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Evaluation of Day and Night Use of Coastal Cities: Tunca River Area, Edirne

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Abstract
Edirne is known for its rich cultural heritage and historical fabric, and it holds an identity as a waterfront city directly connected identity. While the city has developed along the east–west axis, the waterfront areas have been neglected, resulting in low-quality and unsafe spaces. This study focuses on the Tunca River waterfront, identified as a high-potential zone, where accessibility and inclusivity issues were observed. An analysis based on public space quality was conducted, and a coastal prototype was developed to support continuous use. The design prioritizes controlling natural daylight and providing safe, effective artificial lighting at night. Nighttime lighting simulations using the Dialux program comply with international standards to water. However, the lack of integrated urban planning and underutilization of its potential have weakened this. This model reveals Edirne's hidden spatial potential and aims to create more accessible, sustainable urban waterfronts adaptable to other areas.

Keywords
coastal urban planning, urban lighting, day-night use, Dialux, Edirne waterfront areas

1. Introduction

Water, in addition to being an essential resource for life, functions as a pivotal guiding and unifying element in the formation of urban development and character. The term *coast* denotes areas bordered by aquatic features such as lakes, rivers, canals, ports, or bays [1]. Historically, the close interaction between coastal zones and human communities has fostered the emergence of settlements in their vicinity. Within this framework, coastal cities have evolved to possess a distinctive spatial identity, shaped through the interplay of natural and built environment components [2].

In contemporary urban contexts, the rapid growth of urbanization and population density is progressively increasing the demand for public spaces. Within this framework, urban waterfront areas are regarded as strategic zones, functioning simultaneously as natural landscape elements and as venues for social interaction. Owing to their distinctive morphological structures, symbolic representation of the city's vision, scenic landscape value, and environmentally adaptive potential for multifunctional use, waterfronts attract urban residents and serve as carriers of recreational, cultural, and social activities [3]. These areas play a strategic role in enhancing quality of life and elevating the overall standard of public spaces. However, this potential often remains under utilised due to deficiencies in integrated planning processes, the absence of spatial integration, and approaches lacking in functional orientation [4-6].

Within this context, integrating coastal areas into urban planning and re-evaluating them from both physical and functional perspectives will generate opportunities for sustainable development in social, economic, and environmental dimensions [7]. When the planning principles essential to the development of coastal cities are addressed in alignment with international urban design criteria – namely accessibility, sustainability, inclusivity, resilience, and participation – it becomes possible to create high-quality public environments [8]. Accordingly, the reintegration and functional revitalization of coastal areas within urban planning frameworks is considered a necessity.

The study emphasizes the importance of redesigning waterfronts to strengthen urban representation, in line with international urban transformation principles such as accessibility, sustainability, resilience, and inclusiveness. Furthermore, coastal-specific and ecologically- based landscape designs in coastal areas are considered important for the quality of public spaces because they influence users' aesthetic pleasure

and mood. In this respect, coastal designs can be considered a fundamental element in fostering ecological and recreational connections that determine the quality of public spaces [9].

Lighting is a design component that cannot be overlooked in urban planning. In this context, lighting design stands out as a fundamental component that ensures the continuity of public spaces between day and night. Especially in coastal areas where night-time use is limited, the need for artificial lighting becomes a critical requirement for safety, accessibility, and aesthetic experience [10]. Appropriate lighting strategies in urban spaces transform users' relationship with the environment, increasing the space's functionality and enhancing its aesthetic value. Night-time use, particularly in public spaces, is directly related to lighting quality. Inadequate or unevenly lit areas increase the perception of crime, reinforce social exclusion, and limit the use of space [11]. Conversely, well-planned lighting systems increase spatial legibility, facilitate wayfinding, and enable users to move safely at night.

Lighting also plays a crucial role in strengthening urban identity and cultural representation. Lighting is defined as "the application of light to ensure the proper visibility of objects and the environment" [10]. Functions such as emphasizing architectural details, increasing the visibility of historical buildings, and defining social meeting points can be achieved through lighting [11]. In this context, dynamic and interactive lighting systems become tools that encourage user participation and enrich urban life. From an energy efficiency perspective, LED technologies, smart sensor systems, and solutions integrated with renewable energy sources both support environmental sustainability and reduce operating costs [12]. These technologies contribute to cities' carbon footprint reduction targets in line with the United Nations Sustainable Development Goals. Ultimately, lighting is a strategic design tool that enhances social inclusion, reduces spatial inequalities, enhances aesthetic experience, and revitalizes cities by supporting a sustainable urban vision. In particular, ensuring balanced day and night use directly contributes to the quality of urban life, supported by outdoor lighting standards [13].

2. Literature Review

A comprehensive literature review was conducted through various sources such as Jstor, Taylor & Francis, Yöktez, Elsevier, Science Direct, Research Gate, Springer, Journal of Coastal Research (JCR), MDPI journals, the Turkish Chamber of City Planners journal 'Planlama', Acta Biologica Marisiensis, and the Coastal Planning and Management journal. Keywords and phrases such as waterfront areas, riverside areas, coastal planning, coastal design planning, riverfront, coastal spaces, urban planning, urban coastal planning, urban lighting, quality, open public spaces, quality of life, daytime-night-time usage, city lighting master plan, artificial lighting, and outdoor lighting standards were used.

The research examined the concept and significance of coasts, their use as urban spaces, the potential for integration between city and coast, and the role of lighting in urban image and night-time safety. Studies on public space quality and international urban design criteria were reviewed, together with outdoor lighting standards, to propose an integrated approach (Figure 1). National examples such as 'Millet Bahçeleri' (People's Gardens) and international park and square designs were analysed, particularly those applied in coastal contexts. Notably, the Söğütlük Millet Bahçesi (Söğütlük National Park) project in Edirne, opened on 10 June 2025, was studied in terms of public space quality and urban design criteria. Its compliant lighting project offers a strong example for coastal redevelopment.

2.1. Lighting Concept and Standards

Outdoor lighting in urban planning not only ensures visual comfort but also plays a strategic role in safety, wayfinding, aesthetic value creation, and social interaction. Public areas such as roads, squares, sports fields, docks, and piers fall into this category. Well-designed outdoor lighting can highlight key features of a space while concealing less desirable areas. Effective lighting should focus on aesthetic focal points rather than uniform coverage across the entire area [14, 18].

Proper selection and placement of lighting fixtures are essential for maximizing the benefits of lighting. Different scenarios—such as vehicular routes, pedestrian zones, parking areas, sports facilities, building facades, green spaces, and water features—require specialized solutions. Nationally, TS EN 12464-2 standards are applied, while internationally, EN 13201 Road and Area Lighting Standards and IESNA outdoor lighting guidelines are referenced (Figure 2) [15-17].

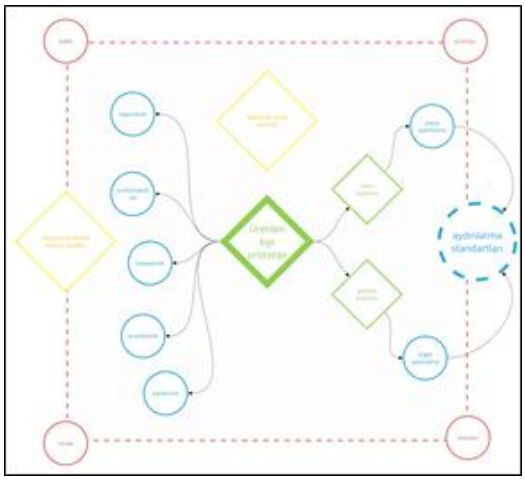


Fig. 1. Concepts of coastal prototype (standard-quality-criteria or principles) (developed by authors)

Standard No.	Referance No.	Job Area or Activity Type	Limits (Lux)
TS EN 12464-2 (Outdoor)	5.1.1	Pedestrian walkways	5
	5.1.2	Traffic areas (up to 10km / h) for slow-moving vehicles such as bicycles, trucks and excavating machines	10
	5.1.3	Regular vehicle traffic (up to 40km/h)	20
	5.7.1	Short-term use of large units and rough materials, loading and unloading of goods without solid packaging	20
	5.9.1	Low traffic, such as parking spaces for shops, terraced houses and apartments, bicycle parking spaces	5

Comparison of EN 13201 and IESNA Outdoor Lighting Standards

Metric	EN 13201	IESNA
Luminance (cd/m²)	Defined for M-class roads	Recommended ranges by road type
Illuminance (lx)	Defined for C and P classes	Footcandles or lux by area
Uniformity (Uo)	Uo ≥ 0.4	3:1 to 6:1 ratios
Disability Glare (TI)	TI ≤ 10-20%	UGR thresholds
Energy Performance (DP, DE)	DP, DE indicators	Lighting Power Density (LPD)
Lighting Classes	M, C, P, SC, EV classes	H, S, P classes
Visual Task Adaptation	Adaptive lighting based on traffic	Task-based lighting design
Environmental Considerations	Dynamic lighting to reduce pollution	Human, animal, plant impact
Glare Control	Edge Illuminance Ratio (EIR)	UGR and mounting height
Color Rendering (CRI)	Not explicitly defined	CRI recommendations

Fig. 2. Outdoor artificial lighting standards (TS EN 12464-2, IESNA, EN 13201)

2.2. International Urban Design Criteria

International urban design criteria include key principles:

- Resilience: The ability of cities to withstand and recover quickly from unexpected events such as natural disasters, climate change impacts, economic crises, and social transformations [19];
- Accessibility: Designing cities to ensure equitable access for all, including people with disabilities, the elderly, children, pregnant women, and those with limited mobility. It is supported by digital access standards such as the United Nations Convention on the Rights of Persons with Disabilities (CRPD), the European Accessibility Act and WCAG;
- Sustainability: Managing environmental, social, and economic systems without compromising the needs of future generations. In sustainable coastal design, lighting systems should be planned with energy efficiency, renewable energy use, and ecological sensitivity in mind. LED technology, motion sensors, and low-intensity lighting systems both reduce environmental impact and enhance the quality of public spaces. Furthermore, safe and accessible lighting solutions for night-time use support social sustainability [20];
- Participation: Involving local communities in decision-making and implementation processes;
- Inclusivity: Ensuring spaces are accessible to all regardless of gender, age, or physical ability [21].

2.3. Public Space Quality

Public space quality is critical for the sustainable improvement of coastal environments. Research by Wu & Li [10] identifies three key factors influencing coastal public space quality: spatial distribution, land use characteristics, and the ratio of service facilities. Lighting plays an equally vital role, directly affecting the continuity of public space use between day and night.

3. Materials and Methods

The methodology of this study involves modelling the selected study area for daytime use using 3ds Max software, and simulating the artificial lighting design for night-time use in accordance with international standards using Dialux EVO software (Table 1).

Table 1. Methodological steps of the study

Step of study
1. Site Selection
2. Urban Waterfront Design Evaluation
3. Site Modelling (3ds Max- Dialux)

3.1. Site Selection

The study area is the Tunca River surroundings in Edirne, recognized for its natural landscape, historical significance, and strong presence in urban memory. Despite its potential, the site faces physical deficiencies, limited usability during day and night, and safety concerns. Selection criteria included physical potential, tourist appeal, privacy, urban memory, and lack of night-time artificial lighting. Accordingly, an integrated urban design prototype was proposed to enhance spatial and public space quality [23].

3.2. Urban Waterfront Design Evaluation

The waterfront was evaluated using urban design principles, emphasizing accessibility, inclusivity, sustainability, resilience, and participation. Day and night observations revealed limited daytime access and unsafe, dark night-time conditions. On-site analysis showed inadequate lighting infrastructure. To address these issues and optimize underused potential, a waterfront prototype was developed to enhance public space quality and increase awareness.

3.3. Site Modelling

Based on spatial data, a digital model of the area was created using exact measurements from maps to ensure accuracy. The existing waterfront was evaluated through the model and supported by photographs. The area was modelled in 3ds Max, and artificial night-time lighting was simulated in Dialux using selected fixtures. Finally, the current conditions and the proposed waterfront design prototype were compared based on different criteria for day and night usage.

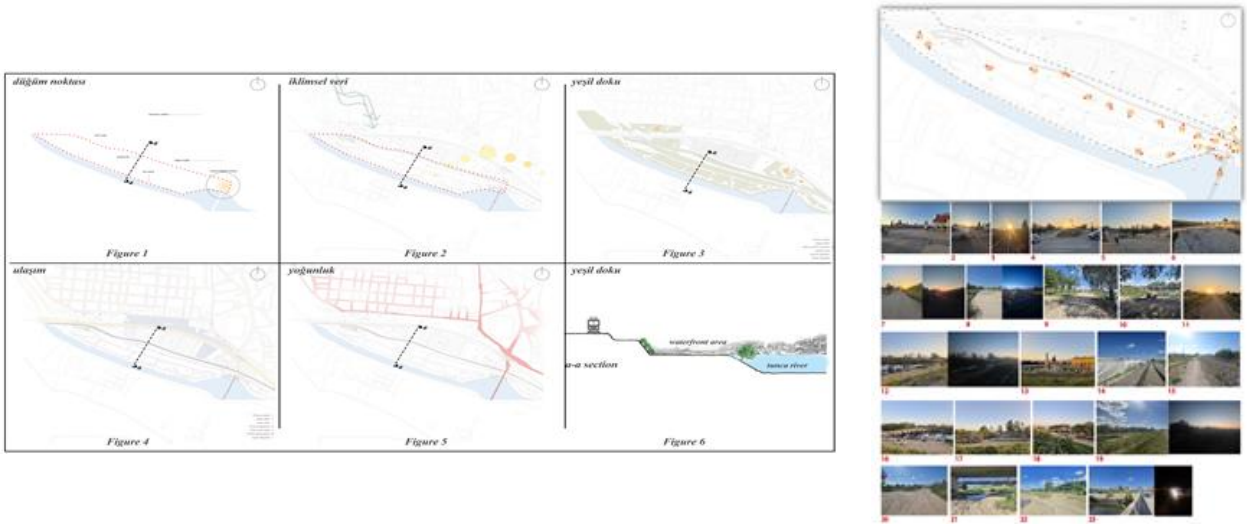
4. Sample Area: Tunca River Surroundings

The study area is approximately 65,000 m^2 and is located on the river bank at the beginning of the Edirne-Tunca Bridge (Figure 3).

Fig. 3. Location data of the area (developed from Google Maps)

Access to the waterfront area, which offers significant potential for public use due to its proximity to the city center and its visual landscape values, is provided through the connection point between the city and the bridge. This transition zone, where pedestrian (Saraçlar Street), motor vehicle (Lozan Street), bicycle, and railway transport axes intersect, functions as a critical node within the urban transportation system. Such transportation nodes play a vital role in optimizing and maintaining urban mobility. Therefore, the proposed intervention for the reuse of the area prioritizes accessibility. By addressing both daytime and night-time use, the intervention aims to attract diverse user groups with varying activity levels and achieve spatial relief through the integration of the transport node with the waterfront areas [24], (Table 2).

Table 2. Field analyses and photographs of the area (developed by the authors)



5. Implementation and Evaluation

The area proposed for reuse, in accordance with international urban design criteria and lighting standards, was modelled using 3ds Max software. The design process for the waterfront aimed to make the city identity more legible and experiential. Accordingly, spatial interventions were structured to support both daytime and night-time use (Figure 4). The proposed waterfront prototype was simulated under natural daylight conditions in 3ds Max for daytime use, while artificial lighting design for night-time use was modelled using Dialux EVO software in compliance with international lighting standards.

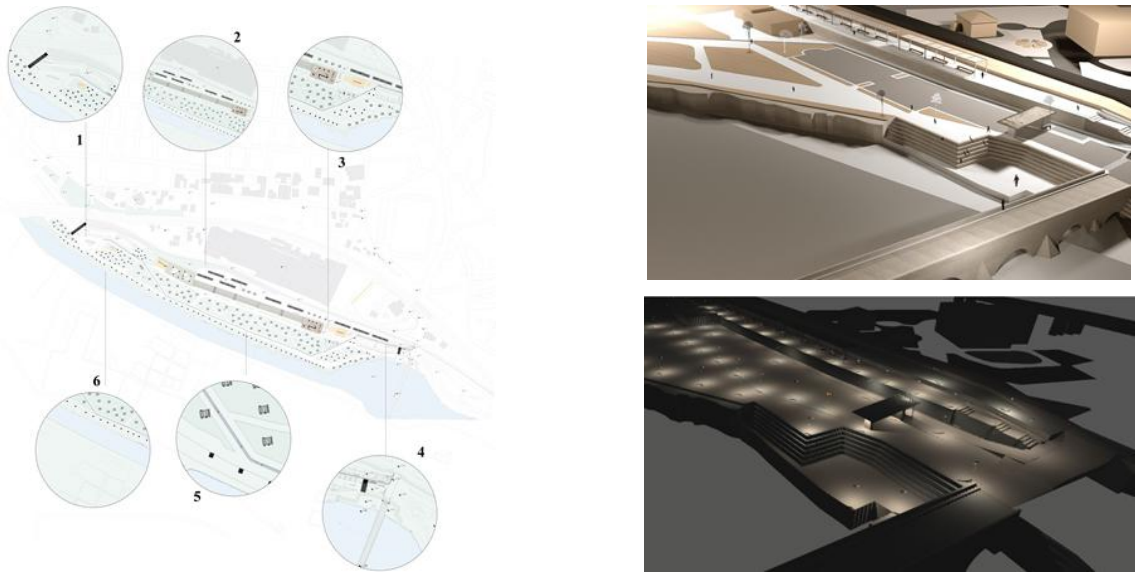
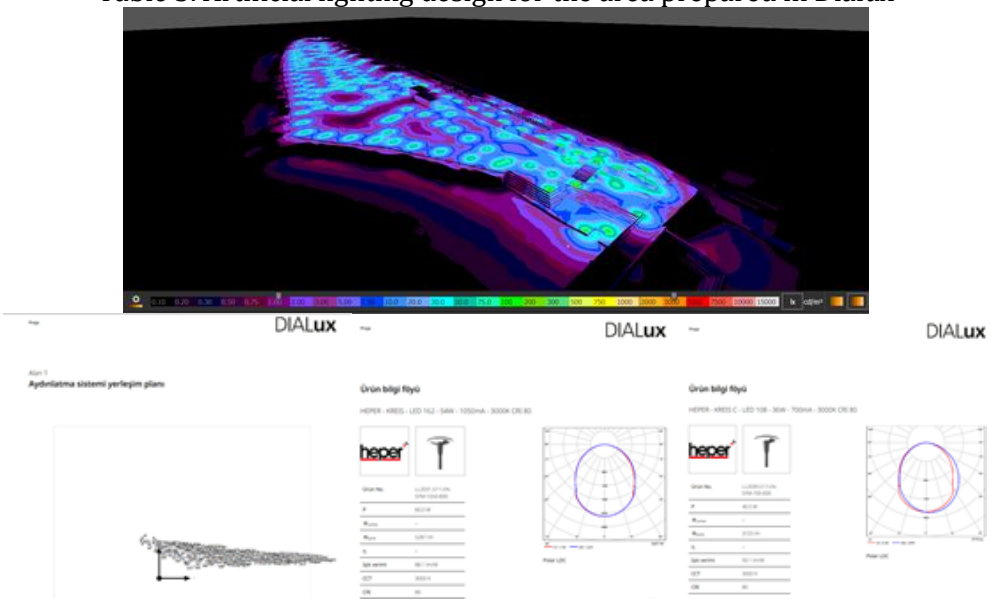


Fig. 4. Coastal prototype proposal and simulation for day and night use (developed by the authors)

The waterfront design developed in this study is conceived as a holistic public waterfront prototype that accommodates both daytime and night-time use. The design process was guided by international urban design criteria – including comprehensiveness, resilience, accessibility, sustainability, and participation – as well as the EN 13201 Road and Area Lighting Standard and the IESNA outdoor lighting guidelines. During daytime hours, open sightlines, shade–sun balance, and user comfort were prioritized to maximize natural lighting, while seating, walking, activity, and gathering areas were organized with functional spatial arrangements.

For night-time use, the area was divided into functionally focused lighting zones for walking paths, stairs and ramps, amphitheatre seating areas, and public event spaces. Dialux simulations yielded uniform illumination levels of approximately 5–10 lx ($U_0 \geq 0.4$) along walking paths, ≥ 20 lx on stairs and ramps, and 20–30 lx in amphitheatre zones. These levels meet or exceed the minimum recommendations set by both EN 13201 and IESNA, enhancing safety, wayfinding, visual comfort, and social interaction during night use. The LED fixtures employed feature optical systems that minimize light pollution and up light, contributing to sustainability through high energy efficiency and long lifespan (Table 3).

Table 3. Artificial lighting design for the area prepared in Dialux



In conclusion, the proposed waterfront prototype ensures balanced distribution of natural light during the day to create an accessible, inclusive, and aesthetically pleasing public environment. At night, it supports safe, comfortable, and active use through artificial lighting compliant with international standards. This approach contributes to the conception of waterfront areas as vibrant, multifunctional, and sustainable public spaces active 24 hours a day [25].

5. Conclusion

This study focuses on Edirne's waterfront areas, emphasizing the need for their reintegration into the city through a re-evaluation within the public space context. Particularly, the waterfront zones along the Tunca River remain underutilized due to a lack of holistic approaches, insufficient public use, and inadequate coordination between the city and the waterfront. As a result, these areas produce a stagnant, unsafe, and low-quality waterfront experience. The findings reveal significant risks related to accessibility and inclusivity. Accordingly, an internationally standardized waterfront prototype was developed to refunction the area for public use and to enhance its quality. The waterfront prototype, presented under Section 4, was modelled using 3ds Max, and the artificial lighting design proposed for night-time use was simulated in Dialux software in accordance with relevant standards. This constitutes the methodology of the study. Both the existing conditions and the prototype proposal were evaluated

against international urban design criteria within the framework of day and night usage. The results were rated and summarized in a table (Table 4).

Table 4. The prototype proposal were evaluated against international urban design criteria (developed by the authors)

International Urban Design Criterion	Current Daytime (Statement)	Current Nighttime (Statement)	Proposed Daytime (Statement)	Proposed Nighttime (Statement)
RESILIENCE	Absence of identifiable green spaces results in lack of user comfort; solar protection and coastal management strategies are inadequate	Lack of lighting infrastructure prevents public safety and comfort; this limits the area's physical and social resilience	Shaded seating areas with climate-resilient materials and vegetation ensure high spatial resilience	Lighting design enhances orientation and safe use at night, minimising hazards; reinforces strong urban identity and resilience
SUSTAINABILITY	High daylight potential remains unused; no solar energy integration; overall energy inefficiency	No lighting system; sustainable energy sources not utilized; sustainability principles absent	Integrated planning of green infrastructure minimizes daytime energy use	LED lighting with sensor systems ensures energy efficiency and sustainability
INCLUSIVENESS	Limited accessibility; insufficient amenities for elderly, children, and women; narrow user profile	Unsafe nighttime conditions; low social inclusiveness; reduced quality of life	Provision of inclusive seating, play and social spaces for all age groups; universal design principles applied	Well-lit, monitored, and open spaces ensure safety, inclusiveness, and high-quality public waterfront
PARTICIPATION	Waterfront amphitheatres rarely used after midday	No social scenarios planned for nighttime use	Designs informed by pre-assessment of user needs; integrated spaces support both daytime and nighttime activities	Nighttime scenarios tailored to diverse user profiles
ACCESSIBILITY	Risky and difficult access; no separation of pedestrians and vehicles reduces quality of life; significant hazards at main entry point	Poor lighting and physical barriers limit access at night; serious challenges for people with disabilities	Pre-design evaluation of user needs; improved access points; enhanced pedestrian and cycling infrastructure	Nighttime accessibility supported by guiding lighting elements and safe pedestrian circulation

In conclusion, this study aims to reveal the hidden waterfront potential of cities based on international urban design standards, supporting tourism, socialization, and recreational activities. By reducing nighttime insecurity and revitalizing neglected areas, the integration between the waterfront and the city will be improved, creating an urban space with high social value. The design intervention not only addresses waterfront usage but also seeks to enhance public safety, activate underused zones, and strengthen the perceptual dimension of urban identity. Thus, Edirne's historical and cultural waterfront identity is reinterpreted to increase its value in terms of tourism, recreation, and social interaction. The spatial discontinuity between the city and the waterfront is expected to be resolved, fostering a more comprehensive, participatory, and secure public life. The trends observed in this area can be applied to other waterfront zones in both day and night contexts.

While the implementation of the proposed prototype is deemed necessary, the discussion opens around the potential improvement in urban life quality through the activation of undefined and low-quality waterfront areas as public spaces.

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