EGU25-3122

Supporting multi-objective natural small water retention measures planning: the Cherio river basin case study, Italy

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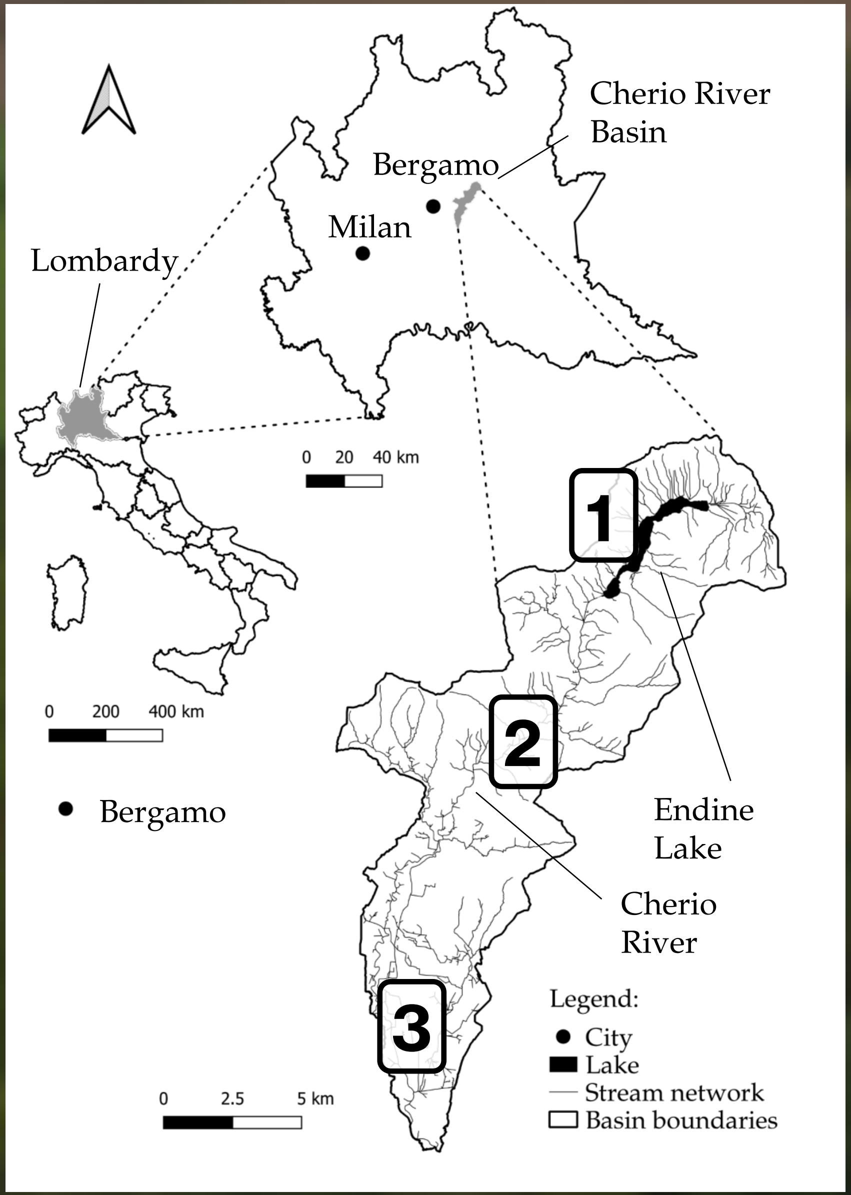
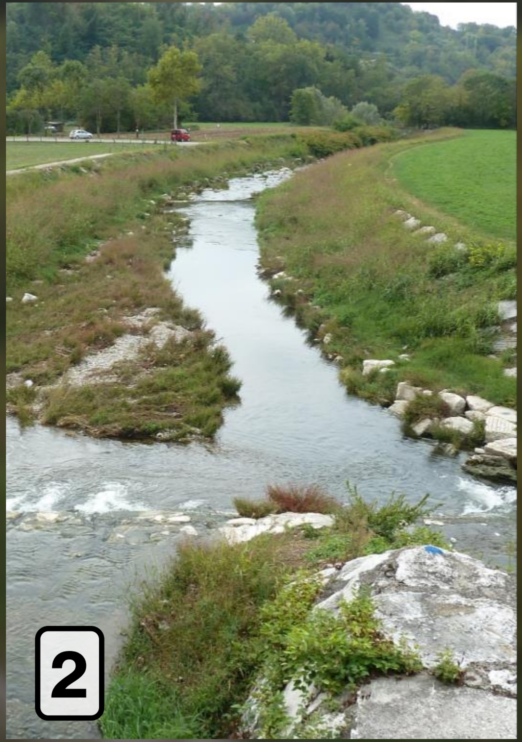
SUMMARY

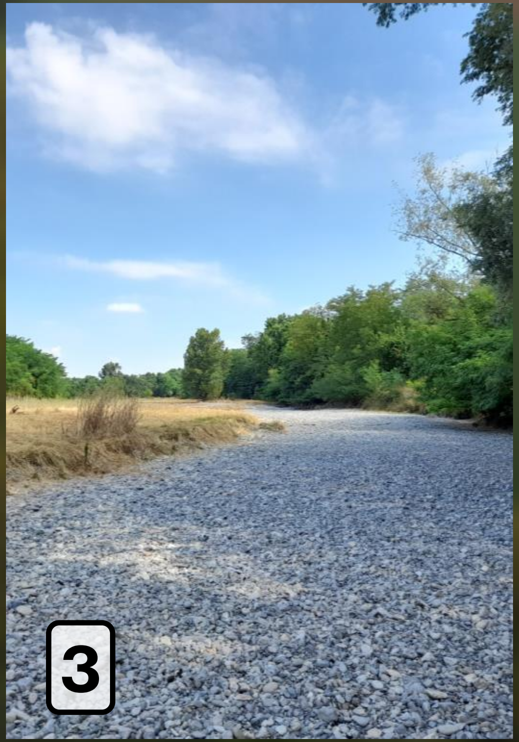


Endine Lake

Diversion



Outlet



What is the optimal planning of Natural Small Water Retention Measure implementation to increase the basin's hydrological resilience?

SUMMARY

SWAT + model

NSWRMs integration

R

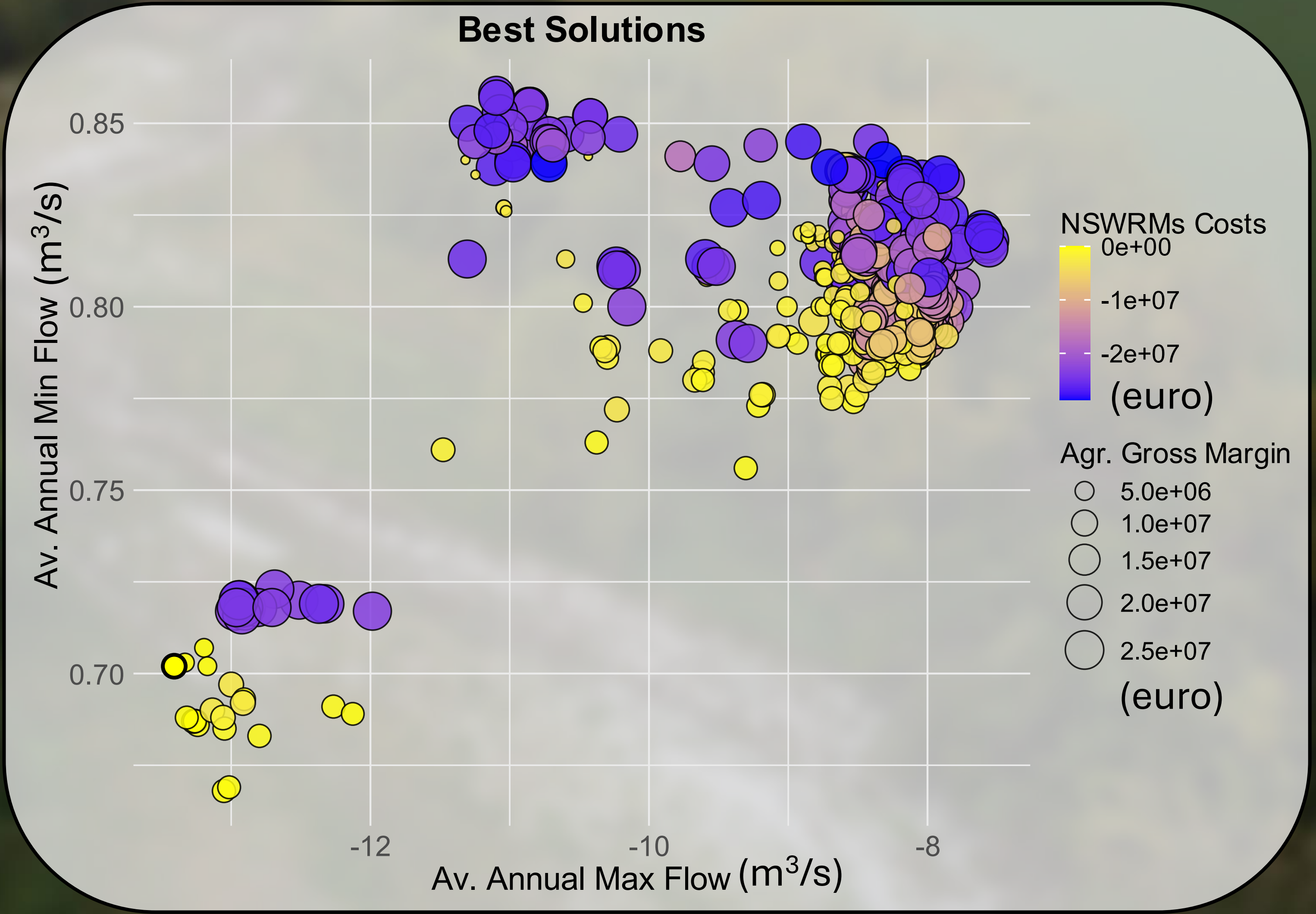
Optimization (NSGA-II)

Python

Output statistical analysis

R-Shiny

Optimization's output



ABSTRACT

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Title

INTRODUCTION

STUDY AREA: **Cherio River Basin**

Agro – Forested basin located North-East of Milan

BASIN FEATURES

CRITICAL ASPECTS & OBJECTIVES

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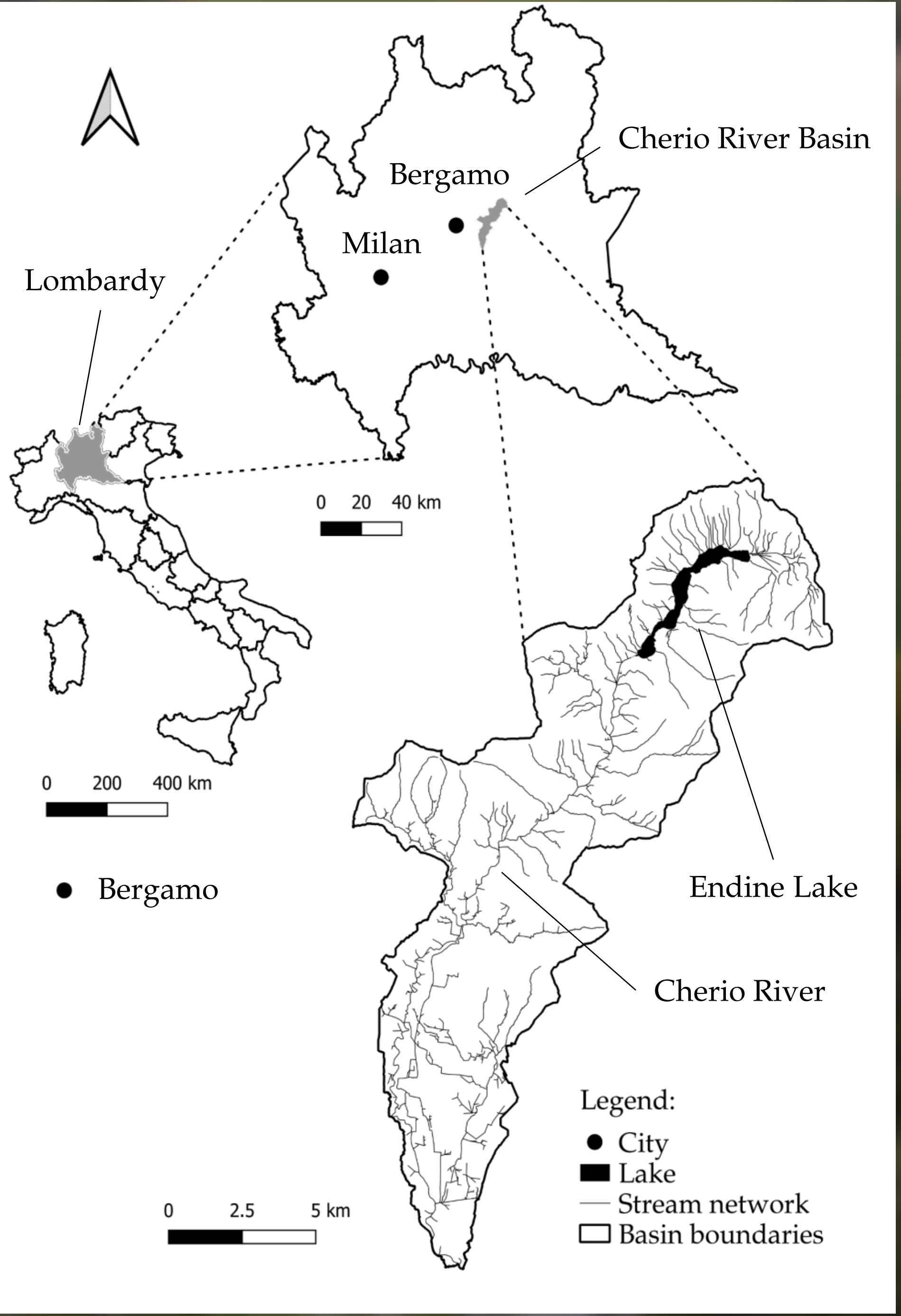


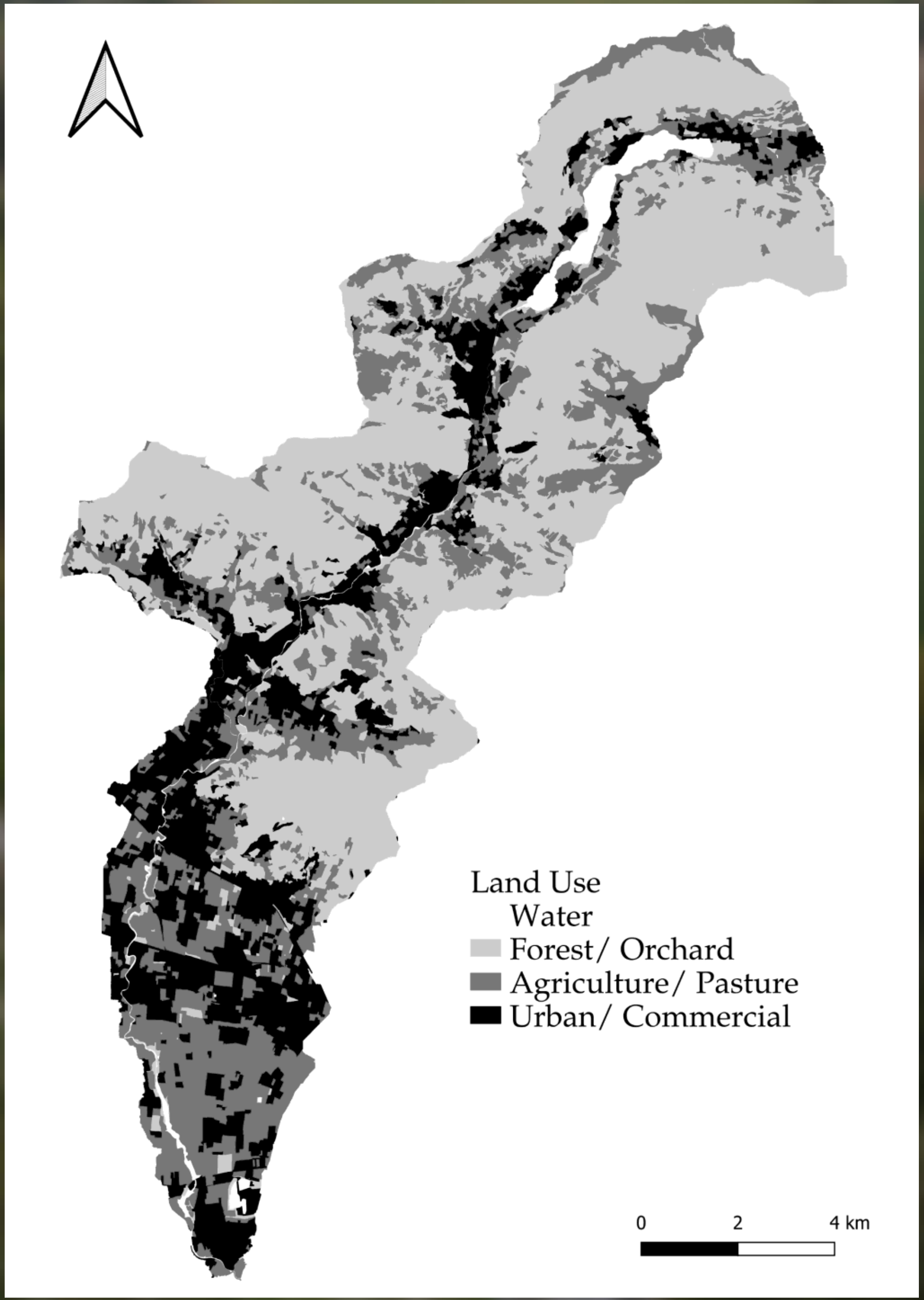
BASIN FEATURES

- **Extension:** 153 Km^2
- **Elevation:** 1376 – 141 m a.s.l.
- **A.A. Precipitation:** 1200 mm
- **Cherio River length:** 30 km
- **Land Use:** 42% forest, 39% pasture, cropland
- **Soil:**

SW section: deep, scarce skeleton, fine texture

NE section: shallow, abundant skeleton, coarse texture

Introduction



CRITICAL ASPECTS & OBJECTIVES

Area main hydrological issues: **Floods and drought**

Can be tackled by

NATURAL SMALL WATER RETENTION MEASURES

NATURAL – **Use or imitate nature**

SMALL – **Field –scale, headwaters**

WATER RETENTION – **Effects on water quantity and quality**

MEASURES – **Structural or practice change**

What are the best territorial planning solutions?

OBJECTIVE: to identify the optimal levels of NSWRM implementation in the Cherio River Basin

Introduction

NSWRMs catalogue

METHODS

MODEL CONFIGURATION

SWAT + model setup

Contiguous Objects connectivity approach

Tool:
- SWATbuild.R
- SWATfarm.R

SWAT + model calibration

Tool:
- SWATtun.R

NSWRMs IMPLEMENTATION

NSWRMs identification:
- **Terrace**
- **Pond**
- **Constructed wetland**
- **Buffer**
- **Drought resistant crop**

NSWRMs implementation

Tool:
- SWATmeas.R

OPTIMIZATION

OBJECTIVES:
- **Environmental**
- **Economical**

Tool:
- Constrained Multi-objective Optimization of Land use Allocation (CoMOLA)
- Pareto_Pick.R

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NSWRMs IMPLEMENTATION

NSWRMs locations

TERRACE:

POND:

BUFFER:

C. WETLAND:

DROUGHT R. CROPS

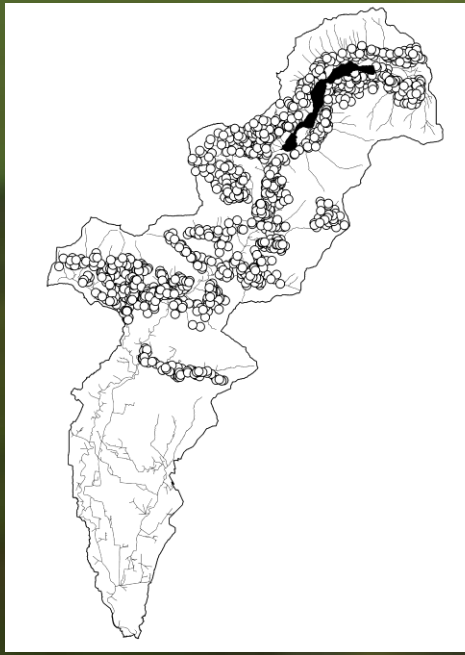
Methods

NSWRMs IMPLEMENTATION

NSWRMs renders

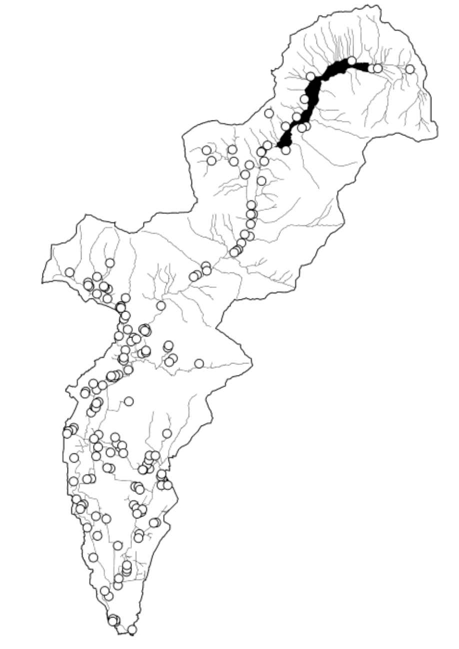
TERRACE:

% of basin total surface: 19



POND:

% of basin total surface: 1.8

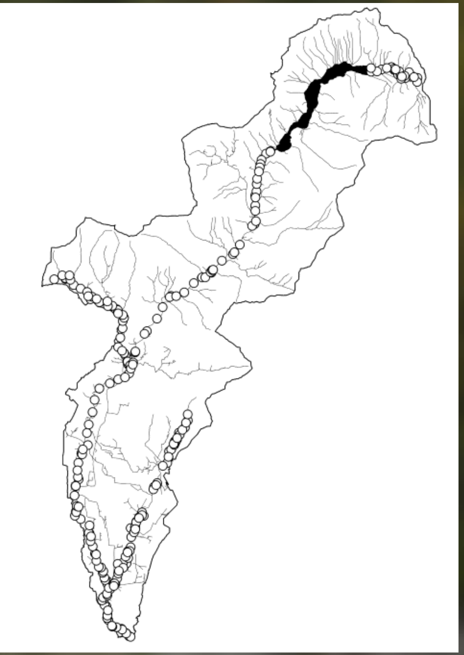


BUFFER:

% of basin total surface: 0.9

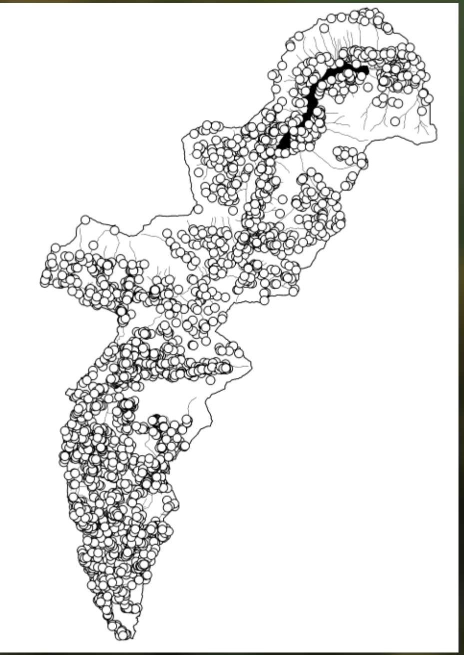
C. WETLAND:

% of basin total surface: 8



DROUGHT R. CROPS

% of basin total surface: 20



Methods

Assessment of NSWRMs effectiveness

OPTIMIZATION

OBJECTIVES:

- **Minimize max flows:** reduction of a. a. peak flows to avoid flooding
- **Maximize min flows:** increment of a.a. minimum flows to maximize irrigation water availability
- **Minimize NSWRMs costs:** minimize implementation and maintenance costs of NSWRMs
- **Maximize Agr. Gross Margin:** maximizing the agriculture productivity of the area

Python NSGA-2

SWAT +, R

Model1
genome: 1, 1, 2, 2 ...

Model2
genome: 2, 2, 2, 2 ...

Model3
genome: 2, 2, 1, 1...

Model100
genome: 2, 1, 2, 1 ...

CoMOLA

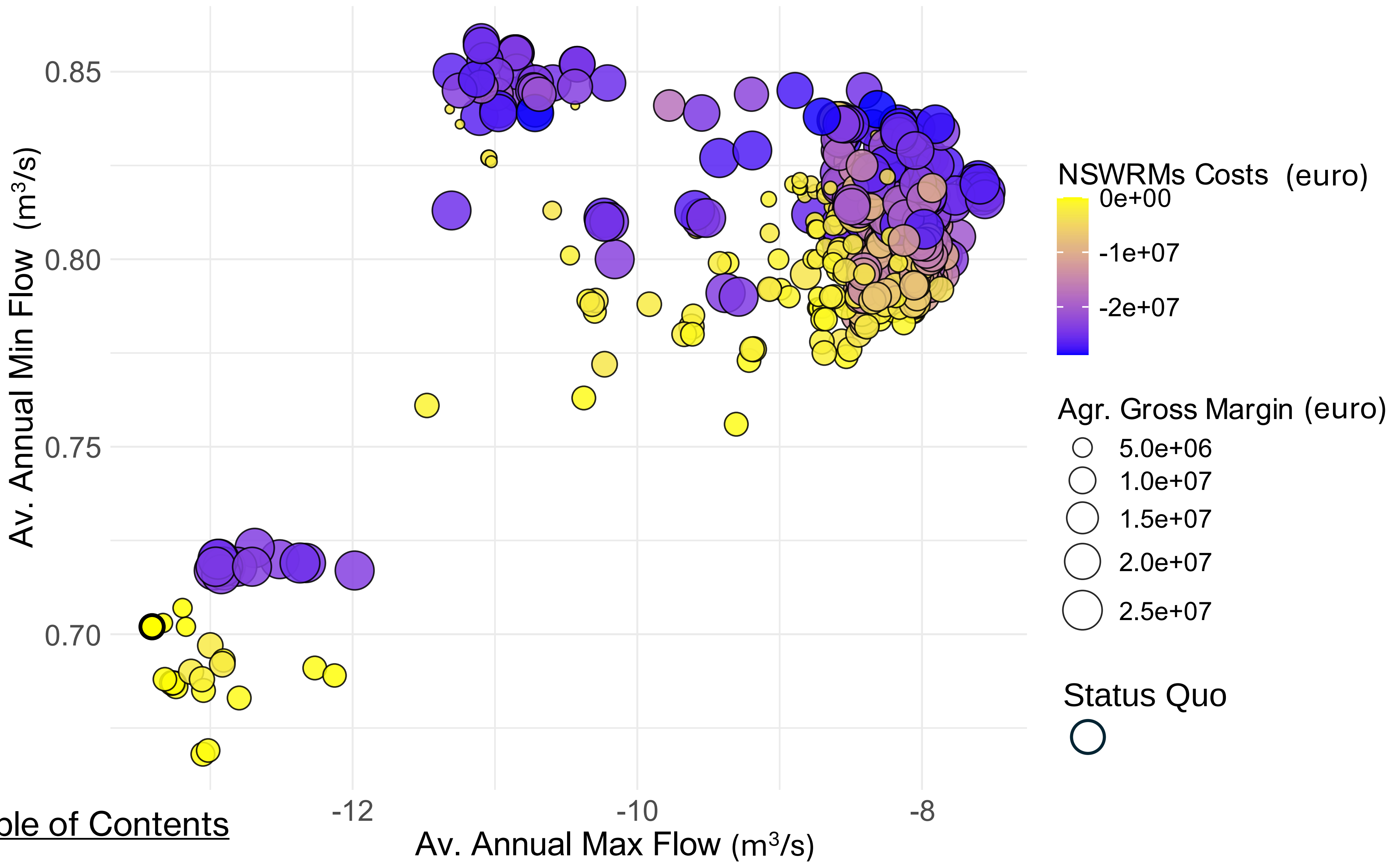
Output visualization, Statistical Analysis

ParetoPick-R (R-Shiny app)

Methods

RESULTS

Best Solutions TO CLUSTERS



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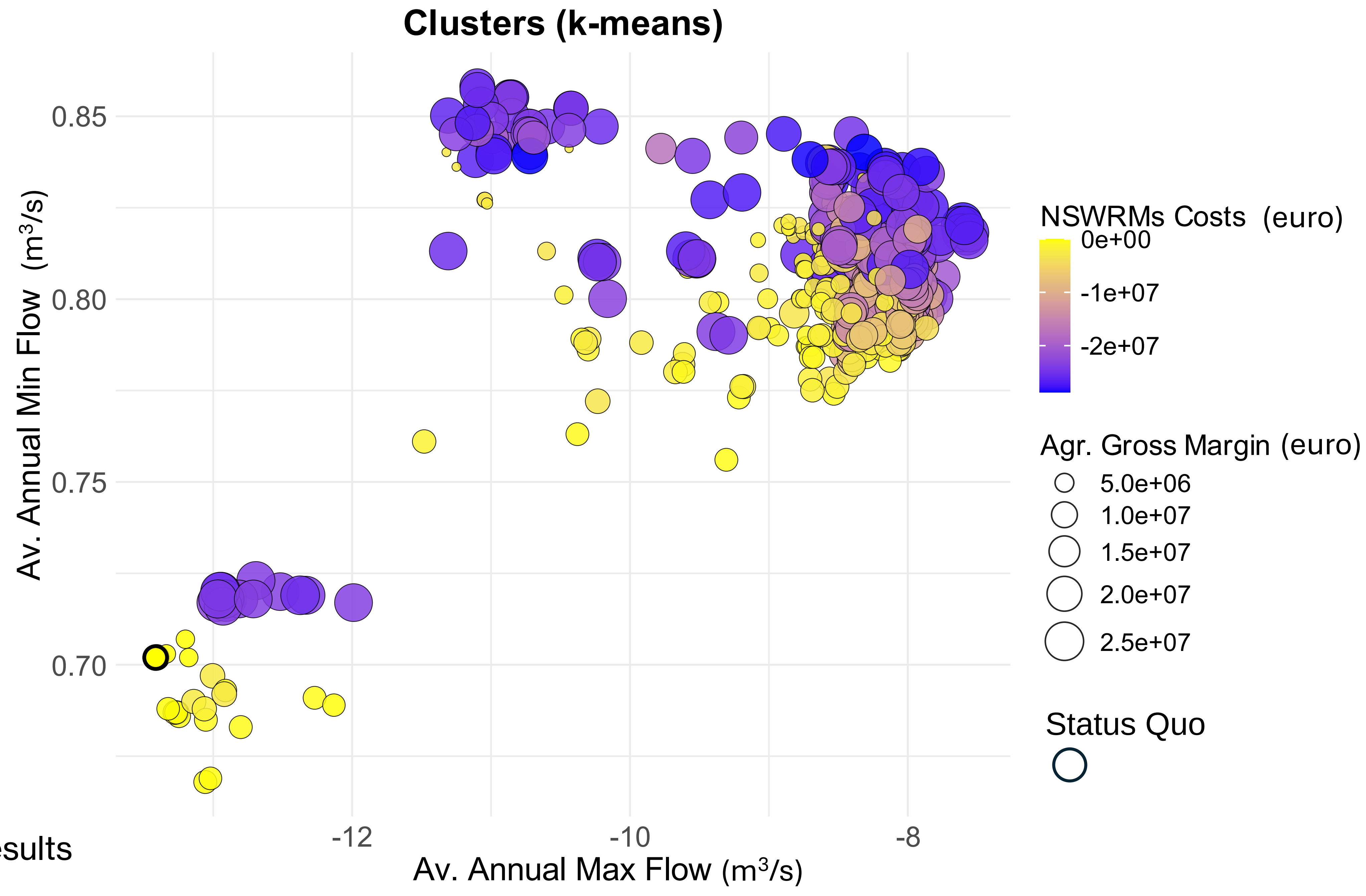
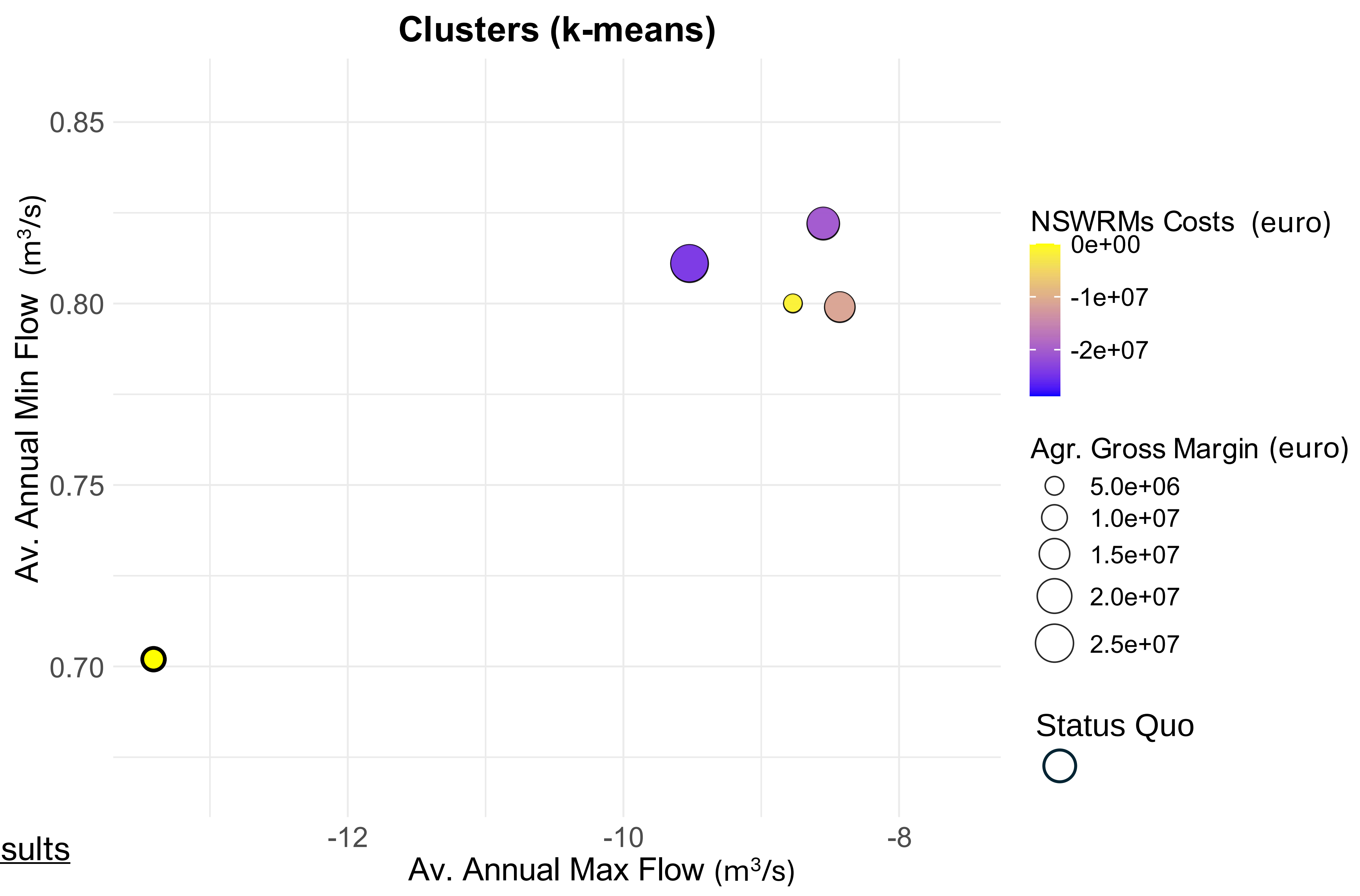


Clusters (k-means)
0.85
0.80
0.75
0.70
Av. Annual Min Flow (m³/s)
-12
-10
-8
Av. Annual Max Flow (m³/s)
NSWRMs Costs (euro)
0e+00
-1e+07
-2e+07
Agr. Gross Margin (euro)
5.0e+06
1.0e+07
1.5e+07
2.0e+07
2.5e+07
Status Quo

Results



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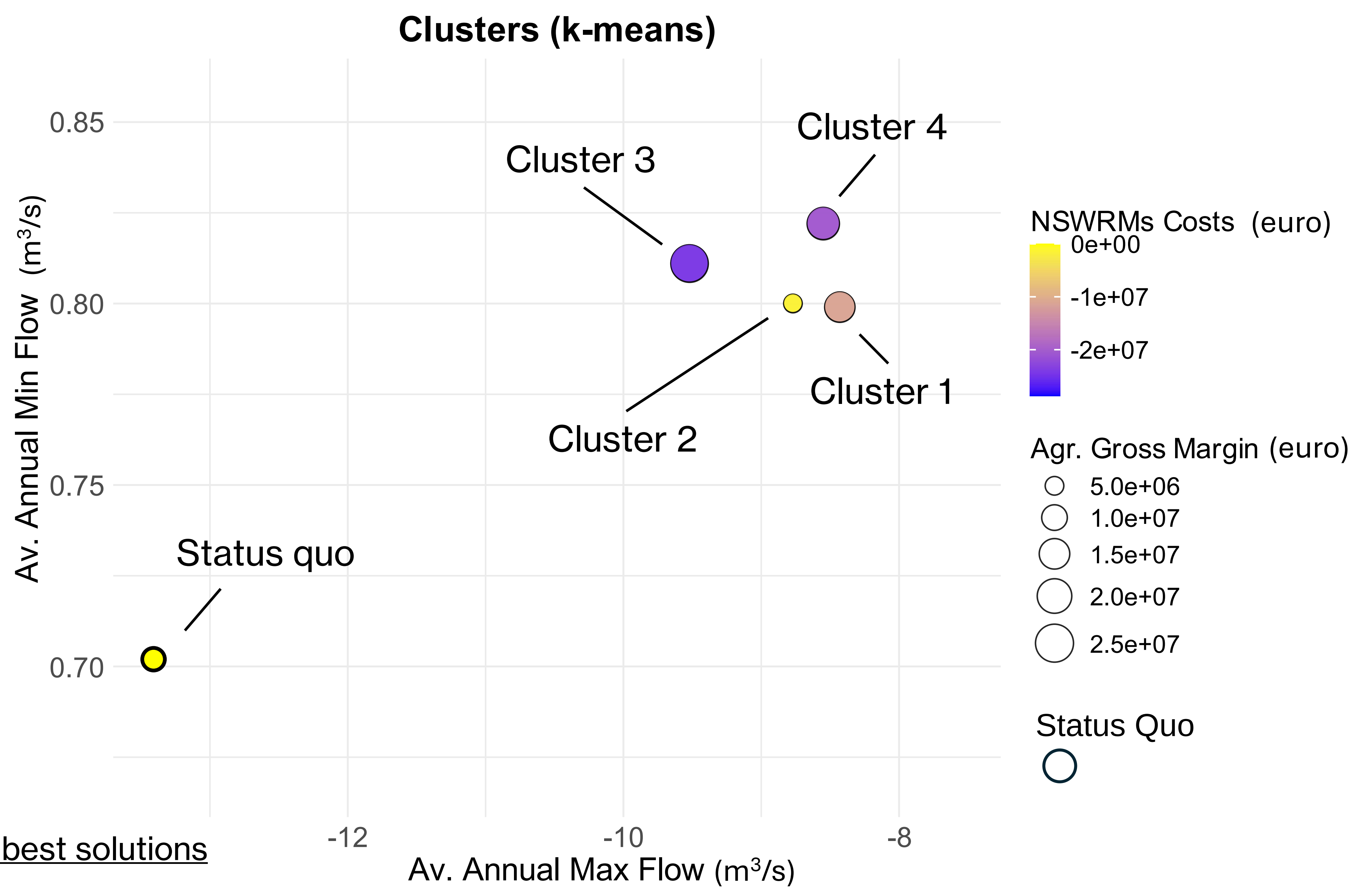


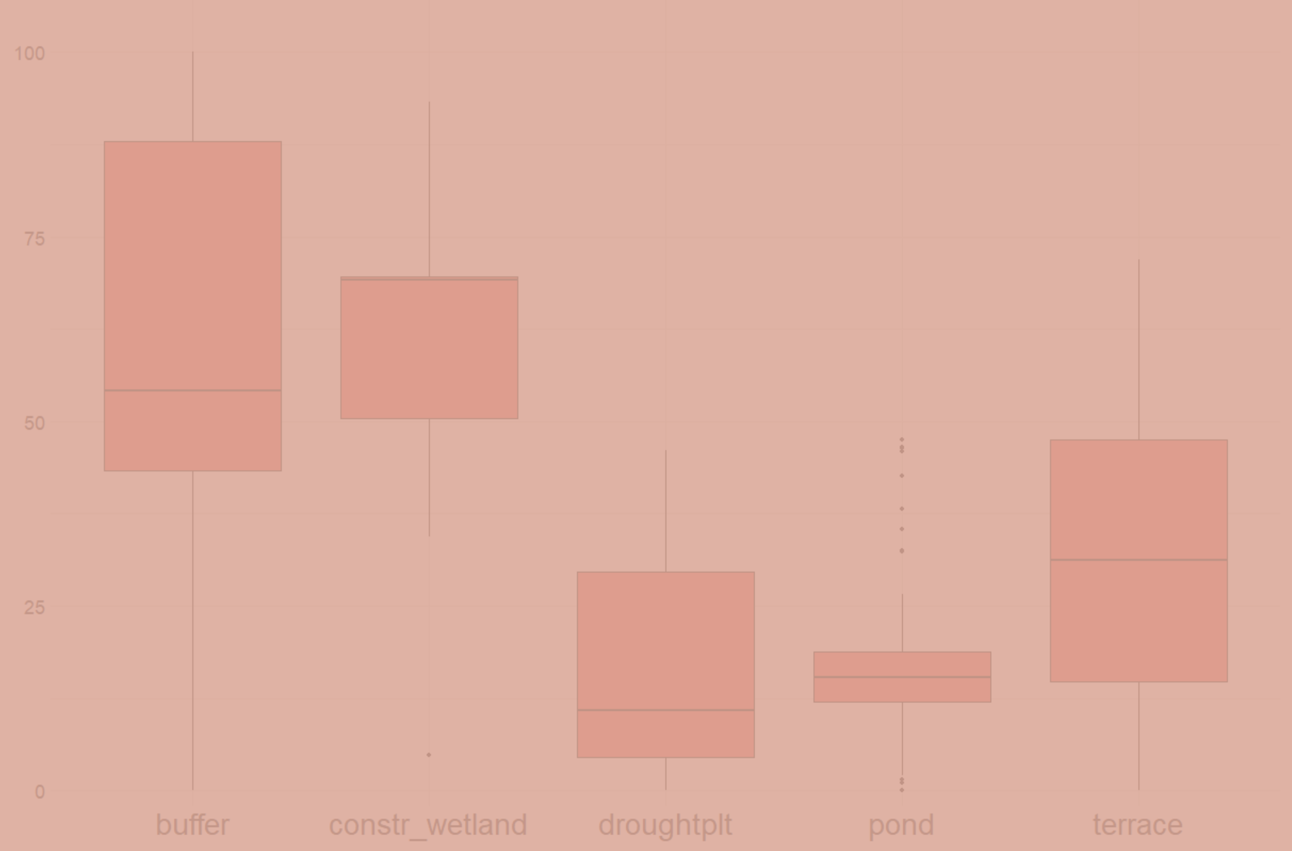
Back to best solutions

Cluster 1

Cluster variation to status-quo

A.A. Max Flows	-37.1%
A.A. Min Flows	+13.8%
NSWRMs Costs	11 mln
Agr. Gross Margin	+201.2%

Individual measures' share in total considered area



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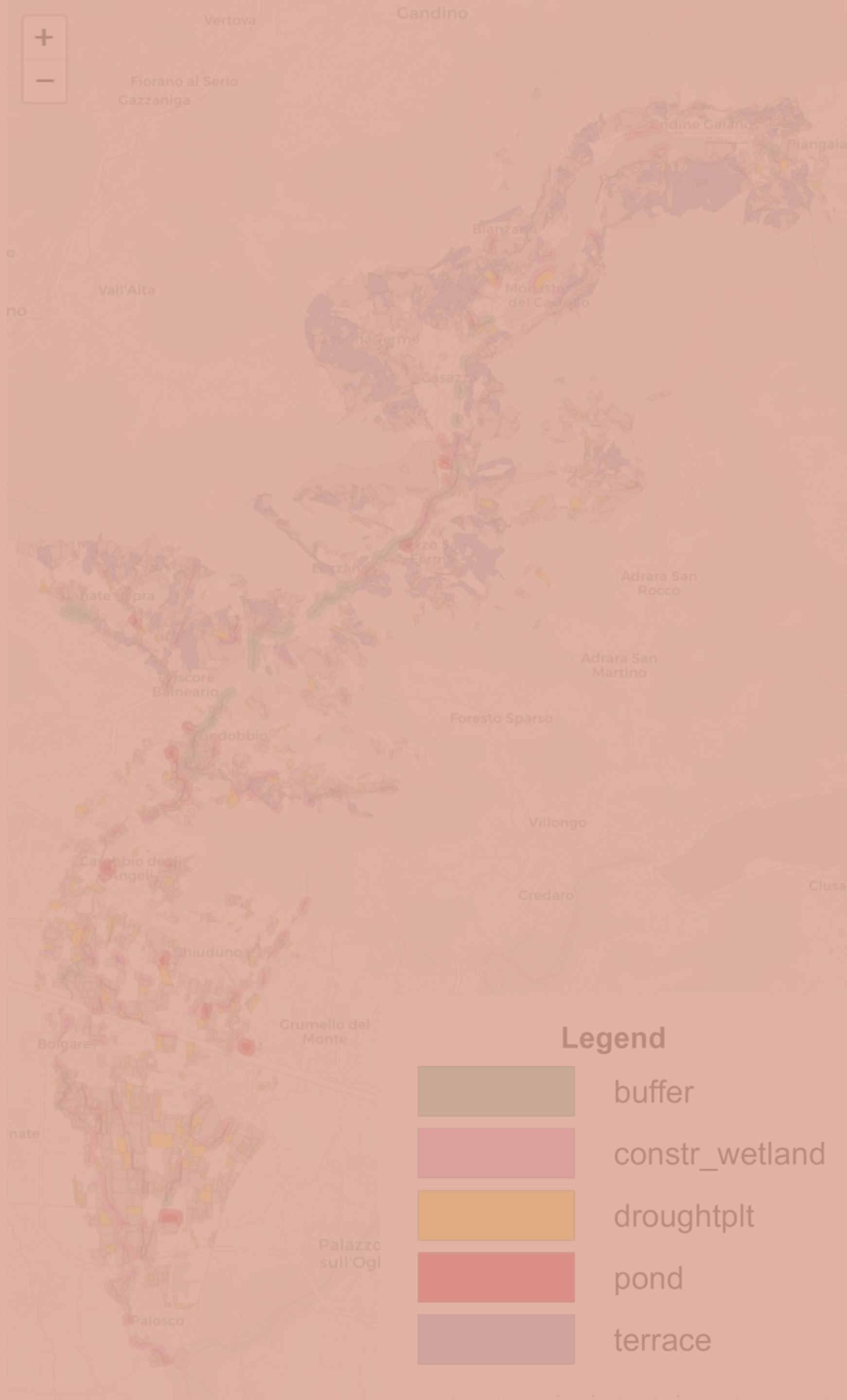

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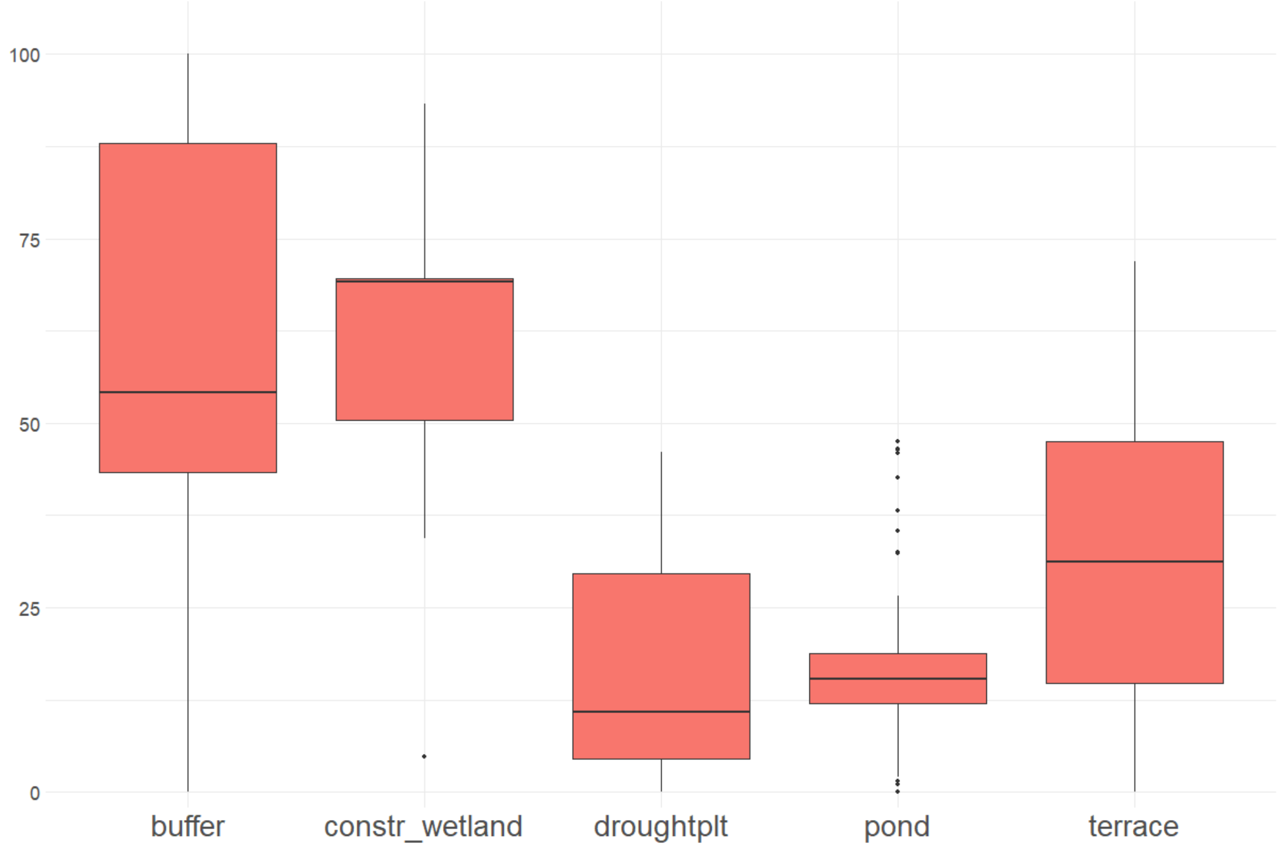
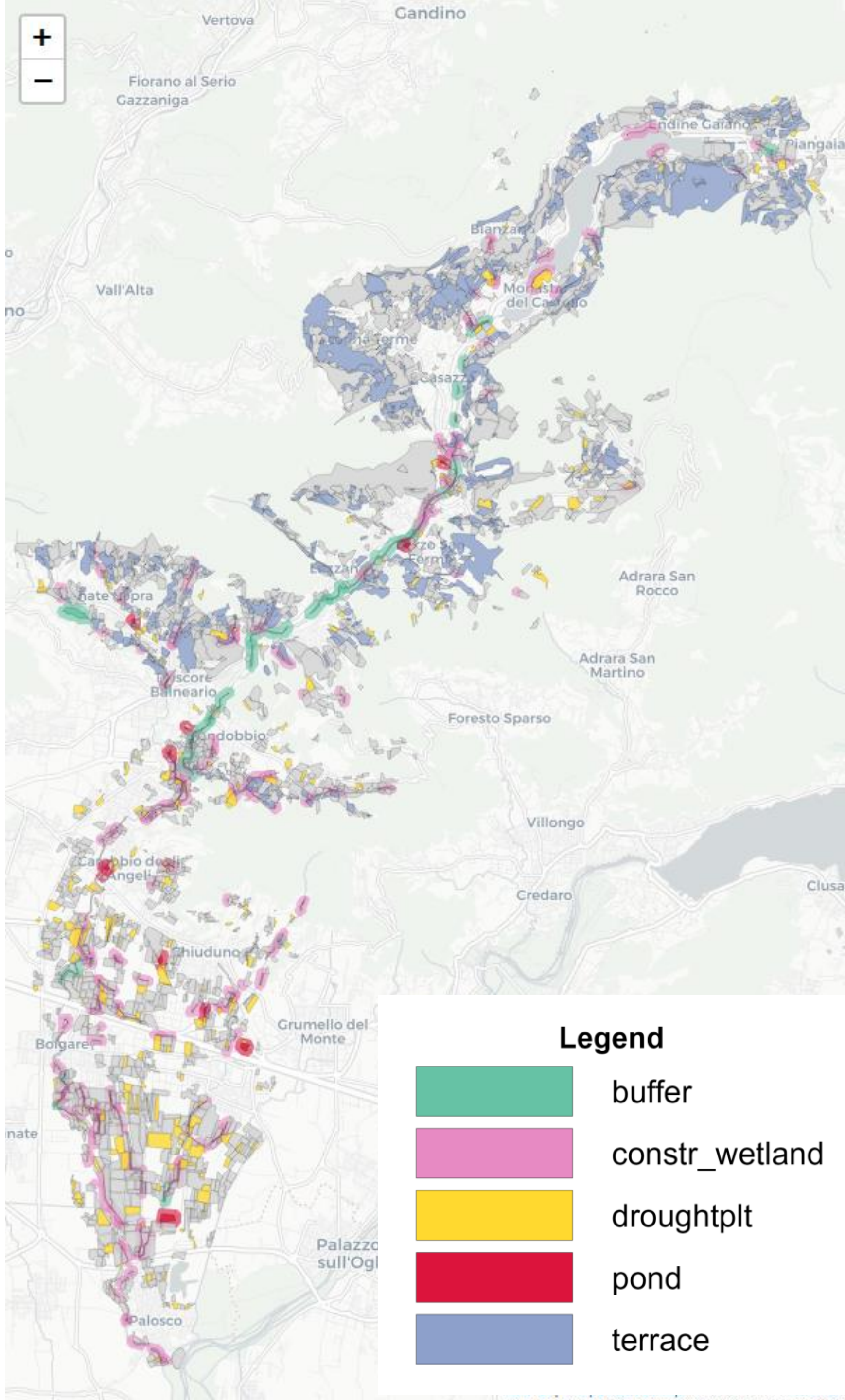


Back to clusters

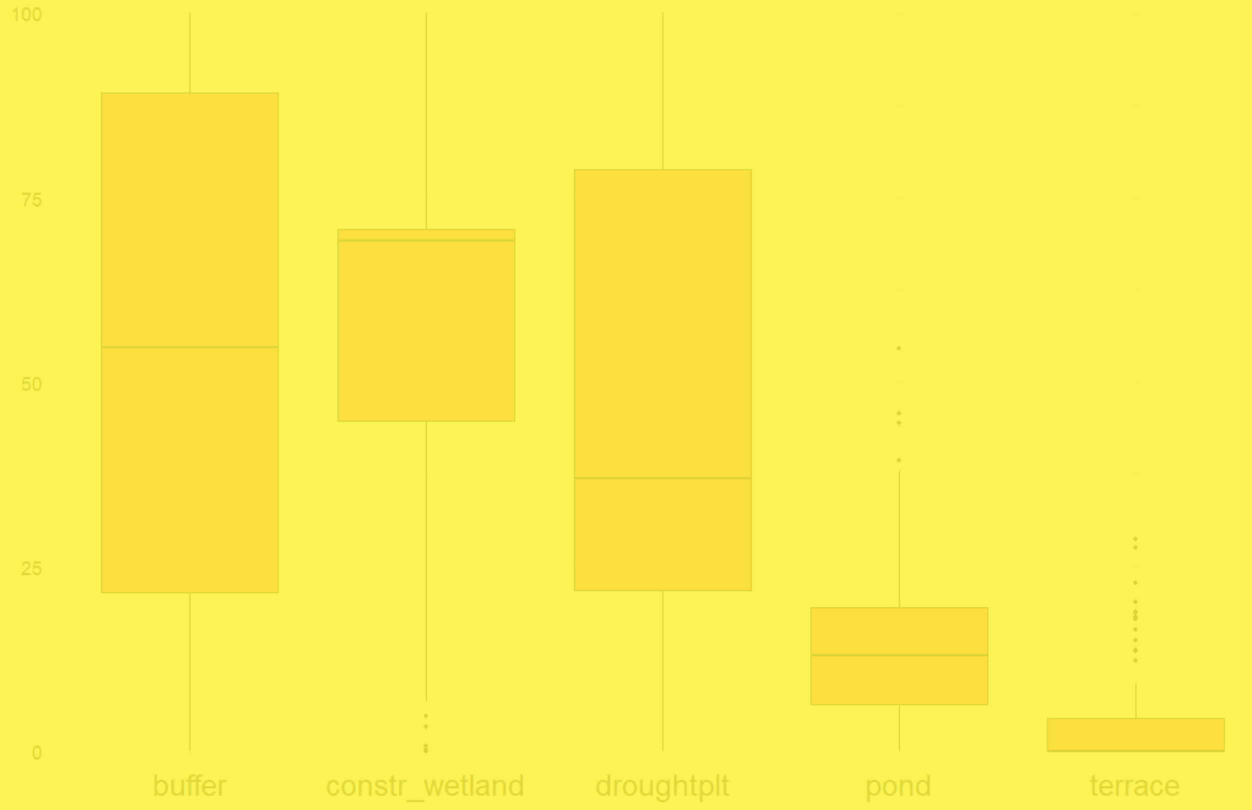


Cluster 2

Cluster variation to status-quo

A.A. Max Flows	-34.6%
A.A. Min Flows	+14.0%
NSWRMs Costs	0.1 mln
Agr. Gross Margin	+0.7%

Individual measures’ share in total considered area



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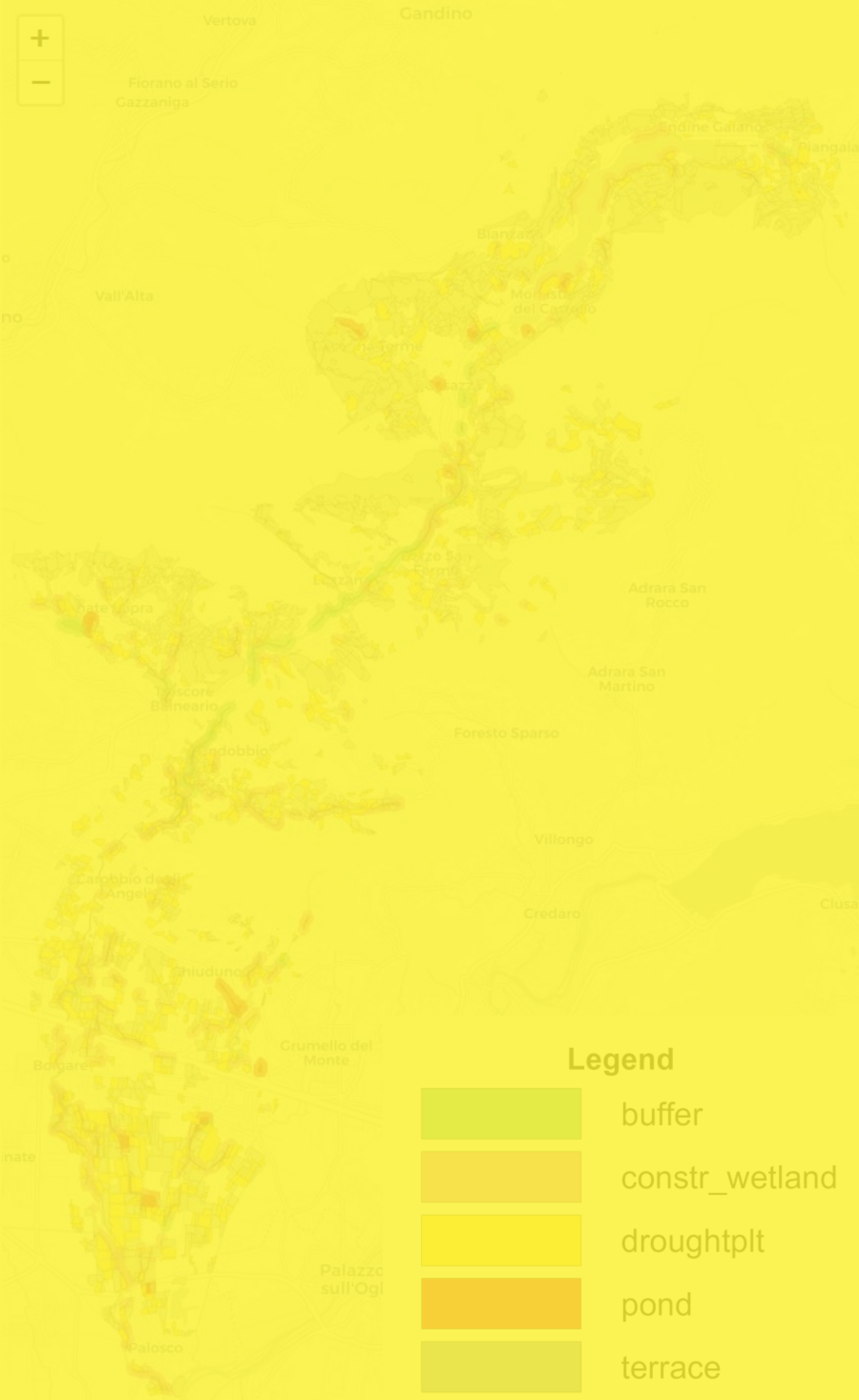

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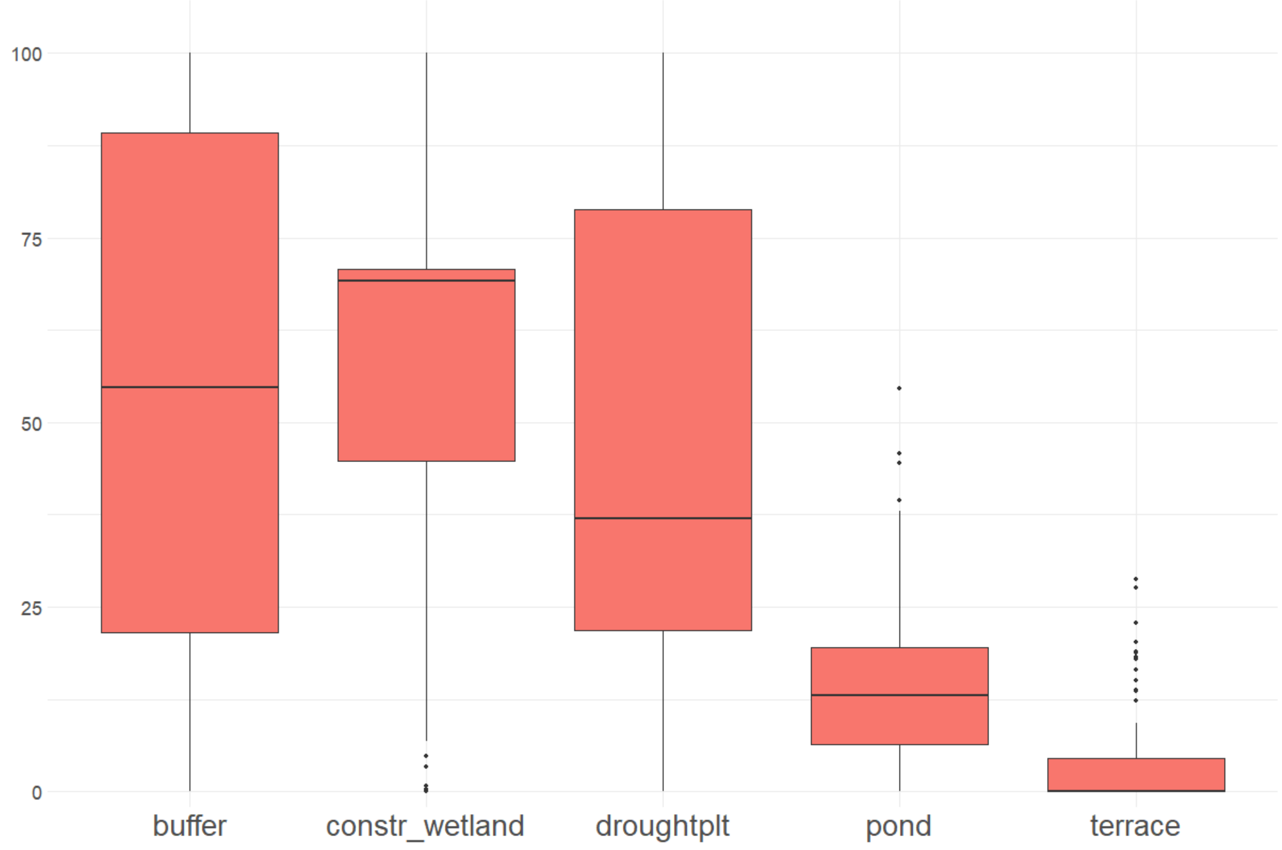

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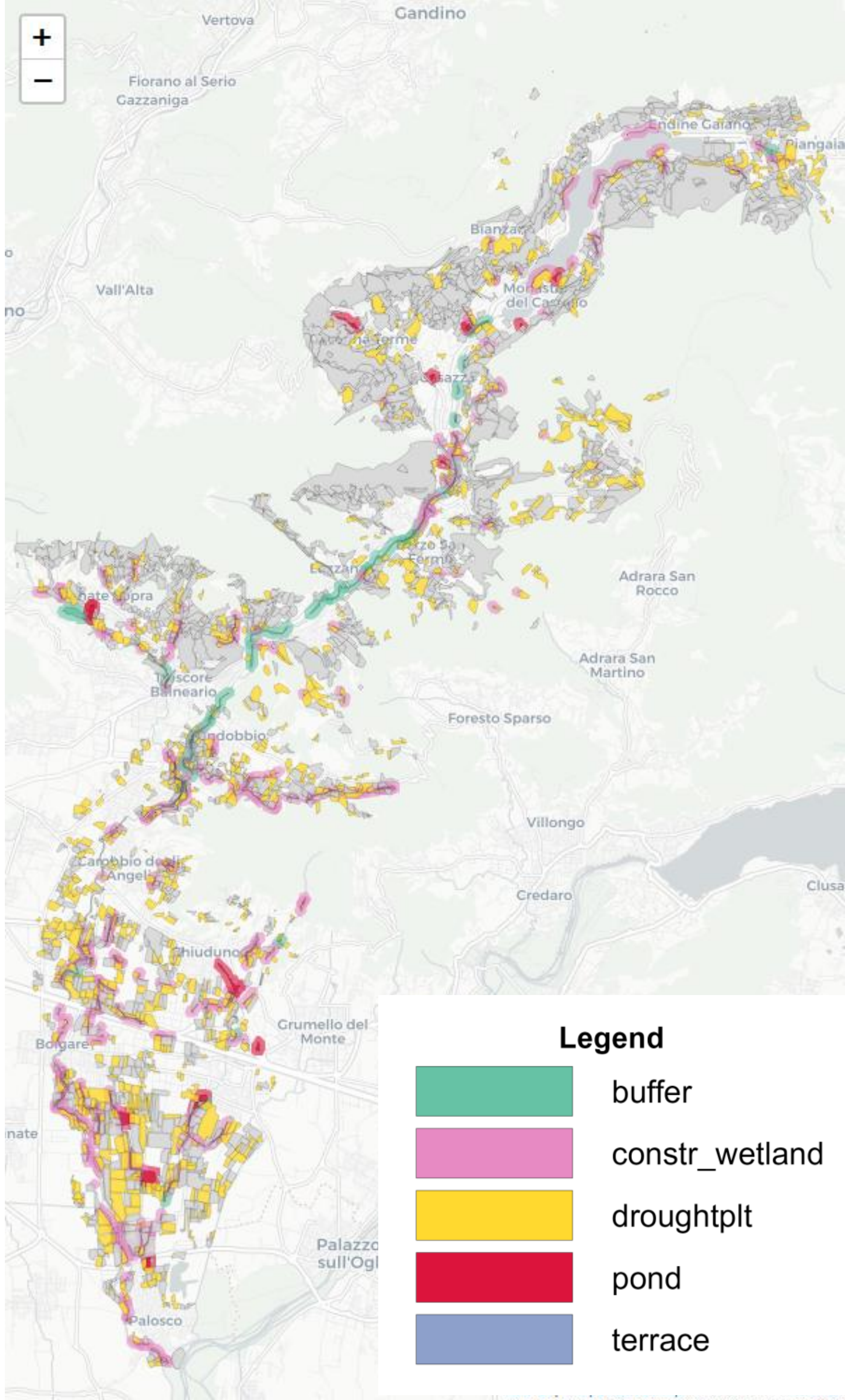
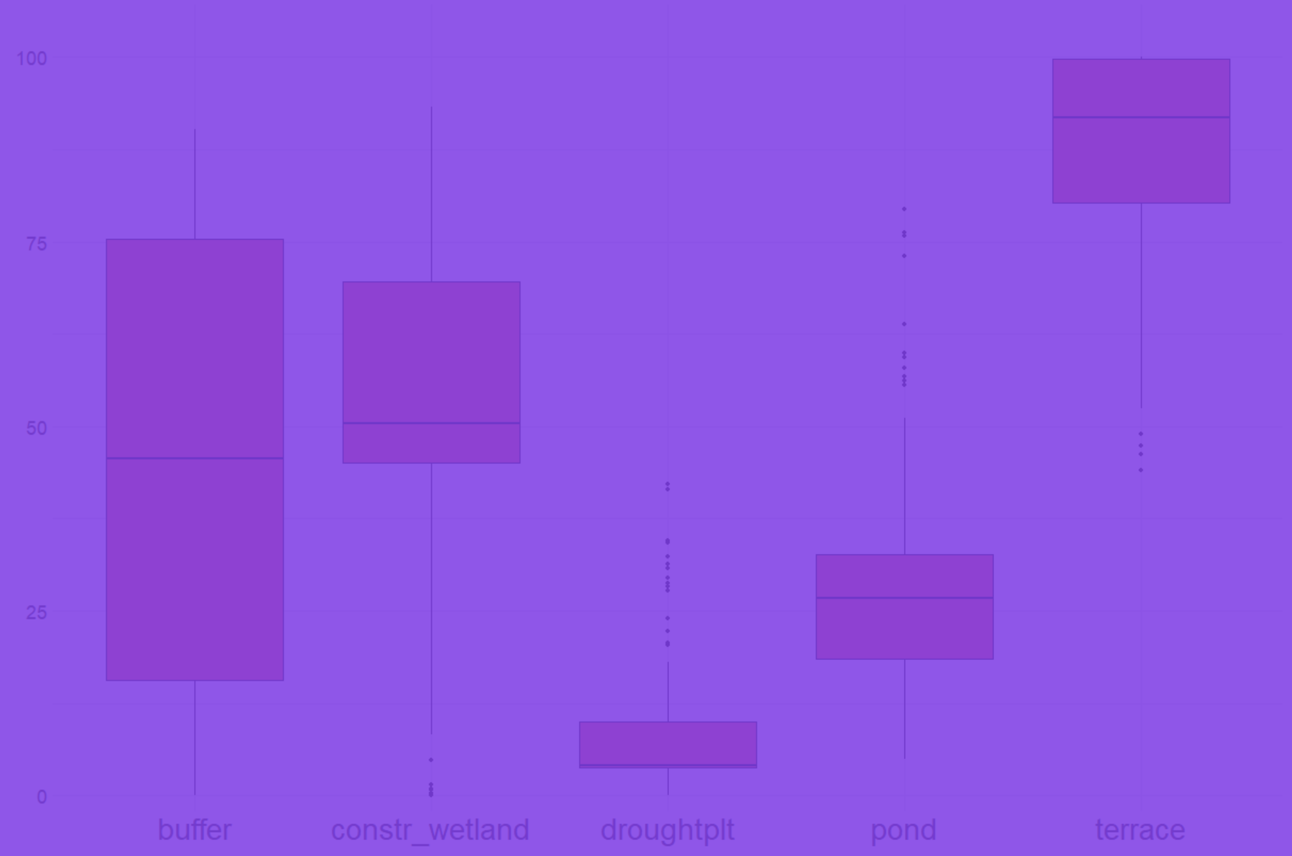


Cluster 3

A.A. Max Flows	-29.0%
A.A. Min Flows	+15.5%
NSWRMs Costs	24 mln
Agr. Gross Margin	+392%

Cluster variation to status-quo

Individual measures' share in total considered area



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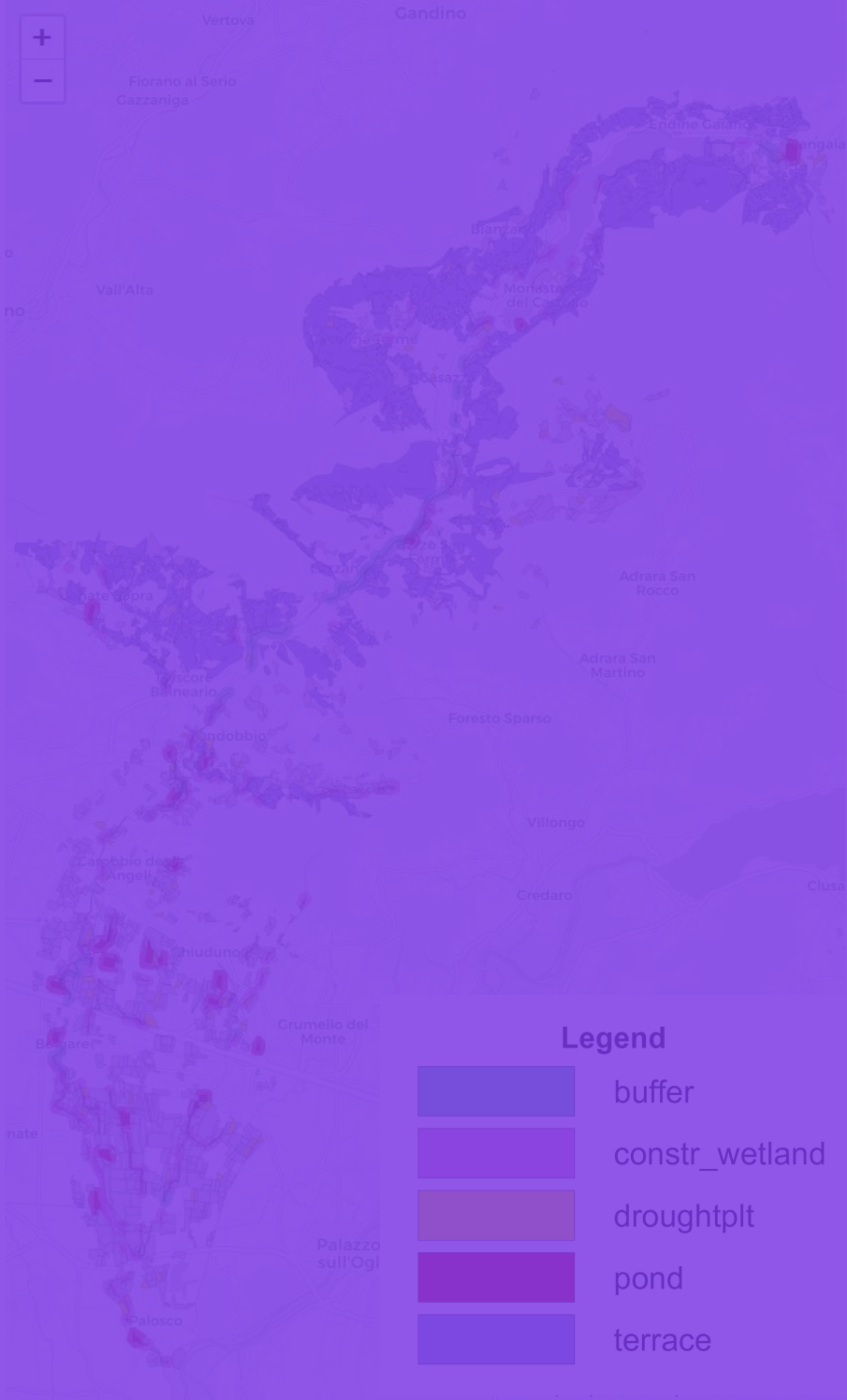

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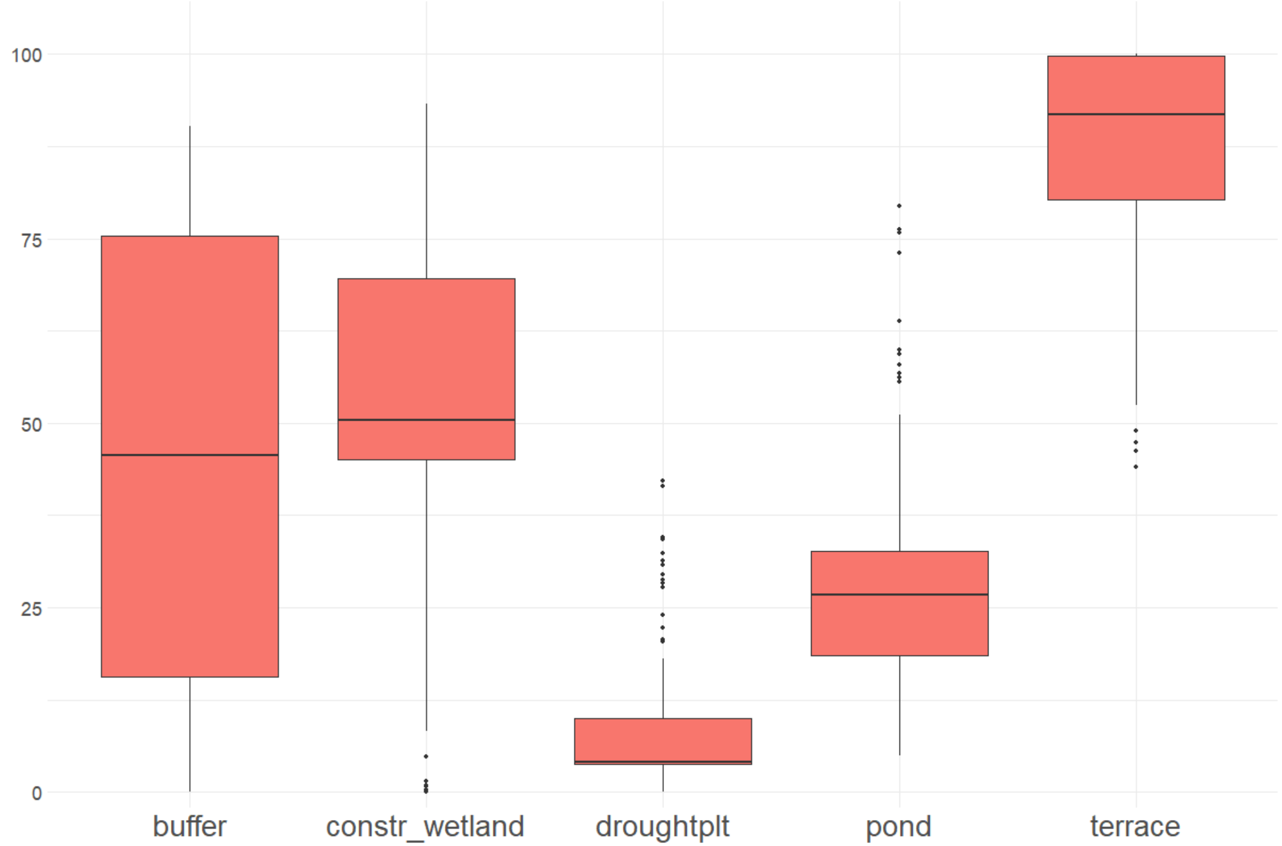

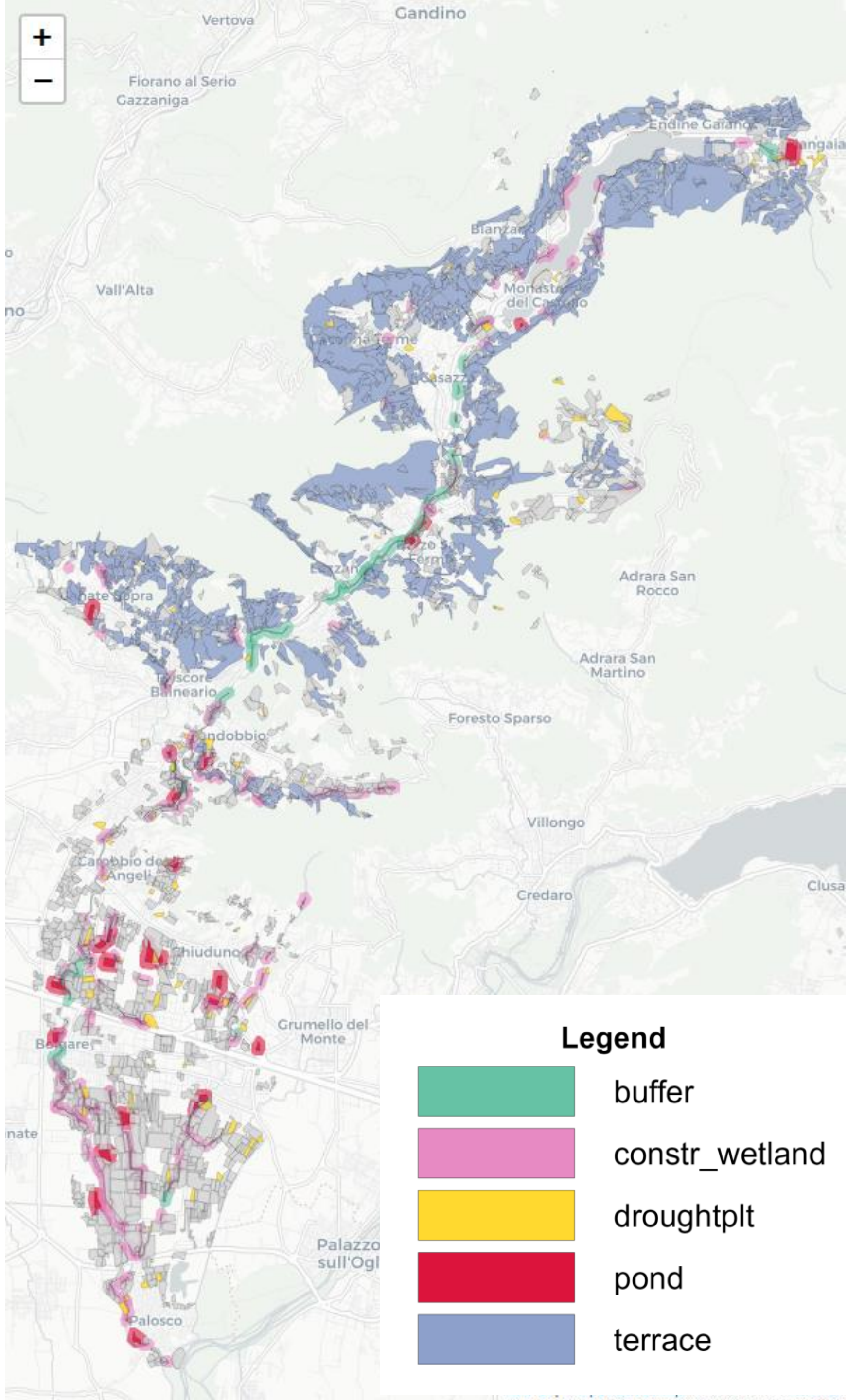

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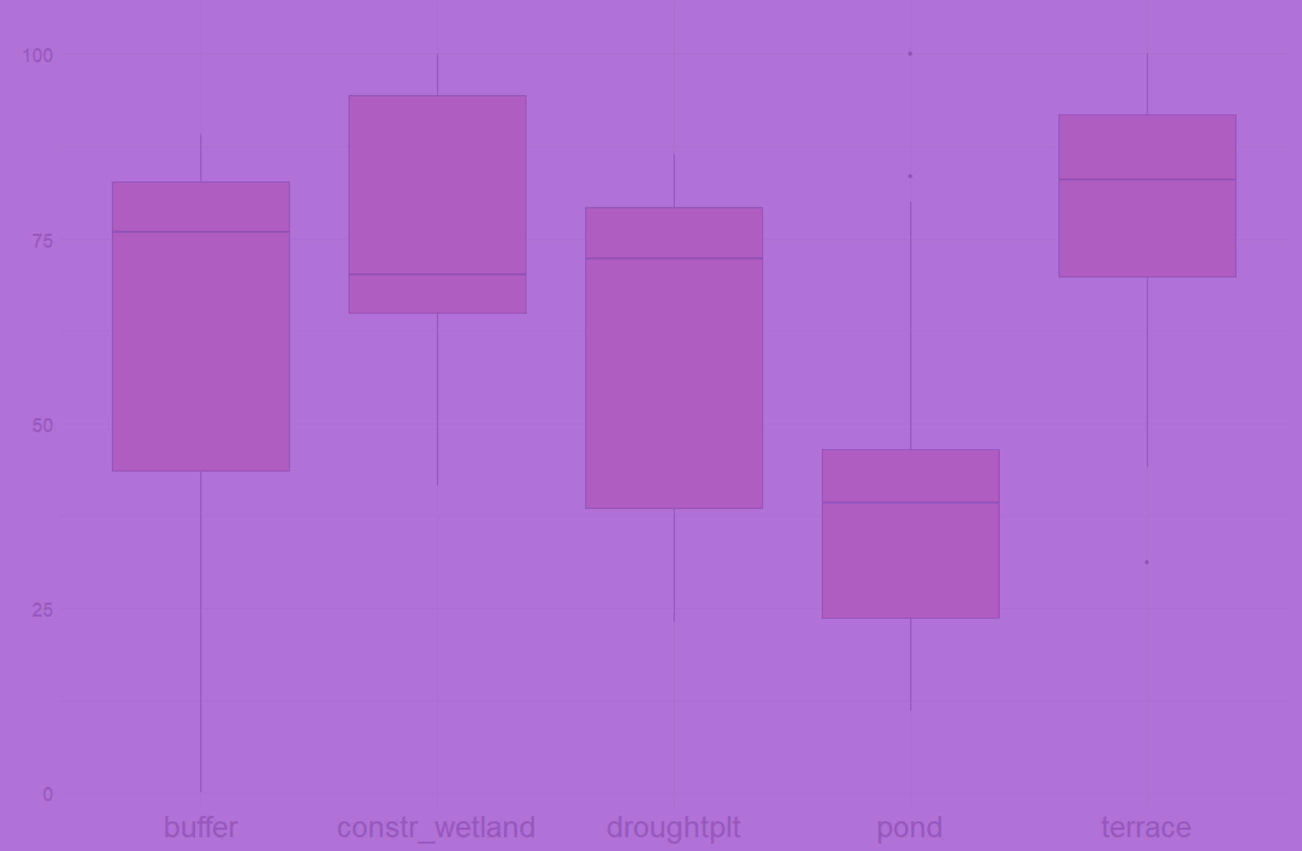
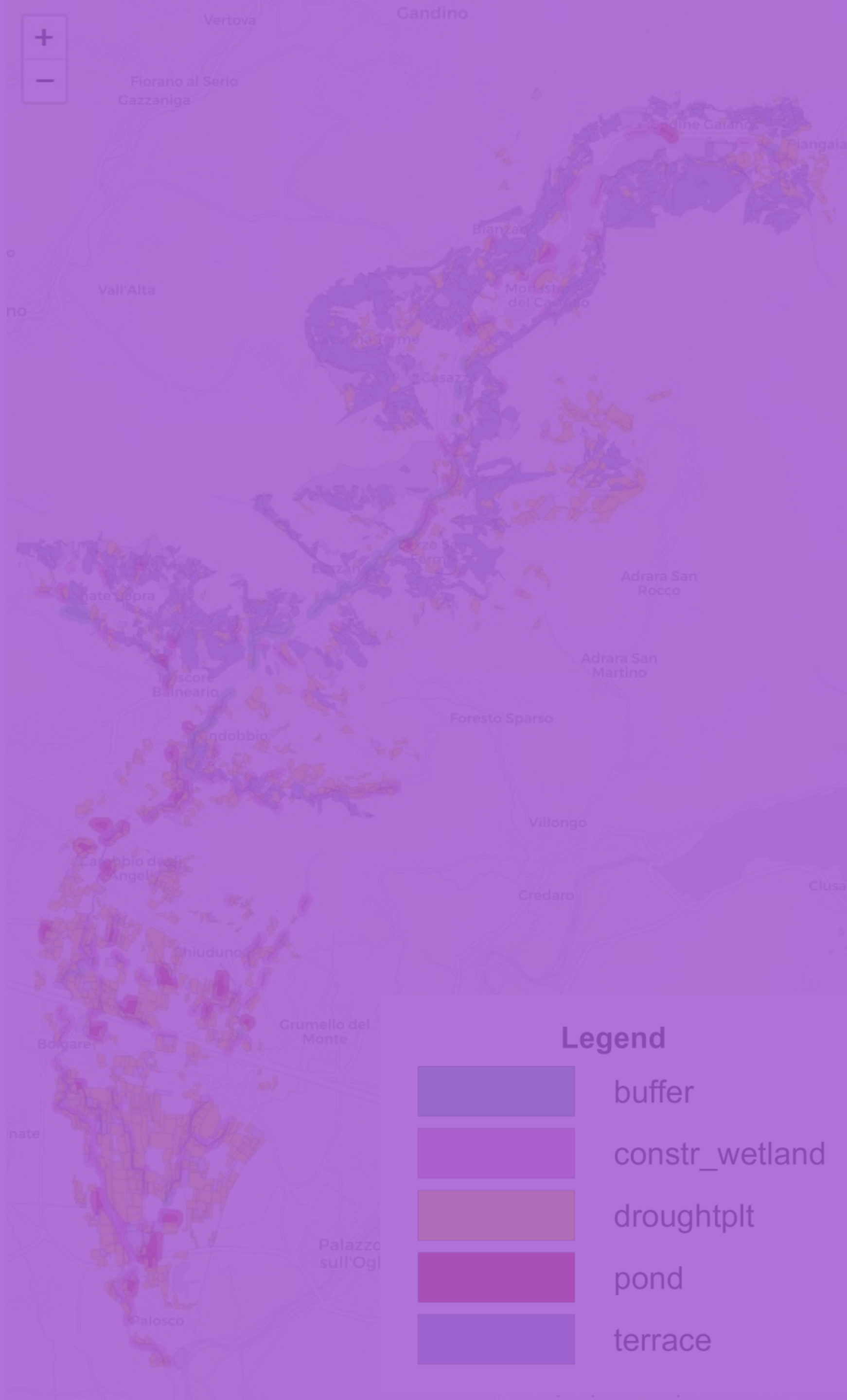
Cluster 4

A.A. Max Flows	-36.2%
A.A. Min Flows	+17.1%
NSWRMs Costs	24 mln
Agr. Gross Margin	+249%

Cluster variation to status-quo

Individual measures’ share in total considered area





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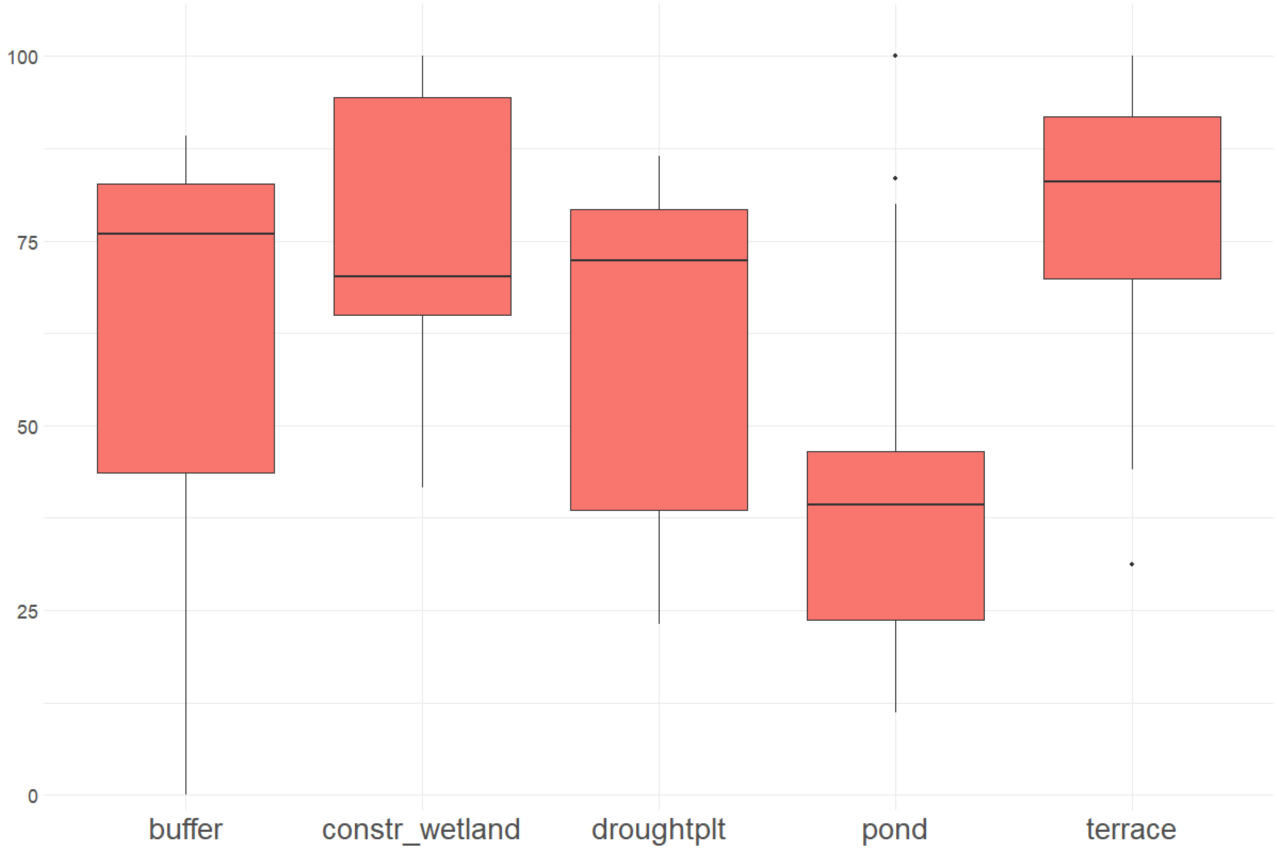
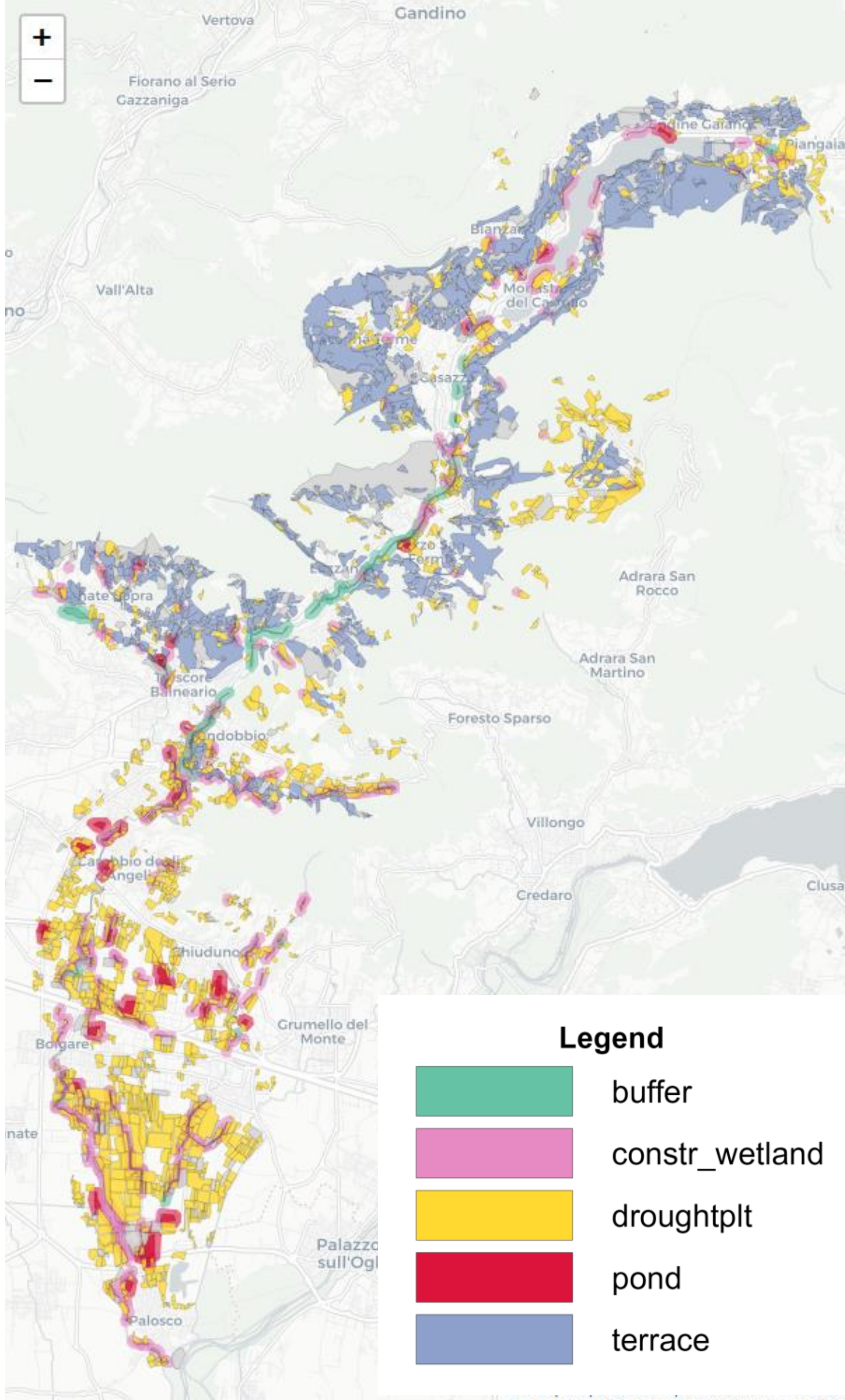
Cluster variation to status-quo

Individual measures' share in total considered area





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CONCLUSIONS

- All four clusters, representative of all the optimal solutions, successfully achieve the environmental objectives with minimal variation among them; the main difference lies in the economic indicators. This suggests that a potential decision-maker may retain a certain degree of flexibility in choosing whether or not to invest in the area's productivity, while still achieving equivalent environmental benefits.

- Certain types of measures, such as buffer strips and constructed wetlands, appear to be the most promising compared to others, as they are the most frequently implemented across all four clusters.

- The future development of this study involves organizing a MARG meeting with various stakeholders from different categories, in order to concretely propose territorial solutions that represent sound compromises among their diverse needs.

- Finally, due to its flexibility, the optimization approach adopted in this study, could be extended to other applications: adoption of different indicators, climate change scenarios optimization, and integration with other models.

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