

Ecological Status in and around Avadhan Industrial Area in Dhule District of Maharashtra, India

Abstract

The ecology and biodiversity of any area is the indicator of that particular area. Increasing population demanding more food and place to sustain, the biodiversity of area can be protected and conserved to better life and sustainability. Rapid industrialization is degrading the local biodiversity, hence it is strongly recommended that the industry set up should be at defined place or notified industrial area viz. MIDC (Maharashtra), GIDC (Gujarat), UPSIDC (Uttar Pradesh), etc.

Keywords: avifauna, biodiversity, industrialization, notified industrial area

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Ashok K Rathoure

M/s Akone Services, Paschim Vihar Colony, Mohan Road, India

Correspondence: Ashok K Rathoure C/O Mr. Gyanendra K Rathoure, Mayashivraj Sadan, Gupta Colony, Hardoi-241001, (UP), India, Tel +91 9450501471, Email asokumr@gmail.com

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Introduction

Peculiarity in the species composition and functioning of ecosystem carried out by anthropogenic activities. The first part to be affected directly as well as indirectly and in a short, medium- and long-term span would be the biotic component of the area.^{1,2} The biological assessment is trustworthy and acceptable method to understand the impact on surroundings. This leads to suggestion of remedial measures for minimizing the anticipated impacts on the ecosystem and living things. The change in biotic community is studied by the pattern in the distribution, abundance and diversity. This peculiarity of plants can be utilized to assess the impacts of ensuring project on flora and fauna of the region, which are important components of biological environment. In this regard, the baseline condition of the study area needs to be studied.^{3,4} As the environment change, species best adapted to that environment becomes predominant. Diversity influences by the nature of the ecosystem. Flora is basically the plant and fauna the animal life that are present in a region or habitat or at a particular time. Flora and fauna form a major part of biodiversity.^{5,6}

The main objectives of the ecology and biodiversity studies in Avadhan Industrial Zone (Maharashtra) and in its surrounding are presented as below:

- To assess the vegetation types, identify the flora and fauna, rare and endangered species.
- To prepare list of flora and fauna of the study area along with classification for fauna as per schedule given in the Wildlife (Protection) Act, 1972.

Methodology

An ecological survey of the study area was conducted particularly with reference to listing of species and assessment of the existing baseline ecological conditions in the study area as per standard protocol⁷⁻²³ and given by Rathoure et. al.²⁴⁻²⁸

Result & discussion

Forest and forest type of study area

Industrial Zone and surrounding area come under dry deciduous and southern thorn forest types.²⁹⁻³¹ Mixed forest consisting of various varieties of species the occurrence of which is considerably influenced by biotic interferences and management. Major tree species occurring

in the forest can be listed as Teak, Anjan, Arjun, Bel, Babul, Khair, Palas, Parijatak etc. Growth of plants quite stunted because of poor soil quality but growth of grasses is abundant in all areas. Major land is covered with scrub forest which is uneconomic and thorny species. Biological environment of the area was studied during the study period. No endangered species have been sighted in the area. No Wildlife Sanctuary, National Park, Biosphere Reserves, Wildlife Corridors exists within study area of 10km radius.³²

Floristic composition

The dominant species in this area are *Acacia catechu*, *Anogeissus latifolia*, *Boswellia serrata*, *Hardwickia binata*, *Ziziphus jujuba* etc. The structure and composition of vegetation in the buffer zone was studied by visual observations during the site visit. The study area is dominated by agricultural fields. Most of the area is covered by active cropping accompanying patches of barren land and grassland in between. The project is in the area which is considered to be dry deciduous zone with geographically having no distinct variation. However, Tapi river and small water bodies comes in 10 km radius and its presence surrounding region is rich in the bird diversity apart from the floral and faunal diversity as compared to other part of the area. The study area has dry and arid type of climate. Most of the area is covered by the agricultural fields with natural vegetation in between. No reserved forest, National Park or any other ecologically sensitive zone like Wildlife Sanctuary is recorded in buffer zone. About the tree vegetation is concerned *Azadirachta indica*, *Acacia nilotica* and *Prosopis juliflora* occur in abundance. Other dominant tree species exhibited by the region are *Acacia leucophlea*, *Albizia lebbek*, *Boswellia serrata*, *Mangifera indica*, *Senna siamea*, *Cassia fistula*, *Tamarindus indicus*, *Ficus bengalensis*, *Ficus racemosa*, *Hardwickia binata*, *Bauhinia racemosa*, *Aegle marmelos*, *Anogeissus latifolia*, *Annona squamosa*, *Bombax ceiba*, *Bougainvillea glabra*, *Butea monosperma*, *Dalbergia sissoo*, *Delonix regia*, *Ficus racemosa*, *Ficus religiosa*, *Mangifera indica*, *Peltophorum pterocarpum* and many others.³³⁻³⁵

Some of the plants introduced by human beings, agencies either as ornamentals, fruits, vegetable sources or merely as the curiosities. Barren and grassy land show the occurrence of *Justicia adathoda*, *Calotropis procera*, *Agave americana*, *Euphorbia tirucali*, *Nerium pulchellum*, *Argemone mexicana*, *Lantana camara*, *Gymnosporia montana*, *Ricinus communis*, etc. grasses are found in abundance, particularly during rainy season. The list of plant species recorded during primary survey listed in Table 1 & Figure 1.

Table I List of plant species recorded in study area

S.No.	Scientific name	Vernacular name	Family
Climbers			
1.	<i>Combretum indicum</i> (L.) DeFilipps	Madhumalati	Combretaceae
2.	<i>Ipomoea carnea</i> Jacq.	Besharam	Convolvulaceae
3.	<i>Cucumis prophetarum</i> L.	Wild kakadi	Cucurbitaceae
4.	<i>Cucumis sativus</i> L.	Wild kakadi	Cucurbitaceae
5.	<i>Mukia maderaspatana</i> (L.) M.Roem.	Bilavi	Cucurbitaceae
6.	<i>Trichosanthes dioica</i> Roxb.	Padval	Cucurbitaceae
7.	<i>Abrus precatorius</i> L.	Gunj	Fabaceae
8.	<i>Acacia concinna</i> (Willd.) DC.	Shikakai	Fabaceae
9.	<i>Caesalpinia sepiaria</i>	Chilar	Fabaceae
10.	<i>Cocculus hirsutus</i> (L.) W.Theob.	Vasanvel	Menispermaceae
11.	<i>Tinospora sinensis</i> (Lour.) Merr.	Gulvel	Rubiaceae
Herbs			
12.	<i>Celosia argentea</i> L.	Kurdu	Acanthaceae
13.	<i>Barleria cristata</i> L.	Koranti	Acanthaceae
14.	<i>Justicia procumbens</i> L.	Karambal	Acanthaceae
15.	<i>Amaranthus spinosus</i> L.	Katemath	Amaranthaceae
16.	<i>Achyranthes aspera</i> L.	Chirchita	Amaranthaceae
17.	<i>Aerva lanata</i> (L.) Juss.	Kapurmadhuri	Amaranthaceae
18.	<i>Hemidesmus indicus</i> (L.)	Karala	Apocynaceae
19.	<i>Agave americana</i> L.	Agave	Asperagaceae
20.	<i>Ageratum conyzoides</i> (L.) L.	Ghanera osadi	Asteraceae
21.	<i>Blumea lacera</i> (Burm.f.) DC.	Bamurda	Asteraceae
22.	<i>Emilia sonchifolia</i> (L.) DC.	Sadamandee	Asteraceae
23.	<i>Spilanthes acmella</i> (L.) L.	Akkalkara	Asteraceae
24.	<i>Synedrella nodiflora</i> (L.) Gaertn.	Pig grass	Asteraceae
25.	<i>Tridax procumbens</i>	Dagadful	Asteraceae
26.	<i>Parthenium hysterophorus</i> L.	Gajar grass	Asteraceae
27.	<i>Tribulus terrestris</i> L.	Gokharu	Boraginaceae
28.	<i>Brassica rapa</i> L.	Mohari	Brassicaceae
29.	<i>Cleome viscosa</i> L.	Tilvan	Capparaceae
30.	<i>Cyperus alternifolius</i> L.		Cyperaceae
31.	<i>Croton bonplandianus</i> Baill.	Ban Tulasi	Euphorbiaceae
32.	<i>Euphorbia hirta</i> L.	Dudhi	Euphorbiaceae
33.	<i>Euphorbia tirucalli</i> L.		Euphorbiaceae
34.	<i>Phyllanthus niruri</i> L.	Bhui Awala	Euphorbiaceae
35.	<i>Senna tora</i> (L.) Roxb.	Vala	Fabaceae
36.	<i>Senna auriculata</i> (L.) Roxb.	Tarvad	Fabaceae
37.	<i>Crotalaria filiceps</i>	Khulkhula	Fabaceae
38.	<i>Desmodium triflorum</i> (L.) DC.	Chipti	Fabaceae
39.	<i>Eichhornia crassipes</i> (Mart.) Solms	Jalparni	Hydranthaceae
40.	<i>Ocimum gratissimum</i> L.	Van tulasi	Lamiaceae
41.	<i>Sida acuta</i> Burm.f.	Chikna	Malvaceae
42.	<i>Urena lobata</i> L.	Van bhendi	Malvaceae
43.	<i>Mimosa pudica</i> L.	Lajalu	Mimosaceae
44.	<i>Boerhavia diffusa</i> L.	punarnava	Nyctaginaceae
45.	<i>Ludwigia prostrata</i> Roxb.	Primerose	Onagraceae
46.	<i>Oxalis stricta</i> L.	Oxalis	Oxalidaceae
47.	<i>Argemone mexicana</i> L.	Mexican poppy	Papaveraceae

Table continued...

S.No.	Scientific name	Vernacular name	Family
48.	<i>Arundinella pumila</i> (Hochst.) Steud.	Grass	Poaceae
49.	<i>Chloris barbata</i> Sw.	Gondvel tan	Poaceae
50.	<i>Cynodon dactylon</i> (L.) Pers.	Harali	Poaceae
51.	<i>Dendrocalamus strictus</i> (Roxb.) Nees	Bamboo	Poaceae
52.	<i>Dichanthium annulatum</i> (Forssk.) Stapf	Grass	Poaceae
53.	<i>Heteropogon contortus</i> (L.)	Grass	Poaceae
54.	<i>Imperata cylindrica</i> (L.) Raeusch.	Grass	Poaceae
55.	<i>Cenchrus ciliaris</i> L.	Buffle grass	Poaceae
56.	<i>Melinis repens</i> (Willd.) Zizka	Grass	Poaceae
57.	<i>Saccharum spontaneum</i> L.	Wild sugarcane	Poaceae
58.	<i>Zea mays</i> L.	Makka	Poaceae
59.	<i>Persicaria glabra</i> (Willd.)	Sheral	Polygonaceae
60.	<i>Portulaca oleracea</i> L.	Parslane	Portulacaceae
61.	<i>Solanum americanum</i> Mill.	Wild bringle	Solanaceae
62.	<i>Solanum xanthocarpum</i> Mill.	Wild bringle	Solanaceae
63.	<i>Solanum virginianum</i> L.	Wild bringle	Solanaceae
64.	<i>Triumfetta rhomboidea</i> Jacq.	Nichardi	Tiliaceae
65.	<i>Typha angustifolia</i> L.	Paankanis	Typhaceae
66.	<i>Aloe vera</i> (L.) Burm.f.	Korphad	Xanthorrhoeaceae
Shrubs			
67.	<i>Nerium oleander</i> L.	Kanher	Apocynaceae
68.	<i>Calotropis gigantea</i> (L.) Dryand.	Rui	Asclepiadaceae
69.	<i>Calotropis procera</i> (Aiton) Dryand.	Mandera	Asclepiadaceae
70.	<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	Eupatorium	Asteraceae
71.	<i>Xanthium strumarium</i> L.	Ghagara	Asteraceae
72.	<i>Tecoma stans</i> (L.) Juss. ex Kunth	Ghantiful	Bignoniaceae
73.	<i>Caesalpinia pulcherrima</i> (L.) Sw.	Shankhasur	Caesalpiniaceae
74.	<i>Gymnosporia spinosa</i> (Forsk) Flori.	Henkal	Celastraceae
75.	<i>Ricinus communis</i> L.	Arandi	Euphorbiaceae
76.	<i>Calliandra haematocephala</i> Hassk.	Red powder puff	Fabaceae
77.	<i>Hyptis suaveolens</i> (L.) Poit.	Darp Tulas	Lamiaceae
78.	<i>Lawsonia inermis</i> L.	Mehandi	Lythraceae
79.	<i>Abutilon indicum</i> (L.) Sweet	Petari	Malvaceae
80.	<i>Hibiscus rosa-sinensis</i> L.	Jaswand	Malvaceae
81.	<i>Bougainvillea spectabilis</i> Willd.	Boganvel	Nyctaginaceae
82.	<i>Duranta erecta</i> L.	Golden duranta	Verbenaceae
83.	<i>Lantana camara</i> L.	Tantani	Verbenaceae
84.	<i>Vitex negundo</i> L.	Nirgudi	Verbenaceae
Tree			
85.	<i>Justicia adhatoda</i> L.	Adulasa	Acanthaceae
86.	<i>Mangifera indica</i> L.	Amba	Anacardiaceae
87.	<i>Annona reticulata</i> L.	Ramfal	Annonaceae
88.	<i>Annona squamosa</i> L.	Sitafal	Annonaceae
89.	<i>Polyalthia longifolia</i>	Ashok	Annonaceae
90.	<i>Alstonia scholaris</i> (L.) R. Br.	Saptparni	Apocynaceae
91.	<i>Plumeria alba</i> L.	Chafa	Apocynaceae
92.	<i>Cocos nucifera</i> L.	Naral	Arecaceae
93.	<i>Spathodea campanulata</i> P.Beauv.	Pichakari	Bignoniaceae
94.	<i>Millingtonia hortensis</i> L.f	Bhuchache zad	Bignoniaceae
95.	<i>Bombax ceiba</i> L.	Katesawar	Bombacaceae

Table continued...

S.No.	Scientific name	Vernacular name	Family
96.	<i>Cordia dichotoma</i> G.Forst.	shelu	Boraginaceae
97.	<i>Boswellia serrata</i> Roxb.	Salai	Burseraceae
98.	<i>Peltophorum pterocarpum</i>	Tambat sheng	Caesalpinaceae
99.	<i>Carica papaya</i> L.	Papaya	Caricaceae
100.	<i>Gymnosporia montana</i> (Roth) Benth.	Mountain spike	Celastraceae
101.	<i>Terminalia arjuna</i>	Arjun	Combretaceae
102.	<i>Terminalia catappa</i> L.	Badam	Combretaceae
103.	<i>Phyllanthus emblica</i> L.	Awala	Euphorbiaceae
104.	<i>Cassia fistula</i> L.	Bahava	Fabaceae
105.	<i>Delonix regia</i> (Hook.) Raf.	Gulmohar	Fabaceae
106.	<i>Acacia auriculiformis</i> Benth.	Australian babul	Fabaceae
107.	<i>Acacia catechu</i> (L.f.) Willd.	Khair	Fabaceae
108.	<i>Acacia leucophloea</i> (Roxb.) Willd.	Pandhara khair	Fabaceae
109.	<i>Acacia nilotica</i> (L.) Delile	Babul	Fabaceae
110.	<i>Bauhinia purpurea</i> L.	Kanchan	Fabaceae
111.	<i>Bauhinia racemosa</i> Lam.	Apta	Fabaceae
112.	<i>Butea monosperma</i> (Lam.) Taub.	Palas	Fabaceae
113.	<i>Senna siamea</i> (Lam.)	Kashid	Fabaceae
114.	<i>Dalbergia latifolia</i> Roxb.	Sisam	Fabaceae
115.	<i>Dalbergia sissoo</i> DC.	Sisoo	Fabaceae
116.	<i>Gliricidia sepium</i> (Jacq.) Walp.	Undirmari	Fabaceae
117.	<i>Hardwickia binata</i> Roxb.	Ajan	Fabaceae
118.	<i>Leucaena latisiliqua</i> (L.)	Subabul	Fabaceae
119.	<i>Pithecellobium dulce</i> (Roxb.) Benth.	Vilayati chinch	Fabaceae
120.	<i>Pongamia pinnata</i> (L.) Pierre	Karanj	Fabaceae
121.	<i>Prosopis juliflora</i> (Sw.) DC.	Shami	Fabaceae
122.	<i>Tamarindus indica</i> L.	Chinch	Fabaceae
123.	<i>Lagerstroemia speciosa</i> (L.) Pers.	Taman	Lythraceae
124.	<i>Punica granatum</i> L.	Dalimb	Lythraceae
125.	<i>Thespesia populnea</i> (L.)	Bhend	Malvaceae
126.	<i>Azadirachta indica</i> A.Juss.	Neem	Meliaceae
127.	<i>Melia azedarach</i> L.	Bakan neem	Meliaceae
128.	<i>Albizia lebeck</i> (L.) Benth.	Shirish	Mimosaceae
129.	<i>Albizia procera</i> (Roxb.) Benth.	Safed Shirish	Mimosaceae
130.	<i>Albizia saman</i> (Jacq.) Merr.	Rain tree	Mimosaceae
131.	<i>Ficus amplissima</i> Sm.	Pimpran	Moraceae
132.	<i>Ficus benghalensis</i> L.	wad	Moraceae
133.	<i>Ficus racemosa</i> L.	Umber	Moraceae
134.	<i>Ficus religiosa</i> L.	Pimpal	Moraceae
135.	<i>Muntingia calabura</i> L.	Singapore cherry	Muntingiaceae
136.	<i>Eucalyptus tereticornis</i> Sm.	Nilgiri	Myrtaceae
137.	<i>Psidium guajava</i> L.	Peru	Myrtaceae
138.	<i>Syzygium cumini</i> (L.) Skeels	Jambhul	Myrtaceae
139.	<i>Nyctanthes arbor-tristis</i> L.	Parijatak	Oleaceae
140.	<i>Ziziphus jujuba</i> Mill.	Ber	Rhamnaceae
141.	<i>Neolamarckia cadamba</i>	Kadamb	Rubiaceae
142.	<i>Morinda citrifolia</i> L.	Bartondi	Rubiaceae
143.	<i>Aegle marmelos</i> (L.) Corrêa	Bel	Rutaceae
144.	<i>Citrus limon</i> (L.) Osbeck	Lemon	Rutaceae
145.	<i>Santalum album</i> L.	Chandan	Santalaceae
146.	<i>Manilkara zapota</i> (L.) P.Royen	Chiku	Sapotaceae
147.	<i>Ailanthus excelsa</i> Roxb.	Maharukh	Simaroubaceae
148.	<i>Grewia tiliifolia</i> Vahl	Dhaman	Tiliaceae
149.	<i>Tectona grandis</i> L.f.	Teak	Verbenaceae



Figure 1 Glimpses of plant species in the study area.

Faunal diversity

Faunal diversity studied during field visit and categorised as per the respective groups and occurrence as well. Tapti river is closer to Avadhan industrial area (within 10km radius) and good diversity of bird species has been observed.

Odonates: Dragonflies and damselflies play key roles in both terrestrial and aquatic habitats. They are predators as both nymphs and adults, feeding on a variety of prey including nuisance species such as mosquitoes and biting flies. They can be indicators of different biotypes and habitats and have been used as tools to assess the biological health of aquatic habitats and to detect levels of heavy

metals such as mercury. They are also considered model organisms to assess the effects of global climate change (Table 2).

Table 2 Odonate species

S. No.	Scientific name	Common name	Family
1.	<i>Branchythemis contaminata</i>	Ditch Jewel	Libellulidae
2.	<i>Diplacodes trivialis</i>	Ground Skimmer	Libellulidae
3.	<i>Tramea basilaris</i>	Red Marsh Trotter	Libellulidae
4.	<i>Trithemis aurora</i>	Crimson Marsh Glider	Libellulidae
5.	<i>Anax guttatus</i>	Blue Tailed Green Darner	Aeshnidae
6.	<i>Ictinogomphus rapax</i>	Common clubtail	Gomphidae
7.	<i>Ischura aurora</i>	Golden dartlet	Coenagrionidae
8.	<i>Ischura senegalensis</i>	Senegal golden dartlet	Coenagrionidae

Beetles: Beetles are important biological control agents of aphids and scale insects and useful as decomposers and recyclers of organic nutrients also. Seven species of beetles (Table 3) found during faunal survey from 3 families of which Coccinellinae is more dominant family.

Table 3 Beetle species

S. No.	Scientific name	Family
1.	<i>Altica sp.</i>	Chrysomelidae
2.	Leaf beetle	Chrysomelidae
3.	<i>Harmonia octomaculata</i>	Coccinellinae
4.	<i>Coccinella transversalis</i>	Coccinellinae
5.	<i>Hycleus polymorphus</i>	Meloidae
6.	<i>Psyllobora sp.</i>	Coccinellinae
7.	<i>Illeis sp.</i>	Coccinellinae

Bugs: Insects are crucial components of many ecosystems, where they perform many important functions. They aerate the soil, pollinate blossoms and control insect and plant pests. As decomposers, insects help create topsoil, the nutrient-rich layer of soil that helps plants grow. Without insects to help break down and dispose of wastes, dead animals and plants would accumulate in our environment and it would be messy indeed. Insects are underappreciated for their role in the food web. They are the sole food source for many amphibians, reptiles, birds, and mammals. Seven bugs (Table 4) were recorded during survey. *Chrysocoris sp.* also known as Jewel bug was most common insect found during survey especially on weed Croton sp., which is host plant for this bug.

Table 4 List of bugs

S. No.	Scientific name	Family
1.	<i>Leptocoris sp.</i>	Alydidae
2.	<i>Homoeocerus sp.</i>	Coreidae
3.	<i>Nezara viridula</i>	Pentatomidae
4.	<i>Riptortus sp.</i>	Alydidae
5.	<i>Cofana sp.</i>	Cicadellidae
6.	<i>Scutellera sp.</i>	Scutelleridae
7.	<i>Chrysocoris sp.</i>	Scutelleridae

Butterflies: Ecosystem value. Butterflies and moths are indicators of a healthy environment and healthy ecosystems. They indicate a wide range of other invertebrates, which comprise over two-thirds of all species. These collectively provide a wide range of environmental benefits, including pollination and natural pest control. Total 23 species of butterflies found during the survey (Table 5 & Figure 2).

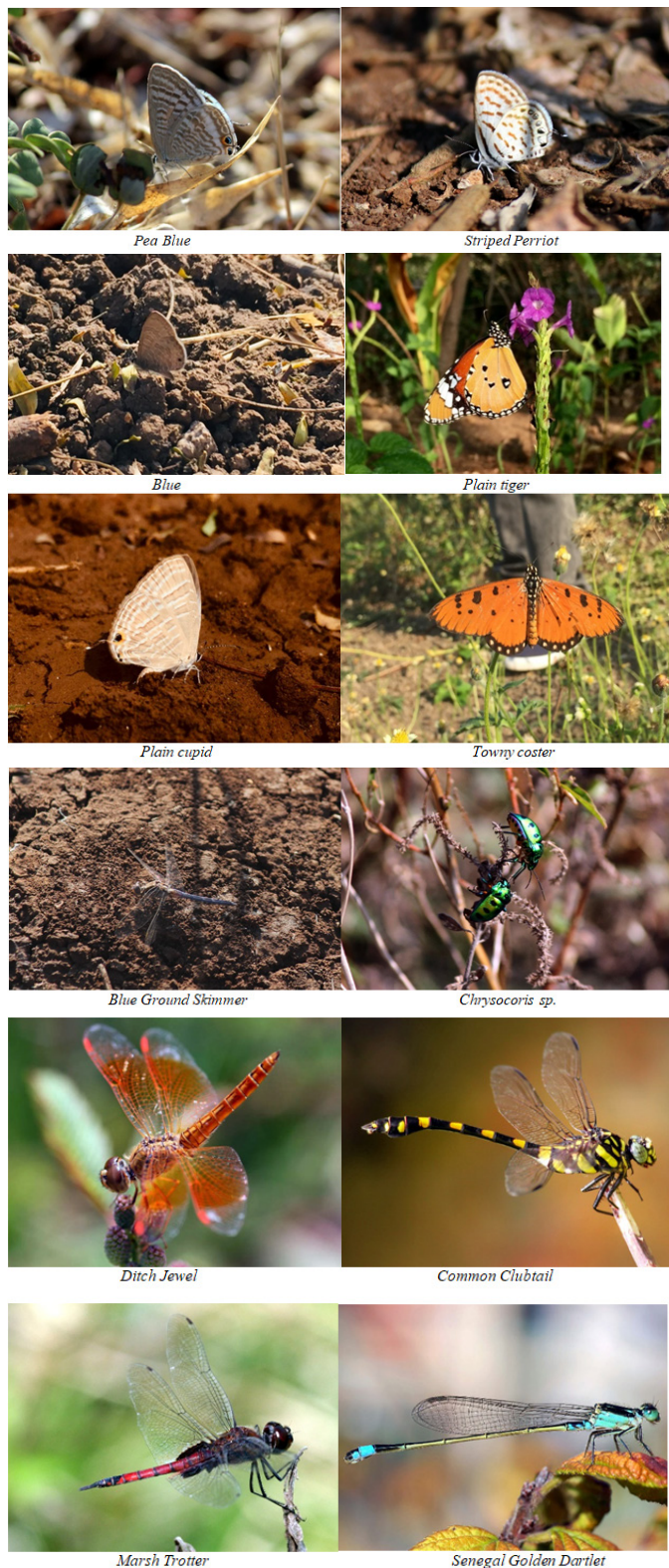


Figure 2 Glimpses of fauna species in study area.

Table 5 List of butterflies in study area

S. No	Scientific name	Common name	Family
1.	<i>Borbo cinnara</i>	Rice swift	<i>Hesperiidae</i>
2.	<i>Castalius rosimon</i>	Common pierrot	<i>Lycaenidae</i>
3.	<i>Pseudo zizeeria</i>	Grass blue	<i>Lycaenidae</i>
4.	<i>Lampides boeticus</i>	Pea blue	<i>Lycaenidae</i>
5.	<i>Melanitis leda</i>	Evening brown	<i>Nymphalidae</i>
6.	<i>Acraea violae</i>	Tawny coster	<i>Nymphalidae</i>
7.	<i>Phalanta phalantha</i>	Common leopard	<i>Nymphalidae</i>
8.	<i>Neptis hylas</i>	Common sailor	<i>Nymphalidae</i>
9.	<i>Danaus chrysippus</i>	Plain tiger	<i>Nymphalidae</i>
10.	<i>Euploea core</i>	Common crow	<i>Nymphalidae</i>
11.	<i>Parantica aglea</i>	Glassy tiger	<i>Nymphalidae</i>
12.	<i>Junonia lemonias</i>	Lemon pansy	<i>Nymphalidae</i>
13.	<i>Junonia orithya</i>	Blue pansy	<i>Nymphalidae</i>
14.	<i>Precis iphita</i>	Chocolate pansy	<i>Nymphalidae</i>
15.	<i>Hypolimnas misippus</i>	Donaid eggfly	<i>Nymphalidae</i>
16.	<i>Pachliopta aristolochiae</i>	Common rose	<i>Papilionidae</i>
17.	<i>Pachliopta hector</i>	Crimson rose	<i>Papilionidae</i>
18.	<i>Graphium Agamemnon</i>	Tailed jay	<i>Papilionidae</i>
19.	<i>Papilio demoleus</i>	Lime butterfly	<i>Papilionidae</i>
20.	<i>Catopsilia Pomona</i>	Common Emigrant	<i>Pieridae</i>
21.	<i>Eurema hecabe</i>	Common grass yellow	<i>Pieridae</i>
22.	<i>Cepora nerissa</i>	Common gull	<i>Pieridae</i>
23.	<i>Ixias marianne</i>	Orange tip	<i>Pieridae</i>

Avifauna: As with other native organisms, birds help maintain sustainable population levels of their prey and predator species and, after death, provide food for scavengers and decomposers. Many birds are important in plant reproduction through their services as pollinators or seed dispersers. The bird species were mostly observed around Tapti river, agriculture fields and human habitation (Table 6 & Figure 3).

Table 6 List of Avifauna

S. No.	Scientific name	Common name	Family
1.	<i>Elanus caeruleus</i>	Black-winged Kite	<i>Accipitridae</i>
2.	<i>Falco tinnunculus</i>	Common Kestrel	<i>Falconidae</i>
3.	<i>Accipiter badius</i>	Shikra	<i>Accipitridae</i>
4.	<i>Milvus migrans</i>	Black Kite	<i>Accipitridae</i>
5.	<i>Acrocephalus dumetorum</i>	Blyth's Reed Warbler	<i>Acrocephalidae</i>
6.	<i>Acrocephalus stentoreus</i>	Clamorous Reed Warbler	<i>Acrocephalidae</i>
7.	<i>Aegithina tiphia</i>	Common lora	<i>Aegithinidae</i>
8.	<i>Alcedo atthis</i>	Common Kingfisher	<i>Alcedinidae</i>
9.	<i>Halcyon smyrnensis</i>	White-throated Kingfisher	<i>Alcedinidae</i>

Table continued...

S. No.	Scientific name	Common name	Family				
10.	<i>Ceryle rudis</i>	Pied Kingfisher	Alcedinidae	44.	<i>Turdoides caudata</i>	Common Babbler	Leiothrichidae
11.	<i>Tadorna ferruginea</i>	Ruddy Shelduck	Anatidae	45.	<i>Turdoides striata</i>	Jungle Babbler	Leiothrichidae
12.	<i>Anas poecilorhyncha</i>	Indian Spot-billed Duck	Anatidae	46.	<i>Psilopogon haemacephalus</i>	Coppersmith Barbet	Megalaimidae
13.	<i>Apus affinis</i>	Little Swift	Apodidae	47.	<i>Merops orientalis</i>	Green Bee-eater	Meropidae
14.	<i>Cypsiurus balasiensis</i>	Asian Palm-Swift	Apodidae	48.	<i>Motacilla cinerea</i>	Gray Wagtail	Motacillidae
15.	<i>Ardea cinerea</i>	Gray Heron	Ardeidae	49.	<i>Motacilla flava</i>	Western Yellow Wagtail	Motacillidae
16.	<i>Ardea intermedia</i>	Intermediate Egret	Ardeidae	50.	<i>Motacilla maderaspatensis</i>	White-browed Wagtail	Motacillidae
17.	<i>Egretta garzetta</i>	Little Egret	Ardeidae	51.	<i>Motacilla alba</i>	White Wagtail	Motacillidae
18.	<i>Bubulcus ibis</i>	Cattle Egret	Ardeidae	52.	<i>Copsychus fulicatus</i>	Indian Robin	Muscicapidae
19.	<i>Ardeola grayii</i>	Indian Pond-Heron	Ardeidae	53.	<i>Copsychus saularis</i>	Oriental Magpie-Robin	Muscicapidae
20.	<i>Ocyrceros birostris</i>	Indian Gray Hornbill	Bucerotidae	54.	<i>Phoenicurus ochruros</i>	Black Redstart	Muscicapidae
21.	<i>Vanellus malabaricus</i>	Yellow-wattled Lapwing	Charadriidae	55.	<i>Monticola solitarius</i>	Blue Rock-Thrush	Muscicapidae
22.	<i>Vanellus indicus</i>	Red-wattled Lapwing	Charadriidae	56.	<i>Saxicola maurus</i>	Siberian Stonechat	Muscicapidae
23.	<i>Anastomus oscitans</i>	Asian Openbill	Ciconiidae	57.	<i>Saxicola caprata</i>	Pied Bushchat	Muscicapidae
24.	<i>Orthotomus sutorius</i>	Common Tailorbird	Cisticolidae	58.	<i>Leptocoma zeylonica</i>	Purple-rumped Sunbird	Nectariniidae
25.	<i>Prinia socialis</i>	Ashy Prinia	Cisticolidae	59.	<i>Cinnyris asiaticus</i>	Purple Sunbird	Nectariniidae
26.	<i>Prinia inornata</i>	Plain Prinia	Cisticolidae	60.	<i>Pericrocotus cinnamomeus</i>	Small Minivet	Oriolidae
27.	<i>Columba livia</i>	Rock Pigeon	Columbidae	61.	<i>Oriolus kundoo</i>	Indian Golden Oriole	Oriolidae
28.	<i>Streptopelia senegalensis</i>	Laughing Dove	Columbidae	62.	<i>Passer domesticus</i>	House Sparrow	Passeridae
29.	<i>Coracias benghalensis</i>	Indian Roller	Coraciidae	63.	<i>Microcarbo niger</i>	Little Cormorant	Phalacrocoracidae
30.	<i>Corvus splendens</i>	House Crow	Corvidae	64.	<i>Coturnix coturnix</i>	Common Quail	Phasianidae
31.	<i>Centropus sinensis</i>	Greater Coucal	Cuculidae	65.	<i>Ploceus philippinus</i>	Baya Weaver	Ploceidae
32.	<i>Eudynamis scolopaceus</i>	Asian Koel	Cuculidae	66.	<i>Psittacula eupatria</i>	Alexandrine Parakeet	Psittaculidae
33.	<i>Cuculus canorus</i>	Common Cuckoo	Cuculidae	67.	<i>Psittacula krameri</i>	Rose-ringed Parakeet	Psittaculidae
34.	<i>Dicrurus macrocerus</i>	Black Drongo	Dicruridae	68.	<i>Pycnonotus cafer</i>	Red-vented Bulbul	Pycnonotidae
35.	<i>Euodice malabarica</i>	Indian Silverbill	Estrildidae	69.	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	Pycnonotidae
36.	<i>Lonchura punctulata</i>	Scaly-breasted Munia	Estrildidae	70.	<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	Rallidae
37.	<i>Ptyonoprogne concolor</i>	Dusky Crag-Martin	Hirundinidae	71.	<i>Himantopus himantopus</i>	Black-winged Stilt	Recurvirostridae
38.	<i>Hirundo rustica</i>	Barn Swallow	Hirundinidae	72.	<i>Rhipidura aureola</i>	White-browed Fantail	Rhipiduridae
39.	<i>Hirundo smithii</i>	Wire-tailed Swallow	Hirundinidae	73.	<i>Actitis hypoleucos</i>	Common Sandpiper	Scolopacidae
40.	<i>Cecropis daurica</i>	Red-rumped Swallow	Hirundinidae	74.	<i>Athene brama</i>	Spotted Owlet	Strigidae
41.	<i>Tephrodornis pondicerianus</i>	Common shrike	Laniidae	75.	<i>Sturnia pagodarum</i>	Brahminy Starling	Sturnidae
42.	<i>Lanius vittatus</i>	Bay-backed Shrike	Laniidae	76.	<i>Acridotheres tristis</i>	Common Myna	Sturnidae
43.	<i>Lanius schach</i>	Long-tailed Shrike	Laniidae	77.	<i>Threskiornis melanocephalus</i>	Black-headed Ibis	Threskiornithidae
				78.	<i>Upupa epops</i>	Common Hoopoe	Upupidae

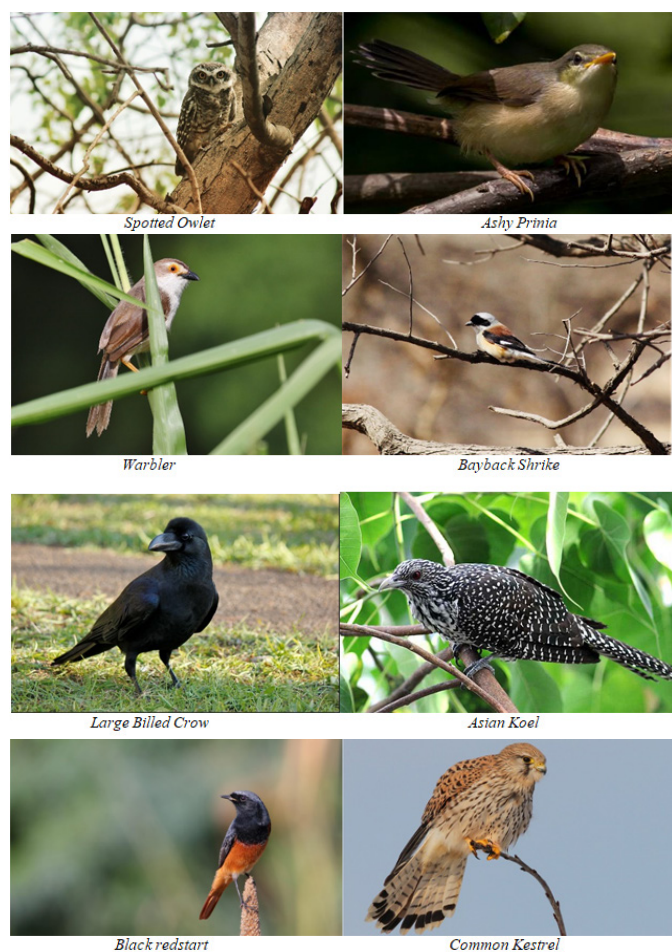


Figure 3 Glimpses of avi-fauna species in study area.

Mammals: Faunal assessment provides a basis for determining relative abundance and rarity of each species which is important for assessing the diversity of fauna of an area. Since animals are capable of movements from one place to another, this makes their study entirely different. Different animals prefer different types of habitat for food and shelter. There was no major physical sighting of large mammals during biodiversity study other than domestic mammals' viz. cow, buffalo, cat, stray dogs, goat etc. During the field studies some tracks and signs Indian Hare (*Lepus nigricollis*) and domesticated animals were observed in the study area (Table 7).

The Industrial development is associated with both positive and negative impacts on the environment. The strong Environmental Management Plan (EMP) should be prepared for the industrial area to minimize negative impacts and is formed on the basis of prevailing environmental conditions and likely impacts of manufacturing activity on various environmental parameters. EMP will also facilitate monitoring of environmental parameters. Preparation of Environmental Management Plan is required for the formulation, implementation and monitoring of environmental protection measures. EMP should include schemes for proper and scientific treatment and disposal mechanism for air, liquid and solid hazardous pollutants. Apart from this, green belt development, safety aspect of the workers, noise control, fire protection etc. should also include in it. Adequate budgetary provisions should be made by proponent/investor. The management for execution of environmental management plans should be framed. The detailed capital and recurring (per annum)

budget should be earmarked for pollution control/monitoring equipment; operation and maintenance of pollution control facilities. A strong EMP will manage almost the negative impacts of any industrial activity.^{36,37}

Conclusion

Based on primary survey, total 149 plants species have been recorded, out of which 65 tree species, 18 shrubs species and 55 herbs and 11 climber species are identified in entire study area. Total 8 species of odonates, 7 species of bugs and 7 species of beetles have been reported during entire field visit from different habitats on project site. Total 23 species of butterflies found during the field survey which shows greater diversity of butterflies. Total 78 bird species were recorded in the study area, most of them around the water bodies and grassland. Mammals observed during field survey were 8 species which are mostly common, no threatened taxa have been reported from Avadhan industrial Zone (Notified Industrial Area). An effective environmental management plan is recommended for industrial area to negate the environmental pollution.

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Conflicts of interest

The author declares there is no conflict of interest.

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