International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:10, No:4, 2016

Restoring Trees Damaged by Cyclone Hudhud at Visakhapatnam, India

Mohan Kotamrazu

Abstract**—**Cyclone Hudhud which battered the city of Visakhapatnam on 12th October, 2014, damaged many buildings, public amenities and infrastructure facilities along the Visakha-Bheemili coastal corridor. More than half the green cover of the city was wiped out. Majority of the trees along the coastal corridor suffered from complete or partial damage. In order to understand the different ways that trees incurred damage during the cyclone, a damage assessment study was carried out by the author. The areas covered by this study included two university campuses, several parks and residential colonies which bore the brunt of the cyclone. Post disaster attempts have been made to restore many of the trees that have suffered from partial or complete damage from the effects of extreme winds. This paper examines the various ways that trees incurred damage from the cyclone Hudhud and presents some examples of the restoration efforts carried out by educational institutions, public parks and religious institutions of the city of Visakhapatnam in the aftermath of the devastating cyclone.

Keywords**—**Defoliation, restoration, salt spray damage, wind throw.

I. Introduction

THE Very Severe Cyclone Hudhud which made its landfall in the coastal city of Visakhapatnam on 12th October, 2014, caused catastrophic damage to its green cover, infrastructure and buildings. Majority of the trees along the Visakaha-Bheemli Beach Road and in University campuses, parks and residential colonies in the vicinity of the coastal corridor were either completely uprooted or suffered from various types of damage.

Post damage assessment studies have been carried out with the objective of assessing the various types of damage incurred by the trees. Since most cyclones can be predicted well in advance, pre-disaster measures like structural pruning of trees can help in minimizing the damage to roadside trees, especially those located under power lines. Damage assessment and vulnerability analysis coupled with restoration efforts can also help in minimizing the damage to trees and making them more resilient to damage from future storms.

II. Types of Damage to Trees

A. Defoliation

In order to reduce the stress from high winds, trees shed their leaves and even limbs if required. This does not imply that trees are dead as they regain their foliage over a period of time. Trees with small leave shed their leaves easily and recover fast from damage due to defoliation. Defoliated *Ficus religiosa* trees at Rushikonda and defoliated *Terminalia catappa* trees at a park in Bheemli are shown in Figs. 1 (a) and (b) respectively. Fresh sprouts on a *Terminalia cattapa* tree at Tenneti Park soon after the storm are shown in Fig. 2 (a) and the same tree regained most of its foliage two months after the storm as shown in Fig. 2 (b).

(a) (b)

Fig. 1 (a) Defoliated *Ficus religiosa* tree at Rushikonda, Visakhapatnam (b) Defoliated *Terminalia catappa* tree in a park at Bheemunipatnam

(a) (b)

Fig. 2 (a) Fresh sprouts on a *Terminalia catappa* tree at Tenneti park (b) Defoliated Terminalia tree with foliage regained two months later

B. Salt Spray Damage

One peculiar type of damage to the majority of the trees was observed in the aftermath of the cyclonic storm. Most of the leaves of the trees turned black. This phenomenon occurs due to the deposition of salt laden water droplets on trees and shrubs. All parts of the plant including leaves, stems, roots and fruits, may be reduced in size [1]-[3]. Damage due to salt spray can be reduced if the plants are washed with water or in the event of rains occurring immediately in the aftermath of a cyclonic storm. Fig. 3 (a) shows salt spray damage to the *Calophyllum inophyllum* and *Tecoma castanifolia* trees in the Gitam University campus. Fig. 3 (b) shows a salt burnt leaf of *Ficus elastica* tree in the Tenneti Park at Visakhapatnam. In the Gitam University campus at Visakhapatnam the leaves of *Mimumsops elengi* trees (Fig. 4 (a)), *Polyalthia longifolia*

Mohan Kotamrazu is with the Gitam University, Visakhapatnam, 530045 India (phone:+91 9866668220; e-mail: profkmohan@gmail.com).

(Fig. 4 (b)) and *Ionophyllum callophylum* (Fig. 5) suffered extensively from salt-spray damage.

(a) (b)

Fig. 3 (a) Salt spray damage to trees in Gitam University (b) Salt spray damage to *Ficus elasticia* leaf at Tenneti Park, Visakhapatnam

(a) (b)

Fig. 4 (a) Salt spray damage to trees in Gitam University (b) Salt spray damage to *Ficus elasticia* leaf at Tenneti Park, Visakhapatnam

Fig. 5 Leaves of *Ionophyllum cannophylum* trees in the Gitam University Campus showing signs of damage by salt spray

C. Damage to Co-dominant stems

A tree with two or more trunks of similar size is said to have co-dominant stems. Trees with co-dominant stems are usually weaker than trees with a single upright stem as inferior quality bark is often deposited in the joints of the co-dominant stems which results in failure of the branches in the face of strong winds [5], [6]. According to [7], co dominant stems are prone to failure as the included bark between these stems do not from a connective tissue. Damage to the co-dominant stems of a *Ficus religiosa* tree along the beach road near Rushikonda is shown in Fig. 6. Fig. 7 (a) shows damaged Peltophorum trees in Gitam University campus at Visakhapatnam. Fig. 7 (b) shows a Peltophorum tree at Kailashgiri in Visakhapatnam where cyclone Hudhud made its landfall. Fig. 8 shows views of Eucalyptus trees before and after the cyclone. Majority of the trees damaged by strong cyclonic winds such as Peltophorum, *Ficus religiosa*, *Acacia auriculformis*, etc. were trees with co-dominant stems. The solution to reduce storm damage to such trees is through structural pruning where competing stems are pruned.

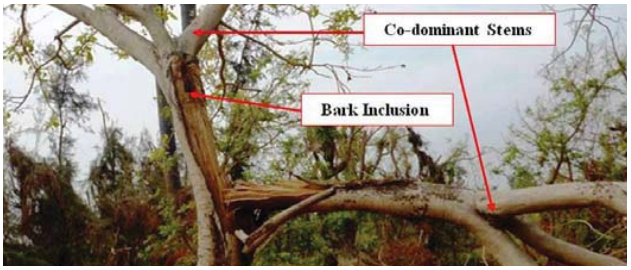

Fig. 6 Damage to co-dominant stems of a Ficus religosa tree on the beach road near Rushikonda, Visakahapatnam

(a) (b)

Fig. 7 (a) Damaged Peltophorum trees in Gitam University (b) Damaged Peltophorum at Kailashgiri, Visakhapatnam

(a) (b)

Fig. 8 Views of the Eucalyptus trees at Gitam University campus before and after the cyclone

D. Wind Throw and Uprooting

Tall trees that are top heavy and possess shallow roots such as *Sweitenia mahagoni*, *Spathodea campanulata*, *Greviella robusta* are more prone to wind throw and uprooting than smaller trees with deep roots [4]. Tall trees with deep roots, widely spaced branches and a symmetrical, tapering crown such as *Araucaria heterophylla* are less vulnerable to damage from wind throw [5]. Trees whose roots get cut during the laying of roads or pavements are also susceptible to damage from wind throw. Wind thrown *Acacia auriculformis* and *Thespesia populnea* trees along the Visakha-Bheemli Beach Road are shown in Fig. 9. An uprooted *Ficus religiosa* tree along a road at Andhra University Campus in Visakhapatnam is shown in Fig. 10 (a). Wind thrown *Sweitenia mahogoni*

trees in the Gitam Univeristy Campus at Visakhapatnamare shown in Fig. 10 (b).

(a) (b)

Fig. 9 (a) Wind thrown *Acacia auriculformis* tree along the Beach Road at Visakhapatnam (b) Wind thrown *Thespesia populnea* tree along the Beach Road at Visakhapatnam.

(a) (b)

Fig. 10 (a) Uprooted *Ficus religosa* tree at Andhra University Campus (b) Wind thrown *Sweitenia mahagoni* trees at Gitam University Campus

III. Restoration Measures

Soon after a cyclonic storm an assessment of the damage to trees, shrubs and landscape elements should be carried out and various actions have to be taken to rescue damaged trees. As pointed out by [1], at least four factors should be evaluated prior to making a decision to save a damaged tree: sentimental value, growth rate, condition of the tree and transplantability. Fig. 11 shows a partially damaged *Ficus religiosa* (Peepal) tree at Visalakshmi Nagar at Visakhapatnam. This tree, located at the entrance of a temple has sentimental value and is worshipped by people who visit the temple.

Defoliated trees should be saved as usually they will refoliate. If the tap root of a fallen tree is intact, then the chances of its survival are good. Leaning trees and trees with roots severed roots which are a source of hazard for buildings or for the movement of pedestrians should be removed.

Pre-disaster pruning of the foliage can save trees, especially top-heavy trees, from blowing over and make them more wind resistant. Trees with damaged co-dominant stems should be pruned rather than topped. Topping (Fig. 12) is a harmful practice where the entire canopy of a tree is severely reduced with heading cuts and leads to tree decay [8].

After the Cyclone Hudhud, many of the fallen or partially damaged trees have been restored in various parks of Visakhapatnam such as Vuda; several restoration efforts have been made in Vuda Park, Tenneti Park and Shivaji Park. Tees have also been restored in the Gitam University campus and Andhra University campus and also in Shanti Ashram.

Fig. 11 A partially damaged *Ficus religiosa* (Peepal) at the entrance of a temple at Visalakshinagar

(a) (b)

Fig. 12 (a) Topped *Polyalthia longifolia* trees in the Botany department at the Andhra University campus (b) Topped *Delonix regia* tree in the Vuda Park at Visakhapatnam

Fig. 13 A restored *Ficus religiosa* tree at Shanthi Ashram at Visakhaptnam. Photo Credit: C. V. Subhramanyam

Fig. 14 Restored *Ficus religiosa* tree with regained foliage one year after the cyclone Hudhud

A fifty year old *Ficus religiosa* tree at the Shanti Ashram was completely uprooted and given up for dead has been

given a new life through careful restoration efforts. The tree had sentimental value for the inmates of the Ashram as it was planted by its founder Swami Omkar. Fig. 13. shows the restoration efforts for the *Ficus religiosa* tree. Earth was dug six feet deep with the help of an earthmover. By crane and some strong ropes were used to provide support and the huge trunk was covered with heaps of soil for replanting the fallen tree. Fig. 14 shows the restored tree with regained foliage one year after the cyclonic storm.

Most of the tall and top heavy Mahagoni trees which got uprooted in the Gitam Campus have been uplifted and staked and have been completely restored as shown in Fig. 15. Restoration of collapsed *Greviella robusta* trees is shown in Figs. 16, 17. Restoration efforts in Shivaji Park, Vuda Park and Andhra University are shown in Figs. 18-20.

Fig. 15 Restoration of *Sweitenia mahagoni* trees at Gitam University, Visakahapatnam

(a) (b) (c)

Fig. 16 (a) A *Greviella robusta* tree before the cyclone Hud-Hud (b) Uprooted *Greviella robusta* trees (c) A resotred *Greviella robusta* tree

Fig. 17 Restored *Greviella robusta* trees in the Gitam University Campus at Visakhapatnam

(a) (b) (c) (d)

Fig. 18 (a) A restored *Ravenelia madagascarens* palm at Shivaji Park (b) A restored *Terminalia catappa* tree at Vuda Park (c) and (d) Restored *Borassus flablifer* palms in Vuda Park

(a) (b)

Fig. 19 (a) Removal of debris of fallen trees at Andhra University (b) A restored *Phyllanthus embilica* tree in the Botany Department at Andhra University Campus

Fig. 20 Structural pruning and restoration of *Terminalia catappa* trees at Vuda Park

IV. Conclusion

A survey of trees before, and after a cyclonic storm is essential for sustainable landscaping in cyclone prone areas. A paradigm shift is essential in the criteria for plant selection in cyclone prone areas. Trees selected should be wind resistant, have a stable architecture, should be salt resistant with deep roots. Pre-disaster and post-disaster assessment damage to trees coupled with structural pruning and suitable conservation measures would help in making landscapes safe, resilient and sustainable.

Acknowledgment

The author thanks Ar. Jagadeesh Gorle, Asst. Professor, School of Architecture, Gitam University, and Visakhapatnam for his help with the preparation of this paper.

REFERENCES

[1] L. Seigendorf, "Hurricane Tree Care", *Journal of Aboriculture*, Vol 10,1984, pp.217-221.
[2] B. Appleton, R.R. Huff and S.C. French "Evaluating Trees for Saltwater Spray Tolerance for Ocean Front Sites", *Journal of Aboriculture,* Vol. 25, 1999, pp. 205-210.
[3] M.A. Dirr, "Selection of Trees for Tolerance to Salt Injury", *Journal of Aboriculture*, Vol.5, 1976, pp. 209-216.
[4] K. Mohan "Wind Damage to Trees in the Gitam University Campus at Visakhapatnam by Cyclone Hudhud", *International Journal of Research in Engineering and Technology*, Vol 3, 2014, pp.55-65.
[5] K. Mohan "Wind damage to buildings, infrastructure and landscape elements along the Beach road at Visakhapatnam", *International Journal of Research in Engineering and Technology"*, Vol. 3, 2014, pp.45-65.
[6] E.T. Smiley "Does included bark reduce the strength of co-dominant stems?" *Journal of Aboriculture*, Vol. 29,2003, pp.104-106.
[7] J.R. Matheny and J.R. Clark, "A *Photographic Guide to the Evaluation of Hazard Trees in Urban Areas"*, International Society of Arboriculture, Champaign, IL, pp. 85.
[8] E.F. Gilaman, M.L. Duryea, E. Kampf, T.J. Partin, A. Delgado, C.J. Lehtola, "Assessing damage and restoring trees after a hurricane", "*Urban forest hurricane recovery program"* 2006, University of Florida.