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Diversity of tree species of industrial area, Korean export processing zone, Chattogram

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Abstract
The research work was shown to calculate the composition of tree species in the Korean Export Processing Zone (KEPZ) of Bangladesh extending to an area of 2492 acres. In the study area, 108 tree species belong to 81 genera and 35 families have been collected from KEPZ. The dominant tree species of KEPZ were *Acacia longifolia* (Andrews) Willd., *Acacia mangium* Willd., *Albizia procera* (Roxb.) Benth., *Syzygium cumini* (L.) Skeels, *Tectona grandis* L.f., *Swietenia macrophylla* King, *Terminalia arjuna* (Roxb. *ex* DC.), *Mangifera indica* L. and *Artocarpus heterophyllus* Lam. on the other hand a rare species of *Barringtonia acutangula* (L.) Gaertn. found in this area. The result revealed the occurrence of 85 least concern species, 15 not evaluated species, 3 conservation dependent species, 4 vulnerable species, and one data deficient species. The result revealed the occurrence of 85 species (85.79%) least concern,15 species (15.14%) not evaluated, three (3) species (3.3%)conservation dependant, four (4) species (4.3%) vulnerable, and one (1) species (1.1%) data deficient. The tree species, which were studied, in this remaining forest, need consideration for instant conservation programs to prevent further degradation of the forest.

Keywords: tree species, conservation initiatives, export processing zone

Introduction
Floristically, the KEPZ area is very rich and diverse. Korean Export Processing Zone (KEPZ) is the Private sector organization established as part of the industrialization in Bangladesh. Youngone Corporation, a Seoul based company, signed with the Government of Bangladesh to set up an EPZ in the private sector in the name of Korean EPZ (KEPZ) Corporation (BD) Ltd. Following Act No. XX of 1996, the Bangladesh Private Export Processing Zones Act, 1996, the company set up the Korean EPZ. However, massive anthropogenic habitat modifications and overexploitation of wildlife are existent and unblemished threats to its biodiversity. There has been no published previous comprehensive plant exploration record in the KEPZ area. In case of proper conservation and management of biodiversity in this reserve, a comprehensive list of flora and fauna including all lower plants and animals along with their present conservation status and recovery plan is required. Therefore, for the assessment of national biodiversity sustainability habitat monitoring is one of the important factors [24]. According to previous research data, ecologists and taxonomists have been mostly concerned about the diversity of plants, animals and their interactions within ecosystems and landscapes [21, 43]. Forests are the storehouse of diversity. As a result, the conservation and management in the diversification of forests is both a matter of insurance and investment to ensure sustainable development of agriculture, forestry, and fisheries production. As a result, the conservation and management in the diversification of forests is both a matter of insurance and investment to ensure sustainable development of agriculture. Conservation of biodiversity act as a buffer against harmful environmental changes and also, as a source of raw material for scientific and industrial revolution and as a matter of moral principle [16] Over the past few decades, a number of floristic inventories have progressed throughout the country. These had resulted in the compilation of a number of checklists [12, 13, 17, 18, 19, 31, 32, 33, 35, 36, 37, 39]. Though, several regions of the Bangladesh have been either poorly investigated or remain unexplored to date. So, floristic records are essential for expanding the holdings from those under-represented areas in order to conserve biodiversity of the Bangladesh. Therefore, it is urgent to explore, document, and analyse the species diversity occurring in the KEPZ area before disappearing its natural resources. Consequently, this research work has been made to explore, collect, document, and analyse the species diversity in the forest of mentioned region.

Materials and Methods
This present study was taken to investigate the flora of KEPZ in order to know the plants of this area. The site sits at the south of Chattogram city. It is approximately 30km from the main city and takes almost 45 mins to reach by road but the time halves if the ferry- road is taken across the Karnapluli river near south Patenga. The present area lies approximately between 22°30’ North latitude and 91°54.7’ East latitude. KEPZ includes 2492

acres (Figure 1). KEPZ is quite different from other EPZ of Bangladesh for its unique eco-friendly environment characterized by artificial lakes, hills, rivers, flora and fauna. The soil of KEPZ includes yellowish, sandy or sandy loam, mixed with scattered magiferous ore. Humic composition is high but its degree of accumulation varies from place to place depending on topography. Chattogram has a tropical monsoonal climate (Köppen-Geiger classification: Am) with a dry season and a heavy monsoon the rest of year, no cold season. The average temperature in Chattogram is 25.1°C (77°F). The range of average monthly temperature is 9°C. The warmest average maximum temperature is 29°C (84.2°F) in April. The coolest average minimum temperature is 11°C (51.8°F) in January. On average July has the most rainy days and December has the least rainy days. This is the number of days each month with rain, snow, hail etc. Mean relative humidity for an average year is recorded as 78% and on a monthly basis it ranges from 58% in January-February to 88% in August. The present work deals with the Korean Export Processing Zone (KEPZ) surrounding area and the survey has been made using area maps and four field trips. Plant specimens have been collected both in the flowering and non-flowering stages from the study area by repeated field trips. The collected specimens were brought in the Herbarium and dried by using plant press with newspaper, preparation of herbarium sheets by mounting and of specimens were made by following standard method. Kew mixture (Mercuric chloride with Methylated sprit) have been sprayed on to the specimens whenever necessary to keep the material fresh. Herbarium materials have been preserved in Chittagong University Herbarium (HCU). Collected plant specimens were critically studied, examined and identified in the Department of Botany, University of Chittagong and Bangladesh National Herbarium (BNH) laboratory. Identification was confirmed by experts and by comparing with herbarium specimens deposited both at Bangladesh National Herbarium (DACB), Dhaka University Salar Khan Herbarium (DUSH), Herbarium of Chittagong University (HCU) and Herbarium of Bangladesh Forest Research Institute (HBFRI) and by consulting standard flora and literatures [1, 2, 3, 4, 5, 7, 8, 11, 14, 20, 21, 22, 27, 29, 30, 34] and clear images available on the websites of different international herbaria. The current nomenclature information of each species was incorporated as per ICBN by consulting with Index kewnsis, recent taxonomic publication [15, 26, 28, 40].

Fig 1: Map of Korean Export Processing Zone (KEPZ) Area.

Results

Present study shows that a total of 108 species belonging 81 genera under 35 families recorded from the KEPZ area (Figure 2). The enumeration reveals that family Mimosaceae contains the highest diversity consist of 10 species belonging 6 genera, followed by the families Moraceae (9 species, 3 genera), Myrtaceae (7 species, 3 genera), Euphorbiaceae (6 species,5 genera), Meliaceae (6 species, 6 genera). In the table 1 showed monocotyledons only one family Streliziaceae under one genus and one species *Ravenala madagascariensis* Sonn.

Table 1: List of tree species recoded from Korean Export Processing Zone (KEPZ)

SL	Scientific Name	Family	Local Name	CS
1.	*Michelia champaca* L.	Magnoliaceae	Champa	LC
2.	*Annona reticulata* L.	Annonaceae	Nona ata	LC
3.	*Polyalthia longifolia* (Sonn.) Thwaites	Annonaceae	Debdaru	LC
4.	*Cinnamomum iners* Reinw. *ex* Blume	Lauraceae	Tezbohu	CD
5.	*Cinnamomum tamala* Nees.	Lauraceae	Tejpata	NE

6.	*Litsea glutinosa* (Lour.) C.B.Rob.	Lauraceae	Kukurchita	LC
7.	*Litsea monopetala* (Roxb.) Pers.	Lauraceae	Medaphuri	NE
8.	*Litsea polyantha* Juss.	Lauraceae	Meda	LC
9.	*Persea americana* P.Mill.	Lauraceae	Avocado	CD
10.	*Persea gamblei* (King *ex* Hook.f.) Kosterm.	Lauraceae	Shum	NE, but seems to be rare.
11.	*Artocarpus chama* Buch.-Ham. *ex* Wall.	Moraceae	Chapalish	NE,but seems to be rare.
12.	*Artocarpus heterophyllus* Lam.	Moraceae	Kanthal	LC
13.	*Artocarpus lacucha* Buch.-Ham.	Moraceae	Deua	LC
14.	*Ficus benghalensis* L.	Moraceae	Bot	LC
15.	*Ficus hispida* L.f.	Moraceae	Kakdumur	LC
16.	*Ficus lamponga* Miq.	Moraceae	Katagularia dumur	LC
17.	*Ficus rumphii* Blume	Moraceae	Jhula bot	LC
18.	*Ficus varigata* Blume	Moraceae	Rangila dumur	NE
19.	*Streblus asper* Lour.	Moraceae	Shaora	LC
20.	*Casuarina equisetifolia* L.	Casuarinaceae	Jhau	LC
21.	*Dillenia indica* L.	Dilleniaceae	Chalta	LC
22.	*Tetracera sarmentosa* (L.) Vahl subsp. *Andamanica* (Hoogl.) Hoggl.	Dilleniaceae	Latachalta	LC
23.	*Dipterocarpus turbinatus* Gaertn.	Dipterocarpaceae	Garjan	LC
24.	*Hopea odorata* Roxb.	Dipterocarpaceae	Telsur	LC
25.	*Eurya acuminata* DC.	Theaceae	Lapet	CD
26.	*Garcinia cowa* Roxb. *ex* DC.	Clusiaceae	Kau	LC
27.	*Mesua ferrea* L.	Clusiaceae	Nageshwar	LC
28.	*Elaeocarpus floribundus* Blume, Bijdr.	Elaeocarpaceae	Jalpai	LC
29.	*Pterospermum semisagittatum* Buch.-Ham.*ex* Roxb.	Sterculiaceae	Bara asar	LC
30.	*Sterculia villosa* Roxb.	Sterculiaceae	Udal	LC
31.	*Bombax ceiba* L.	Bombaceae	Simultula	LC
32.	*Ceiba pentandra* (L.) Gaertn.	Bombaceae	Swetshimul	LC
33.	*Barringtonia acutangula* (L.) Gaertn.	Lecythidaceae	Hijal	LC
34.	*Moringa oleifera* Lam.	Moringaceae	Sajna	LC
35.	*Madhuca longifolia* (Koenig) Mac Bride	Sapotaceae	Mohua	NE
36.	*Mimusops elengi* L.	Sapotaceae	Bokul	LC
37.	*Diospyros discolor* Willd.	Ebenaceae	Ragila gab	VU
38.	*Diospyros malabarica* (Desr.) Kostel.	Ebenaceae	Gab	LC
39.	*Maesa ramentacea* (Roxb.) A.DC.	Myrsinaceae	Moricha	LC
40.	*Acacia catechu* (L. f.) Wild.	Mimosaceae	Khair	LC
41.	*Acacia longifolia* (Andrews) Willd.	Mimosaceae	Katalambu	NE
42.	*Acacia mangium* Willd.	Mimosaceae	Mangium	LC
43.	*Albizia lucidor* (Steud.) I.C.Nielsen	Mimosaceae	Silkoroi	VU
44.	*Albizia odoratissimus* (L.f.) Benth.	Mimosaceae	TetuyaKoroi	LC
45.	*Albizia procera* (Roxb.) Benth.	Mimosaceae	Sadakoroi	LC
46.	*Leucaena leucocephala* (Lam.) de Wit	Mimosaceae	Ipil-Ipil	LC
47.	*Paraserianthes falcataria* (L.) I.C.Nielsen	Mimosaceae	Malakana koroi	LC
48.	*Samanea saman* (Jacq.) Merr.	Mimosaceae	Randi koroi	LC
49.	*Xylia xylocarpa* (Roxb.) Taub. Var. *kerrii* (Craib& Hutch.) I.C.Neilsen	Mimosaceae	Lohakat	LC
50.	*Bauhinia variegata* L.	Caesalpiniaceae	Rakta kanchan	LC
51.	*Cassia fistula* L.	Caesalpiniaceae	Bandarlathi	LC
52.	*Delonix regia* (Hook.) Raf.	Caesalpiniaceae	Krishnachura	LC
53.	*Butea monosperma* (Lam.) Taub.	Fabaceae	Palas	LC
54.	*Erythrina fusca* Lour.	Fabaceae	Kantamandar	LC
55.	*Pongamia pinnata* (L.) Pierre	Fabaceae	Koronja	LC
56.	*Pterocarpus indicus* Willd.	Fabaceae	Paduk	LC
57.	*Sesbania grandiflora* (L.) Pers.	Fabaceae	Bokful	LC
58.	*Lagerstroemia speciosa* (L.) Pers.	Lythraceae	Jarul	LC
59.	*Aquilaria agallocha* Roxb.	Thymeleaceae	Agar	LC
60.	*Callistemon citrinus* (Curtis) Skeels	Myrtaceae	Bottle brush	LC

61.	*Psidium guajava* L.	Myrtaceae	Peyara	LC
62.	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jam	LC
63.	*Syzygium fruiticosum* DC.	Myrtaceae	Khudi jam	LC
64.	*Syzygium grande* (Wight.) Walp.	Myrtaceae	Barojam	LC
65.	*Syzygium operculatum* (Roxb.) Nied.	Myrtaceae	Bon jam	LC
66.	*Syzygium syzyzoides* (Miq.) Merr.& L. M. Perry	Myrtaceae	Khari jam	DD
67.	*Terminalia arjuna* (Roxb. *ex* DC.) Wight &Arn.	Combretaceae	Arjun	VU
68.	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Bohera	LC
69.	*Terminalia chebula* Retz.	Combretaceae	Hritoki	LC
70.	*Carallia brachiata* (Lour.) Merr.	Rhizophoraceae	Rascow	LC
71.	*Aporosa wallichii* Hook.f.	Euphorbiaceae	Kokra	NE
72.	*Bridelia tomentosa* Blume	Euphorbiaceae	Patkhoi	LC
73.	*Macaranga peltata* (Roxb.) Mull.Arg.	Euphorbiaceae	Peltatbura	LC
74.	*Macaranga denticulata* (Blume) Mull.Arg.	Euphorbiaceae	Datibura	LC
75.	*Phyllanthus emblica* L.	Euphorbiaceae	Amloki	LC
76.	*Suregada multiflora* (A.Juss.) Baill.	Euphorbiaceae	Ban naranga	NE
77.	*Lepisanthes rubiginosa* (Roxb.) Leenth.	Sapindaceae	Rubiharina	LC
78.	*Lepisanthes senegalensis* (Poir.) Leenth.	Sapindaceae	Gotaharina	LC
79.	*Litchi chinensis* Sonn.	Sapindaceae	Lichu	LC
80.	*Nephelium ramboutan-ake* (Labill.) Leenh.	Sapindaceae	Ramboutan	LC
81.	*Schleichera oleosa* (Lour.) Merr.	Sapindaceae	Kusum	NE
82.	*Anacardium occidentale* L.	Anacardiaceae	Kajubadam	LC
83.	*Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Bhadi	LC
84.	*Magnifera indica* L.	Anacardiaceae	Aam	LC
85.	*Mangifera sylvatica* Roxb.	Anacardiaceae	Jongliaam	VU
86.	*Aphanamixis polystachya* (Wall.) R.Parker	Meliaceae	Pitraj	LC
87.	*Azadirachta indica* A. Juss.	Meliaceae	Nim	LC
88.	*Chukrasia tabularis* A. Juss.	Meliaceae	Chikrassi	LC
89.	*Melia azedarach* L.	Meliaceae	Goranim	LC
90.	*Swietenia macrophylla* King	Meliaceae	Bara mahogany	LC
91.	*Toona ciliate* Roemer	Meliaceae	Surujbet	LC
92.	*Aegle mermelos* (L.) Corr. Serr.	Rutaceae	Bel	LC
93.	*Citrus aurantifolia* (Christm.) Swingle	Rutaceae	Kagagilebu	LC
94.	*Citrus hystrix* DC.	Rutaceae	Satkora	NE
95.	*Averrhoa carambola* L.	Oxalidaceae	Kamranga	LC
96.	*Alstonia macrophylla* Wall. ex G. Don, Gen. Syst.	Apocynaceae	Chatim	NE
97.	*Alstonia scholaris* (L.) R. Br.	Apocynaceae	Chatim	LC
98.	*Holarrhena antidysenterica* (Roxb. *ex* Fleming) Wall.*ex* A.DC.	Apocynaceae	Kurchi	LC
99.	*Holarrhena floribunda* (G. Don) Durand & Schinz	Apocynaceae	Not Known	LC
100.	*Avicennia officinalis* L.	Verbenaceae	Baen	LC
101.	*Gmelina arborea* Roxb.	Verbenaceae	Gamari	LC
102.	*Tectona grandis* L. f.	Verbenaceae	Segun	LC
103.	*Vitex peduncularis* Wall.*ex* Schauer	Verbenaceae	Horina	NE
104.	*Jacaranda mimosifolia* D.Don	Bignoniaceae	Nilkantha	LC
105.	*Oroxylum indicum* (L.) Kurz	Bignoniaceae	Thona	LC
106.	*Spathodea campanulata* Beauv.	Bignoniaceae	African tulip	NE
107.	*Sterospermum colais* (Buch.-Ham.*ex* Dillw.) D. L. Mabberley	Bignoniaceae	Dharmara	NE
108.	*Ravenala madagascariensis* Sonn.	Strelitziaceae	Panthopadop	LC

[CS = Conservation Status; LS = Least concern; NT=Near threatened; VU=Vulnearable; EN=Endangered; DD=Data Deficient; NE=Not evaluated]

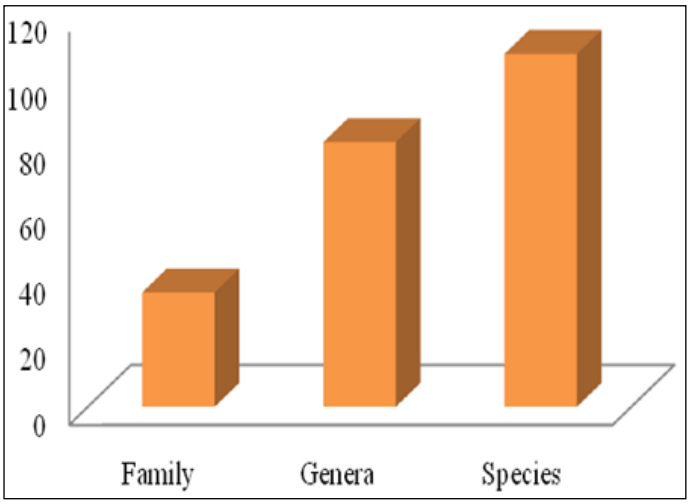

Fig 2: Number of Family, Genera and Species.

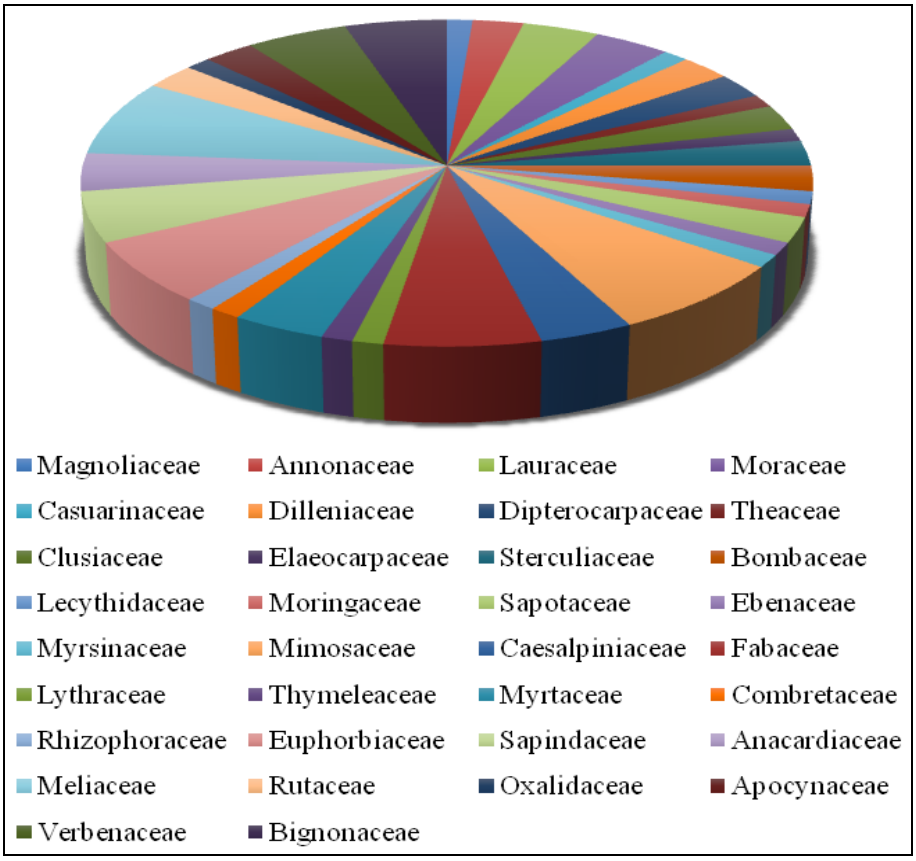

Fig 3: Diversity of species and genus in respect to families (Dicotyledons)

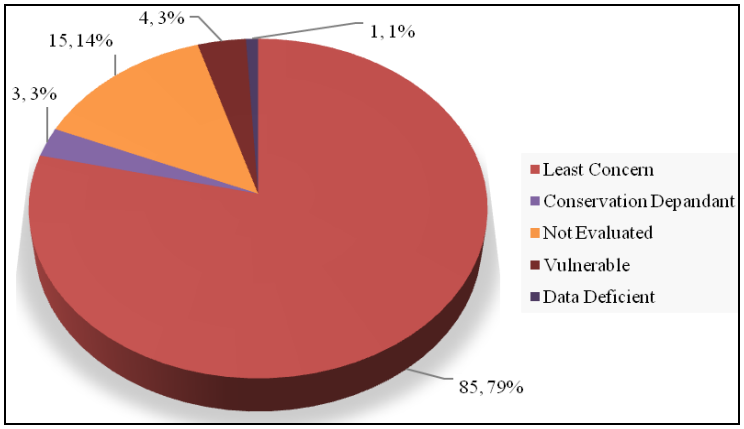

Fig 4: Percentage of status of occurrence.

Conservation status of occurrence

The result figure 4 reveals the occurrence of species; Least concern 85.79% (85 species), Not evaluated 15.14% (15 species), Conservation dependant 3.3% (3 species), Venerable 4.3% (4 species) and Data deficient 1.1% (1 species). Natural forests are diverse in function and form, dynamic and important both economically and ecologically. Careful management of the forest ecosystem will pave the way for sustained use of existing flora but limited forest resources. The present study gives an idea about tree composition and regeneration status in the natural forest of KEPZ, Chattogram. A total of 108 tree species belonging 81 genera under 35 families during the stipulated time. during the study. However, Haider *et al*. [9] recorded 1,051 tree individuals per ha, belonging to 81 species, 59 genera and 33 families from natural forests of Moulvibazar in Sylhet Forest Division. Hossain *et al*. (1997) [13] reported 85 tree species from the Ramu Reserve Forest of Cox's Bazar North Forest Division. In a similar natural forest of Cox's Bazar Forest Division, 215 stems/ha of the tree species was recorded by Haque and Alam [10]. Nath *et al*. [25] found tree density of 381 stems/ha having DBH greater than 10 cm in Sitapahar Reserve Forest of Chittagong Hill Tracts (South) Forest Division while Ahmed and Haque [6] recorded tree density of 257 stems/ha of DBH 10 cm and above from the natural forests of Ukhia Range in Cox's Bazar Forest Division.

Conclusion

This research work has been conducted with a view to assess the diversity of the KEPZ area in Bangladesh. The investigation will be a permanent asset and a guideline for understanding the vegetation of this area and thus it will facilitate the knowledge on the diversity of this area to the stakeholder of the company as well as to meet the aesthetic needs of plant enthusiasts of the world.

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