City Biodiversity Index and its Linkage to Real Estate Pricing

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Key words: Land management, property taxes, real estate development, valuation, city biodiversity index, biodiversity conservation and planning, ecological baseline assessment, ecological restoration and enhancement, urban land use planning, sustainability, climate change.

The term 'biodiversity' is a short form for biological diversity and includes all life forms - mammals, birds, reptiles, amphibians, fish, insects and other invertebrates, plants, fungi and micro-organisms. "Urban biodiversity is the variety and richness of living organisms including genetic variation and habitat diversity found in and on the edge of human settlements. This biodiversity ranges from the rural fringe to the urban core. At the landscape and habitat level it includes - remnants of natural landscapes like leftovers of primeval forests, traditional agricultural landscapes like meadows, areas of arable land, urban–industrial landscapes like city centers, residential areas, industrial parks, railway areas, formal parks and gardens, brown fields. " [Thomas Elmqvist, 2012]

Biodiversity degradation can cause unstable and lesser resilience to ecosystem providing products and services. This leads to food scarcity, fresh water degradation, and increasing temperature in cities all leading to unhealthy ecosystem. In 2002, Conference of the Parties (COP) developed a Strategic Plan to achieve a significant reduction of the current rate of biodiversity loss at the global, regional, and national level' by 2010. Since 1992, ten meetings of the COP to the Convention of Biological Diversity (CBD) have been held. COP-11 provided a unique platform to display, promote, interact, learn and network from each other's experiences and knowledge relating to biodiversity. It has emphasized the importance of Biodiversity indices to quantify the changing biodiversity maps.

Ecosystem health is one of the direct concerns to real estate businesses because many depend on related services, either directly or indirectly and the degradation of ecosystems can present risks in services like marketing and sales in real estate. Real estate indices are one of the measures to quantify the liquidity and exposure of transaction data during sale of properties. Out of the many factors apart from the demand and supply of the property's the transactional volumes of sales in real estate. influence of the ecosystem health on real estate transaction data depends on several factors.

In this paper an effort is made to understand direct impacts of biodiversity degradation on commercial real estate. A quantification method by linking biodiversity indices to real estate market indices is worked to analyze prices in global real estate market

INTRODUCTION

The drivers of Biodiversity degradation are many-fold. Human activities are the main driver behind the decline in biodiversity and result from a number of different threats. Habitat loss and degradation includes reductions in the quality or quantity of habitat available to species and is considered the single greatest threat to endangered species and overall biodiversity. Biodiversity has globally come under increasing pressure on account of factors such as habitat fragmentation, development imperatives, unsustainable consumption pattern and, more recently, global warming.

The forecast of the global urban population under current trends by 2050 is estimated to be 6.3 billion, nearly double the numbers in 2010 . More than 60 percent of the area projected to be urban in 2030 has yet to be built. Most of the growth if happened in small and medium-sized cities, not in megacities could impact on the biodiversity as the probability of degradation of biodiversity increases due to the increase in urban activities.

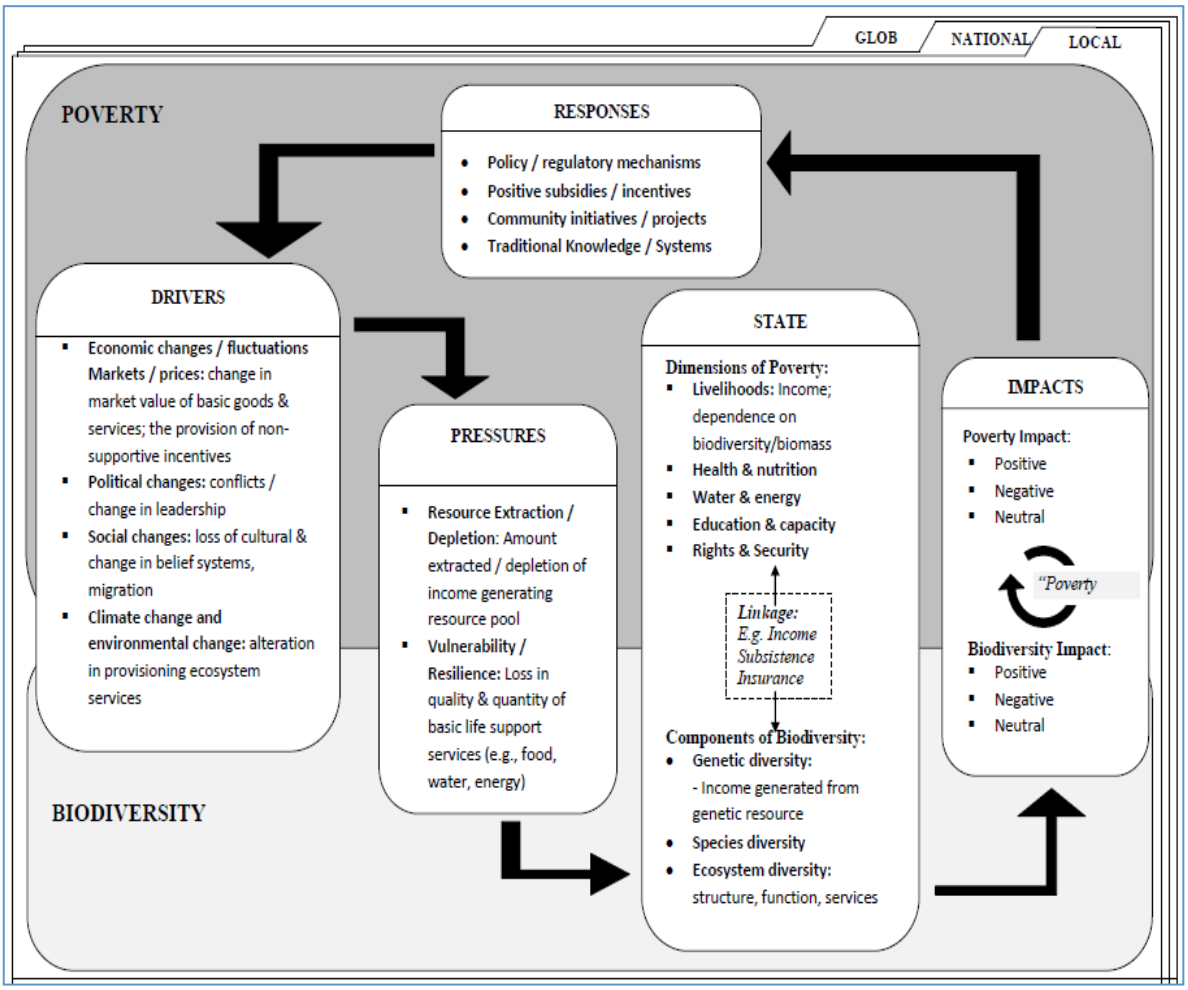


Figure 1: Poverty and Biodiversity interlinkage - Source: Tristan D. Tyrrell et al 2012

The services biodiversity provide to cities are directly part of city planning. The benefits of biodiversity range from directly perceived like water supplies and recreational facilities and indirectly tangible effects of large biodiverse areas that help in bio resources production and climate change stability. Increase in urban activities would mean increasing demand for commercial and residential properties if the number of residential dwellings and commercial properties remain constant. An increase in demand for real estate can be actively linked to property prices and subsequently understood as having an adverse impact on biodiversity. On the contrary an improved biodiversity may not lead to decrease in demand in real estate. The scope of this paper is to establish this intrinsic relation between city biodiversity and real estate prices in the corresponding areas.

INDICATORS OF CITY BIODIVERSITY INDEX

To conserve biological diversity and to ensure the sustainable use of components of Biological diversity the COP meeting in 2008, held in Bonn, Germany proposed the idea of establishing the city biodiversity index (CBI) under the guidance of Convention of biological diversity. The idea was proposed by National Development Minister Mah Bow Tan at the COP to the Convention of Biological Diversity (CBD) in 2008.

After expert level meetings since 2008, it is deliberated that CBI should comprise three components, that is:

(i) native biodiversity in the city,
(ii) ecosystem services provided by native biodiversity in the city, and
(iii) governance and management of native biodiversity in the city.

The first component focuses on different aspects of native biodiversity, in particular what native biodiversity are found in the city, how they are conserved, what are the threats to native biodiversity, etc. The second component concentrates on the ecosystem services provided by native biodiversity in the city, including those pertaining to regulation of water, carbon storage, and recreational and educational services. The third component is concerned with the governance and management of biodiversity, encompassing budget allocation, institutional set-ups, number of biodiversity-related projects, public awareness programmes, administrative procedures, etc. (Lena chan, 2012)

The index is not restricted to cities and can be applied at different scales. For example Singapore has used the index at the sub-city level, in the master planning of the new districts. Master planning of the country like Singapore also supported its real estate market representatives to comprehensively in development of real estate pricing index. There were 23 indicators that were considered in the development of the Singapore's city biodiversity index. The indicators for the CBI (COP11, 2012; Lena chan 2012)

Indicator 1: proportion of natural areas in the city
Indicator 2: connectivity measures or ecological networks to counter fragmentation
Indicator 3: native biodiversity in built-up areas

Figure 2 : City bio diversity index of Hyderabad. (COP11, 2012)

Cities which have provided their results for the Singapore Index	Cities which have agreed to apply the Singapore Index
1. Belgium: Brussels Capital Region	1. Australia: Joondalup
2. Brazil: Curitiba	2. Cambodia: Phnom Penh
3. Canada: Calgary	3. Cambodia: Siem Reap
4. Canada: Edmonton	4. Canada: Calgary
5. Canada: Montreal	5. Canada: Ottawa
6. Estonia: Tallinn	6. Canada: Vancouver
7. France: Montpellier	7. China: HePing
8. Germany: Frankfurt	8. China: Hong Kong
9. Germany: Heidelberg	9. European cities participating in the European Capitals of Biodiversity Competition (from five countries – France, Germany, Hungary, Spain and Slovakia)
10. India: Mira Bhayandar	10. Finland: Helsinki
11. Indonesia: Bandung	11. France: French Regions
12. Japan: Chiba	12. France: Paris
13. Japan: Fukuoka	13. Guatemala: Guatemala City
14. Japan: Hiroshima	14. India: Hyderabad
15. Japan: Kawasaki	15. India: Thane Municipal Corporation
16. Japan: Kitakyusyu	16. India: Visakhapatnam
17. Japan: Kobe	17. Indonesia: Padang
18. Japan: Kyoto	18. Indonesia: Pekanbaru
19. Japan: Nagoya	19. Israel: Jerusalem
20. Japan: Osaka	20. Lao PDR: Luang Prabang
21. Japan: Sapporo	21. Lao PDR: Vientiane
22. Japan: Sendai	22. Lao PDR: Xayaboury
23. Japan: Tokyo	23. Malaysia: Kuantan
24. Japan: Yokohoma	24. Malaysia: Sibu
25. New Zealand: Auckland	25. Mexico: Mexico City
26. New Zealand: Hamilton	26. Netherlands: Amsterdam
27. New Zealand: Waitakere City	27. New Zealand: Plymouth
28. Portugal: Lisbon	28. New Zealand: Wellington
29. Singapore	29. Philippines: Iloilo City
30. South Africa: Durban	30. Philippines: Puerto Princesa City
31. Thailand: Bangkok	31. Philippines: Quezon City
32. Thailand: Chiang Mai	32. Portugal: Porto
33. Thailand: Krabi	33. South Africa: Johannesburg
34. Thailand: Phuket	34. Spain: Barcelona
35. United Kingdom: Edinburgh	35. Spain: Ourense
36. United Kingdom: London	36. Sweden: Stockholm
	37. Sweden: Malmo
	38. USA: New York
	39. Viet Nam: Danang
	40. Viet Nam: Hanoi

Table 1: List of cities in the process of adoption Singapore CBI (Lena chan 2012)

Indicators 4-8: As this is an index focussing on biodiversity in cities, it is essential that the native flora and fauna diversity be incorporated as indicators. Three key taxonomic groups

that are most surveyed worldwide, i.e., plants, birds and butterflies, have been selected as "core indicators". To ensure fairness and objectivity in the index, cities can select 2 other taxonomic groups that would reflect their best biodiversity.
The 3 core groups are:

- Indicator 4 : vascular plants
- Indicator 5 : birds
- Indicator 6 : butterflies

These groups have been selected as data are most easily available and to enable some common comparison.

Cities can select any 2 other taxonomic groups for Indicators 7 and 8 (e.g., bryophytes, fungi, amphibians, reptiles, freshwater fish, molluscs, dragonflies, carabid beetles, spiders, hard corals, marine fish, seagrasses, sponges, etc.)

Indicator 9: proportion of protected natural areas
Indicator 10: proportion of invasive alien species (as opposed to native species)
Indicator 11: regulation of quantity of water
Indicator 12: climate regulation: carbon storage and cooling effect of vegetation
Indicators 13-14: recreational and educational services
Indicator 15: budget allocated to biodiversity
Indicator 16: number of biodiversity projects implemented by the city annually
Indicator 17: policy, rules and regulations – existence of local biodiversity
Indicators 18-19: institutional capacity
Indicators 20-21: participation and partnership
Indicators 22-23: education and awareness

APPLICATION TO CITY BIODIVERSITY INDEX (CBI)

Figure 3 shows us the comparison of the Biodiversity changes between 2005 to 2012. As of August 2012, more than 70 cities are in various stages of test-bedding as shown in Table 1: List of cities in the process of adoption Singapore CBI. The comparison from 2005 to 2012 shows that there has been a decline in the biodiversity especially at these cities which are in process of the application of CBI partly attributable to urbanisation.

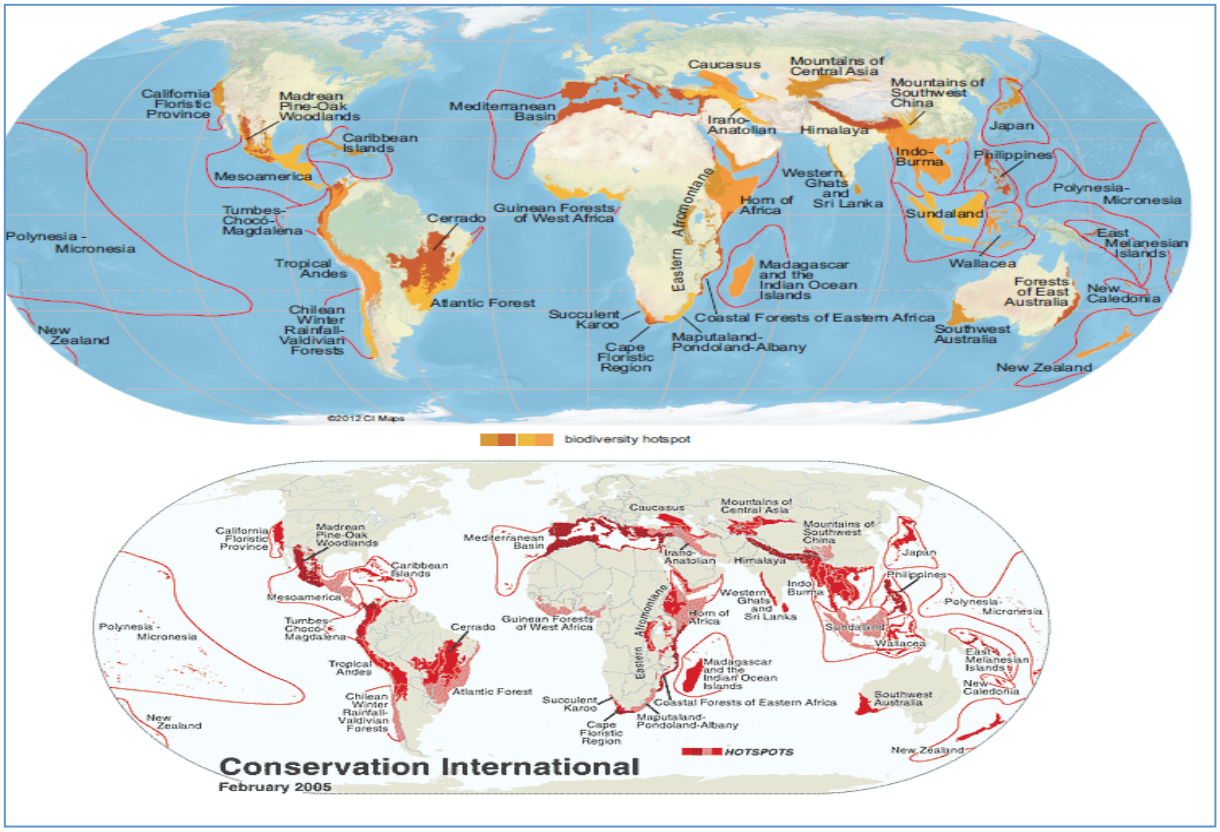


Figure 3: Changes in Biodiversity from 2005 to 2012.

The rate of degradation can be quantified based on the rate of urbanisation and in more detail using the CBI as is computed for a score of 192 from the 23 indicators. An inference for the detailed reasons of decrease in biodiversity and the ranking of these 70 cities across the globe as per the CBI points is possible because the reasons are directly linked to one or more of 23 indicators that are weighted to make the CBI. It is in this context these indicators can also be linked to urbanisation and hence forth the changing prices of real estate in the process of urban development of the cities.

As an illustration of the use of CBI, Hyderabad became the first in India to have a City Biodiversity Index, at 'Cities for Life', a city and sub-national biodiversity summit, organized at the 11th meeting of the Conference of Parties (COP 11) to the Convention on Biodiversity (CBD). The index aids in self-assessment and monitoring in matters relating to biodiversity in urban areas. The historic city of Hyderabad has scored 36 of a possible 92 points in the City Biodiversity Index (CBI) because of its agro-climatic zones and the sunshine throughout year. The CBI of Hyderabad vindicates that there was a need to revive biodiversity, especially the native species which the city had lost in the past few decades. Hyderabad has joined a group of 14 international cities to come out with the CBI. Among the 14 cities, Brussels topped the list with 55 points and more than 50 cities around the world are in various stages of testing the CBI.

For example the city of Hyderabad scored very low on the lake front. At present, the city of Hyderabad has a population density of about 18,500 individuals per sq km. Due to urbanization pressure, the geographical area covered by water bodies declined from 2.5 percent of total area in 1964 to 1.6 percent. The GHMC, however, is launching a major project to revive 176 lakes in the municipal area over the next three years at a cost of Rs. 500 crore under the National Lake Conservation Plan. This would mean a direct increase in the real estate prices in the vicinity of the areas identified as part of national lake conservation plan.

Studies in North America also confirmed that biodiversity affects real estate value "the Halstead Property Company, the single amenity that added the most value to a Manhattan apartment was a good park or river view. Based on the study, a view above the tree line allowed identical apartments to sell for as much as 20 percent higher" (Patrick L.Phillips, 2000)

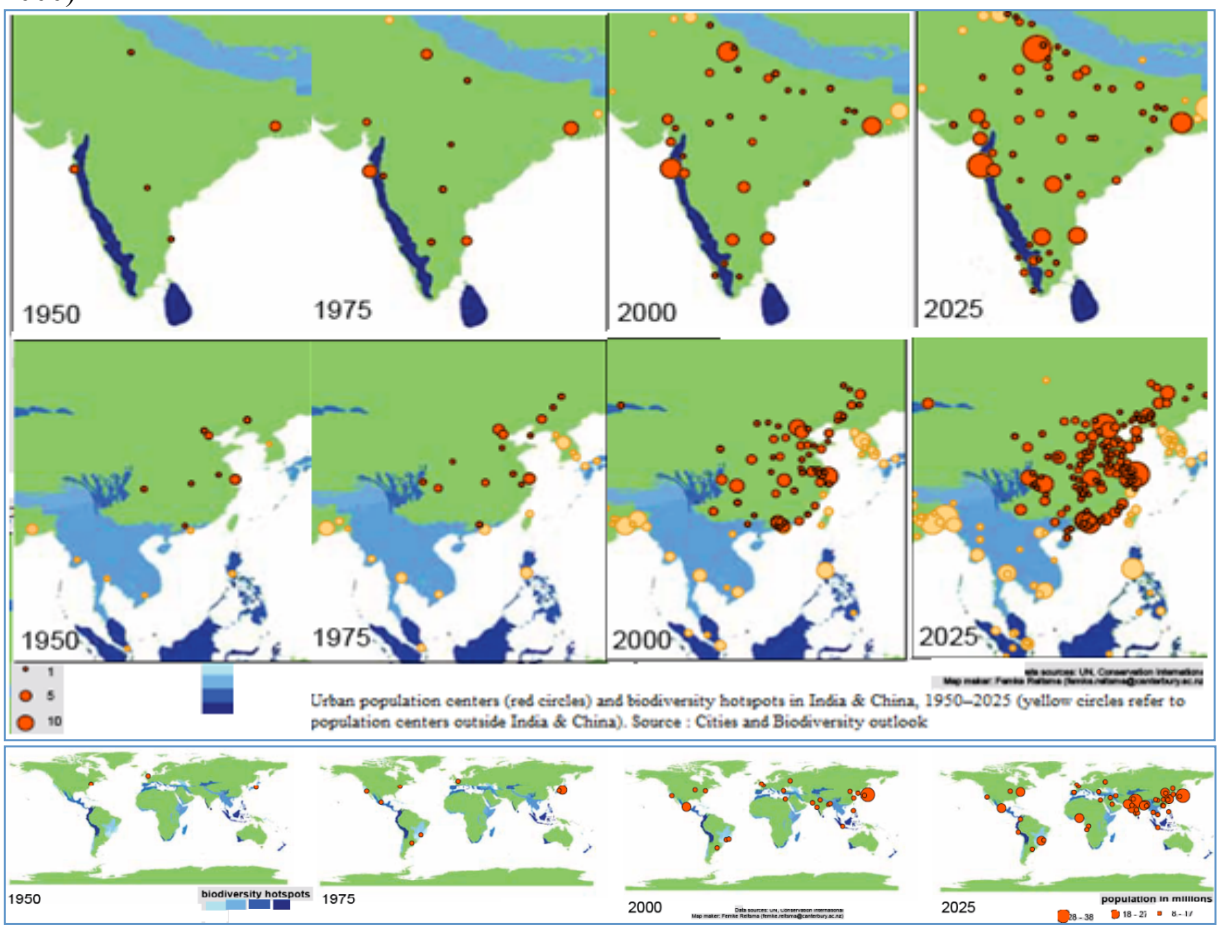


Figure 4: Growth of cities and biodiversity hotspots (City and Biodiversity outlook, 2012)

BIODIVERSITY AND REALESTATE

The total economic value of an environmental resource (ecosystem) consists of its use value (UV) and non-use value (NUV). A use value is a value arising from an actual use

made of a given resource. Use values are further divided in to direct use values (DUV), which refer to actual uses ; indirect use value (IUV) which refer to the benefits deriving from ecosystem functions ; and option value (OV) which is a value approximating an individual's willingness to pay to safeguard an asset for the option of using it at a future date, like an insurance value. NUV are usually divided between a bequest value (BV) and an existence or 'passive' use value (XV).

The total economic value :
TEV = UV+NUV=(DUV+IUV+OV)+(XV+BV)

The ecosystem valuation methods that relates to real estate are hedonic methods that consider housing market and the extra amount paid for higher environmental quality. The price of a house is related to the characteristics of the house and property itself, the characteristics of the neighborhood and community, and environmental characteristics. Some of the indicators of CBI can be directly linked to the quality indicators in the real estate pricing index.

Indicators of CBI that have direct or indirect linkage to real estate prices are Indicator 1 – proportion of natural areas in the city, Indicator 3 – native biodiversity in built-up areas, Indicator 3 - Native biodiversity in built up areas, Indicator 9 – proportion of protected natural areas, Indicator 11- regulation of quantity of water, Indicator 12 – climate regulation : carbon storage and cooling effect of vegetation, Indicator 13-14 : recreational and educational services, Indicator 15 – budget allocated to biodiversity in cities, Indicator 17 – policy, rules and regulations : existence of local biodiversity strategy and action plan.

Indicator 12 – climate regulation: carbon storage and cooling effect of vegetation is an important indicator that aids corporate sustainability strategy of a company. Declining trends in overall ecosystem health is of direct concern to businesses not only because many depend on related services, either directly or indirectly, but also because the degradation of ecosystems can present some of the following risks or, indeed, opportunities. (Carolyne Lane, 2009)

Some of the risks and opportunities can be listed as below:

Operational	Regulatory and legal
Risks: Indicator 11- regulation of quantity of water leads to risks such as higher costs for services as regulations in quality of water whenever the quantity of water is scarce. Opportunities: Planning for water use efficiency and cost savings	Risks: Fines, new user fees, etc to companies Opportunities: Indicator 17 – policy, rules and regulations : existence of local biodiversity strategy and action plan upon which a company depends
Marketing and Sales	Finance
Risk: Change in the purchasing patterns as	Risks: Banks implementing rigorous lending

companies being targeted by non-governmental organizations that result in degradations to natural systems, Customers switching to other suppliers that offer products with lower ecosystem impacts. Opportunities: Indicator 16: Number of biodiversity projects implemented by the city annually as it is a measure of communicating sustainable practices participating in innovative programs that focus on sustainability	requirements Opportunities: Indicators 20-21: Participation and partnership is a measure of banks or government agencies offering incentives to those companies that adopt initiatives that reduce environmental impacts or are aimed at enhancing degraded ecosystems.

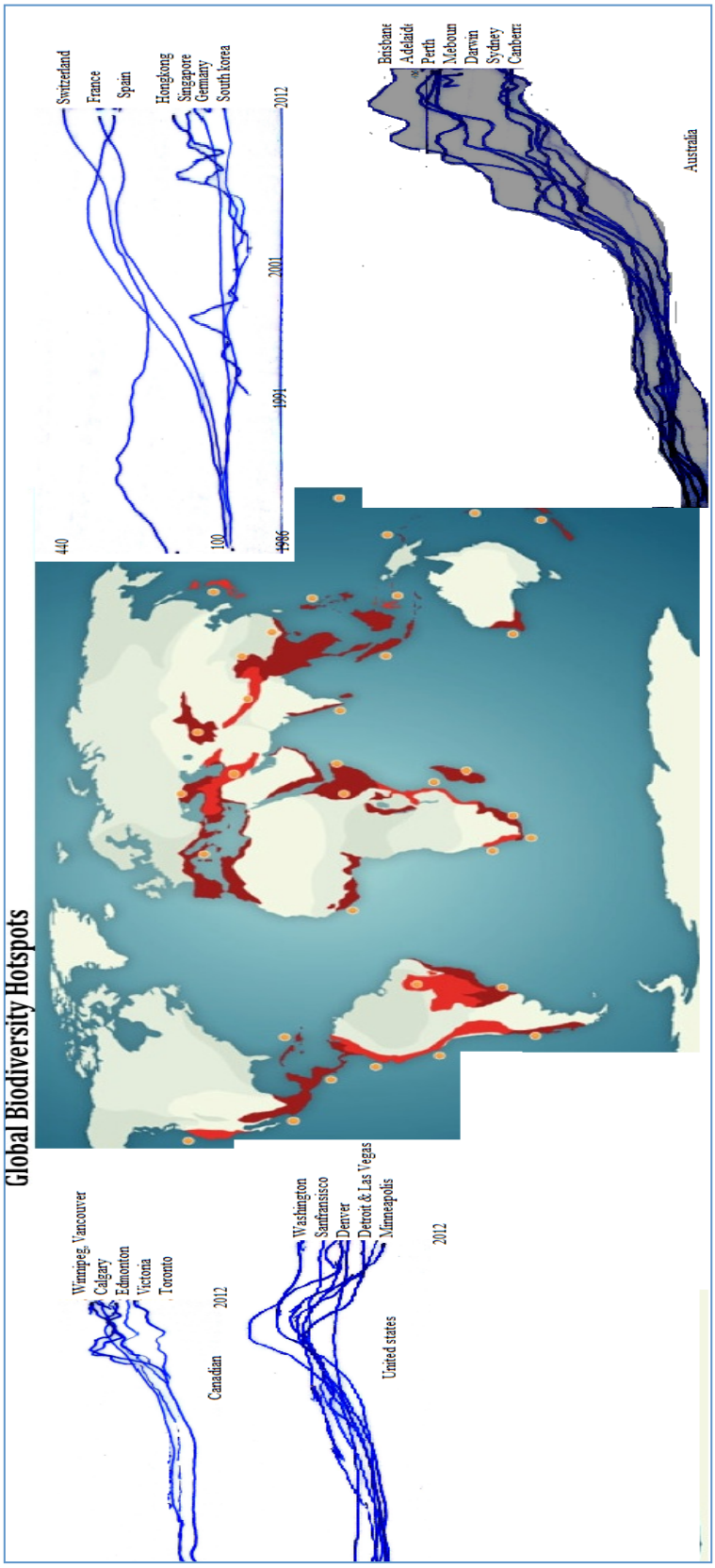
Table 2: Risks and opportunities due to Biodiversity conservation strategy

Valuation of perennial crops associated with agricultural land sales is the estimated value of crops per 4046.9 m^2 in month t using the sales comparison approach, cost approach or income capitalization approach.

OPPORTUNITIES IN REALESTATE DUE TO EMPHASIS ON BIODIVERSITY CONSERVATION

Opportunities in real estate due to addressal of Biodiversity degradation can occur because of the additional budget allocations to conserve biodiversity. Some of the opportunities that are direct or indirect implications of CBI are presented in the above table. The opportunities that are significant spinoffs from the biodiversity conservation planning are information systems used for land fragmentation planning, green roof construction methodology. Greenroofs can aid conservation efforts by mitigating, although not entirely avoiding, the effects of habitat loss associated with urban development.

o “Creation of habitat for pollinating insects and other invertebrates
Three-quarters of flowering plants depend on pollinators for fertilization. The global decline of pollinators (including birds, bats, and bees) is a significant concern that could damage dozens of commercially important crops.



o Creation of stop over areas for migratory birds

The ability of migrants to replenish fat stores may be one of the most significant constraints faced by these birds during their migration. Green roofs designed with the needs of migratory birds in mind have the potential to provide relatively safe areas with a much lower potential exposure to mammalian predators (aerial predators such as raptors will still be an issue), leading to uninhibited foraging intensity." (Carolyne Lane, 2009)

Figure 5: Real estate indices and Biodiversity (Chau. K.W, 2006)

CONCLUSIONS AND FUTURE WORK

While the properties of natural capital are distinctly different from both manufactured and financial capital, its inputs to driving human endeavors have until recently gone unrecognized. As shown in figure 5 above the real estate indices across the world has direct linkage to ecosystems with the indices across the globes varying in different range of scales. Since the 70 cities that are in participation for a CBI their corresponding regional real estate indices are closely in match inversely with range and growth rate of real estate pricing index. Some businesses have

begun to make the connection between healthy ecosystems and a healthy economy, while others are still not fully aware of the extent of their 'traditional' issues of pollution and resource consumption. (Carolyne Lane, 2009)

Commercial real estate industry is in a position to take a leading role and to build on existing endeavors by fully recognizing both the ecological and market value of biodiversity and associated natural capital. Consistent policies that blend environmental priorities and economic development can lead to monitored increase in value of the real estate with appropriate conservation planning. Several studies on policy making and governance inferred that "inconsistencies are spurred by contradictory political commitments, incoherent institutional structure and the lack of long-term policy guidance" (Armelle guignier, 2011).

Further works of this research work will focus on establishing correlations between quality bio diversity and real estate. Efforts to quantify the impact of pricing of commercial complexes like shopping malls on real estate in Singapore is being organized. Public choice behaviors of consumers to real estate pricing due to biodiversity in commercial complex areas is being quantified and would be presented in future.

APPENDIX - I :

Description of Indicators :

Indicator 1: Proportion of natural areas in the city
Calculated as = (Total area of natural areas, restored and naturalized areas) ÷ (Total area of city) × 100%
Natural ecosystems harbour more species than disturbed or man-made landscapes; hence, the higher the percentage of natural areas compared to that of the total city area gives an indication of the biodiversity richness. However, a city by definition has a high proportion of modified land area and this is factored into the scoring. The definition also takes into consideration "restored ecosystems" and "naturalized areas" in order to recognize efforts made by cities to increase the Natural Areas of their city. Restoration helps increase natural areas in the city and cities are encouraged to restore their impacted ecosystems.

Indicator 2: Connectivity measures or ecological networks to counter fragmentation
Fragmentation of natural areas is one of the main threats to the sustainability of biodiversity in a city. Hence, it has been selected as an indicator to chart possible future trends. However, it is not easy to measure fragmentation. Some of the ways to measure fragmentation include mean patch size or distance between patches, etc.

Calculated using the following methodology:

$$IND2 = \frac{1}{A_{\text{total}}}\left(A_1^2 + A_2^2 + A_3^2 + \ldots + A_n^2\right)$$

Where:

- n is the total number of connected natural areas
- A_{total} is the total area of all natural areas

- A_1 to A_n are areas that are distinct from each other (i.e. not connected)

A_1 to A_n may consist of areas that are the sum of two or more smaller patches which are connected. In general, patches are considered as connected if they are less than 100m apart.

Indicator 3: Native biodiversity in built-up areas
Built-up areas and brownfield sites do harbour biodiversity, e.g., birds like swallows and swiftlets nest under roofs of buildings, plants grow on buildings, butterflies flutter around sun-lit shrubs and grassy patches, dragonflies dart above water features, etc

Indicators 4-8: Change in vascular plants, birds, butterflies and any two of the number of native species of bryophytes, fungi, amphibians, reptiles, freshwater fish, molluscs, dragonflies, carabid beetles, spiders, hard corals, marine fish, seagrasses, sponges etc.

Indicator 9: Proportion of protected natural areas
Protected or secured natural areas indicate the city's commitment to biodiversity conservation. Hence, the proportion of protected or secured natural areas is an important indicator. The definition of protected natural areas should be broadened to include legally protected, formally secured areas, and other administratively protected areas, as different cities have different terminologies and means for protecting their natural areas.

Calculated using the indicator: (Area of protected or secured natural areas) ÷ (Total area of the city) × 100%

Indicator 10: Proportion of invasive alien species (as opposed to native species)
Invasive alien species out-compete native species and, thus, threaten the survival of native species and the integrity of ecosystems. As cities are very open to influx of alien species, this indicator measures the status of this threat.

The definition of alien invasive species adopted follows that accepted by the SCBD, i.e.:
An alien species whose introduction and/ or spread threaten biological diversity (For the purposes of the present guiding principles, the term "invasive alien species" shall be deemed the same as "alien invasive species" in decision V/8 of the Conference of the Parties to the Convention on Biological Diversity).

To ensure that the comparison of invasive alien species with that of native species is meaningful, it would have to be a comparison of identical taxonomic groups.
= (Number of invasive alien species) ÷ (Number of native species) × 100%

Indicator 11: regulation of quantity of water
Climate change is in many places predicted to result in increased variability in precipitation which in urban landscapes may translate into high peaks in water-flow and damage to construction, business and transport. Vegetation has a significant effect in reducing the rate of flow of water through the urban landscape, e.g. through presence of forest, parks, lawns, roadside greenery, streams, rivers, waterbodies, etc.

Proportion of all permeable areas (including areas identified in Indicator 1 plus other parks, roadside greenery, green roofs, private gardens, streams, rivers, etc.) to total terrestrial area of city (excluding marine areas and artificial permeable surfaces, if applicable)

Calculating the indicator: (Total permeable area) ÷ (Total terrestrial area of the city) × 100%

Indicator 12: climate regulation: carbon storage and cooling effect of vegetation
Two important aspects of climate regulation services are carbon storage and cooling effects provided by vegetation, in particular tree canopy cover. Climate regulation services are affected by many factors, including the size of trees, the different characteristics of tree species, and other variables, etc.

With regards to carbon storage, plants capture carbon dioxide during photosynthesis, hence, capturing carbon that is emitted by anthropogenic activities. Canopy cover of trees, which includes those that are naturally occurring and planted in a city, is accepted here as an indirect measure of the carbon sequestration and storage services.

Plants, through shading, evapo-transpiration, and decreasing the proportion of reflective surfaces, reduce the ambient heat in the air and the surface temperature in the urban landscape. As a general rule, a 10% increase in vegetation cover reduces the temperature by about 3 degrees, hence, cooling the ambient temperatures.
The extent of tree canopy cover can also act as a proxy measure for filtering of air and numerous other biodiversity benefits. Planting of native trees to increase the canopy cover is encouraged.

Carbon storage and cooling effect of vegetation = (Tree canopy cover) ÷ (Total terrestrial area of the city) × 100%

Indicators 13-14: recreational and educational services
Biodiversity provides invaluable recreational, spiritual, cultural and educational services. It is essential for physical and psychological health.
Calculated using the following formula = (Area of parks with natural areas and protected or secured natural areas)*/ 1000 persons

Contribution of Indicators 12-15 in to CBI enunciates the importance of these indicators to biodiversity impacts on poverty and the subsequent responses of the policy makers in addressing the decreasing standard of living as shown in figure 1.

Indicator 15: Budget allocated to biodiversity
The relative amount spent on biodiversity related administration by a city can be seen as a representation of the city's commitment towards environmental stewardship. It is recognised that there are numerous other factors affecting the amount allocated towards biodiversity, but in general the greater the proportion of the total city's budget allocated, the greater the level of commitment by the city.
Calculated using the following formula =

(Amount spent on biodiversity related administration) ÷ (Total budget of city) × 100%

Indicator 16: Number of biodiversity projects implemented by the city annually
This indicator measures the number of biodiversity related projects and programmes that the city authorities are involved in, either as the main player or in partnerships with other entities where the city is a key collaborator.

Programmes and projects are not limited to the conservation of protected areas but could include those pertaining to species conservation (e.g. plants, birds and butterflies), species recovery, biodiversity surveys, biodiversity enhancement projects, restoration projects, procurement of green services, etc.

Indicator 17: Policy, rules and regulations – existence of local biodiversity
Status of Local Biodiversity Strategy and Action Plan (LBSAP, or equivalent plan); number of associated CBD initiatives

Indicators 18-19: Institutional capacity
Number of essential biodiversity-related functions like - *biodiversity centre, botanical garden, herbarium, zoological garden or museum, insectarium, etc* that the city uses and the number of city or local government agencies involved in inter-agency cooperation pertaining to biodiversity matters
Indicators 20-21: Participation and partnership
Existence and state of formal or informal public consultation process pertaining to biodiversity-related matters and Number of agencies/ private companies/ NGOs/ academic institutions/ international organisations with which the city is partnering in biodiversity activities, projects and programmes.
Indicators 22-23: Education and awareness
Education can be divided into two categories, formal through the school curriculum or informal. Two aspects will be evaluated, i.e., formal education and public awareness. While Indicator 14 gives an indication of school children's use of recreational services provided by ecosystems, Indicators 22 and 23 highlight:
(i) whether biodiversity is included in the school curriculum; and
(ii) the number of outreach or public awareness events are held per year.
The values of the index for Hyderabad are as follows -

		Indicator Value		**Score**	
Sl.No.	**Indicator**	**Earlier Manual**	**Latest Manual**	**Score**	**Hyderabad**
1	Indicator 1: proportion of natural areas in city	0.0414	4.14%	4	1
2	Indicator 2: connectivity measures or ecological networks to counter fragmentation	0.139	285.58	4	1
3	Indicator 3: native biodiversity in built-up areas bird species	>140	>140	4	4

4	Indicators 4: change in number of native species vascular plants	1	1	4	2
5	Indicators 5: change in number of native species birds	0	0	4	1
6	Indicators 6: change in number of native species butterflies	0	0	4	1
7	Indicators 7: change in number of native species reptiles	0	0	4	1
8	Indicators 8: change in number of native species fresh water fishes	0	0	4	1
9	Indicator 9: proportion of protected natural areas	0.003724	0.37%	4	1
10	Indicator 10: proportion of invasive alien species (as opposed to native species)	0.13	13.51%	4	2
11	Indicator 11: regulation of quantity of water	0.36	36%	4	2
12	Indicator 12: climate regulation: carbon storage and cooling effect of vegetation	>0.075	>7.5%	4	1
13	Indicator 13: recreational and educational services (area of parks with natural areas and protected or secured natural areas)*/ 1000 persons)	0.161	0.161	4	1
14	Indicator 14: recreational and educational services (number of formal educational visits per child to parks)	0	0	4	0
15	Indicator 15: budget allocated to biodiversity	0.016	1.60%	4	1
16	Indicator 16: number of biodiversity projects implemented by the city annually	6	6	4	2
17	Indicator 17: policy, rules and regulations – existence of local biodiversity strategy and action plan	0	0	4	0
18	Indicator 18: institutional capacity: number of essential biodiversity-related functionaries in the city	9	9	4	4
19	Indicator 19: institutional capacity: number of city or local government agencies involved in inter-agency cooperation pertaining to biodiversity matters	3	3	4	1

20	Indicator 20: participation and partnership existence and state of formal or informal public consultation process	*	*	4	1
21	Indicator 21: participation and partnership number of agencies/ private companies/ ngos/ academic institutions/ international organisations with which the city is partnering in biodiversity activities, projects and programmes	0	0	4	0
22	Indicator 22: Is biodiversity or nature awareness is included in the school curriculum (e.g. biology, geography, etc.)	*	*	4	4
23	Indicator 23: Number of outreach or public awareness events held in the city per year	>300	>300	4	4
Total				**92**	**36**

Table : Hyderabad city bio-diversity index. (COP!!, 2012)

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