Strategies of Urban Green Infrastructure Planning in Existing Cities

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Abstract: Year after year, the impacts of climate change become more destructive. Accordingly, finding the appropriate solutions to adapt with such impacts begins to be a constant concern of many cities worldwide. In this field, urban green infrastructure or (UGI) provides appropriate solutions for different climate change impacts such as floods, urban heat island, pollution, drought, water scarcity, soil erosion, energy deficit, etc. Literature review indicates a limited knowledge about UGI planning strategies as climate change adaptation (CCA) in existing cities. Accordingly, the current research seeks to extract these strategies from the real world practices of UGI. The applied methodology is known as 'learning by doing'. Many eminent practices of UGI planning in existing cities for the purposes of CCA are selected. A cross analysis is conducted between them to extract their common UGI strategies. The research's results reveal that the explored practices almost depend on similar strategies which based on injecting the natural green and blue assets into the exiting urban land uses such as streets, parking, public buildings, etc. This strategy can be called "urban green injection". So, the opportunity to have UGI in the crowded cities depends on the innovative investment of the public land uses and converting them to vegetated or water-covered assets. Following such a strategy can ensure the alteration of the city image from the traditional natural-lacking character to a more sustainable and vibrant one. Adopting urban green injection can also ensure the maximum possible benefit of UGI employing as it was extracted from the successful outcomes of other practices.

Keywords: Strategies; Urban green infrastructure; green injection; Existing cities

الخلاصة: تزداد اثار التغيير المناخي دماراً عاماً بعد عام. لذا فأن ايجاد الحلول المناسبة للتكيف مع هكذا اثار قد اصبح الشغل الشاغل للعديد من المدن حول العالم. بهذا الخصوص تحديدا، توفر البنى الارتكازية الخضراء جؤاباً موحداً للعديد من الاسئلة حول الحل المناسب للتعامل مع التبعات المناخية المختلفة كالفيضانات والجزر الحرارية الحضرية والتلوث والجفاف وندرة المياه وانجراف التربة ونقص الطاقة وغيرها الكثير. وجد من خلال مراجعة عدد من الدراسات ذات الصلة ان هنالك قلة في المعرفة المتوفرة حول ستراتيجات تخطيط البنى الارتكازية الخضراء لاغراض التكيف مع التغيير المناخي في المدن القائمة. لذا فان هذا البحث يهدف الى توفير المعرفة حول هذه الستراتيجات. يفترض البحث امكانية استنتاج هذا الستراتيجات من ممارسات العالم الحقيقية للبنى الارتكازية الخضراء. تعرف هذه المنهجية بـ" التعلم من خلال التطبيق". وفقا لذلك، فقد تم انتخاب ثلاث تجارب سابقة لتخطيط البنى الارتكازية الخضراء في المدن القائمة. بعد ذلك، تم عمل تحليل مقارن بين هذه الممارسات لاستخراج ستراتيجاتها. وقد وجد نتيجة لذلك، ان التجارب الثلاثة قد اعتمدت تقريباً على ستراتيجات متشابهة في تخطيط البنى الارتكازية الخضراء. وان هذه الستراتيجات قد تمثلت بحقن العناصر الطبيعية الخضراء والزرقاء في استخدامات الارض القائمة كالشوارع ومواقف السيارات والابنية العامة وغيرها. لذلك فأن من الممكن ان تسمى هذه الستراتيجية بستراتيجة "الحقن الحضري الاخضر". وفقاً لهذه الستراتيجية فان فرصة وجود البنى الارتكازية الخضراء في المدن المزدحمة تعتمد على الاستثمار المبتكر لكل الاستخدامات العامة وتحويلها الى عناصر مزروعة او مغطاة بالمياه. ان اتباع مثل هكذا ستراتيجة يضمن قلب الصورة التقليدية للمدينة الى صورة اكثر استدامة وحيوية. كما وتضمن استراتيجية الحقن الحضري الاخضر تحقيق اعلى الفوائد الممكنة ذلك لكونها قد بنيت من الاساس على النجاح الذي حققته التجارب الرائدة السابقة.

1. Introduction

Climate change (CC) continues to happen and its impacts continue to be disruptive. In the past, it caused many species' extinction, large people migration, and many substantial weather changes. So, CC is not a new phenomenon but what is new is increasing the speed of current CC which surpasses the earth's natural ability to absorb or cope. Accordingly, CC became the center of global concern [1]. CC is an inevitable result of the increase of long-lived greenhouse gases (GHG) within the atmosphere. Greenhouse gases trap the solar radiation that reflects from the earth and return it towards the surface. In nature, this process is essential to keep the climate warmer; without it the earth's temperature would be 30° C lower than what it is today. These gases are in a continuous manner of increase. In 2016, for example, it was found that GHG concentration has increased by 46.7% above what it was in 1990. It was projected that this percentage will still grow in the future [2]. Observational evidence proved that global warming had caused many CC impacts [2]. According to UNFCCC, the most frequent identified impacts sequentially include extreme weather (e.g., hurricanes and cyclones, heatwaves, sand and dust storms, wildfire and cold spells, etc.), floods, precipitation change, droughts, temperature rise, sea level [2].

Cities play a crucial role in CC formation as they are responsible for producing about 70% of GHG emissions. On the other hand, cities are more vulnerable to CC impacts than other areas. That is because they already have relatively higher temperatures than rural and non-urban sites [3]. Many pieces of evidence assured that cities' climate is warming up rapidly than rural areas causing the formation of the 'urban heat island' (UHI) phenomenon [4].

To deal with such impacts, many adaptation strategies were adopted. Levina and Tirpak (2006) approved, by conducting a detailed

comparison among the publications of many adaptation- promoting organizations, that there are no single unified definitions for the key terms of climate change adaptation (CCA). Each organization such as IPCC, UNFCCC, UNDP, UKCIP, etc. has its definition for CCA and its related terms. This means different interpretations, expectations and aspirations for different stakeholders. In the light of this, Levina and Tirpak pointed out the urgent need to find a unified precise definition across institutions and organizations to achieve more progress in the field of CCA [5].

IPCC in 2014 defined CCA as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects" [6]. While UNFCCC refers to CCA as "adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change" [7]. UKCIP adopts a definition which is very similar to that of IPCC as "the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" [8].

To define adaptation, these three organizations use the same key term of an "adjustment" in response to the same stimuli of "actual or expected climate and its effects" to achieve the same aim of "moderate harm or exploit beneficial opportunities". So, the difference between the global organizations concerning CCA becomes simpler than it was in 2006 when Levina and Tirpak reviewed it. Accordingly, the adopted CCA definition in the current research is as follows (the process and its result of depending the appropriate adjustments in the human and natural systems to cope with climate change adverse impacts and invest its beneficial opportunities).

Urban green infrastructure support the aims of climate change adaptation. In general, the term 'infrastructure' is used to indicate the systems and structures built-up by human to provide many services. In the 1980s, some scientific opinions considered the natural ecosystems as an 'infrastructure'. That is because these ecosystems, in case of being healthy, also offer many services which are essential to human life. This type of natural infrastructure was known as 'green infrastructure' [9]. UGI was clearly defined in 2013 by the Department for Environment, Food and Rural Affairs (Defra); one of UK twenty-five ministerial departments. The definition states that UGI refers to "the planned network of living systems either within urban areas or located outside but affecting the quality of life in urban areas". This network includes all green spaces, water elements and environmental features founded within and surrounding an urban area. According to Defra, UGI was used to achieve the local target of the green economy [10]. Accordingly, this research aims to offer knowledge about the strategies of UGI planning as CCA in existing cities. To achieve this aim the 'methodology of learning by doing' will be employed.

2. Literature Review

The term 'strategy' refers to "a long-range plan for achieving something or reaching a goal, or the skill of making such plans" [11]. So, following the appropriate strategy assists in achieving the pre-defined aims. Planning UGI as a vital strategy of CCA should depend on certain strategies and steps.

Related to the planning strategies of UGI, there are some publications which were presented by Jack Ahern, a landscape architect and regional planner [12] [13] [14]. In these publications, he assured that selecting the appropriate strategy of UGI planning must depend on the analysis of the site ecosystems and the pre-defining of the planning goals. So, he presented four main strategies which are:

- Protective strategy: this strategy is usually adopted prior to change as a local green ecosystem is already working efficiently. It includes many protective measures to prevent natural elements' structures and functions from getting damaged by any future change. Accordingly, natural assets will be proactively preserved before occurring of any physical or functional alternations [14]. The protective strategy features by two main characteristics; the first is defining the most desirable areas and protecting them and, concurrently, defining the most suitable locations for development or human change. The second is that the protective strategy is a low-cost strategy as it depends on preventing harm instead of treating it. This strategy employs some polices to achieve its targets such as planning theories, law and regulation, significant land acquisitions, education and public awareness, etc. [13].
- Defensive strategy: this strategy is usually adopted when the local green ecosystem is already getting harm such as fragmentation, exhaustion, etc. It includes many defensive policies that reduce and control that negative impacts of current changes [15]. This strategy refers to the 'last opportunity' to deal with harm as it seeks to put the current impacts of change on the brakes. If the climate impact is inevitable, the defensive strategy will not be useful any more as its role limits just on delaying the certain negative impacts [16].
- Offensive strategy: this strategy is usually adopted when the local green ecosystem is deficient and cannot work efficiently. It includes many restorative and remedial policies which aim to strengthen the ecosystem structures and functions. This strategy depends entirely on the spatial planning that takes the site's natural and social character in its account. The offensive strategy is usually requiring high costs and having uncertain results. This strategy involves replacing the current intensive pattern of development (i.e. high urbanized areas) with an extensive pattern where green and open spaces are dominated on the landscape scene [13].
- Opportunistic strategy: this strategy depends on functioning all the non-contributing natural elements which can deliver many

ecosystem services. These elements, regardless of their location, can present good opportunities to counter the change. The potential sites can be founded as separated green corridors and patches. Accordingly, the opportunistic strategy will work on linking them in a useful network [13] [14].

It can be noticed that all proposed strategies are "landscape strategies". This conclusion was based on the following aspects:

- All mentioned strategies propose, regardless of their conditions, the existence of natural ecosystems in the site. The studies assured that defining the appropriate strategy of UGI planning depends mainly on the conditions of the site's ecosystems; what is the current and
- previous status of these ecosystems, and what is the opportunity to enhance their functions and services.
- No mention was noticed about the built-environment or existing cities; the researches spatial scale.

The literature review reveals that there is limited knowledge about the strategies of UGI planning in existing cities.

3. Methodology

Identifying the strategies of UGI planning in exiting cities will be conducted by using the methodology of 'Learning by doing'. This methodology represents a reliable research approach which proved its success in the landscape researches. Learning by doing refers to the process of extracting the theoretical knowledge from the practical experiences [14] [17]. This methodology involves three main processes which are:

- Exploring the strategy of UGI in each practice.
- Proceeding a cross-analysis between the strategies of UGI planning between the selected case studies.
- Concluding the common strategies of UGI planning in existing cities.

In light of being similar as existing cities with arid and temperate climate that followed clear strategies of UGI planning, three main practices were selected. They include Philadelphia in USA, Melbourne in Australia and Tucson in USA. Some practices were also explored to offer more knowledge about the common strategies of UGI planning.

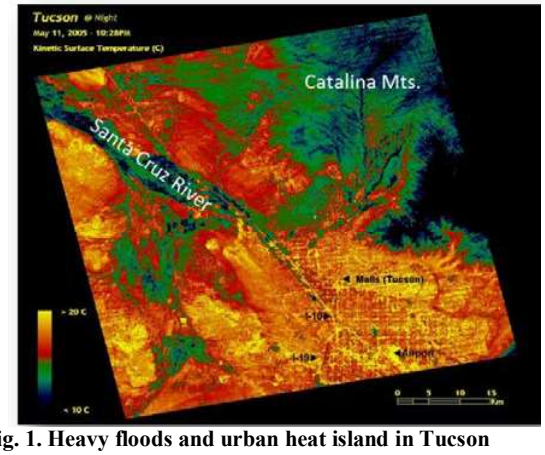


Fig. 1. Heavy floods and urban heat island in Tucson

3.1 Tucson, USA

Tucson is considered as one of the oldest settlements in USA as it dates back to about 2000 ago. Over time, it has developed from a small farming area to a huge urban city with about 520.000 population [18]. Most of the city's neighbourhoods are planned by following the network pattern (grid pattern).

In the first place, UGI was adopted to control floods and urban heat island (Fig. 1) [19]. Tucson's UGI strategy depends on the concept of 'stormwater harvesting' at the neighbourhood scale [20].

Although the primary target of adopting UGI strategy is to control floods, this strategy offers an integrated solution that can also provide many other services. These services include mitigating the urban heat island, increasing the green spaces ratio, supporting friendly environment transportation, etc. [19]. Urban heat island, for

example, has a high rate in the city of Tucson. This heat stress forms a real problem in the state of Arizona which witnessed the highest national rate of weather-related deaths since 1986 [21]. Trees, for example, can reduce the temperature of adjacent built surfaces by 4.45°C. Plants evapotranspiration can lower the air temperature in open green terrain and open suburbs which do not have trees [22].By detailing the potential risks of climate change, many maps have resulted. When these maps were overlaid, the priority places where UGI was needed became obvious. The most suitable spots to have UGI appeared where these maps intersected and overlapped. In general, Tucson's strategy of UGI depends on concentrating the assets in areas where rainwater usually collects instead of spreading them through the whole city [20]. The city UGI strategy includes many assets such as different types of native vegetation, surface mulch, heathy soil, vacant green plots, green street sides, in-street green assets and green parking lots (Fig. 2) ([20]. By reviewing some related publications [23] [20], it was found that most of these assets had previous grey functions as they related to the some grey infrastructure especially transportation. In addition to that, Tucson's UGI strategy was based on preserving nature in the sites of new development and protecting it in the sites of existing development [20].

Fig. 2. Heavy floods in Tucson

A- Native vegetation B- Surface mulch
C- Healthy soil D- Green vacant plots
E- In-street green assets F- Street green sides
G- Green parking

3.2 Philadelphia, USA

Philadelphia is the biggest city in Pennsylvania and locates at 40° 0′N and 75° 8′W at the eastern coast of USA [24] [25]. Originally, Philadelphia is planned by William Penn as a green country town. The city center, which dates back to the 17th Century, has a grid layout with an orientation of east-west and north-south. Within this grid, houses were separated by green squares to prevent the fire spread. This clear master plan cannot stop the parcels' division and the buildings' height increase [26].

UGI strategy was declared in 2019 to control the overflow of the combined sewer system. The combined sewer system, which serves about 48% of the city, refers to the sewer network that collects both of sewage and stormwater in the same tubes and carries them towards the water treatment plant to be reclaimed before discharging into the waterways. In case of moderate or heavy rainfall, the combined sewer system reaches its peak capacity and directly discharges sewage and stormwater into the city water bodies causing in clear water pollution (Fig. 3). The program of Green city- Clean water was identified to control this case of the combined sewer overflow.

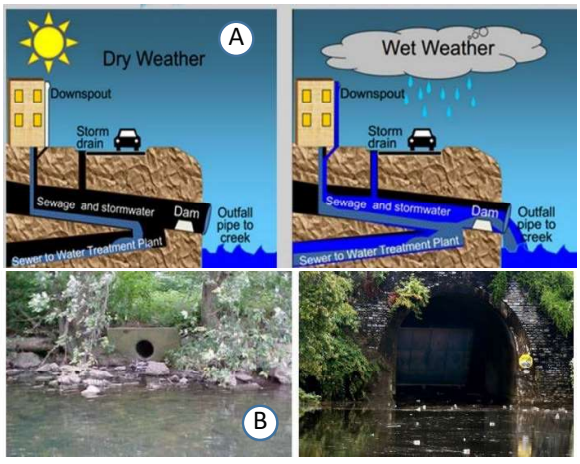


Fig. 3. Floods in Philadelphia

A- Work mechanism of combined sewer system in Philadelphia in dry and wet weather.
B- Rainwater discharge to Philadelphia waterways.

In addition to saving water quality and quantity, the Green city- Clean water program achieves multiple targets such as supporting the old local

infrastructure, controlling climate change other impacts, supporting sustainability and enhancing people well-being. So, this program lays the foundations to transform Philadelphia into a sustainable city [27].

Green city- Clean water program officially began in 2009. By 2035, this program envisions to transform about 35% or 10000 acres of the impervious land that is served by the combined water system to UGI or "Greened Acres". The green acer refers to a particular area of stormwater runoff from a given impervious surface that is controlled by UGI system instead of being directed towards the existing combined sewer system of Philadelphia [28]. This can be calculated by the following formula:

$$GA = IC * Wd$$

Where

GA: the green acres

I.C.: the impervious areas that were transformed into green infrastructure. This includes the area of UGI asset itself and the area served by it.

WD: the depth of the water that covered the impervious lands and managed by UGI.

UGI assets aim to control at least 1 inch of water; otherwise, it will be not feasible [29]. In general, Philadelphia UGI strategy consists of eight different "Green Programs" designed and managed to convert the city impervious lands into the Green Acres. These programs include green streets, schools, public facilities, parking, public open spaces, industry, alleys and homes (Fig. 4). The strategy also provides detail plans to restore and preserve the water stream corridors. By 2035, the target year of Green city-Clean water, over 80% of the impervious land should be converted to green acres [27]. So, these programs include a schedule of five-year plans to achieve this aim gradually [25].

In Philadelphia strategy, brownfield sites represent suitable opportunities to have new UGI within the urban context. UGI, in turn, can assist in converting the image of these sites that were previously used for industrial, commercial, store

Fig. 4. Green Programs in the city of Philadelphia
A- Green streets B- Green school C- Green public facilities D- Green parking
E- Green public open space F- Green industry
H- Green alleys I- Green homes

purposes and contaminated as a result of these uses [30]. An example of such type of UGI assets was the Kensington Creative and Performing Arts High School. It is one of the first components in the green city plan. This project's site was an industrial-contaminated that completely occupied by poor vagrants and unwanted pets. The location was also known as a suspicious area for recreational drug dealing and personal assaults (Fig. 4-B). A powerful youth concept presented to convert the site image from its original dangerous eyesore to a more environmental and social-friendly one. This concept was embodied in constructing a green high school with the minimum possible footprint and full on-site stormwater filtration [31]. This school's green elements formed the starting point for a wider UGI strategy at the city scale [32].

3.3 Melbourne, Australia

Greater Melbourne locates in the southern coast of south-eastern Australia. It is about at 37°49'S and 144°58'E, within the boundaries of Victoria state [33]. In general, Melbourne is featured by a low-density sprawl. In the city's inner areas, construction has predominantly occurred at medium density. Because there were no height limitations, Melbourne city center (CBD) and the surrounding areas have rapidly grown

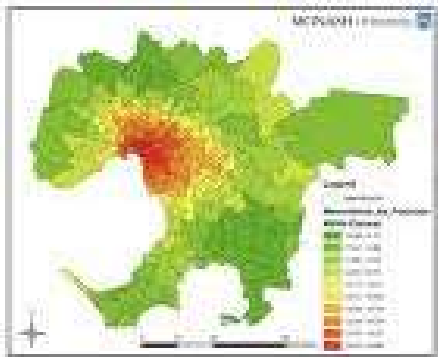
vertically. High skyscrapers dominate the city's skyline, turning it into Australia's most densely area [34].

In Melbourne, UGI strategy was planned to reduce the intensity of surface urban heat island (Fig. 5) [35]. It was found that surface UHI phenomenon has an intensity of about 4°C between Melbourne city center and the surrounding neighbourhoods. The leading causes of increasing temperature in Melbourne include the continuous vegetation loss, dense urban construction, impermeable surfaces increase, high anthropogenic heat, increased air pollution and high capacity and low albedo materials.

Melbourne's UGI strategy aims to reduce the surface radiation by reducing its temperature. This leads to mitigate the surface urban heat islands (SUHI). UGI strategy seeks to achieve this aim by increasing the green cover in the public spaces [36].

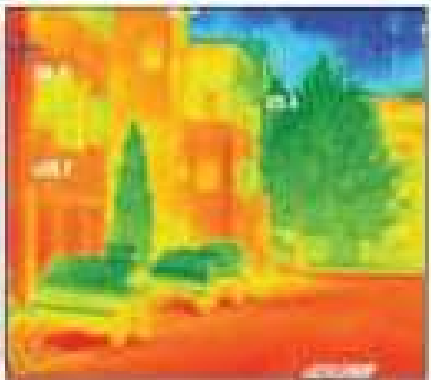
Many UGI assets were proposed for Melbourne. All selected assets have a clear effect of temperature reduction at the micro-scale climate [36].

The first represents the public open spaces such as parks, remnant areas, golf courses, and urban agriculture.



A

B



C

Fig. 5. Surface urban heat island in Melbourne

A- SUHI at the city scale using remote sensing techniques.
B- SUHI at the neighborhood scale using airborne thermal imagery.
C- SUHI at the street scale using a thermal camera.

Finding a space for this type of UGI asset is challenging and push to propose innovative solutions such as closing some quiet streets and converting them to small public parks. Others assets include street trees, green roofs, vertical greening system, pervious ground cover. Some additional supplementary assets were also included in the city's UGI strategy such as bio filters, rain gardens and vine-covered walkways. Melbourne's UGI strategy was mainly based on the concept of retrofitting the surface cover from built, impervious, low albedo and high heat storage to natural, filtrated and evaporation-allowed surfaces. This concept proposes many modifications in the existing urban fabric. It aims to retrofit streets, sidewalks, buildings, parking, etc. with intensive vegetation [36].

3.4 Urban Green Infrastructure in Other Practises

In this section, a quick view would be conducted about the employed UGI strategy in many cities around the world. In Menomonee valley in Wisconsin, USA, UGI strategy depends completely on greening the grey river bank. Menomonee valley industrial center and Community Park was considered as one of the most innovative examples of the greening riverbank, brownfield and vacant lands. In original, wetlands were the main theme of this site. In the late 19th century, the site was completely landfilled to establish a new highway road and offer more lands. Since then, the area was intensively used by the companies of railcars and locomotives industry. After companies' closing in 1985, the site was abandoned with hundreds of vacant buildings and acres of contaminated soils [37]. An innovative UGI master plan that balances the social, environmental and economic requirements intelligently was employed to redevelopment the site (Fig. 6). The site is converted to a home for 11 industrial buildings located at a wide green park [38].

Fig. 6. Menomonee valley industrial center and community park in Wisconsin

On the other hand, some more audacious examples of UGI strategy were employed to completely change the current land use to be ideal green activity. In Seoul, South Korea, a major highway of 5.84 km was converted into an ecological stream park (Fig. 7). Many alternative means of transportation was offered and supported. To construct this highway in 1967, Cheong Gye Cheon River had landfilled and covered. Accordingly, the redevelopment plan presented a pragmatic shift in the urban administration by restoring the original river and convert the heavy traffic line into an ecological park [39].

In addition to that, there are specific strategies that appeared in some famous practices of UGI. For example, in Stuttgart, all buildings, routs and means related to transport were greened even cars and buses [40]. In another example which is Québec, Canada, it was recommended for greening the car parking. That is by planting trees at the parameter and within the parking lots. Besides that, all the asphalt surface should be replaced by a mix of concrete, PVC and some other materials that allow plants to grow [41].

Fig. 7. Cheong Gye Cheon Restoration project

In addition to that, there are specific strategies that appeared in some famous practices of UGI. For example, in Stuttgart, all buildings, routs and means related to transport were greened even cars and buses [40]. In another example which is Québec, Canada, it was recommended for greening the car parking. That is by planting trees at the parameter and within the parking lots. Besides that, all the asphalt surface should be replaced by a mix of concrete, PVC and some other materials that allow plants to grow [41].

4. Cross-Analysis

To define the common strategies of UGI planning in existing cities, a cross-analysis was conducted between UGI strategies of the three selected practices. This analysis dealt with the following aspects:

- The definition of UGI strategy: the key terms of the adapted definition of UGI strategy are not typical or unified. In Philadelphia practice, UGI was defined as a group of soil-water-plants systems.
  In Tucson practice, it was stated as some constructed elements which employ natural systems, while in Melbourne practice as a connected network of natural and human-added vegetation. This assures that there is no single definition for UGI, but there is an agreed concept from which UGI definition was usually generated. This concept refers to the employment of nature to deliver multiple services.
- The type of UGI strategy: in Philadelphia, there are eight UGI assets which are green streets, schools, public facilities, parking, public open spaces, industry, alleys and homes. With an exception to public open spaces, all UGI assets had previous grey land uses and vegetation and natural elements were injected within them. In Melbourne, there are five proposed UGI assets which include public open spaces, street trees, green roofs, vertical greening system, and pervious ground cover. Four of these assets depends on retrofitting grey land uses with vegetation. The matter is similar in the practice of Tucson as all seven adopted UGI assets were injected within the transport land uses.
- The vision of UGI strategy: in all case studies, UGI strategies were declared as general planning vision with a specific sonorous name such as 'Green city- Clean water', 'harvesting the water', etc.
- The aim of UGI strategy: although UGI can achieve multiple purposes, it was noticed that UGI strategy in each case study involves a well-defined aim such as a desirable reduction rate of overflow or surface temperature.
- The opportunities of UGI assets: in the selected practices, most of UGI assets were added to the public land uses such as streets, parking, public building roofs and walls, etc.

The cross analysis reveals that, in general, there is a great deal of compatibility between the strategies of UGI planning as CCA in existing cities.

5. Extraction of Results

Based on the previous cross-analysis, some results about the strategies of UGI as CCA in existing cities were extracted. These results are represented in the following aspects:

- Urban green injection: UGI strategy, in existing cities, depends mainly on injecting the green and blue assets in different grey land uses such as the public buildings, streets, parks, etc. So, UGI planning strategy as CCA in existing cities can be called 'Urban green injection'. It is preferable to plan and design green infrastructure before starting the construction of any other grey components. In general, it was found that the cost of restoring UGI assets is much higher than the cost of its protection and enhancement. In addition to that, the human-made UGI networks cannot act so effectively like the original ones which develop and grow over time [42]. This does not mean that UGI cannot be used in existing cities that have already witnessed many development stages. But in this case, adopting UGI can be achieved by injecting the green and blue assets within the urban context.
- Planning for achieving the target function: UGI planning should perform an exact primary function. The other functions can be considered as supplementary benefits. This enables all involved stakeholders to directly measure and evaluate the UGI real effectiveness in achieving the target function. The additional functions presented by urban green injection increase this strategy's merit and make it more preferred than others of CCA.

- Starting up with public properties: urban green injection starts up with the public or city-owned properties. This can make UGI strategy more applicable and always under high control. Public or capital projects can act as demonstrating projects that assist in raising community awareness about UGI importance as a necessary type of infrastructure. So, most of UGI strategy are starting up with public properties. In private properties, regulation, incentives, grants and billing programs can be adopted to encourage the use of UGI assets.
- Depending on the site analysis: urban green injection relies on studying what the site offers of opportunities to inject the green and blue elements. In general, most of the urban public land uses can be converted to new UGI assets. So, a trade-off between the available opportunities and their potential UGI assets should be conducted. The urban green injection also depends on many site-related aspects such as the cost and funding, local laws and regulations, community cooperation, etc. To have a pragmatic strategy of urban green injection, defining the most suitable opportunities should be conducted according to both local incentives and constraints.
- Depending on innovation: urban green injection depends on the innovation to find the right method to green the available opportunities that are context-related and vary significantly from site to site.
- Having a clear vision: UGI project should be declared with a clear planning vision and a sonorous name. This will grant the strategy a unique character in the people mind. Having an effective name also helps in announcing and marketing the UGI strategy.

6. Conclusions

The current research aimed to offer knowledge about the strategies of UGI planning as CCA in existing cities. By using the methodology of learning by doing, it was proposed that these aspects of knowledge can be extracted from the UGI real practices. Based on the cross-analysis that was conducted between the selected practices, it was found that:

- Urban green injection represents the most employed strategy of UGI as CCA in existing cities. It refers to inject different natural assets within the traditional grey uses.
- Urban green injection should be planned to achieve a well-defined target.
- Urban green injection should begin in public properties.
- Urban green injection depends mainly on a comprehensive study of the site's incentives and constraints.
- Innovation plays an essential role in having an urban green injection that fits with the site's incentives and constraints.

In addition to that, it can be concluded that the strategy of urban green injection can extend to include almost all grey land use. So, UGI can be employed in densely cities by sharing the positions with grey infrastructure such as buildings, roads, planets, etc. Within the city master plan, these positions will have two land use; one is part of the conventional grey network and the other is a modern green infrastructure. These assets form the points where city infrastructure overlap. So, UGI assets cannot be limited to a certain fixed number as they depend on the opportunities that the context offers to inject the green and blue assets.

As a result, the strategy of urban green injection seeks to increase the city's green and blue percentage and convert the land use traditional character to a more sustainable one. Adopting such a strategy already employed in different cities and subjected to repeated evaluation guarantees success. That is by avoiding the potential loss of cost or time and thereby building the new strategy that depends on what has proved its worth. Such strategy offers an applicable method to plan a vital UGI in any city. So, future researches are required about the possibility of employing the strategy of urban green injection in Iraqi cities such as Baghdad city.

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