LAND USE SCENARIOS AND THEIR IMPACT ON WATER AVAILABILITY IN THE TERRA NOVA RIVER BASIN

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Introduction

01

Land use and occupation refer to changes on the earth's surface driven by natural forces and human activities. These transformations directly affect environmental processes and water resources, influencing soil structure, fertility, and hydrological dynamics (Blainski et al., 2017).

02

Alterations in land use affect water quality and quantity by changing infiltration and evapotranspiration processes Understanding these dynamics is crucial for developing adaptive strategies in vulnerable watersheds facing climatic and anthropogenic pressures (Aragaw, 2021).

Introduction

Land Use and Land Cover Modeling

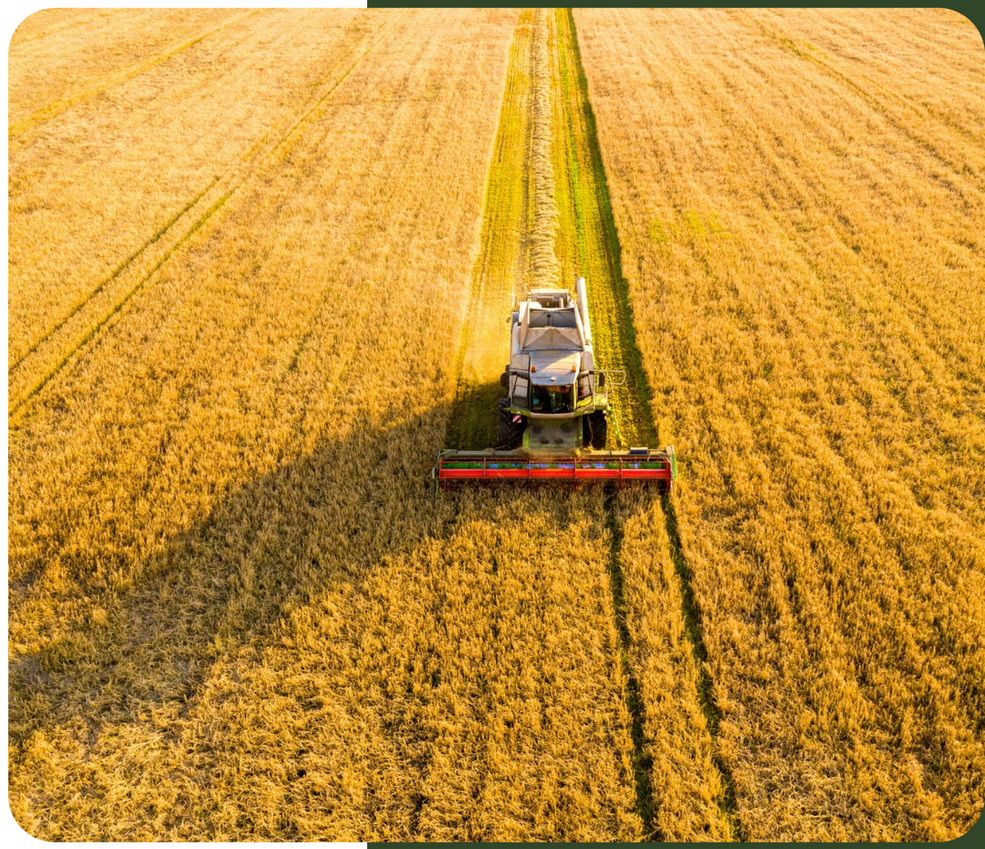
Land use modeling and scenario development are essential for predicting future environmental changes and supporting sustainable land management. By simulating various land use pathways, these models evaluate impacts on hydrological processes and resource availability. This information helps guide adaptive policies to mitigate risks and enhance resilience in vulnerable regions (Shoyamaet al., 2019).

SWAT & SUPer

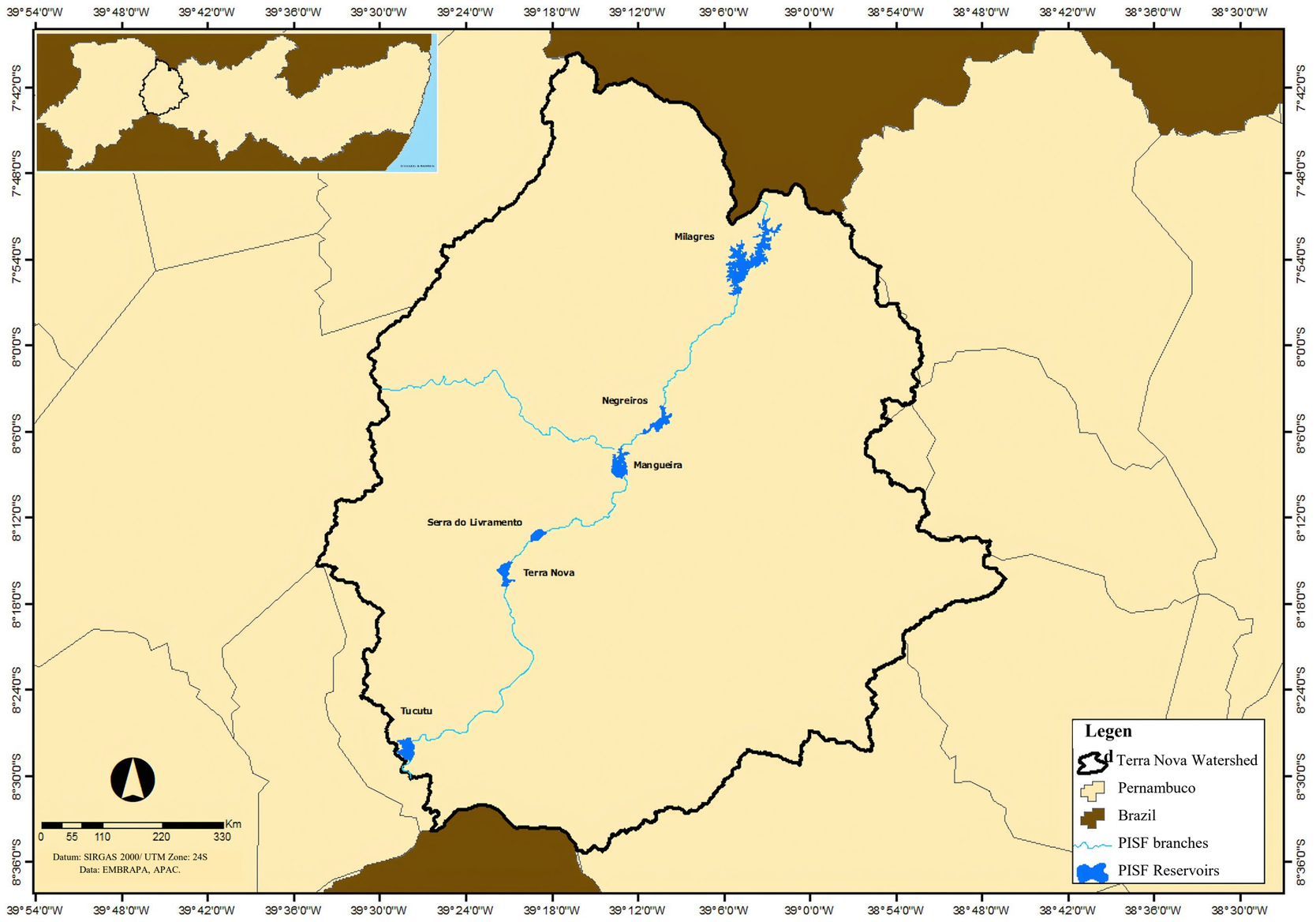
SWAT (Soil & Water Assessment Tool) is widely used to simulate the hydrological cycle in watersheds, allowing the analysis of factors such as land use and climate (Bressiani et al., 2015). SUPer (Hydrological Response Unit System for Pernambuco) uses SWAT and provides state-level data for water resources management (Soareset al., 2024).

Objective

The objective of this study was to simulate land use and land cover change scenarios in the Terra Nova River Basin, located in the semi-arid region of Pernambuco, using the SWAT model. By evaluating different future land use trajectories, the study aimed to assessthe potential impacts of these changes on hydrological processes



Study Area


39°54'0"W
39°48'0"W
39°42'0"W
39°36'0"W
39°30'0"W
39°24'0"W
39°18'0"W
39°12'0"W
39°6'0"W
39°0'0"W
38°54'0"W
38°48'0"W
38°42'0"W
38°36'0"W
38°30'0"W
7°42'0"S
7°48'0"S
7°54'0"S
8°0'0"S
8°6'0"S
8°12'0"S
8°18'0"S
8°24'0"S
8°30'0"S
8°36'0"S
Milagres
Negreiros
Mangueira
Serra do Livramento
Terra Nova
Tucutu
Km
0 55 110 220 330
Datum: SIRGAS 2000/ UTM Zone: 24S
Data: EMBRAPA, APAC.
Legen
Terra Nova Watershed
Pernambuco
Brazil
PISF branches
PISF Reservoirs

Methodology

01

The study adopted the land use scenario methodology by Blainski et al. (2011), customizing land cover classes in the SWAT model to simulate different land use changes such as native vegetation restoration, exposed soil, and urban expansion.

02

Three land use scenarios, based on regional land appropriation trends, were developed for the Terra Nova Watershed to evaluate the hydrological impacts of varying land use practices through comparative analysiswith the current land use (Vascoet al., 2024)

Methodology

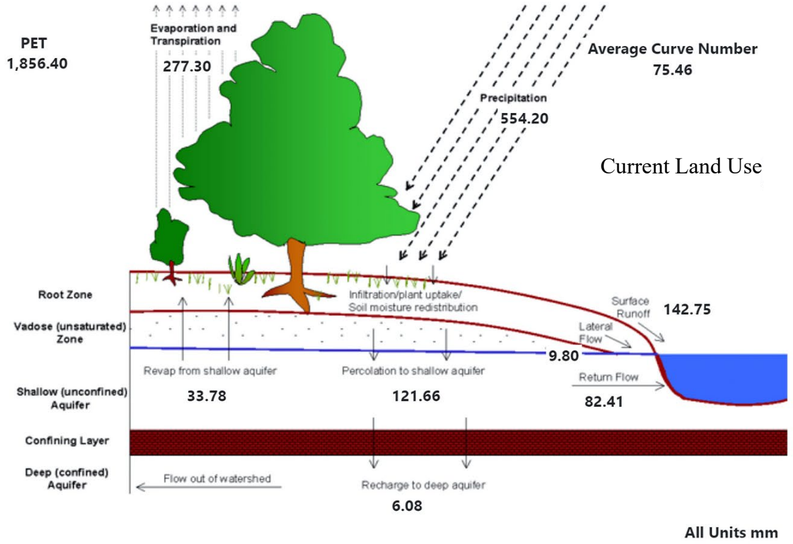
Current Land Use

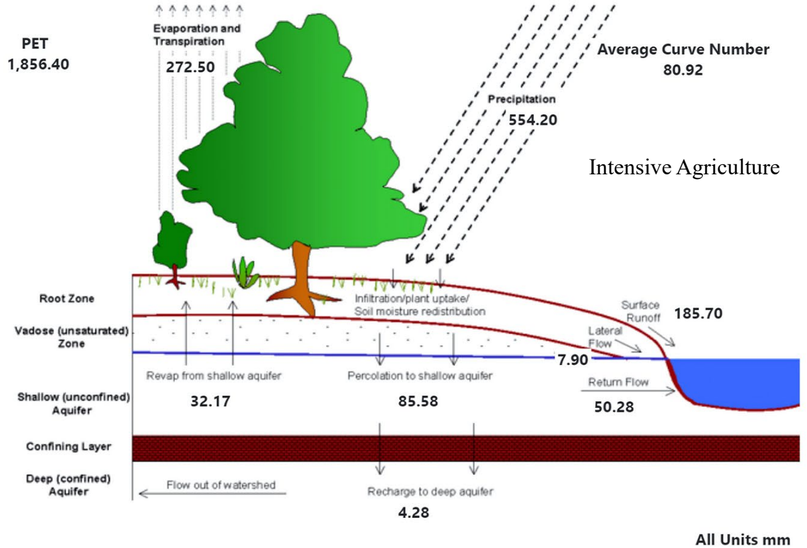
Native Vegetation Restoration

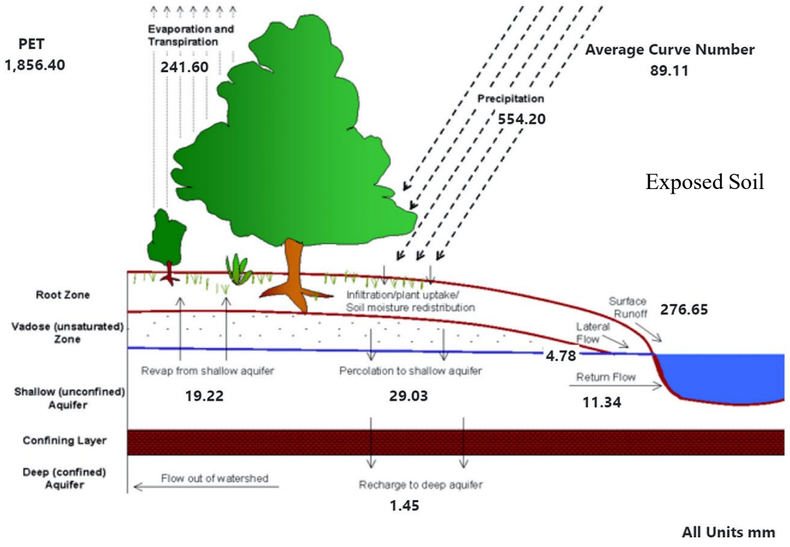
Intensive Agriculture

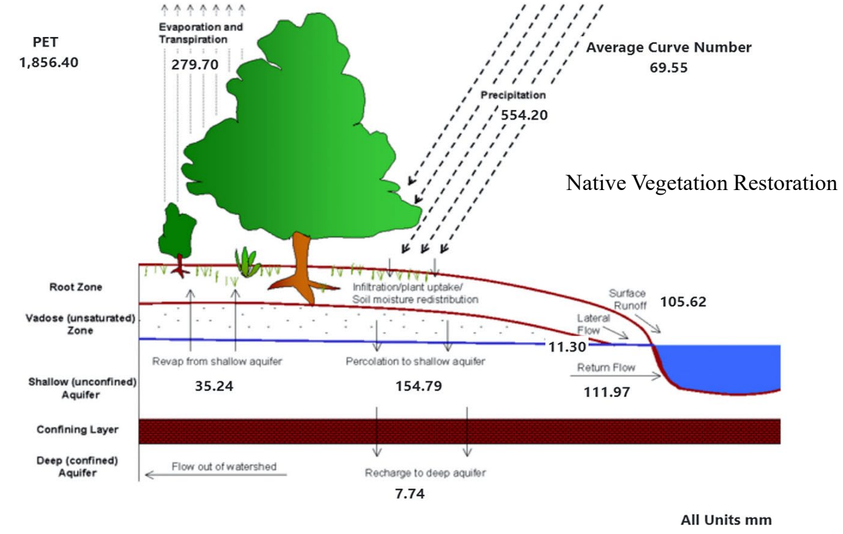
Exposed Soil

Results

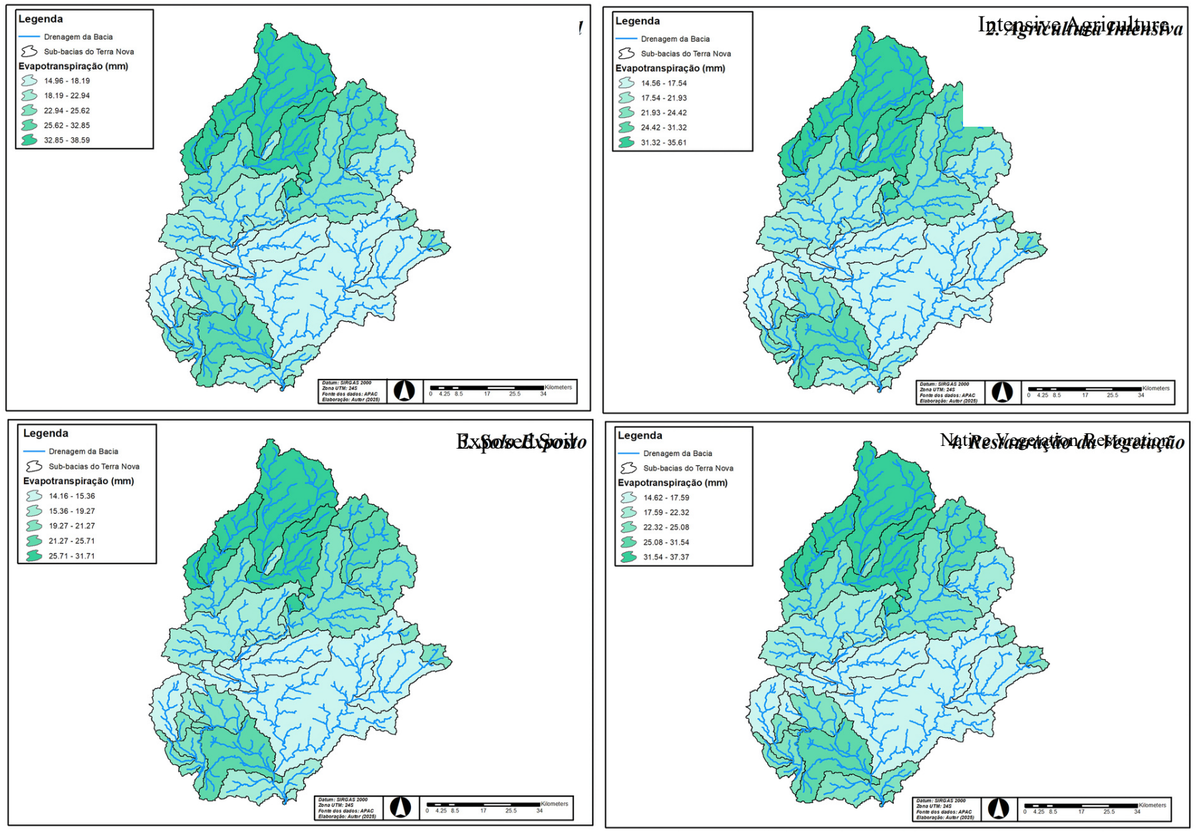

PET
1,856.40
Evaporation and Transpiration
277.30
Average Curve Number
75.46
Precipitation
554.20
Current Land Use
Root Zone
Vadose (unsaturated) Zone
Infiltration/plant uptake/ Soil moisture redistribution
Surface Runoff
142.75
Lateral Flow
9.80
Revap from shallow aquifer
33.78
Percolation to shallow aquifer
121.66
Return Flow
82.41
Shallow (unconfined) Aquifer
Confining Layer
Deep (confined) Aquifer
Flow out of watershed
Recharge to deep aquifer
6.08
All Units mm


PET
1,856.40
Evaporation and Transpiration
272.50
Average Curve Number
80.92
Precipitation
554.20
Intensive Agriculture
Root Zone
Vadose (unsaturated) Zone
Infiltration/plant uptake/ Soil moisture redistribution
Surface Runoff
185.70
Lateral Flow
7.90
Revap from shallow aquifer
32.17
Percolation to shallow aquifer
85.58
Return Flow
50.28
Shallow (unconfined) Aquifer
Confining Layer
Deep (confined) Aquifer
Flow out of watershed
Recharge to deep aquifer
4.28
All Units mm

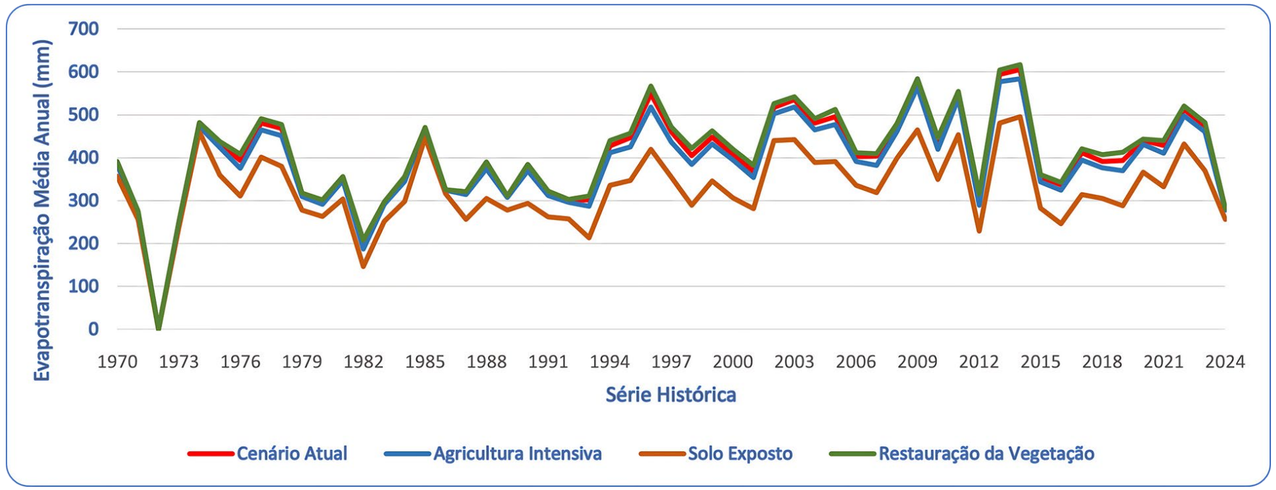

PET
1,856.40
Evaporation and Transpiration
241.60
Average Curve Number
89.11
Precipitation
554.20
Exposed Soil
Root Zone
Vadose (unsaturated) Zone
Infiltration/plant uptake/ Soil moisture redistribution
Surface Runoff
276.65
Lateral Flow
4.78
Revap from shallow aquifer
19.22
Percolation to shallow aquifer
29.03
Return Flow
11.34
Shallow (unconfined) Aquifer
Confining Layer
Deep (confined) Aquifer
Flow out of watershed
Recharge to deep aquifer
1.45
All Units mm


PET
1,856.40
Evaporation and Transpiration
279.70
Average Curve Number
69.55
Precipitation
554.20
Native Vegetation Restoration
Root Zone
Vadose (unsaturated) Zone
Infiltration/plant uptake/ Soil moisture redistribution
Surface Runoff
105.62
Lateral Flow
11.30
Revap from shallow aquifer
35.24
Percolation to shallow aquifer
154.79
Return Flow
111.97
Shallow (unconfined) Aquifer
Confining Layer
Deep (confined) Aquifer
Flow out of watershed
Recharge to deep aquifer
7.74
All Units mm

Results

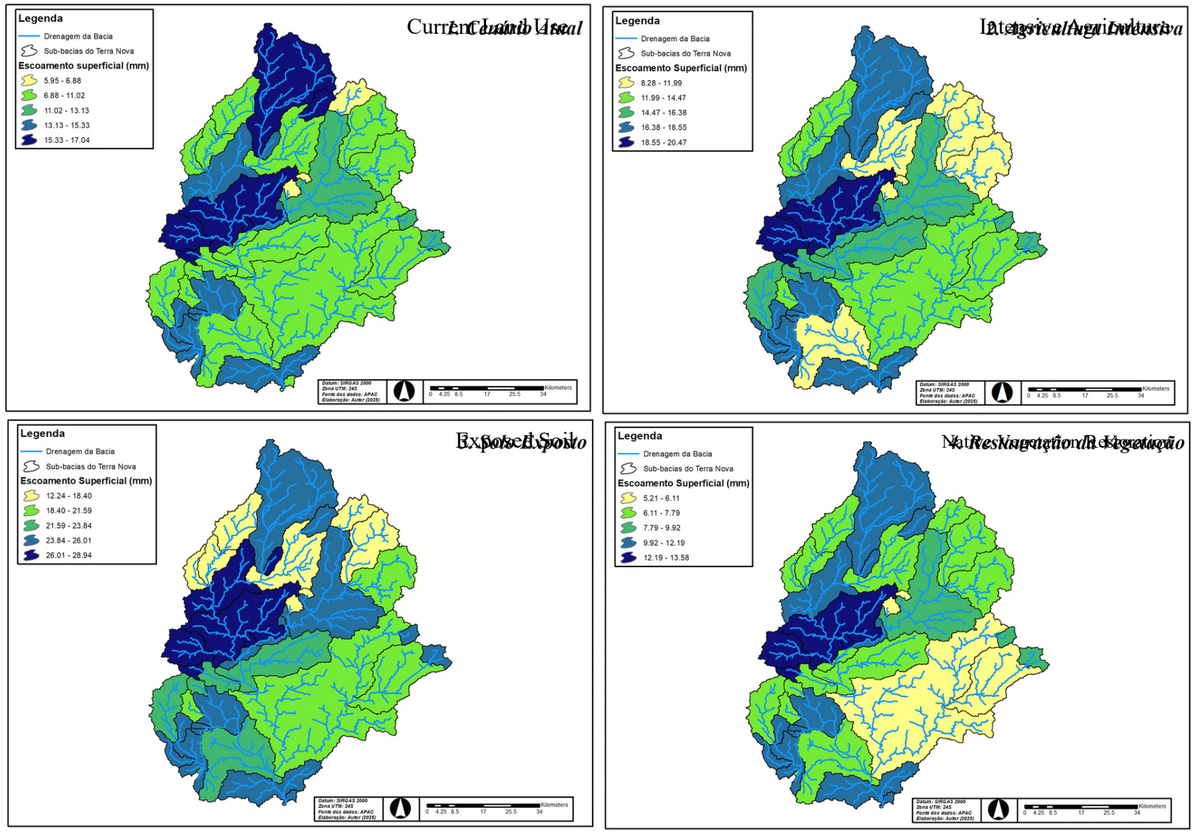


Vegetated landscapes maintain higher evapotranspiration, supporting microclimate stability and the water cycle.

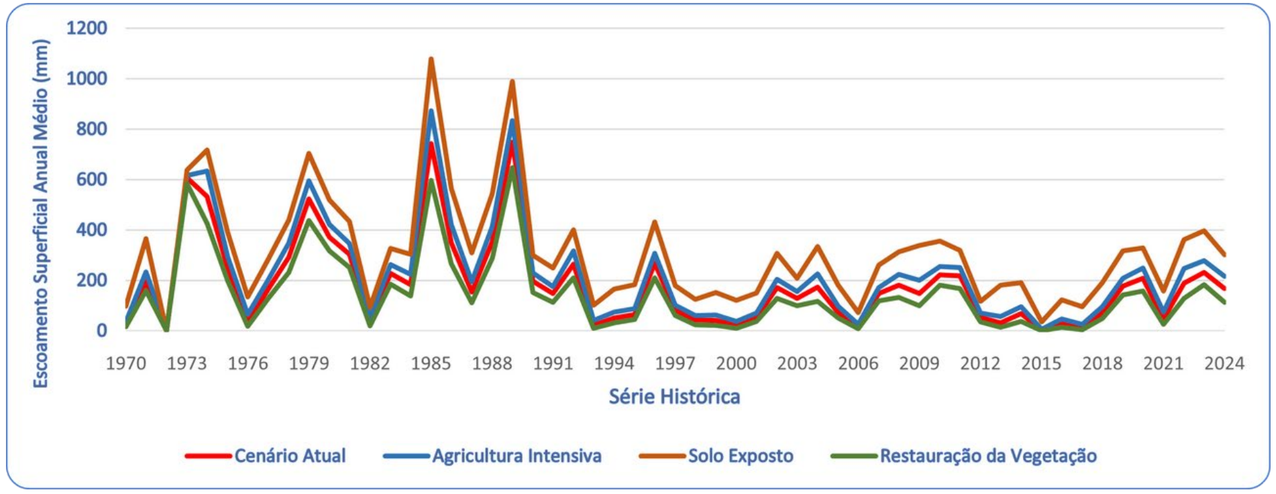


Evapotranspiration

Results

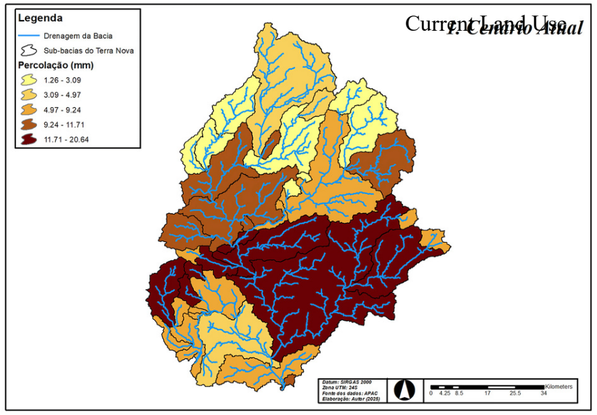


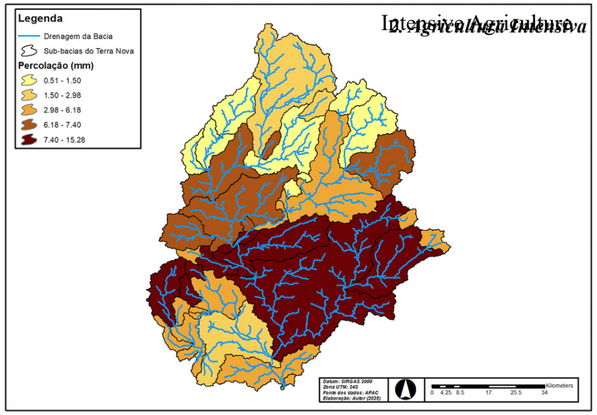
Surface runoff increases dramatically in degraded landscapes, reducing infiltration and amplifying erosion risks,

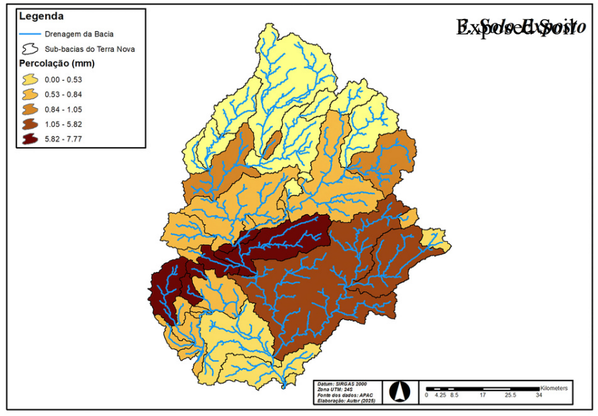


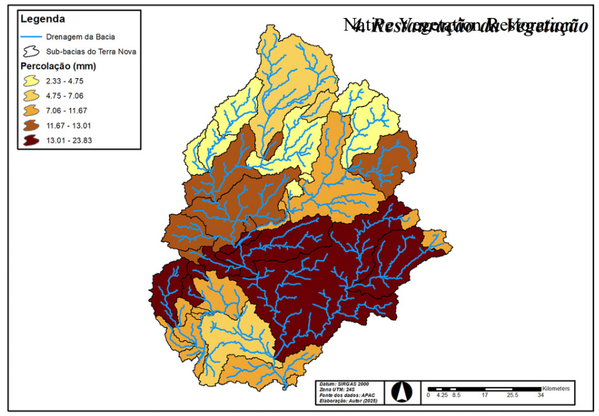
Surface Runoff

Results

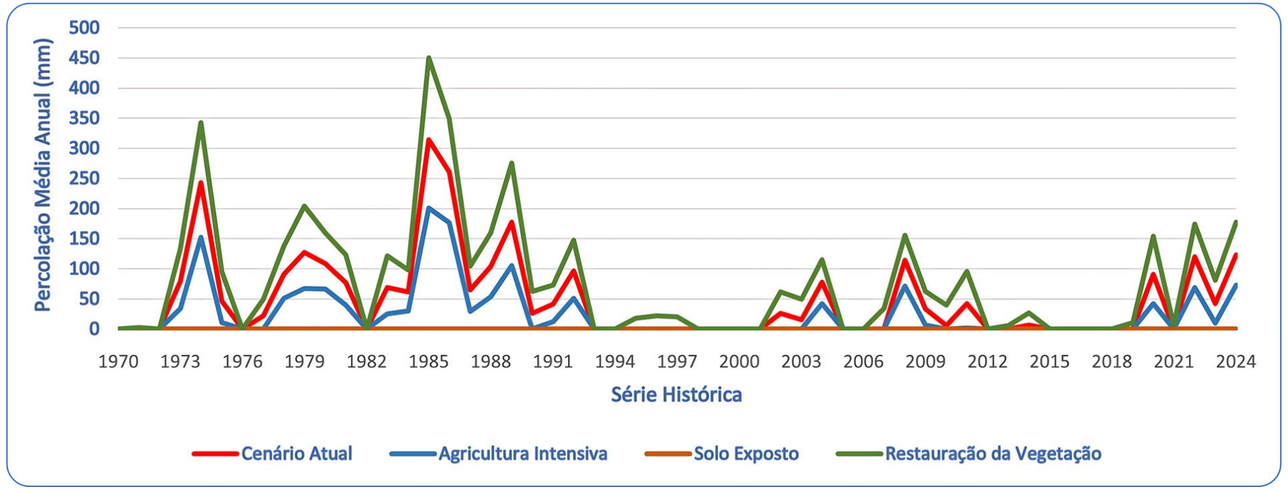








Percolation is maximized under native vegetation and nearly lost in exposed or compacted soils.



Percolation

Results

01

Restoring native vegetation improved hydrological balance by enhancing evapotranspiration, reducing runoff, and increasing groundwater recharge.

02

Exposed and intensively used soils drastically altered the water cycle, concentrating rainfall into rapid surface flow and limiting both infiltration and percolation.

03

The results reinforce the importance of integrating land use planning and water management, especially in vulnerable semiarid regions under climate pressure.

CONCLUSION

The land use scenarios modeled for the Terra Nova Basin revealed notable impacts on the hydrological balance. Restoration of vegetation enhanced infiltration and groundwater recharge, promoting water sustainability. In contrast, intensive agriculture and exposed soil increased surface runoff and decreased water availability, highlighting the need for sustainable land management to ensure water security.

THANK YOU!

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