

# Socio-Economic spatial framework for Assessing the Character of Urban liminal Spaces in Regulating Ecosystem Services Case of Chennai City, India

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## Abstract

*Generally, urban landscapes, and urban spaces are delineated with clear specific boundaries. However due to rapid urbanization, certain areas within these spaces are characterized by co-presence and intermediateness such as the banks of water bodies, coastlines, and peri-urban spaces, referred to as liminal spaces. These spaces are in a state of constant transformation, and transition historically and functionally, due to various socio-economic and cultural factors. This dynamic heterogeneous nature of liminal spaces have been regarded as key providers for many ecological services by urban experts. Apparently, it is noticed that the character and usage of the liminal urban spaces is often affected by the built and land use dynamics and socio-economic conditions of the liminal space and its surrounding area. Moreover, due to the absence of proper ownership, these spaces tend to lack territoriality. As such, they are often overlooked by urban policy makers rendering them more vulnerable to environmental hazards.*

*Most urban planners consent to the spatiotemporal character of liminal spaces and advocate that there is a significant link between urban liminal spaces and climate resilience, thereby, agree that by integrating urban liminal space policies in urban planning there is an ability to adapt to climate change. However, lack of convincing studies with respect to the ecosystem services offered by the liminal spaces and the effect of these ecosystem services provided by the liminal spaces that support this ability might have halted the process of mainstreaming to some extent.*

*In this context, this research paper aims to understand the changing dynamics of liminal spaces. Specifically, this research investigates 1) how the land use dynamics affect the ecosystem services offered by the liminal spaces; and 2) Do these liminal spaces affect the psychosocial, socioeconomic and cultural ability of people in withstanding climate change.*

*This research undertakes a mixed method approach wherein by combining an array of methods, the ecosystem services provided by various liminal spaces are evaluated by both stated preference methods and market based methods assigning value to the indicators. As such the research will aid in establishing a relationship between socioeconomic conditions and environmental degradation as well socioeconomic conditions and consumption of land.*

*Accordingly, this research paves the way for a deeper understanding of ecosystem services offered by liminal spaces. Thereby has an implication for effective decision making related to urban liminal spaces.*

*Also, this research significantly contributes to the field of urban planning and public policy by developing empirical evidence that analyzes the relationship between urban liminal spaces and*

*climate change resilience. This research supports the use of urban liminal spaces as an effective tool in adapting to climate change thereby promoting climate resilience through urban planning. This research has an implication for mainstreaming climate change resilience in urban planning*

## Keywords

*Liminal spaces, ecosystem services, socio-economic conditions, environmental degradation*

## 1. Introduction

As urban areas expand to meet the demands of their growing populations, they create not only functional spaces for living and commerce but also "liminal spaces"—zones that exist in transitional states. The word liminal has its root in Latin, it was derived from the Latin word “Limen” which means boundary or limit. Urban liminal spaces are in between / transition spaces; spatially they represent any piece of land marking a transition, edges, borders, peripheries, terraqueous zones, or any wasteland which are at transition – spatially, temporally, and socially (Fourny, M.C., 2013). These liminal spaces are neither fully integrated into urban functionality nor entirely abandoned, making them unique intersections between the built environment and natural processes (Jorgensen & Tylecote, 2007). Often overlooked in urban planning, these spaces can contribute unexpectedly to biodiversity and environmental resilience, providing habitats for flora and fauna and supporting ecological functions like flood mitigation and air purification. As urbanization intensifies, understanding and reimagining the role of liminal spaces becomes increasingly relevant in promoting sustainable and resilient cities (Krasny & Tidball, 2012).

In the Global South, the character and usage of liminal spaces are often affected by built and land use dynamics and socio-economic conditions of the liminal space and its surrounding area. (Franck, K.A., & Stevens, Q., 2007) (Lehtovuori, P., 2010). Moreover, due to a lack of proper ownership, these spaces tend to lack territoriality (Thompson, C.W., 2002).

Also, liminal spaces have a symbiotic relationship with the environment, the way a liminal space is utilized has a direct impact on the ecosystem. Since urban liminal spaces are products of urbanization and development, these spaces and their connotations should be evaluated quantitatively to shed light on their importance. In this context, this research has utilized ecosystem services as a means to measure the impact of ecosystem services. Ecosystem services is an emerging concept in the field of environmental economics, that aids in the valuation of different services provided by the ecosystem and integrates various management strategies to address the challenges related to water security, climate change, human well-being along with quality of life. According to the Millennium Ecosystem Assessment Report 2005, there are four types of ecosystem, namely, provisioning, regulating, cultural, and supporting. While the concept of liminality is often overlooked due to its qualitative nature, the concept of ecosystem services which provides valuable insights about the ecosystems' worth is rarely studied spatially.

In this setting, the research puts forth to analyse the effects of land use dynamics on the ecosystem services offered by the liminal spaces (L.S.), the role of psychosocial, socioeconomic, and cultural factors, in understanding ULS and the Willingness of people To Pay (WTP) for protecting/preserving the ecosystem services offered by the L.S. The Adyar River flowing in Chennai, Tamil Nadu, India is an urban liminal space satisfying both spatial and temporal liminality and is chosen as the case study area. The river's fabric has a

diverse fabric of socio-economic conditions, land use patterns, and ownership; a result of rapid urbanization, pollution, and encroachment.

Much of the river and its surrounding floodplains have become liminal spaces—underutilized, degraded, and subject to fluctuating, often informal land use. These areas, which are neither fully integrated into the urban fabric nor entirely preserved as natural ecosystems, highlight the complex interaction between urban development, environmental sustainability, and socio-economic factors. This research will offer insights into how urban planning can address the challenges faced by liminal spaces in rapidly urbanizing cities like Chennai.

## 2. Site and Methodology

### 2.1. Site

Adyar river is one of the three rivers which flows across Chennai. Originating from Chembambakkam lake, the river runs a total distance of 42.5 Km from the west to east of Chennai, draining into the Bay of Bengal at Adyar Estuary. The Adyar river has a catchment area of 530 Sq. Km and has depth varying from 0.75 m and 0.5 Km in its upper and lower reaches respectively. The river and its banks have undergone and is undergoing many changes due to various factors like abutting land use, urbanisation, industrialization. The River, which was once a major transportation mode during the British and post-independence times, started facing its downfall upon the advent of industries along the banks, this was further aggravated by the rapid urbanisation – leading to an increase in the number of slums along the banks. This rapid industrialization and contamination led to severe contamination of Adyar, rendering it a dead river. There have been/ are several initiatives to clean up the river, some of which are under process.

The River has been in a state of liminality in both spatial and temporal dimensions. It is also evident and widely accepted by environmental economists that rivers and its banks are major providers of ecosystem services. Based on this, the sizable part of Adyar, 9.68 Km from the mouth of the river till Jaffer Khanpet has been chosen as a case study. This part of the river has been a part of Chennai from the times of British rule, making it a major component of temporal liminality of Chennai City.

### 2.2. Methodology

A mixed-method methodology has been employed in the study. The spatial aspects have been studied with relation to land use, a detailed Survey number based on existing land use (observations through primary survey) for a 200 m buffer of the identified 9.68 Km stretch of the Adyar River. The various ecosystem services available in this stretch are mapped through primary surveys, photo documentation and secondary data from government websites. This has been compared with the existing land use and the Government Land Value of the abutting residential land. With this, the relationship between the land use and land value and the ability of the adjoining stretch of Adyar river bank to provide ecosystem services is analyzed.

For the evaluation of Willingness to pay the people- Contingent valuation, a mixed method survey (online and in-person surveys) has been utilized. By using Tableau and Microsoft Excel, quantitative analysis of the interview transcripts - Descriptive statistics and Correlation analysis - have been carried out. Average WTP was carried for the data collected during the primary survey. ChatGPT was utilized to generate an APA-style reference list.

### 3. Analysis and Findings

#### 3.1. Ecosystem Services

Ecosystem Services are the direct and indirect benefits a person obtains from the ecosystem. According to Costanza, R., d'Arge, R., de Groot, R. et al (1997), ecosystem services could be referred to as ecosystem goods (such as food) and services (such as carbon cycle, waste assimilation) put together. While Costanza, R., d'Arge, R., de Groot, R. et al (1997) had identified 17 ecosystem services: Gas Regulation, Climate Regulation, Disturbance Regulation, Water Regulation, Water Supply, Erosion control and sediment retention, Soil Formation, Nutrient Cycling, Waste treatment, Pollination, Biological Control, Refugia, Food production, Raw materials, Genetic resources, Recreation and Cultural based on different biomes available on Earth. Further, in 2005, the Millennium Ecosystem Assessment framework identified 4 broad categories for identifying and analyzing ecosystem services available, they are:

Provisioning services - These are the products and goods which are taken from the ecosystem to fulfill our needs,, i.e., provisioned by the ecosystem. Some examples of provisional services are food, wood, water, fuel.

Regulating services - These are the benefits obtained from the moderation or regulation of ecosystems. Some examples of regulating services are carbon sequestration, pollination, climate regulation, flood prevention

Supporting Services - These are services which are essential for the functioning of all other services. These services support the functioning of other ecosystem services. Some examples of soil formation, nutrient cycling, habitat provision

Cultural Services - These are the non material services and benefits that are meant for satisfying cultural, aesthetic, educational, spiritual and psychological needs. Examples of cultural services include tourism, audio visual tours, bird watching.

##### 3.1.2. Ecosystem Services offered by the banks of Adyar River

As per the literature reviewed, the banks of the river provide the following ecosystem services:

Provisioning services: Food, fresh water, fibre & fuel, genetic material, biodiversity, etc.

Regulating services: Climate Regulation, Hydrological flows, pollution control & detoxification, habitat, natural hazards, etc.

Cultural: Spiritual & inspirational, Recreational, aesthetic, educational, etc.

Supporting: Carbon sequestration, nutrient cycling, etc.





The availability of Ecosystem services has been surveyed in the case study area. The primary survey observed that the case study area provided Cultural services (17 Nos.) and Regulating services (8 Nos). The cultural services identified fall under recreational and educational categories, while the Regulatory services fall under habitat and Pollution control & Detoxification categories.

To further understand these services and their availability, the location of these services was mapped with the corresponding land use of the Adyar river bank. Based on this mapping it was observed that 41% of the cultural services was found in the open spaces and recreation land use, 29.5 % of the cultural services was found in the institutional land use and the remaining 29.5 % of the cultural services was found in residential land use. From the primary survey, it was evident that the parts of the river bank falling under industrial and commercial land use did not provide for any cultural ecosystem services.

The regulatory ecosystem services were majorly found in institutional land use (50%), followed by open spaces and recreational land use (33%) and the rest (17%) are available in commercial land use. Cumulatively, 36% of the ecosystem services are located in open spaces and recreational land use, 32% of the ecosystem services are located in Institutional land use, 16% of the services are available in residential land use and 4% of the ecosystem services are available in commercial land use. It is observed that industrial land use areas do not contribute to any of the ecosystem services in the study area.

### 3.1.3. Socio-Economic Conditions – Ecosystem Services

Government land value (GLV) has been taken as an indicator for socioeconomic conditions. It is widely accepted by economists that higher land values correlate to wealthier neighbourhoods (Harvey,D., 1973), which implies, the higher the GLV, the better the socio economic conditions. The location of ecosystem services were correlated to the land value of adjacent residential areas. It was observed that predominant of the Ecosystem services were located in the high value neighbourhoods - 12 numbers in INR 25k to 36k per Sq. Ft and (48% of the services), followed by 10 numbers in INR 10k to 15k per Sq.Ft neighbourhoods (40 %). The detailed split up is given in the following table.

Table 1 Location of E.S. and abutting Land Value (Compiled by Author)

| Land Value in abutting Residential areas | No. of services |
|------------------------------------------|-----------------|
| Less than 5000                           | 1               |
| 5001 - 10000                             | 2               |
| 10001- 15000                             | 10              |
| 15001- 20000                             | 0               |
| 20001- 25000                             | 0               |
| 25001- 36000                             | 12              |
| <b>Total</b>                             | <b>25</b>       |



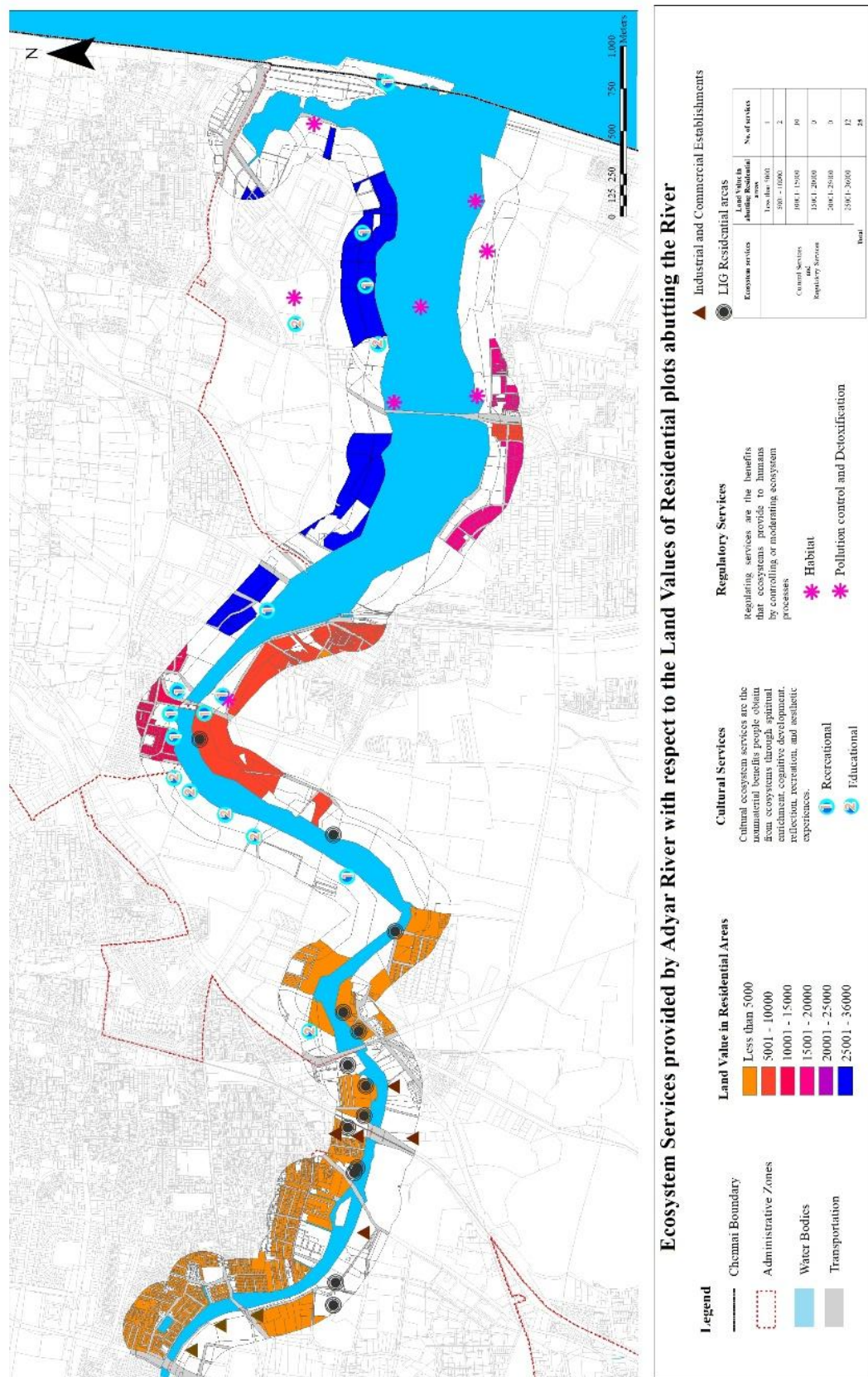


Figure 2 Location of E.S. with respect to Land Value (Source: Author)

To further support the role of socio-economic conditions on the location of ecosystem services, a people perception survey was carried out. The results of which are summarised in the section below.

### 3.2. Ecosystem Services and income level

In the people perception survey, various domains like the importance of ecosystem services, the importance of Adyar River in maintaining religious and cultural identity, cultural impact of Ecosystem services on liminal spaces and annual willingness to pay for ecosystem services among different income groups were analysed.

#### 3.2.1. Importance of ecosystem services

Based on literatures and government plans, 6 types of ecosystem services were shortlisted to study their importance among the general public. The chosen services were Water Quality Improvement, Biodiversity Conservation, Recreational Services, Cultural and religious services, aesthetic value and flood resilience.

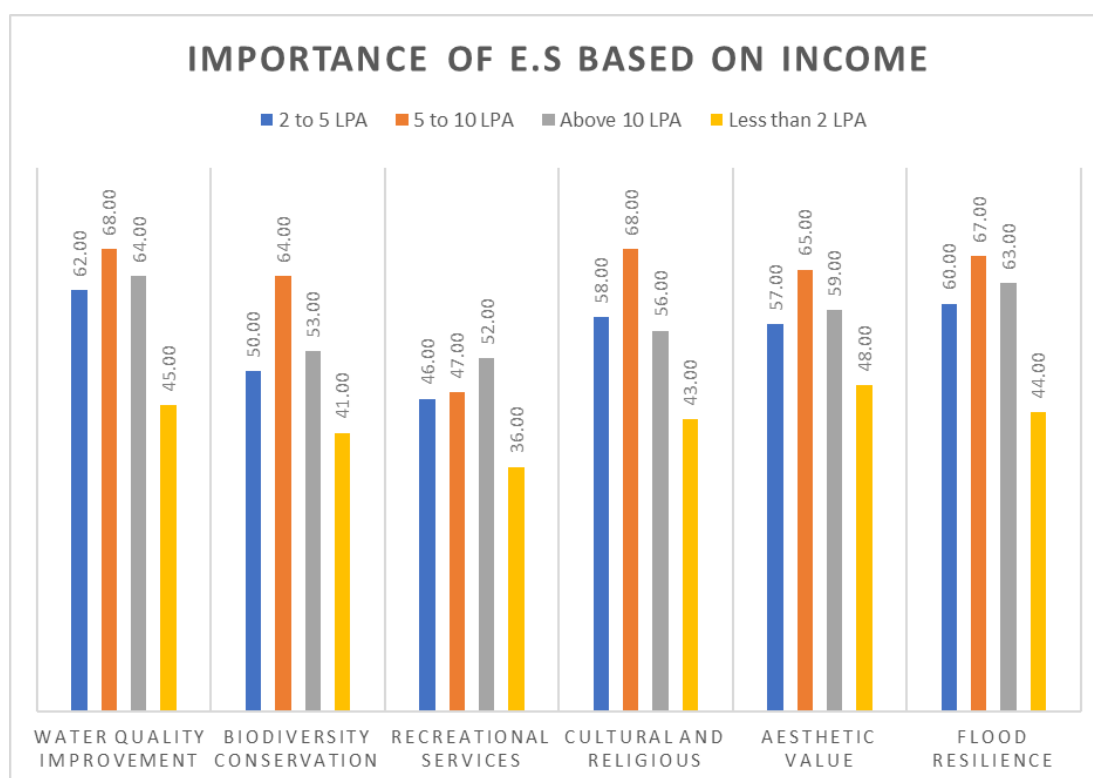


Figure 3 Importance of E.S. Based on income (Source: Author)

Water Quality Improvement: Individuals with higher incomes (5 to 10 LPA and above 10 LPA) rate this service the highest, with scores of 68 and 64, respectively. The 2 to 5 LPA group gives a moderately high importance (62), while the less than 2 LPA group assigns the lowest importance (45).



**Biodiversity Conservation:** Individuals with an income of 5 to 10 LPA (64) and above 10 LPA (59) groups give more importance to biodiversity conservation while people earning 2 to 5 LPA (50) rate it relatively important, and individuals earning less than 2 LPA group (41) give it least preference.

**Recreational Services:** Similar to other services, higher-income groups (above 10 LPA and 5 to 10 LPA) assign higher importance values (52 and 47, respectively). The 2 to 5 LPA group rates it moderately (46), whereas the less than 2 LPA group assigns the lowest score (36).

**Cultural and Religious Services:** This service is most valued by the above 10 LPA (68) and 5 to 10 LPA (58) groups. The 2 to 5 LPA and less than 2 LPA groups rate it lower at 56 and 43, respectively.

**Aesthetic Value:** High importance is noted across all income groups, with the 5 to 10 LPA group assigning the highest importance (65), followed closely by the 2 to 5 LPA group (57), above 10 LPA (59), and a lower score from the less than 2 LPA group (48).

**Flood Resilience:** The highest importance is seen in the 5 to 10 LPA group (67), with above 10 LPA and 2 to 5 LPA groups rating it slightly lower (63 and 60, respectively). The less than 2 LPA group assigns the lowest importance (44).

To summarize, the survey suggests that ecosystem services are valued more by individuals falling under the higher income bracket, while the lower income bracket gives less importance to ecosystem services in general, water quality improvement, and flood resilience in particular. This shows the varying levels of dependence and associateship with ecosystem services across various income levels.

### 3.2.2. Importance of Adyar river in maintaining religious and cultural identity

The data showcases a non-linear trend in perceived importance, with the importance showing an ascending trend from ascending trend from the lowest- and middle-income groups to the highest-income group (more than 10 LPA) rates the importance significantly higher. This suggests that higher-income individuals may have a greater attachment to the Adyar River.

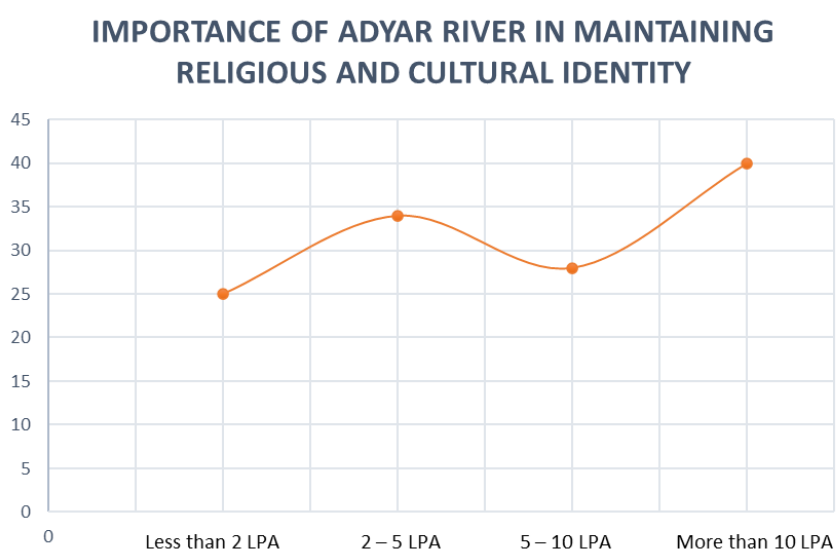


Figure 4 Importance of Adyar River in maintaining religious and cultural identity (Source: Author)

### 3.2.3. Cultural impact of ecosystem system services provided by liminal spaces

Community bonding is the most important factor associated with ecosystem services for individuals with 5 to 10 LPA and less than 2 LPA income groups. On the contrary, for individuals in the 2 to 5 LPA and above 10 LPA income brackets, environmental stewardship is the most important factor. This difference in preferences among various income groups is influenced by the emotional connections that liminal spaces foster, attributing to the respondents' different socioeconomic backgrounds and environmental perspectives.

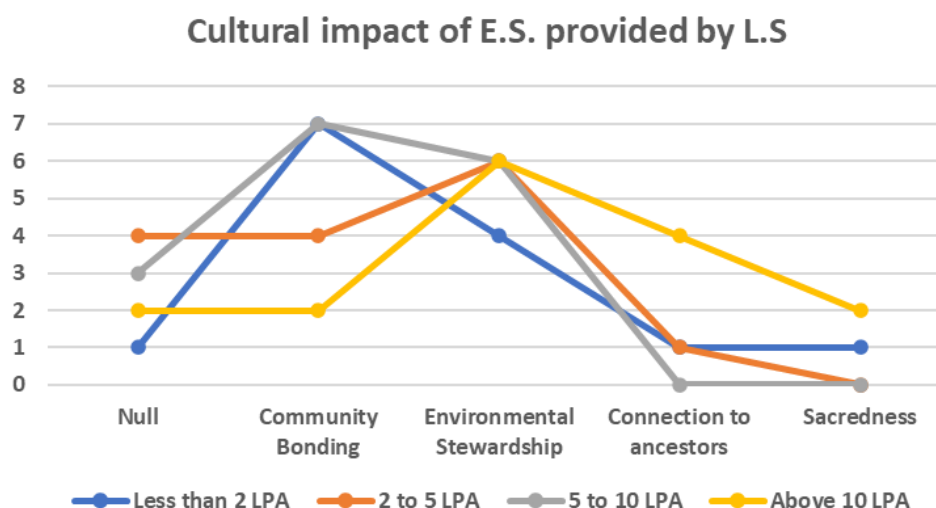


Figure 5 Cultural Impact of E.S. provided by L.S.

### 3.2.4. Annual Willingness to pay for ecosystem services

Concerning willingness to pay (WTP) for the improvement of ecosystem services provided by liminal spaces, individuals in the higher income bracket, i.e., above 10 LPA, exhibited a higher WTP compared to other income groups, which could be attributed to their favorable economic conditions.



Figure 6 Annual W.T.P.

In particular, the survey results show that 72% of the total sample population has shown a willingness to contribute financially to the betterment of ecosystem services. This finding shows a growing acceptance of the importance of ecosystem services across income groups, though with variations in the WTP based on their economic capacity.

### 3.2.5. Willingness to pay - Choice experiment

A sample size of 51 was chosen for the choice experiment. The people were presented with 3 scenarios and their positive responses were noted down. The three scenarios provided were:

Improved water quality and biodiversity at INR 1000 per household

Enhanced Recreational and cultural facilities at INR 500 per household

Riverfront Development with Cultural Preservation at INR 2000 per household

The responses obtained are given in the table below:

**Table 2 Results of Choice Experiment (Compiled by Author)**

| S. No | Scenario                                                                   | Number of Positive Responses | Total Amount                 |
|-------|----------------------------------------------------------------------------|------------------------------|------------------------------|
| 1.    | Improved water quality and biodiversity – INR 1000 Per household           | 37                           | 37,000                       |
| 2.    | Enhanced Recreational and Cultural Facilities – INR 500 per household      | 38                           | 19,000                       |
| 3.    | Riverfront Development with Cultural Preservation – INR 2000 per household | 31                           | 62,000                       |
| Total |                                                                            |                              | INR 1,18,000<br>(or) \$ 1413 |

From the choice experiment conducted with a sample size of 51 participants, it was found that 72% of the survey respondents were willing to pay for the ecosystem services offered by the liminal spaces. A cumulative amount of \$1413 was found as the WTP from the willing respondents. This reflects a sizeable amount of support for investing in the improvement of ecosystem services in the liminal spaces, showcasing the importance and acceptance of these ecosystem services among the sampled population.

## 4. Findings and Recommendations

The mapping of the location of Ecosystem system services with its land use reveals that the cultural ecosystem services are available in open spaces and recreational areas land use, institutional land use, and residential land use; while regulatory ecosystem services are present in the open spaces and recreational areas land use, institutional land use and commercial land use. Statistically speaking, 36% of the ecosystem services are found in open spaces and recreational land use, 32% in institutional areas, 16% in residential zones, and 4% in commercial land use areas. Individuals in the higher income bracket not only perceive the river with increased cultural and religious importance due to their close ties to heritage and natural resources but also demonstrate a strong emphasis on ecosystem services. The socioeconomic conditions of the respondents shaped the differing environmental perspectives, with environmental stewardship given priority among the individuals in the INR 2 to 5 LPA category and above INR 10 LPA category; while community bonding was prioritized by the individuals in the INR 5 to 10 LPA and less than INR 2 LPA brackets. From the choice experiment, it was observed that from a sample size of 51, 72% of the people are willing to pay a total of 1413 USD for the ecosystem services offered by the liminal space, i.e., Adyar River in our scenario. If this experiment is done covering a larger population, we could calculate the willingness to pay (WTP) for the Adyar River Bank which is directly proportional to the importance of the liminal space.

## 5. Conclusion

Liminal spaces are usually studied based on their qualitative nature, but in this research by considering Ecosystem Services as a means of Quantifying liminal spaces, a value could be assigned to them to prove their importance. Though much research has been done based on Ecosystem services, the spatial and social characteristics of places providing ES have not been explored. This paper addresses this issue, a paradigm shift in how ecosystem services are studied. This method could be replicated for other spatial liminal spaces (e.g., peri-urban spaces, edges of urban forests, historical monuments/spots) and determine their economic value, aiding in their protection and conservation.

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