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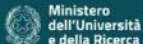
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Unravelling the Interplay Between Land Use Change and Surface Water Quality in Italian Watersheds

Authors: Hung Vuong PHAM, Samuele CASAGRANDE, Olinda RUFO, and Andrea CRITTO





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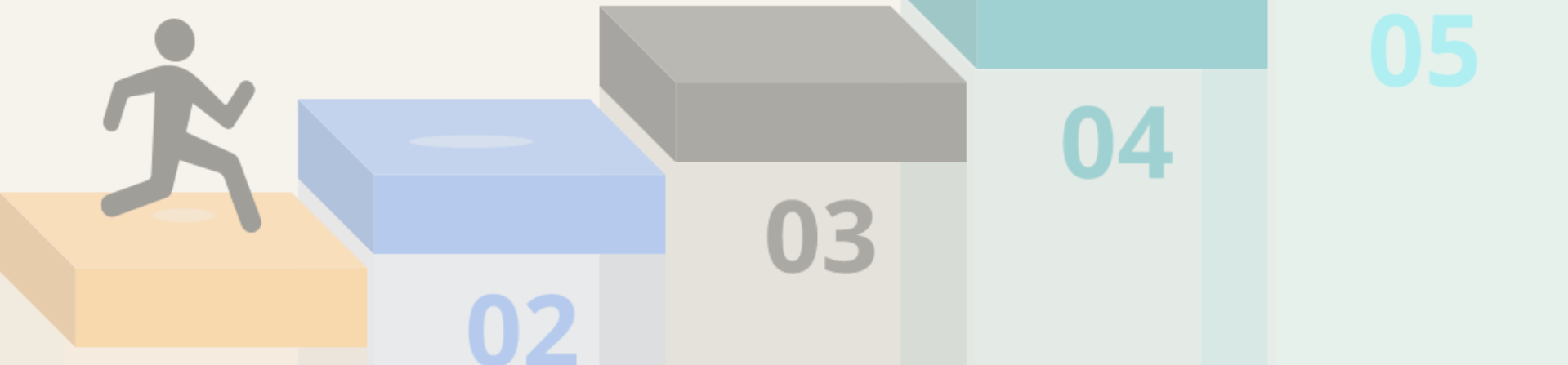


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Table of content

- Recap the project's ideas and progress
- Application on Land Use/ Land cover Change and Surface Water Quality
- Dissemination activities
- What's next

Project ideas and progress



Objectives

- Evaluation of land use/land cover change (**LULCC**) impacts on water quality in accordance to WFD (e.g., indicators and their spatio-temporal trend)
- Evaluation of climate change (**CC**) impacts on water quality in accordance to WFD (e.g., indicators and their spatio-temporal trend)
- Analysis of spatio-temporal dynamic impacts and interaction of LULCC&CC on water quality (e.g., additive, synergistic, compound, etc.)
- Risk assessment and scenario analysis to assist policy-makers in designing mitigation and management strategies (e.g., storyline for different desired future)

Land use change



Climate change



Case study Italy



Water quality

Spatiotemporal analysis...

Correlation analysis
Sensitivity analysis
...



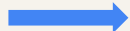
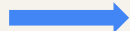
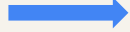
Land use



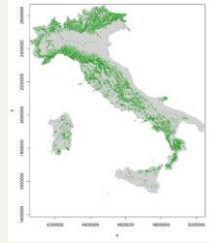
Climate change



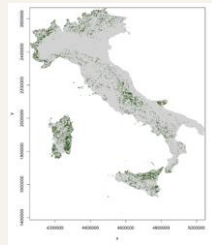
Water quality



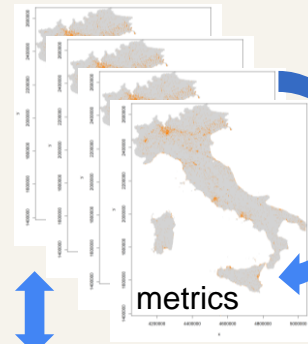
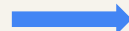
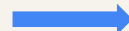
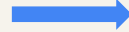
receptors



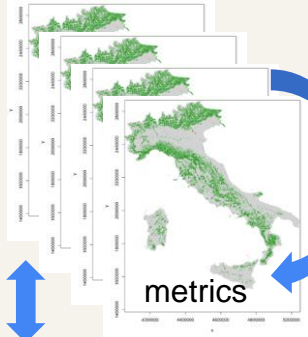
variables



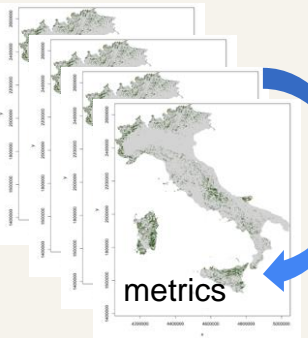
variables



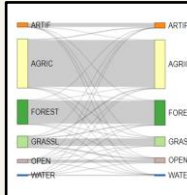
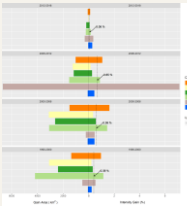
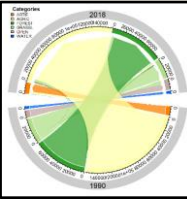
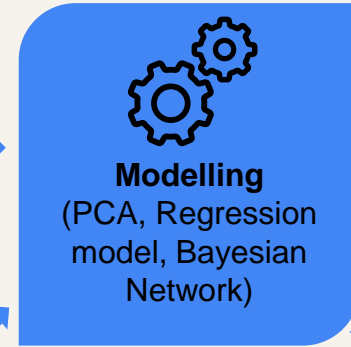
metrics



metrics

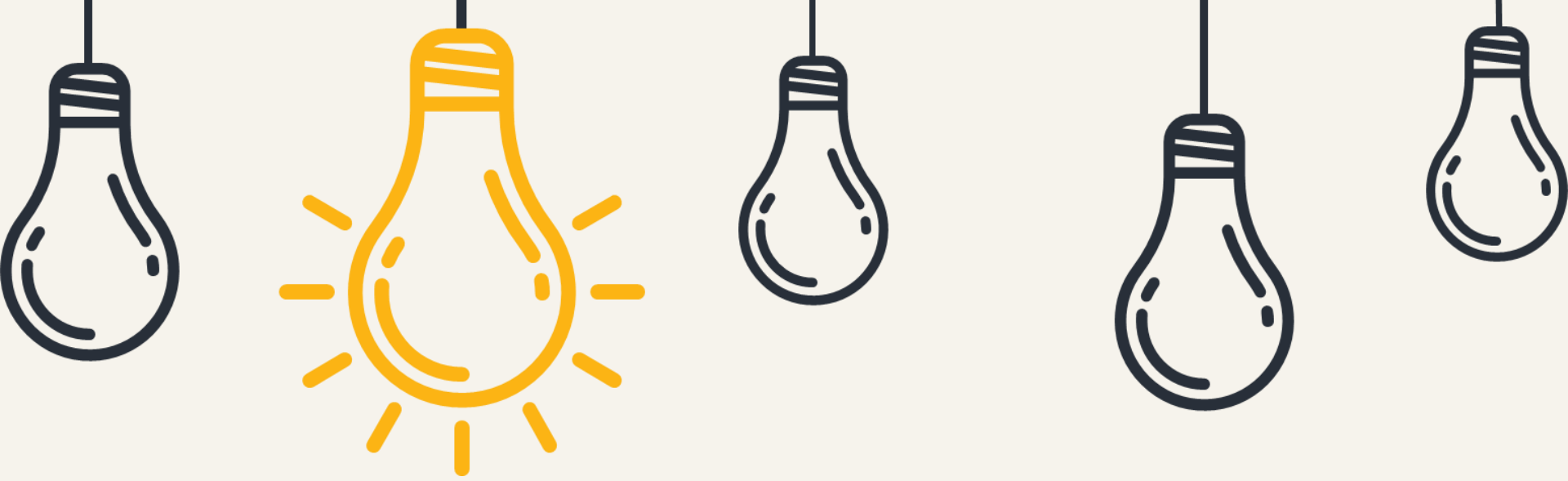


metrics



Overall progress

- Evaluation of land use/land cover change (**LULCC**) on Water Quality => Done. A Master's Thesis was successfully defended in October 2024.
- Evaluation of Climate Change (**CC**) on Water Quality => Complete the conceptual model, Positive evaluation of the 1st year PhD of Olinda Rufo
- Disseminate the results in different conferences across Europe, China, and the USA.



Application on Land Use/ Land cover Change and Surface Water Quality

Objectives Of The Study



LU & LULCC Analysis

- LULCC between **1990** and **2018** in Italy.
- Baseline for **future LULC projections** and policy recommendations.
- **High-resolution LULC maps** for SSP-RCP scenarios

LULC Influence On SWES

- Influence of **upstream LULC** on downstream water quality.
- Likelihood of achieving a **good SWES** under different future **SSP-RCP scenarios**.

Overall methodology

INPUTS



MODELS



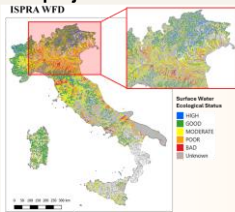
OUTPUTS



LULC baseline



Low resolution LULC projections

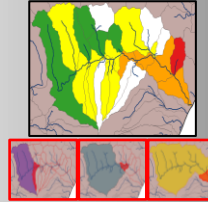


River network

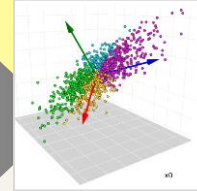
'TOP-UP' and 'CLOSEST PIXELS'



High resolution LULC projections



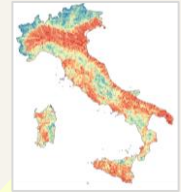
'Source-to-sink' analysis



Principal Components Analysis



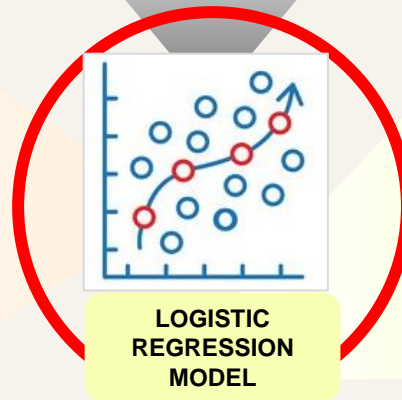
LULCC analysis



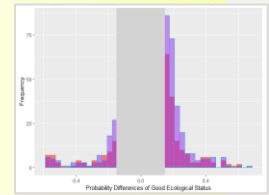
Good SWES probability



Surface Water Ecological Status

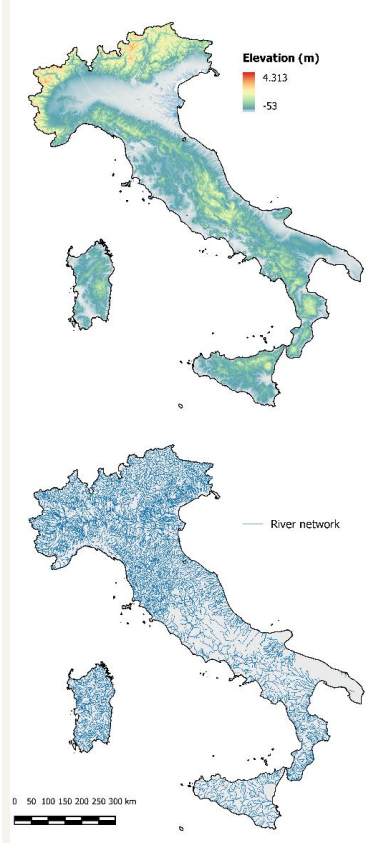


LOGISTIC REGRESSION MODEL



Statistics

Case Study Area



Location

47°50'29" N to 35°47'00" N

Lat.

6°32'05" E to 18°31'01" E

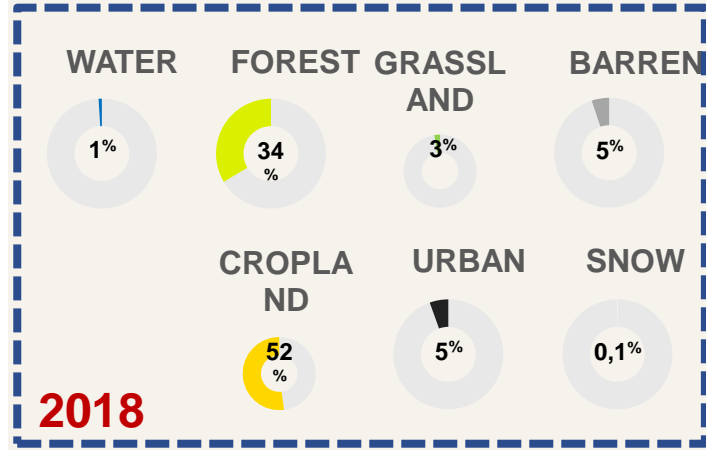
Lon.

Coastline

7,375.3 km

Total area

302,073 km²



Case Study Data

Unravelling the Interplay Between Land Use Change and Surface Water Quality in Italian Watersheds

1

Land Cover (CORINE)

Spat. Domain: Europe
Spat. Res.: 100 m * 100 m
Time Frame: 1990 – 2018
Format: Vector/Raster

2

LULC projections (Chen, 2022)

Spat. Domain: Global
Spat. Res.: 1 km * 1 km
Time Frame: 2015 – 2100
Format: Raster

3

River Network (GISCO)

Spat. Domain: Europe
Spat. Res.: 1 arc-second
Time Frame: - - -
Format: Shapefile

4

Watershed (GISCO)

Spat. Domain: Europe
Spat. Res.: 1 arc-second
Time Frame: - - -
Format: Shapefile

6

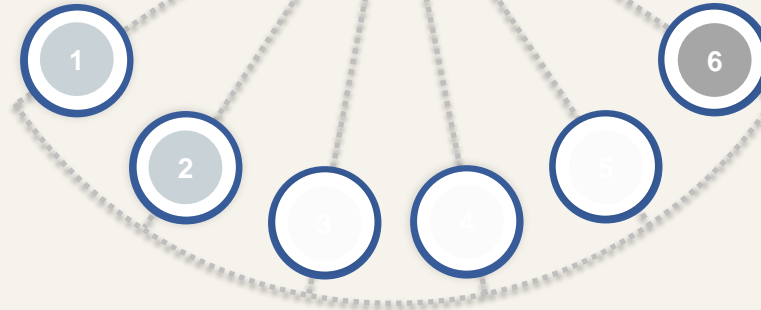
Water Quality WFD (ISPRA)

Spat. Domain: Italy
Spat. Res.: - - -
Time Frame: 2010 – 2016
Format: Vector/Raster

5

Watershed (HydroSHEED)

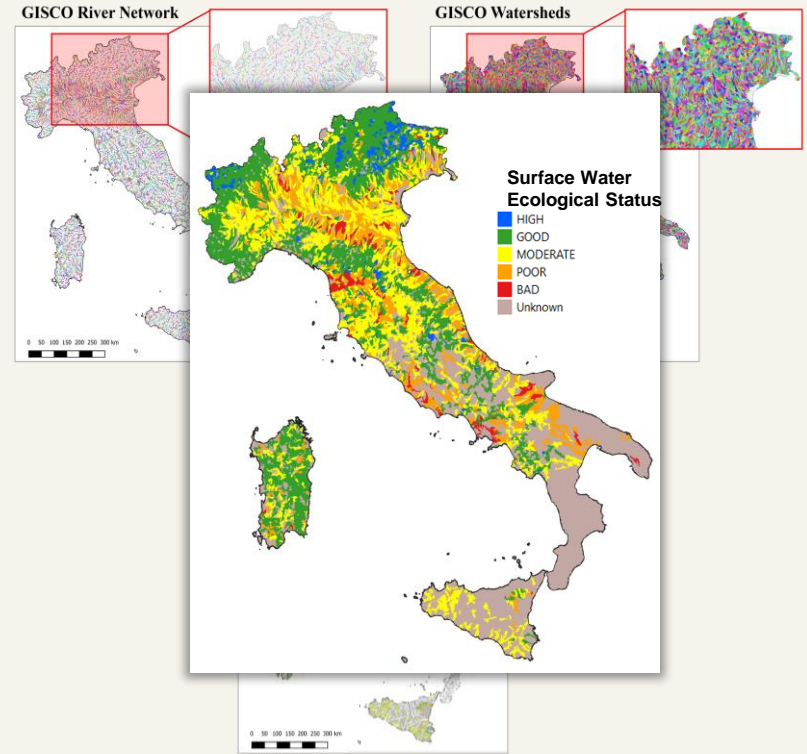
Spat. Domain: Global
Spat. Res.: 15 arc-second
Time Frame: - - -
Format: Shapefile



Surface Water Ecological Status

Water Frame Directive

- 1 High Status:** Near-natural, undisturbed conditions. Physio-chemical elements within pristine ranges.
Full ecosystem functionality
- 2 Good Status:** Some deviation from undisturbed conditions, physio-chemical elements still support ecosystem health. Nutrient levels higher than in pristine conditions.
Ecosystem remains functional
- 3 Moderate Status:** Clear anthropogenic influence. While physio-chemical conditions support ecosystem functioning, they reflect more disturbance.
Suboptimal ecosystem health
- 4 Poor Status:** Significant alterations from natural conditions. Physio-chemical elements are outside the ranges necessary for a healthy ecosystem.
Ecosystem degradation
- 5 Bad Status:** Physio-chemical elements are at extreme, unnatural levels.
Ecosystem collapse and a near-total loss of biodiversity and ecological function



Land Use Land Cover

Layers Harmonization

1. CORINE Land Cover

Standardized framework for LULC analysis across Europe

Nomenclature:

- Level 1: 5 broad-level categories
- Level 2: 15 sub-level categories
- Level 3: 44 detailed thematic classes

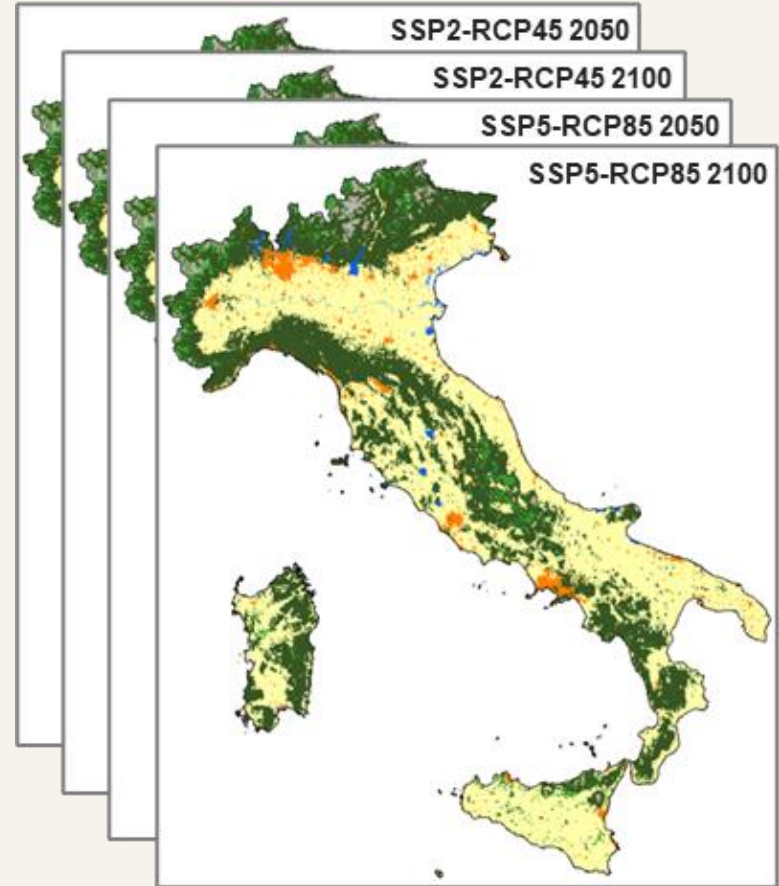
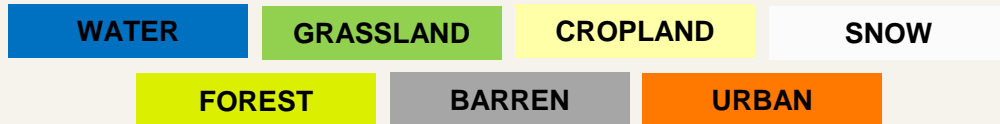
2. ESA Climate Change Initiative (CCI)

Land use framework of the European Space Agency, used by Chen et al. (2022)

Nomenclature:

- 22 thematic classes

→ **Harmonization**: 7 macro-categories



Results - Land Use Land Cover Change Analysis

“Analysis of variations in how land is utilized or covered by different human or natural activities over time, aimed at understanding the ecological, socio-economic, and environmental dynamics affecting the landscape.”

Accumulated Changes Map

Frequency and intensity of land cover transitions at the pixel level

- number of changes each pixel experienced (a)
- number of pixel changes per watershed (b)

Net/Gross Changes

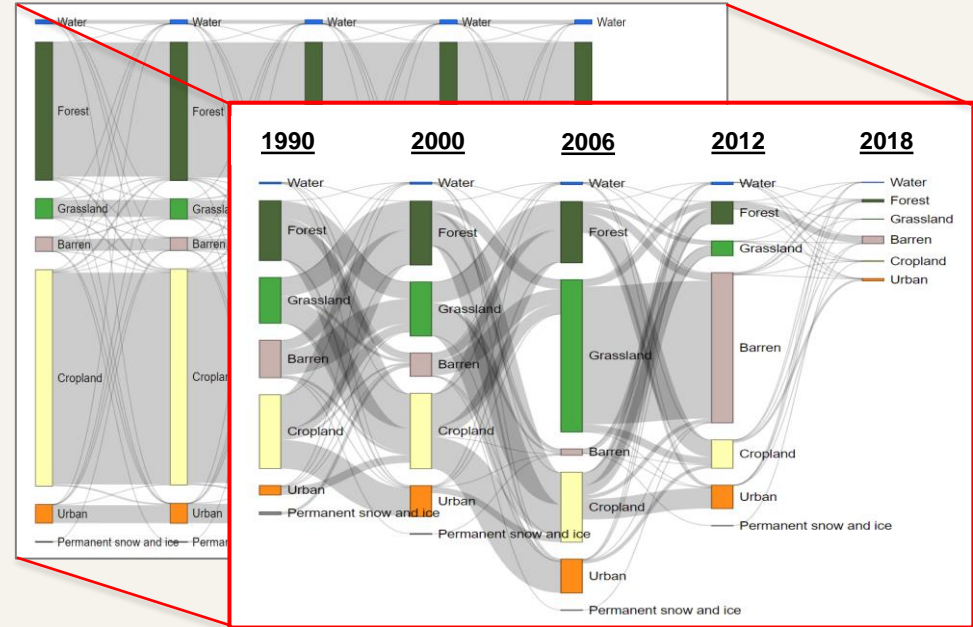
- Gross Gains (GG): total area added to a category
- Gross Losses (GL): total area subtracted from a category
- Net Change (NC): difference between GG and GL

Intensity Analysis – Category level

How size and intensity of GG and GL in each category vary across categories for each time interval

Sankey Land

Net flow of LU area transitions between different LULC categories



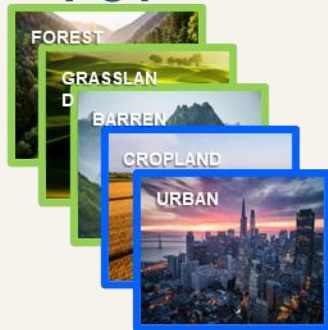
Results - Principal Component Analysis

Reduces dataset dimensionality while retaining the most significant variability.

→ **Principal Component (PC)**: linear combination of the original variables

	PC1	PC2	PC3	PC4	PC5
ED_2	0,14	0,04	-0,25	0,01	-0,07
ED_3	0,20	0,07	0,07	0,14	0,45
ED_4	0,21	-0,03	0,30	-0,04	-0,08
ED_6	-0,17	0,29	0,10	-0,23	0,11
LPI_2	0,22	-0,01	-0,29	-0,19	-0,06
LPI_4	0,15	-0,11	0,43	-0,10	-0,13
LPI_5	-0,27	-0,07	0,06	0,26	0,02
LPI_6	-0,13	0,27	0,11	-0,34	0,14
PLAND_2	0,24	0,02	-0,33	-0,15	-0,09
PLAND_3	0,17	0,06	0,07	0,14	0,44
PLAND_4	0,18	-0,09	0,43	-0,08	-0,14
PLAND_5	-0,28	-0,03	0,03	0,25	0,01
PLAND_6	-0,15	0,31	0,13	-0,32	0,14
AREA_MN_2	0,17	0,08	-0,06	-0,06	-0,19
AREA_MN_4	0,13	-0,02	0,36	-0,02	-0,22
AREA_MN_5	-0,13	-0,03	0,09	0,30	-0,03
AREA_MN_6	-0,06	0,33	0,08	-0,13	-0,02
DIVISION_3	0,22	0,18	0,03	0,24	0,09
DIVISION_4	0,21	0,16	0,04	0,17	-0,11
DIVISION_5	0,20	0,23	-0,15	-0,12	-0,13
DIVISION_6	-0,09	0,35	-0,03	0,19	-0,20
UII_2	0,21	0,21	0,05	0,00	0,09
UII_5	-0,08	0,25	0,03	0,17	-0,09
PD_3	0,17	0,03	-0,02	0,08	0,44
PD_6	-0,18	0,15	0,08	-0,17	0,12
AI_2	0,20	0,10	-0,15	0,02	-0,16
AI_3	0,22	0,18	0,05	0,25	0,11
AI_4	0,23	0,13	0,15	0,14	-0,13
AI_5	-0,13	0,18	-0,06	0,26	-0,13
AI_6	-0,10	0,38	-0,01	0,15	-0,18

PC1

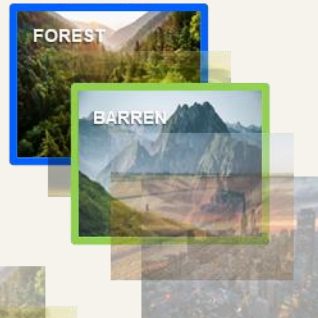


Proportion of Variance:
0,324

- 1 = WATER
- 2 = FOREST
- 3 = GRASSLAND
- 4 = BARREN
- 5 = CROPLAND
- 6 = URBAN
- 7 = SNOW

Positive loading
 Negative loading

PC3



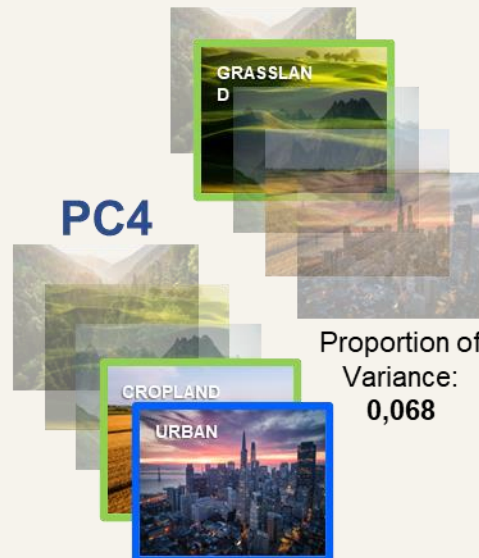
Proportion of Variance:
0,985

PC2



Proportion of Variance:
0,126

PC5



Proportion of Variance:
0,087

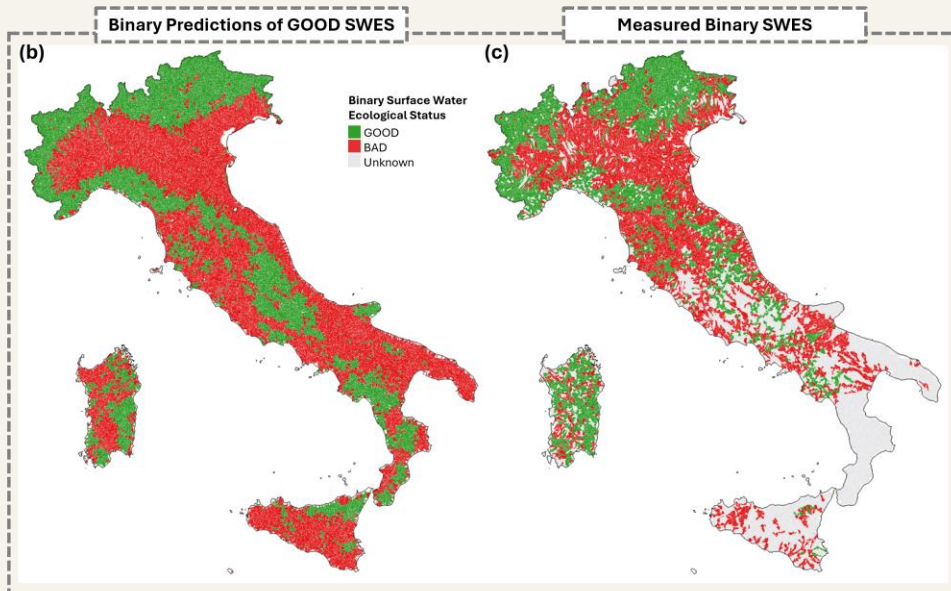
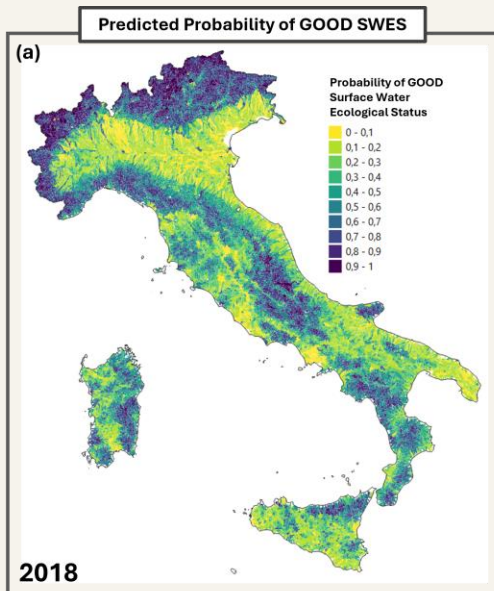
Proportion of Variance:
0,068

Results - Regression Model and SWES Predictions

Binary Logistic Regression (BLR)

Predicted Probability of GOOD SWES $> 0,5 \rightarrow 1 = \text{GOOD}$

Predicted Probability of GOOD SWES $\leq 0,5 \rightarrow 0 = \text{NOT GOOD}$



Measured 2018 (c):

- 28.31% 'good' SWES
- 38.89% 'not-good' SWES
- 32.81% Unknown

Predictions 2018 (b):

- 37.87% 'good' SWES
- 62.13% 'not-good' SWES

MC-CV: 89.54%

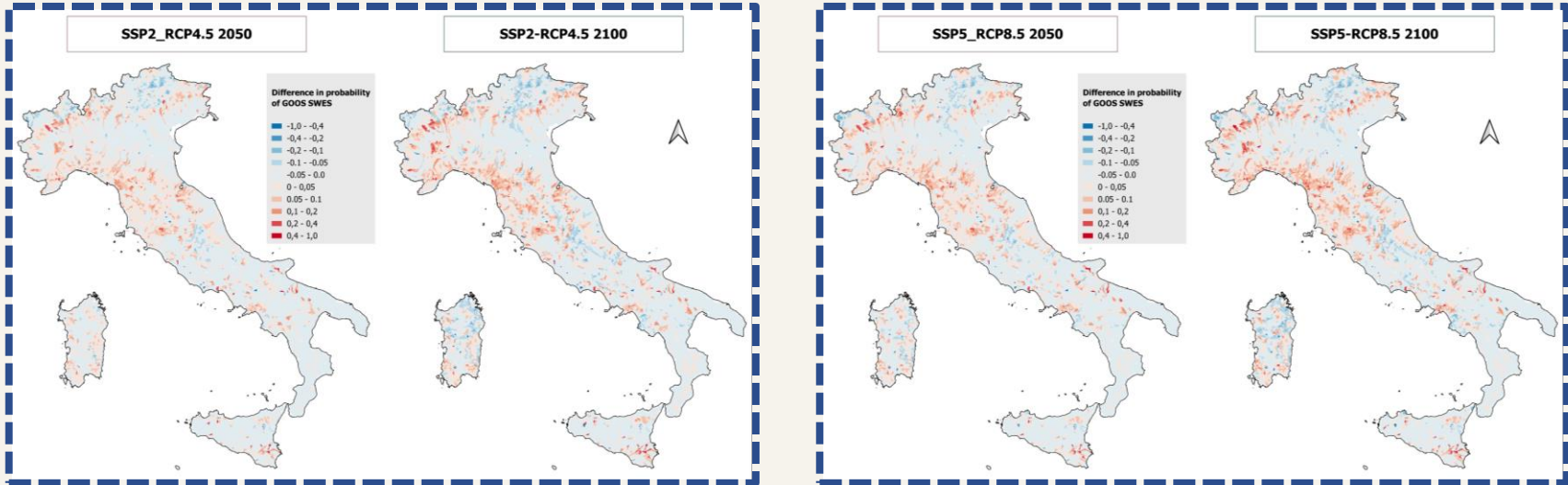
H&L: p-value 0.3949

Results - Water Quality Predictions for Future Scenarios

Differences In Probability Of Good Ecological Status

→ $\text{Probability Good SWES}_{2018} - \text{Probability Good SWES}_{\text{SSP-RCP}}$

- **Negative values** indicate that the probability of achieving good ecological status in 2018 was lower compared to that calculated for the respective SSP-RCP scenario → **INCREASE in water quality !!!**
- **Positive values** indicate that the probability of achieving good ecological status in 2018 was higher compared to that calculated for the respective SSP-RCP scenario → **DECREASE in water quality !!!**



Conclusions & Recommendations

- **Upstream-Downstream Dynamics:** Understanding upstream land use's influence on downstream water quality is critical for predicting surface water ecological status.
- **Conservation & Restoration:** Preserving and restoring natural areas is crucial for enhancing water quality across Italy.
- **SWES Projections:** In 2018, over 60% of Italian watersheds were predicted to fail in achieving good SWES. This percentage slightly increases under future SSP2-RCP4.5 and SSP5-RCP8.5 scenarios.
- **Hotspot Identification:** While significant changes are limited, the method identifies specific hotspots of improvement or decline in water quality, guiding targeted interventions in land use management and policy.

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5th International Workshop on High Temporal Resolution Water Quality Monitoring and Analysis

**The James Hutton Institute, Aberdeen, Scotland
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The EGU General Assembly welcomed 20,979 registered attendees, of which 18,388 made their way to Vienna from 118 countries and 2,591 joined online from 108 countries. It was a great success with 16,894 presentations given in 1,044 sessions. Thanks, 17% of the abstracts were identified as contributions from Earth Career Scientists (ECS).

We thank all of you very much for your attendance and your active contribution to this great event and we look very much forward to keep in touch any time that EGU will share throughout the year. Check out our recorded sessions for on-demand viewing. Take care.

See you in Vienna & online 2025!

The EGU General Assembly resumes at the ACP in Vienna & online on EGU25, 27 April-2 May 2025. Don't miss the regular social media updates of EGU for the start of the organization in summer 2024 with the public call for session proposals.

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WHAT'S NEXT FOR SCIENCE

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ICR Annual Meeting

ICR Annual Meeting
28 September - 02 October 2024
University of Exeter - Earth & Planetary Sciences, Department of Applied
Climate Science (EAS), Exeter

The first Annual Meeting of the Institute for Climate Resilience will be held in Exeter, from September 28th to October 2nd, 2024.

SETAC Asia-Pacific Biennial Meeting

SETAC Asia-Pacific 14th Biennial Meeting

21 - 25 September 2024 • Melbourne
Taglio, China

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Project dissemination

Conference

A comprehensive analysis of land use and climate change impacts on water quality in Italian river basins

Olinda Rufo^{a,b}, Samuele Casagrande^{a,b}, Hung Vuong Pham^{a,b}, Andrea Critto^{a,b}

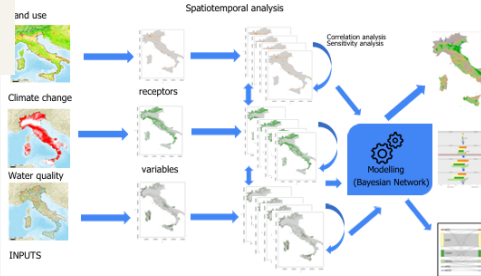
^a University Ca' Foscari Venice, Via Torino 155, 30172 Venezia-Mestre, Venice, Italy; ^b Euro-Mediterranean Center on Climate Change (CMCC), via Augusto Imperatore 16, 73100 Lecce,



[1] ABSTRACT

The degradation of water quality is exacerbated by climate change and land-use/land-cover change (LULCC), which disrupt key processes regulating river flows and runoff. The complex interactions among LULCC and CC have significant impacts on nutrients, pollution concentrations, and sedimentation rates in freshwater ecosystems. This research aims to analyze the dynamics and impacts of LULCC and climate-induced changes on water quality at the river basin scale in Italy, supporting the achievement of good chemical and ecological status of the Water Framework Directive. This study analysis allows the identification of linkages and dependencies between LULCC indicators and their relationships with water quality parameters in each river basin. Additionally, our study examines historical patterns of climate change indicators and their correlation with water quality over time by investigating the compound effects of climate change and the occurrence of extreme events, which are linked to changes in nutrient and pollutant levels. The research activities are mainly composed of three distinct phases. In the first phase, the analysis uses geoinformation system (GIS) techniques to identify sensitivity and changes at the pixel level within different land use types. Then finally the use of machine-learning model is developed to understand and predicting the complex interplay of multiple k factors such as the combined effects of land-use change, climate variability, and other anthropogenic influences water quality.

[2] METHOD



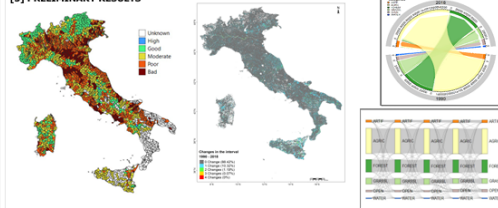
The analysis involves three groups (LULCC, WQ and WQ). Firstly, establishing a list of variable that represent the effects of water quality. For land use, most relevant receptors (e.g., urban, agriculture) and their indicators are calculated to quantify the changes over time. CC metrics are used to track changes over time and correlate trends with water quality data. This vast amount of information is generated to fit to probabilistic model or machine learning to predict future water quality in Italy according to the (WFD). The results of the analysis of the designed aims to support for spatial land planning against water quality deterioration, facilitating more effective and reliable decision-making.

[3] CASE STUDY



Italy, has a varied topography ranging from the Alps in the north to the Mediterranean coast in the south.

[5] PRELIMINARY RESULTS



The landscape in Italy from 1990 to 2018 has experienced significant changes especially between 2000 and 2012. In this period a decrease in artificial, grassland, forest, and agricultural areas were most common. Anthropogenic land-use changes contributed to the increase of highways, landfills, quarries, and urban areas. These changes poorly altered the water quality in rivers close to heavily modified lands, while rivers in the Alps and Apennines, where human influence is less due to land abandonment and rural depopulation, show better quality. Despite limited data on water quality, the results suggest better water quality in these regions.

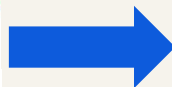
Acknowledgements

This study was funded by the European Union - NextGenerationEU, in the framework of the GRINS - Growing Resilient, Inclusive and Sustainable project (GRINS P10100012 - CUP I17C2200000001). The views and opinions expressed are solely those of authors and do not necessarily reflect those of the European Union, nor can the European Union be held responsible for them.



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Poster



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5th International Workshop on
High Temporal Resolution Water Quality
Monitoring and Analysis

The James Hutton Institute, Aberdeen, Scotland
17th-19th of June 2024
2nd Circular

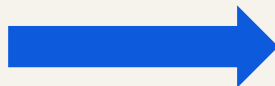
Extended abstract submission deadline: 30th April 2024

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Oral
presentation



Multi-Risk Dynamics of Water Quality under Climate Change and Anthropogenic Pressures: An AI Approach Across Spatial Scales

Authors:

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Abstract

Water quality serves as a critical determinant of ecosystem health and directly impacts water-use sectors like agriculture and public health. However, the synergistic interactions between extreme climate events and anthropogenic activities can significantly alter water quality dynamics. Furthermore, these impacts are likely to be exacerbated within the context of ongoing climate change and socio-economic development. Our work aims at understanding the multi-risk dynamics for water quality at different spatial scales in Italy (Adige river basin, Veneto Region, and national level) respectively in three different projects ([INEST](#), [Myriad-EU](#), and [GRINS](#)). This is achieved by leveraging heterogeneous data at different spatial and temporal scales, e.g. climate data, land-use data, and in-situ water quality measurements by using machine learning techniques and spatio-temporal Bayesian network models. Through the development of water quality multi-risk models, we explore the synergistic impacts of climate extreme events and anthropogenic pressures on physicochemical water quality parameters (i.e. nutrients, suspended solids, DO, temperature), and other key elements (i.e., biological, chemical, overall ecological status), considering also specific vulnerabilities and exposures of river networks and basins. Land-use and climate change impacts on water quality are analyzed in GRINS and MYRIAD-EU at the national and regional scales, respectively. MYRIAD-EU explores the interaction of multiple hazards (i.e., compound hot-dry and wet-dry events) using machine learning techniques, while GRINS focuses mainly on characterizing the effect of in land use/land cover changes with the Bayesian network model. Moreover, INEST focuses on the nexus between water quality indicators and the multiple water-dependent sectors (i.e. food and energy production). These approaches are being developed as potential tools to complement in-situ measurements with additional data sources (e.g. climate, land-use, etc.) for a better understanding of the multi-risk dynamics of water quality at various spatial scales and temporal horizons.

Conference



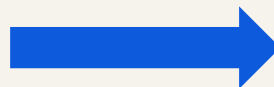
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SETAC Asia-Pacific 14th Biennial Meeting

21 - 25 September 2024 + Add to calendar
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Oral presentation



An Artificial Intelligence Approach for Multi-Risk Dynamics of Water Quality Under Anthropogenic Pressures and Climate Change

Authors:

Andrea Critto^{3,1}, Diep Ngoc Nguyen^{3,1}, Olinda Rufo^{3,1}, Mathilda Vogt³, Samuele Casagrande³, Jacopo Furlanetto^{1,3,2}, Hung Vuong Pham^{3,1}, Anna Sperotto^{3,1,4}, Silvia Torresan^{1,3,2}

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Abstract

Water quality serves as a critical determinant of ecosystem health and directly impacts water-use sectors like agriculture and public health. However, the synergistic interactions between extreme climate events and anthropogenic activities can significantly alter water quality dynamics. Furthermore, these impacts are likely to be exacerbated within the context of ongoing climate change and socio-economic development. The main aim of this work is to understand the multi-risk dynamics for water quality by leveraging heterogeneous data at different spatial and temporal scales, e.g. climate data, land-use data, and in-situ water quality measurements by using machine learning techniques and spatio-temporal Bayesian network models. Water quality multi-risk models are developed to explore the synergistic impacts of climate extreme events and anthropogenic pressures on physicochemical water quality parameters (i.e. nutrients, suspended solids, DO, temperature), and other key elements (i.e., biological, chemical, overall ecological status), considering also specific vulnerabilities and exposures of river networks and basins, including the nexus between water quality indicators and the multiple water-dependent sectors (i.e. food and energy production). Land-use and climate change impacts on water quality are analyzed at different spatial scales in Italy (Adige river basin, Veneto Region, and national level) respectively in three different projects (iNEST, Myriad-EU, and GRINS). These approaches are being developed as potential tools to complement in-situ measurements with additional data sources (e.g. climate, land-use, etc.) for a better understanding of the multi-risk dynamics of water quality at various spatial scales and temporal horizons.



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Conference

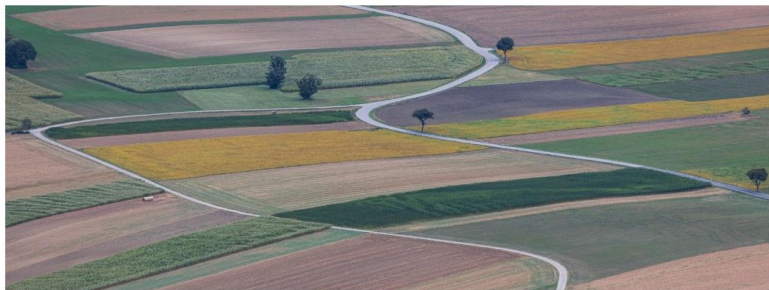


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ICR Annual Meeting

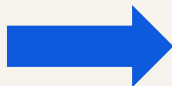
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ICR Annual Meeting
30 September- 02 October, 2024
University of Sassari – Aula Magna Barbieri, Dipartimento di Agraria
Viale Italia 39A, Sassari.



The first Annual Meeting of the [Institute for Climate Resilience](https://www.institute-for-climate-resilience.eu/) will be held in Sassari, from September 30th to October 2nd, 2024.

Poster



Multi-Risk Dynamics of Water Quality under Climate Change and Anthropogenic Pressures: An AI Approach Across Spatial Scales

Hung Vuong Pham^{1,3}, Jacopo Furlanetto^{1,3,2}, Diep Ngoc Nguyen^{1,3,2}, Olinda Rufo^{1,3}, Samuele Casagrande², Silvia Torresan^{1,3,2}, Andrea Critto^{1,3}

1- CMCC Foundation - Euro-Mediterranean Center on Climate Change, Italy, Venice; 2- National Biodiversity Future Center (NBFC), Palermo, Italy; 3- Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice, Venice, Italy

ICR meeting - Sassari, 2024

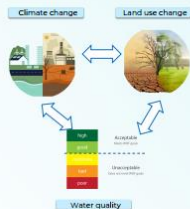
Abstract

Water quality serves as a critical determinant of ecosystem health and directly impacts water-use sectors like agriculture and public health. However, the synergistic interactions between extreme climate events and anthropogenic activities can significantly alter water quality dynamics. Our work aims to understand the multi-risk dynamics for water quality at different spatial scales in Italy (large river basin, Veneto Region, and national level) in two projects (Myriad-EU and GAINS). This is achieved by leveraging heterogeneous data at different spatial and temporal scales, e.g. climate data, land-use data, and in-situ water quality measurements by using machine learning techniques and spatio-temporal Bayesian network models. Myriad-EU explores the interaction of multiple hazards like compound hot-dry and wet-dry events using machine learning techniques, while GAINS focuses mainly on characterizing the effect of land use/land cover changes with the Bayesian network model. These approaches are being developed as potential tools to complement in-situ measurements with additional data sources (e.g., climate, land use, etc.) for a better understanding of the multi-risk dynamics of water quality at various spatial scales and temporal horizons.

Introduction

Understanding the cumulative impacts of single and compound natural hazards, land use & population dynamics, and climate change is crucial for effective management of river water quality.

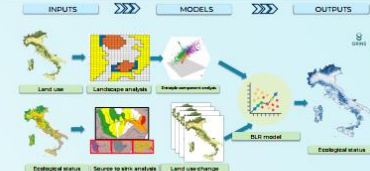
ORINS: funded by the European Union - NextGenerationEU will develop ANIELA - an On-Demand Platform giving access to high quality data and instruments for data analysis for a wide range of applications



Unravel the nexus between climate change, land use/land cover change, and water quality.

Myriad-EU: catalyzes a paradigm shift in how risks are currently assessed and managed by co-developing the first harmonized framework for multi-hazard, multi-sector, and systemic risk management

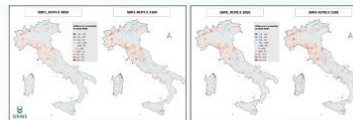
Methodology



Various methods (i.e., Binomial Logistic Regression, Random Forests) were developed for different scales.

Results

Preliminary results at different scales.



Projection of water quality under different socio-economic and climate change scenarios.



References

Biu, H., Meng, W., Zhang, Y., & Wan, J. (2014). Relationships between land use patterns and water quality in the Taih River basin, China. *Ecological indicators*, 41, 187-197. <https://doi.org/10.1016/j.ecolind.2013.08.002>
Black, O., Hagozi, D. K., & Townsend, C. R. (2004). Scale-dependence of land use effects on water quality of streams in agricultural catchments. *Environmental Pollution*, 105(3), 317-328. <https://doi.org/10.1016/j.envpol.2003.10.018>

Conclusion

- Water Quality is a complex problem, branching into different sectors that must be considered.
- A Multi-Hazard approach can provide meaningful insights into this complexity, boosting the system understanding and aiding adaptation strategies to future changes.
- Various spatial and temporal scales of analysis allow for different insights into the water quality problem.
- Each scale comes with relative constraints and advantages.
- Water Quality dynamics can have quick time dynamics, thus, need for high temporal and spatial resolution data.
- In this perspective, properly trained machine learning algorithms can:
 - Prove valuable in areas where such data are not available.
 - Integrate heterogeneous data from multiple sources and sectors.

Acknowledgements

This study was funded by the European Union - NextGenerationEU, in the framework of the GAINS - Growing Resilient, Inclusive and Sustainable project (GAINS PI00000001) - CUP H19C22000000001, National Recovery and Resilience Plan (NRRP) - Mission 4, C2I intervention 1.5. The Myriad-EU project has received funding from the European Union's Horizon 2020 research and innovation programme call H2020-LCIA-2019-2020 under grant agreement number 101001276.

Conference

AGU24
Washington, D.C. | 9-13 December 2024

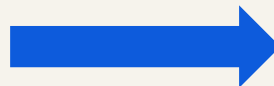
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AGU24

Washington, D.C. | 9-13 December 2024

WHAT'S NEXT FOR SCIENCE

Poster presentation



From land use to water quality: implications of historical changes and future scenarios in Italian watersheds

Olinda Rufo^{a,b}, Samuele Casagrande^{a,b}, Hung Vuong Pham^{a,b}, Andrea Critto^{a,b},

The sustainability of freshwater availability and quality is seriously threatened by climate change (CC) and land-use/land-cover change (LULC). On the other hand, extreme weather and climate-related events depend strongly on LULC. Multiple evidence suggests that rapid global development is the main driving factor altering all the fundamental processes that control the hydrologic cycle and temporal and spatial variations of river basins. Moreover, the interaction between the upstream and downstream of a basin significantly impacts the overall status of the basin. Understanding the “source-to-sink” effect is crucial for managing water quality in river basins. This study aims to understand historical trends of land use changes from 1990 to 2018 in Italy and their impacts on water quality, providing a baseline model for predicting the probability of achieving good ecological status for each watershed under different Shared Socioeconomic Pathways (i.e., SSP2 and SSP5) and Representative Concentration Pathway (i.e., RCP4.5 and RCP8.5) for mid- and long-term timeframe. To achieve this bold objective, this study integrates Principal Component Analysis (PCA) and several regression models to explore the influence of various landscape metrics on the ecological status of each watershed, taking into account the effect of changes in land use from upstream watersheds to downstream ones. The outcomes reveal that conserving natural areas is essential for improving water quality across the territory. However, conservation efforts alone are insufficient without restoring places that were natural previously but are now used for agriculture and urban development. The use of agricultural practices that foster the coexistence and interconnection between natural areas and cultivated zones could be an effective method for mitigating the damage caused by unsustainable farming practices. Future work will focus on integrating climate change variables, including single and compound effects, and spatio-temporal occurrence of extreme events, such as flood and drought hotspots. Moreover, advanced probabilistic models (e.g., Bayesian Network) will be employed to assess the possible interactions between LULC and CC and their impacts on water quality. The outcomes of this analysis contribute to developing adaptive strategies that safeguard water resources and ensure the long-term sustainability of freshwater ecosystems.

What's next?

Finalization of the Manuscript on the analysis of LULCC & WQ to be submitted to a peer-reviewed journal

01

Contact ISPRA to get the data on water quality in 2022 for a complete analysis with a temporal dimension

03

02

Proceed with the analysis of CC & WQ

04

Get in touch with Spoke 0 for the integration of data from the project's results and input data from different sources into the AMELIA platform.

Spatiotemporal analysis...

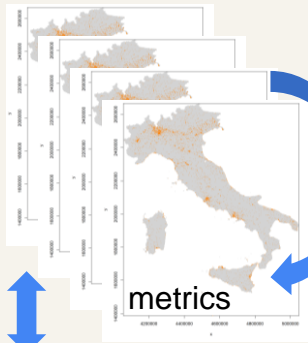
Correlation analysis
Sensitivity analysis
...



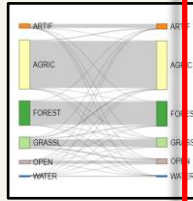
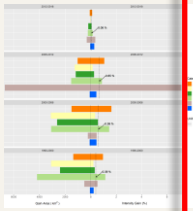
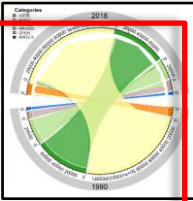
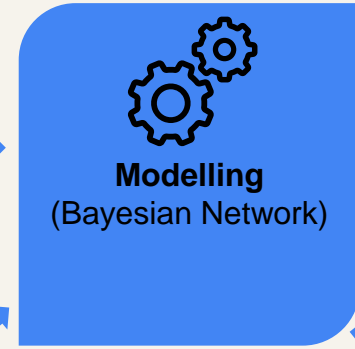
Land use



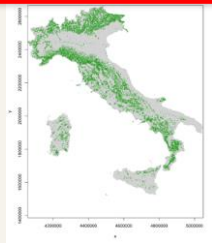
receptors



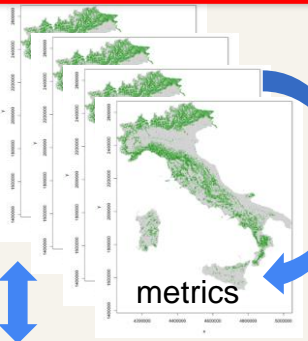
metrics



Climate change



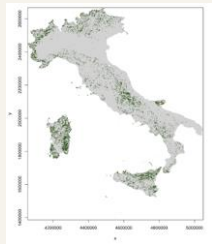
variables



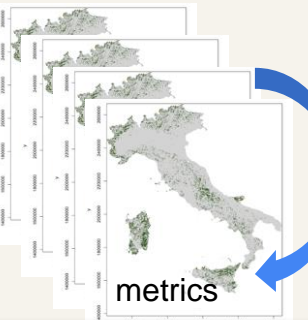
metrics



Water quality

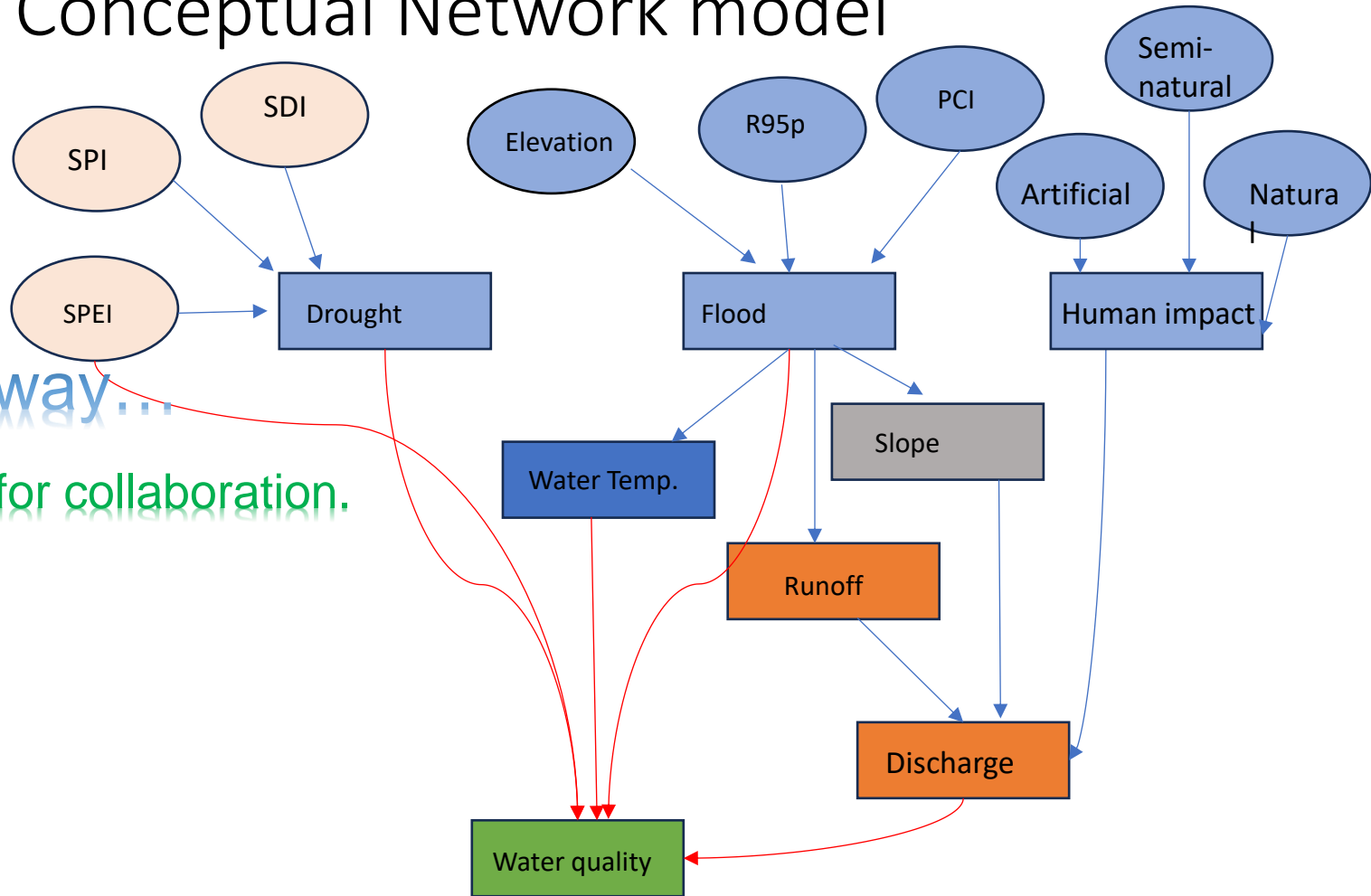


variables



metrics

Conceptual Network model



It is on the way...

We are looking for collaboration.

Thank you for your attention!

Contact: Vuong Pham (Vuong.pham@unive.it)

