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The impact of green roofs on urban runoff quality: a review

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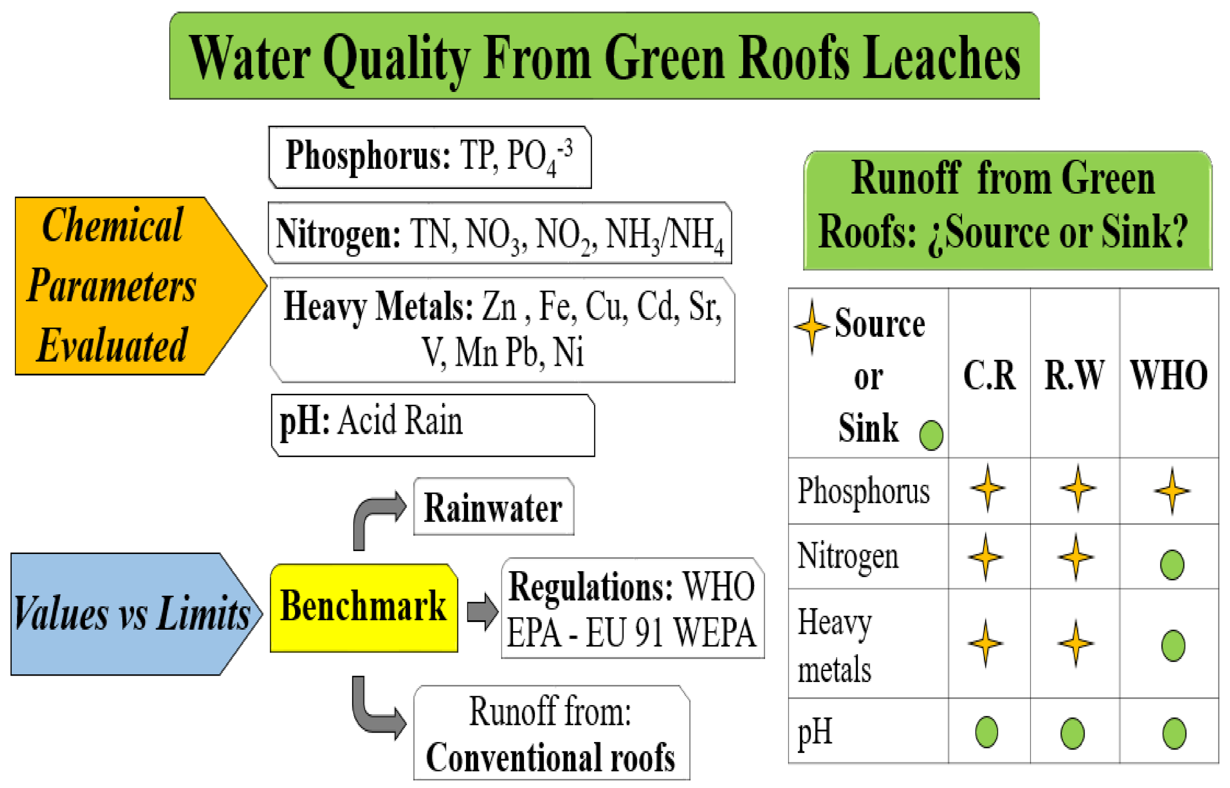
Highlights

- Source or sink effect of green roofs is still unclear.
- Nutrients and metals are parameters influencing source-sink effect.
- Regulatory limits from water quality standards must be considered.
- Green roofs mitigate acid rain effects.

Graphical abstract



Introduction

Green roofs are greenery systems that provide many ecological and economic benefits to urban environments. Green roofs are an important component of sustainable drainage systems that can improve the quality of urban runoff. The materials composition that make up the multi-layered structure of a green roof is a crucial issue for its contribution to improving the quality of urban runoff water. The sink effect of P, N and heavy metals is ambiguous. The benchmarks used to study source-sink effect are disparate, with leachate from GR being compared with leachates from conventional soils and/or rainwater. The use or not of fertilizers during the studies varies the result. This dispersion is compromise the use of green roofs.

Methodology

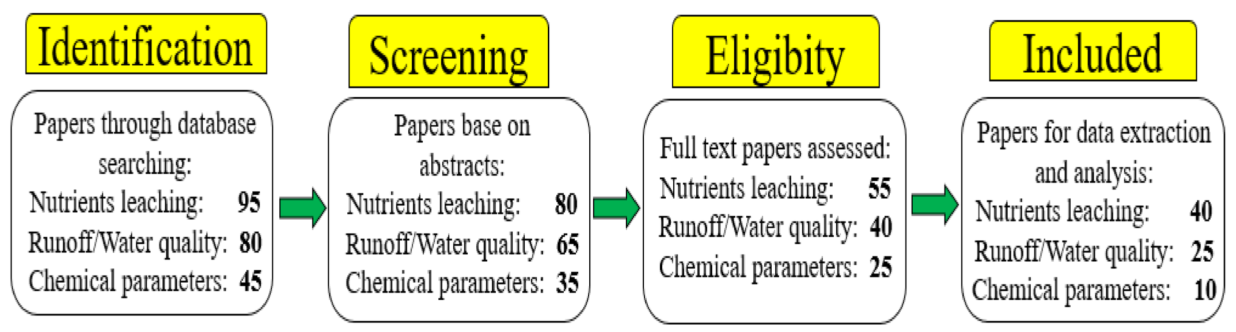


Figure 1. Overview of review papers identified in the steps of the systematic review.

Results

The methodology used in this review, which focuses mainly on the parameters that most influence the source-sink effect of runoff water from green roofs, allows these doubts to be clarified and establishes a good knowledge base for future studies on the quality of water from GR. There are 22 studies concerning the factors encapsulated in the concept model of runoff pollution from green roofs that must be identified as sources or sinks of runoff pollution (Table 1).

Table 1. Sources and sinks of runoff pollutants from green roofs according to the literature.

	Nutrient						***Metal***								
Literature	TP	PO4	TN	NO3	NO2	NH3/NH4	Zn	Cu	Fe	Cd	Pb	Ni	Sr	V	Mn
Teemusk et al.	+●														
Lui et al.	+●														
Monteiro et al.		●													
Chen et al.	●														
Castro et al.	●	●	+●			○			○						
Toland et al.	+●														
Zhang et al.	+●														
Teemusk et al.			+●	+●		+●									
Aitkenhed et al.				+●											
Toland et al.			+●		+●	+●									
Chai et al.			+●		+●	○									
Peczkowki et al.			+●												
Liu et al.			+●												
Liu et al.			+●												
Van et al.			+●	+●		○	-○	-○	-○			●	●	●	
Carpenter et al.			+●	●		○									
Wang et al.								○							
Okita et al.							-○	-○							
Malcolm et al.							○		●						+●
Gregoire et al.							-○	●							
Peczkowski.							●	●		-○	-○				
Ferrans et al.							+●		●		●	+●	+●		+●

Note: Source (●) or sink (○). (**+●**) means that the study concluded in source effect compared with Rain Water (RW) and/or Conventional Roof (CR) but not when compare with the regulation. (**-○**) means that the study concluded in sink effect compared with RW and/or CR roof but not when compare with the regulation.

Conclusion

The influence of GR on runoff quality is a research priority. The methodologies of comparison, between the source or sink effect of GR was the central axis of this research. Within the components of GR, the substrate and fertilizers showed relevance results for nutrients (P and N) and heavy metals lixiviates. GR mitigate damage from acid rain. Finally, each layer and constituent of a GR has a significant influence over the performance of a GR.

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