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Research Article

Cyclone-resistant tree species safeguard of urban greenery in coastal areas

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Abstract: Urban green spaces in cyclone-prone coastal regions are highly vulnerable to wind damage, uprooting and long-term ecological degradation. Identification of tree species capable of withstanding cyclonic stress is essential for sustainable urban forestry and disaster risk reduction. The present study documented cyclone-resistant tree species recorded from urban and peri-urban areas of three coastal districts of Odisha, namely Khordha, Puri and Cuttack. A total of sixteen tree species belonging to ten families were identified based on their consistent survival and persistence under recurrent cyclonic events. Fabaceae was the dominant family, followed by Moraceae and Arecaceae. Species such as *Casuarina equisetifolia*, *Borassus flabellifer*, *Azadirachta indica* and *Ficus benghalensis* exhibited wide distribution and structural stability. The findings emphasize the importance of incorporating cyclone-resilient native and naturalized species in urban plantation programmes to safeguard greenery in coastal regions.

Keywords: Coastal forestry, cyclone resilience, disaster mitigation, Odisha, urban trees

Introduction

Cyclones constitute one of the most severe natural disturbances affecting coastal ecosystems, particularly along the eastern coast of India (Ghosh and Mistri, 2023). The state of Odisha experiences frequent cyclonic storms originating in the Bay of Bengal, resulting in extensive damage to natural vegetation and urban green spaces (Mishra and Kar, 2016; Mondal et al., 2022). High wind velocity, heavy rainfall and storm surges associated with cyclones exert intense mechanical stress on trees, leading to uprooting, stem breakage, canopy loss and mortality (Asbridge et al., 2024). Urban greenery plays a vital role in improving environmental quality, regulating microclimate, reducing air pollution and enhancing the aesthetic value of cities (Halder et al., 2025). In coastal areas, trees additionally serve as protective barriers by reducing wind speed, stabilizing soil and mitigating the impacts of extreme weather events (Berland et al., 2017). However, the effectiveness of urban trees in performing these functions depends largely on the selection of species with inherent resistance to cyclonic forces (Patrick et al., 2022). Cyclone resistance in trees is influenced by several morphological and physiological characteristics, including strong and flexible stems, deep or widespread root systems, compact canopy architecture and high wood density (Stachew et al., 2021). Native and well-adapted species often show greater resilience to extreme climatic events compared to exotic ornamental species that are commonly planted in urban landscapes without consideration of structural stability (Chen et al., 2024). Despite the high frequency of cyclones in Odisha, systematic documentation of cyclone-resistant tree species in urban environments remains limited. Urban plantation programmes often prioritize rapid greening and visual appeal over long-term resilience and ecological suitability. In this context, identification of tree species that have demonstrated consistent survival under cyclonic stress is essential for informed urban forestry planning. The present study aims to document cyclone-resistant tree species occurring in urban and peri-urban areas of Khordha, Puri and Cuttack, with the objective of providing baseline information for strengthening urban green infrastructure in cyclone-prone coastal regions.

Materials and methods

The study was conducted in three coastal districts of Odisha (Khordha, Puri and Cuttack) between 2019-2023. These districts lie within the tropical coastal climatic zone and are regularly affected by cyclonic storms of varying intensity. The region is characterized by high humidity, seasonal rainfall and exposure to saline winds, particularly in coastal stretches. Original field observations were undertaken in urban and peri-urban locations, including roadside plantations, public parks, institutional campuses, residential areas and coastal greenbelts. Tree species that consistently survived cyclonic events and remained structurally intact were recorded. Botanical identification was carried out using standard floristic literature (Saxena and Brahmam, 1994-1996), and details regarding scientific name, common name, family and location were tabulated. The data were analyzed descriptively to assess species composition, family-wise distribution and spatial occurrence across the three districts. Species present across all locations were considered indicative of broad cyclone tolerance.

Results and discussion

The present investigation documented a total of sixteen cyclone-resistant tree species belonging to ten botanical families across the three districts studied (Table 1). The recorded species represent a wide range of growth forms and structural adaptations, indicating that cyclone resilience is distributed across diverse taxonomic groups. Fabaceae emerged as the most dominant family, represented by four species, followed by Moraceae and Arecaceae. The prominence of Fabaceae suggests that species within this family possess adaptive traits such as strong wood and extensive root systems that enhance resistance to wind damage. All recorded species were observed in Khordha, Puri and Cuttack, indicating their adaptability to both coastal and inland urban conditions (Table 1). Coastal species such as *Casuarina equisetifolia* and *Cocos nucifera* were particularly common in Puri and adjoining areas exposed to saline winds and sandy soils. These species exhibited minimal structural damage during cyclonic events, owing to their flexible stems and reduced canopy resistance. Palm species such as *Borassus flabellifer* and *Cocos nucifera* demonstrated high wind tolerance by bending rather than breaking under strong winds. Broad-leaved species including *Azadirachta indica*, *Syzygium cumini* and *Pongamia pinnata* showed resilience through strong trunk structure and deep root systems. Species of *Ficus* were notable for their extensive lateral and aerial roots, which provided enhanced anchorage and reduced uprooting during storms.

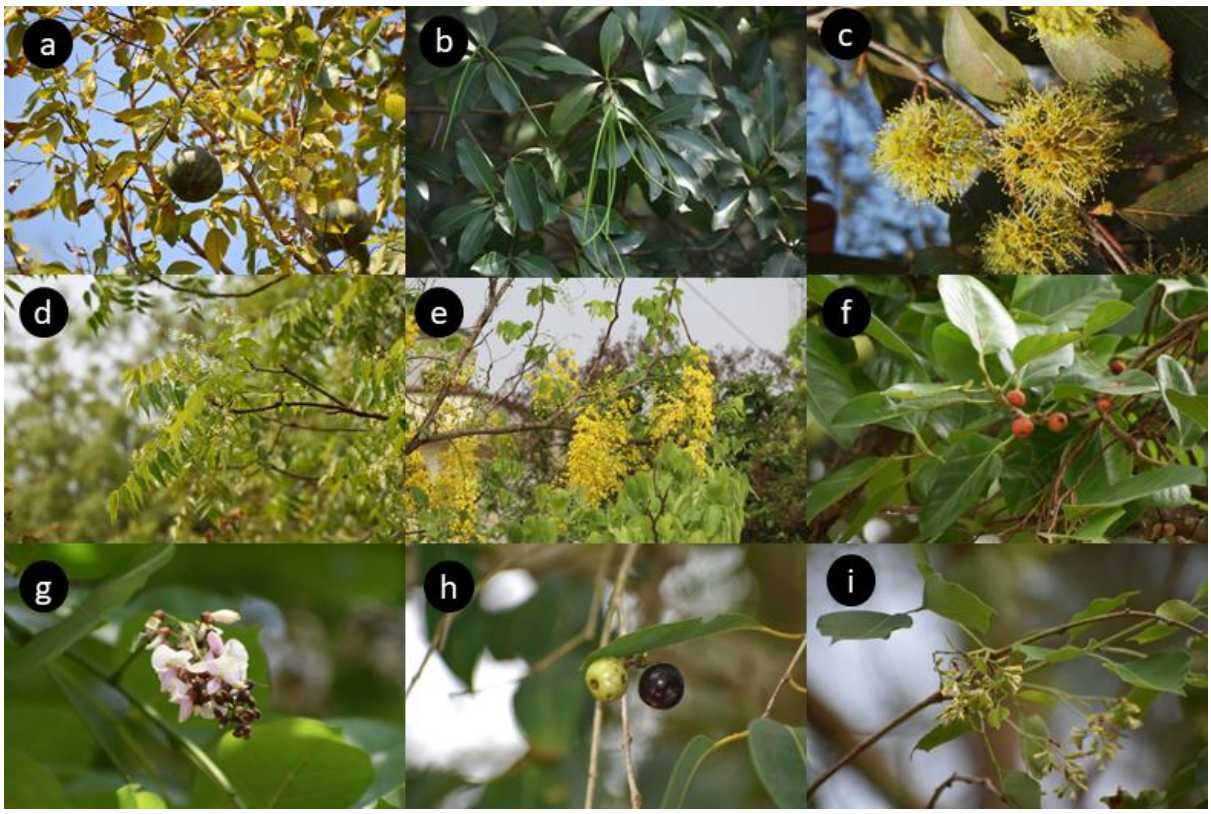


Plate 1: Cyclone- resistant tree species of study areas; a) *Aegle marmelos*, b) *Alstonia scholaris*, c) *Anogeissus acuminata*, d) *Azadirachta indica,* e) *Cassia fistula,* f) *Ficus benghalensis,* g) *Pongamia pinnata,* h) *Syzygium cumini* and i) *Dalbergia sissoo*

Table 1: Enumerated cyclone- resistant tree species

Name	Common name	Family	Location
Aegle marmelos (L.) Corrêa (Plate 1a)	Bel	Rutaceae	Khordha, Puri and Cuttack
Alstonia scholaris (L.) R.Br. (Plate 1b)	Blackboard Tree	Apocynaceae	Khordha, Puri and Cuttack
Anogeissus acuminata (Roxb. ex DC.) Wall. ex Guill. & Perr. (Plate 1c)	Phasi	Combretaceae	Khordha, Puri and Cuttack
Azadirachta indica A. Juss. (Plate 1d)	Neem	Meliaceae	Khordha, Puri and Cuttack
Borassus flabellifer L.	Toddy Palm	Arecaceae	Khordha, Puri and Cuttack
Calophyllum inophyllum L.	Alexandrian laurel	Calophyllaceae	Khordha, Puri and Cuttack
Cassia fistula L. (Plate 1e)	Golden Shower Tree	Fabaceae	Khordha, Puri and Cuttack
Casuarina equisetifolia L.	Whistling Pine	Casuarinaceae	Khordha, Puri and Cuttack
Cocos nucifera L.	Coconut	Arecaceae	Khordha, Puri and Cuttack
Dalbergia sissoo Roxb. ex DC. (Plate 1i)	Sisoo	Fabaceae	Khordha, Puri and Cuttack
Ficus benghalensis L. (Plate 1f)	Banyan	Moraceae	Khordha, Puri and Cuttack
Ficus hispida L.f.	Hairy Fig	Moraceae	Khordha, Puri and Cuttack
Ficus racemosa L.	Cluster Fig	Moraceae	Khordha, Puri and Cuttack
Pongamia pinnata (L.) Pierre (Plate 1g)	Karanja	Fabaceae	Khordha, Puri and Cuttack
Senegalia catechu (L.f.) P.J.H. Hurter & Mabb.	Khair Tree	Fabaceae	Khordha, Puri and Cuttack
Syzygium cumini (L.) Skeels (Plate 1h)	Jamun	Myrtaceae	Khordha, Puri and Cuttack

The findings of the present study highlights the importance of species selection in urban forestry within cyclone-prone coastal regions. The dominance of native and long-naturalized species among the documented cyclone-resistant trees underscores the role of ecological adaptation in conferring resilience to extreme weather events. Species such as *Casuarina equisetifolia* have long been recognized for their role in coastal protection and wind attenuation, while *Ficus* species contribute significantly to structural stability and ecosystem services. The consistent survival of these species across multiple districts suggests their suitability for incorporation into urban plantation and coastal greenbelt programmes. Urban forestry initiatives in Odisha should prioritize cyclone-resilient species over structurally weak or shallow-rooted ornamentals. Integrating such species into city planning can enhance urban safety, reduce post-cyclone recovery costs and promote sustainable urban ecosystems.

Conclusion

The present study provides documented evidence of cyclone-resistant tree species safeguarding urban greenery in coastal Odisha. Sixteen tree species exhibiting consistent survival across three districts were identified, highlighting their potential role in climate-resilient urban forestry. Adoption of these species in plantation and redevelopment programmes can strengthen urban green infrastructure and improve disaster preparedness in cyclone-prone coastal regions.

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