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Editorial: Urban runoff of pollutants and their treatment

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Editorial on the Research Topic
Urban runoff of pollutants and their treatment

Floods are one of the most common natural disasters worldwide. Their increasing incidence in the past years is mainly due to the consequences of climate change coupled with a general trend of the increase of surface impermeabilization in the cities.

In particular, the past years' rapid urbanization and human land use originated environment modification, with consequent surface modification: in the urban area, most of the surface is covered by buildings and impermeable pavements, which strongly limits snowmelt and rainwater infiltration into the subsurface.

However, floods are sometimes predictable events (Enríquez et al., 2022). To account for the vulnerability of a territory, due to extreme events, patterns of development coupled with demographic studies are considered. As a result, the score of flood risk is available as a risk index, evaluated by a dedicated committee of the European (European Commission, 2022). The 2022 flood risk is shown in Figure 1. It appears that only a few countries have a relatively low risk (less than 5), and Vietnam and Bangladesh are the countries with the higher flood risk (the index score is 10).

Urban runoff is water deriving from rain and outdoor water usage, comprising stormwater and snowmelt, which drains from roofs, roads, car parks sidewalks, driveways, and other surfaces, and does not soak into the ground. It is widely recognised as a major carrier for the pollutants transport and release in the urban environment. Therefore, it also represents a significant contributor to the degradation of surface water bodies (EPA, 2003). As a consequence, urban runoff is one of the key pathways in the transfer of pollutants to the aquatic and marine environment. The contaminants associated with urban runoff can be divided into different categories such as heavy metals, solids, toxic chemicals, biodegradable organic matter (chemical or biochemical oxygen demand COD/BOD), organic micropollutants (among them polycyclic aromatic hydrocarbons PAHs, polychlorinated biphenyls PCBs), pathogenic microorganisms (such as *Escherichia Coli*), nutrients (nitrogen and phosphorus) and microplastics (Wei et al., 2013; Piñon-Colin et al., 2020). For example, Wang et al. (2022) reveal that the concentrations of microplastics in urban stormwater are much higher than those found in wastewater effluents.

The source of pollutants can be natural (soil, leaves and organic debris) or anthropogenic (construction materials, exhausted particles, roadway debris, fertilizers, and so on) (Trujillo-González et al., 2019). Generally, the road deposited sediment represents one of the primary contaminants contributors to urban runoff (Piñon-Colin et al., 2020). In the worst cases, when the stormwater collection is in connection with the sanitary sewage system, an accidental release of raw sewage may also happen because of important precipitation events, with the result of dramatic environmental and economic impacts.

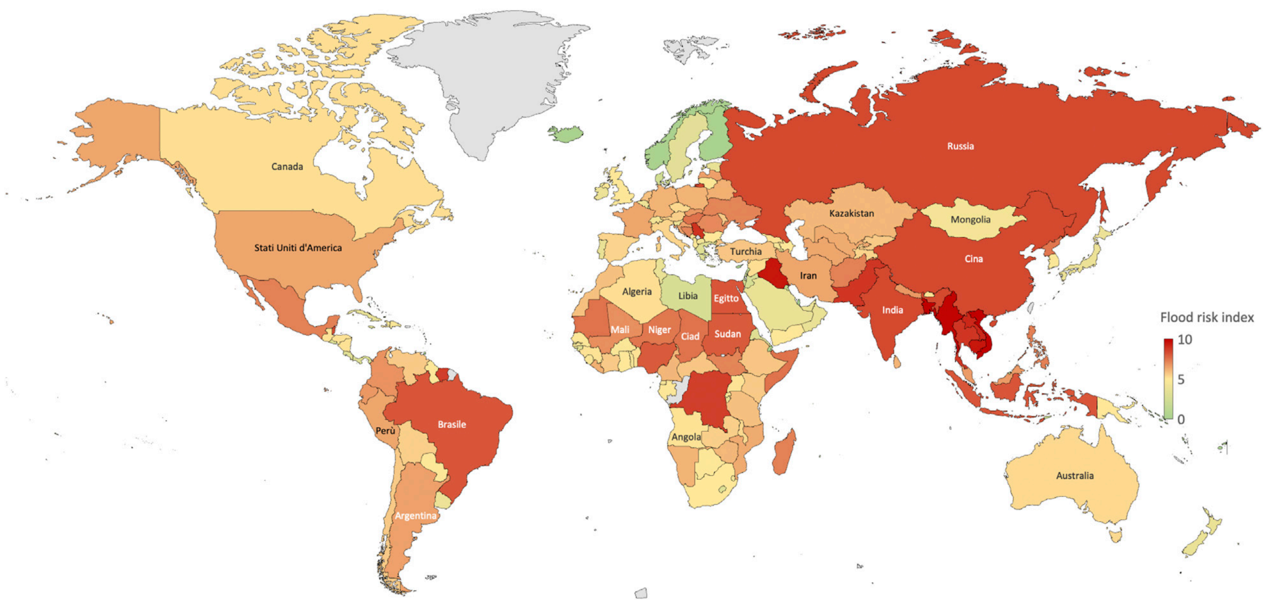

FIGURE 1
2022 Flood risk index reported for all the world. The index can assume a value between 0 and 10 (the higher the score, the higher the risk). It is calculated based on the estimated number of people exposed to floods per year.

The pollutants can harm flora and aquatic fauna and contaminate Campo's drinking wat (EPA, 2003).

This Research Topic proposes four papers devoted to the main concerns related to urban runoff, dealing with its sources and the presence of the contaminants, with attention to emerging pollutants and micropollutants, and the treatments devoted to their decontamination. Even if at low contamination levels some minor actions can be provided (for example, intervention on transport and diffusion mechanism), in other cases, other activities should be foreseen.

One of the main goals is to propose wastewater reuse, for example, in some domestic applications, which has opened concerns about emerging micropollutants in water bodies.

With the rapid urbanization and the effect of climate change on rainfall, it is likely that the urban runoff volumes will increase in the future (Khan et al., 2022). Therefore, some solutions must be proposed to reduce the possible by-product effects of urban runoff. For example, permeable pavements are a suitable way to reduce the urban runoff volume (Field et al., 1982; EPA, 2003). Green roofs represent another sustainable solution to mitigate the adverse impacts of climate change on urban stormwater (Liu et al., 2023).

The flood risk relates to several aspects of sustainability, for example, the quality of the surface water, the pollution, the impacts on jobs, and the damage to infrastructures. Achieving Sustainable Development Goals (SDGs) needs great attention to the flood risk, with the aim to mitigate the derived effects and rise the population adaptation, which are fundamental steps to reach the objectives of resilience, regeneration, ad suitability.

However, despite that several studies have been proposed in the literature to evaluate the most suitable technologies devoted to reducing the pollutants in water bodies, only a few works have been proposed on the fate and toxicity of the resulting degradation by-products.

The work presented by (Yacouba et al.) aimed to evaluate the potential removal of by-products resulting from the ozonation of carbamazepine pharmaceutical product, by nanofiltration and to estimate the acute toxicity evolution of this effluent through the coupling process. The authors showed that the synergic effects of coupled treatments result to be effective for the elimination of some organic micropollutants.

Degenhart and Helmreich reviewed, for the first time, the papers treating inorganic pollutants in stormwater runoff of non-metal roofs. Little attention is devoted in literature to the possibility to have non-metal roofs, which can also be coupled with vegetation. Moreover, they present biases such as gutter materials and atmospheric depositions. This works shows the assessed roof typologies and the potential inorganic substances, which may be found in the runoff. Then, the authors show that these non-metal roofs can increase the possibility of water contamination. Therefore, extreme events can generate new pollutants, which can be released into the environment. This possibility needs great attention because of the necessity of appropriate treatment for water decontamination before it is released into the environment.

Drapper et al. presented a paper analysing the historic data about pollutants in Australian urban stormwater. They summarized results from multiple datasets, collected across different geographic locations and climatic regions, covering a broad range of rain intensities. In this work, they show all the problems and open issues correlated with the regulation implemented to take into account stormwater management, for sustainable urban design solutions. In particular, the authors also suggest the development of monitoring guidelines including standard analytes, meta-data required, sampling techniques, the minimum number of samples to be collected and events, and in the guidelines.

Wright et al. analysed removal efficiencies for nitrogen, phosphorus and total suspended sediment of a constructed wetland, under baseflow and event flow conditions. Constructed wetlands are stormwater control measures, representing an effective way to treat nutrient and sediment pollution. They are designed to replicate processes normally occurring in nature, with the aim to remove sediments and nutrients and sediments before they can enter a receiving waterway. The results of this study highlight that improper maintenance operations, for example, physical disturbance, which results in a mass export of suspended sediment, can cause more damage than benefits in this kind of control measure.

In conclusion, as shown in Figure 1, the flood risk, mainly due to more frequent heavy precipitation, the rise of the sea level, and the increased impermeable pavement surfaces of cities, is a global issue, with a high impact on urban runoff events. Indeed, all the works presented in this Research Topic highlight that urban runoff remains an open issue, needing attention and continuous monitoring. Even if dedicated strategies addressing some issues can be proposed (for example the use of permeable pavements), more research activities are also fundamental to solve the remaining knowledge gaps and help to support devoted actions to increase population resilience and reduce the negative impacts of these extreme events. For example, more statistical analysis and comparison among different areas can help to increase the knowledge about the emerging contaminants which may affect the ecosystems and support the development of the most suitable treatment technologies.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

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