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Natural Capital Accounting in the Greater Hyderabad Area : A Comprehensive Valuation of Urban Ecosystems

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ABSTRACT

The study titled “Natural Capital Accounting in the Greater Hyderabad Area : A Comprehensive Valuation of Urban Ecosystems” aims to provide economic values for Greater Hyderabad’s natural resources and examines the impact of economic and non-economic benefits on urban spaces. It also studies the challenges of assessing an urban ecosystem from a marketing perspective, while aligning with mainstream global practices. It simultaneously examines the intersections between business, sustainability and ecological research, providing a valuation framework for economically relevant urban development policies.

Keywords: Greater Hyderabad Area; Natural Capital Accounting; Natural Resources; Sustainability; Urban Development; Valuation.

1.0 Introduction

Natural Capital Accounting is the systematic measurement and valuation of natural resources and ecosystems within a given geographical area that integrates the value of nature into economic decision-making and encompasses the valuation of various ecosystem services. It aims to redefine our perception of nature’s value within economic frameworks by quantifying the wealth found in natural resources and ecosystems. It also helps manufacturing, agriculture, energy, tourism and finance sectors identify potential risks and opportunities linked to their operations and supply chains, while facilitating efficient utilization of resources, judicious allocation of raw materials and optimization of extraction processes. The study aims to apply natural capital accounting principles to evaluate the environmental and economical health of natural resources like land & soil, water, air quality and green spaces within the Greater Hyderabad study area, while enhancing resource allocation mechanisms for the preservation of natural assets.

1.1 Objectives of the study

- The study assesses the economic value of natural capital of the Greater Hyderabad, an area of 677.12 km² across four subsets : Land & Soil, Water, Air Quality, Green Spaces.
- The study examines the health of Greater Hyderabad’s natural capital through detailed analysis of environmental data.

2.0 Review of Literature

Natural capital accounting is a critical component of sustainable development efforts, particularly in urban environments, as highlighted by leading organizations like the United Nations System of Environmental-Economic Accounting (UN-SEEA) and environmental scientists.

Sukhdev (2010) emphasizes the significance of natural capital accounting in economic decision making and the benefits ecosystems offer. Similarly, Trucost's (2013) report acknowledges the environmental costs associated with business operations, and advocates for integration of sustainability into corporate models. The National Academies (2005) stresses the importance of valuing ecosystem services to ensure a comprehensive understanding of their benefits. Also, The Natural Conservancy (2009) presents a compelling argument for businesses to invest in ecosystem services, showcasing successful integration into business models. Finally, The United Nations Environment Programme (2012) underscores the importance of natural capital accounting and overseeing the implementation to account for environmental factors in decision processes.

3.0 Research Methodology

3.1 Research Design

The study adopts an exploratory research design that employs quantitative statistical tools like mean, range dependent weight assignment methods, spatial analysis and multi-axis bar graphs to synthesize relevant secondary data sourced from various platforms including Geographic Information Systems (GIS), satellite imaging, and environmental databases and analyze the economical and ecological aspects of the Greater Hyderabad Area.

3.2 Sources of Data

The study relies on secondary data collected from credit-worthy government agencies, satellite imaging companies and open-to-public databases as follows:

Greater Hyderabad Municipal Corporation (Financial reports); The Hyderabad Metropolitan Water Supply and Sewerage Board (Water data); Telangana State Pollution Control Board (Air quality data); Hyderabad Metropolitan Development Authority (Land Records); Telangana State Forest Development Corporation (Biodiversity insights); Open Data Telangana (Bio-physical data); EOSDA Landviewer (GIS and satellite imagery); Soil and Land Use Survey of India (Soil and land records); UN SEEA (Valuation framework).

3.3 Adapted Framework of Valuation (AFV)

The Adapted Framework of Valuation (AFV) integrates economic and non-economic factors to assess the comprehensive value of urban ecosystems by combining the principles of integration from the Total Economic Value (TEV) Framework Method and the principles of weighting from the Multi-Criteria Analysis (MCA) Method. The methodology involves six steps for valuation per subset :

A. Computation of Net Economic Value (NEV) : Net Economic Value = Relevant Asset Balances + Operational, Improvement, Maintenance Costs - Revenue Generated

B. Selection of factors and enumeration of values : 5 significant factors with their unit of measurement, quantity of resource, annual mean value ($\bar{x}$), closing value (x_t), recommended value range ($a - b$), and average recommended value ($a + b / 2 = c$).

C. Computation of ratio of deviation (RoD) from annual mean and recommended range: Ratios of deviation from annual mean ($|x_t - \bar{x}| / \bar{x}$) and the recommended range ($|c - \bar{x}| / c$) based on the previous step.

D. Computation of weighted ratios and factor values : Weights assigned to the ratios of deviation for each factor to compute the weighted ratios ($\text{RoD}_{AM/ARV} \times \text{Weight}$) of annual mean (WR_{AM}) and average recommended value (WR_{ARV}), followed by the 5 factor values, computed as ($FV_n = WR_{ARV} + WR_{AM} / 2$); n = number of factor(s); as shown in Table 1:

Table 1: Weight Assignment Index Table

Ratio of Deviation to $\bar{x}$ or c	Weight	Interpretation
min - 0.19	5	Negligible Change (healthy)
0.2 - 0.39	4	Minor Change (not dangerous)
0.4 - 0.59	3	Moderate Change (warrants attention)
0.6 - 0.79	2	Significant Change (concerning)
0.8 - max	1	Severe Change (potential risk)

Source : Secondary Data - based off environmental compliance standards

E. Computation of Cumulative Average Factor Value (CAFV) : CAFV = Sum of all factor values ($FV_1 + FV_2 \dots FV_5$) / Number of factors - N ; where $N = 5$.

F. Value of Natural Capital of the subset : CAFV $\times$ Subset Index Value $\times$ NEV + NEV

4.0 Analysis

The analysis conducted across four subsets (Land & Soil, Water, Air Quality, Green Spaces) by employing the AFV provides valuable insights into the state of natural capital within the Greater Hyderabad study area, as tabulated in Table 2:

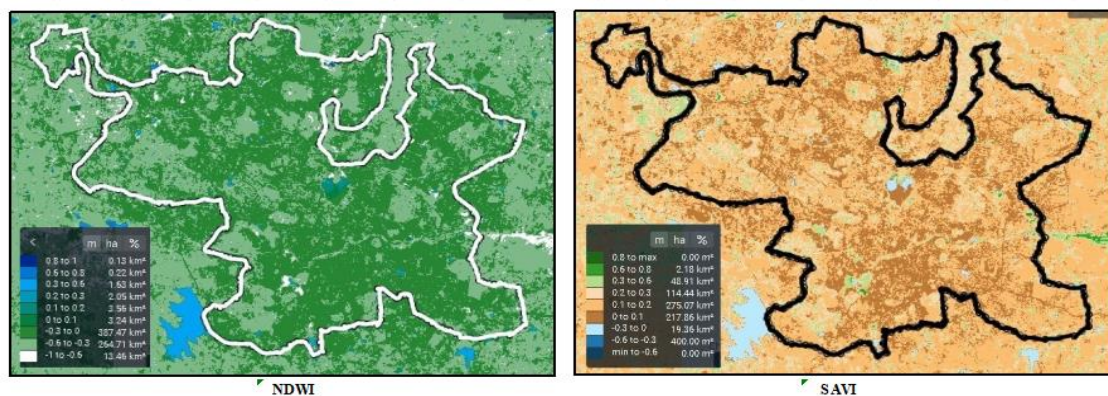
Table 2: Comprehensive analysis of Natural Capital across subsets

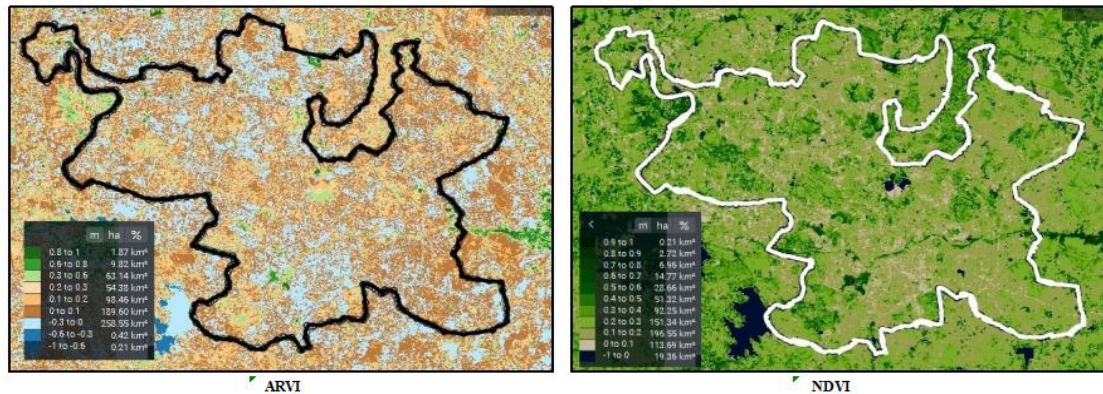
Subset	NEV*	Factors Considered	CAFV	Subset Index	Subset Index Value	Value of Natural Capital*
Land & Soil	15,815.74	pH, Electrical Conductivity, Exchangeable Sodium Percentage, Organic Carbon, Soil Temperature	0.606	SAVI	0.15	17,253.39
Water	2,951.68	pH, Dissolved Oxygen, Biological Oxygen Demand, Total Phosphorus, Turbidity	0.824	NDWI	0.11	3,219.22
Air Quality	3,426.01	PM 2.5, CO, Ozone, AQI, SO ₂	1.222	ARVI	0.15	4,053.99
Green Spaces	2,301.16	pH, Plant Mortality Rate, Exchangeable Sodium Percentage, Organic Carbon, Soil Temperature	1.042	NDVI	0.18	2,732.76

Source : Secondary Data (* in Crores - ₹)

The subset indices utilized - Soil Adjusted Vegetation Index (SAVI) , Normalized Difference Water Index (NDWI) , Atmospherically Resistant Vegetation Index (ARVI) and Normalized Difference Vegetation Index (NDVI) were facilitated by satellite index maps from EOSDA Landviewer's Sentinel 2 L2A satellite, streamlining the evaluation of natural resources by providing insights about soil characteristics, water presence, air quality and vegetation health across the Greater Hyderabad study area.

Figure 1: Index Maps of the Greater Hyderabad Area





Source : EOSDA Landviewer Sentinel 2 L2A Satellite Imagery - Greater Hyderabad Area

From Figure 1, the total study area of 677.12 km² constitutes 639.05 km² of non-vegetated land, 26.69 km² of vegetated land, 10.30 km² of water resources and 1.55 km² of unclassified area. The normal water withdrawal rate from reservoirs, lakes and groundwater levels in the study area is estimated to be >2,000 million gallons per day (MGD) / 7,57,08,23,600 liters per day (LPD).

5.0 Findings & Interpretation

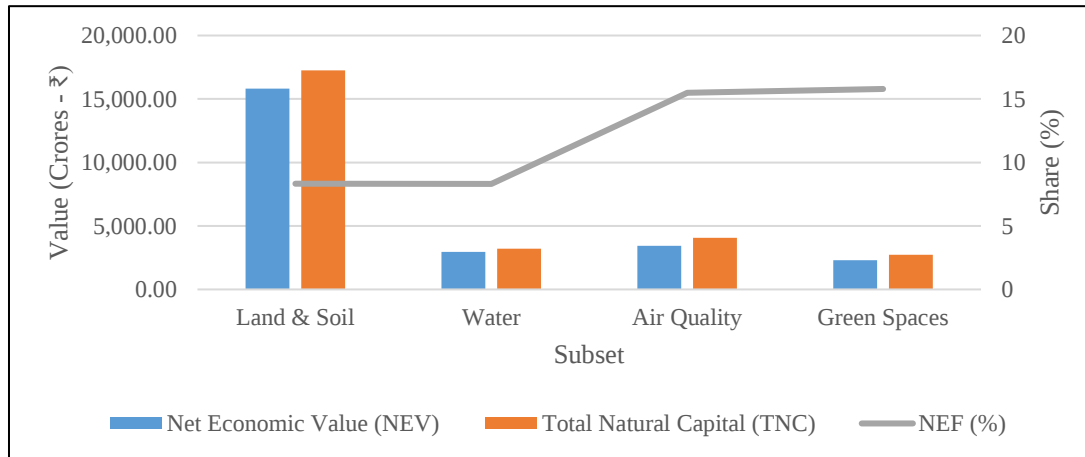
Table 3: Consolidated Natural Capital Report (Subset-wise Share Analysis)

Subset	Net Economic Value (NEV)*	NEV %	Total Natural Capital (TNC)*	TNC %	Growth Rate %	Difference* (Δ)	NEF %
Land & Soil	15,815.74	64.57	17,253.39	63.29	9.08	1,437.65	8.33
Water	2,951.68	12.05	3,219.22	11.80	9.06	267.54	8.31
Air Quality	3,426.01	13.99	4,053.99	14.87	18.32	627.98	15.49
Green Spaces	2,301.16	9.39	2,732.76	10.02	18.75	431.60	15.79
Total	24,494.59		27,259.36			2,764.77	

Source : Secondary Data (* in Crores - ₹)

Table 3 reveals that Land & Soil account for the largest share of NEV and TNC comprising 64.57% and 63.29% respectively. Air Quality follows closely in the second place, with a notable value, trailed by Water and Green Spaces. The Difference (Δ), represents the ecological value between NEV and TNC, underscoring the significant benefits derived from these ecosystems. Similarly, the NEF % (Non Economic Factors) represents the share of non-economic factors (Difference - Δ) as a part of the TNC. Particularly noteworthy is the substantial contribution of NEF to the valuation of Air Quality and Green Spaces, with the highest shares of 15.49% and 15.79% respectively. Besides the contributions, the growth rate indicates the increase in the value of natural capital from NEV to TNC, justifying that Air Quality and Green Spaces has grown by 2x (~18%) post integration with NEF, compared to Land & Soil and Water (~9%), as depicted in Figure 2.

Figure 2: Comparison of Net Economic Value, Total Natural Capital and NEF %



Source : Secondary Data

Further inference also indicates that the subset-wise share of NEV and TNC of Land & Soil and Water have decreased by 1.28% and 0.25% respectively. Conversely, Air Quality and Green Spaces have experienced an corresponding increase of 0.88% and 0.63%, highlighting the growing significance of ecological value in these subsets. Key metrics were also utilized to assess environmental performance against modern benchmarks as follows:

1. **Total Natural Capital Per Capita** : Rs. 24,627.03
2. **Natural Capital of GHMC as a percentage of Telangana's GSDP** : 1.88 %
3. **Average Natural Capital of GHMC per km²** : Rs. 40,25,77,977.31

Parametric health reports were employed to evaluate the environmental health of the subsets. Factors such as Electrical Conductivity and Exchangeable Sodium Percentage show significant changes, while Dissolved Oxygen and pH remain within safe levels. Concerns are raised regarding factors like Biological Oxygen Demand, Turbidity, PM 2.5, and Air Quality Index (AQI), suggesting potential risks to environmental health and crucial for mitigation and implementation of effective strategies.

6.0 Conclusion

The study offers a comprehensive examination of natural capital accounting within the Greater Hyderabad area, focusing on the valuation of urban ecosystems. As cities continue to grapple with the challenges of urbanization and environmental degradation, the insights provided by this study would serve as a valuable resource for policymakers, urban planners, and stakeholders to create resilient, inclusive, and environmentally sustainable urban environments that not only thrive economically, but also serve as models of environmental stewardship for generations to come.

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