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Ecosystem Service of Urban Green and Blue Spaces towards Sustainable Urban Ecosystem: A Meta-Analysis

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Abstract

Globally, cities face daunting challenges such as climate change, water insecurity, air pollution, and ecosystem depletion which are worsening public health and well-being. Currently, cities are looking for new strategies to deal with climate-related impacts and other environmental issues by protecting urban blue and green spaces. The paper's main objective is to explore and establish the socio-economic, and environmental benefits of Green and Blue Spaces (GBS) through a systematic review of the literature. This can help for the re-establishment of GBS activity. Findings suggest that increased urbanization and development have placed the urban green spaces under extreme pressure, while unplanned urban growth resulted in the loss of urban ecosystems. This paper underlines the significant contributions of Urban GBSs to improve the Urban Ecosystem to ensure social and economic and environmental sustainability. The GBI has multiple social, economic, cultural, and environmental benefits for the urban and pre-urban inhabitants. These include; social benefit (health and wellbeing, recreational and educational value); economic benefits (economic value, energy-saving, and green job opportunities), and the environmental benefit of GBI (includes an ecological response, carbon reduction, and sequestration, improving urban air quality and climate change and adaptation response).

Keywords: Ecosystem Service (ES); Green and Blue Spaces (GBS); Urban Ecosystem (UE); Sustainable Development (SD); Urban Heat Island (UHI)

Introduction

Background

The impacts of climate change are affecting people on a more frequent basis. As a result, climate change adaptation has become a key topic in environmental sciences. However, humans are still dependent on nature for their livelihood and human well-being and health are closely related to the availability of nature.

Rising urbanization causes 50% of the world's population to become increasingly dense and wide, most often at the expense of green areas. More than 50% of the world's population lives in urban areas, making the urban environment the most common habitat for man. Nearly 70% of the world's population is expected to reside in urban areas by 2050. Urbanization trends of half of the world's over seven billion people also indicate that an additional three billion people will be living in cities by 2050, increasing the urban share of the world's population to two-thirds. According to and report, Planning for environmental sustainable cities is a complex process addressing the fundamental areas of socio-economic equitable sustainability, according to the World Sustainability Report by the United Nations Environment Programme (UNEP) and the City of London's Department of Planning and Urban Development (COP).

The global climate is changing rapidly and is predicted to change at an even faster rate in the future. The mean surface air temperature has increased by 0.5°C in the twentieth century and will rise by 1.5 to 4.5°C by the end of the next century, which poses a critical threat to the environmental system. The increase in air temperature is mainly caused by the increasing emissions of Green House Gases (GHG) [1].

Urban areas with populations of 50,000 or more can be particularly vulnerable to these changes due to UHI effects and exacerbated effects of drought and extreme storms due to impervious cover and a high concentration of built structures. UGBI and the ecosystem services it provides are important to increase the resilience of cities against the impacts of climate change and natural hazards such as droughts and floods. UGI is meant to reduce the UHI effect, and improve limited water retention and infiltration capacity in densely urbanized areas, while at the same time enhancing biodiversity and human.

In this paper, current scientific works of literature were reviewed and analyzed with the aim of the Value of Urban GBS for improving UE, urban GBS type, and methodological aspects (study type, use of contrasts, and ES indicators). Based on the findings of the literature review, potential directions and recommendations will be identified for future research [2].

Concepts and Types of UE

Urban water bodies (blue space) and vegetated open spaces (greenspace) are key sites for building urban sustainability, promoting social, economic, and environmental objectives, and influencing human well-being. Building sustainable cities require an understanding of how urbanities value these amenities, how values vary within cities, and of the factors influencing these values. A UE is simply the community of plants, animals, and humans that inhabit the urban environment.

According to 'urban blue space' and 'urban water bodies; refer to all substantial bodies of static or dynamic surface water found in urban areas. Urban blue space is often also created and/or managed

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specifically to provide key ecosystem services. These include canals for transport and more recently sustainable drainage and rainwater harvesting systems.

Urban GBSs provide multiple benefits to city dwellers. These include mitigation of pressures such as air and water pollution, heat stress, noise, and flooding, as well as more direct benefits resulting from access to green space which improves physical and mental well-being.

The types of Urban Greens are classified into different types mentioned in Urban Green Guidelines, 2014. They are 1) Reserved Forests, 2) Protected Park 3) National Park 4) District Park 5) Neighborhood Park 6) Tot lots 7) Playgrounds 8) Green Belts 9) Green Strip 10) Tree Cover. Generally, playgrounds, botanical gardens, parks, open spaces, water bodies, and other natural features are classified as recreational areas.

According to the GBS are clustered through an iterative process with distinct GBS types:

Methods

The open search for scientific articles was based on the terms "Urban green space", "UE services", "Urban blue space". To identify and analyze the scientific literature relevant to paper objectives, it is carried out a meta-analysis of published scientific papers. The search results started from 1990 to 2022 listed approximately 2,000 papers arranged according to importance. The first 650 results listed papers that included two or more search terms. 104 potentially relevant papers were scanned that are relevant to the paper's aim.

A cumulative number of peer-reviewed publications assessing urban ES about urban GBI published between 1990 and Jan 2022 (N = 645) showed up to the year [3].

Socio-Economic and Environmental Benefit of Urban GBS

Socioeconomic Benefits, Health, and Well-Being

According to "Urban green spaces may reduce cardiovascular diseases exaggerated by heat stress or noise because of their climate regulation and noise-buffering potential". Mental health is truly strengthened when urban planners deliberately design GBSs so that they feel safe for marginalized communities, have features for seniors and youth alike, and are open and easily reached by all.

Reducing polluted runoff that flows into rivers, streams, and coastal waters is a cost-effective strategy to ensure that these waters are safe for swimming, boating, and fishing. The study by, showed that "illness and death caused by eating contaminated seafood is estimated to cost local economies an average of $ 22 million per year from missed workdays, medical expenses, and investigation of the contamination". Illnesses attributable to water contaminated by urban runoff can have a substantial economic impact. Hence, Urban green and blue can have significant contributions to minimizing pollution and providing a healthy environment.

According to people, over 3.5 million could be sick by water contamination from sewage. However, the presence of GBS reduces the pollutants that enter the water and can help to reduce the impact of these economic losses.

Various medical studies indicated that people living and viewing GBSs reduce stress which is confirmed by hospital patients and the general public. Thus, the connection between people and nature is significant and strong for everyday enjoyment, work productivity, and general mental health.

They found that people living around 2 km from the coast in Ireland were significantly more satisfied with their life than people living > 5 km away. They have mentioned in the research that in Canada, living near the coast or inland water bodies is associated with better mental health, e.g.), China on their findings provide the support that street view GBSs are protective against depression for the elderly in China, yet longitudinal confirmation to infer causality is necessary. Street view and satellite-derived GBS measures represent different aspects of natural environments. Both street view data and deep learning are valuable tools for automated environmental exposure assessments for health-related studies [4].

It was found that physical distancing measures caused a significant increase in the recreational use of urban GBS during the partial COVID-19 lockdown in Oslo (Norway), especially on trails within the greener and suburban periphery. They have analyzed the COVID-19 guides on the frequency of visiting the green area at the global, regional and national levels. For most countries, it is observed a higher number of park visitors from February 2020 than during the pre-epidemic period. It was stated that Restrictions on social gatherings and free movement and the closure of workplaces and indoor recreational places proved to be correlated with a higher park visit frequency.

In many developed countries, homes close to inland and coastal waters, especially those with blue space views, tend to be more expensive including in Hong Kong. Something which extends to hospitality globally with waterfront hotels and sea views commanding higher prices. Economists assume that people are willing to spend more on accommodation close to blue spaces because buyers derive extra benefit or 'utility'.

They found a protective effect for water bodies, whereby living closer to water bodies was associated with lower anxiety/mood disorder hospitalizations. In contrast, they observed that living closer to a land surface was associated with higher hospitalizations. Therefore, the economic benefit of GBS is for SD.

Ecological Response

There are many reasons for enlarging the networked system of GBS in cities. Urban GBS ameliorates the climate; filters the air, water, and soil of many pollutants; and provides a habitat for fauna and flora.

According to them, Vegetated areas provide locations where unsealed soils exist, thus simultaneously decreasing excessive surface run-off and combined sewer flows that damage local streams, and reducing the urban heat-island effect via greater evapotranspiration. These vegetated soils also may contain a greater diversity of microbes, such as mycorrhizal fungi that are beneficial to trees and other plants. Moreover, the effects of vegetation on the urban climate are important even in the case of small green spaces, like neighborhood parks [5].

Green spaces are important for nature conservation as they provide habitats for a wide range of flora and fauna. Urban green spaces provide cities with ecosystem benefits ranging from the maintenance of biodiversity to the regulation of urban climate. A study conducted in Turkey indicates that GBS provides many functions as a protection center for the reproduction of species and the conservation of plants, soil, and water quality. In the study, green spaces that feature good connectivity and act as wildlife corridors or function as urban forests can maintain viable populations of species that would otherwise disappear from built environments.

The ecosystem services associated with UGI can be further divided into provisional and regulatory services also, psychological wellbeing.

The ecological benefits of urban green infrastructure are largely related to the provision of habitat. There is a big variation compared with rural areas, in solar input, rainfall pattern and temperature are usual in urban areas, hence solar radiation, air temperature, wind speed, and relative humidity vary significantly due to the built environment in cities.

In UK Neighborhoods, Cities and Regions Analysis Division analysis indicated that the ecosystem is finely tuned with plant and animal species highly interdependent for survival. Thus, urban green spaces provide valuable habitats for animals and plants but species can respond strongly to environmental change.

Studies carried out in London illustrated that green spaces are increasingly being recognized for their ecological significance. The combination of mowed turf, trees, and natural areas provides a diverse environment for people and wildlife, and preserving these green spaces improves the environmental quality of the entire community.

In serving the Energy crisis, by increasing vegetation strategizing cost-effective measures by improving the air circulation of the city, in turn, helps in making a conductive environment for the residents.

Urban GBS Structure and its Potential for Carbon Sinks

Carbon stored and sequestered by the urban forest may vary between and within the urban areas. Apart from absorbing the atmospheric carbon, they also reduce carbon emissions from residential buildings by shading which decreases the demand for cooling, which in turn decreases power plant emissions. The trees should be fast-growing, increase biomass at a fast rate, and should have a huge canopy. Green roofs, bio-retention/rain gardens, and trees provide carbon reduction benefits by sequestering CO_2 from the air as they grow. Vegetation intercepts airborne particulate matter (PM10), reducing concentrations in air, thereby improving air quality. This reduces the amount of PM10 exposure to humans and, in turn, reduces the incidence of respiratory illness [6].

Recent research shows that 12 million tons of dust, soil, and other particulate matter can be purified and trapped by GBSs in combination. Various studies explored the links between urban tree cover and air quality.

The city of Tshwane Metropolitan Municipality (South Africa) has 115,200 indigenous street trees planted during the period 2002-to 2008. It has been estimated that tree planting will result in 200,492 tons of carbon dioxide equivalent reduction and that 54,630 tons of carbon will be sequestered. Carbon sequestration in Pune City (India) is 1% of the total standing biomass. Accordingly, the trees of the city are currently sequestrating 15,000 tons of carbon each year; indicating that 2% of the city's emissions are absorbed and 98% remains atmospheric overload. Within Pune City, the most crowded area shows excess carbon emissions because of high population density and fewer trees covered.

Hence, understanding the importance of carbon dynamics by planners and conservationists will be helpful for urban planning. Carbon stored and sequestered by the urban green and blue area may vary between and within the urban areas. Apart from absorbing the atmospheric carbon, they also reduce carbon emissions from residential buildings by shading which decreases the demand for cooling, which in turn decreases power plant emissions.

Urban Air Quality Improvement

GBS acts as a filter to improve air quality, in this case, vegetation and water body have a great contribution to improving air quality by removing gas and dust-related pollutants. Certainly, improvements in air quality due to vegetation have a positive impact on physical health with such obvious benefits as a decrease in respiratory illnesses. Major pollutants in urban areas are Carbon Monoxide (CO), Nitrogen Oxides (NOx), Ozone (O_3), Volatile Organic Compounds (VOCs), Sulphur Dioxides (SO_2), and particulate matter.

GBS can have a positive impact on air quality. Vegetation is capable of removing Ammonia (NH_3), Carbon Dioxide (CO_2), Oxides of Nitrogen (NOx), Ozone (O_3), Particulate Matter (PM; dust), and Sulphur Dioxide (SO_2) from the air. The ability of trees to intercept pollution varies between species, throughout the age of the tree, and with the planting design. A case study carried out in West Midlands on urban forests reported that some species of tree have a greater potential to improve air quality (O_3, NO_2, HNO_3, NO, and PAN) while others could have a detrimental impact. While, a recognized ES provided by urban trees and vegetation mainly improves air quality in cities and towns. This can have positive impacts in terms of climate change mitigation (CO_2) and human health (PM, SO_2, and O_3).

A recent study used a suite of models to predict the impacts of a 10 x 10 km area of the proposed East London Green Grid on particulate pollution. This estimated that 25 percent tree cover (20 percent broadleaf, 5 percent conifer) on the green spaces could result in 90 tons of particulate matter being removed from the air each year, corresponding to the avoidance of two deaths and two hospital admissions per year (Standards, n.d.).

A study in the City of Portland, on green roofs, showed that each square foot of green roof removed 0.04 pounds of dust and particulate matter out of the air. Their analysis found that "one 40,000 square foot green roof would remove 1,600 pounds of particulate matter from the air every year and would yield $ 3,024 annually in avoided healthcare costs". Therefore, the use of urban GBS offers significant potential in moderating the increase in summer temperatures expected with climate change [7].

Climate Change & Adaptation Response and Urban Heat Islands

GBS can also play an important role in dropping some of the influences of climate change in urban environments. GBS alleviates the impacts of climate change, such as flooding and the heat-island effect, and brings effective ecosystem services that are expensive and hard to exchange with man-made solutions. Urban areas have significantly warmer air and surface temperatures than their surrounding rural areas. Buildings, roads, and paved surfaces store heat during the day which is then released in the evening and night resulting in increased temperatures.

UHI is a complex phenomenon experienced by cities around the globe, resulting in increased heat retained by dark, often impervious surfaces which gain and hold heat during the day and slowly release heat over the nighttime. Studies analyzed that the result is higher nighttime surface temperatures which start the city at higher temperatures the following morning. These increased night-time temperatures affect plant growth, agriculture, habitat, animal life, and even human health and well-being. As daily temperatures rise worldwide, this effect has been increasing, although the factors which can impact the intensity of UHI are not well understood.

The main cause of the UHI effect is the modification of land surfaces. The UHI effect can be reduced by increasing vegetation cover with sufficient soil moisture for evapotranspiration.

Gill (2007) showed that increasing urban green cover, in high-density areas could decrease the expected maximum surface temperature in the 2080s by approximately 2.5°C). The use of urban GBS suggests significant potential in moderating the increase in summer temperatures expected with climate change. Mainly in urban areas, where evaporative cooling and shading provided by the green infrastructure can ensure that towns and cities continue to be attractive and comfortable places to live, work, visit and invest [8].

UEs are subjected to high temperatures extreme heat events, chronically hot weather, or both through interactions between local and global climate processes. United Nations 2004 mentioned that regionally enhanced urban temperatures, commonly referred to as Urban Heat Islands (UHI), create many socio-ecological challenges for cities, which affect the majority of the world's population who now live in urban centers. The interactive dynamics in the Food, Water, and Energy System as a Nexus (FWEN) are critical to the SD of global cities, and they can be mediated by Green and Blue Infrastructure (GBS) in the urban area.

According to, Increasing trees and vegetation in urban areas is one strategy for mitigating UHI effects and cooling is one of many reasons why urban forest expansion programs are becoming popular. Urban green spaces reduce the UHI effect and impact social equity by reducing energy costs, improving human living conditions, providing food and habitat to wildlife, and improving aesthetics and land values.

Studies considering the cooling benefits of blue space are relatively fewer in comparison to greenspace and tend to focus on the daytime influence on urban temperatures.

Generally, the blue space effects on the UE are important for cities and towns. Blue spaces have long been considered a possible mitigation strategy to ameliorate the UHI. However, the knowledge regarding the interaction of water bodies with their urban surroundings is still limited.

Most large towns and cities are sited on the coast or near large inland water bodies to exploit the potential benefits to human well-being they provide. Blue spaces, especially in the urban context, offer important temperature regulation processes, absorbing heat during the day when air temperatures exceed water temperatures and releasing heat during the night when water temperatures exceed air temperature.

A study done in 2016 has discussed that according to air pollution blue spaces have the kind of direct air pollution mitigation effects that green spaces might have. Nonetheless, green spaces need water to maintain their greenness, thus eventually water is needed for even greenspace's ability to reduce air pollution. Therefore, the linkage between urban and green can increase the benefit to the UE [9].

Conclusion and Recommendation

Green and blue infrastructure practices can be less expensive and more cost-effective than traditional infrastructure approaches, say researchers. They can increase energy efficiency and reduce energy costs, improve air quality, mitigate climate change and flooding impact, improve public health and keep the quality of city life and attract visitors.

Developed countries have established ground and go far to exploit benefits obtained from each GBI activity. African countries have remained very huge assignment to get the optimum benefit from GBI. Constraints regard to GBI development include a lack of political will, declining revenue budgets, and increased maintenance responsibilities.

Conservation and GBS implementation have a great potential to conserve the surrounding environment and protect water bodies from polluted runoff and waste.

The ambient temperature in urban areas is usually several degrees higher than that of their surrounding suburban and rural areas. A green roof is one of the best technologies to reduce energy for heating and cooling and minimize the UHI effect as a whole, but it is not common in Ethiopia [10].

Investments in green infrastructure provide jobs as well as business opportunities. Studies showed that globally up to 25 million new green jobs will be generated by 2050. GBI investment has a great contribution to creating new economic and job opportunities for the lower community members. It also helps to build partnerships with different institutions and stakeholders.

Urban green areas can provide and maintain a wide range of basic ecological, social, and economic functions and values upon which human well-being depends. This Paperwork calls for increased research attention towards increasing the coverage of less studied ES, GBS types, and regions.

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Conflict of Interest

None

References

1. Katsman CA, Sterl A, Beersma JJ (2011) Exploring high-end scenarios for local sea level rise to develop flood protection strategies for a low-lying delta the Netherlands as an example. Climatic Change 109: 617- 645.
2. Sterr H (2008) Assessment of Vulnerability and Adaptation to Sea-Level Rise for the Coastal Zone of Germany. J Coast Res 242: 380-393.
3. Thomsen Dana C, Smith, Timothy F, Keys, Noni (2012) "Adaptation or Manipulation? Unpacking Climate Change Response Strategies". Ecol Soc 17: 3-5.
4. Prandi P, Meyssignac B, Ablain M, Spada G, Ribes A, et al. (2021) Local sea level trends, accelerations and uncertainties over 19930-2019. Sci Data 8: 1-12.
5. Hereher ME (2020) Assessment of climate change Impacts on sea surface temperatures and sea level rise. The Arabian Gulf Climate 8: 50-52.
6. Strohecker K (2008) World sea levels to rise 1.5 m by 2100: scientists, a New scientist news service and Reuters publication.106: 21527-21532.
7. Milne GA, Gehrels WR, Hughes CW, Tamisiea ME (2009) Identifying the causes of sea-level rise. Nat Geosci 2: 471-478.
8. Vermeer M, Rahmstorf S (2009) Global sea level linked to global temperature. Proceedings of the National Academy of Sciences of the United States of America. 106: 21527-21532.
9. Rahmstorf S (2010)A new view on sea level rise. Nature Reports Climate Change. 8: 50-52.
10. Aldogoml D, Albesher S, Al Mansoori S, Nazzal T (2020). Assessing Coastal Land Dynamics along UAE shoreline using GIS and Remote Sensing Techniques. IOP Conf. Series: Earth and Environmental Science 540: 012031.