EGU2020 - *Sharing Geoscience Online*

HS1.2.4 Panta Rhei: Hydrology, Society & Environmental Change

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola
Alma Mater Studiorum - Università di Bologna

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola
Alma Mater Studiorum - Università di Bologna

Surface water resources are severely affected by human activities and climate variability, and their rapid depletion is becoming a global-scale challenge. Water scarcity is expected to intensify due to climate change, world population growth and the associated sprawl of urban areas. This study aims to answer the question:

What are the effects of human and climate dynamics on water resources availability?

The relation between surface water depletion, changes in precipitation, and human dynamics across the USA watersheds is investigated using remote sensing data. The contribution of urbanization and precipitation variation to surface water decrease in the last 35 years (from 1984 to 2018) is evaluated at the basin scale, and a clustering analysis is performed to explore the behavior of surface water loss with distance from urban areas.

INTRODUCTION

STUDY AREA
& DATA

DATA PROCESSING
& METHODS

RESULTS
& CONCLUSIONS

Study area and data

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

This analysis employs the following datasets:

USA watershed boundaries

from HydroSHEDS layers

Surface Water Transitions

from Global Surface Water dataset

Global Human Settlement – BUILT-UP

from Global Human Settlement Layer dataset

Annual Precipitation

from DAYMET dataset

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

USA basins boundaries

87406 polygons delineating watersheds and sub-basins boundaries at 15 arc-sec resolution

This analysis considers only basins having an **area ≥ 1000 km²** , resulting in 287 basins covering **96% of total area**

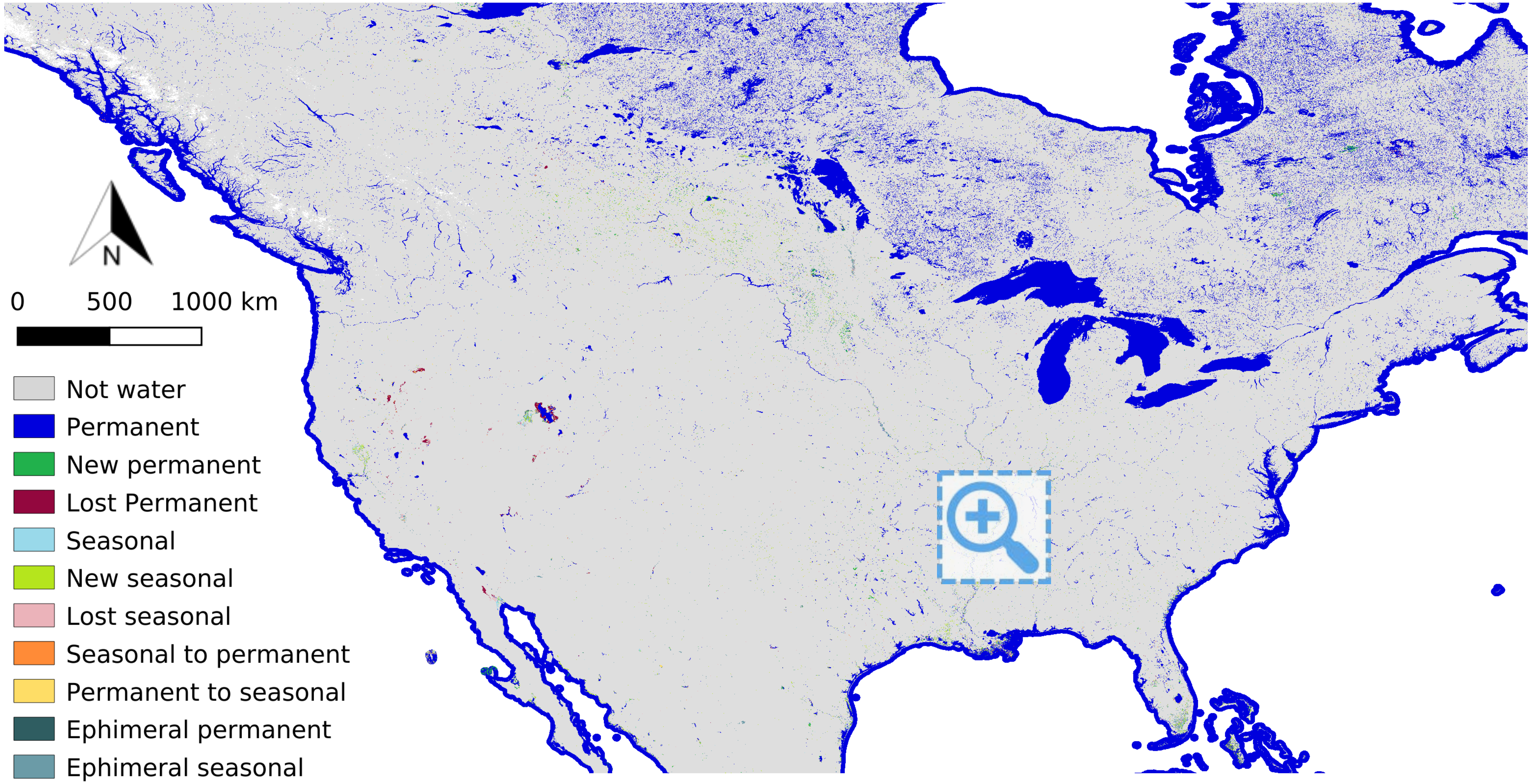
Study area and data

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Surface Water Transitions

Changes in state of surface water between 1984 and 2018 at 30 m resolution



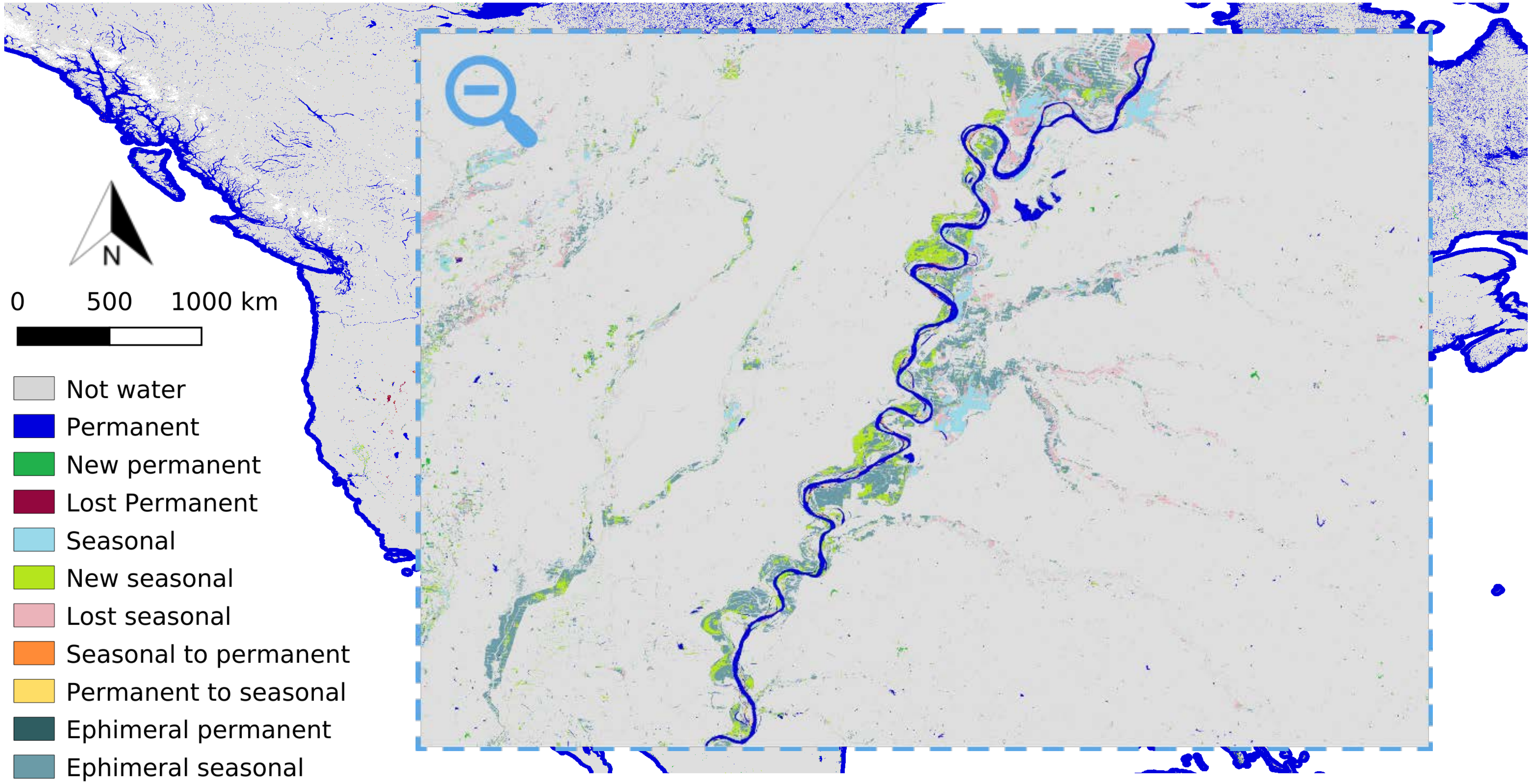
Study area and data

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Surface Water Transitions

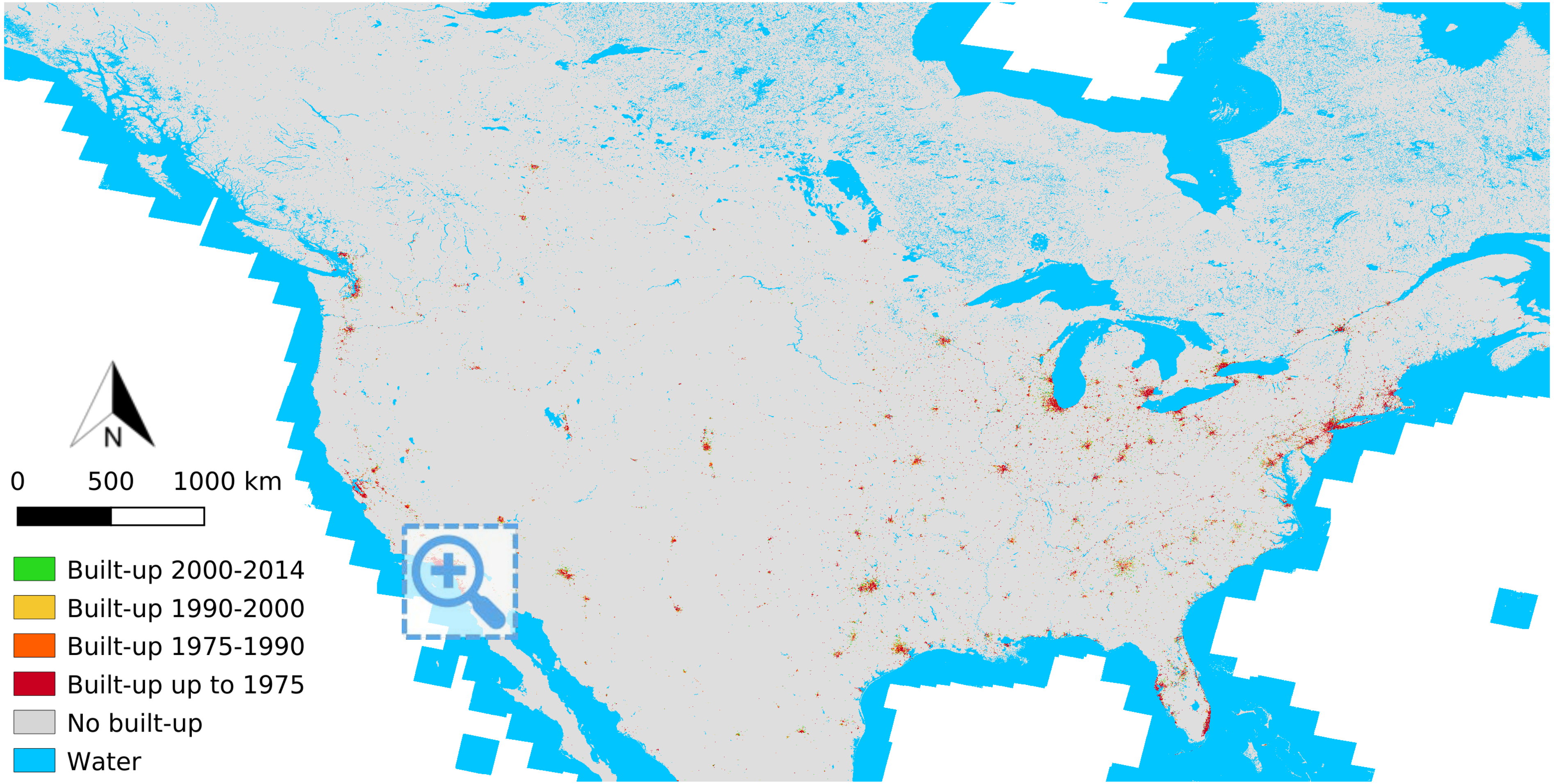
Changes in state of surface water between 1984 and 2018 at 30 m resolution



Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Global Human Settlement – BUILT-UP

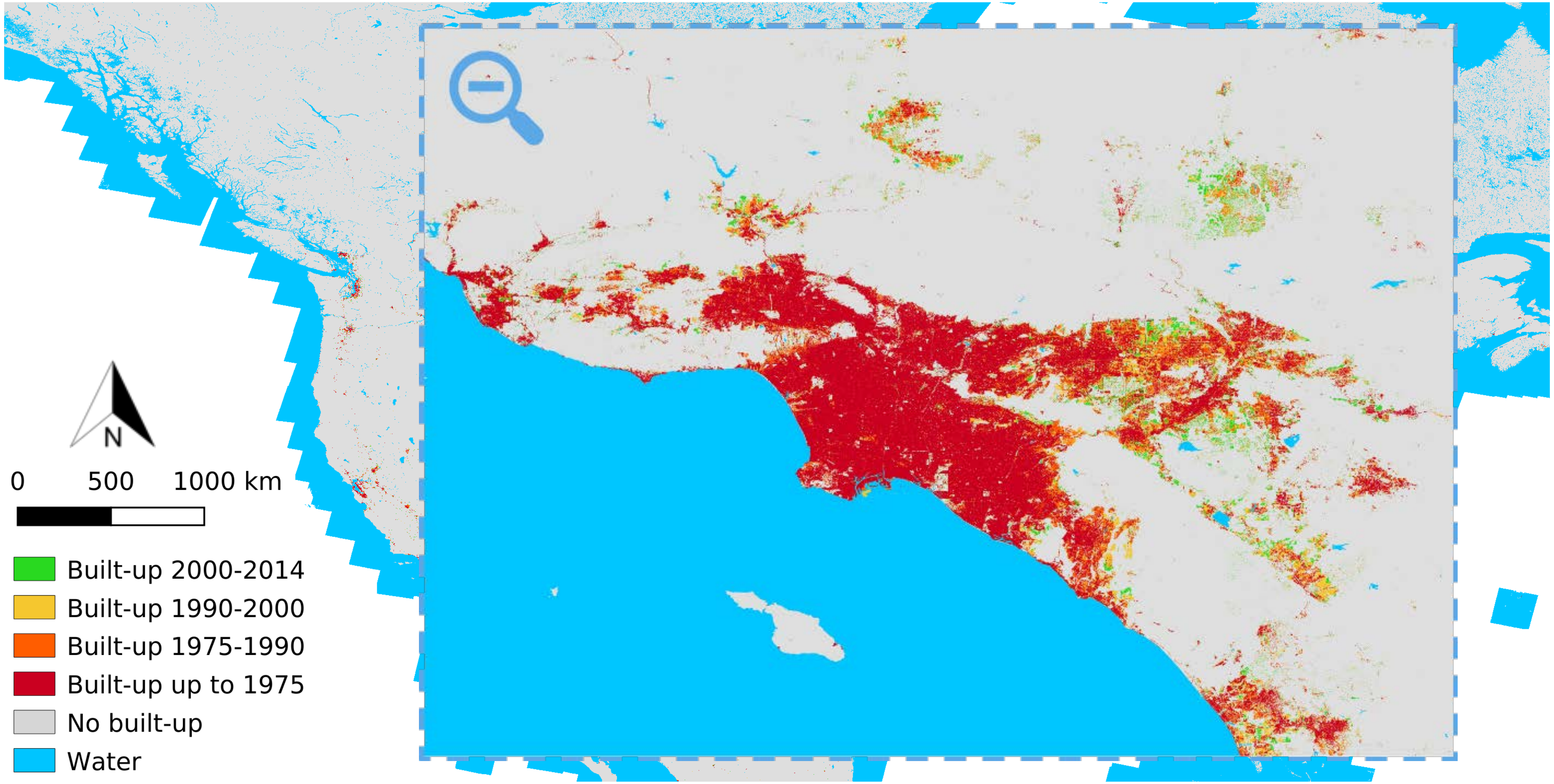
Multitemporal classification of built-up presence (before 1975, 1975-1990, 1990-2000, 2000-2014) at 30 m resolution



Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

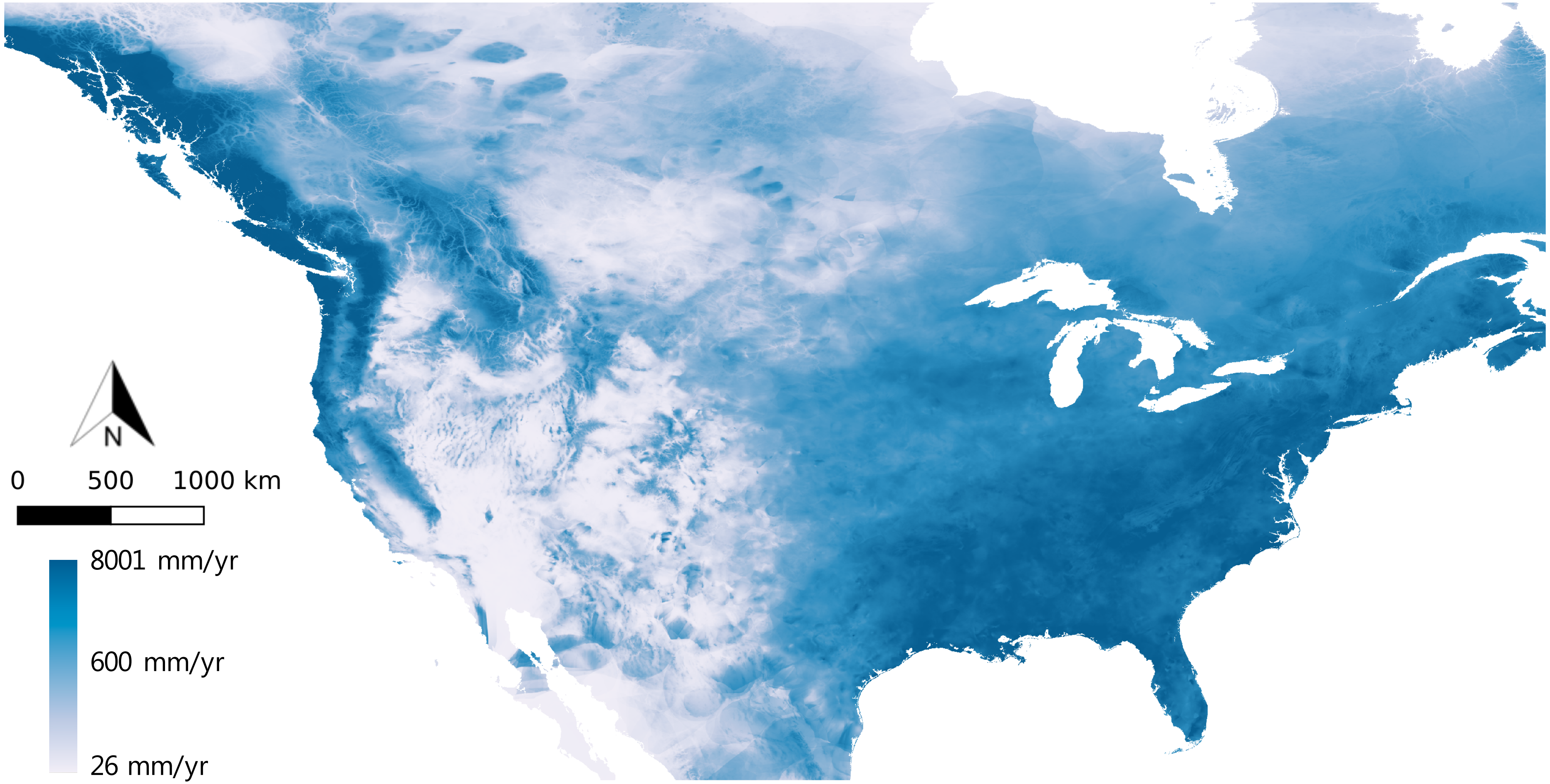
Global Human Settlement – BUILT-UP

Multitemporal classification of built-up presence (before 1975, 1975-1990, 1990-2000, 2000-2014) at 30 m resolution



Annual Precipitation

Annual total precipitation from 1984 to 2018 in mm/year at 2.5 km resolution



Data processing and methods

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Data processing

- Surface Water Loss map from the Transitions layer
- Urbanization map from the Global Human Settlement – Built-Up layer
- Annual Precipitation Change map from the Annual Precipitation dataset

Methodology

- Data aggregation at the basin level
- Spatial clustering analysis of surface water loss

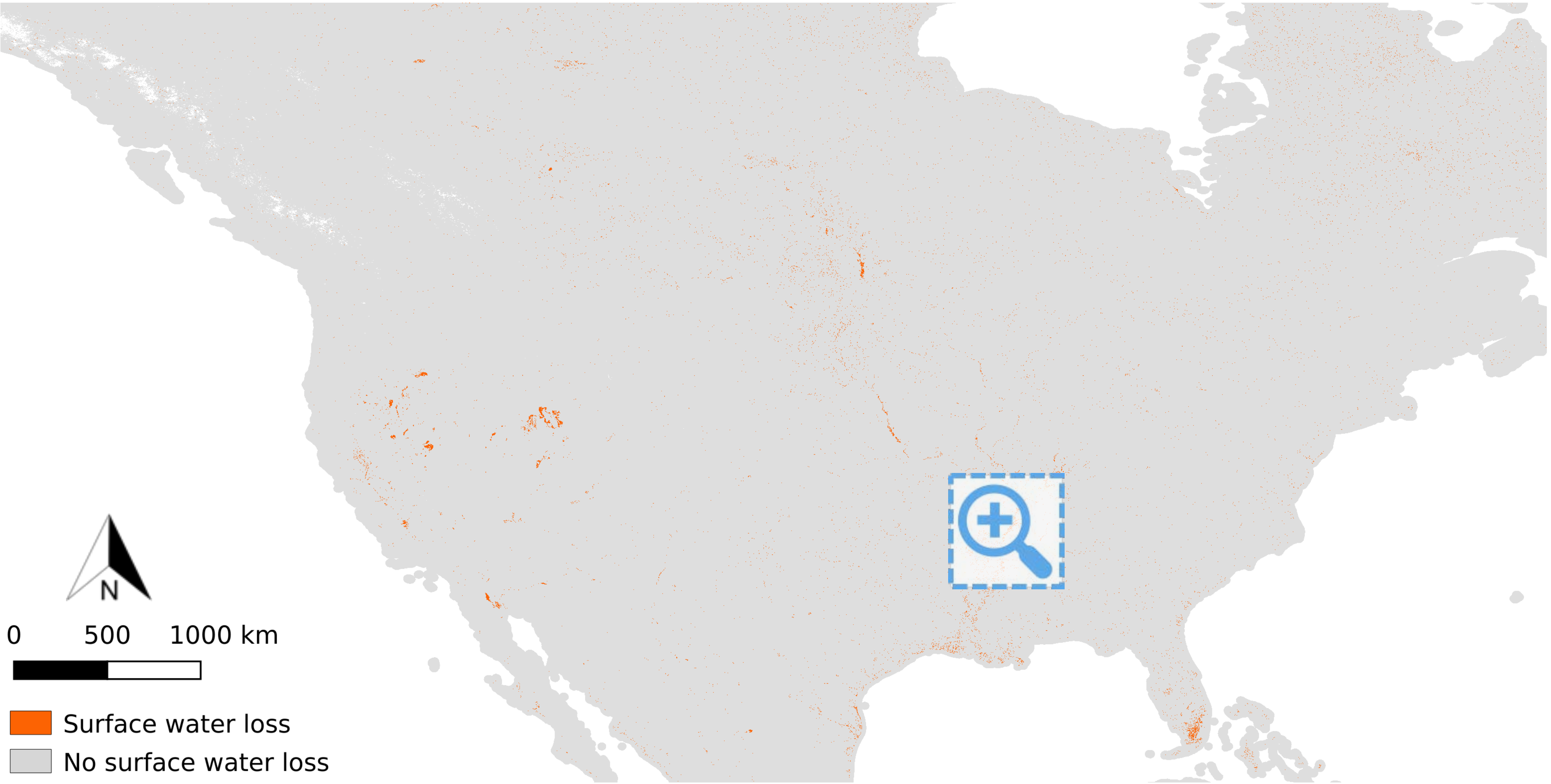
Data processing and methods

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

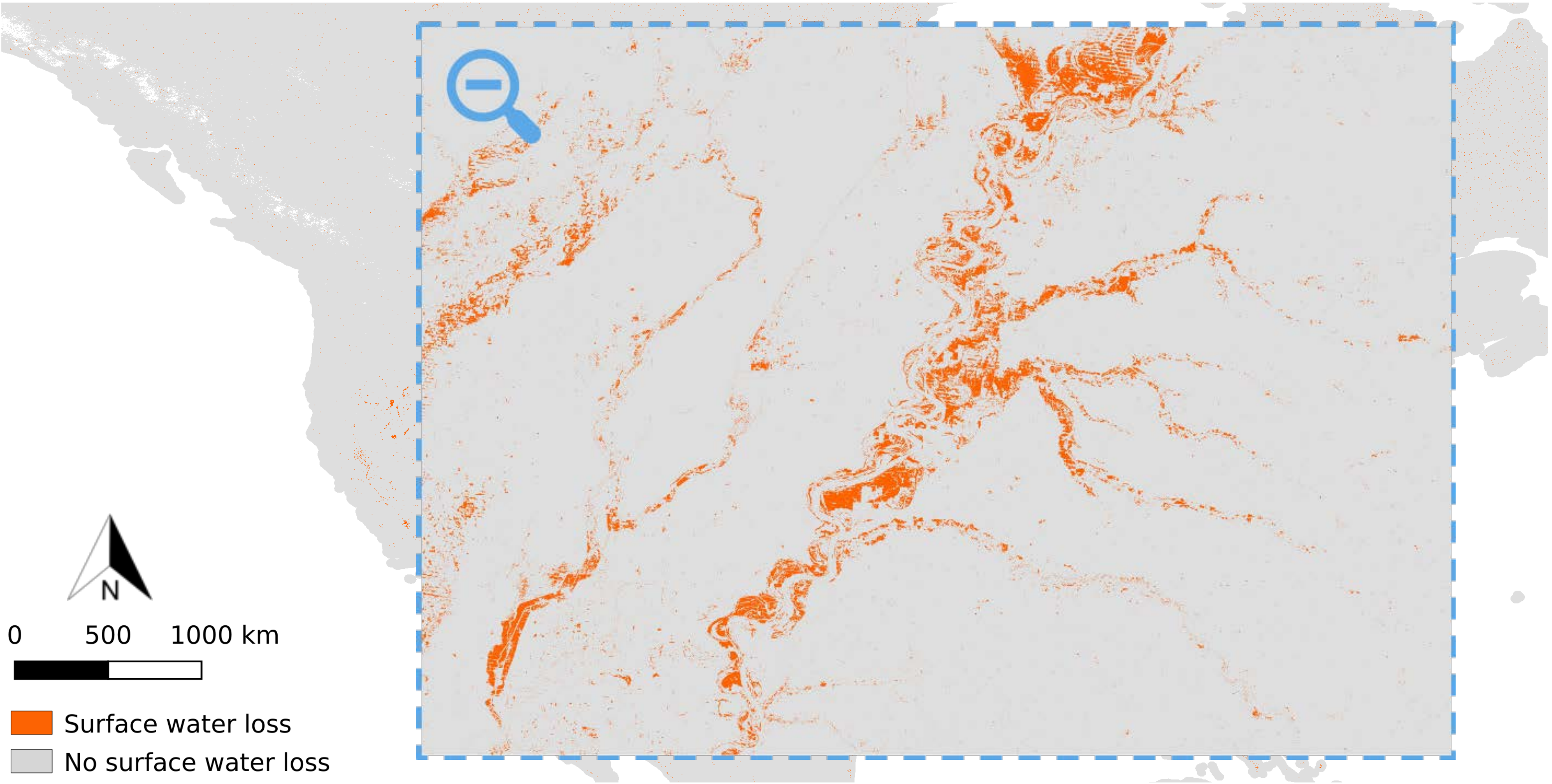
Surface Water Loss map

Extraction of **locations with a loss of permanent and seasonal surface water** in the Transitions layer



Surface Water Loss map

Extraction of **locations with a loss of permanent and seasonal surface water** in the Transitions layer



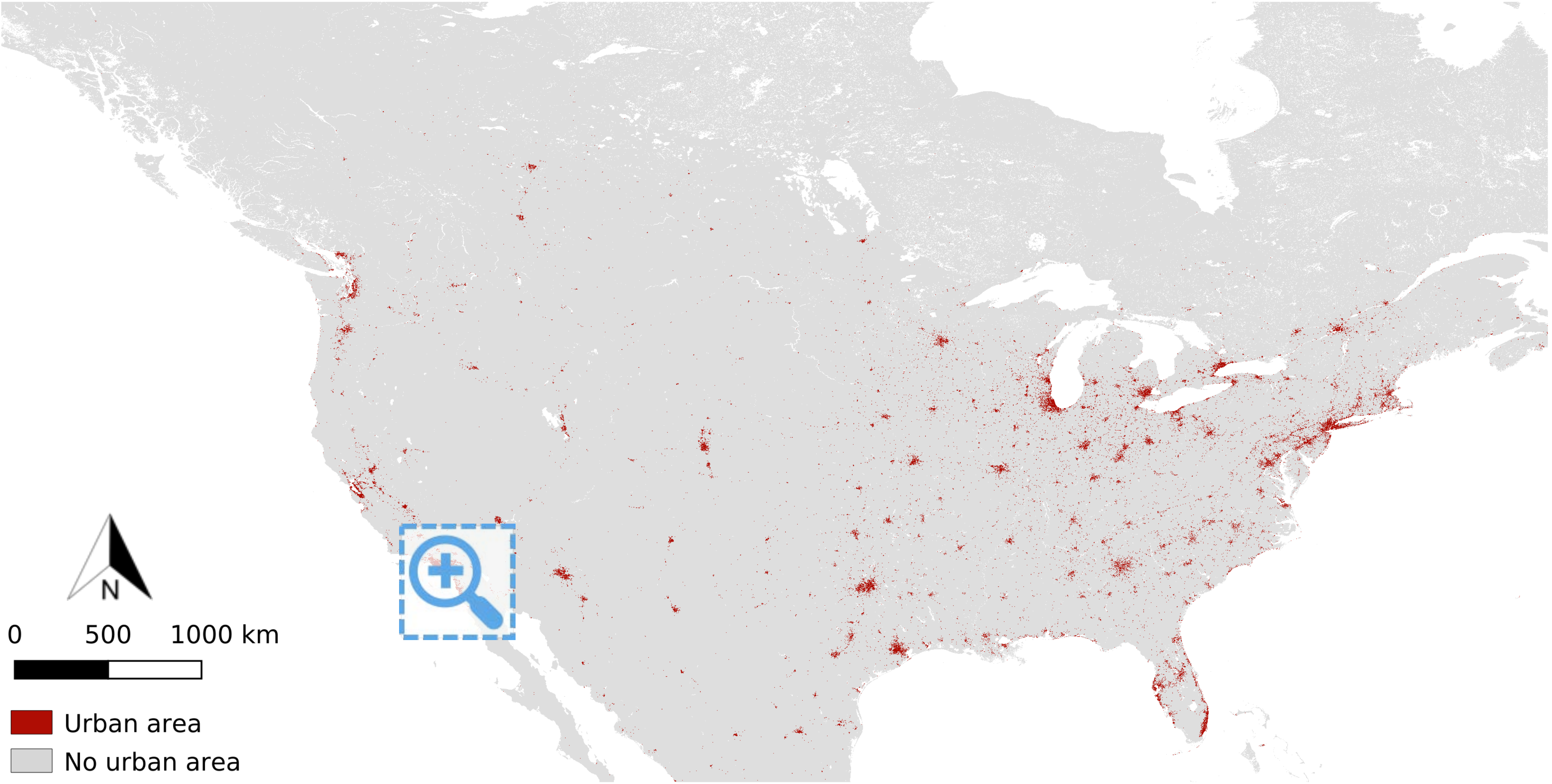
Data processing and methods

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Urbanization map

Identification of **areas urbanized during 2000-2014** in the Global Human Settlement – BUILT-UP layer



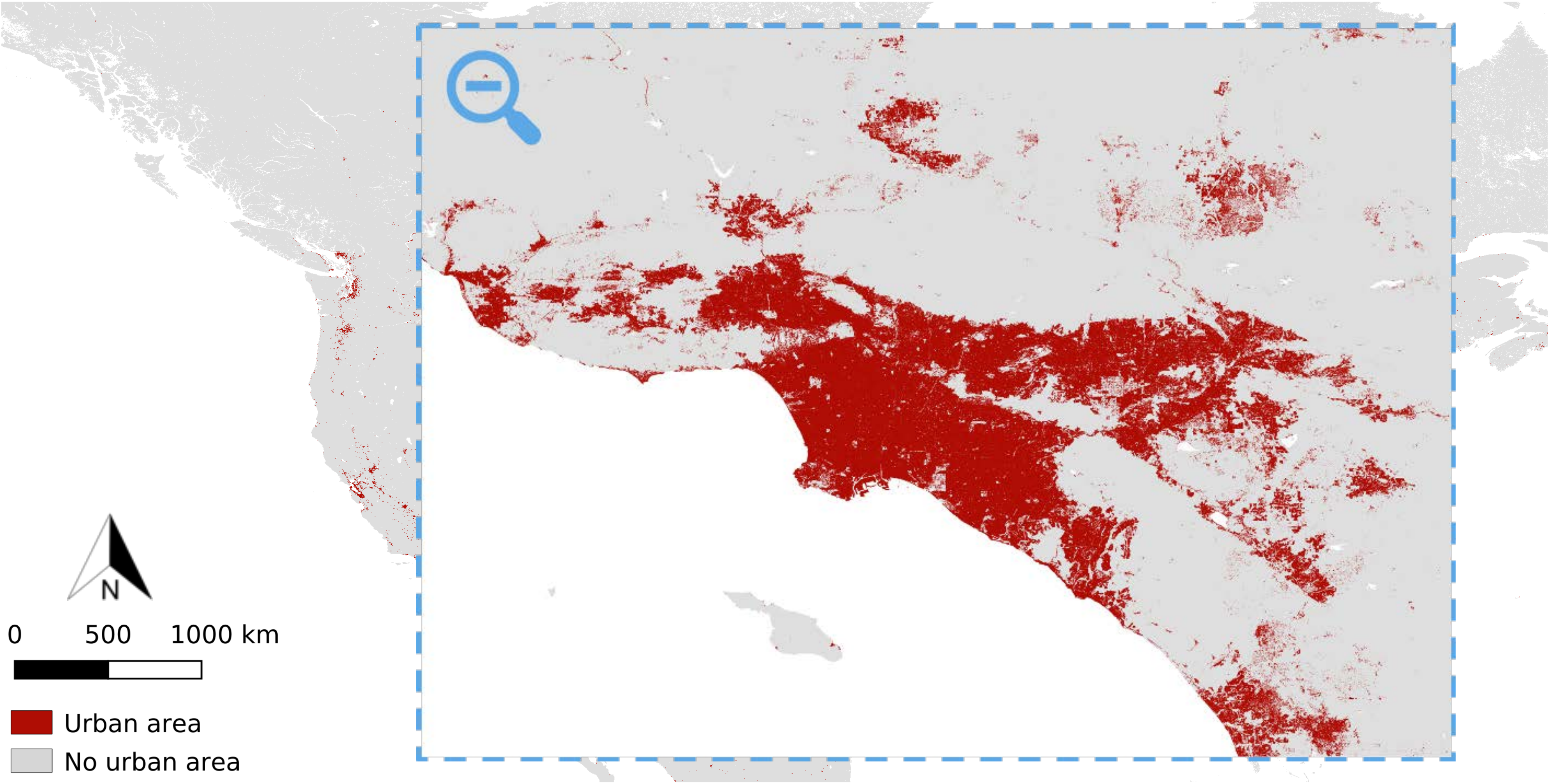
Data processing and methods

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Urbanization map

Identification of **areas urbanized during 2000-2014** in the Global Human Settlement – BUILT-UP layer



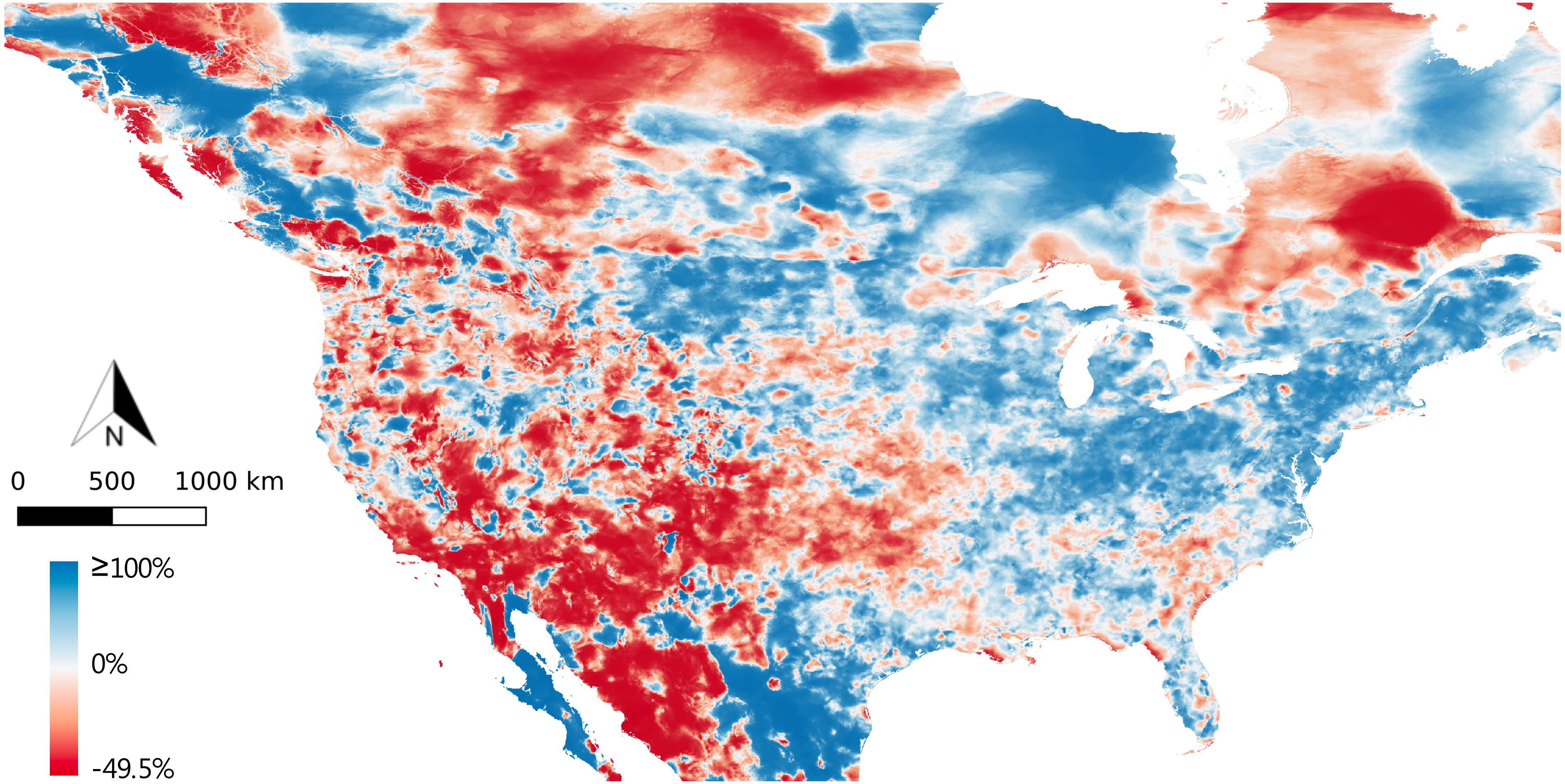
Data processing and methods

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Annual Precipitation Change map

Evaluation of the **relative change in the mean annual precipitation between 1984-1999 and 2000-2018**



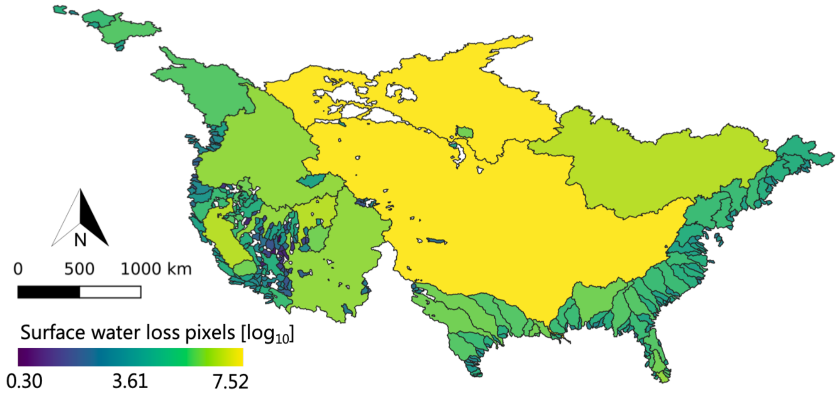
Data processing and methods

Anthropogenic and climatic controls on surface water loss across USA

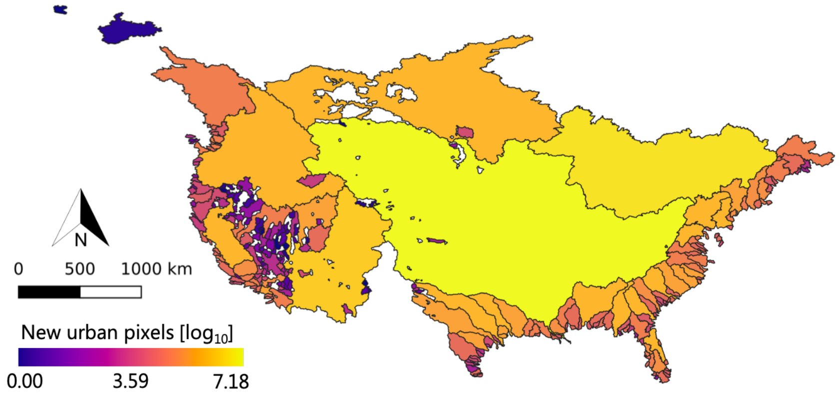
Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Data aggregation

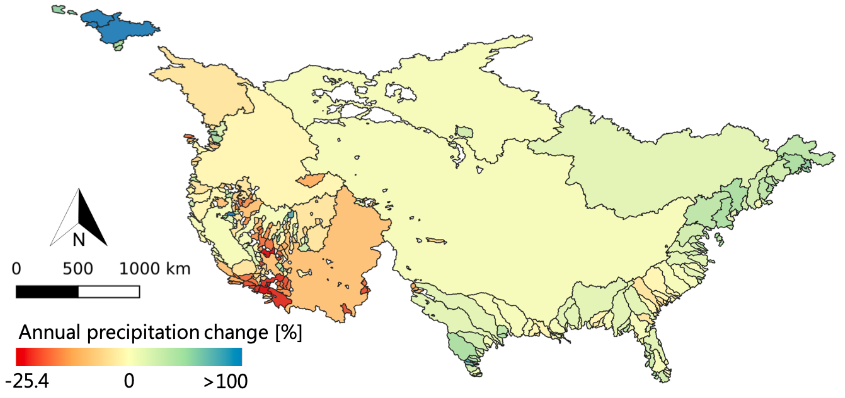
Count number of surface water loss pixels within each basin



Count number of urbanization pixels within each basin



Variation of total annual precipitation between 1984-1999 and 2000-2018 within each basin



Focus on basins that experiences a net surface water loss and study **interrelation among surface water change, urbanization, and precipitation change** at the **basin scale**

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Spatial clustering analysis

Clustering analysis to test the hypothesis "**surface water loss becomes less intense as distance from urbanized areas increases**"

1. Identify **urbanization areas** within each basin and calculate the **Euclidean distance**

2. Evaluate **fraction of total surface water loss** (fr_{swloss}) at increasing distances from the outer boundaries of the urbanized region within each basin:

$$fr_{swloss}(d_1, d_2) = \frac{\lambda(d_1, d_2)}{\lambda_{TOT}}$$

$\lambda(d_1, d_2)$ = number of surface water loss hotspots between distance d_1 and d_2
λ_{TOT} = total number of surface water loss hotspots in the whole basin

4.24	3.61	3.16	3.00	3.16	3.61	4.24
3.61	2.00	2.24	2.00	2.24	2.00	3.61
3.16	2.24	1.41	1.00	1.41	2.24	3.16
3.00	2.00	1.00		1.00	2.00	3.00
3.16	2.24	1.41	1.00	1.41	2.24	3.16
3.61	2.00	2.24	2.00	2.24	2.00	3.61
4.24	3.61	3.16	3.00	3.16	3.61	4.24

Results and conclusions

Anthropogenic and climatic controls on surface water loss across USA

Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Aggregation at the basin level

This analysis shows the presence of a statistically significant correlation between surface water loss and urban area growth. It is also observed a counterintuitive relation between surface water decrease and annual precipitation change (Palazzoli et al., in preparation).

Spatial clustering analysis

Surface water loss is larger and occurs more frequently close to recently urbanized areas. Overall, this trend is found both at the basin and continental scales (Palazzoli et al., in preparation).

Results and conclusions

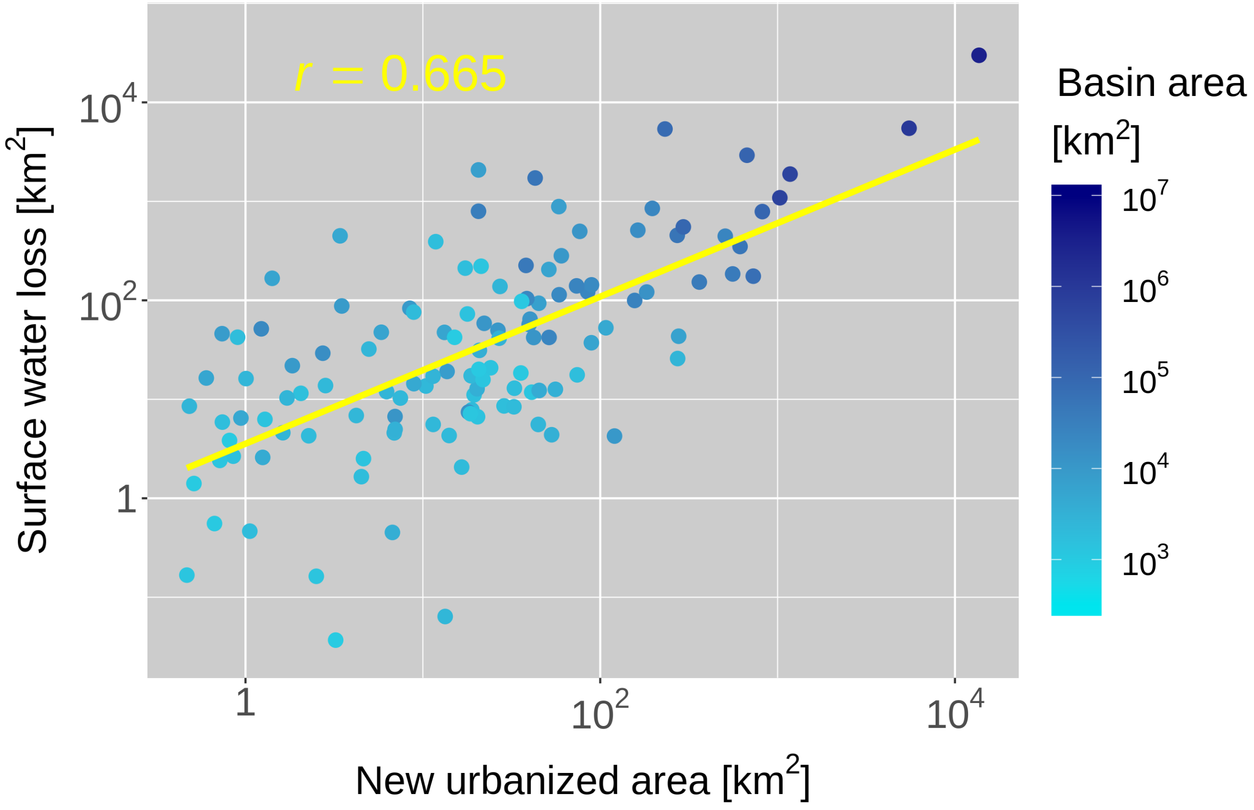
Anthropogenic and climatic controls on surface water loss across USA

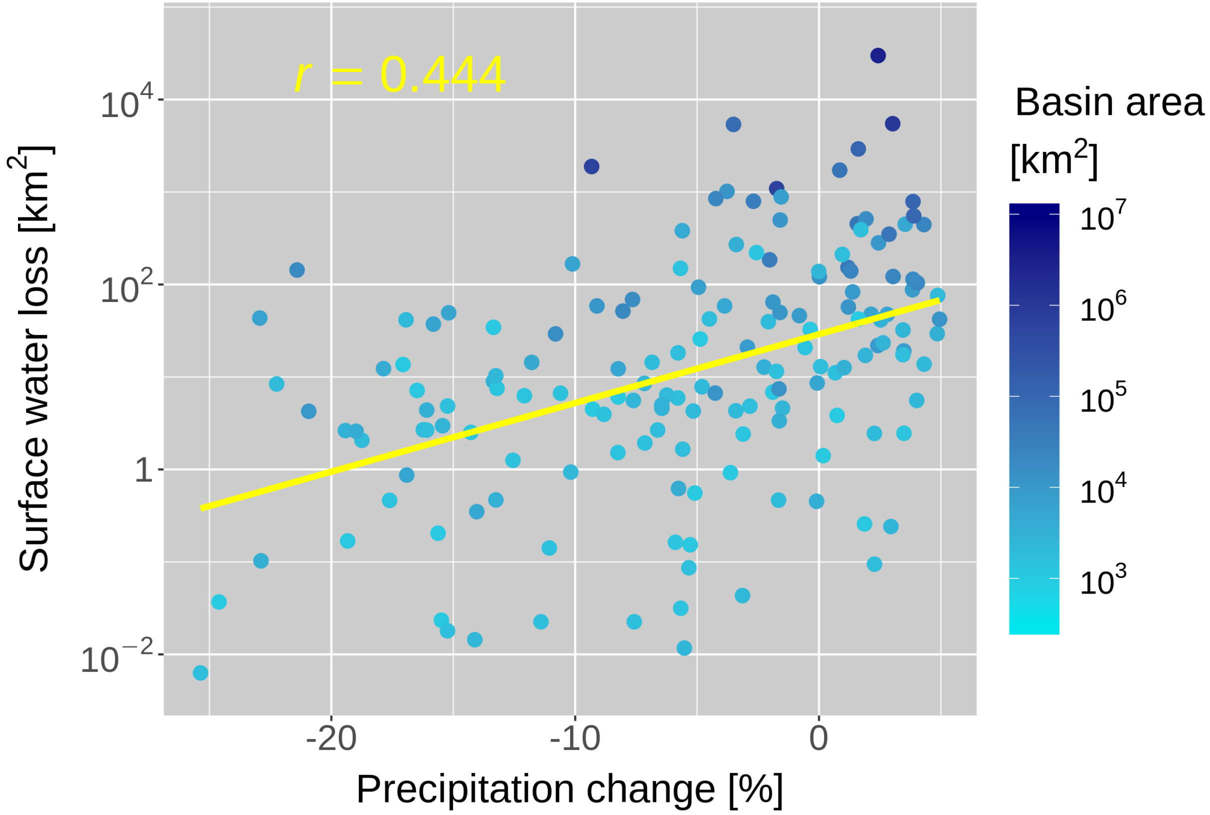
Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Aggregation at the basin level

Palazzoli et al., in preparation

Surface water loss – urbanization correlation and surface water loss – precipitation change correlation





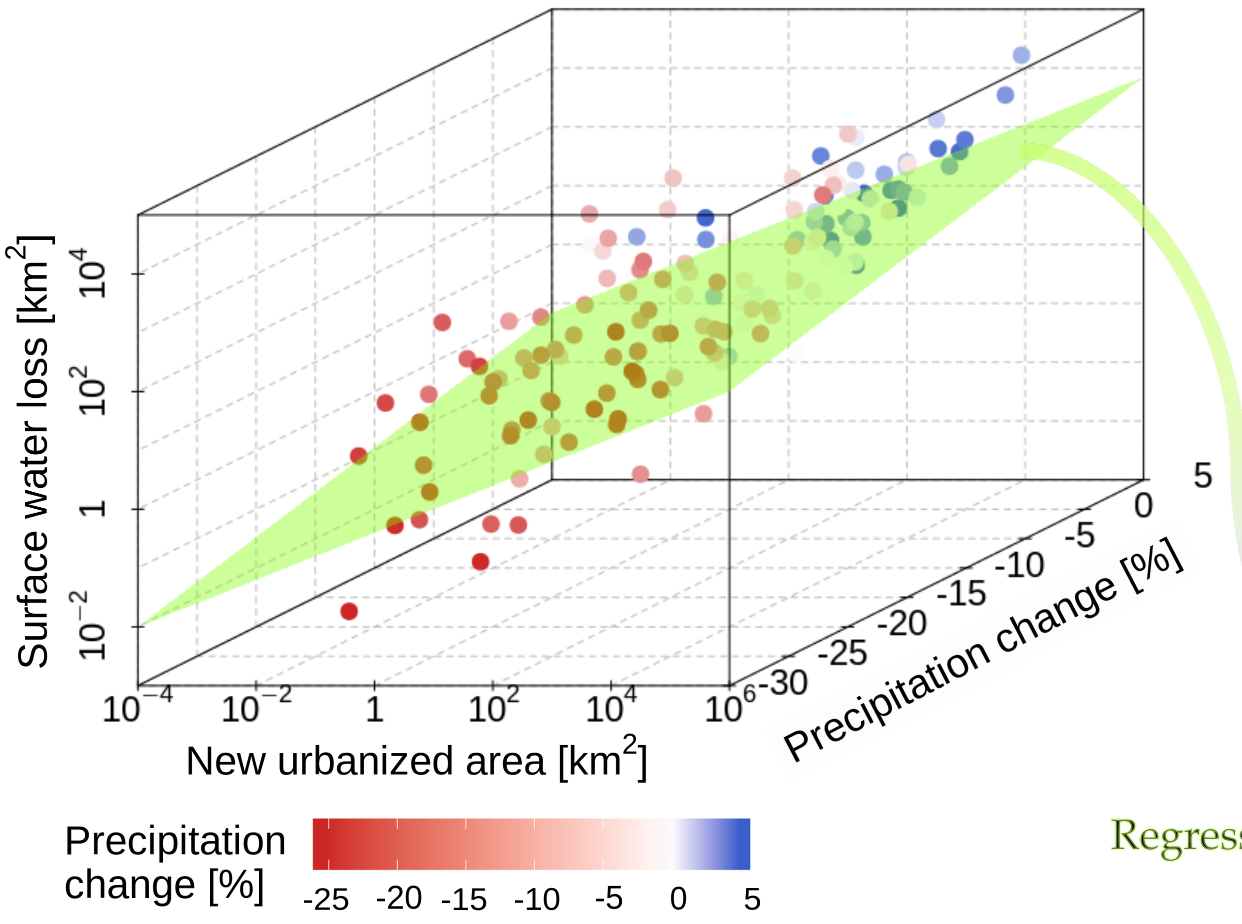
Results and conclusions

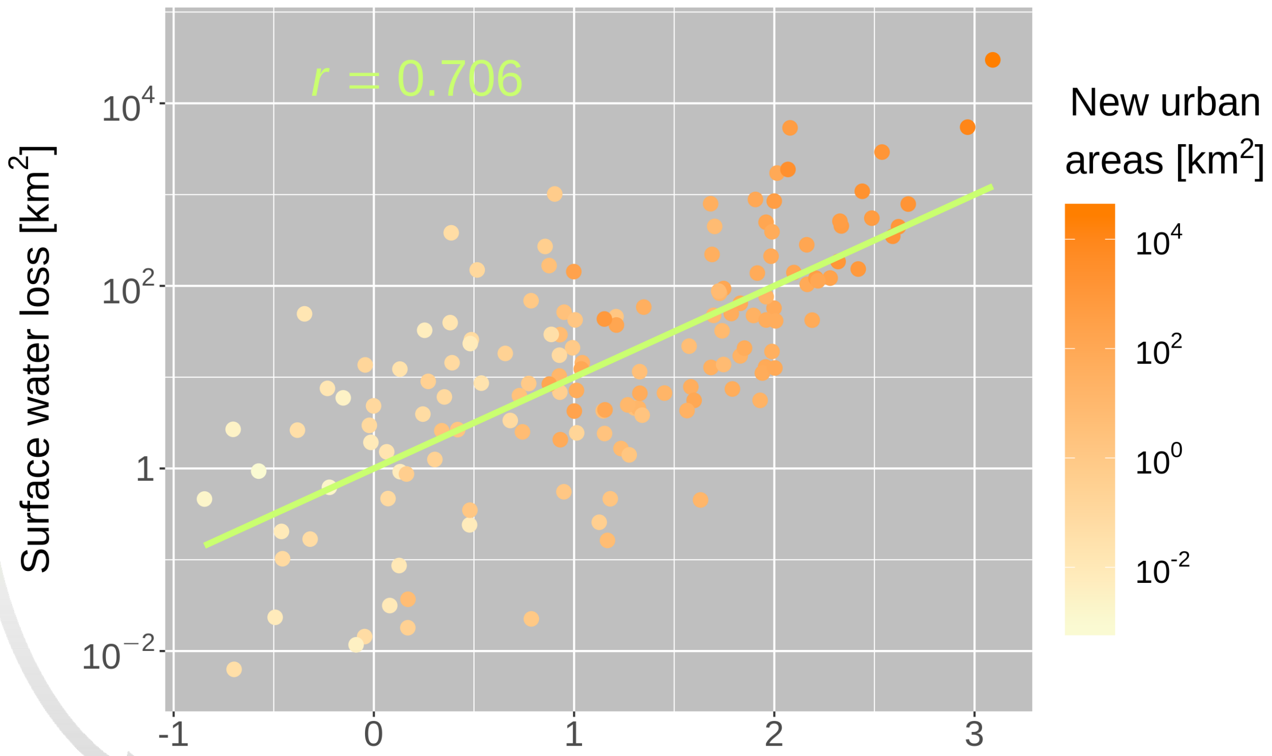
Anthropogenic and climatic controls on surface water loss across USA
Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Aggregation at the basin level

Palazzoli et al., in preparation

Multivariate regression among surface water loss, urbanization, and annual precipitation change





1.18 + 0.40 $\log_{10}$(urbanArea) + 0.05 pcpChange

Regression plane equation

Results and conclusions

Anthropogenic and climatic controls on surface water loss across USA
Irene Palazzoli and Serena Ceola, Alma Mater Studiorum - Università di Bologna

Spatial clustering analysis

Palazzoli et al., in preparation

Fraction of total surface water loss as a function of distance from urban areas at basin and continental scale