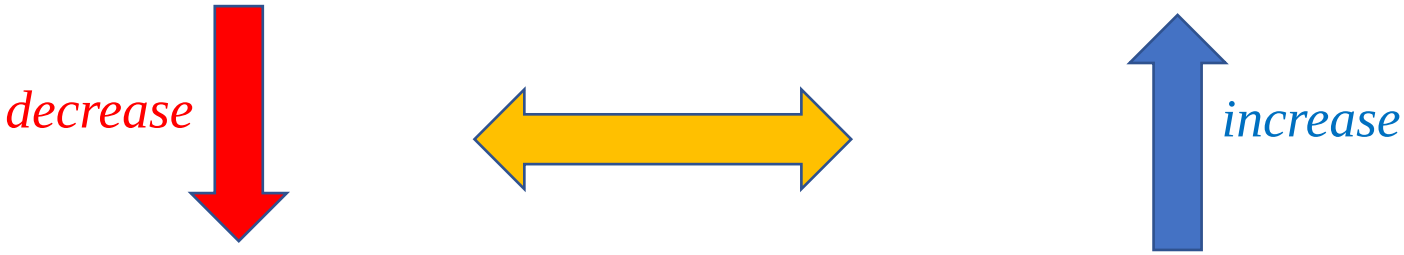
A.1 Axis: Decision Support on a Local Range

A.1.1 Line: Data acquisition for agricultural and environmental monitoring in the short term
A.1.2 Line: Precision Agriculture
A.1.3 Line: Precision Livestock Farming (PLF)
A.1.4 Line: Agricultural Robotics & Automation

A.2 Axis: Decision Support on Global and Regional Ranges

A.2.1 Line: Impacts of Climate change on national agriculture
A.2.2 Line: Agricultural and environmental monitoring methods, and crop planning

Current and Future Challenges for Agribusiness



Water Consumption

Production

Land Use

Quality

CO_2 Emissions

Traceability

Environmental Impacts

CO_2 Capture

Deforestation

Financial Income

Axis A.2 Decision Support with Regional and Global Scope

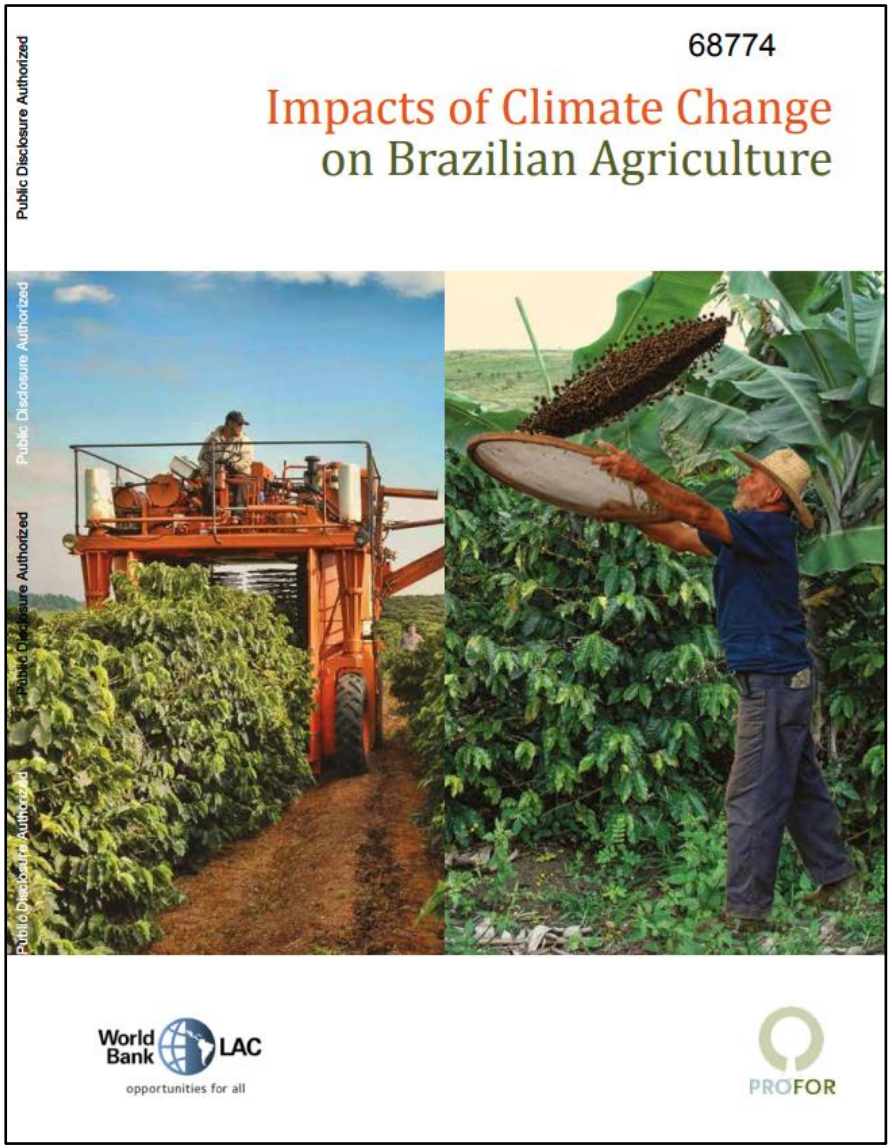
A.2.1 – Objective: Use of AI methods to predict the impacts of climate change on national agriculture in the next three decades

- **Challenge: Choice of climate change models that will be used to generate impact scenarios** ***(Estimating the weights for combining an ensemble of models)***

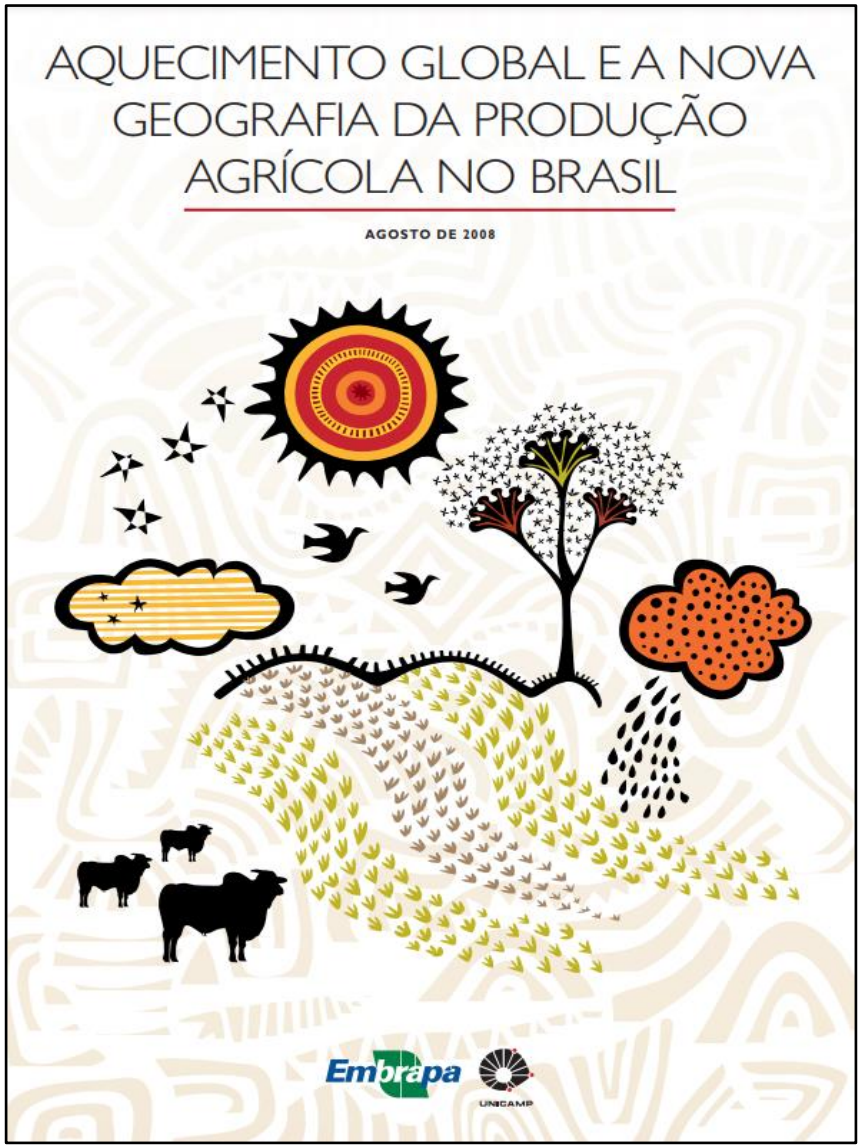
A.2.2 – Objective: Propose an operational and systematic system to monitor crop yield and planted area evolution, in the time frame of a harvest cycle and on a regional scale, based on numerical agrometeorological-spectral models and other data sources

- **Challenge: Identification of numerical agrometeorological-spectral models available in the literature that can be used in agricultural and environmental monitoring, within the time frame of an agricultural harvest cycle and with regional scope**

Impacts of Climate Change on Brazilian Agriculture

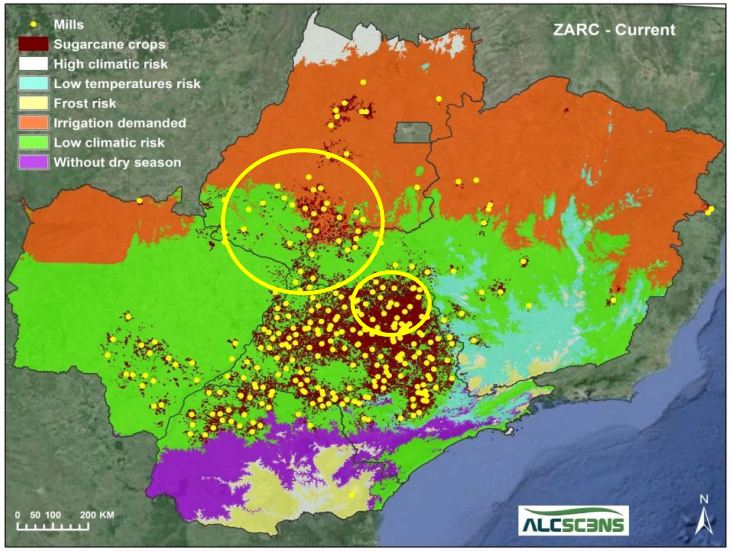


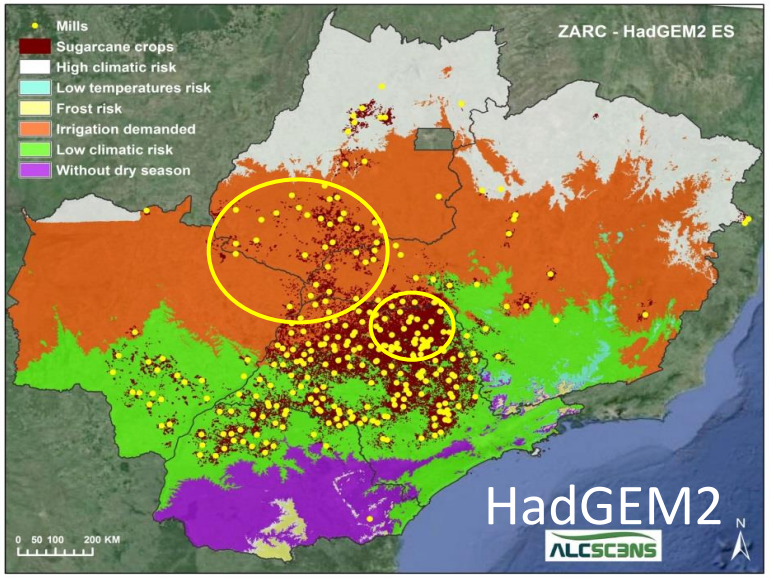
https://openknowledge.worldbank.org/bitstream/handle/10986/18740/687740Revised00LIC00web0brasil02030.pdf?sequence=1&isAllowed=y

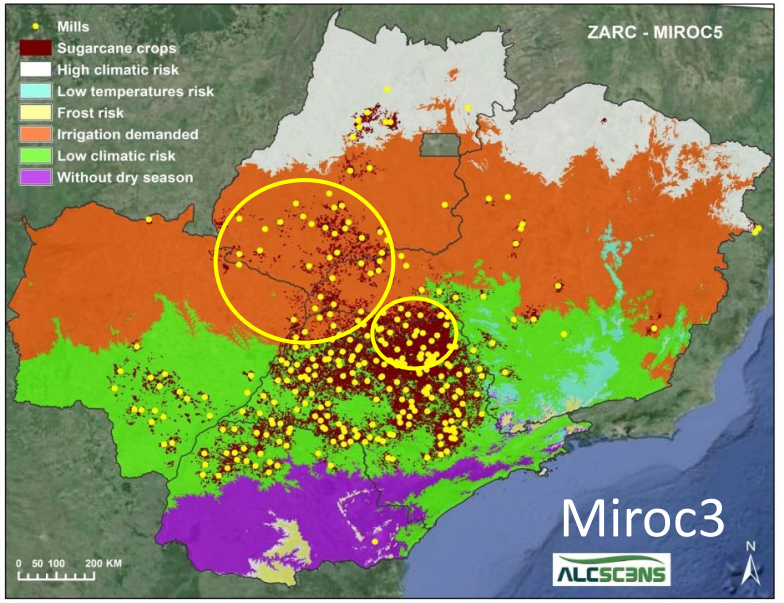


http://mudancasclimaticas.cptec.inpe.br/~rmclima/pdfs/destaques/CLIMA_E_AGRICULTURA_BRASIL_300908_FINAL.pdf

Sugar Cane







Climatic Change (2018)

DOI: http://dx.doi.org/10.1007/s10584-018-2249-4.

Axis A.1 Decision Support with Local Scope

A.1.1 – Objective: Integration and processing of different types of available data, and its use in tasks such as crop rotation planning and predicting the behavior of a given agricultural crop in protected environments

- **Challenge 1: Development of solutions to manage the large volume of available agrometeorological and remote sensing data *(Multimodal data fusion - unsupervised matrix and tensor factorization algorithms)***

- **Challenge 2: Development of new methodologies to understand and predict the behavior of agricultural crops in protected environments, such as greenhouse gases and patches of plant growth *(Computer vision methods, Deep learning models, Transfer learning strategies)***

A.1.2 – Objective: Development of low-cost, economical and robust systems, in order to enable the use of WSNs (Wireless sensor networks) in small rural properties

- **Challenge 1: Development of solutions to identify the locations of network sensors based on distributed and collaborative processing strategies**

- **Challenge 2: Search for methodologies allowing the implementation of machine learning algorithms in systems with limited computational resources**

Axis A.1 Decision Support with Local Scope

A.1.3 – Objective: Use of data-driven techniques for tasks such as automatic herd weight monitoring and identification of groups of animals that develop properly (Precision Livestock Problems)

- **Challenge 1: Automatic identification of the cattle body condition score (BCS)** ***(Computer vision methods based on deep learning)***
- **Challenge 2: Development of decision-support systems for livestock trading** ***(Mixed-integer-programming and machine learning techniques)***

A.1.4 – Objective: Use of robots in applications such as planting, identifying and removing weeds, diagnosing diseases, monitoring crops and harvesting (Agricultural robotics)

- **Challenge 1: Characteristics of real-world agricultural environments – highly complex and variable**
- **Challenge 2: Development of systems based on swarm robotics**

Examples of initiatives (total = 29) carried out by the Agro track of BI0S, for the discussion, elaboration and development of research projects, submitted to agencies, calls for proposals, companies or institutions, since the announcement of the approval of BI0S (05/04/2021), until August 2024

1. Coffee and Climate Change – CNPq – Under development

2. MangueIA: AI and citizen science to identify invasive plants in mangroves in the state of Rio Grande do Norte – Petrobras – Portfolio

3. Smart climate monitoring solution for the production and environmental aspects of cocoa farming - Designing the future of cocoa in a changing climate – FINEP – Submitted on August/2024

4. Use of remote sensing for fire monitoring – Self Funded - Under Development

5. Urban Environment - Temperature, humidity and rainfall automatic monitoring in the city of São Paulo – Private Company – Project in preparation

6. Intelligent system for monitoring and analyzing environmental variables for hydroelectric plants (SIMAVAH) – Norte Energia – Portfolio

7. Animal Biometrics – Under Development

Muzzle patterns to identify cattles – Animal biometrics

Fonte: Fabrício Lira - CPQD

BI0S's expected impacts of **Agro track**

- Improving the quality and yield of crops for food, fiber, biofuel, timber, raw material, supplies, drugs;
- Improving decision making at different time and spatial scales, to reduce waste and promote sustainable practices;
- Reducing the impact of agriculture on biodiversity, deforestation and human health;
- Supporting the establishment of public policies in the agricultural and environment sectors;
- Supporting the adaptation of agricultural practices to possible changes to the climate;
- Providing technical consultancy for the genetic enhancement of plants, in the face of environmental stress;
- Reducing the pressure over forested areas, and thus deforestation;
- Creating, organizing, and maintaining a database containing environmental parameters. Access will be provided for the other tracks at BI0S and for users at large.

Expected impacts of BIOS in different fronts

- Developing AI solutions at different technology readiness levels (TRL);
- Establishing a scientific and technological ecosystem to foster the creation of spin-offs;
- Establishing an interdisciplinary core group of 102 researchers ready to act on relevant problems in Health and Agro, as well as in problems at the intersection of these areas, and able to quickly respond to new scientific and technological challenges that will arise in the near future;
- Internationalizing Brazilian research in relevant areas, through the associations between BI0S and other centers at the forefront of AI research;
- Establishing a transdisciplinary group that can contribute to building and improving national strategies and public policies related to AI;
- Training human resources of high scientific level, with unique skills and knowledge, a spirit of leadership and high capacity for interactions with multiple areas of expertise;
- Publishing scientific papers in high-impact journals and conferences, as well as books on the central topic of the Center.

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