Analysis of flow estimation through changes in land use in a river basin in the semi-arid region of Pernambuco, Brazil

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INTRODUCTION

Land use has a significant impact on the hydrological cycle, affecting water infiltration, evapotranspiration, surface runoff, and aquifer recharge.

Increase in soil degradation

+

Decrease of water availability

+

Climate Change

+

Replacement of natural vegetation

Changes in the **hydrological dynamics** of river basins

OBJECTIVE

THIS RESEARCH SEEKS TO EVALUATE POSSIBLE HYDROLOGICAL CHANGES, THROUGH CHANGES IN LAND USE, IN A RIVER BASIN LOCATED IN THE SEMI-ARID REGION OF BRAZIL.

METHODOLOGY

Study Area

- The Pajeú river basin in Pernambuco, Northeast Brazil, is the state's largest, covering 16,838.70 km² with an intermittent river.
- Main economic activities are rainfed agriculture and livestock farming, with extensive livestock exploitation impacting economic stability.
- The region has irregular rainfall, mainly from January to April, with annual totals between 400 and 1200 mm.
- The dry period lasts 7 to 10 months, with the southern area near the São Francisco River receiving 400 to 500 mm annually.

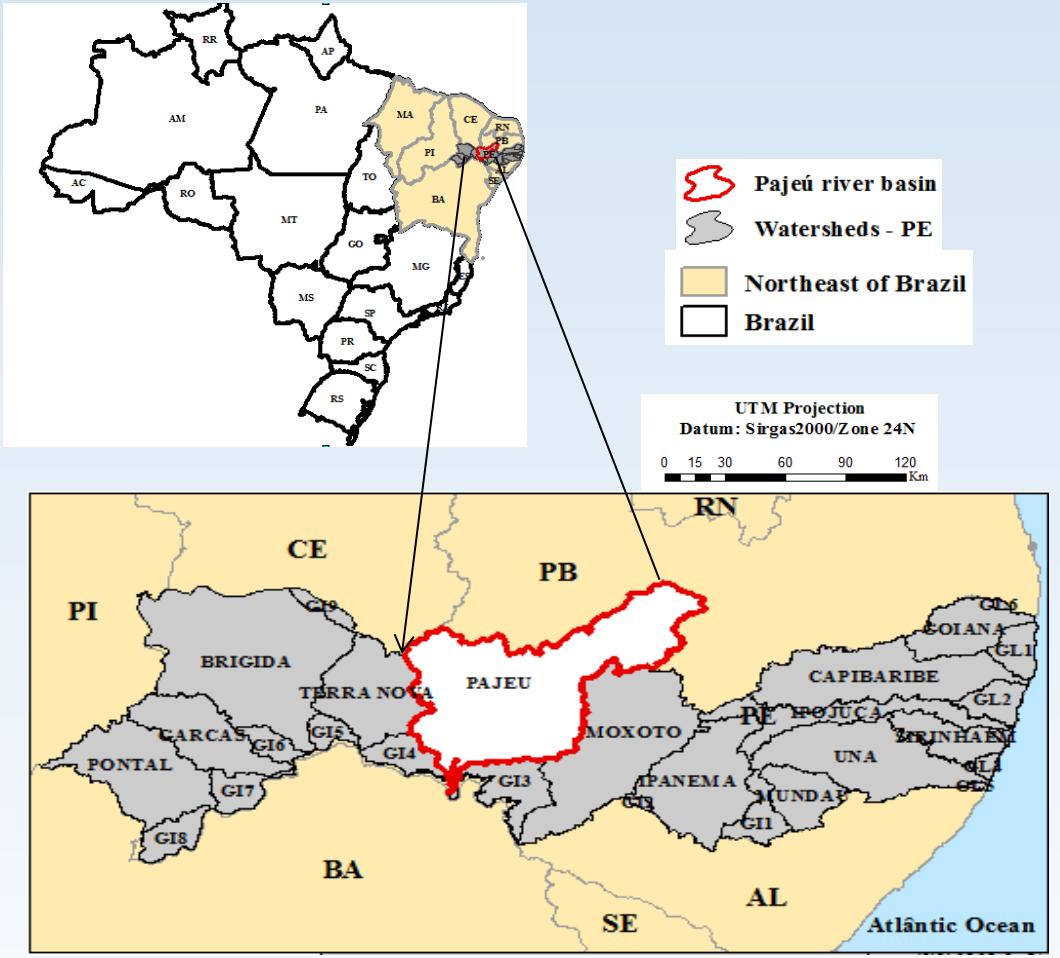


Figure 1 - Location map of Pajeú river basin.

METHODOLOGY

Hydrological simulation

Soil & Water Assessment Tool | SWAT

Semi-conceptual, semi-distributed, physically based and continuous in time.

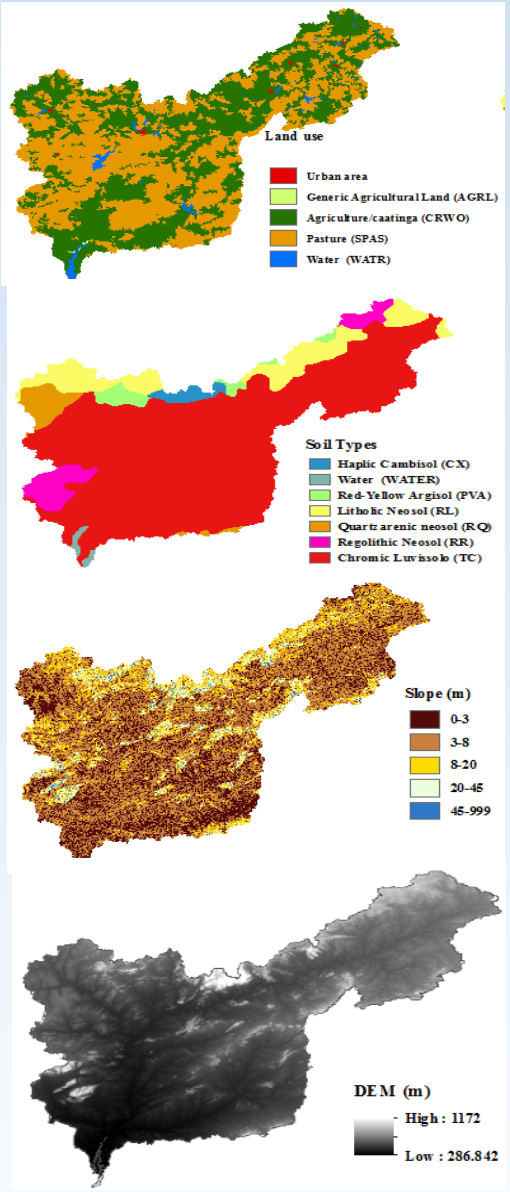
Input data

Terrain: TOPODATA from INPE

Soil types: IBGE and EMBRAPA Soils

Land uses: IBGE

Climate: APAC and INMET Reservoirs: APAC



METHODOLOGY

The MapBiomas project is an initiative of the Climate Observatory, co-created and developed by a multi-institutional network involving universities, NGOs, and technology companies with **the purpose of annually mapping Brazil's land cover and use and monitoring territorial changes.**

Land use maps obtained through Mapbiomas (https://brasil.mapbiomas.org/) for 1985, 1995, 2005 and 2015.

METHODOLOGY

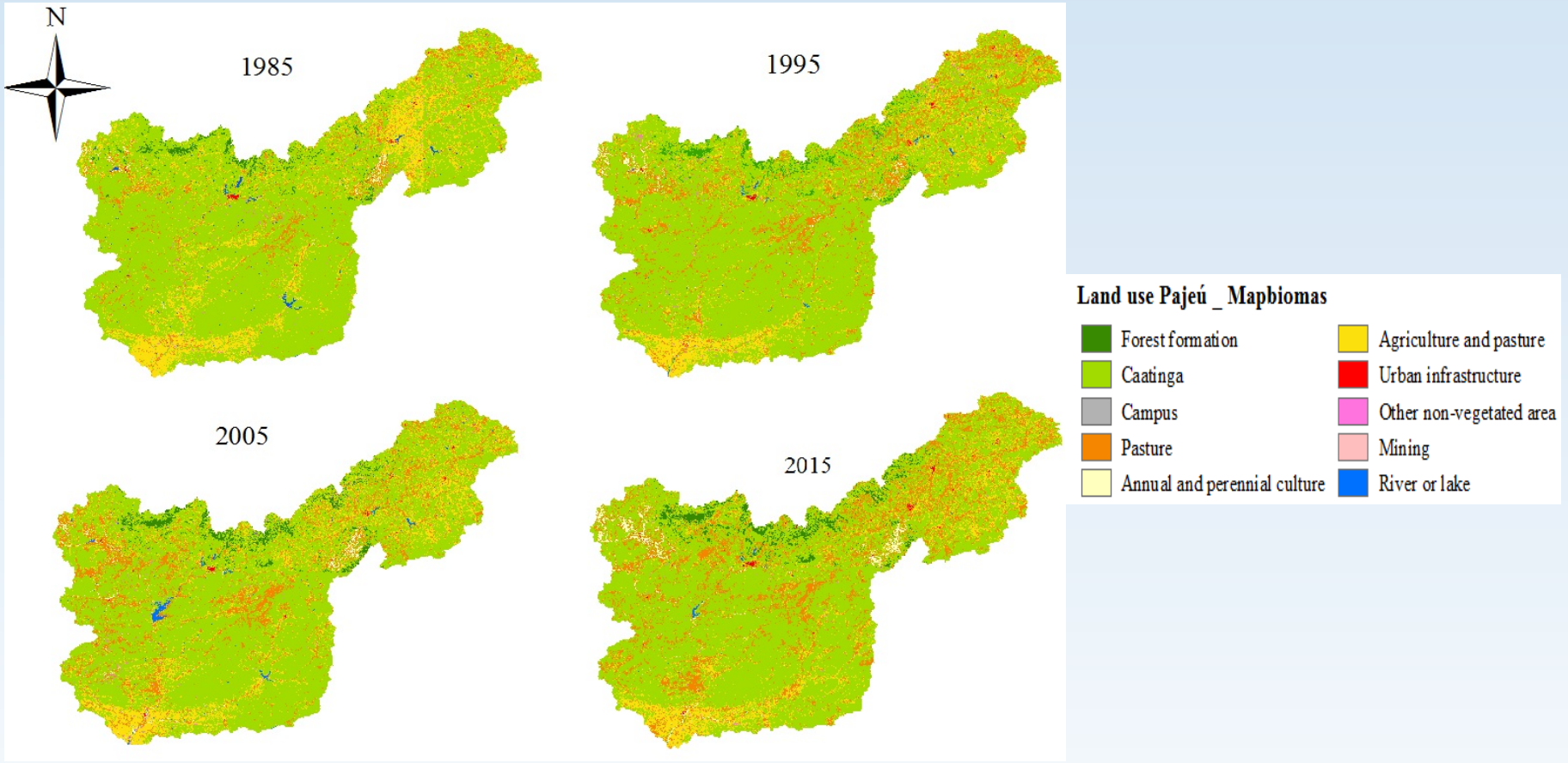


Figure 3 – Classification of land use for 1985, 1995, 2005 and 2015 using MapBiomas.

METHODOLOGY

Classes do SWAT	Classes	Área 1985		Área 1995		Área 2005		Área 2015	
		(km²)	%	(km²)	%	(km²)	%	(km²)	%
(FRST)	Florest formation	216.10	1.28	317.66	1.89	398.89	2.37	446.17	2.65
(RNGB)	Caatinga	12711.50	75.49	12502.29	74.25	11840.17	70.32	11635.86	69.10
(Gras)	Campus	6.02	0.04	0.65	0.00	7.04	0.04	1.57	0.01
(Past)	Pasture	1090.34	6.48	1988.66	11.81	2088.30	12.40	2724.68	16.18
(CRGR)	Annual and Perennial culture	77.67	0.46	98.69	0.59	120.08	0.71	229.62	1.36
(AGRL)	Agriculture and Pasture	2610.06	15.50	1854.59	11.01	2248.06	13.35	1767.01	10.49
(URBN)	Urban area	20.61	0.12	20.59	0.12	21.47	0.13	29.85	0.18
(BARR)	Non-vegetated area	84.73	0.50	63.91	0.38	84.36	0.50	34.44	0.20
(WATR)	River or lake	72.70	0.43	42.64	0.25	81.34	0.48	20.42	0.12

RESULTS

Flow variability for diferente Land Uses

Different land uses	R^2				
	Sub14	Sub36	Sub41	Sub49	Sub76
1985	0.41	0.75	0.67	0.45	0.31
1995	0.41	0.61	0.67	0.49	0.29
2005	0.41	0.75	0.67	0.45	0.31
2015	0.39	0.72	0.77	0.50	0.28

- The results of the flow simulation for different land uses showed similar variability between land uses for the five different fluviometric stations, consistent with the rainfall in the region and the observed flows.
- Fluviometric station 76 exhibited more differentiated behavior and lower flow compared to estimates.
- The coefficient of determination indicated a good correlation between the simulated flows and observed flows in subbasins 36 and 41.
- In other subbasins, flow estimates were unsatisfactory, with coefficients below 0.50 according to Moriasi et al. (2007).
- There were more faults in the observed flows at the fluviometric stations in these subbasins.

RESULTS

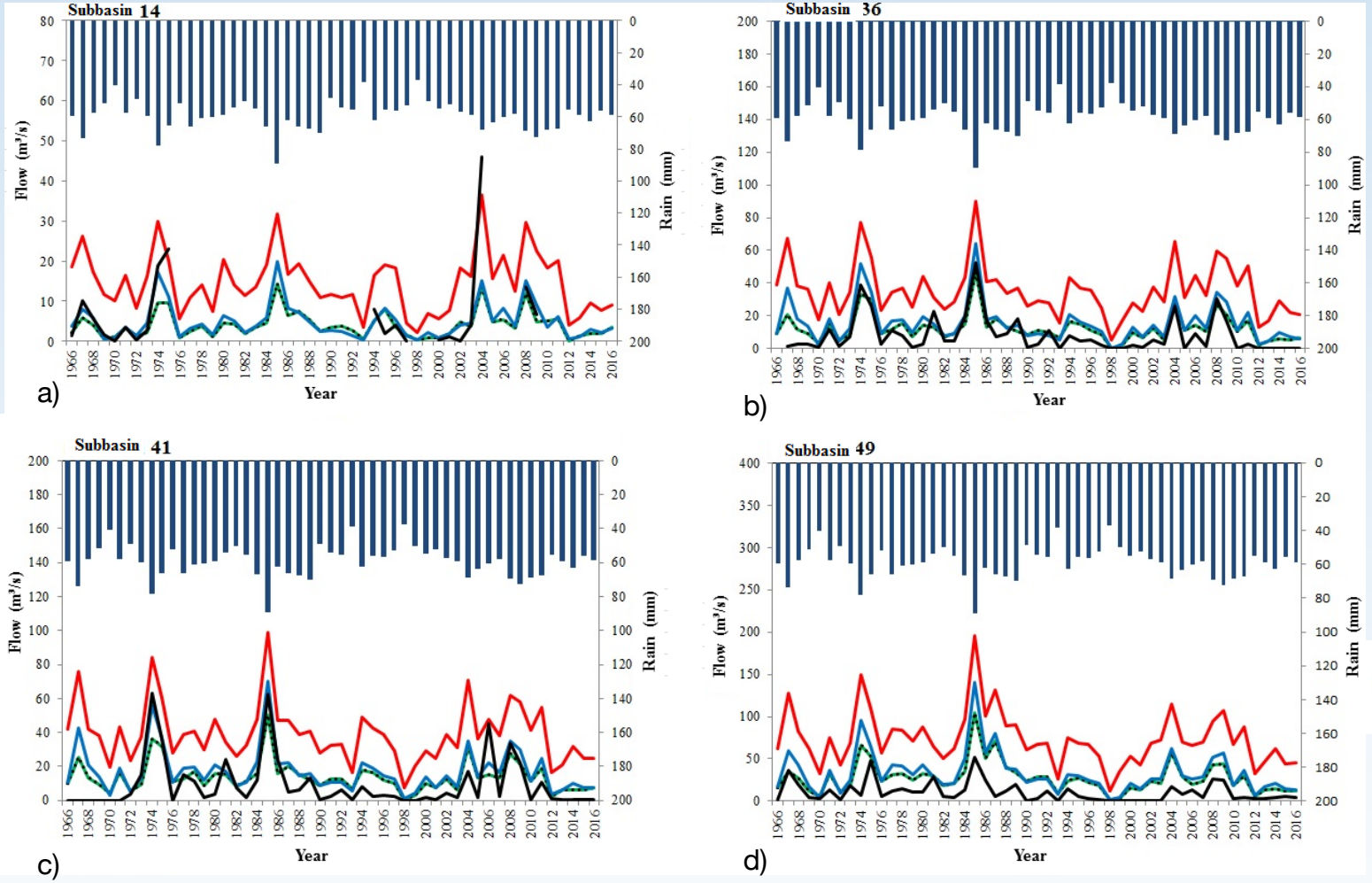


Figure 3- a) Flow hydrograph of subbasin 14; b) Flow hydrograph of subbasin 36; c) Flow hydrograph of subbasin 41; d) Flow hydrograph of subbasin 49; e) Flow hydrograph of subbasin 76

RESULTS

- It is possible to observe that the flow obtained with Uso1995 presents higher rates in all fluviometric stations analyzed, especially in stations 41, 49 and 76, whose highest peaks range from 80 to almost 250 mm, as well as higher in relation to observed flows.

- The flows observed in Use 2015 showed higher peaks compared to those in 1985 and 2005, but the smaller peaks and the base flow were similar to them.

- The 1985 and 2005 uses presented very similar results, from the peak flow to the base flow and the hydrograph recession.

- The simulated flows obtained with the 1985, 2005 and 2015 uses are closer to the observed values, with lower estimates, however subbasin 14 presents faulty data for some years and 76 lower flows, between 0 and 50 m^3/s, which also present a greater number of failures in relation to the other three sub-basins with fluviometric stations.

CONCLUSIONS

- In the modeling analysis for different land uses, the results showed more significant flow estimates for the years 1995 and 2015. These periods had a greater area occupied by pasture and agriculture compared to other periods.

- It can be inferred that, in addition to precipitation and the region's relief, land uses in the Pajeú river basin, especially pasture and agriculture, significantly impact the basin's hydrosedimentological dynamics. If management measures to control the expansion of these uses are not implemented rationally, their impact will be more pronounced.

- Further research should focus on climate, land use management, and control to preserve natural vegetation and water in the region, which is a vital resource for the population of Sertão Pernambucano and the world.

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DANIELA MARIA FERNANDES TAVARES

THANK YOU!