Water-Energy-Food-Ecosystems Footprint

Developed by

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TRL

TRL1 → TRL5

Tested in

5 case studies

Thematic Area: WEFE Nexus, Policy, Informed decision making

Challenges

The WEFE Nexus Footprint was developed in response to mounting global pressures on natural resources caused by climate change, population growth, and unsustainable management practices. These pressures result in water scarcity, energy insecurity, food shortages, and ecosystem degradation — all of which threaten biodiversity, economic stability, and human well-being.

The WEFE Nexus Footprint addresses the need for an integrated, cross-sectoral decision-support tool that helps policymakers anticipate and manage trade-offs and synergies across water, energy, food, and ecosystems (WEFE).

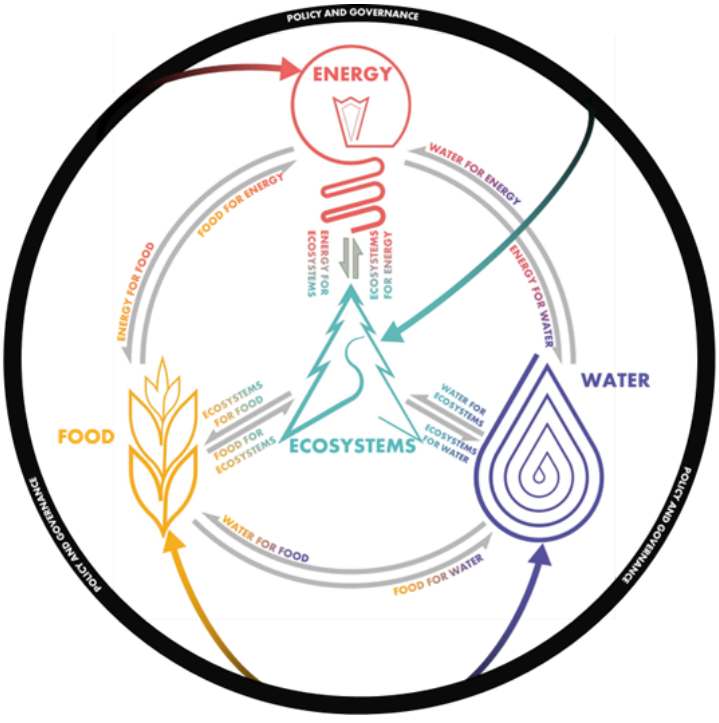
The WEFE Footprint

The WEFE Nexus Footprint is a composite indicator designed to assess and visualise the **interactions and trade-offs between water, energy, food, and ecosystems**. It provides a visualisation of the WEFE system's status at a particular point in time for a specific river basin for a particular modelling scenario. The footprint is a visual tool that supports policymakers, researchers, and decision-makers in identifying key issues and making **informed choices that benefit both society and the environment**.

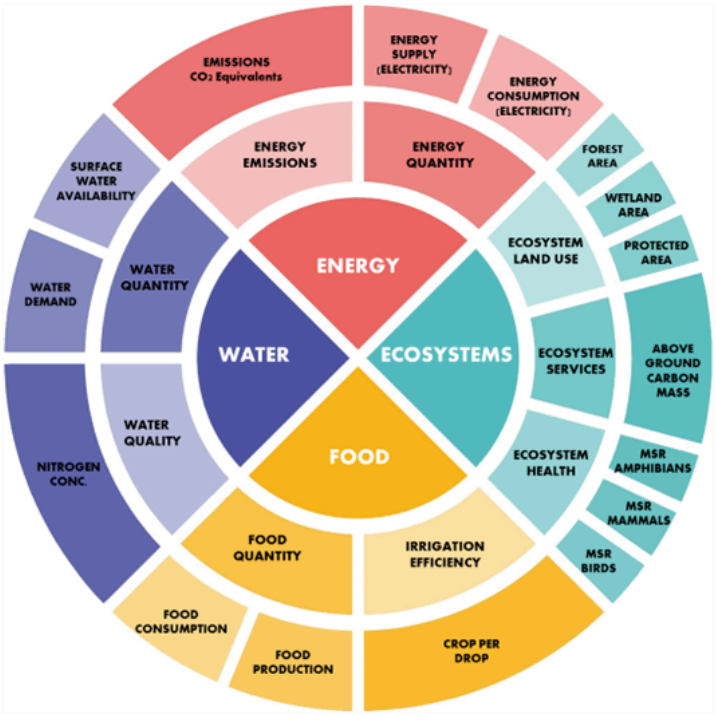
It is fully integrated into the NExus Policy Assessment Tool (NEPAT) and has been tested across five case study basins in Europe and Africa.

The Index consists of four pillars:

- **Water** (quantity [demand, availability], quality [nitrogen concentration])
- **Energy** (quantity, [supply, consumption], emissions [CO_2 equivalents])
- **Food** (quantity [production, consumption], irrigation efficiency [crop per drop])
- **Ecosystems** (land use [protected, wetlands, forests], health [mean species richness – birds, mammals, amphibians], services [above ground biomass])



Nexus Footprint pillars



Nexus Footprint sub-pillars

Methodology

The WEFE Footprint index value is calculated using **JRC-COIN's ten-step methodology**, 2019, as a basis. The data for each indicator is treated for outliers and normalised. The normalisation of each indicator is based on the distance from the Initial value of the indicator:

$$\tilde{x}_{I,n} = \frac{x_{I,n} - x_{I,0}}{\max(x_I) - \min(x_I)} * 100$$

where:

$\tilde{x}_{I,n}$: *Normalised value of indicator I in year n*

$x_{I,0}$: *Value of indicator I in year 0*

$x_{I,n}$: *Value of indicator I in year n*

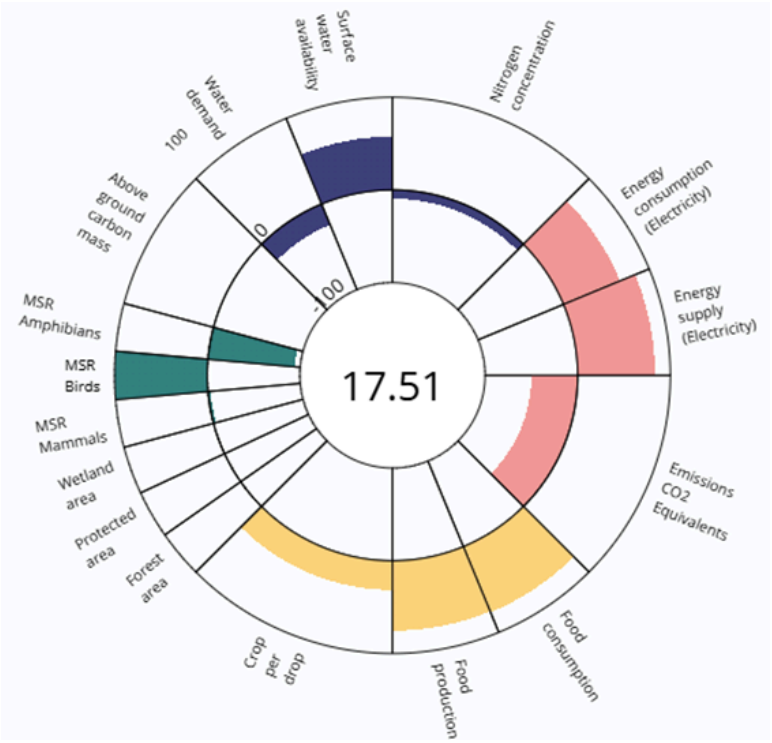
$\min(x_I)$: *Minimum value of indicator I for all reference and policy future scenarios*

$\max(x_I)$: *Maximum value of indicator I for all reference and policy future scenarios*

The weightings of each indicator are represented by the portion of the circle allocated to each indicator. Equal weighting was given to:

- each indicator within a sub-pillar,
- each sub-pillar within a pillar, and
- each pillar within the WEFE Index.

The indicators that were allocated a negative direction are indicated as red text. An arithmetic mean was used to aggregate the indicators. The resulting Index has a value between -100 and 100.



Nexus Footprint Index

The overall footprint index is shown in the centre of the footprint. The coloured bands for each indicator show the index value for each indicator.

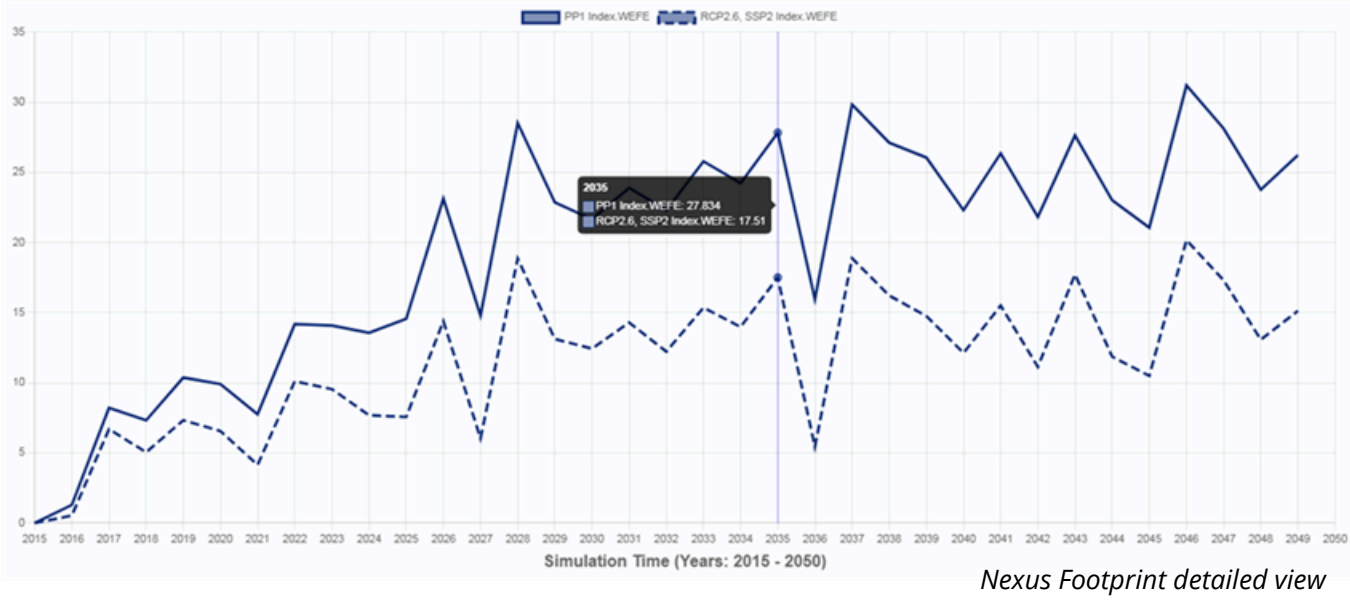
The index value will vary between -100 (centre of the circle) and 100 (outside of the circle), where 0 represents the index and associated indicator values at the start of modelling.

Negative values represent a deterioration and positive values represent an improvement in the nexus from the start of modelling.

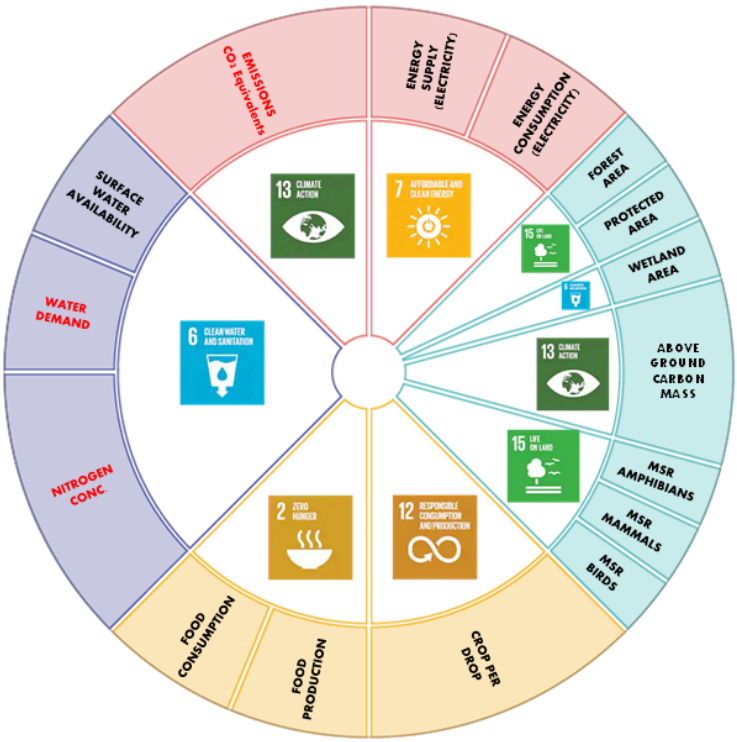
As can be seen in the figure to the left, the Mean Species Richness (MSR) of birds has improved, and the MSR of Amphibians has deteriorated.

Policy impacts on the WEFE Footprint

The impact of the policy packages on the WEFE Footprint, pillars, sub-pillars and indicator index value can be observed in the "Nexus Footprint Detailed View". The view compares reference scenario and policy future scenarios over time. In the example below the WEFE index is improving over time for both scenarios but the applied policy package (solid line) is showing a higher improvement than the selected base case (dashed line).



Nexus Footprint detailed view



WEFE Footprint and SDGs

WEFE Footprint and Sustainable Development Goals

The selected indicators can be linked to various Sustainable Development Goals (SDGs) as per the image on the left. The multi-disciplinary nature of NEXOGENESIS, the cross-sectoral stakeholder partnerships being formed, and the technologies being applied within the NXG project align well with "SDG 17: Partnerships for the goals". The primary SDG associated with each indicator includes SDGs 2, 6, 7, 12, 13 and 15. There are secondary links to SDGs 1, 3, 4, 8, 9, 10, 11, and 14.

Key benefits

Environmental impact: The Index promotes sustainable resource management, reducing environmental degradation and enhancing ecosystem resilience.

Economic benefits: By identifying inefficiencies in resource use, it helps optimise investments, reduce waste, and enhance long-term economic stability.

Social benefits: Ensuring equitable access to water, energy, and food improves quality of life, enhances resilience to climate change, and supports sustainable communities.

Scalability & replication potential

The WEFE Nexus Index can be adapted for different regions and scales, from local to global applications, making it a valuable tool for diverse governance and planning frameworks.

🌍 Learn more about the WEFE Footprint: here

🟦 Explore the full project: https://nexogenesis.eu/

📱 Stay tuned for updates and results on our social media channels!

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The NEXOGENESIS consortium

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