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Impact of Gaja cyclone on tree damage in Nagapattinam, Tamil Nadu, India

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Abstract

The cyclone Gaja causes extensive damage in tree mortality and vegetation on the Nagapattinam especially on vedaranyam in 2018. The heavy wind with high rainfall causes damaging, broken and uprooting of the trees. We selected the area for observation as Ayakkaranpula-II that is affected highly on the Vedaranyam city. Many species were identified that damaged due to the Gaja cyclone. A total of 1120 trees, accounting for 16.54% of the total, were uprooted during the Gaja cyclone in the Ayakkaranpula-II region. Moreover, more than 20,000 trees in the area sustained damage as a result of the cyclone. These findings were derived through a combination of field measurements, satellite imagery, and GIS software mapping. The selected tree species for observations are Mangifera indica, Cocos nucifera, Tamarind, Arecaceae, Casuarina equisetifolia. The probability of beaking and uprooting of trees is equal in same species. Wood density provides similar relationship to the broken trees. The uprooting of the trees is greater in Tamarind and Cocos nucifera. The damage and broken of the trees is greater in Mangifera indica and Casuarina equisetifolia. Arecaceae provide better resisitance to the cyclone of Gaja.

Key words : Gaja cyclone, Tree damage, NDVI, GIS, Wood specific gravity.

Introduction

The heavy wind causes various effect to both the society and tree mortality. Immediate cyclonic impacts affects the plantation and crops such as defoliation, damage etc., The severe wind causes major damage the structures, trees, electrical cables and boats. The cyclonic disturbance alters the cyclic process of the plants and trees. Various forms of damage have impacted the trees, including defoliation, snapping, and uprooting, affecting multiple tree species. The Cyclone modifies the tree species such as breakage of branches, stems, stripping of leaves and uprooting. Severe wind causes widespread damage for the canopy trees, breakage of vines and crown stem and leads to tree fall.

The storm instensity of Gaja is very higher than the past major cyclone of Thane. The wind speed identified by the government in nagapattinam is above 120 kmph. This cyclones creates canopy gaps to some important species in vedaranyam. The factors mitigating the effect of tree attributes e.i., properties of the wood, roots, leaves and the soil.

The effect of cyclone on trees and production of plantation are species specific. The resistance to the wind may vary by species of the trees and their properties of wood, roots and soil condition.

The condition of the soil plays a major role in uprooting of the trees. According to the heavy rainfall, the soil has very wet in condition and loosening of its density. This condition is very favourable for uprooting of trees even has high penetration of roots into the soil. Wind events like hurricanes, typhoons, tornadoes, and thunderstorms can occur in countries all around the world. The effect of damage, alter in compositions are based on the frequency and severity of the wind events. Although particular information of wind events has been gathered from the South America forest ecosystems, North America and Australian rainforests, the data limited for the world topics and particularly in india i.e., Tamil Nadu and Nagapattinam, Impact of cyclone on plantation damage in terms of economical return and common damage in the economy was generated in order to offer relief fund, however scientific data on damage in ecological prospective of tamilnadu is nil. The past cyclones namely Thane, Nisha, jall and now Gaja have affected Tamilnadu and Nagapattinam but no published information of Thane, Nisha and Jall cyclones on tree damage in Nagapattinam is available. Therefore the data generated is act as an baseline data for the further prediction and comparison for the future cyclone effect on tree damage.

The Gaja is named by the weather reporters so as to reach the people easily. The Gaja cyclone not only Cause major defoliation of trees on Nagapattinam but also on various districts on Tamilnadu such as Thanjavur, Pudukkottai etc., The cyclone Causes to fell of various trees across the road that cause transportation loss for several days. It creates water scarcity due to lack of electricity all over the affected areas.

The published information of the Impact of cyclone on the Tree species and sources are not available for the Nagapattinam district. Therefore, the present study is intended to address the effect of cyclone on various species of trees and it is used for prediction of loss of vegetation on the future wind event of cyclone. In this study, we also represents that which wood specific gravity can offer better resistance to the severe wind action, it is used to take decision of which plantation can choose for the deltaic region.

Study area and descriptions

Ayakkaranpulam-II (10º 24′ N,79º 45′ E), covers the central

portion of the Vedaranyam, Nagapattinam, Tamilnadu, India. It is located at the east coast of the Tamilnadu. It covers an of area about1400 acres. The vedaranyam has acheive the high vegetation index on the Nagapattinam districts know about by NDVI (Normalized Difference Vegetation Index) of the Vedaranyam shown in the figure 2. The Ayakaranpulam-II area is selected for that the area is surrounded by low lying areas and the Cyclone causes less damage in low lying areas. The Ayakkaranpulam-II has faced high loss of tree mortality, Plantation and crop damage. It has the tropical climate with high rainfall on the Northeast monsoon and inconsistence on South west monsoon (june-september).

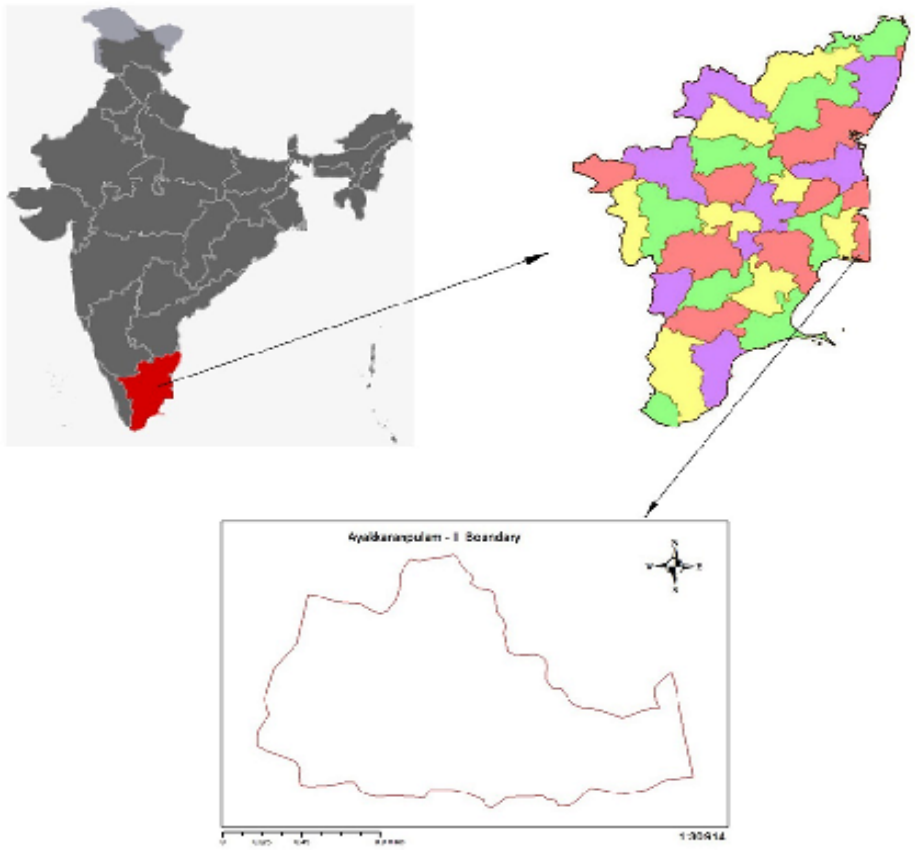

Fig 1 : LOCATION OF STUDY AREA – AYAKKARANPULAM-II

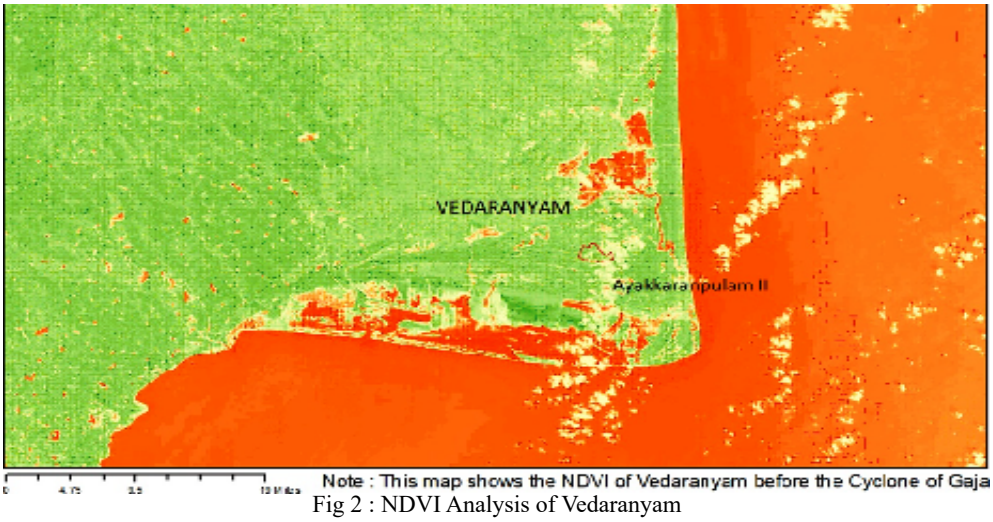

Fig 2 : NDVI Analysis of Vedaranyam

The soil exhibits a red fertility type, characterized by its sandy texture and excellent drainage properties. The Ayakaranpulam-II has covered 1400 acres on vedaranyam, it enclosed with evergreen shrub and palm species.

Background of 'Gaja' cyclone

A severe cyclone storm named Gaja crossed the coast of Tamilnadu along vedaranyam at the latitude of 10.5º N and longitude of 79.8º E with the wind speed of 95 to 110 kmph during 12:00 to 2:00 hrs (IST)

on 15th November , 2018. It was recorded by the private weather observers. In the vedaranyam, the speed of the wind is high on the height of 5m from the ground level. The IMD (Indian Meteorological Department) was issued the red alert to the coastal Tamilnadu for tropical cyclone formation named 'Gaja' a deep depression in Bay of Bengal on 12th November 2018, that creates the landfall and heavy rainfall in the Tamilnadu at November 15, 2018. The IMD (Indian Meteorological Department) has reported that the cyclone made landfall between the Chennai and Nagapattinam districts. They also noted that very heavy rainfall is expected in the regions spanning Tamil Nadu to Kerala and along the southern coast of Andhra Pradesh. The Joint Typhoon Warning Center also issued an alert for cyclone formation on the east coast of the Tamilnadu. Due to heavy storm surge, the sea wave raised for about 2m and causes extensive damage to the east coast of Tamilnadu and damaged the fisherman's boats of the landed on the coastline.

Methods

For the observation, the entire Ayakkaranpulam-II area was divided by 5 sub-sites namely Site I (which is located at the north west side of the area) Site II (located at north east side of Ayakkarnpulam-II area), Site III (located at the south-west of Ayakkanpulam-II area), Site IV lies in between the site III and site V, Site V (located at south-east of the area). We selected 5 tree species for the observation i.e., Mangifera indica, Cocos nucifera, Tamarind, Arecaceae, Casuarina equisetifolia.

The data is collected on Sites are done by visual recordings and estimation of tree and its species. The damage data i.e., trees uprooted, damaged, broken and standing are recorded manually on each sites by using Quadrant method (Site I – 3 quadrants, Site II - 4 quadrant, Site III – 5 quadrant, Site IV – 4 quadrant, Site V – 4 quadrant). Each quadrants has 1000 x 500mts in size. Also record the diameter of each tree at its breast height for the height to breath comparison of tree damage.

Simultaneously the wood samples of each species of trees from the main trunk was collected for the comparison of tree damage and specific gravity. Due to Gaja cyclone most of the trees are uprooted so its an good opportunity to collect the wood samples from the uprooted trees.

The density of the wood sample calculated by the simple formula of

Density = Mass / volume

The collected wood sample is drying on the oven on 105º C for about 48 hrs and weighted it to get its mass. To calculate the volume of the sample, the collected wood sample is submerged on the measured water on a measurement beaker and the amount of water displaced is measured and taken it as the volume of the sample. The specific gravity was calculated as density of the wood sample by density of the water. The measured specific gravity of the each species of tree is given on the table 1. Linear regression analysis is used to findout the relationship of the tree damage and specific gravity.

Finally the collected datas are recorded and creating a mapping on GIS (Geographical Information System) software of all sites and the location of the tree species. The created boundary mapping with seperated site and location of tree species is shown on the Figure 3.

NAME OF SPECIES	WOOD SPECIFIC GRAVITY	SOURCE
Cocos nucifera	0.43	Present study
Mangifera indica	0.55	Present study
Tamarind	0.9	Present study
Arecaceae	0.83	Present study
Casuarina equisetifolia	0.8	Present study

Table 1 : Wood specific gravity of different tree species in Ayakkaranpulam-II

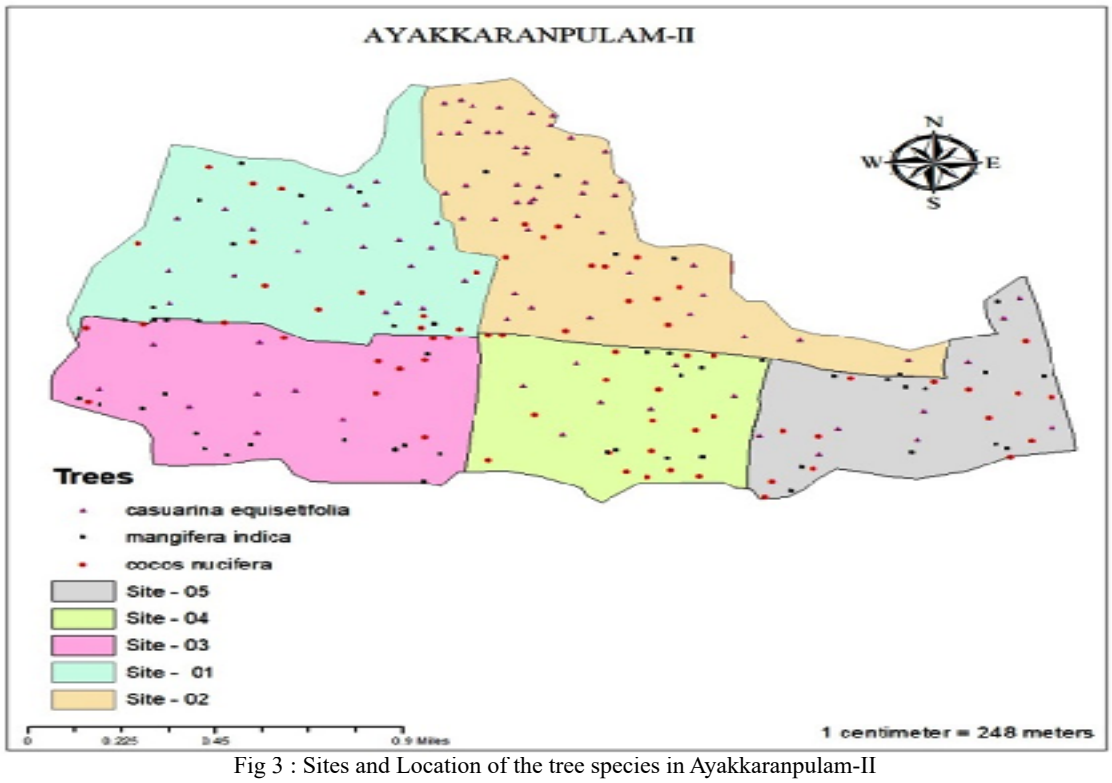

Fig 3 : Sites and Location of the tree species in Ayakkaranpulam-II

Results

The damage by the severe cyclone Gaja was obdained that total of 5411 (73.37) trees were affected in the selected species at the Ayakkaranpulam-II area; 1220 (16.54%) trees were uprooted, 3431 (46.52%) trees were broken at the girth and 760 (10.3%) were damaged (broken of branches and removal of leaves) due to the cyclone. There are 225 (14.6%) trees were uprooted, 841 (54.5%) trees were broken, 169 (10.95%) trees were damaged due to the severe wind in Site 1; 285 (17.18%) trees were uprooted, 696 (43.5%) trees were broken, 160 (10%) trees were damaged in site 2; 399 (22.82%) trees were uprooted, 812 (46.45%) trees were broken, 146 (8.35%) trees were damaged in the Site 3; 108 (8.27%) trees were uprooted, 767 (58.77%) trees were broken, 115 (8.81%) trees were damaged in the Site 4; 159 (13.46%) trees were uprooted, 550 (46.64%) trees were broken, 158 (13.4%) trees were damaged in the Site 5. All of the trees are in observed 5 tree species with greater than 10mm DBH (Diameter at Breast Height).

The uprooted trees are high in site 3 and the broken of the trees are high in Site 1 and damage of the trees are high in site 5. Site 2 and 4 offer much resistance to damage due to the cyclone.

On the all 5 sites Cocos nucifera sustained to high broken on stem of 1689 (52.2%) than the other species. Tamarind sustained to high uprootment of 363 (63.9%) that the all other species. The damage of branches also higher in tamarind followed by Mangifera indica. The species of Arecaceae offers high resistance to damage, broken, uprooting for the cyclone. The standing ratio is high in the species of Arecaceae. The numbers of individual damage to the cyclone is plotted on the figure 4.

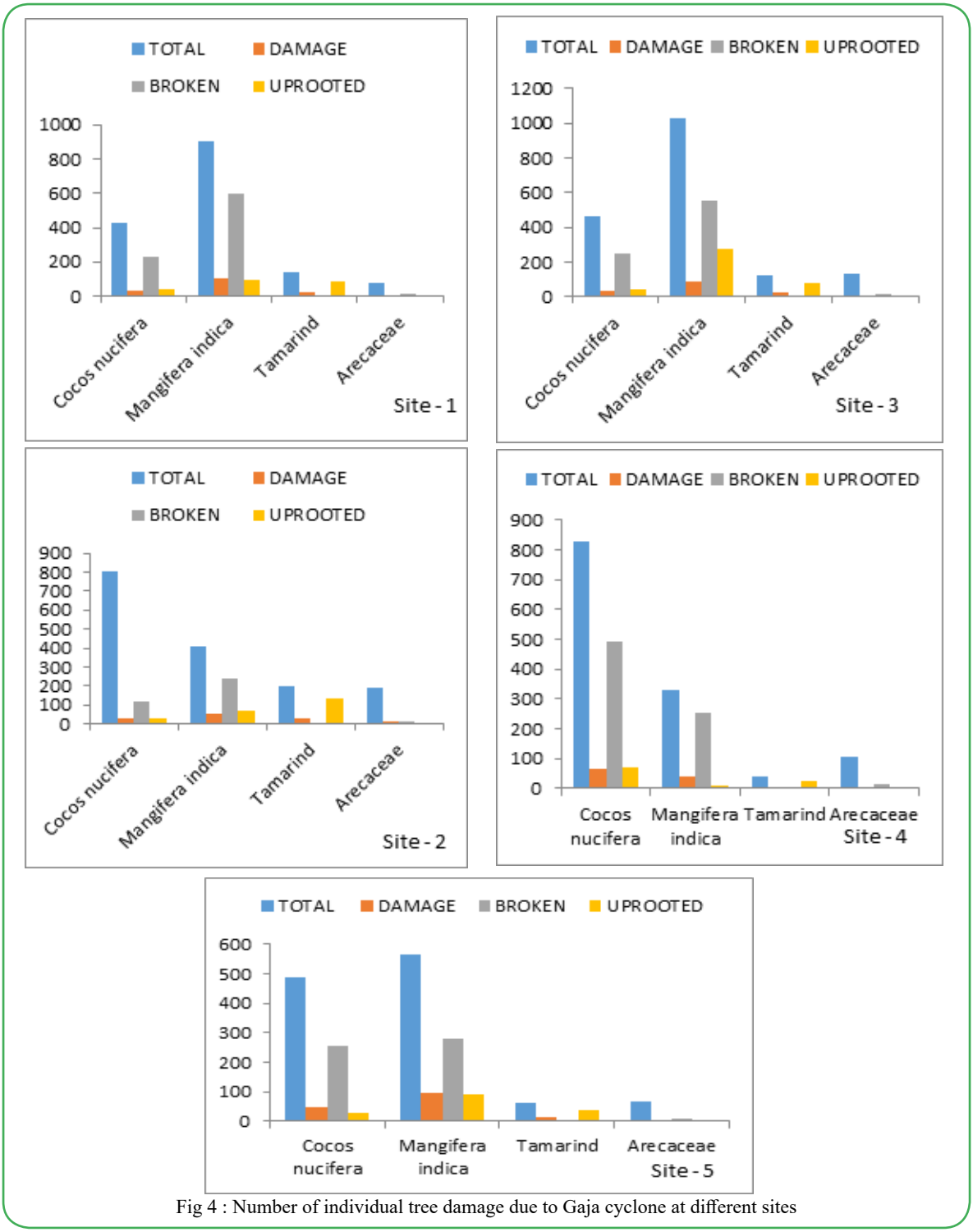

Fig 4 : Number of individual tree damage due to Gaja cyclone at different sites

Height to breadth ratio show the significant relationship to the damage due to cyclone of Gaja. The percentage of tree damage increased along with the increasing of Height to breadth ratio. At certain stage the percentage of tree damage decreased when increasing of the ratio due to the increasing of wood specific gravity of certain species. In this study wood specific gravity shows significant relationship to the tree damage should be discussed below. From the field observation Cocos nucifera and Arecaceae has the highest height to breadth ratio than all other species. But the damage of the two species is differ by specific gravity of the wood.

By considering this study, the wood Specific gravity plays an vital role tree damage. The comparison of wood specific gravity and the damage (standing, broken, uprooted) of trees are plotted in figure 6. The plot shows that the wood specific gravity did not show any significant relationship to the standing and uprooted trees of $R^2 = 0.2442$ and $R^2 = 0.1436$ respectively solved by Linear regressive analysis on the comparison. The Linear regressive analysis shows that relationship found to the Wood specific gravity and broken of the trees ($R^2 = 0.704$). The increase in wood specific gravity decreases the broken of the trees.

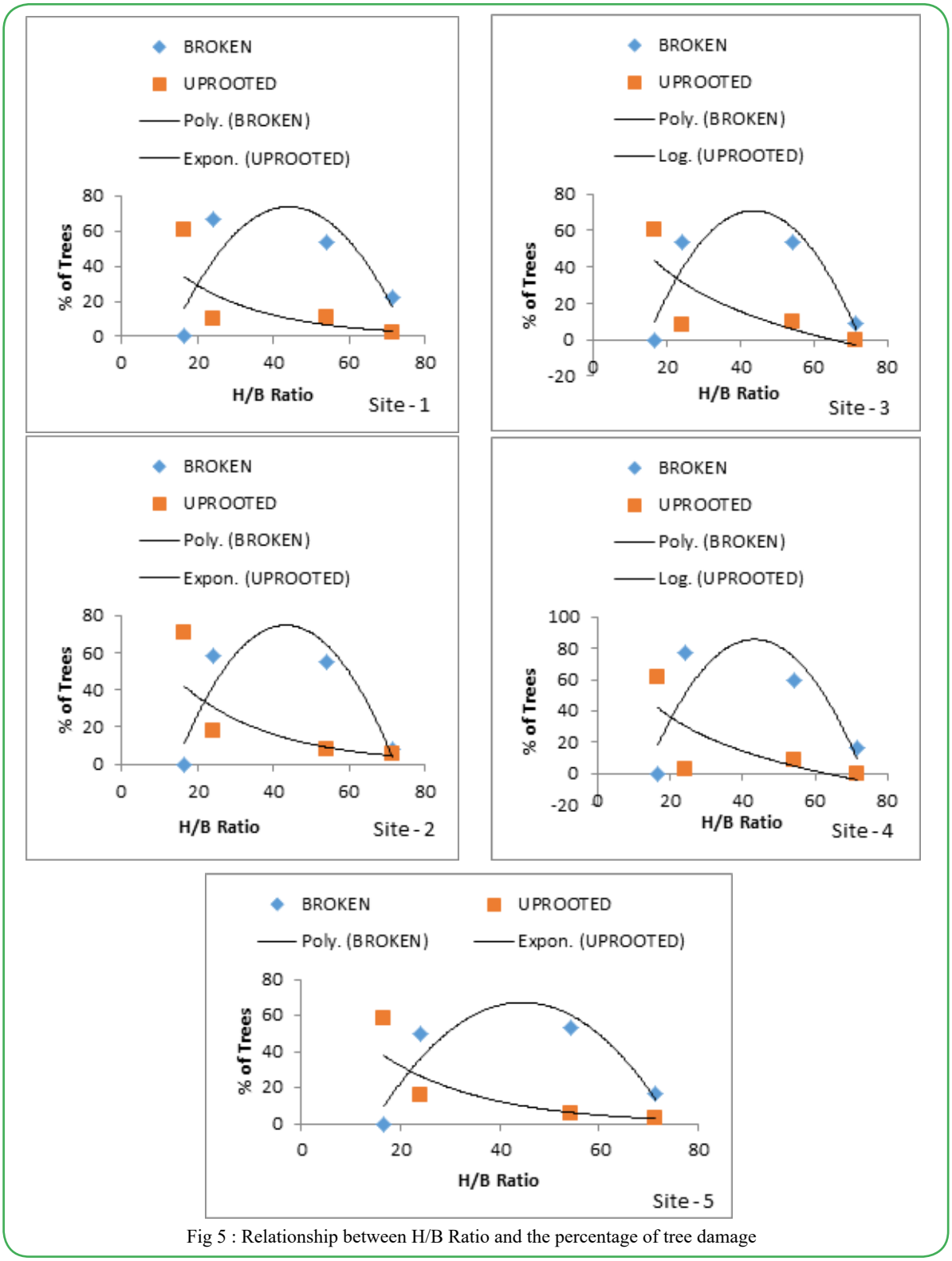

Fig 5 : Relationship between H/B Ratio and the percentage of tree damage

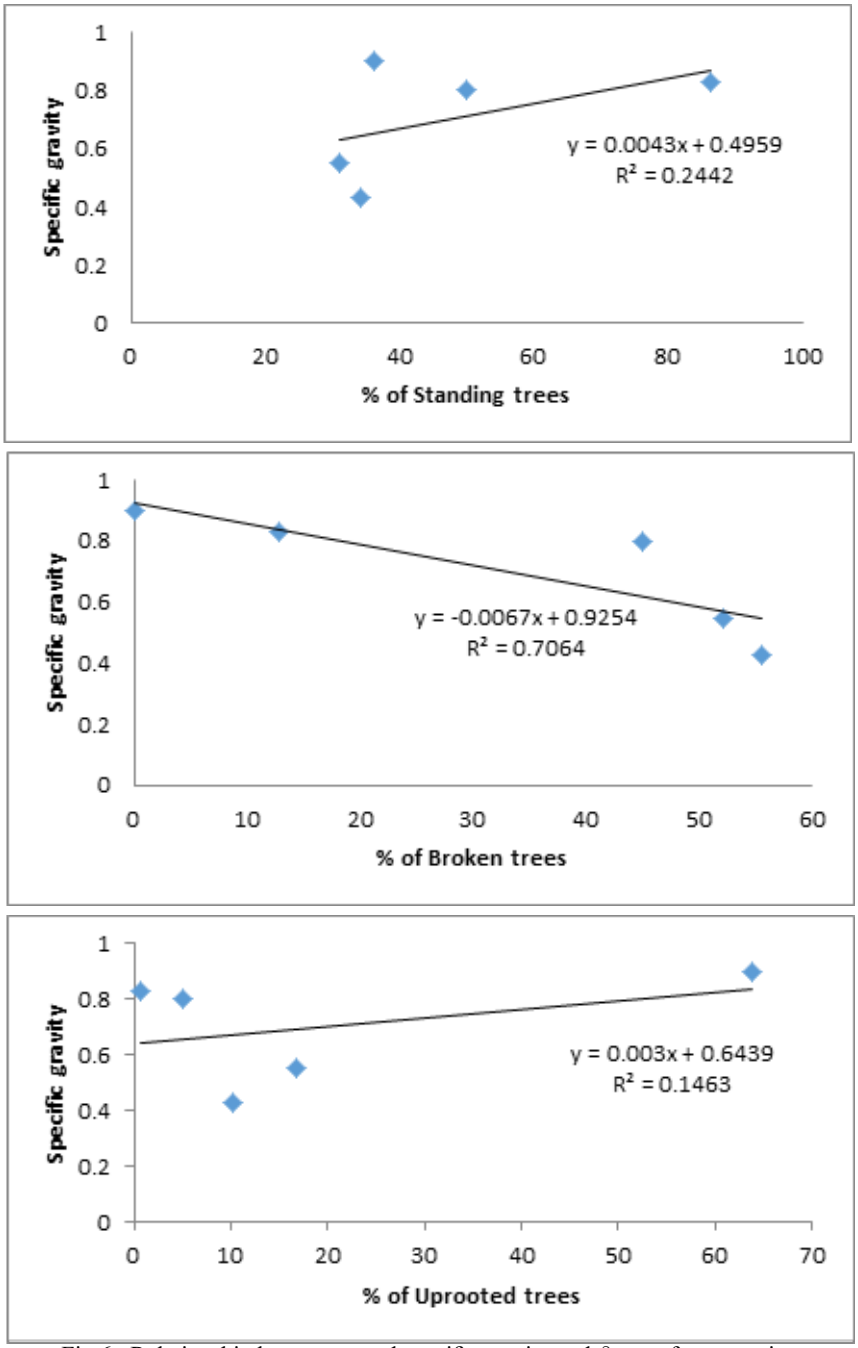

Fig 6 : Relationship between wood specific gravity and status of tree species

Discussion

The tropical cyclone of Gaja formation on the East coast of Bay of Bengal cause an extensive damage on the tree mortality to the various district of Tamilnadu. The Nagapattinam is one of the most affected district on structural and tree damage. In the study area of Ayakkaranpulam-II, Vedaranyam, more than 20000 trees were snapped out and 1120 trees were uprooted on the specified species of the tree. The Gaja is one of the most strongest cyclone than past cyclone of Thane and Nisha. About 6 districts were heavily affected due to the Gaja cyclone.

Conclusion

In the current research, a significant number of tree species experienced defoliation and uprooting. The Casuarina equisetifolia plantation, in particular, was heavily impacted, with its leaves completely stripped by the severe winds. This forced individuals to completely remove the Casuarina plantation and sell it in the market. The market value of a one-acre Casuarina equisetifolia plantation, once it reaches full maturity, is approximately 1 lakh. However, due to the partial removal of the plantation, owners only managed to sell it for a considerably lower price, typically ranging from 10,000 to 20,000, resulting in substantial financial losses for them.

Based on the aforementioned observations, it is clear that wood density serves as an indicator for predicting tree damage specifically in terms of breakage at the girth. However, it does not establish any correlation with tree uprooting or survival. Some previous studies have reported a negative association between wood density and tree damage, as noted by Putz et al. [1], Vendecar et al. [2], and Curran et al. [3]. Additionally, certain literature suggests a modest connection between wood density and a tree's resistance to cyclones, as seen in Ostertag et al. [4] and Bellingam et al. [5].

Competing interests: The author declares no competing interests.

References

1. Putz. F.E., A.Montalva, P.D.Coley,K.Lu and A.Aiello, (1983). Uprooting and Snapping of trees. Structural determinants and ecological consequence. *Can.J .For.Res. 13*: 1011-1020
2. Karen L.Vandecar, Christiane W.Runyan, Paolo D;Odorico, Birgit Schmook, Deborah Lawrence, Rishiraj Das., (2011). Phosphororus input through fog deposition in a dry tropical forest. *Geophysical Research: Biogeosciences, 120*: 257 – 268.
3. Timothy J.Curran, N.Gerbach, Will Edwards, Andrew K.Krockenberger., (2008b). Wood density predicts plant damage and vegetation recovery rates caused by cyclone disturbance in tropical rainforest tree species of north quessland, Australia. *Austral Ecology 33*:442-450.
4. Ostertag, R., Silver.W.L, and Lugo.A.E. (2005). Factors affecting mortality and resistance to damage following hurricans in a rehabilitated subtropical moist forest. *Biotropica 37*:16-24.
5. P.J. Bellingham, E.V.J. Taneer and J.R.Healey., (1995). Damage and responsiveness of Jamaican Montane Tree Species after Disturbance by a Hurricane. *Ecology, Vol 76*, NO.8, pp. 2562-2580.