

Economic assessment of urban space and blue-green infrastructure in Singapore

Mabel Lim¹ and Stefanos Xenarios ^{2,3,*}

¹School of Design & Environment, National University of Singapore, 4 Architecture Dr, 117566 Singapore, Singapore, ²Graduate School of Public Policy (GSPP), Nazarbayev University, Kabanbay batyr Ave., 53, Block C3 (42), 010000 Nur-Sultan city, Republic of Kazakhstan and ³Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore, 469C Bukit Timah Road, 259772 Singapore, Singapore

*Corresponding author. E-mail: stefanos.xenarios@nu.edu.kz

Submitted: 18 March 2021; Received (in revised form): 12 June 2021; Accepted: 25 June 2021

Abstract

The urban conglomeration has accentuated the role of urban greenery as a determinant factor for sustainable living, especially in highly dense cities. The country of Singapore has consistently attempted to develop and rehabilitate urban greenery by attempting to align the green space policy with the pursuit of better life quality. In this study, we assess the benefits arising from the rehabilitated Bishan-Ang Mo Kio (AMK) Park in north Singapore and the effects on economic welfare. The Bishan-AMK Park was initially constructed in the late 70s as a drainage area for the avoidance of flooding incidents. In 2012, a pilot project was introduced to create a blue-green infrastructure (BGI) space for the provision of drainage and flood prevention but also for recreational and environmental improvement in the area. Yet, the benefits emerging from BGI are not well explored and still underestimated. To this extent, we evaluate selected services related to recreational, socio-cultural and tourism-related values by indicating the economic benefits from the introduction of BGI in condensed urban environments like Singapore. The findings indicate that the benefits deriving from the selected services could be within the range of US\$100 million to US\$220 million with a mean value of US\$160 million per year by substantially contributing to human well-being. The assessment of environmental services can raise the awareness of residents and local authorities on the contribution of urban greenery to livelihoods and economic development in Singapore and similar densely populated areas.

Key words: parks and reserves, economic valuation, environmental goods and services, river basin, Singapore

Introduction

The first insights into urban green infrastructure were traced in the UK by town planners in the late 19th century. It was during the First Industrial Revolution in the UK and more broadly in the western countries where the planning of residential areas was conducted far away from polluting industries due to health-related concerns (Brimblecombe 1978). The cities became gradually concentrated living enclaves whereas its wealthier residents began to seek green open spaces in the suburban areas or countryside. For those, however, without economic affordability to move out of the cities, the lack of green

space and scarcity of common areas became quite acute. Public parks were established even in the heartlands of big cities to improve the health of those living in polluted and crowded urban centers (Churchill, Crawford, and Barker 2018; Loughran 2020).

Indicatively, the Garden City Movement that was initiated at the beginning of the last century in the UK, supported the development of open green spaces, quality recreation and sports grounds in the frame of an integrated urban design that could entail a well-functioning livelihood (Sutcliffe 1990). Similarly, the concept of Town-Country also born in the UK highlighted the 'beauty of nature' as a top priority for a balanced society (Fields in Trust 2018).

The concept of Town-Country was also manifested in Singapore after its independence as a unique city-state that could embrace green space in the urban developments. The acknowledgment of green space in the improvement of living conditions has been realized in the early days of Singapore's state development. Just 2 years after independence in 1967, Singapore had launched the Garden City program, with a vision to make Singapore a highly liveable city endorsed with green space as per other developed nations. Nature Reserves were conserved and expanded in the aftermath of the colonial period while community parks were built throughout the country.

Decentralized new towns were planned in Singapore since the early 70s to accommodate a growing population largely living in dilapidated houses on a small island. Through governmental support, the urban development foundation was laid by the Land Acquisition and Resettlement Act in 1967 (HistorySG 2020). Within this Act, 23 new towns and three estates were planned with high population density but also with urban green space to provide recreational zones within the town areas (Liu 2013). The Housing & Development Board (HDB 2020) became the executive branch of the Act to enable a nationwide public housing program with more than 1 million flats in the 23 planned towns and 3 estates. HDB flats are nowadays home to over 80% of Singapore's resident population, with about 90% ownership (HDB 2020). The population density ranges among the towns from 9500 (Bishan Town) to 27 600 pop/km² (Choa Chu Kang Town) depending on the geographical area, business interest, and other parameters. Within each town, about 3.7–15.5% is allocated for parks and gardens which includes public spaces but also private green areas (Prihanto 2018). Singapore has been consistently highly ranked in many liveability surveys, including Mercer's 2010 Quality of Living Survey (Mercer 2020) and Siemens's Asian Green City Index (The Economist 2011).

The Sustainable Blueprint of Singapore adopted by the state in 2015 (Sustainable Singapore Blueprint 2015) has emphasized the expansion of green spaces and increase of connecting pathways ('park connectors') among urban greenery. The expansion of green spaces was prioritized in the Sustainable Blueprint by indicating the attaining of a Park Provision Ratio (PPR) at 0.8 ha/1000 population by the year 2030. This ratio is taken following the green space allocation in other developed cities worldwide where a balance between built and green areas is sought (Tan et al. 2020). The ratio has to ensure that sufficient green spaces could be in close distance of the town dwellers for at least 80% of the entire households in Singapore [Ministry of the Environment and Water Resources (MEWR) and Ministry of National Development (MND) 2014]. The imminence of green park space within the town can offer a sense of low population density in Singapore which is one of the main challenges in the country (Liu 2013).

The rehabilitation of existent parks and related infrastructure has been also prioritized for the reaching of the PPR indicator as per the appointed target. The rehabilitation projects could extend the availability of urban green space through geoenvironmental interventions. Indicatively, many rehabilitation projects were completed in Asia for flood mitigation and stormwater management like in Tianjin Cultural Park, Sanya Mangrove Park and Quzhou Luming Park in Tianjin, Hainan and Zhejiang provinces of China [Ramboll 2012; ASLA (American Society of Landscape Architects) Professional Awards 2016a,b, 2020].

In our study, we focus on the rehabilitation of urban greenery for the creation of safe and affordable liveable places and the improvement of urban planning in Singapore. We adopt the case study of Bishan-Ang Mo Kio (AMK) Park which is a major rehabilitation project constructed between 2009 and 2012 by

introducing the blue-green infrastructure (BGI) approach. The BGI approach was a major attempt to support environmental services pertaining to freshwater systems but to also provide substantial recreation and leisure services to the visitors and the surrounding communities. We employ approaches from the domain of environmental economics to assess the economic benefits arising from selected environmental services associated with the rehabilitation of Bishan-AMK Park in north Singapore.

Urban greenery and BGI in Singapore

Island-state Singapore has a 725 km² island area with a central water catchment in the northern parts of the island. Located at the tip of the Southeast Asia continent, the country has a uniform equatorial tropical climate and annual rainfall of more than 2300 mm. Green space planning in Singapore began in the 1960s and remains embedded in all urban development to date by limiting the proportion of built areas to 34% of the territory [Organization for Economic Co-operation and Development (OECD) 2020]. Approximately 56% of Singapore's land area is vegetation cover, of which 27% is actively managed (parks, gardens, lawns etc.) and 29% is spontaneous vegetation (Yee et al. 2011). Another 10% of the land area is used for public service facilities with open space and infrastructural services.

Urban greenery has become an integral part of the urban fabric, playing an indispensable role in mitigating the high densities and ensuring a quality living environment (Cheong 2018). The built areas and urban green spaces have offered throughout the years 'a high level of heterogeneity of spatial forms and extent, culture and economic activities, and embed to varying degrees, natural and semi-natural spaces such as woodlands, wetlands, parks and other green spaces amidst the built environment' (Tan 2016).

The maintenance and conservation of urban, peri-urban, and natural parks within the country have been arranged by the National Park Board (NParks). The NParks authority is responsible for creating a living environment through excellence in nature conservation, greenery and recreation and veterinary care, in partnership with the community (NParks 2020a). According to the annual report of NParks, the parks have provided crucial environmental good and services which directly and indirectly improve human well-being. A major attempt has been made by NParks to sustain water catchments with natural vegetation, develop a network of 'green corridors' among neighborhoods and provide greenery pathways for the local communities as shown in Fig. 1.

There have been also major efforts to rehabilitate existent drainage infrastructure in the country mainly used for flood prevention purposes. The Bishan-AMK Park is a case of drainage infrastructure at the heart of a suburban neighborhood in north Singapore as shown in Fig. 2. The park hosts the upper stream of Kallang river which is originated from the main natural water catchment of Singapore (Lower Pierce Reservoir) and empties to the Marina Barrage in the south of the country.

A BGI approach has been introduced for the rehabilitation of Bishan-AMK Park to increase the greenery density and improve human welfare. The BGI approach is among the key strategies adopted in Singapore to transform existent infrastructure to recreation and green areas where the community can be an integral part of the spaces associated. The essence of BGI is a natural ecosystem-based to stormwater management solution through a biophysical process (retention, detention, infiltration, natural treatment and release), distinguished from the conventional monofunctional concrete infrastructure. Re-naturalization of a river in the

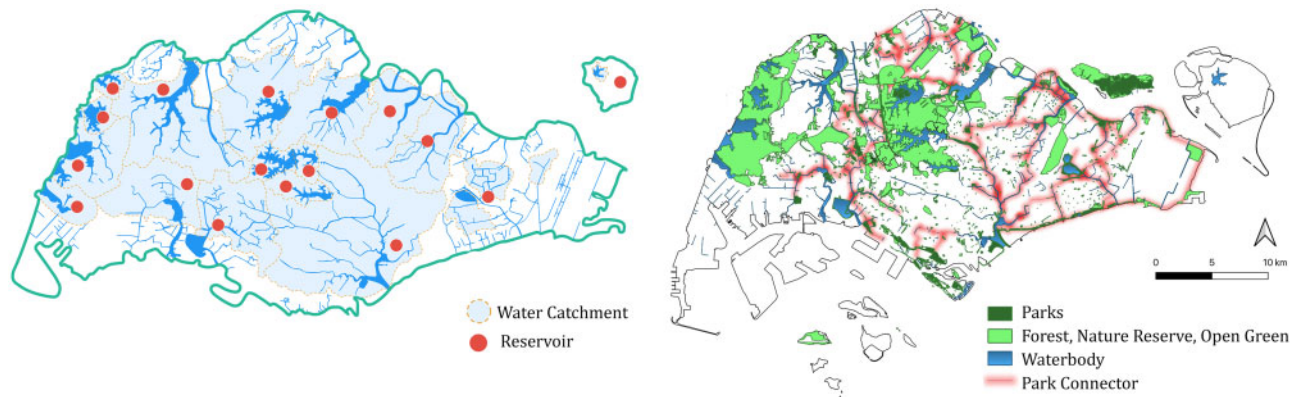


Figure 1: Water catchments and connections of parks and urban spaces in Singapore. Source: Generated GIS map from PUB- Singapore's National Water Agency (2020)

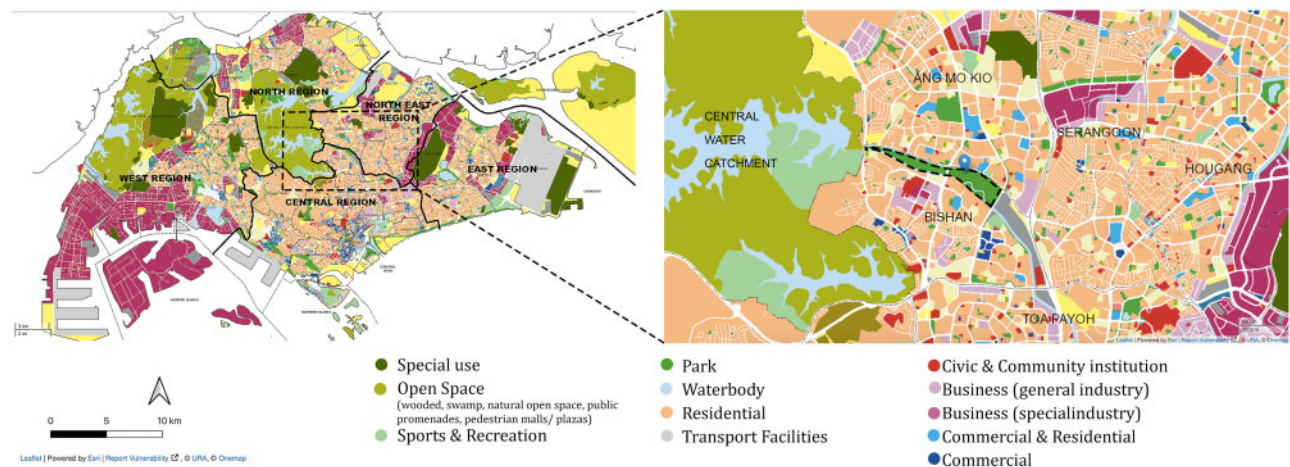


Figure 2: Bishan-AMK Park at downstream of Lower Pierce Reservoir surrounded by the AMK and Bishan Planning Area. Source: Generated GIS map from Urban Redevelopment Authority (URA 2019)

urban greenery context tackles stormwater at the source, designed to mimic natural hydrology by integrating aquatic and terrestrial ecosystems (Liao, Deng, and Tan 2017). This form of urban greenery gradually replaces existing gray infrastructure used for civil drainage purposes and has shown major benefits in the rehabilitation of urban green spaces (Perini and Sabbion 2016; Lamond and Everett 2019).

The Marina Barrage (As per the VisitSingapore webpage 'Built across the mouth of the 350-m wide Marina Channel, the Marina Barrage creates the country's 15th reservoir, with a catchment area that spans a whopping 10 000 ha'. Source: <https://www.visitsingapore.com/see-do-singapore/architecture/modern/marina-barrage/>) and Bishan and AMK are two such examples of BGI which have successfully managed to rehabilitate freshwater systems and become amongst the most visited places within Singapore. The above projects have been supported by different programs like the ABC Waters (Active, Beautiful and Clean Waters), the WSUD—Water Sensitive Urban Design and LID—Low Impact Development programs funded by the Public Utilities Board (PUB)—Singapore's National Water Agency (PUB 2020). The PUB financed these programs to transform the country's water bodies beyond their functions of drainage and water supply, into vibrant, new spaces for community bonding and recreation. There was also an attempt to raise awareness of the environmental goods and services

sectors (EGSS) offered by water bodies and inculcate a sense of stewardship towards water systems [CLC (Centre of Liveable Cities Singapore) 2017].

The BGI project in Bishan-AMK Park is estimated at 62 ha which covers two main purposes: (i) to increase retention capacity and reduce flow velocity for flood prevention by re-naturalizing concretized river and (ii) to integrate recreation in the urban infrastructure. Due to the extended area of the river-side park from the former conveyance channel, the carrying capacity has increased by 40% as presented in Fig. 3 (Dreiseitl Consulting 2012). With the enlarged riverine ecosystem, the park now hosts over 60 species of wildflower, more than 50 bird species and over 20 species of dragonfly, some of which are rare to see outside of a nature reserve (Liao 2012). Larger fauna and long-absent endangered species like otters, have made their presence and reaffirmed the major contribution of Bishan-AMK Park on biodiversity aspects (Wilkinson et al. 2021).

The waterscape in Bishan-AMK Park transforms in accordance with the rainfall events; during the dry days with the lower water level, the park allows visitors to be close to the river, whereas on rainy days the water is raised and floods the riverplain. In Fig. 4, Bishan-AMK Park is presented before and after the BGI interventions.

We compile the main characteristics of Bishan-AMK Park based on different published sources as shown in Table 1. The

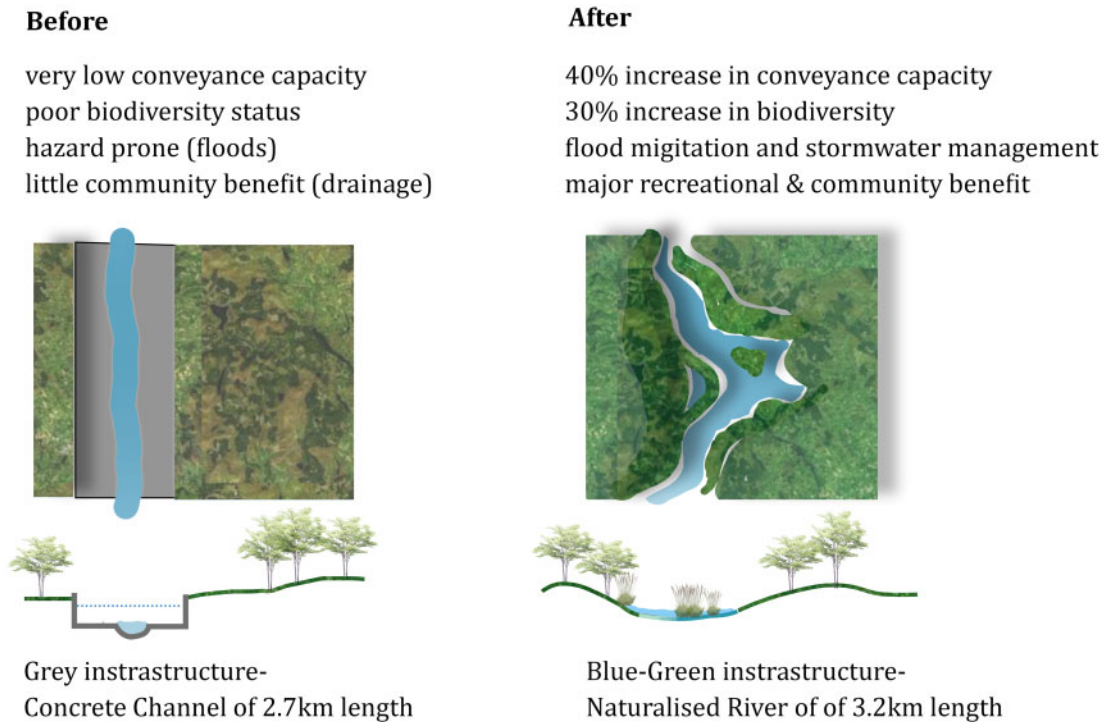


Figure 3: The re-naturalization of the river in Bishan-AMK Park is utilized for flood prevention and stormwater management. Source: Adapted from Dreiseitl Consulting (2012)

park has not introduced fee entrance and hosts about 4 000 000 visitors per annum according to the latest record of the year 2018, by offering open access all day and night with a large capacity of car parking (NParks 2018). Several leisure facilities for children, training exercise and events for venues have been constructed while a variety of gardens are nurtured within the park. Although there is not an exact estimation of the location origin of the visitors, it has been approximated that 52% of the visitors are in walking distance from the park (up to 3 km), while 48% is further away and use transportation to reach the park (Dreiseitl, Leonardsen, and Wanschura 2015). The major activities taken in the park are related to exercising (60%), and then recreation (20%) and socializing (10%). However, the interchange or sequencing of the above is also noticed. A mixture of individuals, families, and friends visits the park whereas walking and strolling seem to be commonly occurring by all.

Based also on the literature, we are aware that about 65% of the visitors in Bishan-AMK Park are adults without families and 35% are visitors with children (Kho, Vogta, and Tan 2014; NParks 2019). From the adult visitors, about 50% enjoy sports and use the park's facilities while all the children visit the park for entertainment in the playground areas. Nearly, 5% of all visitors make use of the pet facilities installed in the park while another 5% visit the park as an alternative option of attending an event or participating in a happening (e.g. festival, concert, family day, outdoor picnic etc.). An almost 1% of the visitors arrange some celebrating events in the park (e.g. birthdays, wedding venues) with a considerable number of participants.

Methods

We attempt to evaluate selected EGSS in economic terms through methods borrowed from the domain of environmental economics. There is abundant literature on the categorization

of EGSS whereas also the terms are interchanged between 'environmental' or 'ecosystem' goods and services depending on the economic and ecological-oriented perspectives (Heal 2000; Gómez-Baggethun and Barton 2013; Schröter et al. 2019). There is also the wider perspective connecting the ecosystem background with the human welfare and economic values as indicated presented in Fig. 5 by the global initiative on Economics of Ecosystems and Biodiversity [The Economics of Ecosystems and Biodiversity (TEEB) 2020]. The assessed ecosystem (e.g. freshwater system) is perceived as a primary source where the biophysical structures are interpreted in functions and then are contextualized as services to evaluate the economic contributions to livelihoods.

The most common categorization of EGSS that is widely accepted by the scientific community is the distinction between provisioning, regulating, habitat and cultural services (TEEB 2020). The economic discipline has attempted to identify the utility derived from Use and Non-Use values associated with EGSS and cluster them accordingly (Turner, Pearce and Bateman 1994; Bateman et al. 2002). The Use and Non-Use values are further disaggregated in other sub-categories that are presented in Fig. 6. Most of the literature is focused on the Direct Use values which could be easier interpreted in economic terms due to the existent association with market mechanisms (Bergstrom 1990; Pearce and Seccombe-Hett 2000; Polasky et al. 2019).

In our study, we assess selected environmental services identified with the Direct Use and Non-Consumptive values which are provided for free in Bishan-AMK Park but can be valued through market proxy mechanisms. We focus on recreational, socio-cultural and tourism-related services due to the significance given to the urban parks of Singapore on the relevant activities and the data availability from published sources. The opportunity cost approach is employed for the evaluation of the foregone recreational, socio-cultural and tourism pertinent costs that have been averted



Figure 4: Bishan-AMK Park before and after the BGI interventions. Source: ASLA (American Society of Landscape Architects Professional Awards 2016a,b)

Table 1: Main features and activities in Bishan-AMK Park in north Singapore for the year 2018

Area	62 ha	
Visitors	~4 000 000	
Opening hours	24 h	
Entry	Free	
Carpark (A-C)		268 cars, 49 motorcycles
Bicycle racks	48	
Dog run	1	
Shelters	18	
Playgrounds	3	
Fitness corners	4	
Food and lifestyle outlets	5	
Event venues	5	
Other Gardens	4	Including Recycled Hill, Allotment Garden, Therapeutic Garden and Community and Herbs Gardens
Park users		52% within 0–3 km (walking distance) 48% more than 3 km (transportation)
Main activity in the park	60%	Exercise
	20%	Relaxing
	10%	Socializing
Main activity in the park by social unit	Individuals	Jogging, walking, exercising and cycling
	Family	Walking, jogging, cycling and sitting
	Friends	Walking, sitting, jogging and eating

Sources: Kho (2014), Dreiseitl, Leonardsen and Wanschura (2015) and NParks (2018).

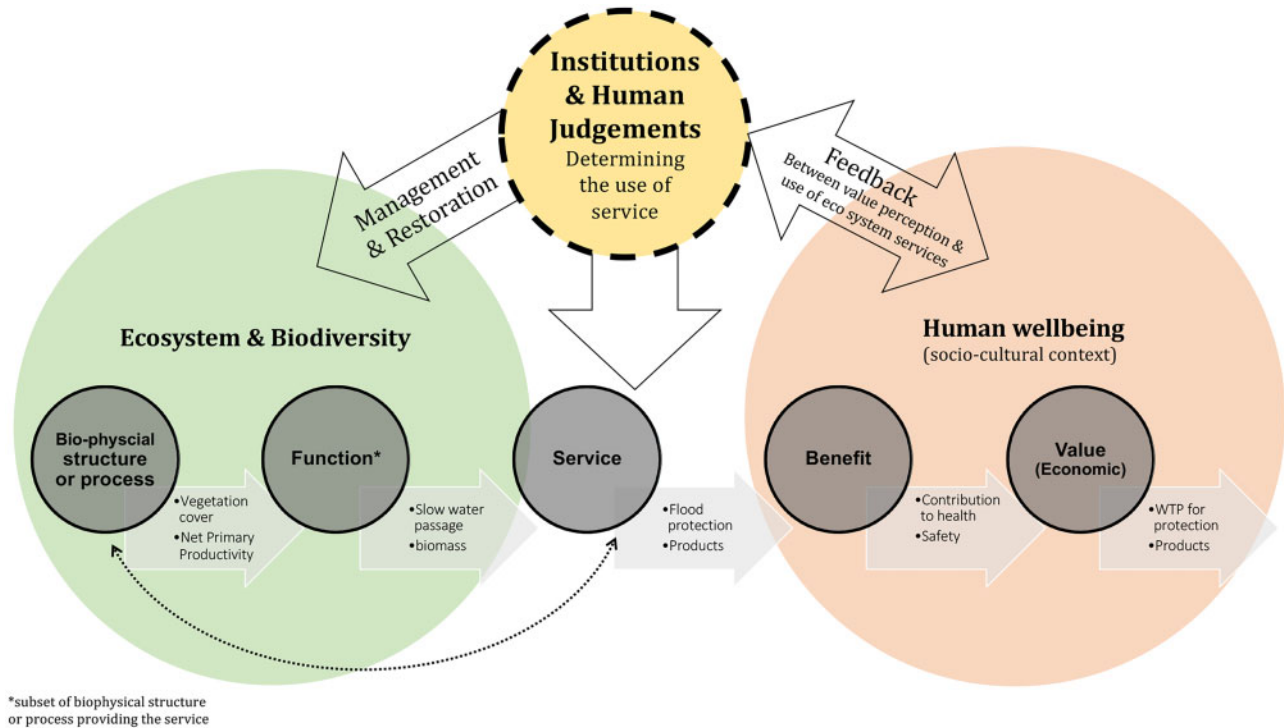


Figure 5: Contribution of EGSS to human well-being through an environmental-economic perspective. Source: Adapted from TEEB (2020)

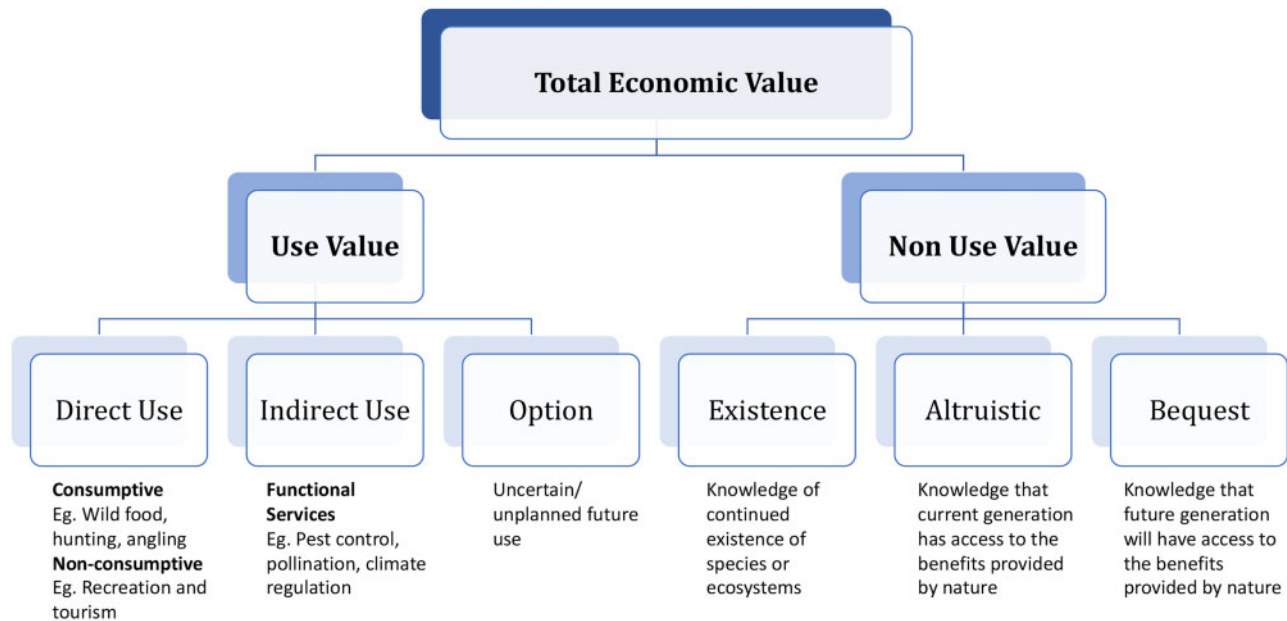


Figure 6: An indicative distinction of EGSS into economic values. Source: Adapted from Tinch and Mathieu (2011)

due to the provision of the relevant services in Bishan-AMK Park without charges. The averted costs (benefits) are calculated through proxy values from the market by introducing some assumptions based on the literature and empirical knowledge of the relevant study area (Breuste, Haase, and Elmqvist 2012; Schaefer and Spim 2014).

Effectively, we consider that the visitors in Bishan-AMK Park would be willing to seek marketed services that are nearly identical to the ones offered in the park if these services would be no longer available. Selected marketed services offered in the

nearby area of Bishan-AMK are used as proxy values to assess the freely available services provided by the park by also identifying the lower and upper costs for the estimation of the mean values.

We initially assess the recreational services by evaluating the costs from the leisure and exercising in private facilities as well as the costs related to the organization of events in private premises that are provided with no costs in the Bishan-AMK Park. In particular, for the case of leisure and exercising, we consider the charges from nearby centers and premises while for

the celebration and festivities occurring in the park, we calculate the charges by private event organizers for the arrangement of major happenings.

We further estimate the opportunity costs (benefits) by foreign tourists visiting for free the Bishan-AMK Park regarding the overall amount spent during their stay in the country. In particular, we initially estimate the mean daily expenditures (US\$202/day) incurred by a visitor in Singapore and the average amount of days (3.33 days/visitor) expended in the country as per the year 2018 (Singapore Tourism Board 2019). We then calculate the opportunity costs of visiting the Bishan-AMK Park based on statistical evidence that 10% of foreign tourists visit the park and remain about 4 h in the premises (Dreiseitl, Leonardsen, and Wanschura 2015).

We also assess the averted mental health-related expenditures associated with the exercising and motion activities in the park, as well as the time spent to reach the park's premises. For the health-related foregone economic costs derived from exercising and motion activities, we consider the number of people with anxiety disorder in Singapore (1.6% for the year 2016) which could be relieved by accessing the parks as noted in the relevant literature (Institute of Mental Health 2018 ; Bojorquez and Ojeda-Revah 2018; Swierad and Huang 2018; Buckley et al. 2019). We estimate the costs of adult consultation and frequency on yearly basis, and we apportion the number of visitors with depression, anxiety, and stress to the overall visitors in Bishan-AMK Park. Regarding the time consumed to reach the park, the estimations are based on the fees as per the usage of public transport means for those using transportation to reach the park's premises.

It is noted that we employ only secondary data from the literature and proxy markets due to the time and costs constraints on surveying park visitors along with the study. All the values are presented in US\$ instead of the Singaporean Dollar (SGD) as a more widely used currency denominator. The exchange rate is estimated at 1 SGD equal to 0.75 US\$ as of 28 April 2021. The year 2018 is adopted as a baseline for the estimation of the economic values in the relevant services.

Results

The valuation of the selected services through its interpretation in direct use values offers some indicative economic approximations of the economic benefits emerging from Bishan-AMK Park to the visitors and society at large. As noted in Table 2, the relevant services are shown in the first column from the left side, while in the second column the null costs borne by Bishan-AMK for the provision of these amenities are indicated. In the third column, the proxies used to estimate the nearly equivalent marketed services are noted, whereas the fourth column shows the range of these costs depending on the relevant providers in the nearby area. The fifth column presents the mean costs for each service while the number of visitors as a percentage of the overall annual visitors (4 000 000) in Bishan-AMK Park is mentioned in the sixth column. The rest of the columns present the minimum, maximum and mean use values to demonstrate the potential range of the economic values for each of the selected services.

The highest economic benefits (mean value, US\$59 747 500/year) appear to come from the recreational uses of the park when we estimate the aggregated opportunity costs of the leisure services offered on an annual basis. A lower but yet noticeable economic benefit, (US\$37 334 632/year) derives from the foreign tourism influx to the park.

Further, based on the estimation of the mean visit time in the Bishan-AMK Park and the mean cost saving in health-related expenditures per individual as noted in other similar studies, we attempt to offer an approximation of the yearly savings derived from the park use to the visitors. Major benefits (mean value, US\$59 904 000/year) are emerging from the Bishan-AMK Park through the estimated savings from the medication and hospitalization or else health services that are proactively offered by the park's facilities. The expenditures related to the public transportation means to reach the park are a relatively low but still noteworthy benefit (mean value, US\$2 880 000/year).

Finally, we estimate the range of the total value for the selected services (US\$159 868 132–US\$220 193 632) and the hypothetical benefits per visitor (US\$24.89–55.05) on yearly basis. The high range of the above values indicates the relative uncertainty of the economic assessment by however signifying the overall major economic contribution to human welfare.

Discussion

The findings on the selected services have shown that the recreational services capture about one-third (37.37%) of the overall mean annual benefits with a nearly identical amount contributed to mental-related health benefits (37.47%). Foreign tourism remains a considerable contributor (23.35%) while transportation is lower but not negligible (1.80%).

The marketed services associated with the environmental ones maybe not be identically matched. For instance, in the case of the recreational services, there is not absolute validation that in the case of park closure all the visitors enjoying sport facilities and social gatherings in the park would shift to training centers and cafeterias or alike. The same uncertainty holds for the tourism-related services and foreign visitors to the Bishan-AMK Park.

There is literature however stating the significance of the parks as replacement of these marketed services in recreation and tourism and the tendency of visitors to seek alternative options of nearly equal satisfaction (Harnik, Welle and Keenan 2009; National Trust 2017; Fields in Trust 2018). Also, for the recreational service, we have indicated the lower and higher market values for each activity to capture as much as possible the different tastes and preferences of visitors as a substitute to the park's amenities.

The economic values generated by physical and mental well-being might be inaccurate as we cannot validate that the same proportion of adults visiting Bishan-AMK Park (1.6%) suffer from anxiety disorder as in the case of the entire population in the country. The actual percentage of anxiety disorder in the park visitors may deviate from the general population proportion. It is not also certain that the visitors suffering from anxiety disorder could be relieved and to what extent as if having consultations in psychologically related centers. There are however relevant studies suggesting that people with anxiety disorder problems are encouraged along their consultation to visit greenery areas and parks for the tension relieving purposes (Bedimo-Rung 2005; Depledge, Stone, and Bird 2011; Barret, Miller and Frumkin 2014; Martin et al. 2020; Mikihiro et al. 2019; Thompson et al. 2020). Also, the association of green space contribution to anxiety disorder issues through experimental approaches has been more consolidated in the literature in recent years. Indicatively, the University of Exeter has assessed the relationship between green space and well-being by surveying and monitoring a sample of 1000 people with mental health data for

Table 2: Economic assessment of direct use benefits in Bishan-AMK Park for the year 2018

1. Recreational activities in Bishan-AMK Park	Cost in Bishan-AMK Park	Cost in other private premises	Cost Range (US\$)	Mean (US\$)	Number of Users (%)	Mean Annual Economic Value (\$US/year)	Min. Annual Economic Value (\$US/year)	Max. Annual Economic Value (\$US/year)
General park use (playgrounds, trails, dog walking, dog play area, picnicking, sitting, Yoga, Dance etc.)	0	Café and restaurant per person (drinking and beverage services)	6-18.8	12.38	70	22 522 500	10 920 000	34 125 000
	0	Pet Sitting facilities (pet caring)	9-22.5	15.75	5	3,150,000	1 800 000	4 500 000
	0	Indoor Playgrounds (recreational services for children)	7.5-22.5	15.00	35	21 000 000	10 500 000	31,500,000
Sports facilities use (team sports, bicycling, running, active walking etc.)	0	Gym daily charges (daily passes)	4.5-11.3	7.88	50	10 237 500	5 850 000	14 625 000
Entertainment use (festival, concert, family day, picnic etc.)	0	Indoor entertaining activities	9-22.5	15.75	5	2 047 500	1 170 000	2 925 000
Celebration and festivities use (retreats, weddings, birthdays, events, etc.)	0	Rental costs of premises in commercial areas	30-52.5/m ²	41.25	1	792 000	576 000	1 008 000
2. Foreign tourism visiting Bishan-AMK Park	Cost in Bishan-AMK Park	Mean Time Spent in Bishan-AMK Park	Opportunity Cost of Visiting Bishan-AMK(US\$)					
Tourism-related use from overnight visitors	0	4h	20.2			37 334 632	37 334 632	37 334 632
3. Mental-related health issues in Bishan-AMK Park	Cost in Bishan-AMK Park	Amount of people with mental stress in Singapore (%)	Adult consultation range (US\$)	Mean (US\$)	Number of users (%)			
Mental-related aspects (e.g. anxiety disorder, stress) of visitors	0	1.60%	30-90	60	1.6	59 904 000	29 952 000	89 856 000
4. Transportation to visit Bishan-AMK Park	Time spent		Cost range (US\$)	Mean (US\$)	Number of users (%)			
Travelling time spent to visit the park	20-60 min		0.8-2.3	1.50	90	2 880 000	1 440 000	4 320 000
Total value for the selected services (US\$/year)						159 868 132	99 542 632	220 193 632
Total economic value per visitor yearly (US\$/year)						39.97	24.89	55.05

5 years (Alcock et al. 2014). The outcomes indicated that the increase of urban greenery (e.g. parks, gardens, green corridors etc.) could significantly improve mental health. The effect on an individual level was reported as being relatively small, but when scaled up to a community level the positive impact was substantial. The same university has also created a webpage named 'Beyond Greenspace' where numerous papers, reports, and resources manifest the significance of green space on mental health and well-being (Beyond Greenspace, 2021).

For the year 2017, the Singaporean government allocated US\$8.025 billion (2.5% of national GDP) to healthcare—the third-largest budget for the relevant ministry, behind education and defense [Ministry of Finance (MOF) 2020]. There are not yet established studies in Singapore to associate the value of green spaces and the significance attributed to the health aspects and the livelihoods. There has been however a strong message from the NParks of Singapore that urban greenery provides recreational values by reducing stress, enhancing a positive mood, improving cognitive skills and academic performance, as well as moderating the effects of ADHD, autism and other childhood disorders (NParks 2020b).

We acknowledge that some of the identified services may overlap with each other e.g. the benefit of exercising and leisure may overlap with the benefits derived from the health-cost savings. We tried to identify the preferences and activities of the visitors based on different sources and minimize as possible the relevant bias. We consider however that the overlapping of different services is an endogenous problem faced in similar assessment as demonstrated in the literature (Pearce and Seccombe-Hett 2000; Bateman 2002).

Further, the amount of overall visitors per year does not preclude the visiting of the same persons for more than one time per annum. As a result, the benefits attributed to each visitor per year (Table 2) may be skewed towards visitors that have visited more than one time Bishan-AMK Park. The actual counting of visits per person per annum could mitigate this challenge; however, it was practically impossible to detect the visitor's frequency in the park, thus, a single entry visit per person was accounted for. A further study could better identify the distribution of the relevant benefits per visitor and the persons that benefit the most in terms of their preferences, activities, location and other features.

Conclusion

The current research attempted to identify the economic values of urban green spaces in Singapore by focusing on selected ecosystem services in a park rehabilitated through the BGI approach. The case study of Bishan-AMK Park was chosen as a pioneer of BGI initiatives in the tropical zones. The park is distinctive in its existential way, given its geographical location in the highly dense city-state of Singapore where a big effort is made to provide access to urban greenery to all neighborhoods. Its rehabilitation has converted a mainly terrestrial ecosystem and non-inhabitable infrastructure to integrated BGI with constructed wetland ecosystem, soil bioengineering and sustainable construction of riverbanks using natural materials. As a result, the urban water catchment capacity was largely increased, whereas the park provided access to nearby neighborhoods, but also other residents and foreign tourism.

Despite the major gains deriving from urban green spaces and rehabilitations like the BGI in Bishan-AMK Park, there is not yet sound literature on the appraisal of the economic benefits for the park users and the society at large. There are some

assessments on the well-being improvement associated with the frequent use of local parks and green spaces mostly in developed countries. Indicatively, an amount worth £34.2 billion per year is estimated to derive from environmental services offered by green spaces and parks to the entire UK adult population which accounts for more than 20% of UK public spending in the healthcare sector (£160.8 billion) (Fields in Trust 2018; UK Public Spending 2020).

In this study, we have tried to identify the economic benefits emerging for selected services in an attempt to signify the importance of urban greenery, especially in highly dense urban environments. We acknowledge that more sophisticated methods like the Travel Cost (As mentioned 'The travel-cost method (TCM) is used for calculating economic values of environmental goods. Unlike the contingent valuation method, TCM can only estimate use value of an environmental good or service. It is mainly applied for determining economic values of sites that are used for recreation, such as national parks'. Source: <http://www.ejolt.org/2013/01/travel-cost-method/>) and Contingent Valuation (As noted 'Contingent valuation, a survey-based method of determining the economic value of a nonmarket resource. It is used to estimate the value of resources and goods not typically traded in economic markets. It is most commonly related to natural and environmental resources'. Source: <https://www.britannica.com/topic/contingent-valuation>.) could better capture the EGSS related to recreational services as well as the visitors' preferences towards selected goods and services. We consider, however, that there is still a major knowledge vacuum on the contribution of urban greenery and parks to human welfare, which can be understood by policymakers and the wider society through the suggested economic approach.

Densely populated countries like Singapore will become more frequent all over the globe, thus the accessibility to urban greenery and the advocacy of the economic benefits emerging from parks and open spaces need better argumentation. Singapore and similar dense urban centers would need strong and scientifically based evidence to support major investments in future BGI programs to improve access to green space. This study offers some insights on the benefits associated with urban greenery so to better defend the conservation and expansion of such areas and the rehabilitation efforts as occurred in the case of Bishan-AMK Park in Singapore.

Conflict of interest statement. There is not any conflict of interest declared.

Data availability

The datasets assessed during this study are available upon request.

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