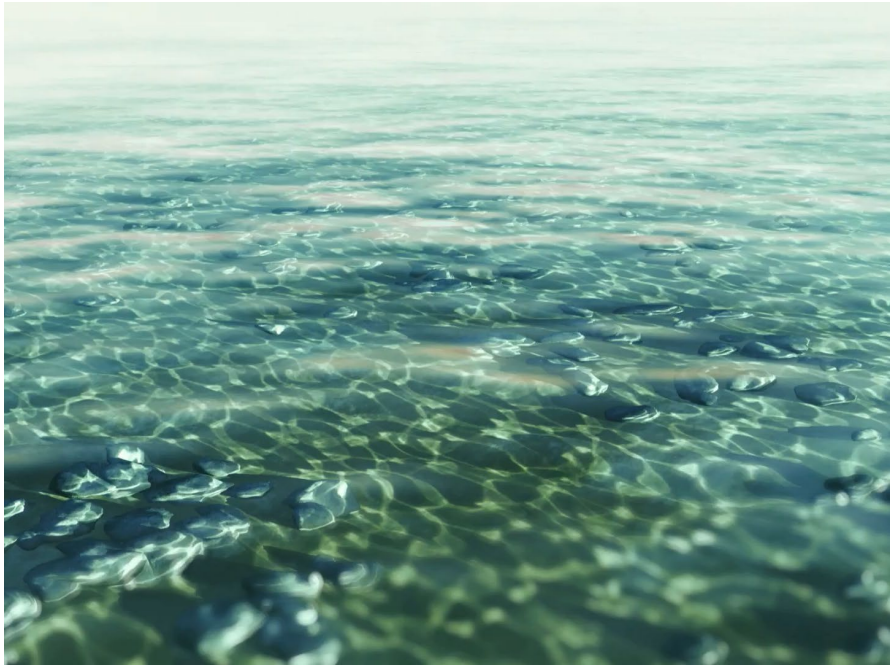
Integrating Hydrological Modeling and Renewable Energy for Sustainable Water Management in the São Francisco River Basin

Josicleda D. Galvincio (UFPE), Mario Mendiondo (USP), Suzana G. Montenegro (UFPE/APAC), Rodrigo Q. Miranda (UFPE),
Weronica M. Souza (UFAPE), Rejane M. Pimentel (UFRPE), Valéria S. Costa (Ciamb),
Magna S. Moura (EMBRAPA), Luz A. Cuartas (CEMADEN), Danielle Bressiani (UFPel), Enio B. Pereira (INPE)



Introduction

Water and energy security are critical in semi-arid regions, especially Northeastern Brazil.

The project assesses climate change impacts and floating solar potential in the São Francisco River Basin.

Methodology

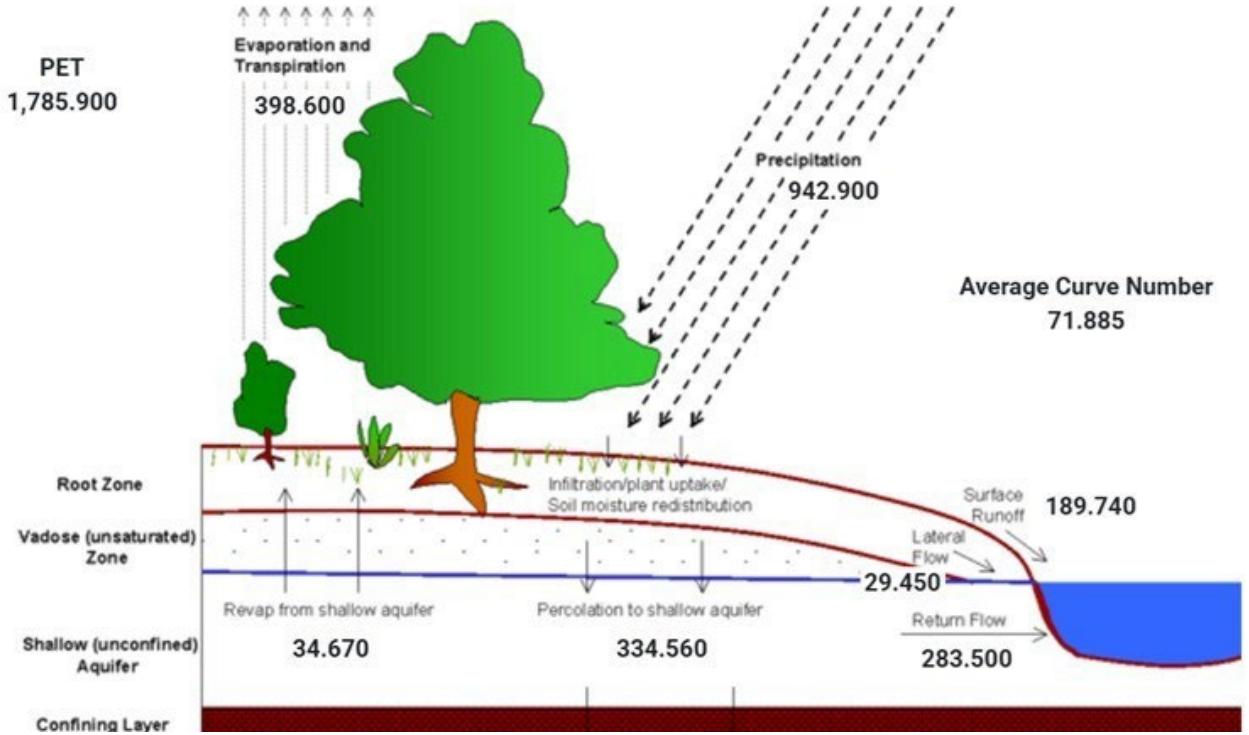
- SWAT model applied to Sobradinho Reservoir and other basins in Pernambuco.
- Data: 1961–2021 – climate trends, land use, water availability.
- Calibration emphasized groundwater's role in hydrological balance.

Study área- Sobradinho basin-São Francisco river

SUPer Sistema de Unidades de resposta hidrológica para Pernambuco
Uma ferramenta de avaliação hidrológica e de qualidade de água

Annual Water balance

SUPer Sistema de Unidades de resposta hidrológica para Pernambuco
Uma ferramenta de avaliação hidrológica e de qualidade de água

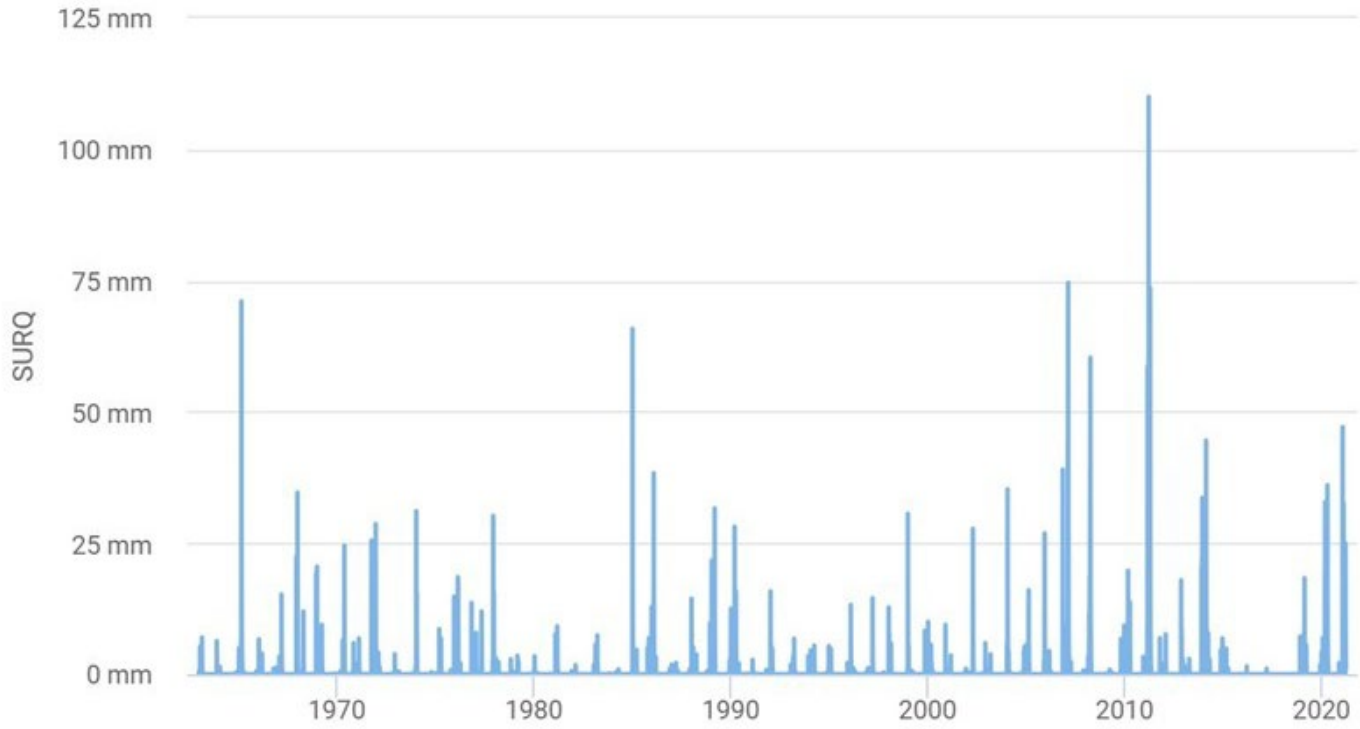


SURQ

SUPer

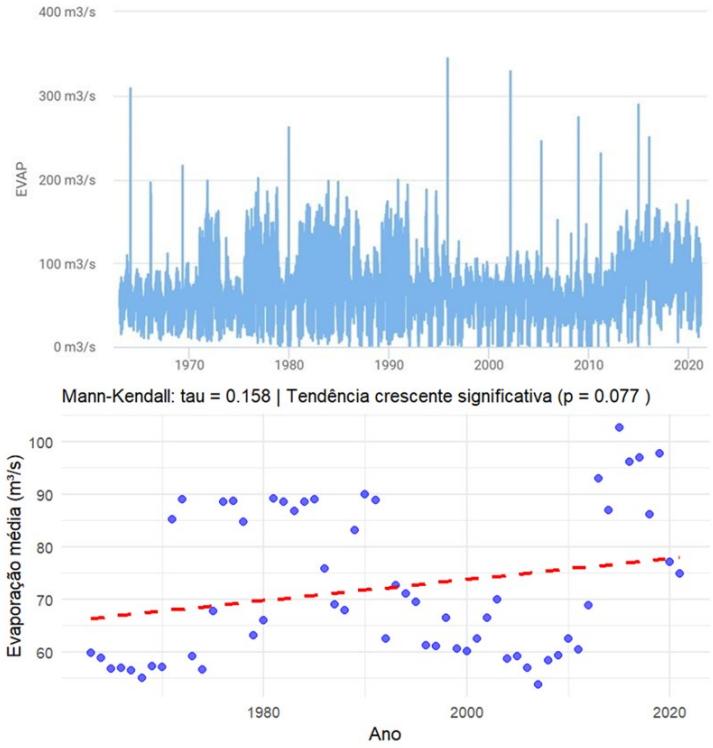
Sistema de Unidades de resposta hidrológica para Pernambuco

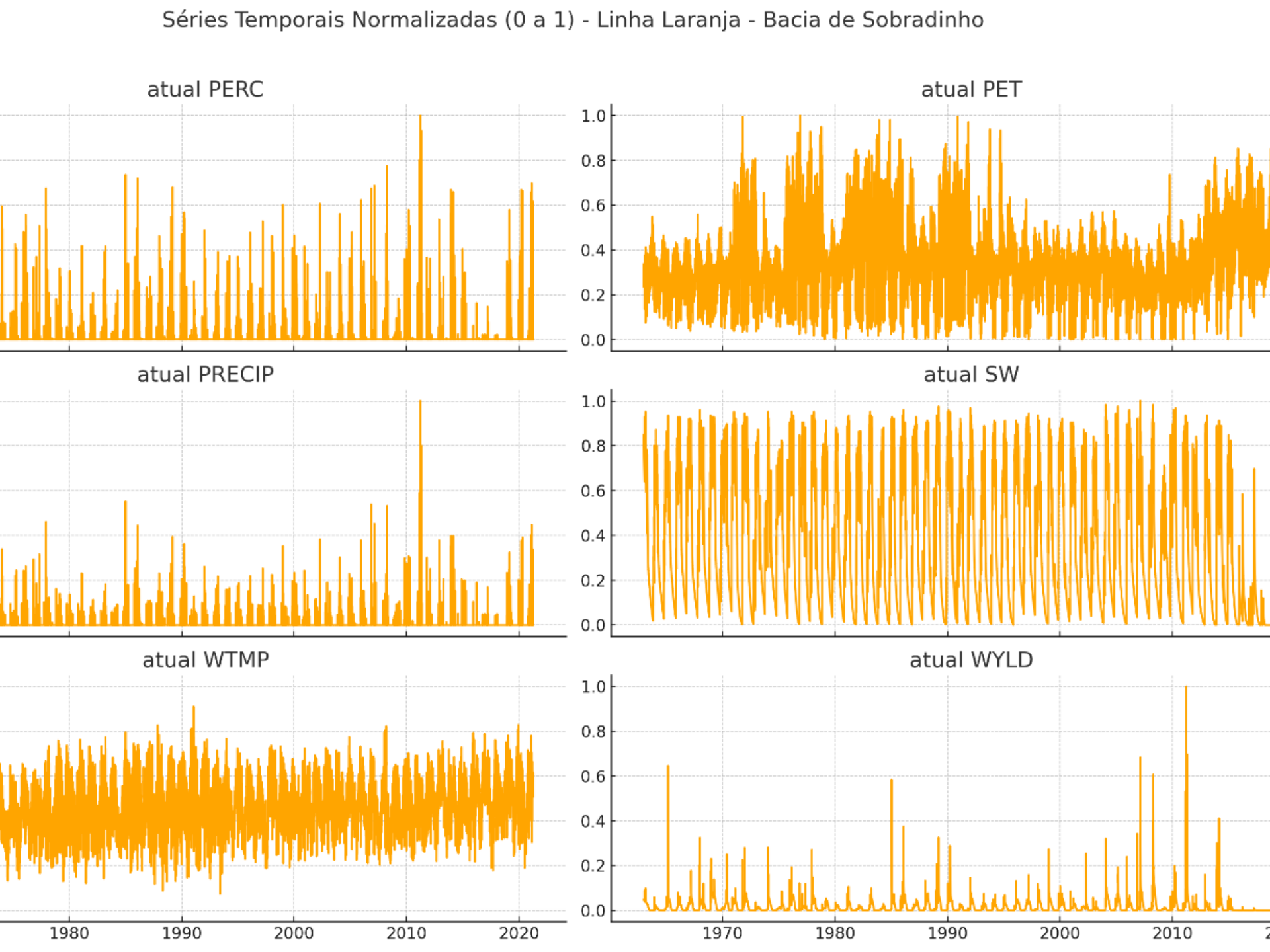
Uma ferramenta de avaliação hidrológica e de qualidade de água



Evaporation

SUPer Sistema de Unidades de resposta hidrológica para Pernambuco
Uma ferramenta de avaliação hidrológica e de qualidade de água




Séries Temporais Normalizadas (0 a 1) - Linha Laranja - Bacia de Sobradinho
atual PERC
atual PET
atual PRECIP
atual SW
atual WTMP
atual WYLD
1.0
0.8
0.6
0.4
0.2
0.0
1970
1980
1990
2000
2010
2020

Key Hydrological Findings

- Groundwater recharge and depletion are crucial for reservoir stability.
- Land use changes (agriculture, deforestation, urbanization) affect infiltration and runoff.
- Highlights the need for integrated groundwater management.

Floating Solar Energy

- • Floating solar panels reduce evaporation and optimize land use.
- • Offer clean energy solutions in high solar radiation regions.
- • Coupling hydrology and energy planning enhances resilience.

Fluxograma dos impactos esperados das mudanças climáticas na bacia do reservatório de Sobradinho, com base nas simulações SWAT/SUPer

Causas climáticas (topo)

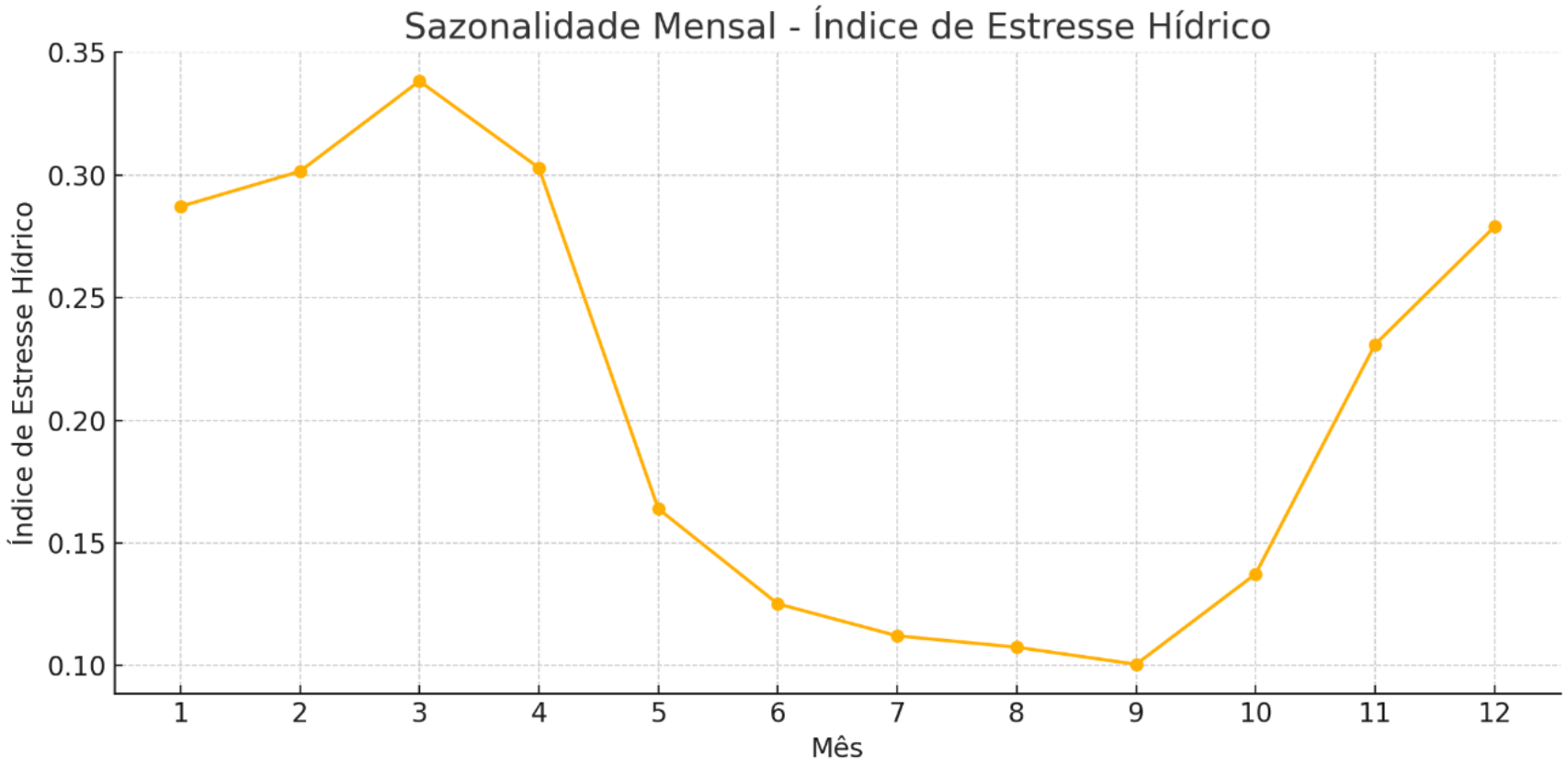
- → Aumento da PET
- → Aumento da Temperatura da Água (WTMP)
- → Redução da Precipitação (PRECIP)
- → Redução do Armazenamento no Solo (SW)

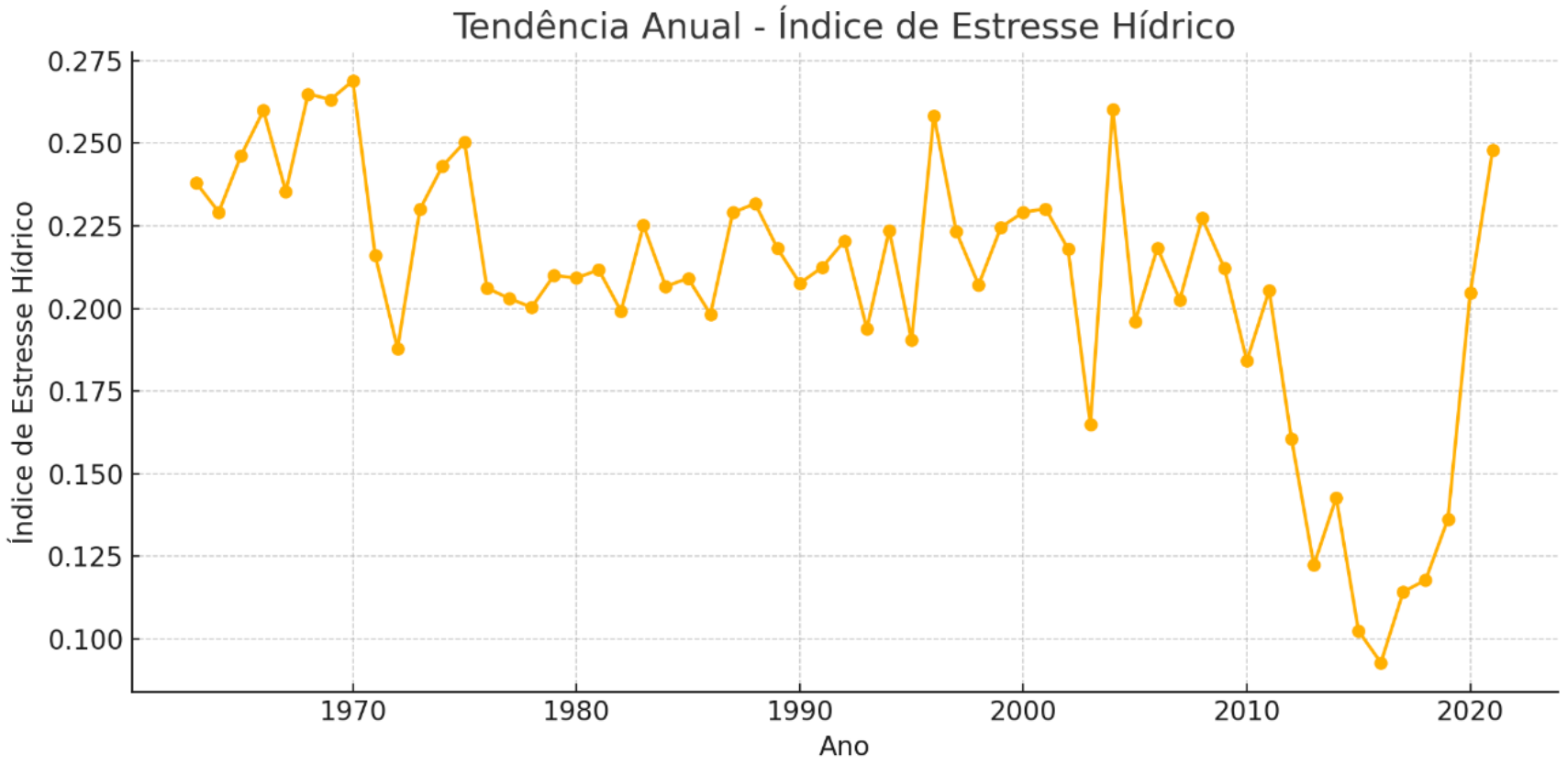
Efeitos intermediários

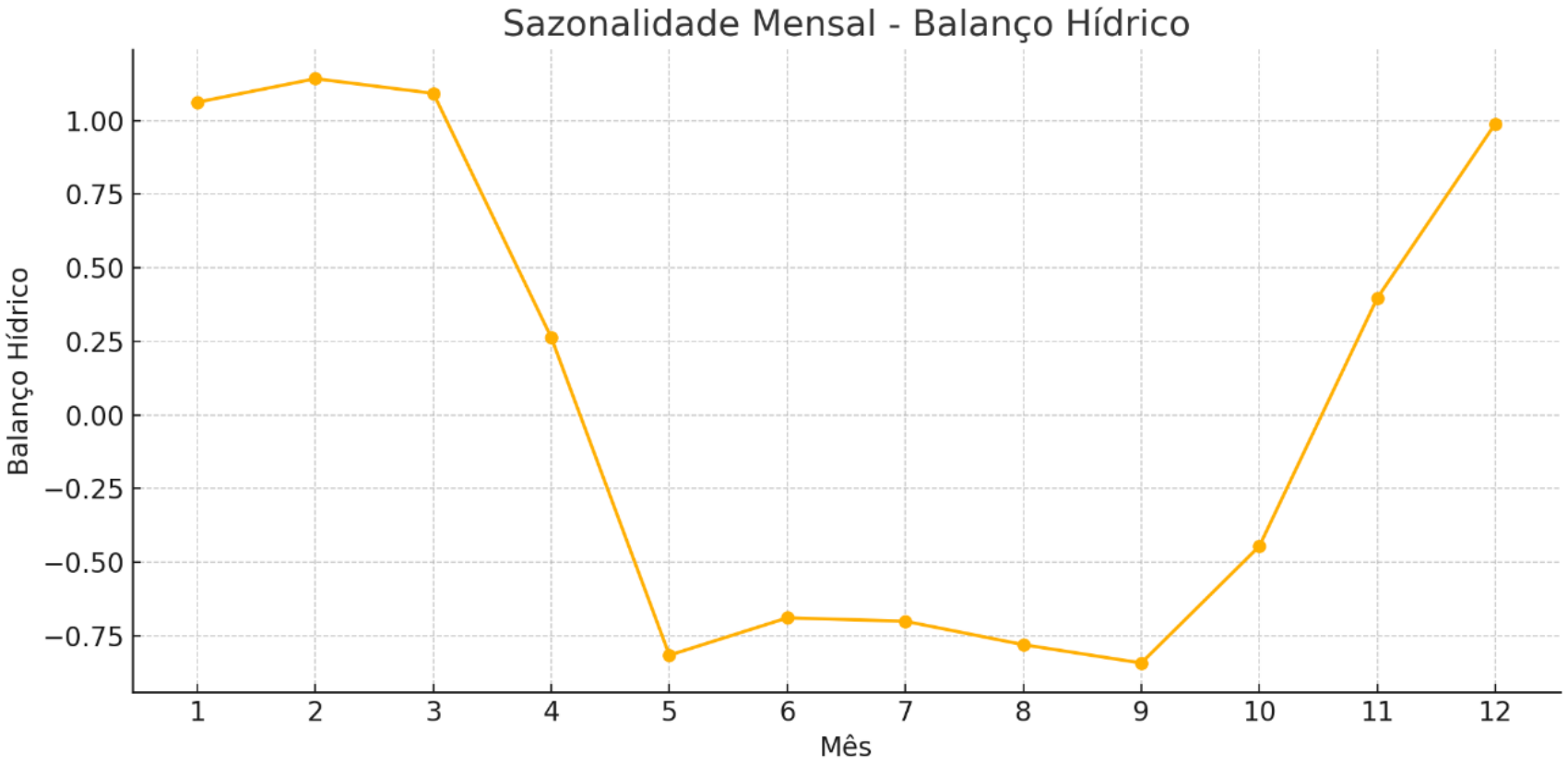
- → Maior evaporação e déficit hídrico
- → Redução da recarga subterrânea

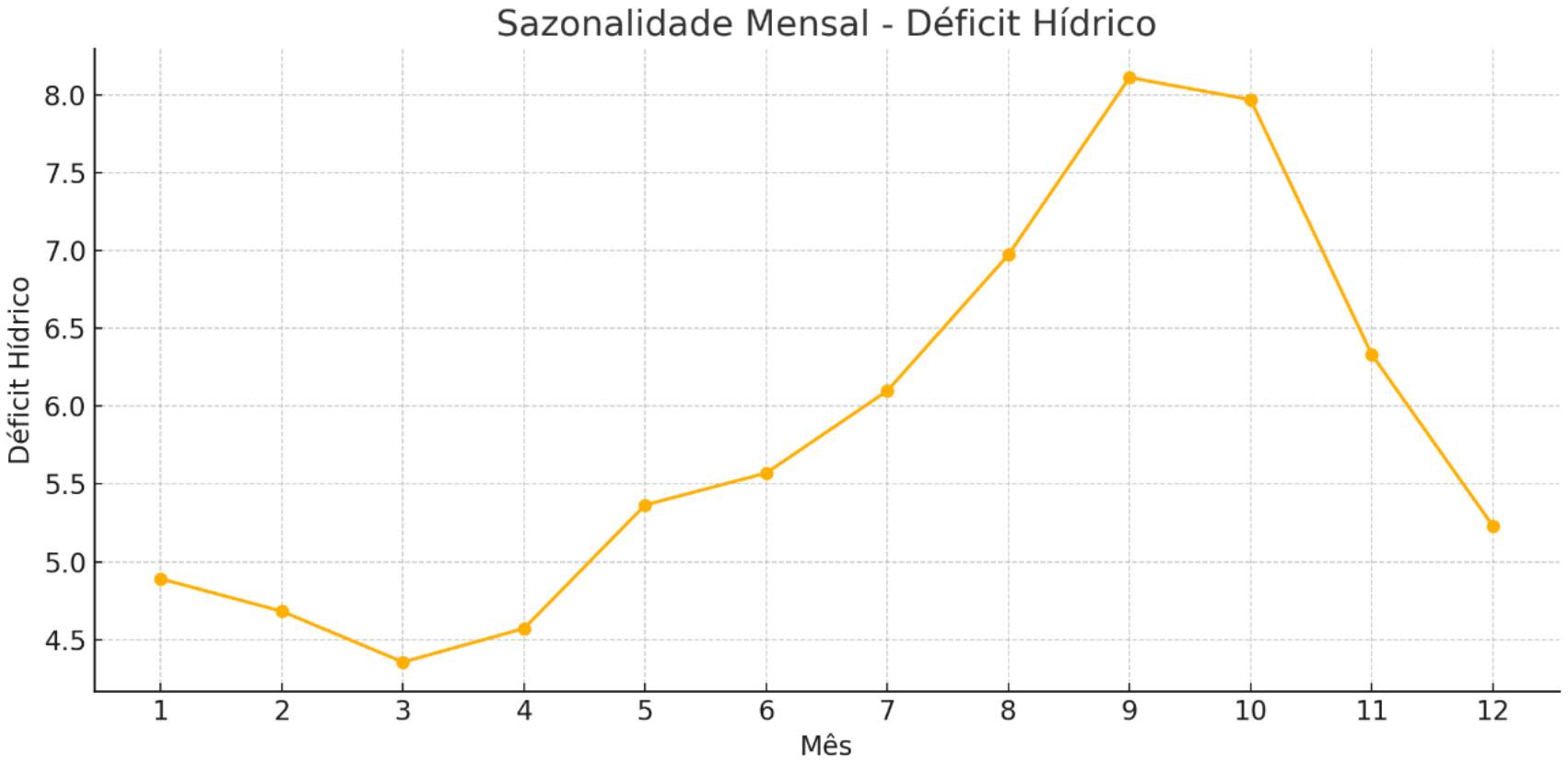
Impacto final

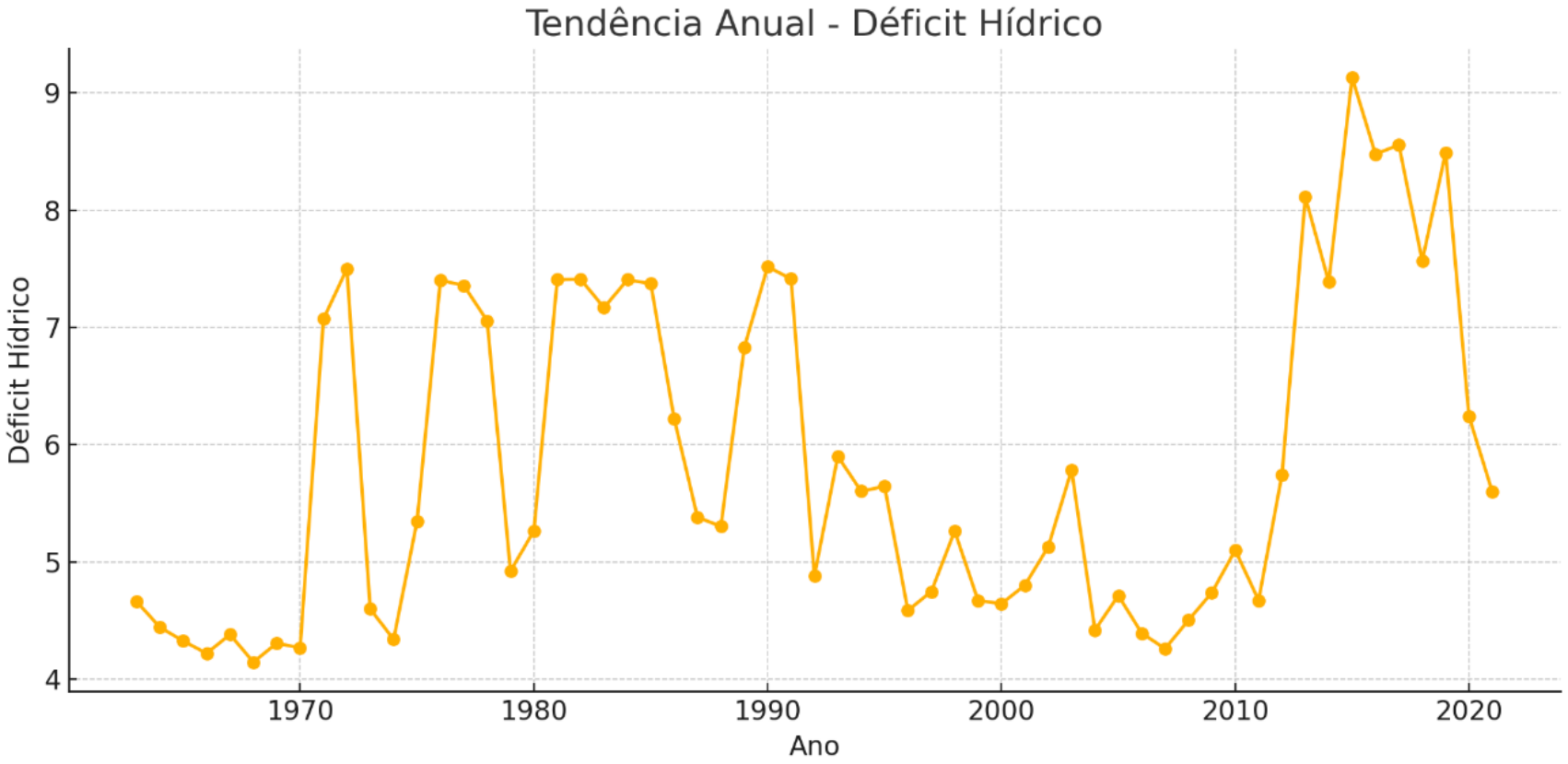
- → Maior estresse hídrico regional

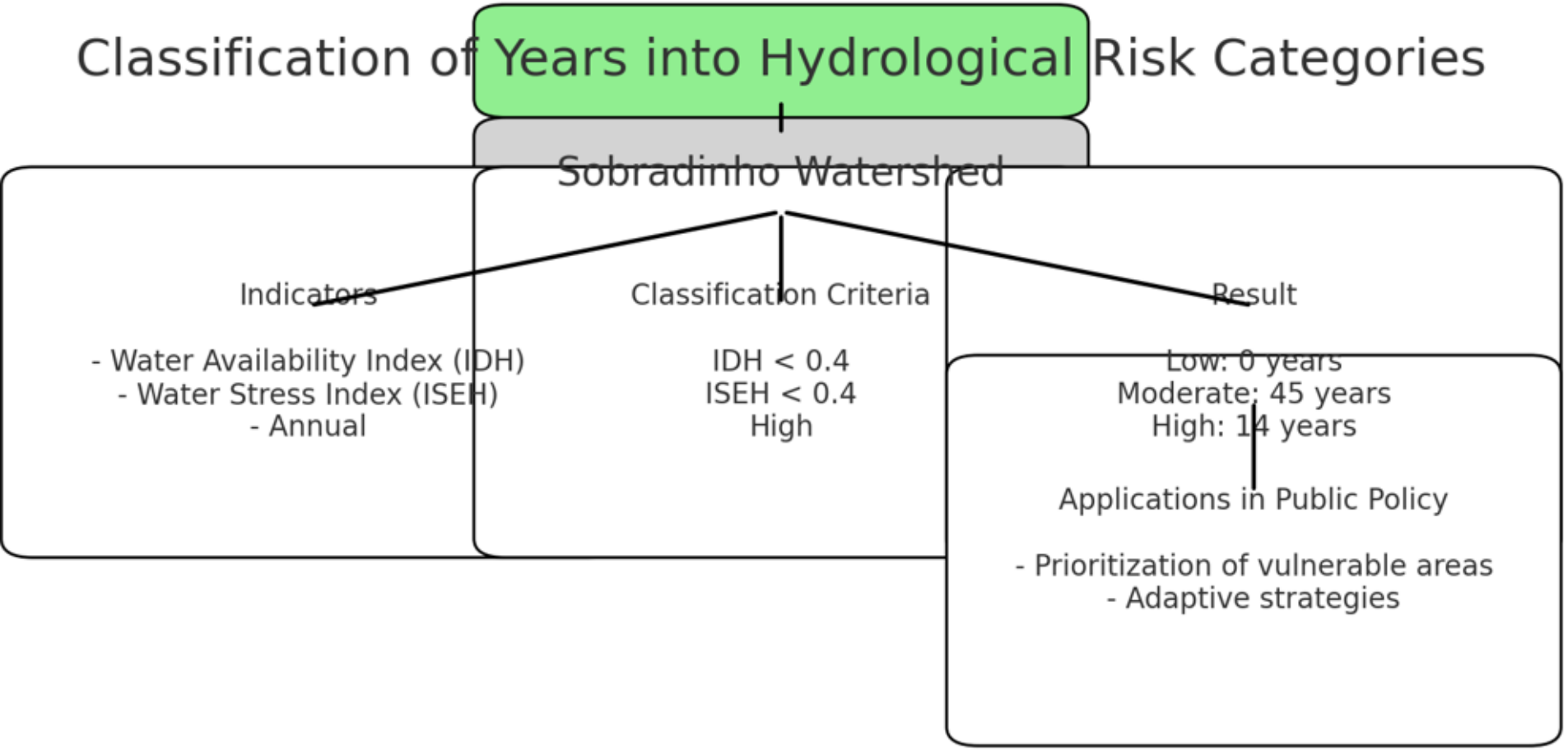

Sazonalidade Mensal - Índice de Estresse Hídrico
Índice de Estresse Hídrico
0.35
0.30
0.25
0.20
0.15
0.10
1
2
3
4
5
6
7
8
9
10
11
12
Mês


Tendência Anual - Índice de Estresse Hídrico
Índice de Estresse Hídrico
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
1970
1980
1990
2000
2010
2020
Ano


Sazonalidade Mensal - Balanço Hídrico
Balanço Hídrico
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
1
2
3
4
5
6
7
8
9
10
11
12
Mês

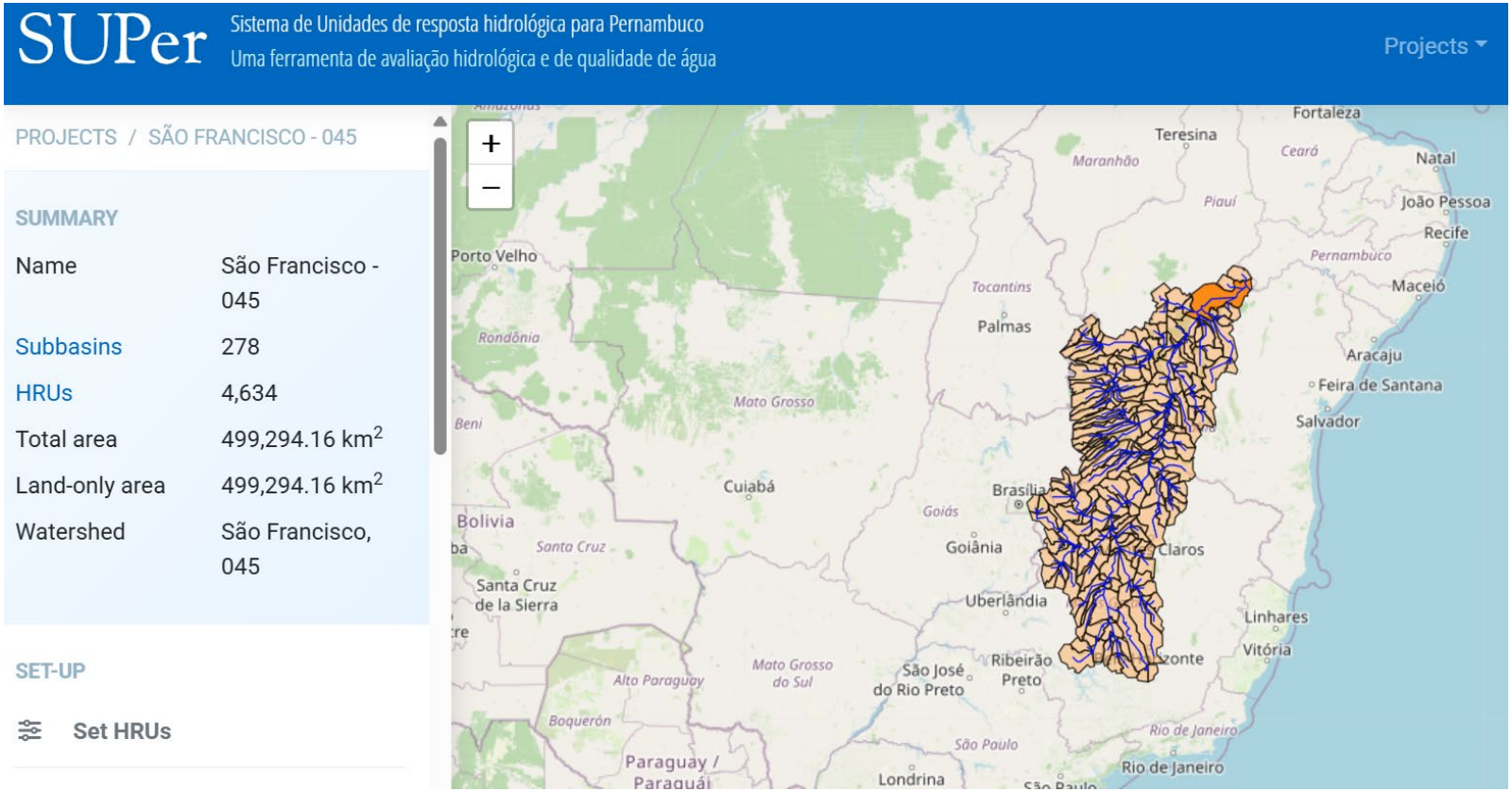

Sazonalidade Mensal - Déficit Hídrico
Déficit Hídrico
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
1
2
3
4
5
6
7
8
9
10
11
12
Mês


Tendência Anual - Déficit Hídrico
Déficit Hídrico
Ano
4
5
6
7
8
9
1970
1980
1990
2000
2010
2020


Classification of Years into Hydrological Risk Categories
Sobradinho Watershed
Indicators
- Water Availability Index (IDH)
- Water Stress Index (ISEH)
- Annual
Classification Criteria
IDH < 0.4
ISEH < 0.4
High
Result
Low: 0 years
Moderate: 45 years
High: 14 years
Applications in Public Policy
- Prioritization of vulnerable areas
- Adaptive strategies

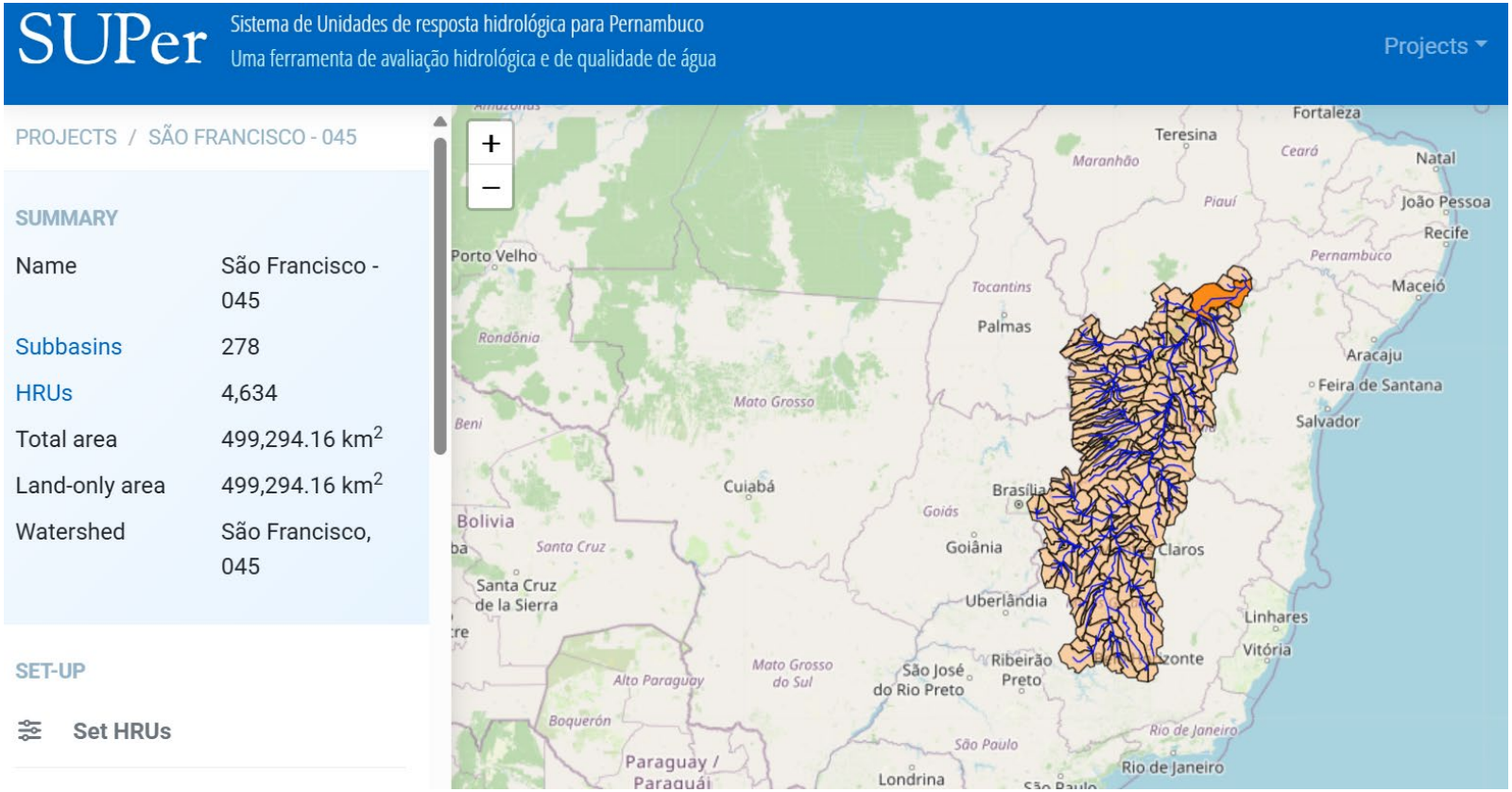
Decision-Support Tools

- • Expansion of SUPer with São Francisco Basin data.
- • Development of BEST – Brazilian Ecohydrological Simulation Tool.
- • Aids managers and policymakers in water governance.



Decision-Support Tools

- • Expansion of SUPer with São Francisco Basin data.
- • Development of BEST – Brazilian Ecohydrological Simulation Tool.
- • Aids managers and policymakers in water governance.

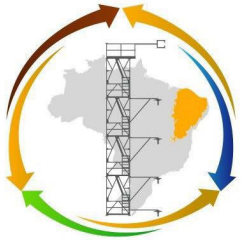


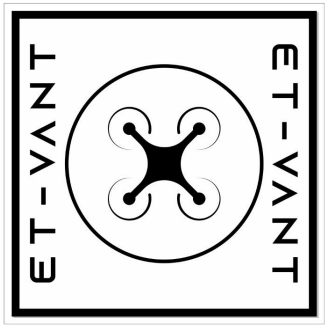
Conclusion

- • Integrated modeling and renewable energy enhance sustainability.
- • Emphasis on groundwater, land use, and floating solar.
- • Provides a robust framework for water-energy adaptation in semi-arid regions.

Acknowledgments

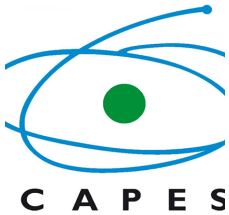
Acknowledgments





Spatial Sciences Laboratory

DEPARTMENT OF ECOLOGY AND CONSERVATION BIOLOGY



Acknowledgments