Protecting Our Cities from Climate Disasters: Parametric Insurance, Sanitation, and Securitization on the Road to COP30

November, 2025

FGV INSTITUTO DE INOVAÇÃO EM SEGUROS E RESSEGUROS

Multidisciplinary Team Engaged in the Project...

Climate models

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CRD Bond Structure

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Sustainable drainage

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Bachelor's in Civil Engineering from UFSCAR. Consultant and Engineer in Public Policy Projects for Social and Environmental Development.

Economic and financial structure

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Túlio Marques

Civil Engineer with Master’s in International Business, specialist in Insurance in Brazil.

Luccas Saqueto

Economist, Master's in Political Economy.

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Acknowledgments...

This study was made possible with the invaluable support of the Insurance and Reinsurance Innovation Institute (IISR) of the Getulio Vargas Foundation (FGV). We are grateful for the investment and trust in our research, which were essential for advancing knowledge and pursuing innovative solutions to protect municipalities from climate extremes.

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Produtos gerados...

- Research Report
- Article submitted to the *International Journal of Disaster Risk Management*
- Presentation at the ABES Congress:

https://www.youtube.com/live/4u7oyYbQTZM?si=tbDzy2W63ucw47JC

- Framework for the Municipal Handbook

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Study Objective...

1

PROTEÇÃO AOS MUNICÍPIOS CONTRA EXTREMOS CLIMÁTICOS: A IMPORTÂNCIA DO SEGURO PARAMÉTRICO E O REÚSO DE ÁGUA

Sumário

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1. INTRODUÇÃO

O objetivo deste artigo é estabelecer as bases conceituais para uma orientação de melhores práticas dos gestores visando a construção de um seguro contra extremos climáticos, utilizando inovações financeiras e o saneamento ambiental. Uma revisão sistemática da literatura sugere que este tema tem sido pouco tratado, especialmente na América Latina e no Brasil em particular.

O artigo está dividido em seis seções, incluindo esta introdução. A Seção 2 relata brevemente a constatação de uma maior intensidade e frequência dos extremos climáticos, bem como seus efeitos socioeconômicos devastadores (Zurich Insurance Group, 2025). O escopo do trabalho foi delimitado de forma a restringir a atenção a um tipo de extremo climático: a seca, cuja definição será feita adiante.

As projeções dos principais centros de pesquisa climática são igualmente sombrias, indicando uma maior concentração e severidade de eventos de precipitação intensa e um prolongamento dos períodos de seca. Este cenário mostra a importância de mecanismos de mitigação e especialmente de adaptação aos extremos climáticos. .

A Seção 3 define um **vetor de métricas relevantes que podem ser obtidas a partir de um projeto de reúso de água.** Sabe-se que há uma grande variabilidade de iniciativas nesta área. A ideia aqui é selecionar um tipo que seja frequente e que possa ser tomado como referência, bem como oferecer o leque de potenciais soluções que serão selecionadas conforme as características de cada município ou região.

Tais métricas permitem uma mensuração da redução dos prejuízos causados por uma seca severa. As métricas serão inseridas sob a forma de uma matriz (setores da economia vs. métricas), indicando as diferentes possibilidades de forma qualitativa.

Definidas tais métricas, a Seção 4 aprofundará a relação entre o reúso de água e o seguro paramétrico, detalhando seu efeito sobre o prêmio de seguro. Esta seção abordará os Fundamentos Microeconômicos do Seguro e sua Adaptação aos Seguros Paramétricos (Subseção 4.1), bem como as Falhas de Mercado e Assimetria de Informação no Contexto dos Seguros de Seca (Subseção 4.2),

1. INTRODUÇÃO

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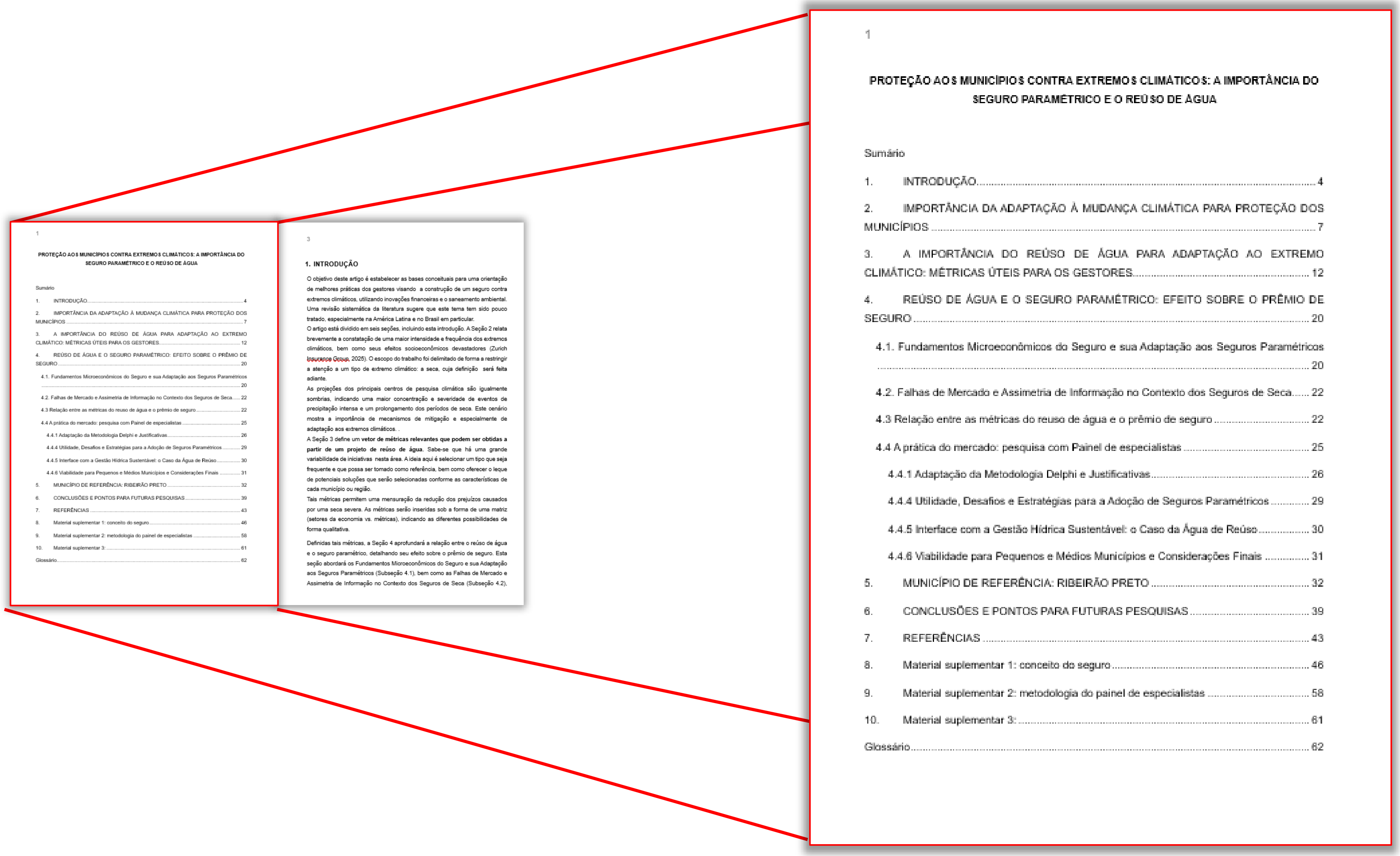
Structure of the Research Report...



1

PROTEÇÃO AOS MUNICÍPIOS CONTRA EXTREMOS CLIMÁTICOS: A IMPORTÂNCIA DO SEGURO PARAMÉTRICO E O REÚSO DE ÁGUA

Sumário

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Three points…

- Importance of Infrastructure for Climate Resilience
- Importance of Environmental Sanitation for Climate Resilience
- Parametric Insurance for Municipalities

1. Importance of Infrastructure for Climate Resilience...

"Investment in infrastructure is not a cost, but a legacy for the future"

John F. Kennedy, President of the United States from 1961 to 1963.

Resilient infrastructure is essential to face the challenges of climate change...

- ✅ reduced costs from natural disasters
- ✅ protection of lives and material assets
- ✅ increased water and energy security
- ✅ sustainable development with lower environmental impact
- ✅ improved quality of life for the population

Nature´s time is out..

Catânia, Itály
October, 2021

Bahia, Brazil
December, 2021

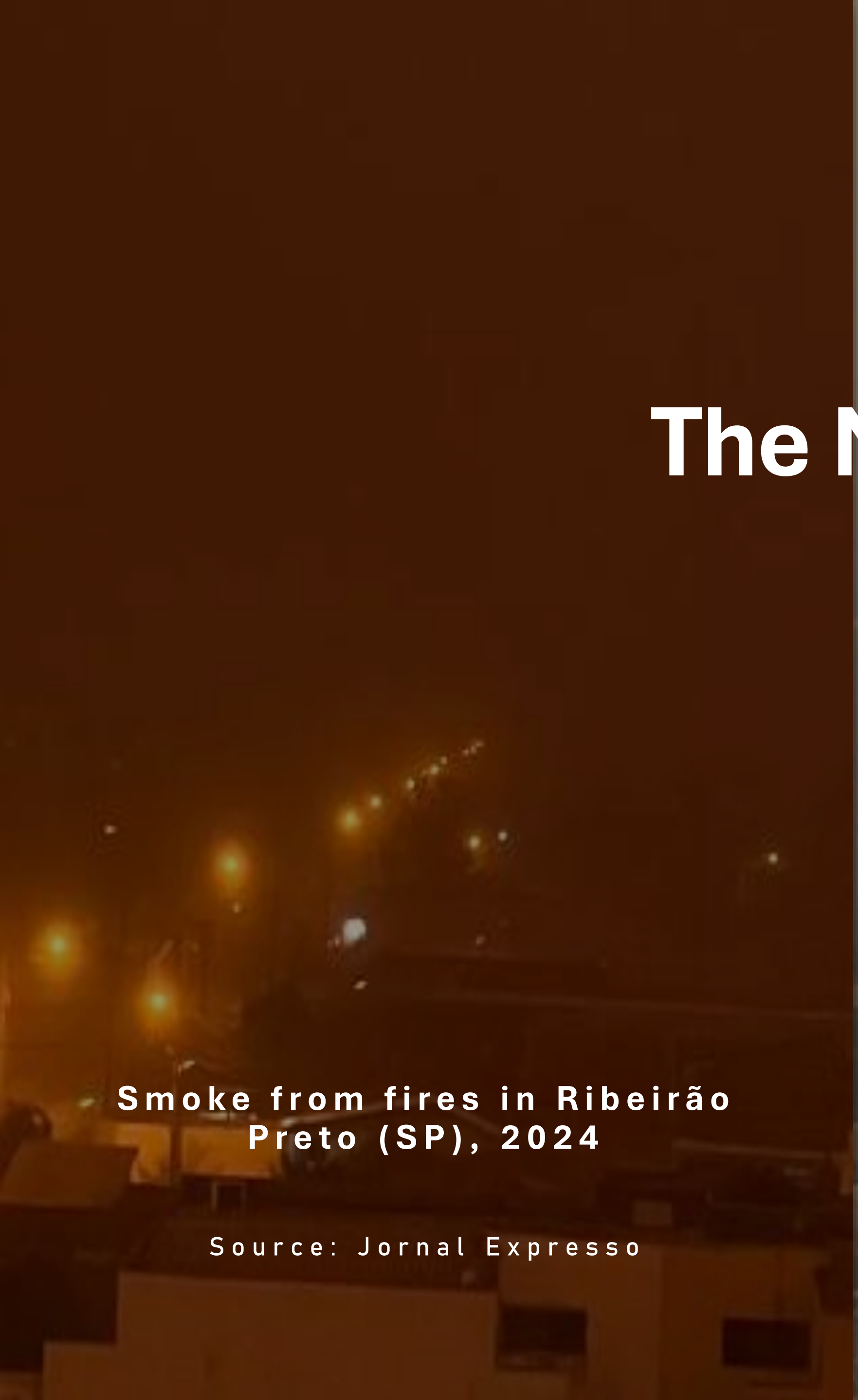
São Paulo, Brazil
January, 2023

Rio Grande do Sul, Brazil. April and e may, 2024

Florida, USA (Hurricane Milton), October 2024

Hurricane Melissa in the Caribbean Sea – October 2025

The New Reality of Climate Extremes...



Smoke from fires in Ribeirão Preto (SP), 2024

Source: Jornal Expresso

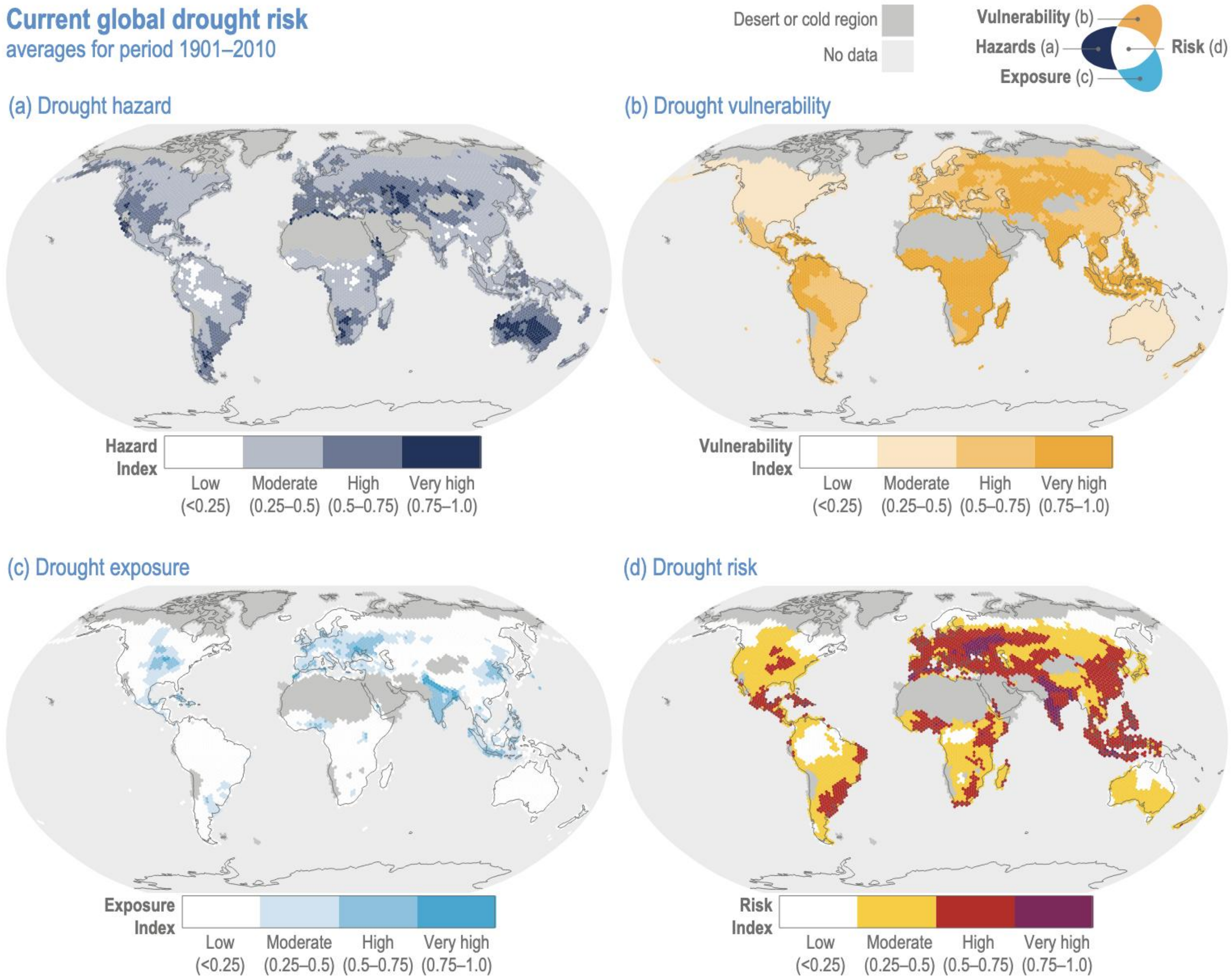
Smoke from fires in Ribeirão Preto (SP), 2014

Source: EPTV

Floods in Rio Grande do Sul, 2024

Source: G1

Current Global Drought Risk and its Components...



Source: Figure 4.9, Chapter 4 of the IPCC Working Group II Report

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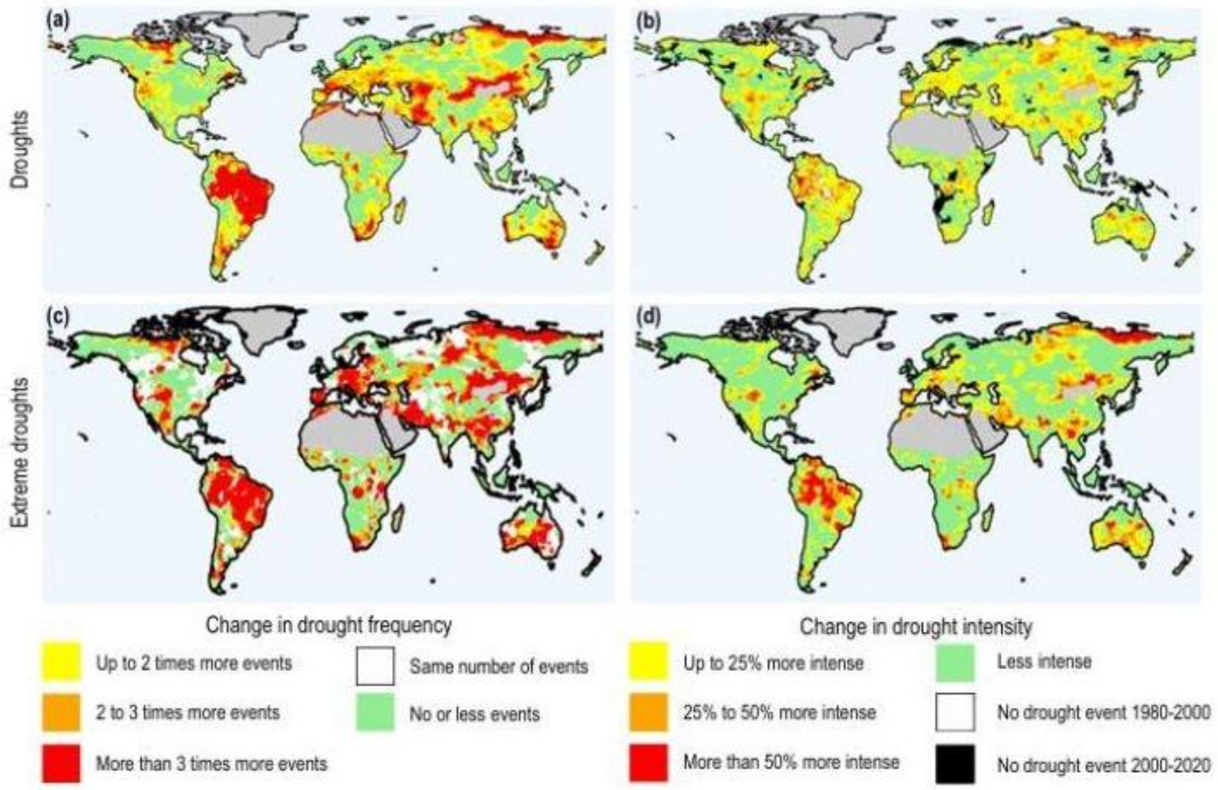
Changes in Drought Frequency and Intensity (1950–2000 vs. 2000–2020)...

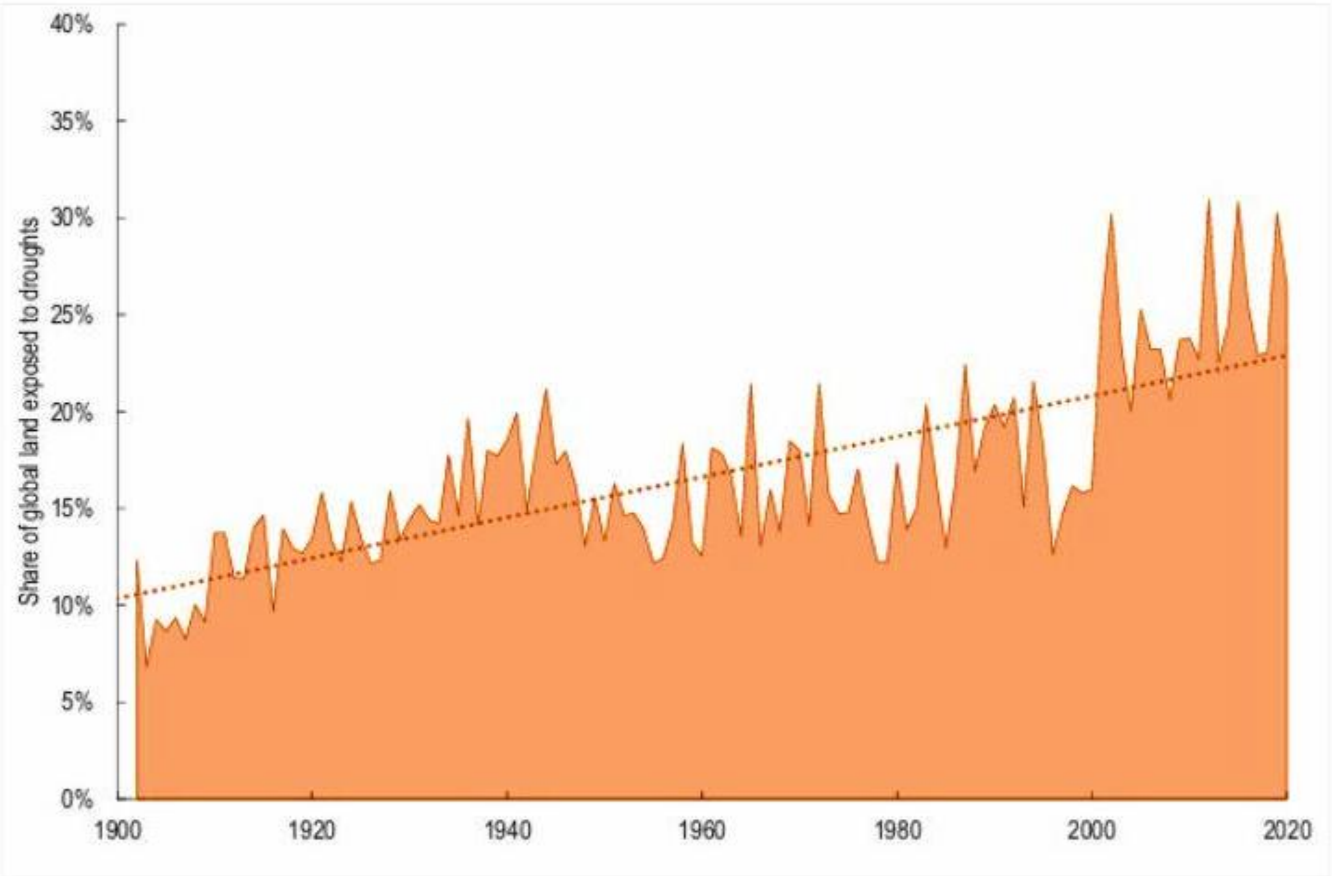
Change in the average number of drought events ((a) and (c)) and their intensity ((b) and (d)) in the period 2000-2020 compared to 1950-2000



How to read this figure: Graph (a) shows that South of France has experienced more than three times more drought events in the period 2000–2020 than in the period 1950–2000, while Northern Mexico experienced a decrease in the number of droughts over the same periods. Graph (b) shows that, in most of Northern Africa, the average intensity of all drought events (average SPEI values below –1) occurring during the period 2000–2020 was more than 50% more intense than the average of those occurring during 1950–2000.
Interior Australia has experienced over three times more extreme drought events in the period 2000–2020 than in the period 1950–2000, while Indonesia experienced a decrease in the number of extreme droughts over the same periods. Graph (d) shows that, in most of Brazil, the most extreme event (event with the lowest SPEI value) during the period 2000–2020 was more than 50% more intense than the most severe event recorded during the period 1950–2000.
Note: Drought events are defined as years in which the average annual SPEI value falls below –1 (Jain et al., 2015[17]). Drought frequency (a and c) is calculated as the number of drought events occurring at each location during the two periods, divided by the number of years in each period. Drought intensity (b) represents the average SPEI value of the drought events for each period. Panel (d) shows the change in the maximum intensity of extreme drought events, calculated as the ratio of the lowest SPEI value during 2000–2020 and the lowest value during 1950–2000 at each location. A drought event is considered as extreme if the annual SPEI value is below or equal to –2, based on the drought severity classification from Jain et al. (2015[17]).

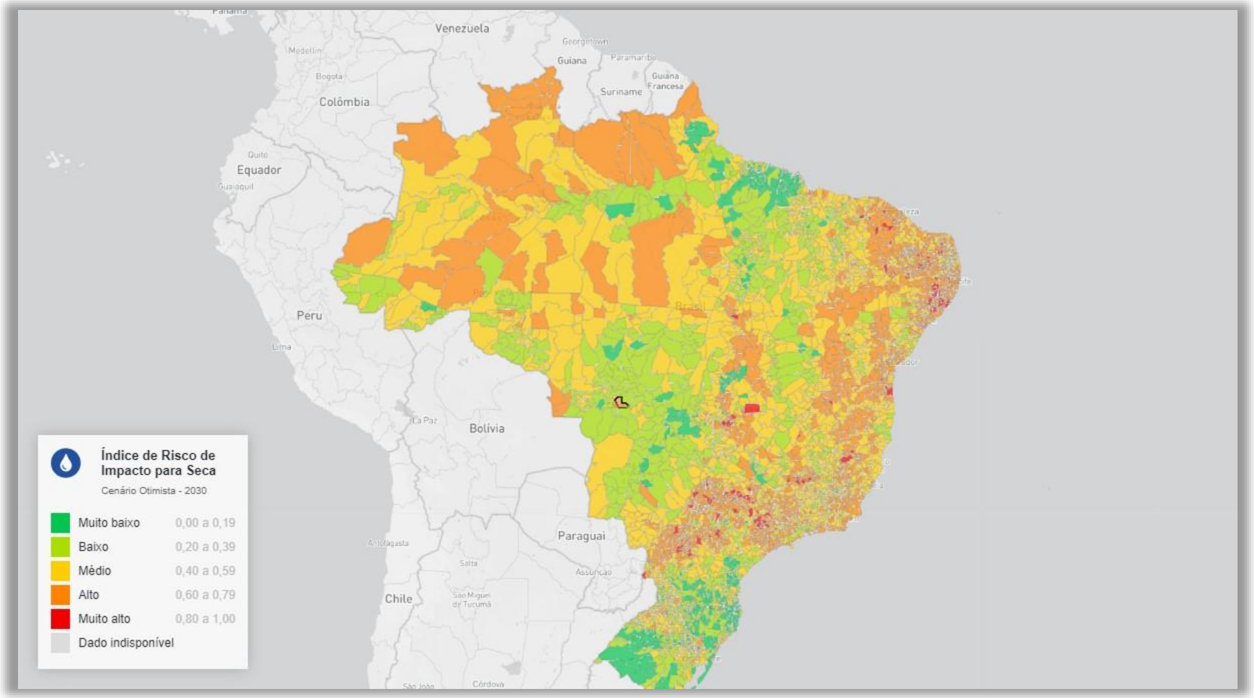
Fonte: Elaborado pelo autor, com base em dados do Copernicus Climate Change Service (2022[19]).

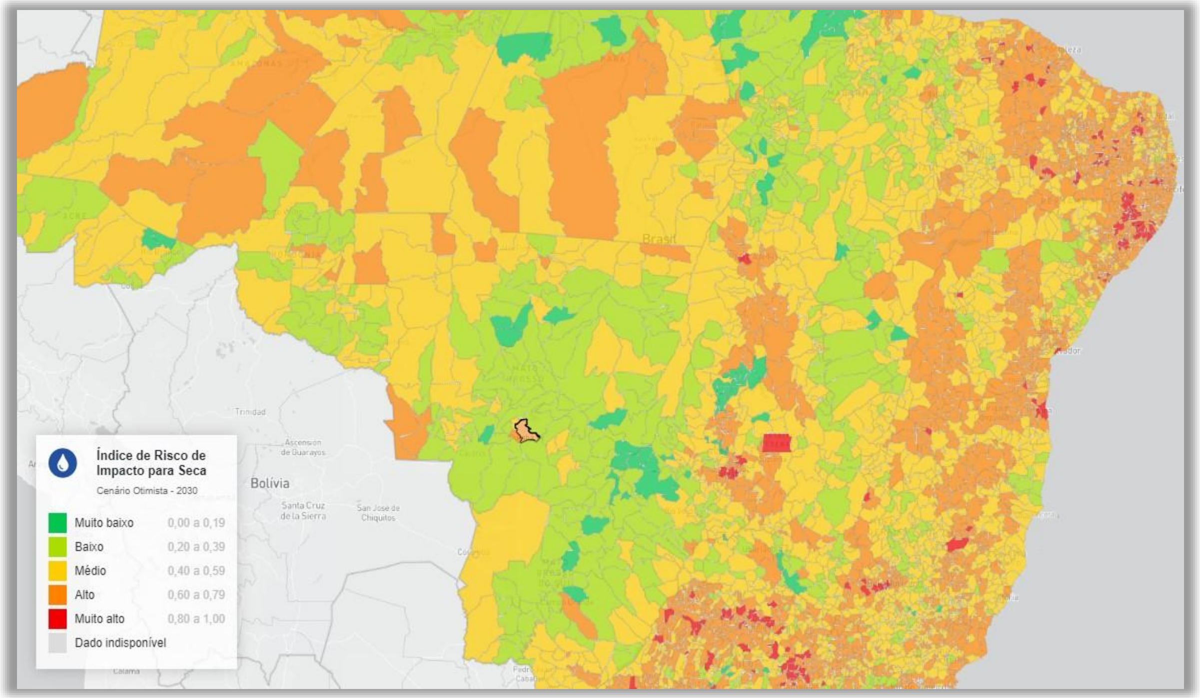
Proportion of global land area affected by droughts (1900–2020)...

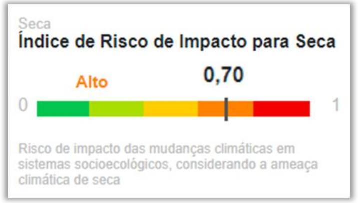


Note: Areas identified as affected by drought in a given year are those where the Standardised Precipitation Evapotranspiration Index (SPEI) value falls below -1 (Jain et al., 2015[17]).
Source: Author's own, based on data from Beguería et al. (2023[18]).

AdaptaBrasil Data Project: High Drought Risk for Brazil's Southeast and Central-West Regions by 2030...







Source: AdaptaBrasil - MCTI

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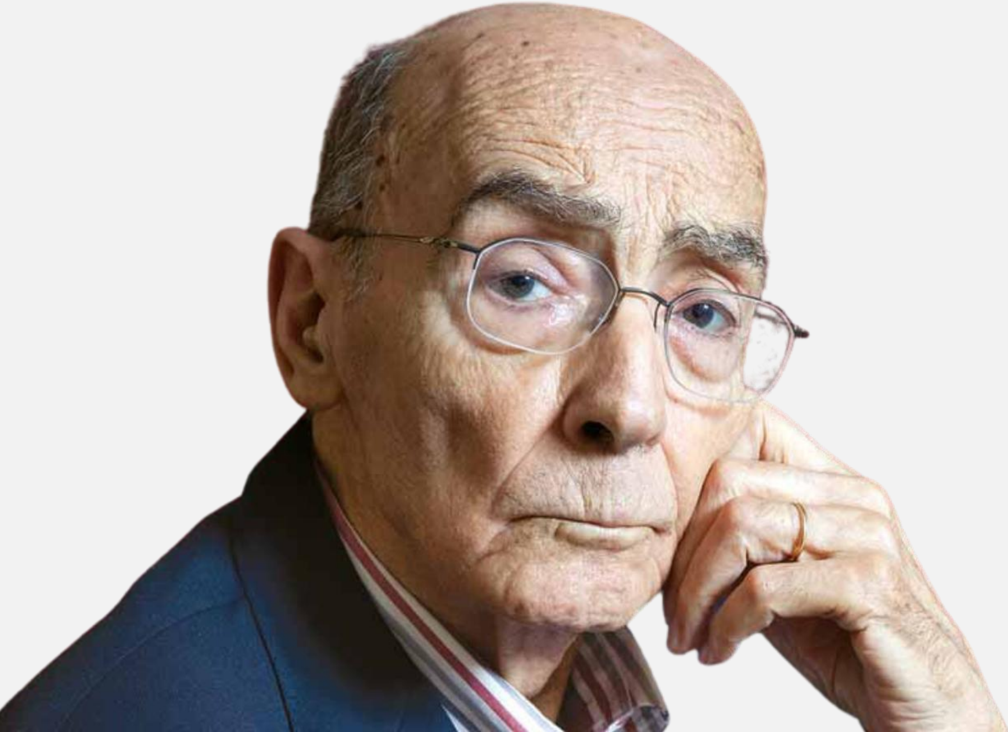
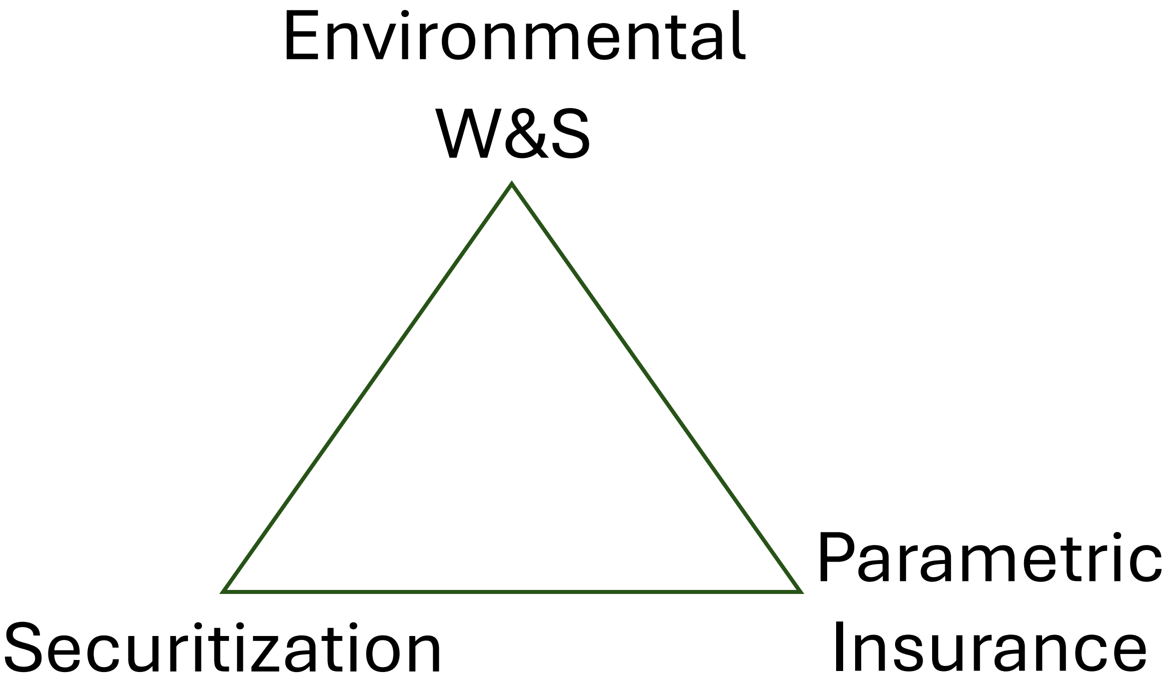
2. Importance of water and sanitation for climate resilience...



"Let us not rush, but let us not waste time either"

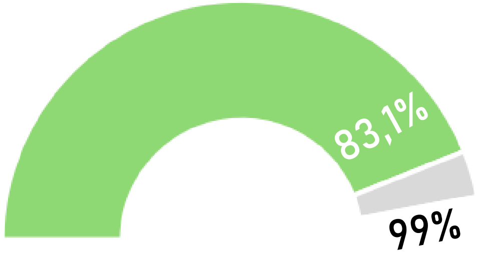
José Saramago (Portuguese writer, 1922–2010)

The Three S Pillars for Municipal Climate Resilience...



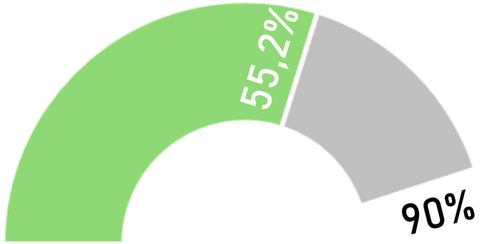
W&S indicators must Improve to meet the new legal framework targets...

Water Supply



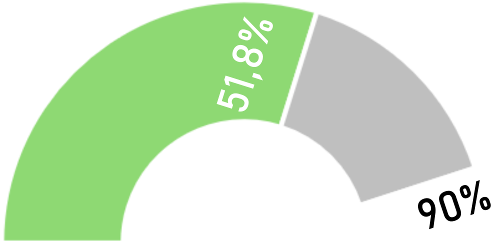
Current Coverage
Goal in the New Framework

Sewage Collection



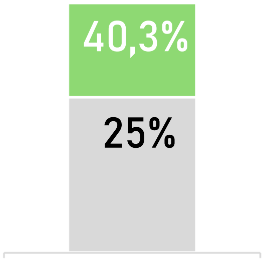
Current Coverage
Goal in the New Framework

Wastewater Treatment in Relation to Water Consumption



Current Coverage
Goal in the New Framework

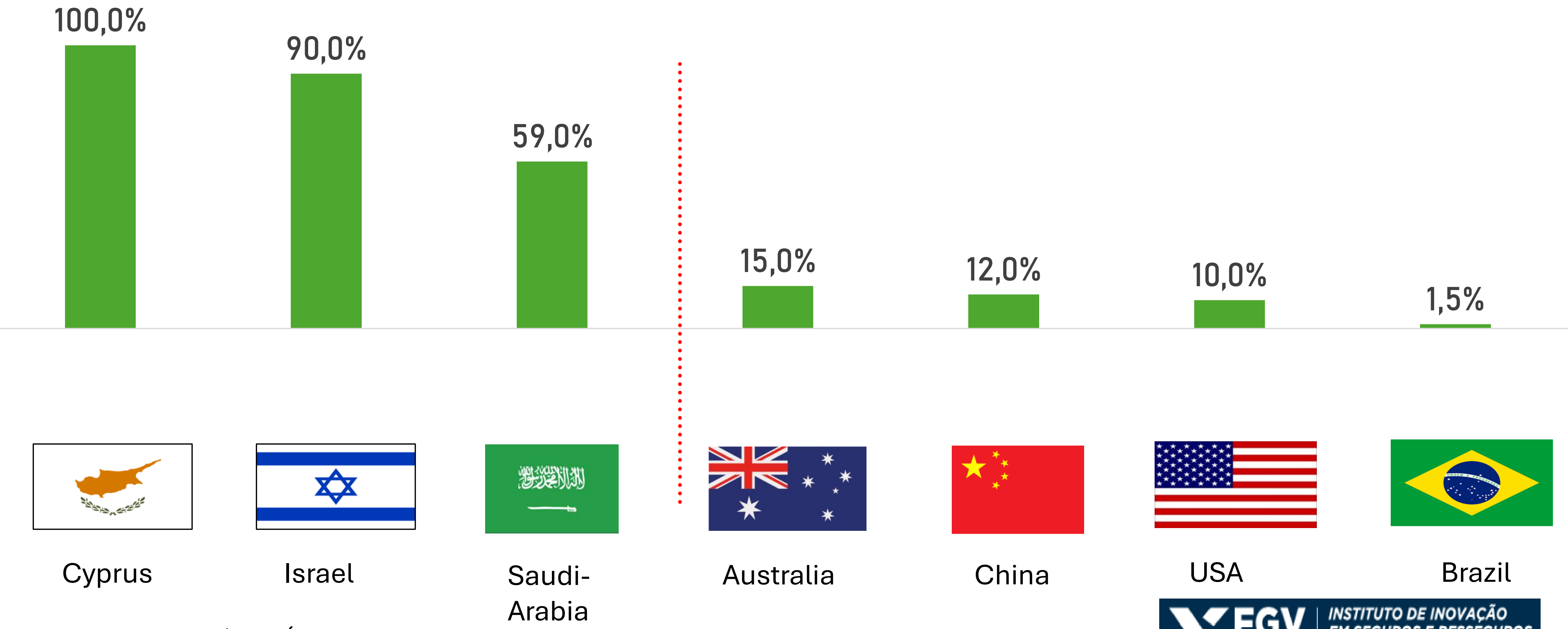
Distribution Loss Index



Current Coverage
Goal in the New Framework

Source: SINISA 2024 (reference year: 2023)

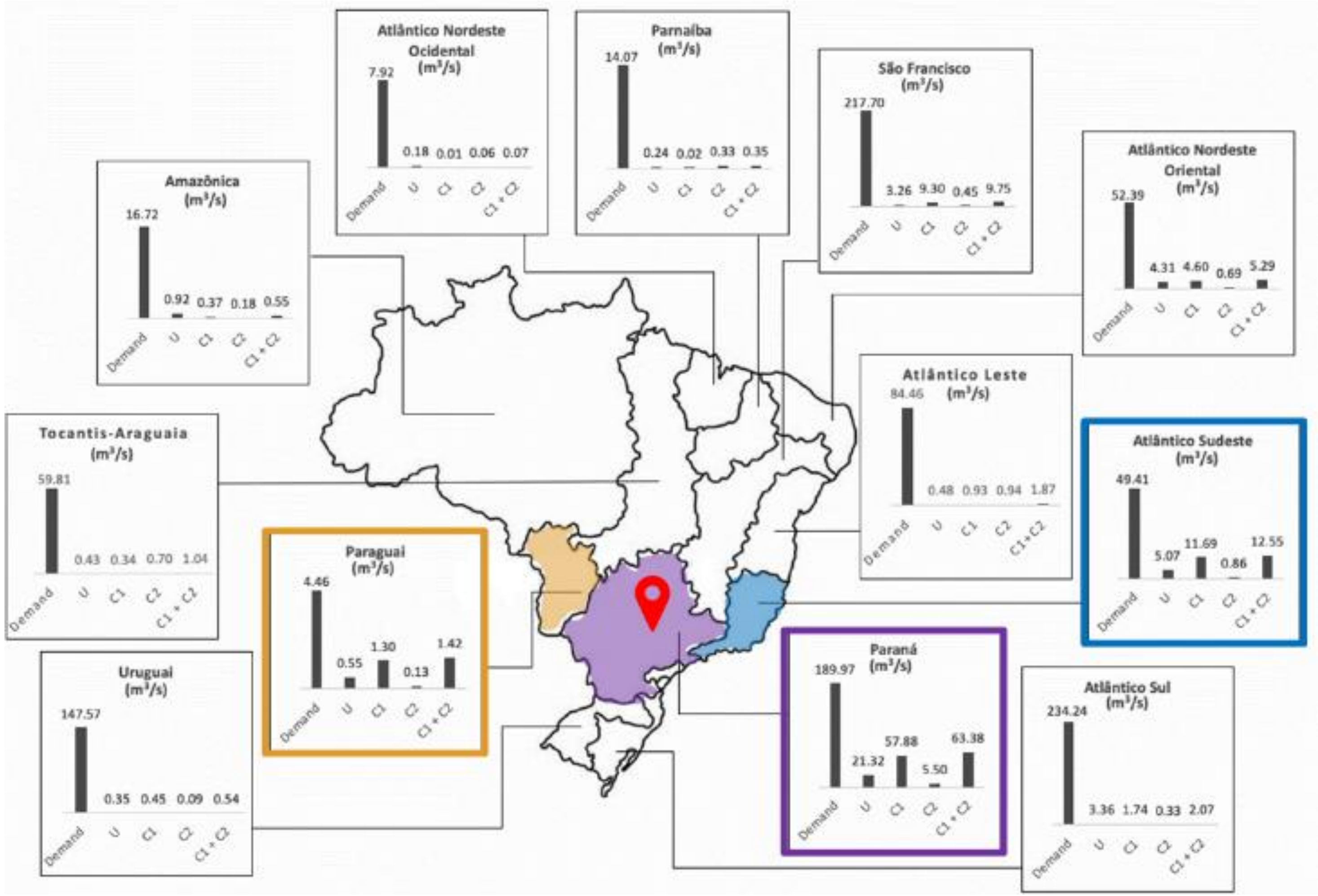
Brazil should reuse a larger share of treated wastewater...



Source: Instituto Reúso de Água (2024).

Recycled water can meet a significant portion of demand…

- In the Paraná River Basin, treated effluent (C1 + C2) accounts for 33% of the water demand for irrigation.
- In the Paraguay River Basin, treated wastewater (C1 + C2) represents 31% of the water demand for irrigation.
- In the Southeast Atlantic Basin, treated wastewater (C1 + C2) meets 25% of the water demand for irrigation.



Source: Lima et al. (2021)

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The relationship between water reuse metrics and parametric insurance premia...

Relevant variables		Water reuse modality		
		Urban	Agricultural	Industrial
1	Flow rate	x	xx	xxx
2	Quality	x	xx	xxx
3	Operationalization: operational quality	x	xx	xxx
4	Distance (producer/consumer)	x	xxx	xx
5	Transport logistics	x	xxx	xx
6	Cost-benefit	x	xx	xxx
7	Area occupied	–	–	–
8	Financial guarantees	–	–	–
9	Existence of regulation	x	xxx	xxx
10	Anchor client	x	xx	xxx
11	Institutional support	x	xx	xxx

Reuse Metrics

↓

Climate Resilience

↓

Insurance Premium

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3. Parametric Insurance for Municipalities...

"If I could, I would write the word 'insurance' upon the door of every cottage and upon the blotting book of every public man, so convinced am I that insurance is a way by which families can be protected against catastrophes at a trifling cost..."

— Winston Churchill, Chancellor of the Exchequer, 1924

Example of how water reuse and parametric insurance can protect a municipality...

MUNICÍPIO X:
Located in a tropical region, it has rainy summers and dry winters. In the last 10 years, it has faced two severe droughts, resulting in a series of fires with serious environmental and public health implications, damaging the strong local agriculture. The main water source is deep tube wells.

Average annual precipitation: 1,450 mm
Wettest month: January (200 mm)
Droughtiest month: July (20 mm)

Trigger: Accumulated precipitation from June to September (dry season and early spring) of less than 150 mm. Or 30 consecutive days with precipitation of less than 1 mm.
Compensation: R$100 million
Award Value: R$3.5 million

After implementing the water reuse project, the municipality now has 30% of its agricultural water needs and 15% of its industrial water needs covered by this new source.
In this scenario, we will have:

Trigger: Accumulated precipitation from June to September (dry season and early spring) of less than 150 mm. Or 30 consecutive days with precipitation of less than 1 mm.
Compensation: R$100 million
Award Amount: R$3.0 million

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Key attributes of parametric insurance…

Attribute	Summary	Implicações/Pontos Chave	Evidence
1. Payment Speed and Efficiency	Automatic and fast payment when predefined triggers are met, without a traditional claims process.	Immediate financial recovery after disasters, minimizing economic impact. Ex: CCRIF[1].	som.yale.edu www.iais.org www.gfdrr.orguphelp.org
2. Transparency and Fraud Prevention	Objective nature of triggers, based on third-party verifiable data.	Enhances transparency and significantly reduces susceptibility to fraud.	www.vaia.com www.munichre.com cgspace.cgiar.org
3. Basis Risk Mitigation	Main limitation: Payment may not exactly correspond to the actual loss suffered.	This is the main challenge, a focus for innovation to optimize triggers and align coverage with loss.	www.iais.org uphelp.org www.guycarp.com www.artemis.bm
4. Filling Gaps in Protection and Covering Non-Damage Losses	Covers intangible losses, business interruptions without direct physical damage.	Innovative to "fill gaps" and for "harder to insure" risks; flexibility in the use of capital.	www.marsh.com www.iais.org uphelp.org | www.swissre.com www.munichre.com www.policyholderpulse.com
5. Incentives for Climate Resilience and Adaptation	Mechanism to transfer risks and proactively encourage investments in climate resilience.	Growing ILS2/Cat Bonds market, promoting loss prevention and adaptation projects.	www.alliance4water.org www.imf.org www.wri.org www.climate-x.com
6. Cost, Accessibility and Modeling	The complexity of modeling and the need for reliable data can influence cost and accessibility.	Potential to reduce administrative costs; advances (AI/ML[3]) facilitate accessibility, including in emerging markets.	www.iais.org www.policyholderpulse.com www.imf.org

1 - Caribbean Catastrophe Risk Insurance Facility ; 2 - Insurance-Linked Securities; 3 - Machine Learning

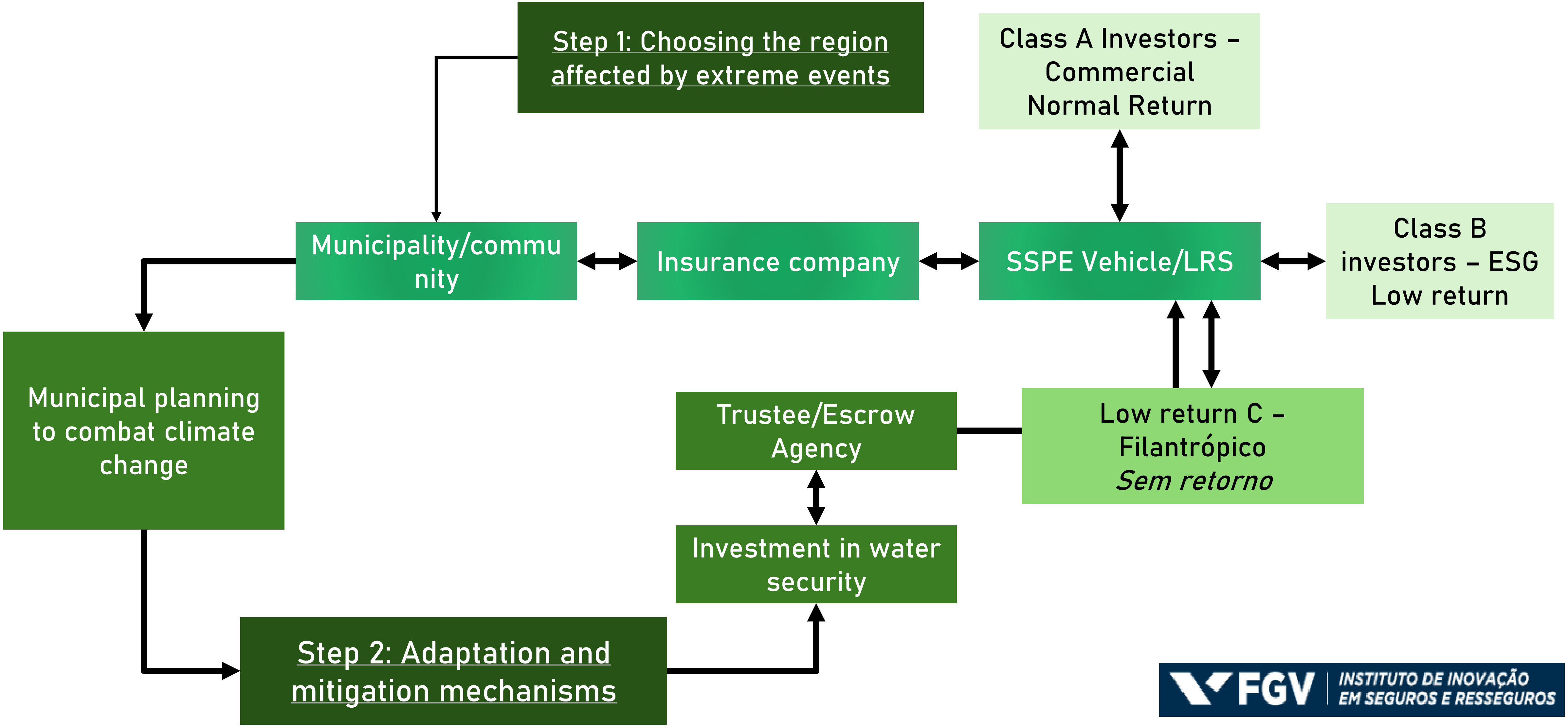
COMPARTIVE BETWEEN TI & PI...

	Traditional Insurance	Vs	Parametric Insurance
Definition & Design	Typically, insurable risks. Can be named perils or comprehensive (All Risks)	Covered Risks	Any risks that are fortuitous and not speculative. Only named perils.
	Varies from standardized models (personal lines) to complex and customized coverages (large and commercial lines)	Product Design	Coverages are commonly customized and adapted to the specific needs of the insured or a group of insureds
Processes & Obligations	Loss or damage to the insured object	Trigger	Occurrence or covered event
	Repair or replacement of the actual damage suffered, or reimbursement of the actual loss suffered	Insurer's Obligations	Pre-determined payment in cash or equivalent
Term & Adjustment	As a rule, annual	Covert Period	Generally seasonal (for climate risk coverage or based on harvests) or annual. Eventually, multi-year
	Based on the assessment of actual losses. Can take weeks or months	Adjustment & Settlement	Fast and transparent payment due to no requirement for loss assessment

COMPARTIVE BETWEEN TI & PI...

	Traditional Insurance	Vs	Parametric Insurance
Market Failures	Medium to high	Adverse Selection	Low
	Medium to high	Moral Hazard	Low
RISKS	Policy conditions, exclusions, and policy limits	Basis Risk	Correlation between the model-based loss (or payment) and the actual loss suffered
	High	Litigation Potential	Low, objective criteria
Examples	Indemnification after flood	Rain	Payment after intense rain
	Indemnification after Agricultural Losses due to Drought	Drought	Automatic Payment after Low Rainfall

Project promotes two steps: criterion of choice and environmental sanitation as prevention...



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4. Case Study: Ribeirão Preto in São Paulo...

"Action is what cities are capable of delivering. When it comes to climate change, it's not the endgame, it's the ongoing game."

Mayor Frank Cownie of Des Moines (Iowa, USA).

Ribeirão Preto, São Paulo State...

Ribeirão Preto	
Mayor	Ricardo Augusto Machado da Silva [2024]
Territorial area	650,916 km^2 [2022]
Resident population	698,259 people [2022]
Population density	1.072,73 hab/km^2 [2022]
Education from 6 to 14 years old	96,9 % [2010]
Human Development Index (HDI)	0,800 [2010]
Infant mortality	7.12 deaths/thousand births [2020]
Realized revenue	2.888.565,29 R$ (×1000) [2017]
Committed expenses	2.497.642,51 R$ (×1000) [2017]
GDP per capita	49.476,86 R$ [2020]

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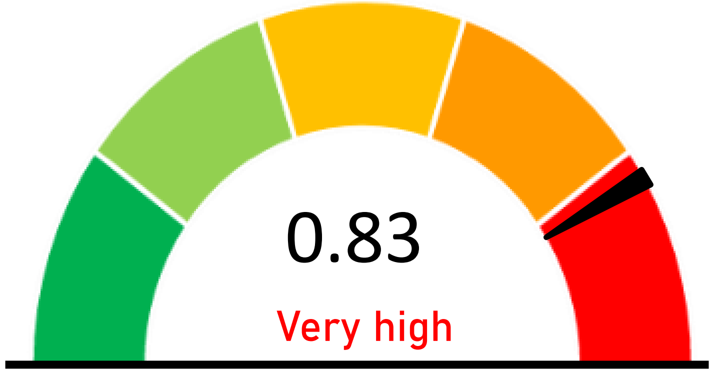
Ribeirão Preto
2014, September

Impacts of floods and droughts in Ribeirão Preto...

Floods

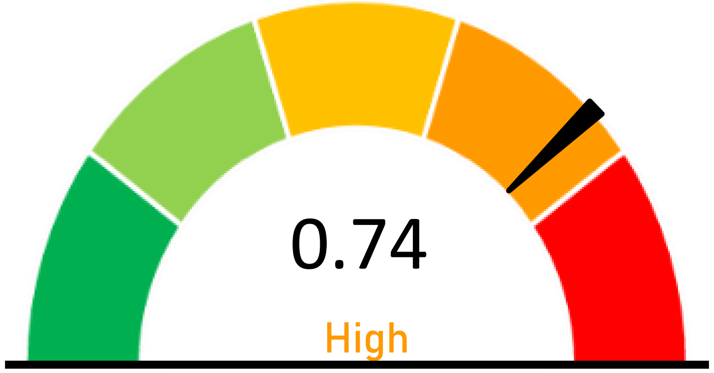
Flood Threat Index



2030 Optimistic Scenario

Droughts

Drought Impact Risk Index



2030 Optimistic Scenario

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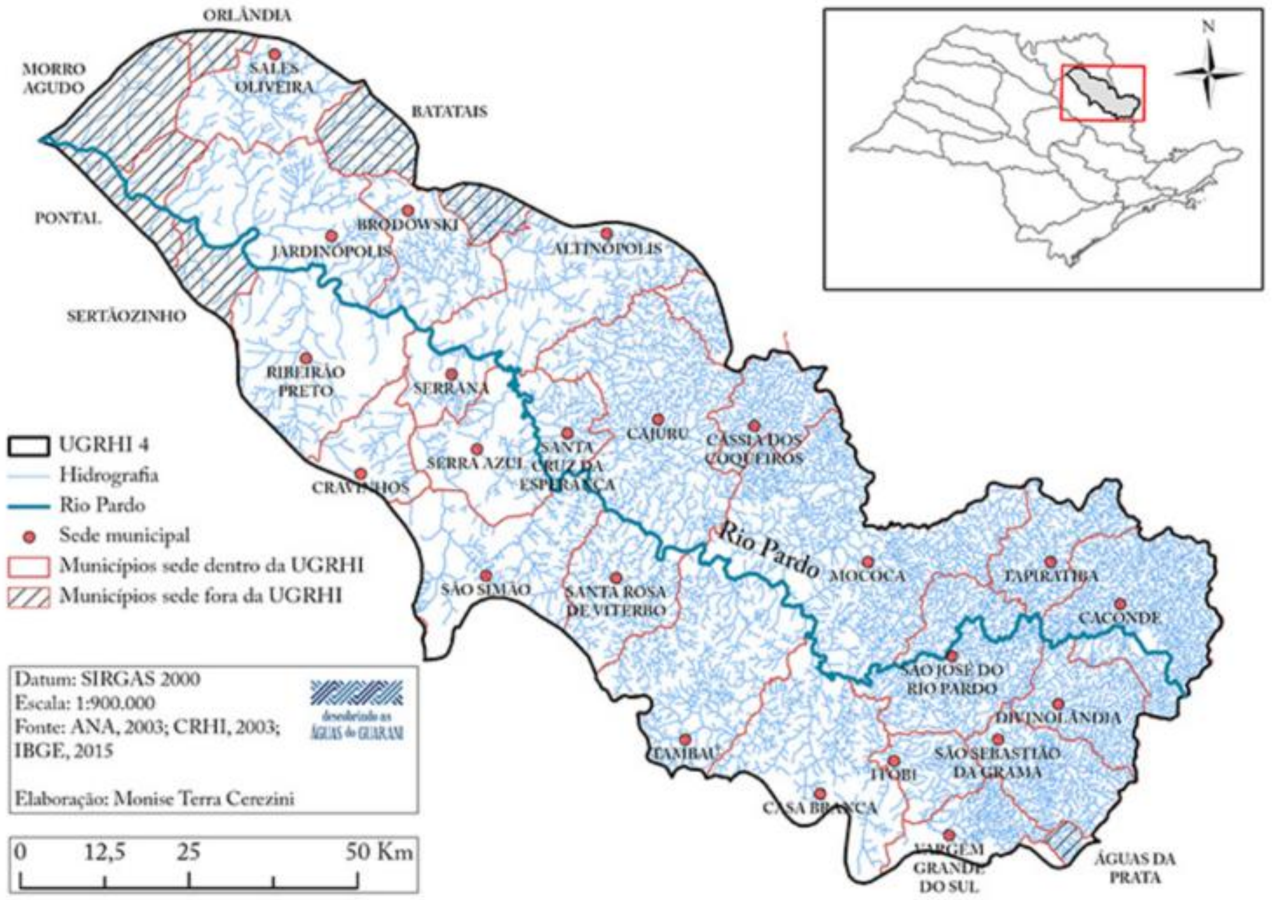
Characteristics of Pardo basie of Ribeirão Preto...

- The municipality of Ribeirão Preto belonging to the Pardo Hydrographic Basin

- The city's water supply is carried out through groundwater, being its main and only source of water



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Water Demand and Potential Capacity of Recycled Water...

- The city has a high level of wastewater treatment, with 99.3% of sewage collected and 94% of it treated.
- The sewage treatment plants (ETEs) – Ribeirão Preto and Caiçara – reach 95% organic matter removal efficiency.
- Based on total treated flow and organic matter removal, the potential volume for reuse is approximately 1.5 m^3/s.
- Regarding the water demand to supply the region's water needs, irrigation is the one that consumes the most water, representing 9.6 m3/s, followed by public supply, with 7.7 m3/s and industry with 2 m3/s.

This Represents:

- 15% of irrigation demand
- 20% of potable water demand
- 75% of industrial water demand

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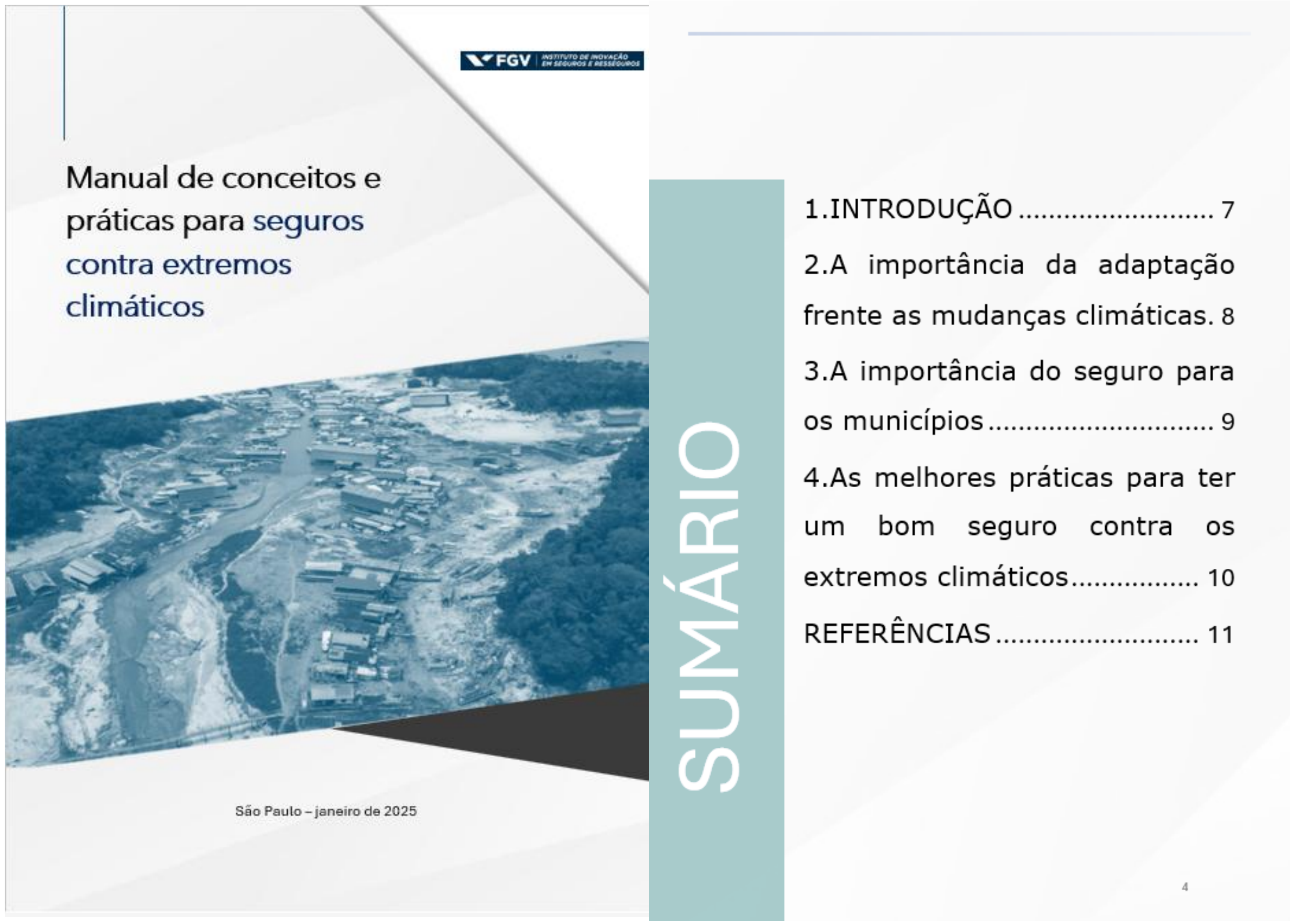
5. Structure of the Manual for municipalities...

"I must present it to them briefly so they will read it, clearly so they will understand it, forcefully so they will appreciate it, picturesquely so they will remember it — and, above all, accurately so they will be guided by its light."

Joseph Pulitzer, journalist and former U.S. Congressman.

Proposal to tackle climate extremes...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Manual de conceitos e práticas para seguros contra extremos climáticos

São Paulo – janeiro de 2025

SUMÁRIO

4

The project aims to develop a handbook of concepts and best practices to support municipalities in addressing climate extremes.

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Three conclusions...

- The combination of **water reuse** and parametric insurance provides climate resilience
- **Parametric insurance** provides fast payouts and mitigates moral hazard and adverse selection
- **Securitization** can provide more resources to finance insurance for municipalities to cope with extreme weather

COP30 Special Edition

COP 30
BRASIL
AMAZÔNIA
BELÉM 2025

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Economist

Thelma Krug
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Thank you!

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