The Economic Significance of Ecosystem Services in Urban Areas for Developing Nations

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Abstract: The correlation between urbanization and the ecological surroundings still needs to be more conclusive in research. The research utilized regional information from Developing nations spanning 2000 to 2020 to experimentally examine the correlation between the urbanization ratio and the natural surroundings, as shown by the Normalized Differential Vegetation Indicator (NDVI) derived from satellite imaging information. The findings demonstrate that the relationship coefficient between urbanization and Gross Domestic Product (GDP) per person is statistically significant and unfavorable. Still, the factor for urbanization alone is negligible and not statistically noteworthy. Urbanization diminishes ecological excellence, especially in affluent areas. An increased urbanization ratio correlates with a more significant adverse effect. It suggests that urban growth diminishes the natural surroundings. The influence of economic progress on NDVI can be categorized into three phases: the initial phase, where NDVI enhances with rising GDP per person (urbanization rate below 78%); the intermediate phase, where NDVI remains unaffected by GDP per person levels; and the final phase, where NDVI declines as GDP per person increases.

Keywords: Ecosystem; Urban; Economy; Developing Nation.

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I. Introduction

Ecosystems are deteriorating daily due to significant resource extraction, unregulated urbanization, and the depletion of vegetation and water sources. These surface characteristics directly influence the biophysical elements of the urban surroundings, including Land Surface Temperature (LST), greenery, moisture, and irritation (Alexander, 2020). The modifications of these biophysical surface qualities impact wildlife, ecosystems, and local weather patterns. Urban ecology is crucial in sustaining the flow of Ecosystem Services (ES) inside urban settings (Mandle et al., 2021). The amount and quality of urban environmental variables influence urban ecosystem services by regulating the regional climate, hydrological cycles, ecosystems, and the delivery of ecosystem services. Ecological factors impact aesthetic understanding, happiness, and community in metropolitan environments (Mouratidis & Yiannakou, 2022). The recent decline attributable to urbanization has emerged as a primary factor.

The conversion of ecological regions into developed regions led to the significant decline of urban ecology and its functions. The configuration and operations of a community are predominantly influenced by urban sprawl and the transformation of natural habitats (including aquatic systems, vegetative cover, and marshes) into anthropogenic environments such as developed regions and infrastructure projects (Huang et al., 2021). Ongoing ecosystem degradation leads to conflict within the socio-ecological interface and diminishes the general state of the urban environment.

Emerging nations such as developing nations, urban habitats, and environmental spaces face significant threats due to unplanned and chaotic urban expansion, resulting in a substantial decline in Environmental Service Volume (ESV) (Liu et al., 2021). The decline of the condition of cities in developing countries results in additional economic, social, and environmental issues, including poverty and the mishandling of natural assets. The detrimental effects on the urban setting undermine the urban ecology and its facilities. It is imperative to delineate and construct an extensive Urban Ecological Effectiveness (UEE) structure, providing a scientific foundation for the long-term preservation of the urban environment and economic welfare (Song et al., 2020).

Using remote Surveillance (RS) and Geographical Informational Systems (GIS) has become a sophisticated method for scientists to assess ecological quality and effectiveness at the regional scale (Abdollahi et al., 2021). These two methodologies were deemed the most efficient for assessing ecological state and variability. The urban environmental condition was previously evaluated using many ecological metrics, including the Normalized Differential Vegetative Indicator (NDVI), Normalized Differential Built-Up Indicator (NDBI), LST, normalizing differential impervious surface indicator (NDISI), and Land Subsurface Moisture (LSM). The evaluation of urban environmental quality or effectiveness cannot rely solely on a singular indicator, as it does not accurately represent the significant dimensions of Urban Environmental State (UES) (Lumeng & Jianguo, 2022).

Recent works established a methodology for assessing the environmental quality utilizing a four-layer measure across fourteen towns in a developing nation. The study established an extensive structure for evaluating ecological quality in Chinese cities, whereas the survey employed analogous indices-based methodologies in the developing nation's River Delta region. Satellite sensing-based evaluations of ecological state have emerged as a prevalent tool, extensively utilized across several domains of ecology, including urban environments, aquatic ecosystems, forest environments, and agricultural ecosystems. The past literature indicates that most research investigations on environmental views were conducted in developing nations and other nations. This research yields significant findings that could influence policy in Developing nation regions and other fast-expanding metropolitan regions in emerging countries.

II. Methods

Modifications to the quantity and attributes of green spaces in cities influence species distribution and plenty, vegetative framework, urban people's access to greenery, and the capacity of these places to provide ecological services. Economic variables affect the ecosystem services provided by greenery by modifying the quantity of green space in urban areas and its management (Figure 1). City rules, zoning rules, and the handling of public and private landscapes significantly affect the quantity, layout, and arrangement of urban plants, that control temperatures if intentionally operated. These laws and oversight strategies are frequently affected by socioeconomic factors.

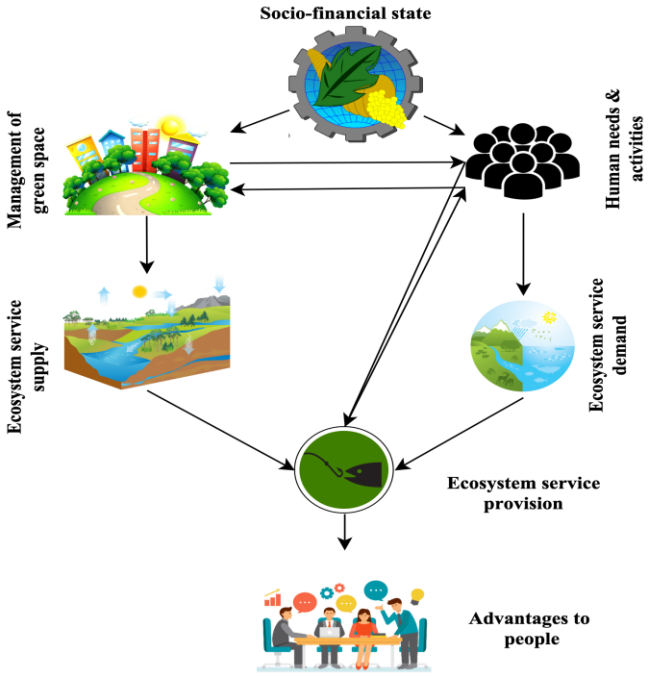

Figure 1: UES Model

Conceptual Methodology

The methodology employed in the investigation to assess the influence of urbanism on vegetative cover, utilizing the NDVI marker, is illustrated in Figure 2. NDVI has been used extensively to evaluate vegetation covering and environmental conditions. Initially, the research provides an overview of the terminology and metrics for urbanization pace, financial growth, and NDVI nationally. The side effects of urbanization and financial development are assessed individually using economic modeling. The ideal econometric strategy is ultimately chosen by evaluating the outcomes of several models. Figure 2 illustrates the primary factors, model architecture, and logical structure pertinent to this study.

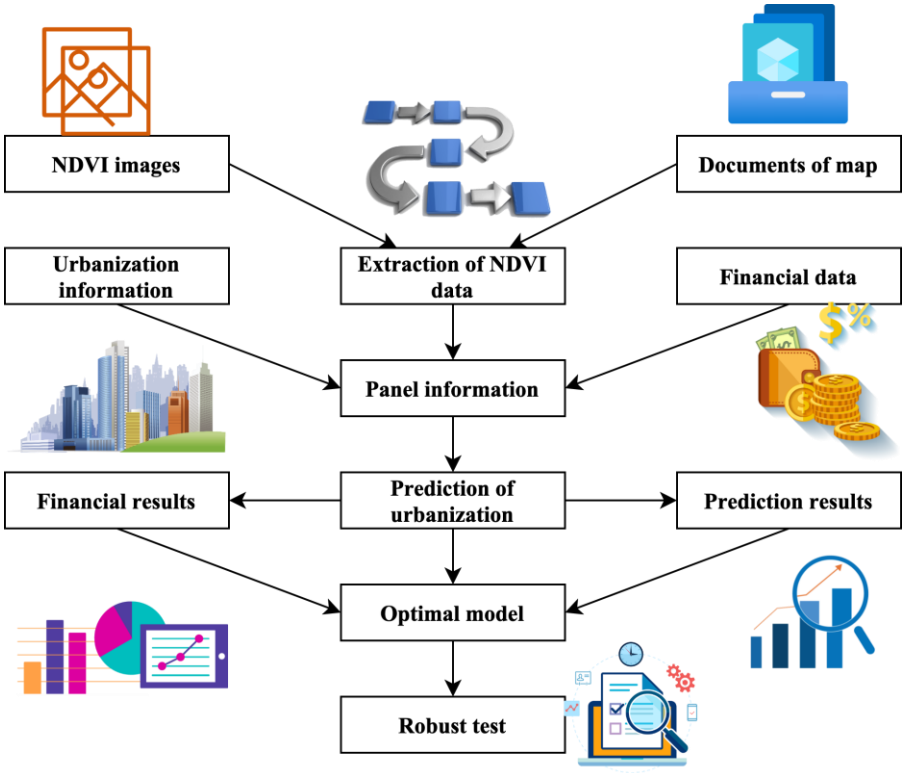

Figure 2: Conceptual Methodology

III. Results

Table 1 depicts the temporal variation in ESV among regions. In 2000, the northwest and southern areas of the city exhibited elevated ESV levels. Lakes and plants exhibited elevated ESV values and were situated in that region. However, the prevalence of these categories has diminished as time passes, as has the usefulness of ESV. The map indicates an elevated ESV score in 2000; the quantity of regions with greater ESV values has diminished after 2005. This pattern recurred in 2010 and 2020. The fall of the higher-value sector over the years is extremely startling.

Table 1: ESV Score Analysis of Different Categories

Class	2000	2005	2010	2015	2020
Farmland	4.25	3.52	3.12	2.63	1.87
Vegetations	17.42	19.32	9.42	6.32	5.32
Water sources	19.23	10.32	6.32	3.63	7.42
Empty area	0.54	0.72	0.46	0.35	0.29
Building	0.03	0.05	0.02	0.01	0.01

Reservoirs and farmland were transformed into unoccupied land and developed areas. The absence of the ESV rate in the built-up region and the minimal ESV rate in empty land significantly contributed to the decrease in the ESV rate. This research assessed the economic value of diverse ecological services. Table 1 illustrates the average variations in the ESV of ecological service function subcategories for the study's area from 2000 to 2020. Primary environmental services encompass water supply and waste management. Additional areas encompass the preservation of biodiversity, climate administration, and pollution regulation. They supplied a mean of 86.1% ESV, and their overall significance remained stable during the study. Table 1 illustrates that the averages of these factors have significantly declined over time, signifying a substantial degree of urban expansion in the metropolis. In 2000, the ESV was $35.2 million; by 2005, it had decreased to $26.24 million. It diminished by approximately 33.7% over a decade. Between 2005 and 2010, the ESV value declined to 17.4 million dollars. In 2020, it further deteriorated, declining to 10.2 million dollars. From 2010 to 2020, ESV decreased by approximately 69.2% (Table 2).

Table 2: Predicted ESV Change Analysis

Class	2000	2005	2010	2015	2020
Farmland	-0.12	-0.02	-0.47	-0.66	-0.98
Vegetations	-3.92	-2.22	-3.3	-1.42	-4.59
Water sources	-0.59	-3.82	-0.84	-3.81	-3.11
Empty area	-0.71	-0.01	-0.82	-0.11	-0.62
Building	-0.03	-0.07	-0.09	-0.03	-0.03
Settlements	0.01	0.02	0.03	0.01	0.02

The temporal alterations in each ESV category include (A) supplies, (B) controlling, (C) sustaining, and (D) culture environmental services. The result illustrates the temporal variations in per-hectare metrics for each class. The evaluations of all services are declining with time, indicating a significant decrease in ESV. ESV has diminished, but the Gross Domestic Product (GDP) has significantly increased (Table 3). Between 2000 and 2020, the City's GDP rose from approximately $15 billion to $150 billion, as reported. Dhaka has significantly developed, and the city's financial growth is praiseworthy. Both the density of people and the overall population have risen over the years. Over the past 35 years, the population density has increased by approximately 11.8%, while the overall population has tripled.

Empty land has increased by approximately 5.2%, while the developed area has expanded by almost 26.1%. ESV diminished by around 30.2% from 2000 to 2020 (Table 3). The rise in population and financial growth led to the construction of several communities throughout this period, causing a reduction in agricultural area. Because of urban and economic development, the reduction of land for agriculture and critical factors such as water bodies and flora has led to a decline in the worth of ESV throughout the years.

Table 3: Ecosystem Analysis

Indicator	Rate (%)	2000 - 2005	2005 - 2010	2010 - 2015	2015 - 2020
ESV	-30	-10	-12	-11	-13
Population	13.2	4.2	3.9	4.6	5.1
Empty area	3.04	3.12	2.86	2.54	1.42
GDP	64.2	58.2	15.4	18.3	52.6
Building	20.3	8.43	7.43	8.42	9.32
People density	14.21	5.42	6.32	3.42	2.94

IV. Conclusion

The correlation between urbanization and environmental factors still needs to be more conclusive in research. The research utilized province data from developing nations spanning 2000 to 2020 to experimentally examine the correlation between the urbanization rate and the natural surroundings, as shown by NDVI, which is derived from remote sensing information. Economic progress is significantly associated with urbanization; elevated urbanization indicates an elevated financial growth rate. In an

econometric approach, it is necessary to incorporate the relationship between economic development and urbanism. The factor for the interaction between urbanization and GDP per person is statistically significant and unfavorable, whereas the indicator for urbanization alone is minimal and not statistically noteworthy. Urbanization diminishes ecological excellence, especially in affluent areas. An increased urbanization ratio correlates with a more significant adverse effect. It suggests that urban growth diminishes the natural world.

The influence of GDP per person on NDVI can be categorized into three phases: the initial phase, where NDVI enhances with rising GDP per person (development rate below 78%); the intermediate phase, where NDVI remains unaffected by GDP per person (development rate at 78%); and the final phase, where NDVI declines as GDP per person increases. The urbanization ratio in most regions of Developing nations is far below 78%, a level often observed in industrialized nations globally. Most areas in Developing countries are in the initial stage when an increase in regional GDP per person correlates with an enhancement in the NDVI. This does not imply that financial progress can proceed to the detriment of the surroundings.

This phenomenon can be attributed to the heightened national consciousness regarding environmental conservation, coupled with advancements in economic growth. At the same time, a portion of arable land has been solidified or transformed into rewilding areas due to farmers migrating to urban centers for employment.

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