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Original Article

Interface Zones: Assessing Porosity for an Integrated Urban Blue Spaces in Davao City's Seafront

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Abstract. The complexity of interface zones—determined by level of access to water and edge porosity—defines the extent of urban land-water integration. This study investigates the spatial and functional connection between urban land and water in public open spaces of Davao City, Philippines. Specifically, it explored the features of urban blue spaces across designated-use (9 stations), formal-use (4 stations), and informal-use (14 stations) typologies in the downtown Davao City seafront. A descriptive-exploratory approach integrating the spatial analysis with qualitative fieldwork was utilized to map the water's edge profile and quantitatively assess porosity levels by developing an index using factors such as land-water connection (C), land-water edge section (E), urban blue space use (U), and urban blue space edge (BSE). Findings revealed high porosity scores throughout most urban blue space sections, driven by complex water edges, direct waterline connections, and permeable designs that facilitate land-water connectivity and human interactions. The analysis revealed critical insights into urban blue space dynamics across edge types, using edge porosity and water accessibility as primary measures of land-water relationships. Important physical features that contribute to high porosity were identified, emphasizing the role of unrestricted access to water. These features vary by spatial typology and involve trade-offs among water edge design, functionality, and regulatory control. While enhancing land-water connectivity, these attributes present management challenges inherent to waterfront public open spaces. The findings underscore the necessity of context-sensitive planning approaches that balance porosity, security, equity, and ecology to enhance recreational, aesthetic, and resilient waterfronts, aligning with studies on blue-green integration.

Keywords: *Accessibility; Urban blue space porosity; Public open spaces; Land-water connection.*

Cities worldwide are increasingly revitalizing their waterfronts into vital hubs for land-water synergy, turning urban blue space risks into assets through careful planning and design of their transition areas. Globally, waterfront designs are shifting toward climate-adaptive features, including elevated edges, permeable shorelines, and smart water management systems, thereby expanding public open spaces with accessible ecosystems and integrating circular materials into urban designs (Dubinina, Wawrzyńska, & Krośnicka, 2022). These urban waterfront design changes promote porosity through permeable water edges, direct access, and mixed-use designs, boosting recreation, biodiversity, urban health, and well-being. This urban planning approach acknowledges the multifaceted role of urban blue spaces as dynamic interfaces for anthropogenic activities, fostering physical connectivity with nature (Smith et al., 2021). Natural or built —such as rivers, lakes,

oceans, and waterways—urban blue spaces enable access and connectivity, reflecting a complex interplay between terrestrial and aquatic ecosystems (Avni & Teschner, 2019). However, these hybrid spaces pose several risks despite their health and economic benefits, particularly in densely populated coastal cities such as those in the Philippines. Challenges often stem from unstable economic conditions, heightened vulnerability to flooding, urban marginality, inadequate management of waterfront accessibility, and limited land-use and water-system management (Atilano-Tang, 2023). This situation is frequently compounded by a fast-growing population, with over 60% of residents projected to live in urban areas by 2030, most of them in coastal regions. The country's evolving socio-economic conditions and sea level rise in metropolitan areas profoundly influence the shape, movement, and access to interface zones, transforming spatial features and urban morphologies (Toomey et al., 2021). This evolution has turned urban blue spaces into integral components of waterfronts, altering their structure and function (Taufen & Yocom, 2021). However, this shift from traditional waterfront to built-up environments has fragmented the urban fabric, erecting physical barriers between cities and blue spaces (Toomey et al., 2021). Benabbou et al. (2022) also emphasized that fragmentation and privatization gradually contribute to the loss of shared water connections at the land-water interface. This sparks conflicts over water use, widespread degradation, and diminished harmony between urban and natural landscapes.

Despite several urban planning efforts, Davao City, a significant urban center in the Southeast Philippines, faces conflicts over access to water areas and the use of urban blue spaces in public open spaces along the Davao Gulf. Few local studies examine waterfront transition spaces and their integration with urban blue spaces, particularly the porosity of water edges and access to water in urban public open spaces along Davao City's waterfront. Such contextual evaluation is crucial knowledge for developing innovative urban designs and reclamation strategies that leverage the spatial synergies between urban aquatic environments and urban development. (Ansari, 2009). At present, it remains unclear to what extent these public open spaces facilitate spatial connectivity, limiting understanding of the key functions of interface zones and water edges porosity for public access, recreation, and ecological sustainability. This paper, therefore, aims to bridge this knowledge gap by exploring how access to waterfront public open spaces creates opportunities to enhance land-water connectivity in Davao City, Philippines. It examines features of urban blue space in waterfront public open spaces, analyzing land and seawater edge profiles, quantifying blue space porosity, edge design, use, and water accessibility. The comparison across designated-use, formal-use, and informal-use types of public open spaces aims to identify core features contributing to land-water connectivity. By developing a conceptual framework (Figure 1), this study aims to equip planners and designers with evidence-based insights for creating accessible, functional urban blue spaces that support future land-water integration initiatives and diversify waterfront design.

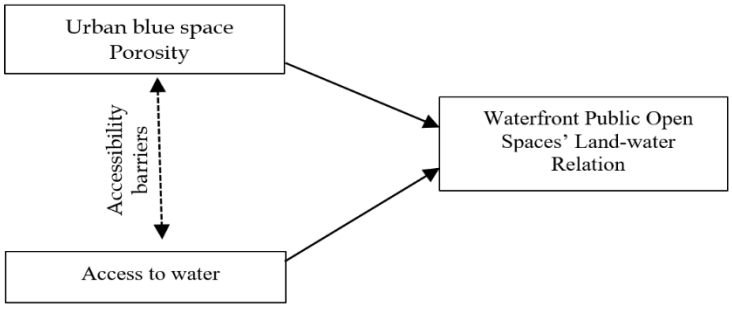


Figure 1. *Conceptual Framework*

Methodology

Research Design

This study used a mixed-methods research design, integrating quantitative spatial analysis to assess waterfront spaces and water-related activities, and qualitative assessments of user accessibility experiences and perceptions. Specifically, the methodology incorporates mapping techniques for spatial analysis of urban blue space features, alongside field observations and interviews to capture diverse perspectives on waterfront access and functional qualities. The integration of land-use and accessibility data, often sourced from online imagery and local agencies, enables an assessment of the existing structure of waterfront public open spaces and their surrounding areas. This multi-faceted data integration strategy is essential for evaluating physical accessibility, usage patterns, and barriers that limit connectivity to water spaces. This systematic approach facilitates the characterization of the edges of waterfront public open areas and the quantification of their porosity and water accessibility.

Research Locale

This study was conducted in the coastal area of the Davao City urban center following the pandemic partial reopening to the public in 2022. The city is a highly urbanized metropolis in the Southeastern Philippines, reliant on access to Davao Gulf waters for livelihoods, leisure, and social activities since the 1980s (Davao City CLUP). With 43% of households in coastal areas (City Government of Davao and its constituents, 2006), the Población area is a high-density mixed residential-commercial zone traversing at least six (6) coastal barangays selected in this study. These Barangays (76-A, 31-D, 21-C, 23-C, 27 C, & 22-C) host key waterfront public open spaces suitable and relevant for this research.

Research Participants

The study examines urban blue spaces in Población waterfront public open spaces across designated-use (9 stations), formal-use (4 stations), or informal-use (14 stations) typologies. A total of twenty-seven (27) stations were selected for their proximity to water, within intertidal zones, or exposed to tides. Locations of these stations were identified using the Davao City Comprehensive Land Use Plan 2013–2022 and the Davao City Coastal Zone Management Plan 2006 recommendations, online maps, and web-based tools, and were verified through ocular inspections. Designated-use areas are characterized by infrastructure such as coastal roads and sidewalks that enable water-edge mobility and access. Formal-use public open spaces include parks, playgrounds, and recreation areas for institutional, educational, or leisure purposes. Informal-use public open spaces are resident-initiated sites for social and recreational needs that lack formal designation or ownership. Moreover, interview respondents were randomly selected from households located within 200 meters of the shoreline to capture community perceptions relevant to the study.

Research Instrument

This study adopted spatial mapping techniques and applied systematic methodologies to locate sample observation stations, photograph, and sketch the layout and cross-section profiles of urban blue spaces, focusing on water-edge features and land-water physical barriers. Land-water edge features were assessed based on the edge plan and section in relation to the waterline (Figures 2 and 3). Land-water physical barriers were assessed using tangible indicators, such as the presence of a wall, signage indicating regulations, or a site's natural conditions, such as topography, that limit human access to the water. Intangible accessibility barriers were identified through content analysis of interview responses, which captured community perceptions of access limitations, daily activities, and the frequency of use of public open areas. The level of access to the water was categorized using a three-tier scale adapted Wilczyńska et al. (2023): (a) restricted access, with no evident access to the water; (b) partially open access, where natural site conditions allow reasonable access, and regulations or use limitations are clearly communicated; and (c) open access, indicating excellent access to water enhanced by purpose-built structures. Additionally, this study developed an Urban Blue Space Porosity (UBSP) scoring index based on Breś and Krośnicka's (2021) porosity framework to quantitatively measure the degree of spatial integration between Davao Gulf water and its adjacent urban blue space. The UBSP index classifies porosity on a low-to-high scale: high porosity refers to the integration of more than half (>50%) of the urban blue space areas with the water space; moderate porosity ranges from 20-50 percent; and low porosity indicates less than 20% integration, including blue spaces isolated or disconnected from the water areas. Breś and Krośnicka (2021) also argue that higher porosity is linked to better access to urban blue spaces, such that high accessibility means that more than half of the urban blue space area is accessible to the water.

Data Gathering Procedure

The data collection process began with the acquisition of relevant secondary data from the City Planning and Development Office (CPDO) of Davao City, including the land use map, the barangay boundary map, and built-up area data. These materials, supplemented by online resources, are essential for identifying and locating the study area. The street networks and foot walks were direct observation points for determining various ways of accessing and using the land-water areas. Primary data collection involved ocular site visits along the entire coastal length, allowing the researcher to document various coastal features, tidal patterns, water quality, water-related activities, and supporting infrastructure. Photographic documentation and schematic sketches were used to visually capture the spatial and physical attributes of urban blue space. To complement spatial observations, a separate semi-structured, free-form interview process in the local language was conducted with community residents living in the vicinity of the waterfront, who were employed as respondents. These interviews were conducted to explore respondents' perceptions of water level variations (such as low and high tides), barriers to

water access, usage patterns, and other relevant concerns. Additionally, key informant interviews were conducted online with representatives from coastal management agencies, design and planning experts, and relevant public authorities to triangulate and validate the primary data gathered.

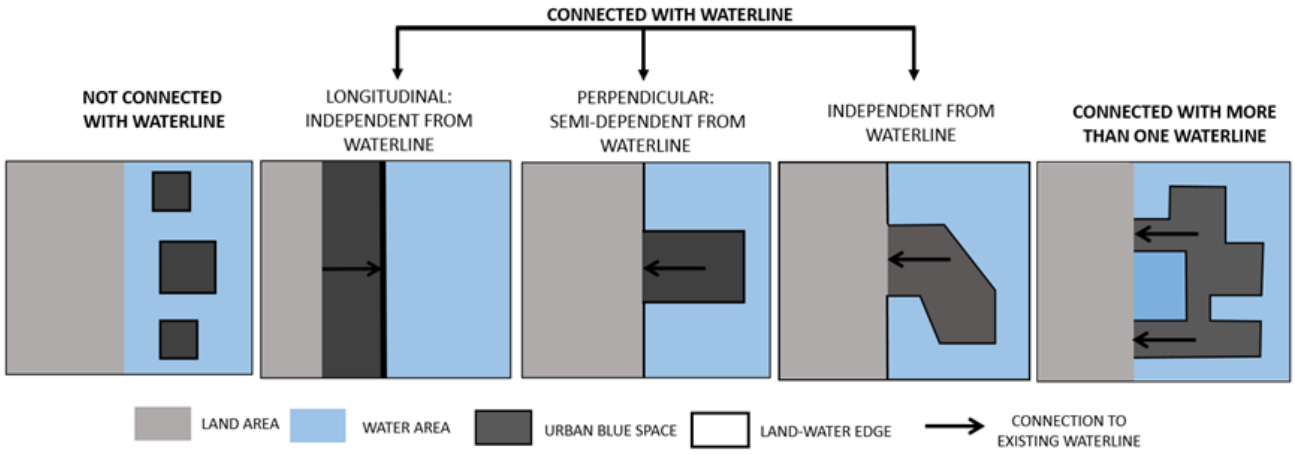


Figure 2. *Types of Land-Water Edge Spatial Layouts in Relation to Water-Land Integration (Breś & Krośnicka, 2021)*

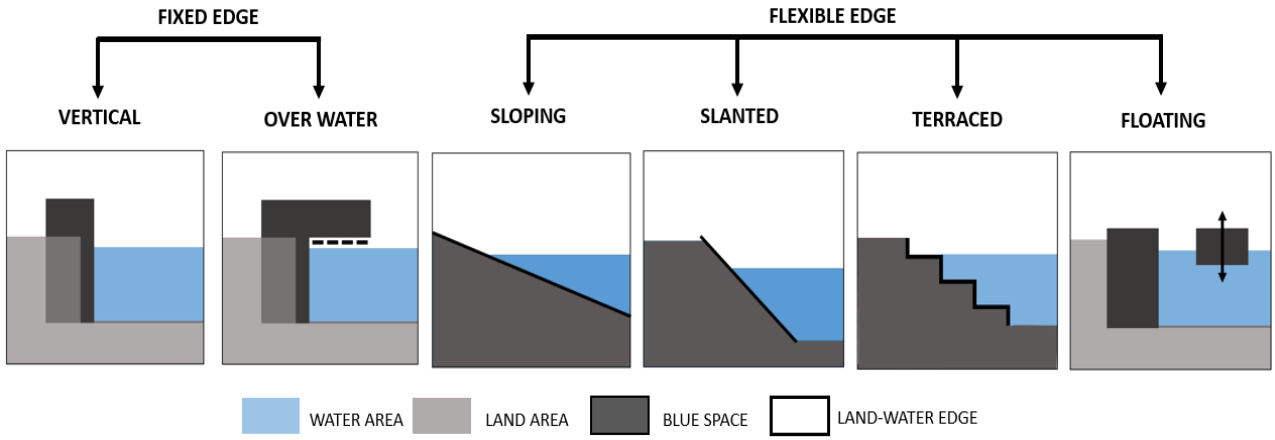


Figure 3. *Types of Land-Water Edges According to Their Relation to the Waterline (Shore or Riverbank), after Breś and Krośnicka (2021)*

Ethical Considerations

This research study adhered to ethical guidelines throughout the data collection process. Respondent participation was both randomly selected and entirely voluntary. The necessary approvals to survey within the selected communities were obtained from the respective barangay offices. All data collection activities complied with the minimum health and safety requirements mandated by the local government. Fieldwork was conducted in the presence of purok leaders or barangay representatives to facilitate coordination and ensure safety and transparency. Before each interview, respondents received a clear explanation of the study's objectives, including its purpose and scope, and were assured of confidentiality and anonymity to protect their privacy.

Table 1. *Scoring Index for the Urban Blue Space Porosity Level Developed after Breś and Krośnicka (2021)*

Porosity Component	0	1	2	Data Needed
Land-Water Connection (C)	Not connected physically.	Connected physically with the waterline.	Connected physical with more than one (1) waterline.	Edge Spatial Layout, Perspectives
Land-Water Edge Section (LWE)	Floating, independent, and not attached to land.	A fixed vertical structure attached to land and/or extending over the water's edge has no direct access to water.	A flexible land-water edge physically connected to the shore, offering extended and varied points of contact with the aquatic environment.	Edge Section, Perspectives
Urban Blue Space Use (U)	Natural environment for environmental protection and research.	Industrial use in urban environments: infrastructure, transport, ports, defense, energy production, waste disposal.	An inhabited urban environment comprising public transportation, residential, cultural, educational, commercial, and recreational functions.	Land Use and Coastal Water Zoning, Key Informant Interview Data
Urban Blue Space Edge (BSE)	Has a solid high wall, fence, building walls, or continuous row of plants that blocks visual access to the water.	Has a solid low or perforated wall, fence, or line of buildings or plants that maintains sightlines toward the water.	No walls or barriers; open, porous, and flexible edges that remain loosely defined and allow direct physical access to the water.	Edge Section, Perspectives

Given the guides for scoring, the values generated per Porosity Component were substituted in the formula:

$$Urban\ blue\ space\ porosity\ (UBSP) = C + LWE + U + BSE$$

Results and Discussion

Profile of Davao City Center's Coastal Stretch

Aspects of accessibility to waterfront public open spaces that enhance land-water connectivity in Davao City, Philippines, were explored in this study. Specifically, it examined urban blue space features, land and seawater edge characteristics, and porosity scores of waterfront public open spaces along the coastal length of Davao City center. Results show that the city's coastal stretch is characterized by a dynamic interface between gently sloping urban land and the Davao Gulf, delineated by at least one shoreline edge and adjoining densely populated neighborhoods (Figure 4).

The mixed-use settlements surrounding waterfront boundaries and open spaces are linked by a variety of circulation networks from land areas to urban blue spaces. Cycle paths, footways, streets, and road systems facilitate traffic flow and pedestrian movement, linking a wide range of water-based anthropogenic activities—recreational, institutional, and economic—in foreshore areas and shaping Davao City's urban fabric into a complex, multi-nodal structure. Findings on how public open spaces support land-water connectivity in the Davao City setting are synthesized in the following discussion of the spatial and functional characteristics of urban blue spaces across waterfront public open spaces designated for formal or informal use. The comparative analysis reveals that urban blue spaces across waterfront public open spaces foster land-water integration.

Figure 4. *Profile of Urban Blue Spaces in Davao City*

Spatial and Functional Features of Urban Blue Spaces Adjoining Waterfront Public Open Spaces

The urban blue spaces of the three waterfront public open space typologies in Davao City share commonalities but vary in their spatial and functional features. Among the three typologies, the urban blue spaces next to designated types of public open spaces were found to exhibit distinctive physical features due to their engineered design and defined usage (Table 2). For instance, urban blue spaces next to ports or public utility areas often have land-water layouts, with sections organized longitudinally along the waterline and perpendicularly into the waterbody (Table 3).

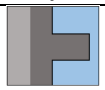
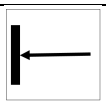
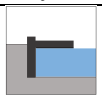
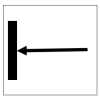
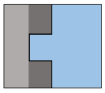
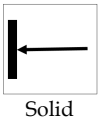
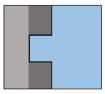
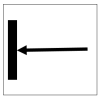
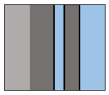
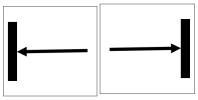
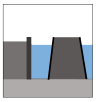
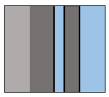
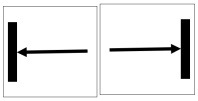
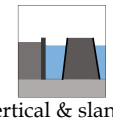
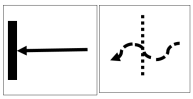
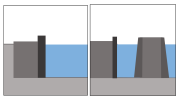
Table 2. *List of Urban Blue Spaces in Designated-use Waterfront Public Open Space*

Station	Public Open Spaces	Barangay	Urban Blue Space Use	Near Water Space Use	Water Edge (Meters)
1	Sta. Ana Wharf	27 C	Berth Areas / Wharf	Port Operations	520
2	Sta. Ana Wharf	27 C	Berth Areas / Wharf	Port Operations	400
3	Perpendicular Open Area	23 C	Small Boats Docking	Port Operations	40
4	Longitudinal Shore	31 D	Docking	Port Operations	15
5	Pumping Station 1	22 C	Drainage	Flood Control Facility	45
6	Pumping Station 2	31 D	Drainage	Flood Control Facility	40
7	Barangay Road	76 A	Overland Transport	Multi-function	410
8	Coastal Road	76 A	Reclaimed Space	Multi-function	2240
9	Reclamation	31 D, 21 C, 23 C, & 27 C	Road Construction	Multi-function	2000

The longitudinal layout of urban blue spaces follows the original watercourse, running parallel to the shoreline, creating extended surfaces for transport functions, flood control, drainage, viewing, seating, and continuous movement corridors that integrate these open spaces with the urban grid. On the other hand, perpendicular layouts are also extended surfaces perpendicular to the waterline, such as piers and boardwalks that project into the water. These structures support port and fishing activities, providing direct, functional access to the water for people and vessels. The combination of longitudinal and perpendicular layouts helps optimize spatial flow and operational connections between land-based activities and water transport vehicles. Additionally, the land-water

boundaries that define urban blue spaces evolve from natural sloping banks to vertical wharf barriers, overhanging structures, and slanted fixed edges, all of which increase access to water and enhance walkability, serving as public infrastructure. Its water edges act as protective boundaries, preventing people and activities on the constructed platform from being exposed to water. These barriers create a physical separation that safeguards users from getting wet while maintaining a clear division between the built environment and the water surface. Nevertheless, the perceived benefits of these barriers with respect to functional utility and safety remain substantial, since blue spaces—defined as outdoor areas shaped by water—serve as essential transition areas linking the city to neighboring islands, towns, and cities.

Table 3. *Land-Water Edge Features of Urban Blue Spaces in Designated-use Waterfront Public Open Spaces*

Station	Urban Blue Space Edge		Land-Water Edge		Connected with the Waterline	Water Accessibility
	Layout	Section	Layout	Section		
1		 Solid	 Over Water	Fixed Edge	Connected	Partially Open
2		 Solid	 Vertical	Fixed Edge	Connected	Partially Open
3		 Undefined	 Slanted	Flexible Edge	Connected	Open
4		 Undefined	 Slanted	Flexible Edge	Connected	Open
5		 Solid	 Over Water	Fixed Edge	Not Connected	Partially Open
6		 Solid	 Over Water	Fixed Edge	Not Connected	Partially Open
7		 Both Directions Solid	 Vertical & Slanted	Fixed Edge	Connected	Restricted
8		 Both Directions Solid	 Vertical & slanted	Fixed Edge	Connected	Restricted
9		 Solid Undefined	 Vertical & Sloping	Combine Fixed & Flexible Edge	Connected	Partially Open

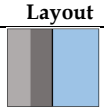
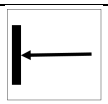
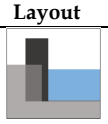
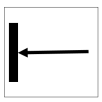
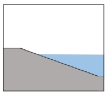
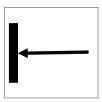
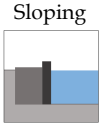
In contrast, urban blue spaces adjoining formal-use waterfront public open spaces—such as Magsaysay Park, institutional grounds, and other enclosed recreational parks fronting the Davao Gulf—exhibit core spatial and functional features. These include natural shorelines and graded areas with hardscaping, where existing dilapidated structures are reused as offices and gathering spaces. Features of natural shorelines typically have soft, sloping land-water edges that serve coastal residents by providing docking for their fishing boats and allowing navigation. These natural edges foster ecological continuity and functional access to water without the need for engineered barriers. These structural differentiations underscore how architectural and urban solutions, such as permeable quays or reshaped edges, can modulate the permeability of waterfronts, thereby influencing both ecological integration and human engagement with aquatic environments (Dubinina et al., 2022)—on the

other hand, graded built-up water edges running parallel to natural shoreline features, solid and perforated walls in varying heights, from low to very high, as seen in Magsaysay Park. Such solid vertical walls partially or fully restrict access to and from water. Other vertical barriers, such as perforated walls, plants, natural barriers, and low-solid walls, permit visual connectivity to the water. Conversely, high solid barriers in some areas of these public spaces obstruct views of the ocean, isolating land-based activities from adjacent water use. Integrating these different types of barriers regulates user access to water, fostering privacy and independence from activities taken on either side of the edge. However, the permeability of waterfronts is often dictated by adjacent land uses, resulting in barriers at the water's edge that are not synchronized. This deliberate design choice warrants careful consideration in large-scale waterfront planning in Davao City. Tomey et al. (2023) emphasized that permeability is critical for understanding how urban planning can either facilitate or impede the socio-ecological co-production of space in waterfront areas.

Table 3. *List of Urban Blue Spaces in Formal-use Waterfront Public Open Spaces*

Station	Public Open Spaces	Barangay	Urban Blue Space Use	Near Water Space Use	Water Edge (Meters)
1	Ramon Magasaysay Park	23 C	Building Wall	Fishing Boat Docking and Navigation	200
2	Ramon Magsaysay Park	23 C	Viewing and Seating Area	Fishing Boat Docking and Navigation	242
3	Zonta Elementary School	23 C	Activity Area	Fishing Boat Docking and Navigation	62
4	Bucana Covered Court	76 A	Activity Area	Fishing Boat Docking and Navigation	28

Table 4. *Land-Water Edge Features of Urban Blue Spaces in Formal-use Waterfront Public Open Space in Davao City*

Section	Urban Blue Space Edge Layout	Urban Blue Space Edge Section	Land-Water Edge Layout	Land-Water Edge Section	Connected with the Waterline	Water Access
1		 Solid	 Vertical	Fixed Edge	Not Connected	Restricted
2		 Solid	 Vertical	Fixed Edge	Connected	Partially Open
3		 Undefined	 Sloping	Flexible Edge	Connected	Open
4		 Solid	 Vertical	Fixed Edge	Connected	Partially Open

Moreover, urban blue spaces in informally used waterfront public open spaces reveal distinctly communal features, serving as multifunctional areas that extend from the original shoreline to areas above the water (Tables 5 & 6). These extended open areas serve as vital shared venues for social interaction, domestic tasks such as clothes drying, cultivation of potted plants, small-scale poultry keeping, and children's play areas. Shared areas are interconnected by streets, paths, boardwalks, over-water wooden decks, and other makeshift platforms connected to the waterline. At the end of stilted paths, unintended vantage points emerge, offering residents a view of the water (Figure 5). Built with highly porous, unsafe, and substandard materials, these extended platforms interconnect temporary over-the-water dwellings constructed for informal settler families (ISF). Overwater structures feature multiple on-stilts foundations that intersect the land-water edge, allowing water to flow beneath the platforms during high tides (Figure 4). Characterized by multiple, obscured corners, these urban blue space edges allow easy, flexible, and unsecured access to and use of water for washing, floating, and navigation.

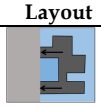
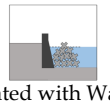
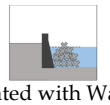
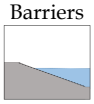
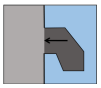
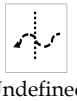
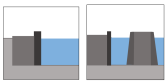
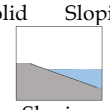
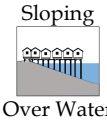
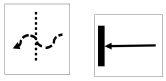
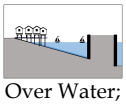
Table 5. *Urban Blue Spaces Within Informal-use Waterfront Public Open Spaces*

Station	Public Open Spaces	Barangay	Urban Blue Space Use	Near Water Space Use	Water Edge (Meters)
1	Bamboo Floor Deck	22C	Communal	Floating, Open Drain, Navigation, Swimming, and Washing	2
2	Open Shoreline	31D	Multifunctional	Floating, Open Drain, Navigation, Swimming, and Washing	311
3	Reclaimed Open Area	31D	Ongoing Road Construction	Floating, Open Drain, Navigation, Swimming, and Washing	264
4	Reclaimed Open Shoreline	37D	Ongoing Road Construction	Floating, Open Drain, Navigation, Swimming, and Washing	110
5	Path Walks	23C	Access to the ISF Houses on Stilts	Open Drain	< 25 Meters from Shore, Width 1.5 m
6	Path Walks	22C	Access to the ISF Houses on Stilts	Floating, Open Drain, Navigation, Swimming, and Washing	12
7	Motor Path	22C	Access to the ISF Houses on Stilts	Open Drain	< 25 Meters Long from Shore, Width 1.2 - 2.0m
8	Sea Wall	23C	Water Barrier	Floating, Open Drain, Navigation, Swimming, and Washing	280
9	Reclaimed Open Shoreline	31D, 37D	Undefined	Floating, Open Drain, Navigation, Swimming, and Washing	405
10	Badjao Center	23C	Multifunctional Activity Area	Floating, Open Drain, Navigation, Swimming, and Washing	<20
11	ISF Houses on Stilts, Boat Docking Space	21C	ISF Residents' Communal Area	Floating, Open Drain, Navigation, Swimming, and Washing	Indefinite
12	Path Walk	21C	Access to the ISF Houses on Stilts	Open Drain	Indefinite
13	ISF Houses on Stilts, Boat Docking Space	37D	Undefined	Floating and Navigation	8
14	ISF Houses on Stilts, Boat Docking Space	31D	ISF Residents' Communal Area	Floating and Navigation	10

Results reveal variations in urban blue space features across the three types of public open spaces next to Davao Gulf waters in Davao City center. While the City's coastal stretch features a mix of water edges, the clear spatial and functional distinctions of urban blue spaces underscore the differential capacities of these spaces to facilitate human-nature interactions and integrate water use within the urban matrix. This divergence critically influences changes at land-water edges, shifting from natural forms to artificial structures and, more recently, to the reclamation of water spaces for infrastructure and facility expansion, enhancing urban accessibility and integration with waterways.

Figure 5. *Left to Right: ISF Houses on Stilts; Wooden Deck*

Table 6. *Land-Water Edge Features of Urban Blue Spaces in Informal-use Waterfront Public Open Spaces in Davao City*

Section	Urban Blue Space Edge		Land-Water Edge		Connected with Waterline	Water Accessibility
	Layout	Section	Layout	Section		
1		 Porous	 Over Water	Multiple Fixed Edge	Connected	Open
2		 Solid	 Slanted with Water Barriers	Combined Flexible & Multiple Fixed Edge	Connected	Partially Open
3		 Solid	 Slanted with Water Barriers	Combined Flexible & Multiple Fixed Edge	Connected	Open
4		 Undefined	 Sloping	Flexible Edge	Connected	Open
5		 Porous	 Over Water	Fixed Edge	Not Connected	Partially Open
6		 Porous	 Over Water	Fixed Edge	Not Connected	Partially Open
7		 Porous	 Both Sides Vertical	Multiple Fixed Edge	Connected	Partially Open
8		 Undefined	 Solid Sloping	Vertical Fixed Edge; 2-sided Slanted Edge	Connected	Restricted
9		 Undefined	 Sloping	Flexible Edge	Connected	Partially Open
10		 Porous	 Over Water	Multiple Fixed Edges	Connected	Open
11		 Porous	 Over Water	Multiple Fixed Edges	Connected	Open
12		 Porous	 Over Water	Multiple Fixed Edges	Connected	Open
13		 Undefined Solid	 Over Water; Vertical	Multiple Fixed Edges	Connected	Open
14		Porous	Over water	Multiple Fixed Edges	Connected	Open

Indeed, many temporary structures and former natural land-water interfaces in Davao City have been strategically transformed into rigid and complex transition zones, thereby creating contemporary waterfront public open spaces that foster dynamic relationships with water. Described as a stage with tangible spatial influence, urban blue spaces represent critical interfaces for ecological dispersal and human engagement in waterfront areas. A transformation that reflects a broader global trend in urban planning, in which waterfront regeneration initiatives

prioritize the creation of hybrid ecological, economic, and social transition zones (Taufen & Yocom, 2021). A new approach to urban waterfront regeneration that demands an in-depth understanding of evolving conditions to better shape user interaction with water, accessibility regulations, and connectivity.

Land-Water Connectivity and Porosity Features in Davao City

The urban blue space porosity scores across the three typologies of waterfront public open spaces indicate high porosity in 21 stations distributed among informal-use (83.04%), designated-use (70.83%), and formal-use (65.63%) types. Results show that the elevated porosity is attributed to their proximity to densely populated urban environments, direct physical connections to the waterline, and the presence of flexible, permeable, and multiple-cornered land-water edges (Figure 6). High porosity stems from land-water spatial connections, use, and physical barriers, enabling diverse human interaction, ranging from recreational pursuits to informal social and economic activities, which are often concentrated in temporary and unstable city environments. In contrast, urban blue spaces with low porosity, high solid walls, and grey infrastructure tend to restrict access to water, limit ecological integration, and reduce opportunities for interaction with aquatic environments. This choice of water-edge design underscores a deliberate trade-off among privacy, security, and connectivity. Such interventions are increasingly recognized to have planning implications. Urban planners must weigh these elements to optimize edge design, prioritizing permeable interventions that enhance porosity to enhance sustainability and social value, as emphasized in recent studies on blue–green infrastructure (Dubinina et al., 2022; Toomey et al.). (2023). This approach not only enhances ecological functions but also fosters inclusive urban resilience in Davao City's evolving waterfront matrix.

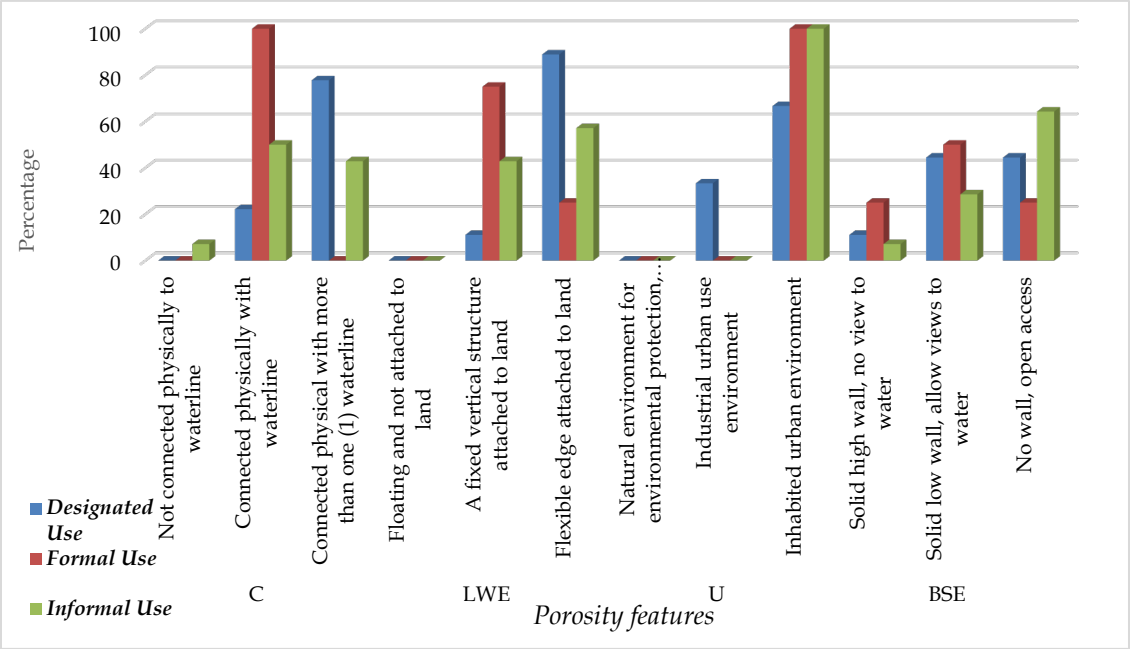


Figure 6. *Summary of Porosity Features of Urban Blue Spaces in Davao City's Waterfront Public Open Spaces*

Furthermore, high porosity levels are associated with unrestricted or open access in waterfront areas, particularly in informal-use communal spaces (Figure 7), where overwater extensions provide multiple entry points without barriers or usage guidelines. These organic patterns mirror the fluid boundaries typical of informal settlements, encouraging interconnected urban blue spaces through minimal infrastructure. However, such areas lack essential amenities and safety features common in formally planned urban blue spaces, raising equity concerns about access and maintenance. In contrast, designated and formal-use spaces combine high porosity with partially open or restricted access to water to prioritize safety and control, as exemplified by structured parks and dedicated viewing areas. Enhancing accessibility within formal and designated urban blue spaces requires targeted interventions such as improved signage, clearly defined pathways to water access points, and visual and physical connectivity cues. Such measures could reconcile control and safety objectives with the community's desire for meaningful interactions with water environments, thereby increasing the recreational and aesthetic viability of these spaces.

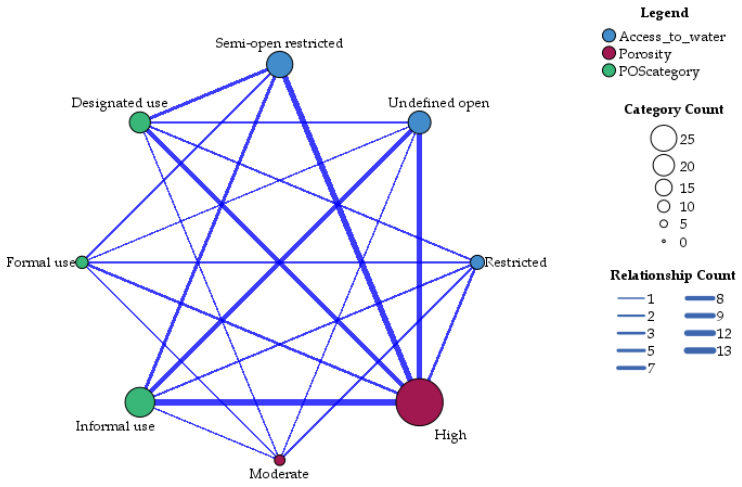


Figure 7. *Relation Map Between Porosity, Access-to-Water, and Types of Waterfront Public Open Space*

Land-water spatial connections in waterfront public open spaces differ fundamentally by adjacent land use and function: designated spaces prioritize control, security, and infrastructure; formal-use spaces emphasize managed recreational activities; and informal-use spaces support more unrestricted, organically driven community access. High physical porosity −though multiple access points via extended surfaces to water areas enabling direct land-water interaction, this alone does not guarantee equitable use. Mishra et al. (2021) and Yin et al. (2022) stress the need for integrated accessibility to enhance recreational and aesthetic potential. Tailoring strategies across typologies is a management approach that could support a more inclusive, functional, and resilient waterfront by balancing porosity with equitable amenities, safety, and community needs.

Conclusion

This study aimed to explore land-water spatial relations using urban blue space porosity and water accessibility features in selected sections of waterfront public open areas in the Davao City center. Critical insights into the dynamics of urban blue spaces were obtained by using porosity and water accessibility as measures to understand the land-water relationship. This study illuminates the multifaceted nature of accessibility in Davao City's waterfront public open spaces. It reveals spatial patterns of urban blue spaces that strengthen land–water connectivity. These include confounded water edges near densely populated shorelines, direct waterline connections, and flexible, permeable, multi-cornered land–water interfaces that enable edge porosity and land–water integration, thereby shaping the core functions of adjacent spaces and the design of urban blue space edges. The differences in the city's urban blue space characteristics underscore varying capacities for human–nature interaction and water integration within the urban fabric. This planning imperative suggests that deliberate urban blue space edge design is essential for balancing social benefits, privacy, security, and ecological connectivity. It aligns with Brown and Mijic's (2019) argument that integrating blue spaces with adjacent land uses is crucial for enhancing land–water accessibility. The differentiation of urban blue space highlights the need for tailored urban planning interventions that acknowledge the unique ecological and social contributions of each waterfront typology. However, this also means that while physical porosity is crucial, the enabling role of policies and the balancing of ecology and anthropogenic activities are significant in determining the true accessibility and utilization of urban blue spaces.

Contributions of Authors

Author 1: conceptualization, data gathering, data analysis
Author 2: proposal writing, data analysis, final paper writing

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Conflict of Interests

The authors declare no conflicts of interest regarding the publication of this paper.

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