

Assessing the Influence of Spatial Patterns on Runoff and Infiltration in Rapidly Developing Urban Catchments Across Climate Zones

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INTRODUCTION

- Urbanization significantly modifies natural flow regimes by increasing surface runoff and reducing infiltration.
- Conventional impervious surface metrics quantify the overall extent of impervious cover but fail to represent spatial configuration characteristics such as clustering and fragmentation. This limits their accuracy in simulating hydrological responses and assessing urban flood risk.
- While spatial heterogeneity affects runoff and infiltration, its influence across climate zones remains underexplored.

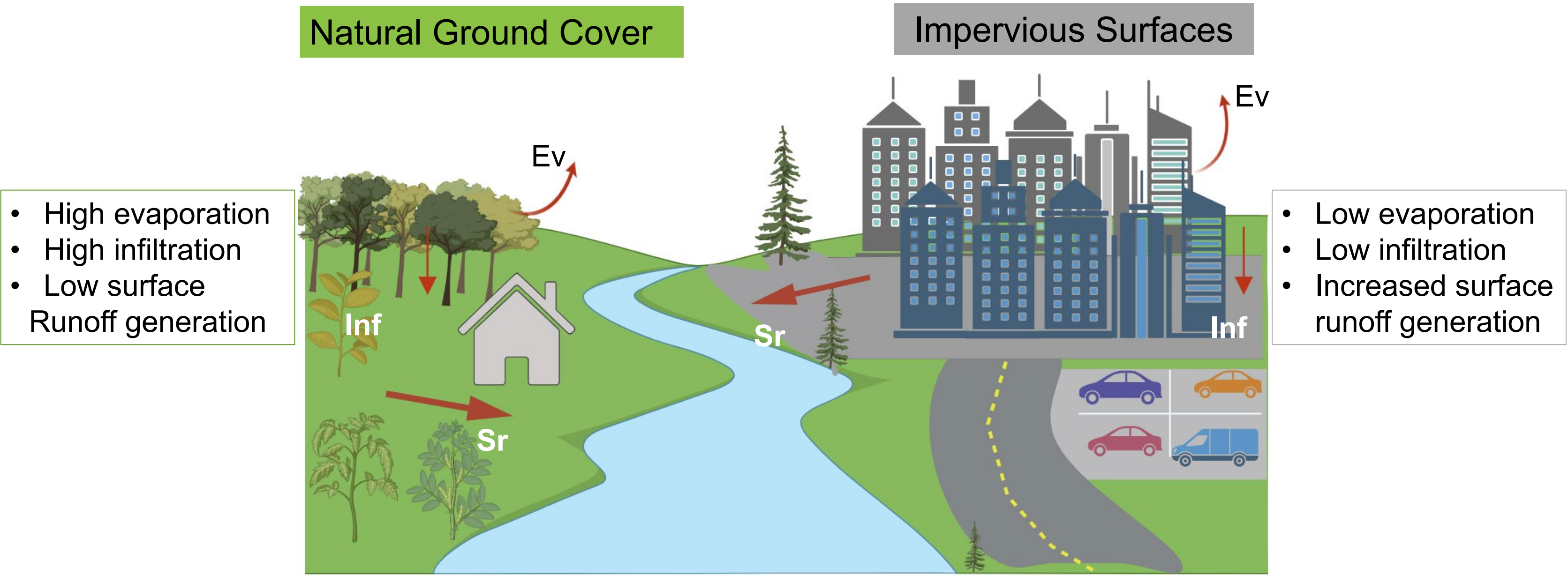
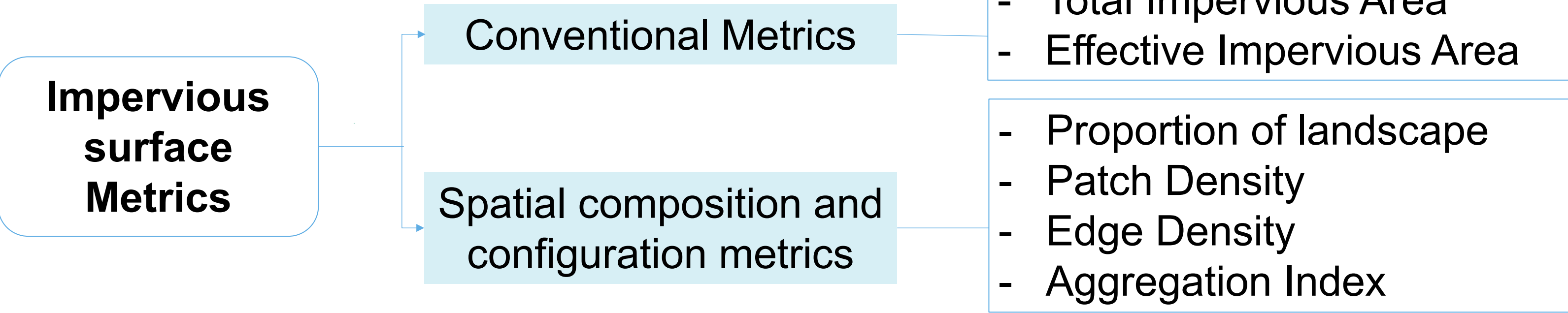


Figure 1: Effects of urbanization on the hydrologic cycle



STUDY OBJECTIVES

Main Aim: To investigate the impact of spatial configuration and heterogeneity of impervious surfaces on key hydrologic responses in rapidly developing urban catchments across climate zones in the US.

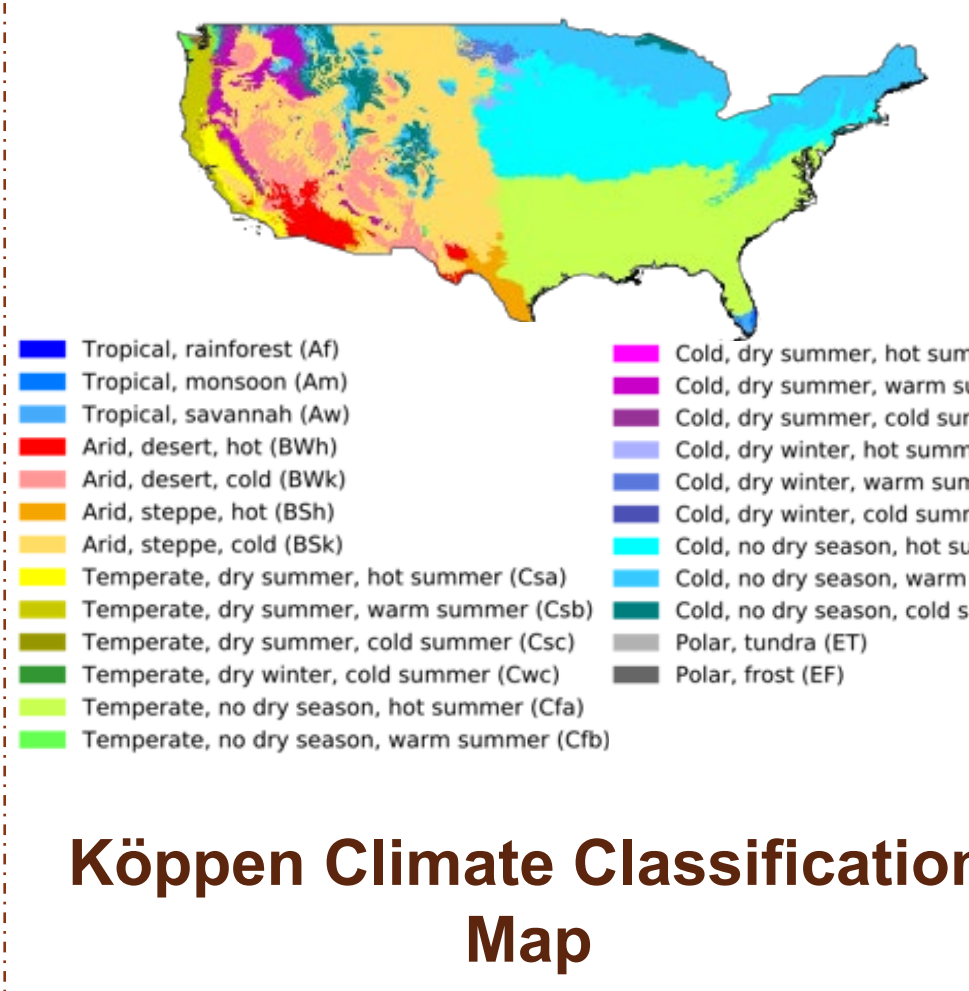
Specific Objectives:

- Simulate hydrologic responses under contrasting urban land surface and rainfall scenarios using the PCSWMM model.
- Assess the relationship between urban spatial configuration and hydrologic behavior of watersheds.
- Develop transferable spatial planning and stormwater management solutions to guide reconfiguration of urban catchments.

METHODOLOGY

Study Area Selection

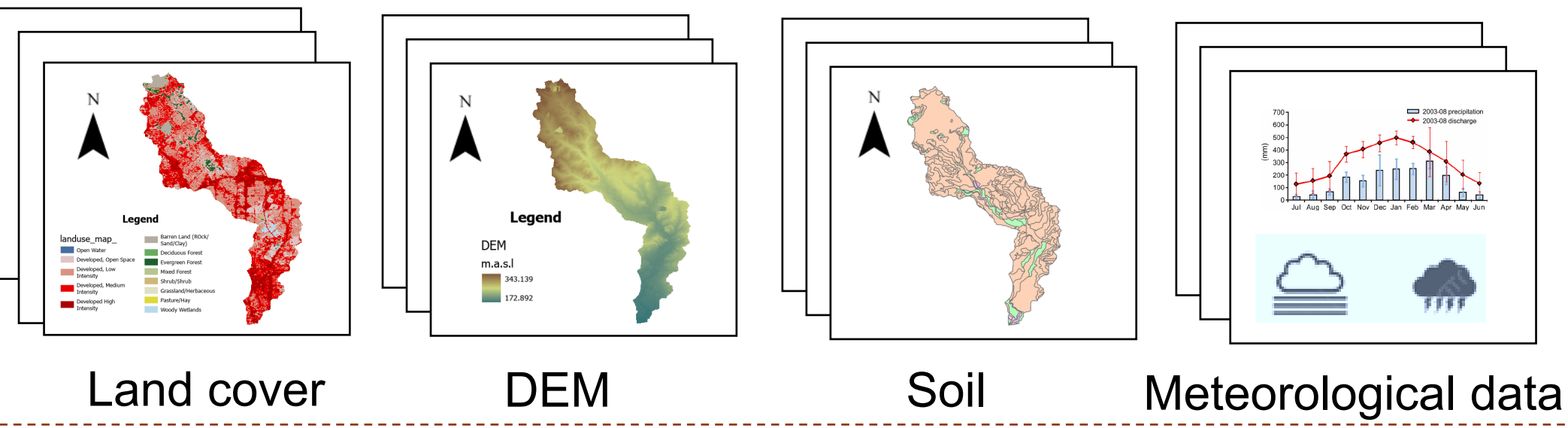
- 3 highly urbanized watersheds selected from different climate zones in CONUS
- Semi-arid; Humid; Mediterranean



Köppen Climate Classification Map

SWMM Model Development

1. Data Collection



2. Data Pre-processing



5. Calibration, Validation

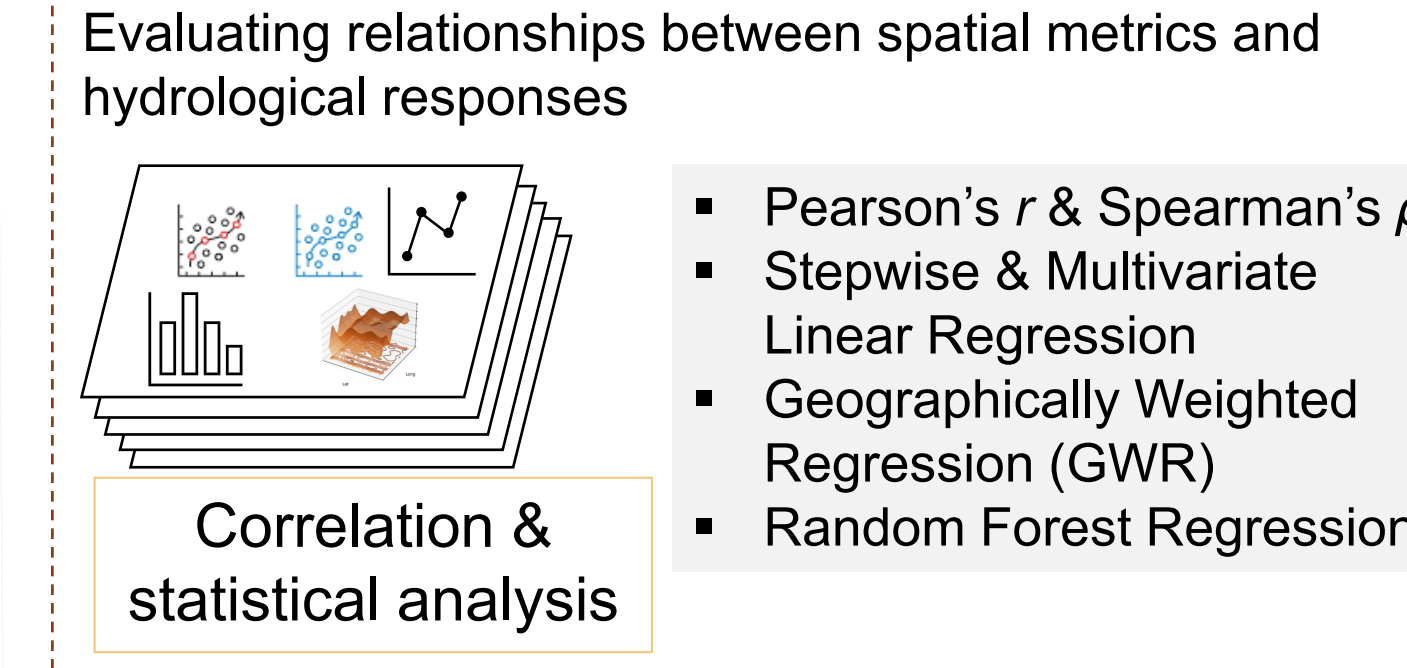
6. Scenario Development

- Pre- and highly urbanized scenarios
- Contrasting rainfall scenarios
- Targeted reconfiguration of impervious surfaces

3. Model simulation

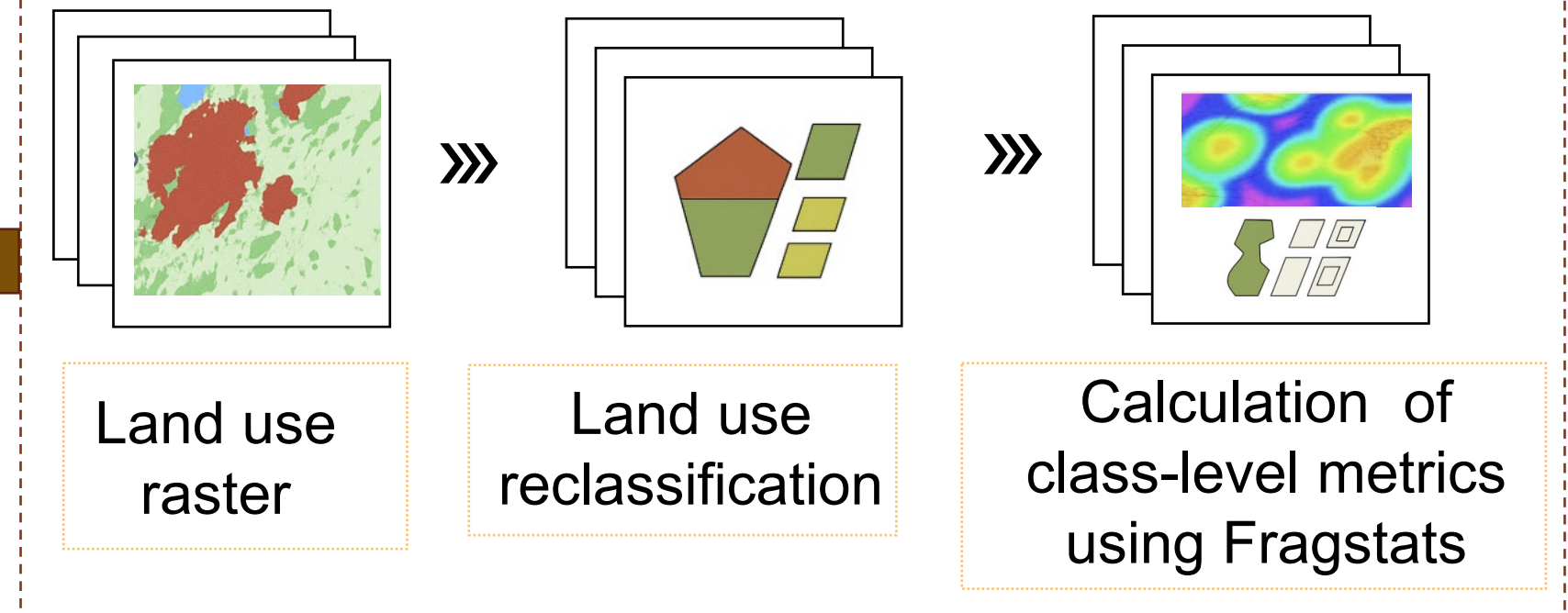
4. Sensitivity Analysis

Quantitative Relationship Analysis



Correlation & statistical analysis

Calculation of Spatial Metrics



Land use raster, Land use reclassification, Calculation of class-level metrics using Fragstats

Evaluation of urbanization impact

- Comparative evaluation of hydrologic-landscape relationships across urbanized watersheds.
- Cross-scenario synthesis of hydrologic and landscape dynamics
- Development of transferable strategies for urban stormwater management

PRELIMINARY RESULTS

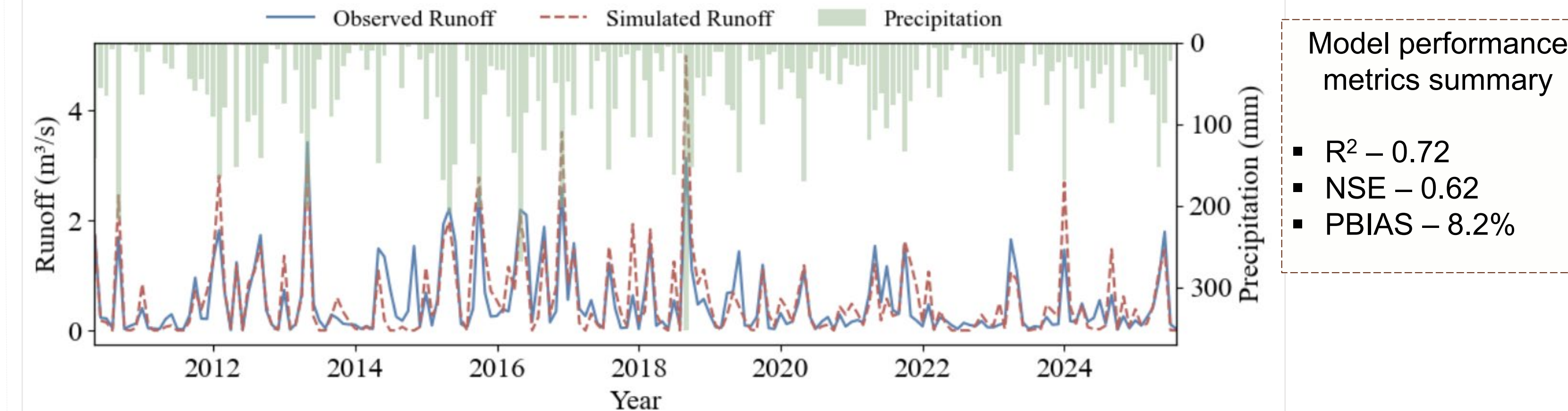
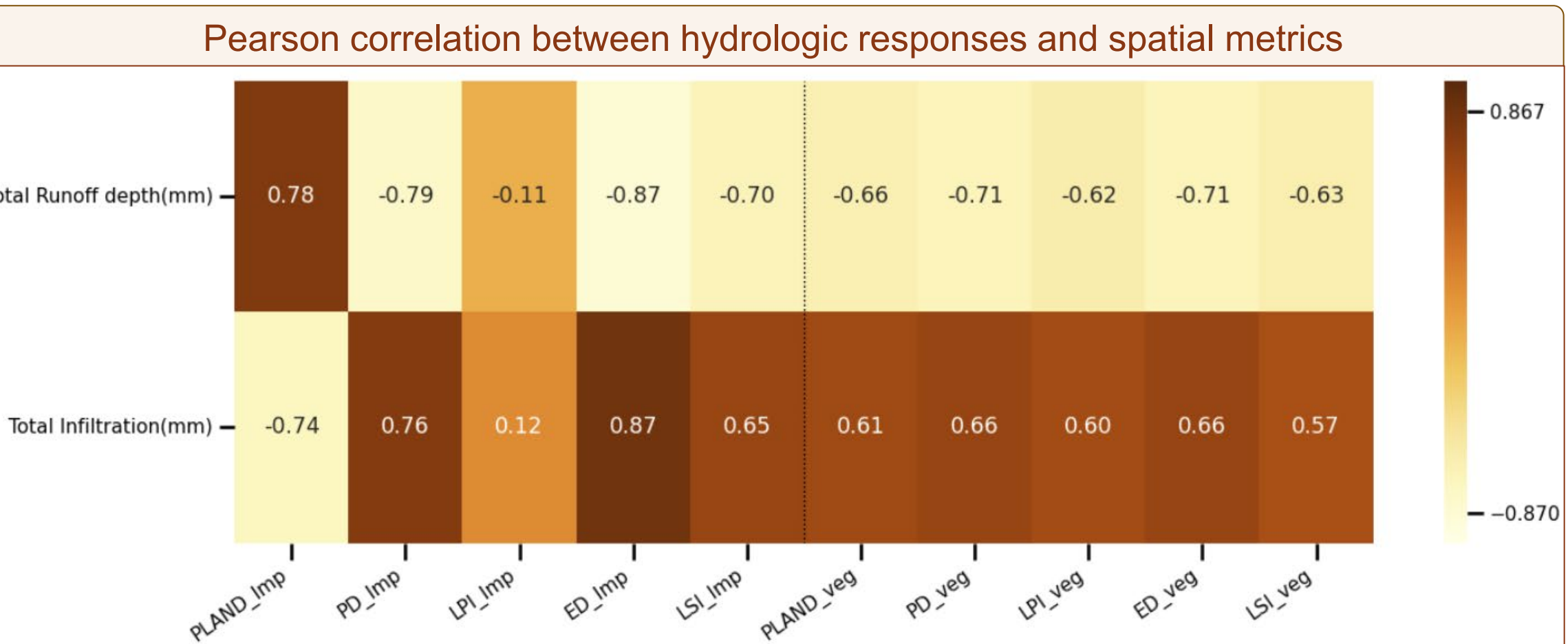
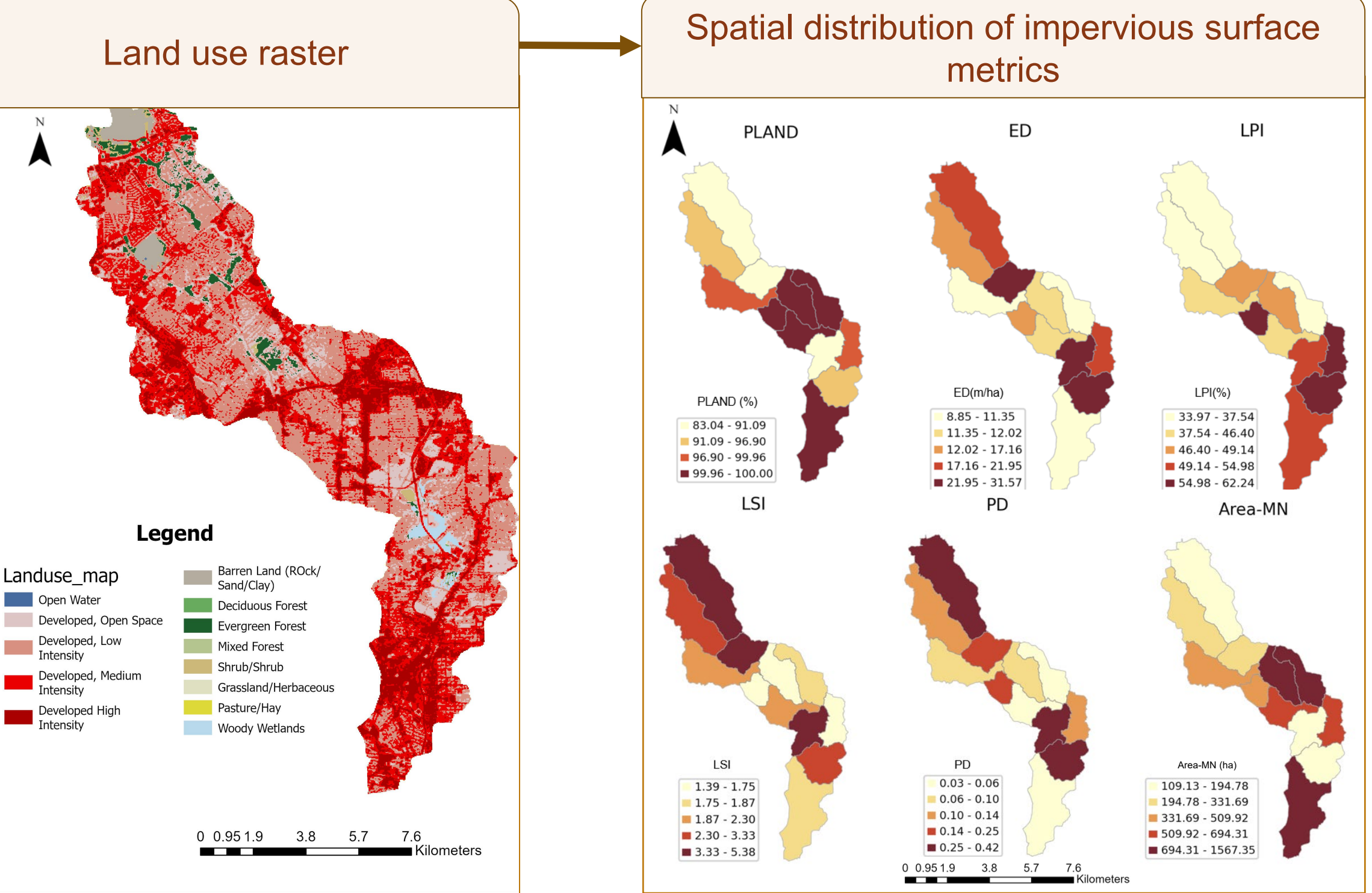


Figure 2: Comparison of monthly observed and simulated runoff with precipitation in the Olmos Creek watershed (2010-2025)

Study catchment 1 – Olmos Creek Watershed

- Total area – 109 km²
- Percentage of developed land – 93.9%



ONGOING/FUTURE WORK

- Conducting statistical analyses across spatial scales, including finer unit-level analyses
- Simulation of different rainfall and urbanization scenarios to evaluate the impact of spatial configuration under varying conditions.
- Comparison of findings across watersheds and climate zones

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REFERENCES

Scan QR Code to access the list of citations.

