

How Much Water Is Embedded in Trade?

A systematic review of methods, comparability and policy relevance under climate constraints - Focus Morocco

Fatima Tasra^{1*}, Driss Mafamane²

¹ PhD Candidate, Université Mohammed V – Rabat

² Professor, Université Mohammed V – Rabat

*Presenting author: fatima.tasra@um5r.ac.ma



192 full texts assessed | 157 studies included | WFA - IO/MRIO - LCA - Hydrological models | PRISMA-based synthesis

Research question & contribution

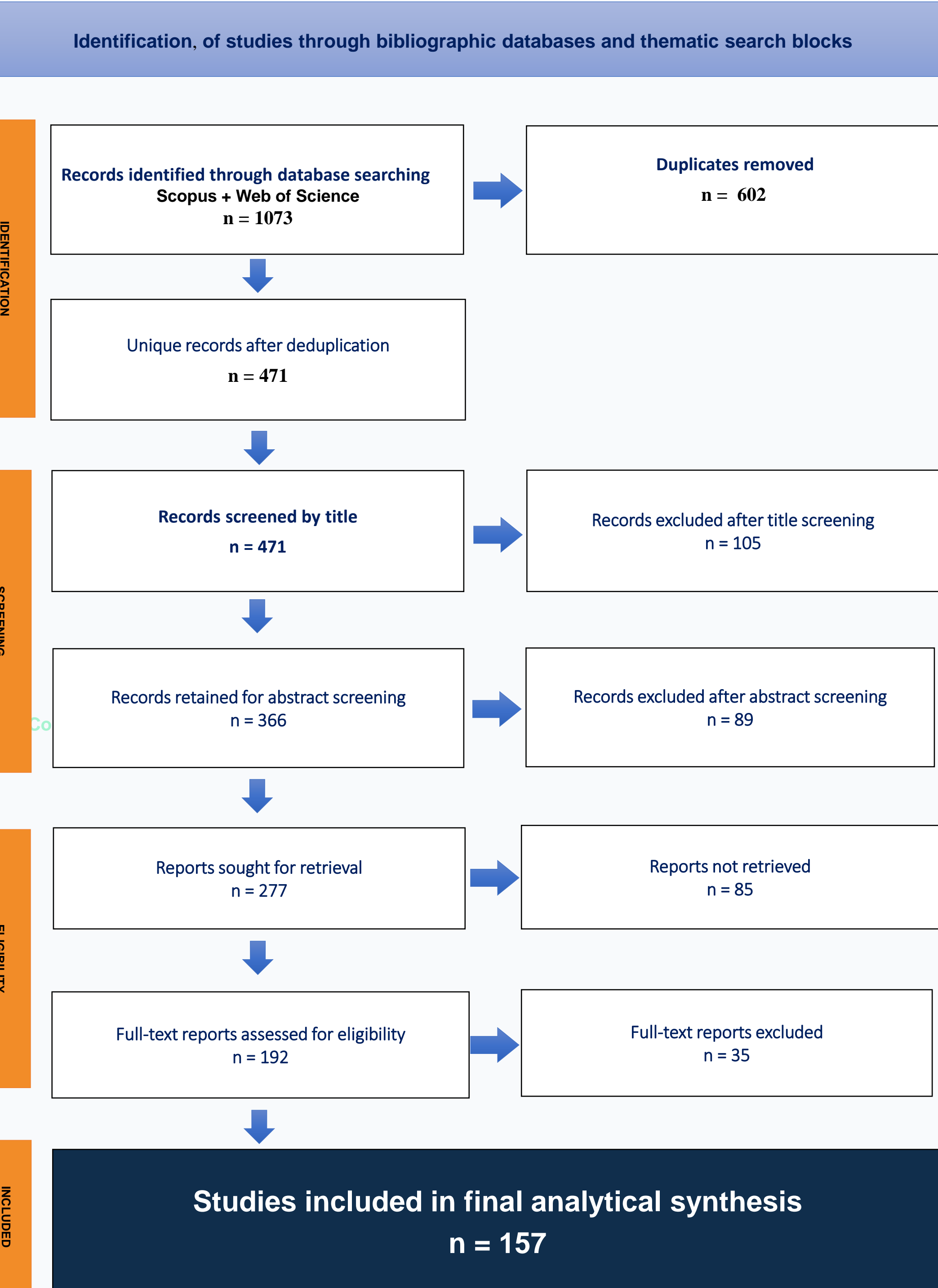
How are trade-related water footprints estimated, why are existing results difficult to compare, and what protocol can support a climate-sensitive, policy-relevant application to Morocco?

Why it matters

- Trade shifts water demand across regions, countries and supply chains.
- Existing studies use heterogeneous methods: WFA, IO/MRIO, EEIO, LCA and hydrological models.
- For Morocco, policy relevance requires linking trade flows with blue/green/grey water, basin scarcity, groundwater stress and climate risk.

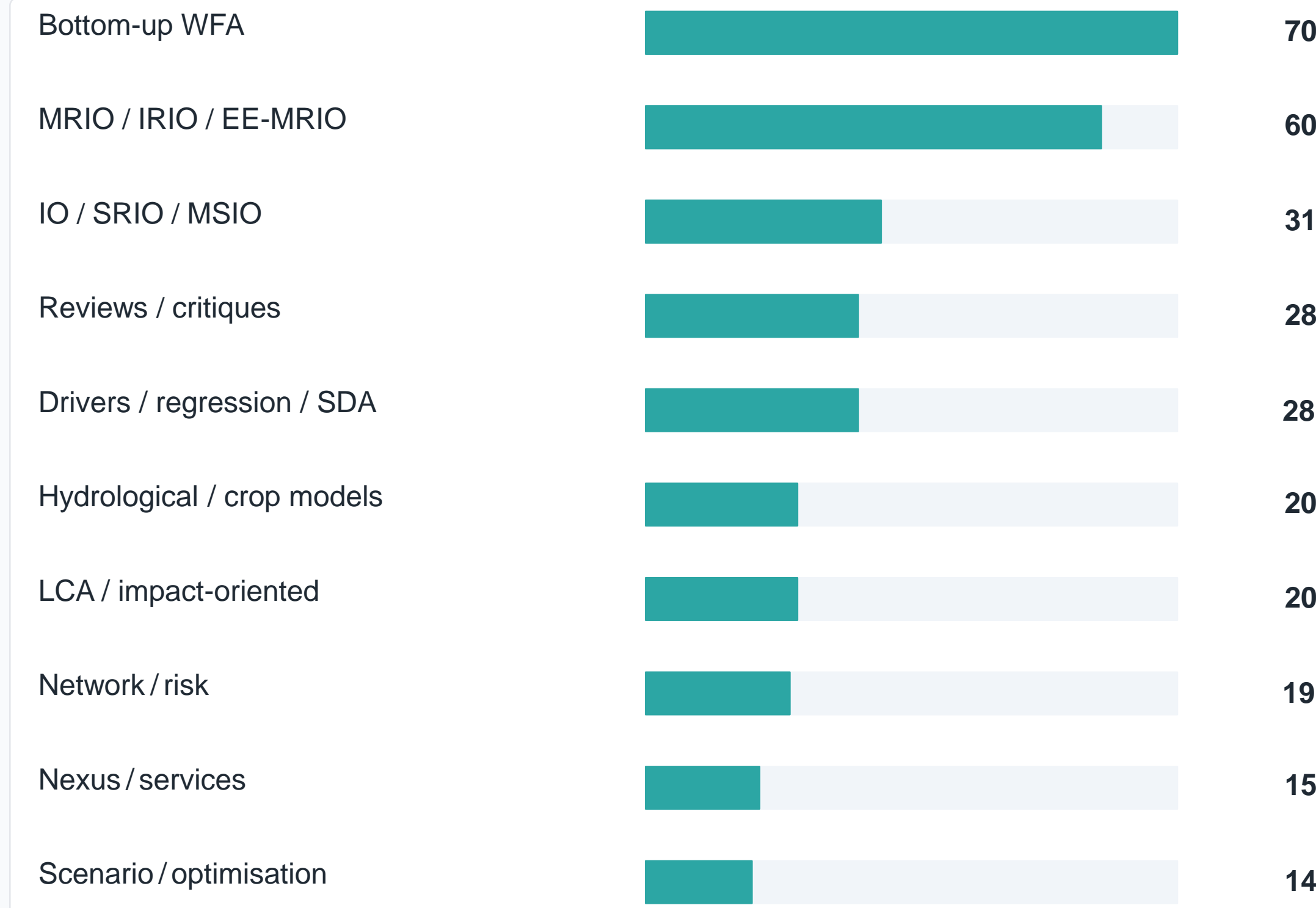
Contribution: A PRISMA-based methodological synthesis of 192 full texts and 157 retained studies, linking trade accounting, water indicators, climate integration and policy transferability for Morocco.

PRISMA snapshot

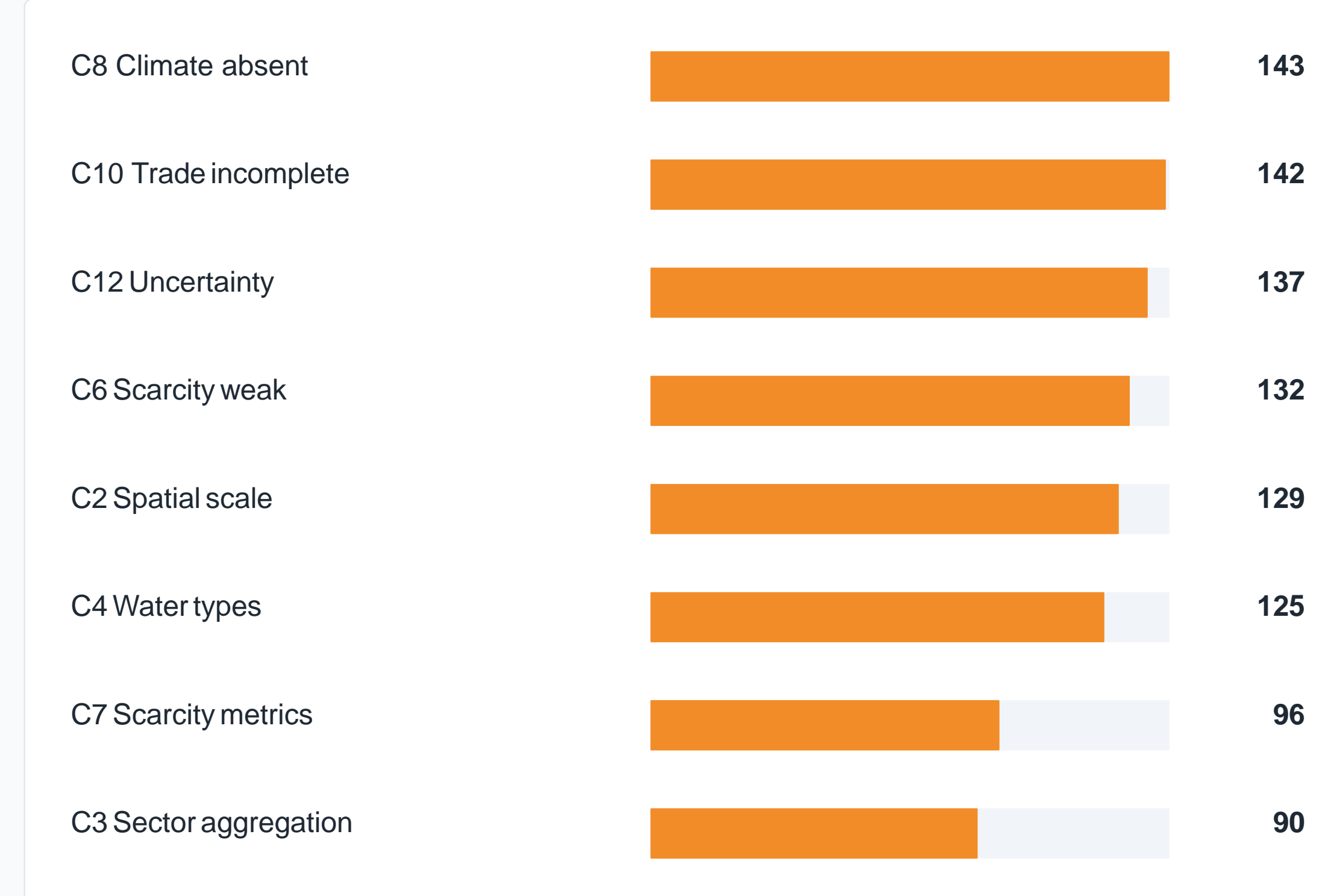


The field can trace water embedded in trade, but it cannot yet compare methods reliably across water type, trade boundary, scarcity, scale and climate constraints.

Methodological landscape (n = 157, multi-label)



Main comparability bottlenecks



WFA and MRIO dominate, but many studies combine several methodological families.

Comparability is mainly limited by climate omission, incomplete trade boundaries, uncertainty, weak scarcity integration and inconsistent water-type definitions.

Three take-home results

1 Two paradigms dominate

Methods are rich but fragmented
Bottom-up WFA and MRIO dominate, but they measure different objects: crop-level virtual water vs supply-chain responsibility.

2 Comparability is weak

Comparability is the core bottleneck
Differences in water type, trade boundaries, spatial scale, scarcity metrics and data uncertainty limit cross-study comparison..

3 Climate is under-integrated

Climate remains under-integrated
119/157 studies do not integrate climate beyond absence or contextual mention; only 6 use explicit future climate scenarios.

Research gaps identified

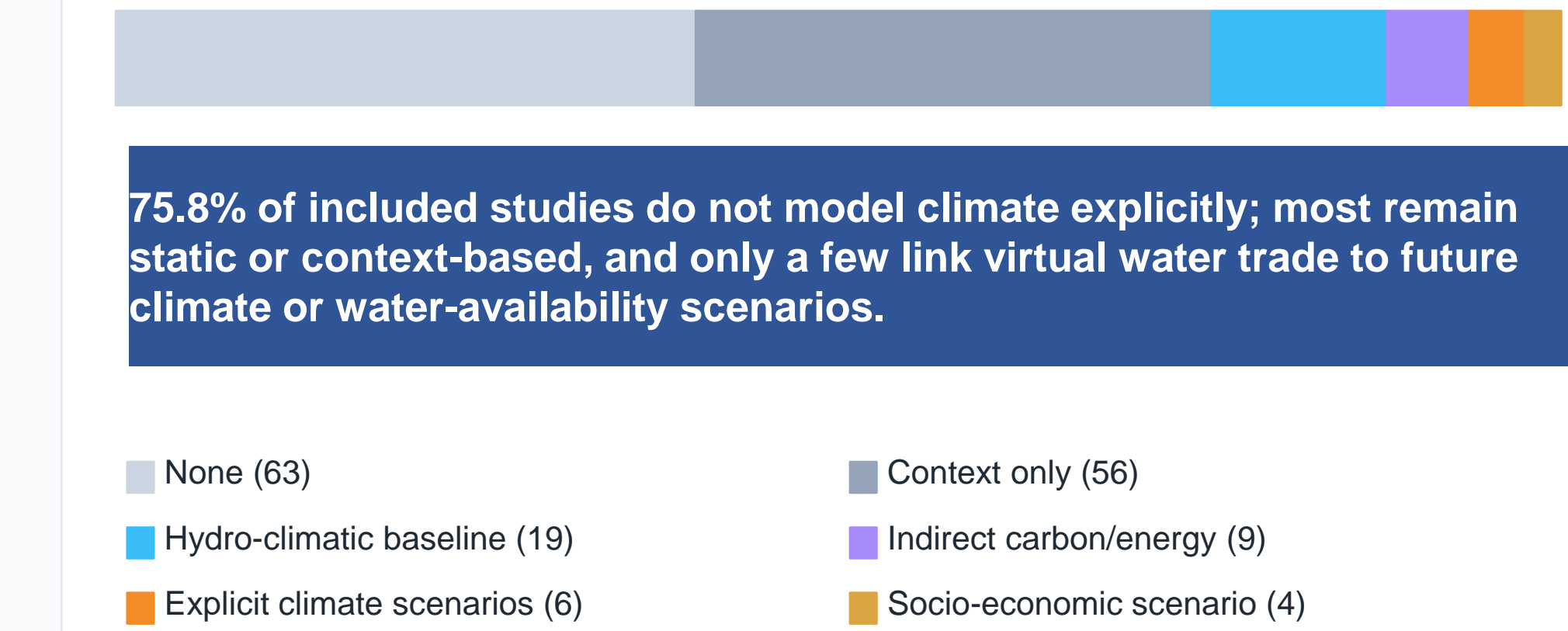
- Weak coupling between virtual water trade and future climate scenarios
- Limited integration of basin-level scarcity and groundwater stress
- Inconsistent treatment of blue, green and grey water
- Incomplete representation of trade boundaries and supply chains
- Few operational protocols for arid import-dependent countries such as Morocco

What this review adds

- A PRISMA-based full-text synthesis
- A typology of WFA, IO/MRIO, LCA and hybrid methods
- A diagnosis of comparability bottlenecks
- A Morocco-oriented methodological roadmap

For Morocco, the key issue is not only how much water is embedded in trade, but which embedded water is blue, scarce, polluted, climate-vulnerable and policy-actionable.

Climate integration gap

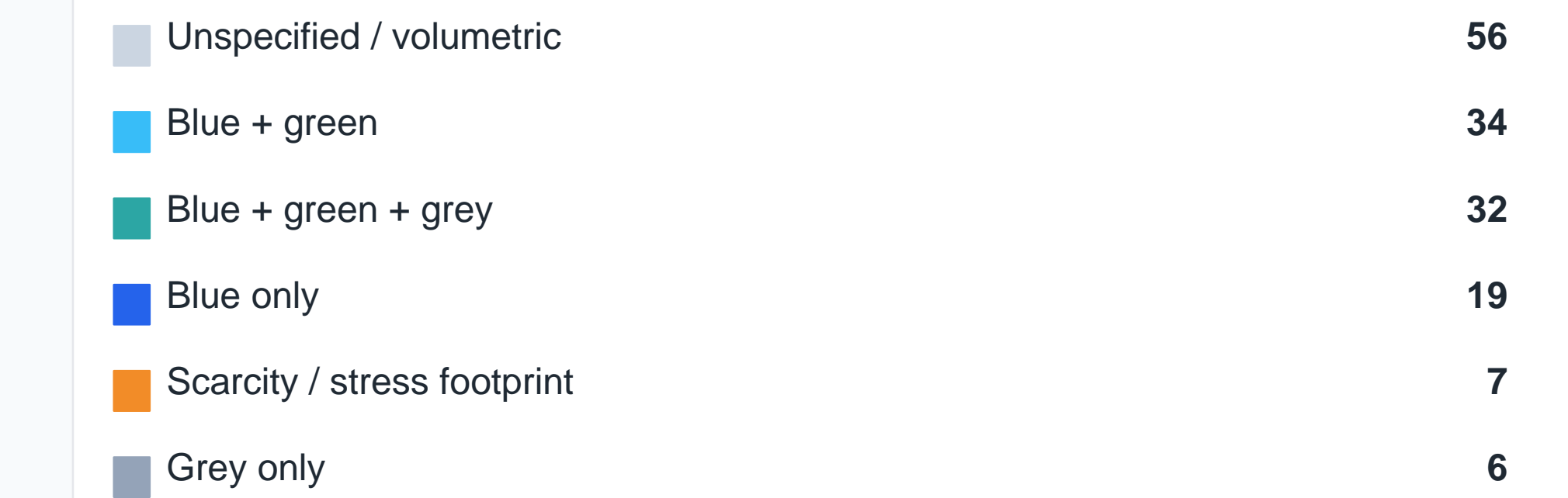


Methodological trade-offs across trade, climate and policy dimensions

Method	Trade coverage	Climate integration	Policy relevance
WFA	Medium	Low	Medium
MRIO / IO	High	Low	Medium
LCA	Low	Medium	Low
Hybrid	Medium	High	High

Qualitative synthesis: MRIO/IO captures trade structures best, but hybrid frameworks offer stronger potential for climate-sensitive policy applications.

Water indicators: not directly comparable



Policy meaning changes with water type: green water, blue irrigation, grey pollution, and scarce water are not interchangeable.

Roadmap for Morocco

From volumetric virtual water accounting to climate-sensitive trade risk

