JUNE 4, 2025

#EU GREEN WEEK

EU Green Week Partner Event

A Quantitative Framework for Assessing the WEFE Nexus: Indicator Harmonization and Policy Integration for Climate Resilience in the EU

Mohammed Assaf, Abdelrahman Habash, Vladimir Kitanovski, Nikolaos Mellios, Chrysaida-Aliki Papadopoulou, Milena Rajić, Virginia Rosa Coletta, Maria Vrachioli

THE WATER-ENERGY-FOOD NEXUS: BUILDING RESILIENCE TO GLOBAL CHALLENGES

NexusNet

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Challenges towards monitoring and modelling the nexus

- The nexus requires a clear definition and the identification of its trade-offs and synergies.

Awareness and understanding of the nexus

- Shaping regional policy is challenging due to differing national governance structures.

Governance and decision-making process

- A shared knowledge base or glossary is essential for common understanding.

Interdisciplinary project work

- The key challenge is prioritizing cross-border collaboration over national or regional limits.

Geographical application of the projects

- Integrated modeling faces challenges in scenario design, analysis, and interconnections.

Complexity of connecting the nexus components

- Data availability and accessibility are key challenges due to fragmented institutions and diverse management practices.

Data provision, availability, and sharing

- Strategic negotiation bridges industry and research, fosters dialogue, proves viability, and secures resources for stakeholder engagement.

Stakeholder engagement

Connect findings to policy trade-offs/synergies

1.Database Refinement

1. Review and consolidate collected WEFE-related databases.
2. Identify gaps in datasets for nexus quantification (e.g., water-energy trade-offs, food security).
3. Use collected databases to calculate interlinkages between WEFE dimensions.

2.Quantitative Analysis

1. Identify and quantify metrics/indicators to measure trade-offs and synergies across WEFE.
2. Use statistical/machine learning models to analyze interdependencies and spatial/temporal trends.

3.Policy Mapping

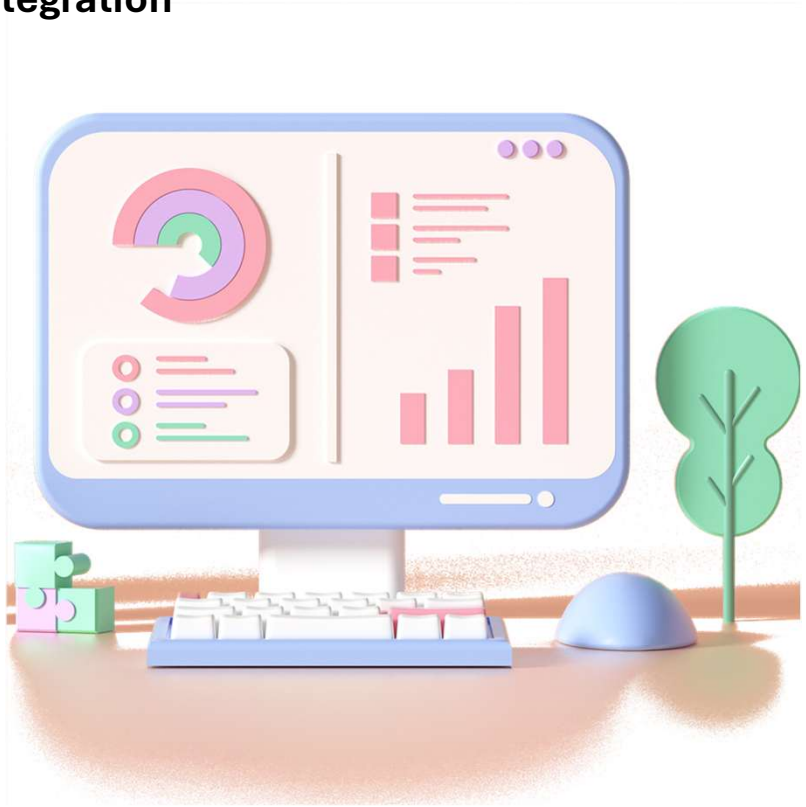
1.Policy mapping
2. Align quantified nexus findings with relevant policy frameworks.
3. Identify key synergies and trade-offs across policy domains (climate, agriculture, energy).

Datasets Analysis and Indicators Harmonization

From Data Discovery to Integration

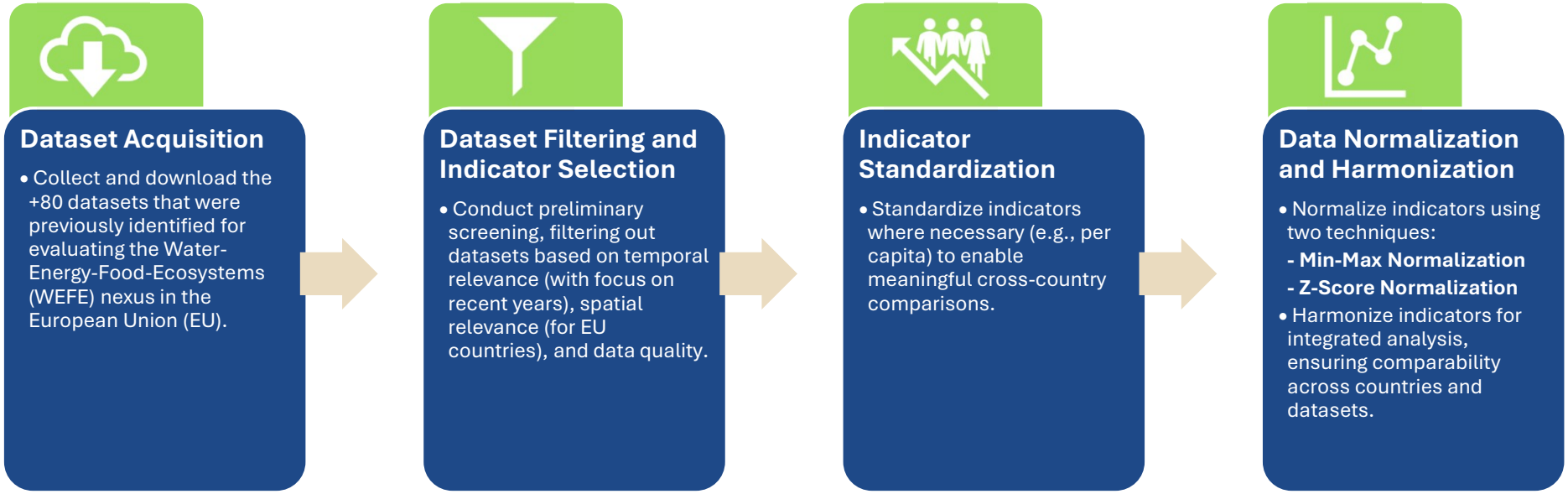
In the preliminary phase of this study, over 80 potential datasets were identified as critical sources for evaluating the Water-Energy-Food-Ecosystems (WEFE) nexus. These datasets, which encompass key metrics and indicators, form the foundational basis for the comprehensive analysis.

The current phase focuses on a rigorous and systematic refinement of these datasets, extracting its indicators, standardizing, normalizing, and harmonizing them through the following steps:



Datasets Analysis and Indicators Harmonization

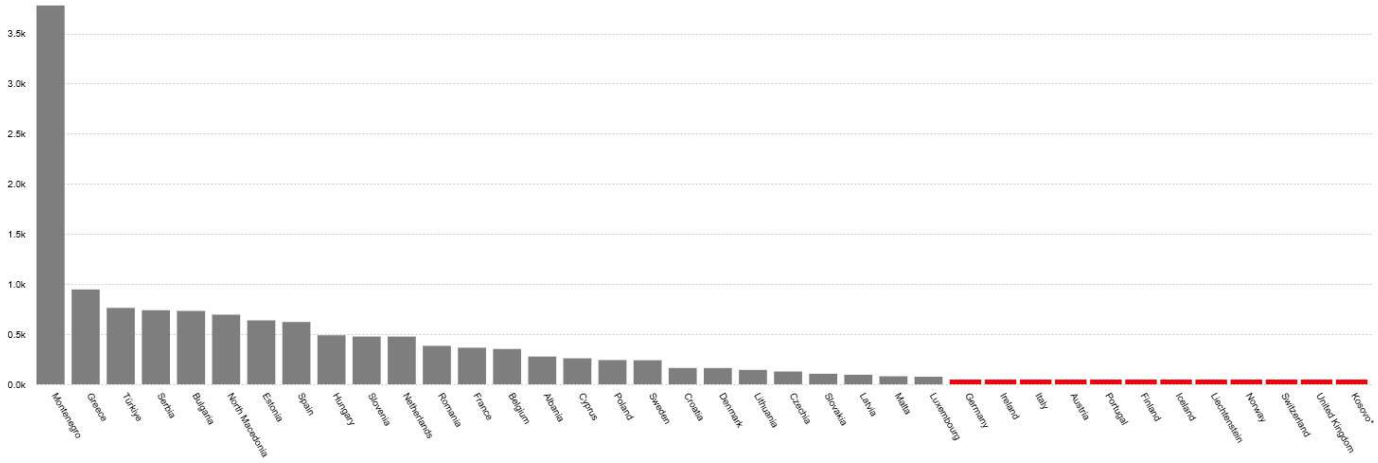
Methodology flowchart

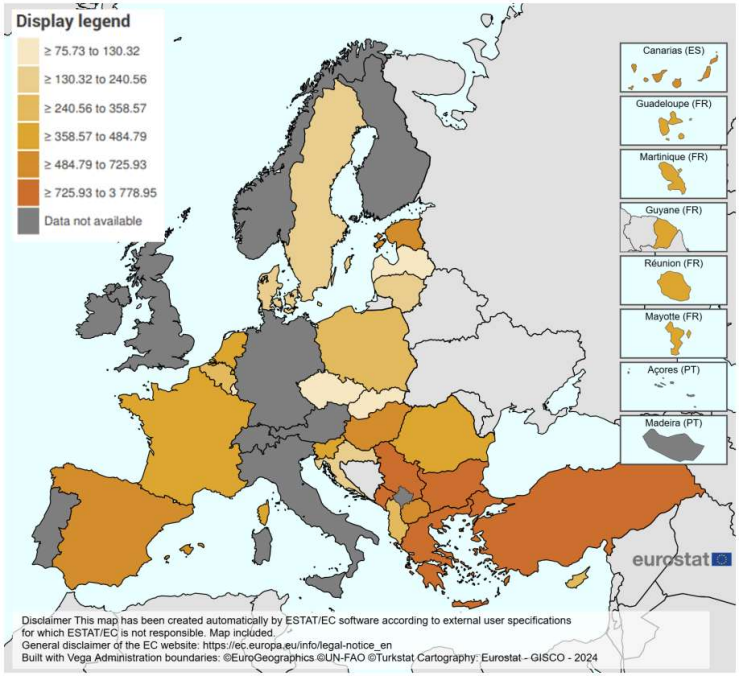


Datasets Analysis and Indicators Harmonization

Sample indicator visualization

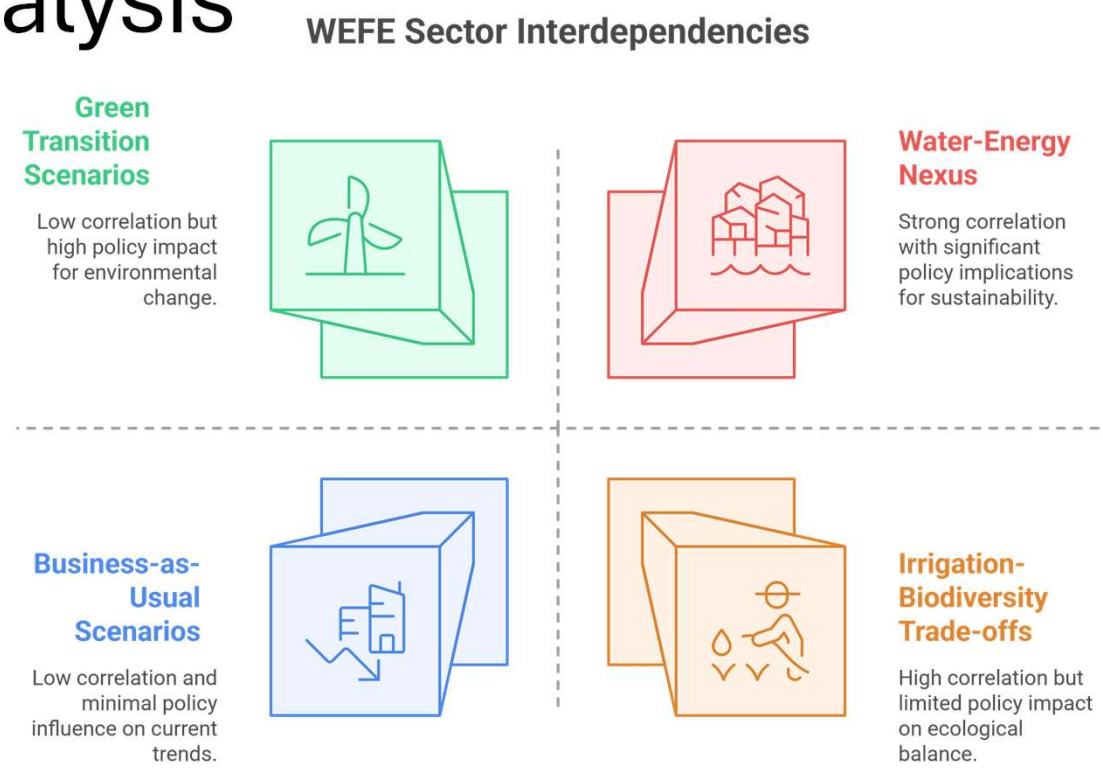
- Fresh water abstraction in 2020 for EU countries (m^3 per capita)



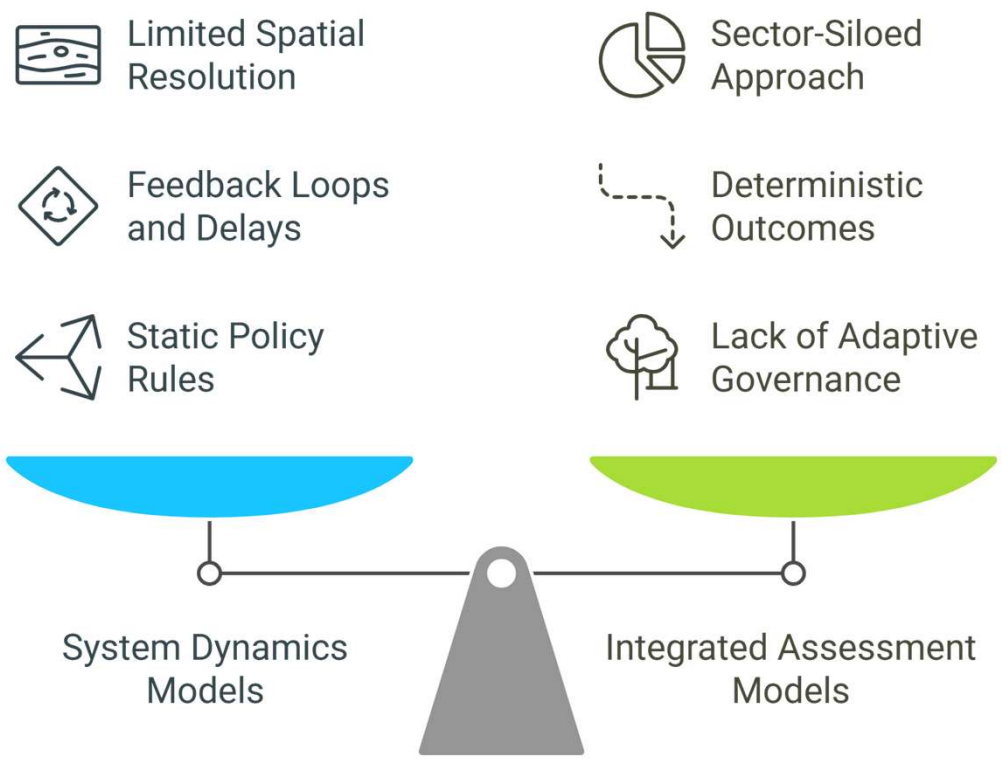


Quantifying Synergies: Methods for Interdependency Analysis

- Correlation Analysis
- Identification of statistical relationships between WEFE sectors
- Scenario Modelling
- Evaluation of sectoral performance under different policy/ climate scenarios



Challenges in Current WEFE Modelling Frameworks



- Reviewed Modelling Approaches:

System Dynamics Models (SDM)

Integrated Assessment Models (IAMs)

- Identified Gaps:

Weak cross-sectoral coupling

Models treat water, energy, food, ecosystems separately

Inadequate uncertainty representation

Especially under extreme events (e.g., drought, floods)

Limited policy responsiveness

Static policy rules; lack of adaptive governance features

Virtual Mobility on: Nexus Governance in EU – Water, Energy, Climate, Food/Agriculture, Land/Soil and Ecosystems sectors

- ✓ Grantee: Dr. Mohammed Assaf, Research Fellow, University of Pavia, Italy, mohammed.assaf@unipv.it
- ✓ Supervisor: Dr. Chrysaida-Aliki Papadopoulou, Senior Researcher, National Technical University of Athens, Greece, xpap@survey.ntua.gr

Nexus Governance in EU – Water, Energy, Climate, Food/Agriculture, Land/Soil and Ecosystems sectors

Creation of a database including policies governing the sectors of water, energy, climate, food/agriculture, land/soil and ecosystems at EU level (policy mapping). Conflicts, trade-offs and synergies will be explored and aligned with nexus interlinkages identified by NEXUSNET-WG1 members.

Working Plan

- ✓ Policy identification and collection
- ✓ Analysis of synergies, conflicts and trade-offs
- ✓ Alignment with physical interlinkages
- ✓ Reporting and scientific output

Interactions with previous activities

- ✓ Linkage of policy landscape to quantified interlinkages (data and indicators) – Data collection and analysis for Nexus quantification
- ✓ Linkage of policy landscape to modelled interlinkages – Advanced quantitative assessment of WEFE nexus interactions: metrics, synergies and trade-offs