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REVIEW ARTICLE

Greywater footprints and the sustainability of city gardens

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Abstract

Urban city gardens are facing increasing pressure to balance water consumption with sustainability goals, to amid growing concerns over water scarcity and environmental degradation. This article examines the concept of “greywater footprints” and its potential to support sustainability in urban city gardens. Greywater, which is the waste produced from household activities excluding toilet use, has become a useful resource for irrigating urban gardens, helping to decrease the dependency on drinking water and easing the strain on freshwater resources. By redirecting greywater from conventional wastewater systems, urban gardens can significantly reduce their water usage while also promoting sustainable practices. Its composition varies depending on its source, which is primarily kitchen and detergent waste, with probable chemical changes from laundry and bathing. Its use in urban gardens saves water while also improving soil fertility and plant health, contributing to the overall sustainability and productivity of urban agricultural systems. This article examines the feasibility and effectiveness of utilizing nature-based systems for the treatment of greywater, highlighting their minimal energy consumption, environmental advantages and cost efficiency. It also examines how greywater contributes to enhancing resilience in urban gardens, facilitating climate adaptation and reducing environmental impact. In summary, adopting greywater management techniques in city gardens provides a sustainable approach to addressing water scarcity challenges while promoting the development of thriving, productive and resilient urban ecosystems. By leveraging greywater resources, urban environments can contribute to a more sustainable future for both urban agriculture and water management.

Keywords: environmental impacts; grey water; grey water footprints; heat island effect; heavy metals; perspective; phytoremediation; sustainability; urban gardening; water scarcity

Introduction

In recent years, water scarcity has been escalating in many parts of the world. Effective and sustainable water management solutions are becoming increasingly essential due to the ever increasing global population, urbanization and the challenges posed by climate change (1). However, the irrigation requirements in water-scarce places conflict with water sustainability goals (2). Plants are significantly impacted by water scarcity, which affects their overall performance as well as their growth and development. Studies show that when there is a water deficit, plants alter their morphological, physiological and molecular characteristics to increase water absorption, reduce water loss and prevent withering (3, 4). Furthermore, plants react to water scarcity by initiating hormone- and self-regulated signing pathways, which cause stomatal closure, decreased transpiration rates and modifications to photosynthetic processes (5). This issue can be rectified by using greywater as this will reduce the need for potable water (PW).

Grey water (GW) is the domestic wastewater produced in residences or commercial buildings, without any contributions from toilet water. Fig. 1 shows that a major share of water used in households ends up as greywater, accounting for nearly 70 % of the total wastewater. It is also known as ‘sullage’ in the United States. Kitchen waste and detergent waste are the two significant sources of greywater. In some cases, kitchen wastewater is kept separate from greywater to reduce the organic loading from food waste and oil, which is referred to as lightly polluted greywater. This strategy reduces household and community spending while promoting climate resilience, benefiting the environment, the economy and society. Utilizing nature-based systems for greywater treatment is a popular method because of its low energy use, capacity to sequester carbon, ecological advantages and usually reduced cost and complexity (6-8).

In addition, this study focused on the major role of greywater and its sustainability in urban gardens.

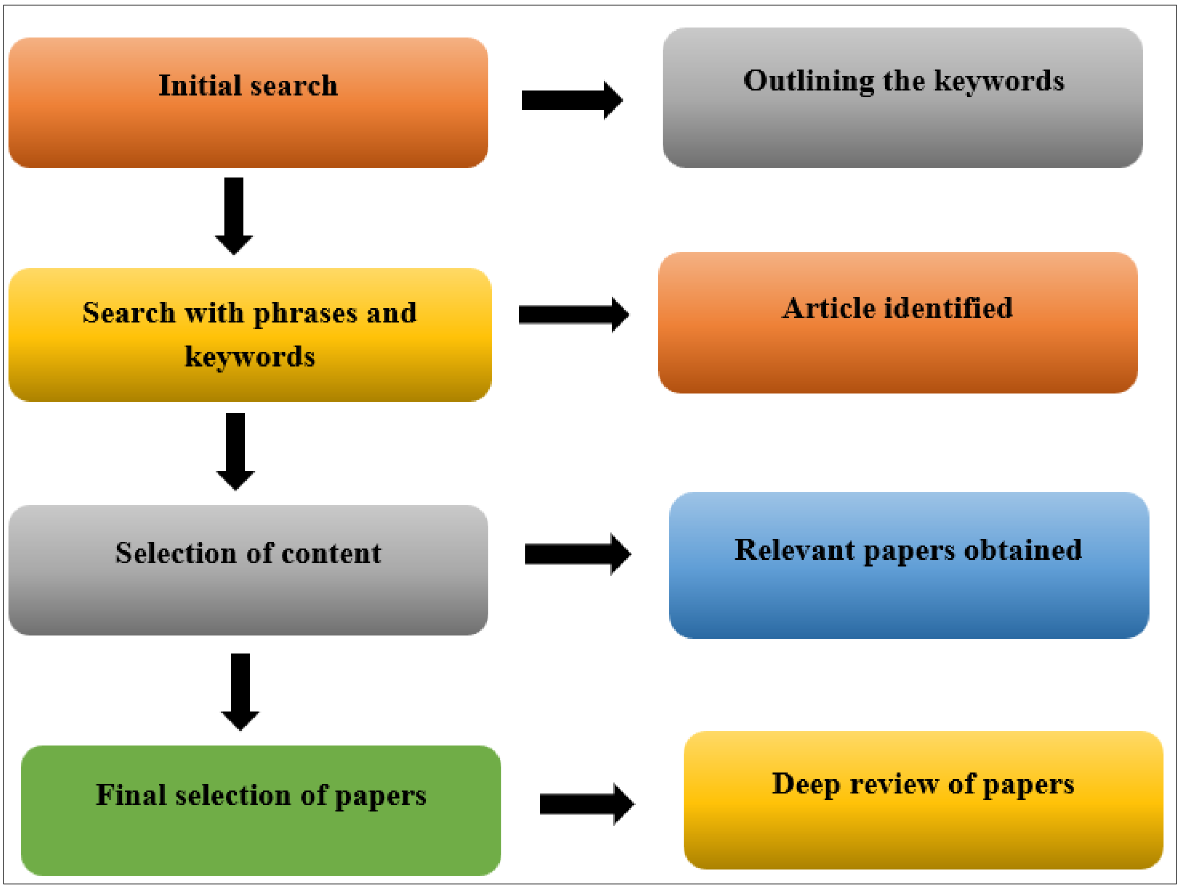

Fig. 1. Process of methodology.

Methodology

The methodology process includes literature study, secondary data collection and comparative data analysis from different literatures. The detailed procedure for this literature search methodology is depicted in Fig. 2. These articles were first filtered based on title relevancy following an initial search using keywords and phrases. These papers were then selected based on the abstract. This study lays out a deep look at the benefits of greywater in urban city gardens and this section deals with the search steps used for this systematic literature review.

Revitalizing cities through urban gardening

Urban gardening promotes healthy lifestyles, enhances well-being, creates social connections and fosters environmental sustainability through the transformation of urban spaces (9). Additionally, urban Gardens improve psychological and physiological health, it also increase social capital and provide sustainable food sources in urban areas (10).

Transforming urban landscapes through the incorporation of green plants, such as those found in urban green infrastructure and ecological green-plant systems, has several advantages. Green roofs and urban vegetation can enhance air quality, provide ecosystem services and promote biodiversity by incorporating plant species with diverse life cycles and characteristics (11, 12). Green plants significantly enhance urban transformation, as they increase biodiversity, address environmental problems and improve the quality of life for city dwellers. Incorporating plant landscaping not only enhances the aesthetic appeal of urban spaces but also plays a vital role in creating sustainable ecosystems by mitigating ecological problems like habitat destruction, pollution and climate change (11, 13, 14).

Furthermore, the idea of green infrastructure (GI) underlines the multifunctional role of urban green spaces in economic growth and environmental conservation, underlining the significance of interconnected ecosystems and new techniques to address modern challenges sustainably (15). Urban gardening spaces are open space assets that promote civic engagement, empowerment and community building (16). Urban gardening spaces offer a profitable and socially inclusive use of open green spaces in cities, combining the city and nature, as well as social and environmental elements (17). As a result, numerous public and private actors have aggressively supported and advocated for urban gardening initiatives. Open green spaces compete with other possible uses of urban space, such as residential and commercial zones, because there is a shortage of space (18).

Grey water footprints (GWF)

The grey water footprint (GWF) is an indicator that considers water quality issues. This indication refers to an equivalent volume of freshwater necessary for digesting pollutant loads emitted into the water body during the process phase (19). When evaluating water pollution and its effects on plant life, greywater footprints are an essential component. Research has demonstrated that the greywater footprint methodology may be applied to assess the efficacy of wastewater treatment plants and the consequences of their discharge on aquatic environments (20, 21).

Furthermore, crop planting structures can be optimized to minimize environmental effects and minimize

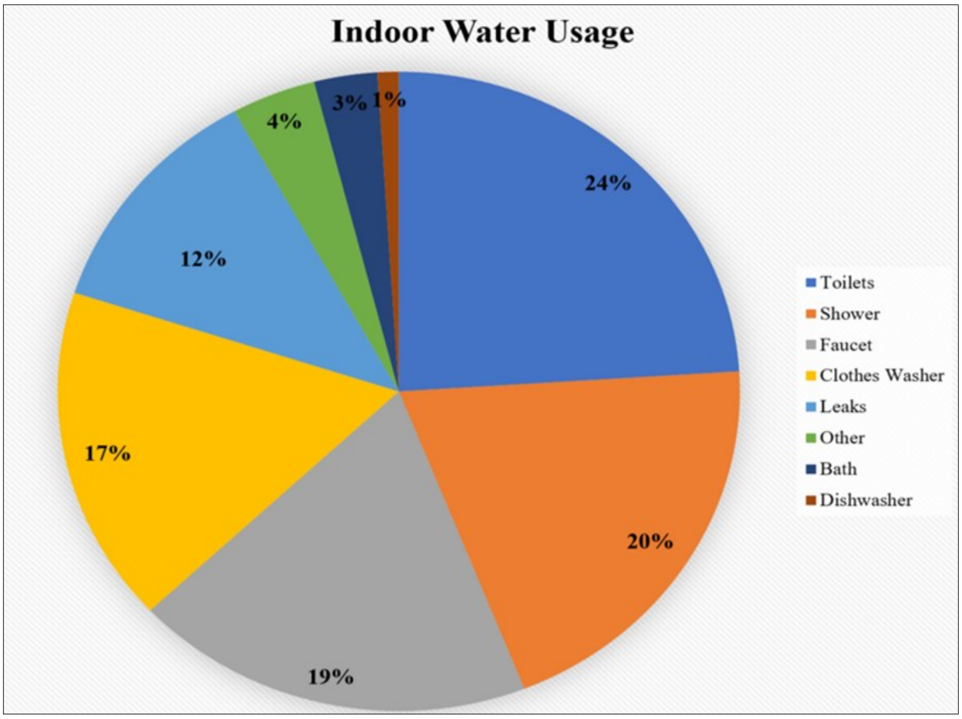

Fig. 2. Water consumption in the household.

water pollution by incorporating grey water footprint theory into agricultural models. This would ultimately maximize crop economic benefits while decreasing water pollution (22). Also, the evaluation of agricultural greywater footprints in various locations, such as the Yellow River Basin, has highlighted the temporal and spatial fluctuations caused by variables such as crop productivity, economic magnitude and technological advancement, emphasizing the need of sustainable water resource management in the planting sector (23).

GWF proposes rephrasing environmental impacts in terms of water volume for better decision-making. Pollution intensifies water scarcity by rendering water bodies useless for certain purposes (24). Pollution, including heavy metals and nutrients, can contribute to differences in GWF accounting. This is a major drawback of GWF, with the altered AWQS. An AWQS is an allowable amount of materials, as a concentration of pollutants in water. Standards for ambient water quality may also cover other aspects of the water, such as pH or temperature. Standards are established to guard against potential harm to animals, human health and welfare, or the health of ecosystems (25). As a result, some academics have recently focused on developing modeling techniques to standardize water quality and account for multiple pollutants in the GWF. The focus is on managing nitrogen (N) and phosphorus (P) in croplands to minimize negative environmental effects (26). The greywater footprint can be calculated by dividing the total amount of pollutants by the difference between the maximum allowable concentration and the background concentration found in nature (27). Grey water footprint (WFgy) in agriculture can be computed by multiplying the leaching-runoff fraction (α, %) by the chemical application rate (Appl, kg/ha) Divide by the difference between the maximum permitted concentration of nitrogen (Cmax, kg/m^3) and the natural concentration of nitrogen in the receiving water body (cnat, kg/m^3), as well as the actual yield (Y, ton/ha). The primary cause of non-point source pollution of surface and subsurface water bodies is nutrients seeping or flowing off from agricultural areas (28).

The “grey” component is the amount of contaminated water used in the production of products and services; it is measured as the amount of water needed to dilute pollutants to the point where the ambient water quality stays above established water quality requirements (28). This would be the amount of dilution needed for crop production to bring soil levels of pesticides and fertilizers, such as nitrate and phosphate, down to predetermined levels (29).

Mitigate the urban island effect

The urban heat island (UHI) effect, first described by Luke Howard in the 19th century, refers to the exchange of energy between a city’s climate and its surroundings. The issue became a global problem in the 21st century due to rising human-caused activity that disrupted energy balance (30, 31). Urban gardening, which encompasses both private and communal gardens, is crucial for mitigating the urban heat island effect (UHI) as it increases the amount of green space in densely populated areas, reduces flood risk and enhances thermal comfort. Research studies support the idea that gardening is a promising way to mitigate the urban heat island (UHI) effect (32). As illustrated in the case of Imbaba, where inventive vegetation measures were implemented to create cool public spaces, incorporating greenery measures in high-density areas can effectively reduce UHI (33).

Additionally, the benefits of vegetation and green areas in urban areas are highlighted as being essential for improving thermal comfort and lowering the negative consequences of rising temperatures associated with the urban heat island effect (34). According to research, gardening is a promising approach for minimizing the urban heat island (UHI) effect. Increasing surface greenery and vegetation (ISG) helps mitigate the impact of urban heat islands (UHIs) by lowering land surface temperatures and improving overall urban climate conditions (35, 36). Studies highlight the significance of optimizing building density, height and urban area in addition to boosting albedo values and vegetation metrics to lessen UHI intensity (37). Additionally, as shown by simulations of urban canopy wind -heat systems, increasing the porosity of urban regions and lowering anthropogenic heat can effectively decrease the UHI effect (38).

Increases in energy consumption, the temperature-humidity index, the quantity of air pollutants and particle matter and the speed at which smog and ozone form are all effects of UHI (39). The solution is to adapt or reduce the UHI effect using a mitigation strategy until it reaches an acceptable level for urban residents (30). Adapting to UHI involves responding to current and future effects, such as increasing air conditioning, installing cool roofs, planting trees and building water tunnels to prevent flooding. In comparison, UHI mitigation refers to a series of long-term initiatives aimed at mitigating the impact of UHI on metropolitan areas by preventing or reducing CO_2 emissions. Adding more green and blue spaces, such as pools and fishponds, can reduce the UHI effect by cooling the land through photosynthesis and evaporation (40, 41). A study by Li and Yu discovered that green places, such as urban parks, have a greater cooling effect than lakes (40). Green vegetation on land provides cooling energy through reflecting surfaces, canopy shadows and evapotranspiration (41).

Perspective of grey water usage

Greywater use has various advantages, including water conservation, less reliance on freshwater sources and economic rewards. Greywater, which accounts for a major amount of domestic wastewater, can be processed and reused for different non-potable activities such as irrigation, flushing and cleaning (42-44). Diverting greywater from traditional sewage systems can result in water and energy savings, leading to greater sustainability and resilience of local water systems (45).

The use of greywater in plants offers numerous advantages, including enhanced plant growth and yield, soil conservation and potential water savings. Studies have demonstrated that treated greywater has a positive impact on plant height, yield and photosynthetic activity, contributing to improved plant resistance and ionic balance (42, 46). Furthermore, greywater irrigation can significantly influence chlorophyll pigment concentrations in plants, such as *Vicia faba* and *Citrullus lanatus*, when compared to tap water irrigation, demonstrating its potential for increasing plant vitality and production (47).

Greywater from laundry can be reused as irrigation water for growing tomatoes. Compared to tap water, greywater-irrigated plants absorb more Na (83 %) and Fe (86 %). Laundry detergents primarily contain non-volatile chemicals and salts, which can benefit plants by providing nutrients. However, a balanced dosage is necessary to prevent nutrient insufficiency or toxicity (48). While irrigating grey water in the garden, the parameters, such as the qualitative ones, need to be analyzed. Qualitative parameters include biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), ammonium (NH4+), total phosphorus, boron, salts, metals, surfactants, synthetic chemicals, oils and greases, xenobiotic compounds and microorganisms (49-53). Greywater can be utilized to replace irrigation water, depending on the type of residence and the size of the manicured green spaces. To improve the quality of greywater for reuse, it is recommended that it be segregated from other sources, such as kitchen and laundry (54).

Environmental impacts on greywater

The environmental impact of using recycled greywater for watering of garden plants varies depending on the treatment and type of plant. When compared to untreated greywater, treated greywater has been shown to improve plant growth and fruit output, with the potential for long-term improvements in soil salinity and alkalinity (55). The impacts of greywater on some plants are shown in Table 1. Greywater irrigation can also lessen the demand for freshwater resources, particularly in areas where water is scarce (56). However, untreated greywater may contain elements that could have a negative influence on soils, plants and water bodies, therefore the quality of the water and how well it is treated are important factors in determining the environmental implications (57).

Perspective of urban city gardens

Urban city gardens offer several benefits, including mitigating the urban heat island effect, reducing flood risk, enhancing water retention and promoting sustainable practices. According to research, urban gardens have high permeability rates, catch rainwater for irrigation and help to reduce the impact and speed of rainwater (58). Additionally, urban gardens help fight the heat island effect by providing thermal comfort, conserving electricity and minimizing water runoff (32). Furthermore, when managed using agroecological principles, urban gardens provide essential ecosystem services such as cultural benefits and sustainable food production, which help to meet the Sustainable Development Goals (59).

Urban gardens also serve an important role in linking city people with nature, instilling a care ethic for the soil and forging a new interaction between citizens and the environment (60). Furthermore, urban gardens have high amounts of soil organic matter, which promotes infiltration, water-holding capacity and improved evapotranspiration, all of which contribute to the hydrologic ecosystem services of urban greenspaces (61).

Sustainability driven urban gardens

Greywater is critical to the sustainability of urban gardens since it serves as an irrigation water source while also reducing the requirement for freshwater sources (62, 63). Fig. 3 presents the irrigation model for gardens utilizing greywater. Water conservation efforts can be aided by the use of sustainable greywater treatment systems, which can result in large reductions in urban potable water consumption, ranging from 30 % to 70 % (42).

In Australia, ecologically sustainable development encompasses more than just safeguarding the environment from pollution’s effects but also maintaining and conserving

Table 1. Impact of greywater treatments on selected plant species

Crop	Matrix	Dosage	Effects	Author
Limonium perezii	Irrigation water with suppressed salinity	2.5 dS m^{-1}	Shorter and lighter stems	Grieve and Poss (2005) (58)
Ceratostigma Plumbaginoides	Irrigation water with electrical conductivity (EC)	0.8, 3.2, 6.4 and 12.0 dS m^{-1}	Increase in shoot dry weight	Niu and Rodriguez (2006) (59)
Three rose rootstocks: *Rosa fotuniana,* *Rosa multiflora,* *Rosa odorata*	Irrigating with saline water with varying EC	1.6, 3.0, 6.0 and 9.0 dS m^{-1}	A decline in growth was observed	Niu et al. (2008) (60)
Grevillea juniperina	Saline water	70 mM NaCl (7.4 dS m^{-1})	A decline in relative growth	Cassaniti et al. (2009) (61)
Bougainvillea glabra, *Eugenia myrtifolia,* *Leptospermum scoparium*	Saline water with high concentration	More NaCl concentration	Severe leaf injuries	Cassaniti et al. (2009) (61)
Angelonia sp, Ornamental pepper, Helenium	Saline water irrigation + Nacl + $MgSO_4$ + $CaCl_2$	0.8 to 7.4 dS m^{-1}	Decreases in shoot dry weight	Niu et al. (2010) (62)
Pansy ,Zinnia, Verbena, Petunia, Coleus and Begonia	NaCl + E.C.	NaCl- 0, 20, 40, 60 and 80 mM E.C. - 4, 7, 9.8, 12.1 and 14.2 dS m^{-1}	Highest sensitivity, no height loss	Gonzalo and Neil (2011) (63)
Tagetes erecta	Treated wastewater	------------	Development of blooming characters	Shahram and Mahmood (2013) (64)
Bermudagrass	Treated wastewater	1.31 kg/m^2	No effect on lawn visuality	Licata et al. (2016) (64)
Cynodon dactylon	Wastewater irrigation	(ETC) at 75, 100 and 125 %	Lawn with high quality and colour	Gurjar and Kaur (2018) (65)

Fig. 3. Greywater irrigation model.

natural resources. In an urban environmental context, this refers to urban development (both greenfield development and urban renewal) that aims to have no long-term effects on various aspects of the environment, including greenhouse gas levels, material resources, biodiversity and ambient water environments. Urban growth can have a significant impact on aquatic habitats, including waterways, coastal waters and water supply catchments. Water Sensitive Urban Design in Australia has progressed beyond its initial link with stormwater management to provide a broader framework for sustainable urban water management. It offers a common and unified method (64).

Impact of greywater on ornamental plants

Greywater's effects on ornamental plants vary based on the treatment method and plant physical form. Studies have shown that using treated greywater for irrigation can significantly boost the development of attractive plants such as sunflowers, with no detrimental impacts identified up to a certain dilution level (65). Additionally, it has been demonstrated that using greywater irrigation-either by itself or in conjunction with poultry biochar-improves soil qualities and stimulates wheat crop growth, suggesting the potential advantages of nutrient recycling for plant nutrition and sustainability (66).

Additionally, the introduction of decorative and climbing plants in artificial wetlands has demonstrated positive outcomes in the treatment of greywater, with vegetated systems showing greater removal rates of contaminants such as turbidity and Chemical Oxygen Demand than unvegetated ones (67). The plant growth and flower quality are not affected by greywater (68). *Iris pseudacorus* and *Eichornia crassipes* could not thrive at greater sewage loading rates and fertilizer contents (69).

Heavy metals-tolerant native plants

The effects of anthropogenic activity and urbanization have led to a rise in heavy metal concentrations to potentially hazardous levels in recent years. These days, it is commonly known that a variety of pollutants that contaminate the air, water and soil cause significant pollution in cities (70). Heavy metals such as arsenic, cadmium, chromium, nickel, lead, etc. (Table 2) have been identified by the International Agency for Research on Cancer as carcinogenic to humans and wildlife (71).

Recently, there has been a lot of interest in developing cost-effective, ecologically suitable methods for cleaning up heavy metal-contaminated soil and water (72). Thus, it is possible to mitigate heavy metal pollution from soil by the employment of plants. This economical method is known as phytoremediation, or the “green solution” (73). Plants that have grown in contaminated areas for a long time have developed metal tolerance as a result of their adaptive responses. Native plants are more effective for phytoremediation, as they exhibit higher survival, growth and reproduction rates under environmental stress compared to introduced species (74).

Absorption and recovery of heavy metals

Phytoremediation, a bioremediation approach for heavy metals, has gained popularity among academics due to its ability to clean up damaged environments. Fig. 4 depicts the overall mechanisms involved in phytoremediation process. It refers to the use of plants and related soil bacteria to lessen environmental pollutant concentrations or their harmful

Table 2. Accumulation of heavy metals in different native plants

Plants	Heavy metals
Tephrosia perpurea (L.)Pers	Chromium, Zinc, Nickel
Cyanodon dactylon (L.)Pers	Chromium, Zinc
Chenopodium album L.	Chromium, Zinc
Croton bonplandianum	Chromium
Physalis minima L. var. indica (Lam)	Chromium, Nickel
Casia occidentalis L.	Chromium, Zinc
Amaranthus viridis L.	Zinc
Acacia nilotica	Iron
Primula minimia	Iron
Achryanthus aspera var.Perphyristachya Hook L.	Iron
Saccharum munja Roxb	Iron, Copper

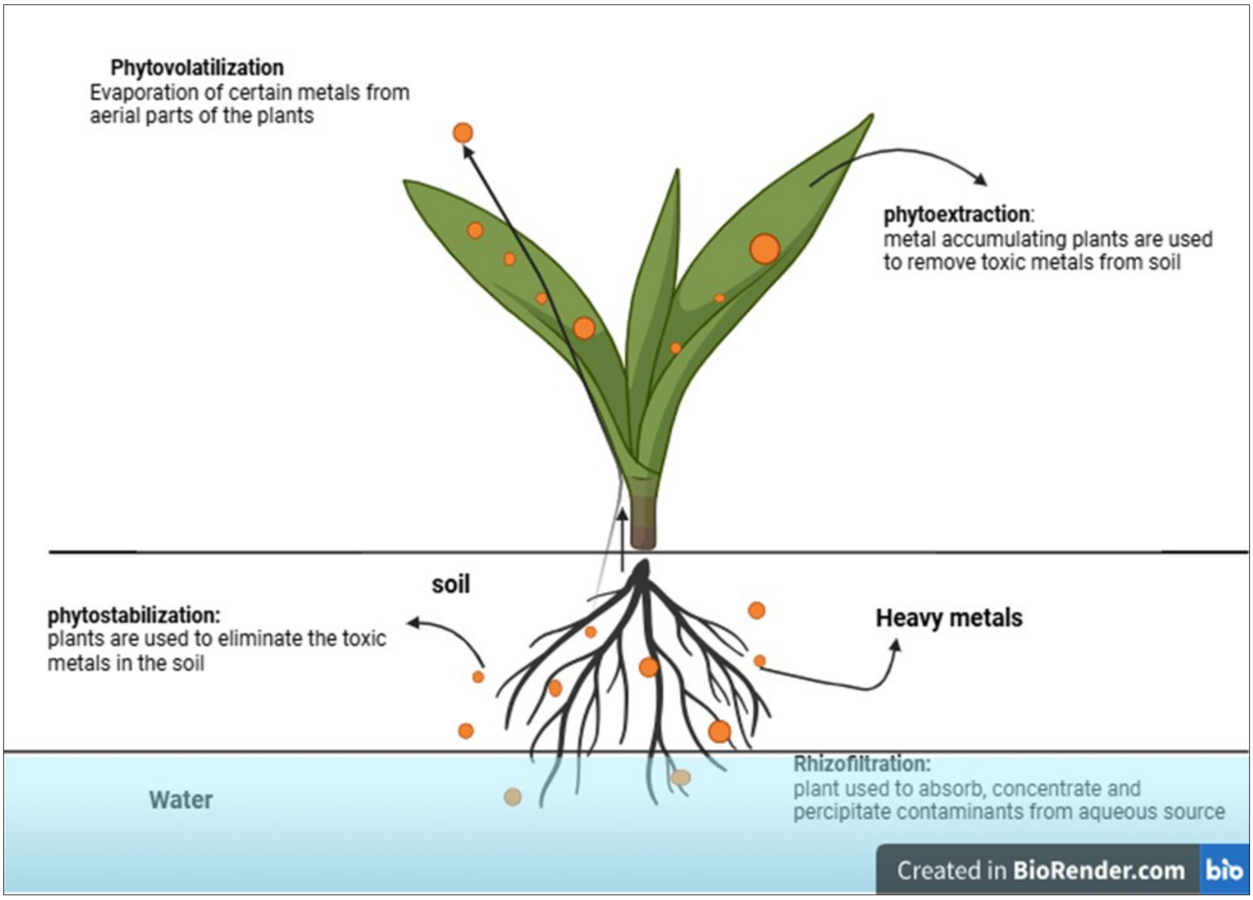

Fig. 4. Process of phytoremediation.

effects. Many people agree that phytoremediation is an affordable method of restoring the environment. An alternative to engineering techniques that are typically more harmful to the soil is phytoremediation. To achieve acceptable levels of pollutants in the environment, phytoremediation of contaminated sites should ideally take no more than ten years. It involves removing heavy metals via several processes, including phytoextraction, rhizofiltration, phytovolatilization and phytostabilization.

Phytoextraction involves plants absorbing pollutants from their surroundings through their roots and storing them in their aerial parts. It may remove heavy metals from contaminated environments while maintaining soil fertility (75). The capacity of plants to accumulate pollutants in the aboveground, as well as harvestable biomass, is used in phytoextraction (Fig. 4). There are two types of phytoextraction: induced (using chemicals to improve the bioavailability of metals in the soil) and continuous (using metal hyperaccumulating plants or fast-growing plants). The foundation of continuous phytoextraction is the capacity of some plants to progressively incorporate pollutants, primarily metals, into their biomass. Metals can build up excessively in some plants without causing harm. These plants are suited to metalliferous, naturally occurring soils. Over 400 plant species have the ability to hyperaccumulate different metals. However, only one particular metal may be hyperaccumulated by the majority of plants. On the other hand, contaminants, including heavy metals, are absorbed by plant roots (rhizosphere) from the water during the rhizofiltration process (76).

Phytovolatilization converts heavy metals stored in aboveground biomass into less harmful volatile forms, which are then released into the atmosphere (77). The process by which pollutants are absorbed by plant roots, transformed into a gas and then released into the atmosphere is known as phytovolatilization. Plant evapotranspiration is what propels this process (Fig. 4). phytovolatilization, plants with a high rate of evapotranspiration are desired. Plants passively volatilize organic pollutants, particularly volatile organic compounds (VOCs). Phytovolatilization removes heavy metals from polluted sources without requiring harvesting and disposal, unlike other phytoremediation techniques (78).

Phytostabilization aims to keep pollutants in the soil and stop them from spreading. It is possible to stabilize contaminants in the rhizosphere or the roots. Certain plants' roots release natural chelates that can combine with metals in the rhizosphere to form complexes. These consist of phenolics, organic acids and siderophores. Enzymes on the roots of wetland plants can change metals like the poisonous Chromium (III) into the far less dangerous Chromium (VI). It converts harmful heavy metals into less toxic forms, reducing their mobility through redox enzymes in the root zone and preventing their entry into food chains and groundwater (79).

Using plants and related soil bacteria, phytoremediation is a new technology that provides an affordable way to lessen the amount of pollutants in the environment or their harmful effects. Among the technologies used in phytoremediation are (a) phytostabilization, which keeps contaminants in the soil; (b) phytodegradation, which turns organic contaminants into less toxic forms; (c) phytovolatilization, which turns contaminants into gas inside plants and releases it into the atmosphere through evapotranspiration; and (d) phytoextraction, which uses plants to accumulate contaminants in the aboveground, harvestable biomass.

Greywater treatment and purification

Due to rising worldwide water scarcity, on-site source-separated treatment and reuse of less polluted greywater is a viable solution (80). Treated greywater can be utilized for irrigation, car washing, toilet flushing and firefighting. Different countries implement greywater treatment and reuse technologies for a variety of reasons (81). India, a heavily populated, tropical and drought-prone country, requires greywater reuse technologies (79).

A greywater purification system utilizing woodchips, a sand filter, banana peels and coconut husk layers with varying removal efficiencies was constructed (Table 3). The filter unit was made of a rust-resistant PVC container measuring 100 cm in height and 30 cm in breadth. Layers of materials, including sand, gravel, fly ash, banana peels, woodchips and coconut husk, were placed in the container, leaving a 20 cm free space above the filter medium. The requirements for these layers are shown in the table. Both raw and filtered greywater were tested using several criteria such as pH, turbidity, COD and BOD (79).

Greywater reuse strategies

Greywater generation in a household varies based on conditions and the number of people. This plan depicts our greywater treatment and reuse system for a single dwelling. Tank 1 stores fresh water, while blue pipelines supply it to the kitchen sink, washbasin, laundry and bathing areas. Separate pipelines must be constructed in the house to collect greywater from individual sources. Greywater is collected using gravity.

Greywater is routed underground to a collection tank. Black pipelines depict greywater collection pipes. After the collection tank, the filter unit is placed to treat greywater as needed. The filtering device is located next to the collection tank. Greywater travels to the filtration unit via pipelines. Greywater will be treated and utilized for various uses, such as toilet flushing and household tasks, using separate pipelines. In addition, the water can be used for gardening at home. Greywater can also be used to treat artificial or imitation fountains (79).

Table 3. Filtration layer

Filter layer	Size/(cm)
Large-size gravel (at the bottom)	15
Small and medium-sized gravel	10
Powdered fly ash bricks	6
Small-sized gravel	8
Coconut husk	10
Wood chips	8
Banana peels	8
Fine sand	20

Results

Urban greywater use in city gardens has become an accepted method for alleviating water scarcity issues, with numerous studies suggesting considerable potential in its use for reducing freshwater consumption. Research suggests that when treated sufficiently, greywater from bathing and laundry can be safely used to irrigate urban gardens, often resulting in household water savings of 30 % and 50 %. The success of such implementations depends on several critical factors, including the selection of suitable treatment systems, soil properties and plant types. Although greywater may possess elevated levels of salts, surfactants and organic materials compared to freshwater, these challenges can be effectively mitigated through appropriate filtration and application techniques. There are numerous case studies from various cities that report the success of greywater irrigation systems in community gardens, rooftop gardens and residential areas. However, researchers emphasize the need for continued monitoring and maintenance to ensure long-term safety and effectiveness. The economic benefits of greywater systems are offset by initial installation costs over a period of 2-5 years due to reduced water bills, as well as through improving urban water security and aligning with the sustainable urban development objectives.

Conclusion

The review states that using greywater footprints offers a compelling way to enhance sustainability in urban gardens by addressing significant issues such as environmental harm and water scarcity. Urban gardeners can significantly reduce their reliance on potable water while promoting resource conservation and efficiency by repurposing greywater from conventional wastewater systems for irrigation. The sustainable management of greywater in urban gardens offers several benefits, such as enhanced soil fertility, improved plant health and reduced water consumption. Additionally, utilizing nature-based systems for treating greywater illustrates the potential for low-energy, cost-effective methods that align with ecological principles. Furthermore, incorporating greywater management strategies into urban gardening not only promotes the plant growth and community resilience but also adds to broader sustainability objectives, such as climate adaptations.

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Authors' contributions

SRKC carried out the survey, analyzed the data and formulated the manuscript. GRV assisted in data collection and Analysis as part of the research study. AM and SK contributed by developing ideas, reviewing the manuscript and assisting with procuring research grants. SKB provided additional support and contributions to the research study.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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