



THE IMPACT OF NEWLY ESTABLISHED BANGALORE INTERNATIONAL AIRPORT (BIA) ON LOCAL BIODIVERSITY

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Abstract

The Impact study on Establish of Bangalore International Airport on Biodiversity was conducted. In this study, we assessed the diversity parameters of Birds and Butterflies in correspond to establishment of International Airport in Devanahalli covering different locations. During the study, totally 65 bird species and 26 butterflies species were recorded. The overall result shows that there is rich diversity of birds and butterflies community in the locations than that of proximal to airport. The present study establish a lesson for future conservation of few birds and butterfly communities.

Key Words: *bird, butterflies, species, diversity.*

Introduction

Expansion of human settlements, increased land fragmentation and depletion of water resources result in decline of plant and animal species (Robinson and Quinn, 1988). Urbanization is one of the most extreme and rapidly growing anthropogenic pressures on the natural world. Urban development has led to substantial fragmentation of areas of natural habitat, resulting in significant impacts on biodiversity and disruptions to ecological processes (Christie and Hochuli, 2005). The association of biodiversity and urban ecosystems has usually concerned the impact of urbanization on biodiversity. However, biodiversity concepts can easily be applied to the urban ecosystem itself. As more and more people live in cities, restoration, preservation and enhancement of biodiversity in urban areas become important. Enhancement of biodiversity in urban ecosystems can have a positive impact on the quality of life and education of urban dwellers and thus facilitate the preservation of biodiversity in natural ecosystems (Sudhira *et al.*, 2007).

Biodiversity will certainly be impacted due to the establishment of BIA. The impacts of BIA will be much (25 sq km) beyond the boundary of the BIA, affecting the landscapes and the lives of the inhabitants. The key impacts include air pollution, biodiversity impacts, noise, traffic, water and light pollution, disturbances of landscape, wetlands, employment and economic changes. Important biological causes for the loss of biological diversity include the loss of habitats, introduction of exotic species, over-harvesting of biodiversity resources, and homogenization of species in agriculture. The common factor of all these elements is that they are human-driven through the process of urbanization resulting in extinction of species as causing the impact on biodiversity (Mc. Kinney, 2006). The effects of urbanization on native and introduced biota in developing countries are poorly known and the scarce evidence that exists tends to focus on the effects with regards to specific taxa in particular situations.

Air traffic results in air pollution (Rich and Longcore, 2006). The consequences of air pollution to biota and resulting impacts on Biodiversity are not clearly known; only fragmentary information may be available. Because of the complexity and variability of conservation resources, the significance of any loss of plant or animal species and agricultural resources and practices can be determined by an assessment.

Materials and Methods

Study area (Fig.1), Devanahalli is located in south eastern part of Karnataka and very much near to Bengaluru city at a distance of 40 kms from on Bengaluru-hyderabad National Highway (NH 7 & 207), at Latitude 13° 23' N and Longitude 77° 7' E, and comes under Bengaluru Rural District. Devanahalli is 1000 m AMSL (Plate.1). Six locations were considered for the study.



Fig 1 Study location

Considering or deciding the biodiversity elements to be studied is very critical in any impact studies and developmental activities. The targeted biodiversity elements should depict or represent the whole biodiversity sphere and justify the worthiness of impact study. Lawton *et al* (1998) and Christian *et al* (2004) have suggested that the birds and butterflies act as flagship species and good indicators of biodiversity loss and used frequently in biodiversity studies. Birds are suggested as good indicators, as habitat loss through intensification and specialization result in the significant decline in their populations (Donald *et al.*, 2001). Butterfly species richness and abundance can be used as an indicator, as they are sensitive to changes in habitat quality (Collinge *et al.*, 2003). Both these biodiversity elements are comparatively easy to observe, identify and also easy for rapid monitoring in the field. Hence in the present study, birds and butterflies were selected for impact study.

Birds

The birds were observed through a pair of 8 x10 binoculars along a each direction of the airport and all species and individuals of birds sighted for an hour were recorded. Hour count method was adopted both in the morning and evening. A slow walk along a path of open stretch of land in each direction for an hour with binoculars constituted a count; the birds were recorded at monthly intervals from March 2009 to March 2010. The birds were identified with the help of ornithologist and the Hand book of Indian birds by Salim Ali (2003).

Butterflies

Butterfly species composition and relative abundances are sampled using transect counts, modified from Pollard (1977). Transect routes are established as appropriate for each site, typically including distinct segments near the base of a sloped habitat, mid-slope, and along ridge tops. Butterflies were observed within a 5 meter band on both sides of a transect, while walking at a slow and steady pace. Species identifications were made visually, using binoculars when needed. Transects are walked during midday hours (1000–1500) on at least one day during each month in the sampling period of one year. Sampling was restricted to relatively calm conditions and times. The hand net was swept to and fro strokes over plant canopy and butterflies collected were identified. The butterflies after identification were released back to nature. The butterflies were handled carefully and gently.

Statistical Analysis

The biodiversity indices as detailed below were calculated to quantify selected biodiversity elements sampled in the study area following aforementioned procedures. Biodiversity indices such as diversity (H'), Evenness (E_1), and species richness (R_1) were used to estimate the populations of various biodiversity elements. Biodiversity indices are measures of species diversity expressed as ratios between number of species and importance of values (i.e. Number, Biomass, productivity and so on) of individuals. The term may also refer to genetic diversity and diversity of habitats or communities (<http://stats.oecd.org/glossary>). Diversity indices provide important information about rarity and commonness of species in a community (<http://www.tiem.utk.edu/gross>).

Shannon-weiner index (H'):

Diversity of different select biodiversity elements were estimated according to Shannon and Weiner diversity index, Ludwig, J.A. and Reynolds (1988) using the following formula:

$$H' = - \sum_{i=1}^s \left[\left(\frac{n_i}{n} \right) * \ln \left(\frac{n_i}{n} \right) \right]$$

Where,

n_i = Number of individuals belonging to i^{th} species

n = Total number of individuals in the sample

Shannon-Weiner index is used for measuring the diversity of organisms in a particular ecosystem. The diversity is characterised by a number of individuals presented by each species/category in a sample. A high species diversity may indicate a healthy environment (<http://www.miljolare.no/virtue/biodiversity>).

Evenness index (E_1)

Pielou (1977) evenness index was used for calculation of evenness of biodiversity elements. This index, which measures the evenness of species abundance, is complimentary to diversity index concept and it indicates how the individuals of various species are distributed in a community. Evenness is ranged from zero to one. When evenness is close to zero, it indicates that most of the individuals belong to one or a few species / categories. When the evenness is close to one it indicates that each species consist of almost same number of individuals (<http://www.miljolare.no/virtue>). For estimating evenness of species Shannon's diversity index is calculated using the following formula:

$$E_1 = H' / \ln(s)$$

Where, H' = Shannon Weiner diversity index

s = number of species

Species richness (R_1)

The number of species at a site in a region or in a collection represents species richness, which are the simplest and most useful measures of species diversity. The simplest form of richness is the Hill's number 0 (N_0) which is the total number of species (S) in a given habitat. Species richness was calculated based on Marglef's richness index using the following formula:

$$R_1 = (S-1) / \ln(n)$$

Where,

S = the number of species in a community

n = the total number of individuals observed

Results and Discussion

The species richness of birds recorded from different localities is presented in the table 1. It reveals that in Doddasannae village totally 63 species, Bettakote lake 65, Bettakote state forest 57, Ramanahalli 59 species, Nallur Tamarind groove 63 species and in Sadahalli 62 species were recorded. With respect to diversity parameters at Doddasannae, Bettakote lake, Bettakote state forest, Ramanahalli, Nallur tamarind groove and Sadahalli the bird species diversity following Shannon-weiner index (H') was 1.61, 1.615, 1.543, 0.512, 1.637 and 1.323 for the area, respectively. Species evenness indicated by Pielou's Evenness index (E_1) was 0.64, 0.999, 0.878, 0.915, 0.913 and 0.740 and the species richness indicated by Marglef's richness index was 19.54, 19.518, 18.129, 17.831, 18.495 and 18.494, respectively (Table. 1).

At Doddasanne the cultivated patches served as diversified habitat and water source in the form of fresh water tank supported a range of biodiversity elements. So this location recorded higher diversity value. Most common species found here are, based on frequency of occurrence, Blue rock pigeon, Rose ringed parakeet, Small bee-eater, Common swallow, Common myna, Jungle myna, House crow, Indian robin, Spotted munia and Ashy wren warbler were the most frequent. These results suggest that the habitat favored birds preferring scrub and hedges. The birds prevalent at these locations preferred open country sides dotted with vegetation patches embracing small trees, shrubs and hedges. Some of the least abundant species were Eagle owl, Rosy starling, Grey headed starling, Black red start, Blue headed rock thrush, Bay backed shrike and mottled wood owl represents with the partially disturbed ecosystem here and climax vegetation types. With increase in urbanization we tend to lose the species from the area.

Recent studies indicate that patch size also seems to have some influence on species richness. Watling and Donnelly (2006) found in their analysis of 148 studies that species richness increased with patch size more commonly for bird species than for invertebrates, but it affected both groups' species richness. Their discussion of the effects of patch size and patch isolation emphasized the proper design of patches to maximize their use as stepping stones.

At Bettakote lake results suggest that the habitat favored birds preferring scrub and hedges along the lake sides, these values indicated that the area recorded high bird diversity and high species evenness suggesting that the birds were evenly distributed across different species when these index values were compared with different locations a comparative picture concerning bird community emerges and this location is characterized by diversified patches of cultivated land, lake, open land, scrub and there combinations which meet the requirements of several species of birds with varied requirements. Most abundant species found here were Common myna, Spotted munia, Rose ringed parakeet, House Crow and Blue Rock Pigeon. Some rare species like Bay backed shrike, grey tit, blue headed rock thrush is also seen here in this location indicating high diversity.

Nallur tamarind groove is hospitable for a wide variety of birds. Some of the abundant bird species in the area were Jungle myna, Rose ringed parakeet, Small green bee-eater and singing bush lark. Some of the least abundant species recorded were grey francolin, black kite, spotted owlet and the Indian tree pie, birds preferring scrub, land open area covered with wooded trees were found in the tamarind groove. One of the main reasons for the groove to be rich in birds is that it is an undisturbed preserved area, free from human interference. The area also supported nesting and roosting of species like doves, Barbets, munias, bull bulls, pigeons, parakeet and a wide variety of other passerine birds. Nallur tamarind groove has been declared by the Karnataka Biodiversity Board as a heritage site in 2010. This has greatly helped the conservation of biodiversity elements not only in the tamarind groove but as a area as a whole. Tamarind forms the major tree species and trees are more than 600 years old therefore Nallur tamarind groove is a unique habitat for not only tamarind but for birds too. Some of the rare species in Nallur tamarind groove were Black shouldered kite, Small green billed malkoha, Mottled wood owl, Ashy drongo, Paradise fly catcher and Blue headed rock thrush.

Sadahalli provided niche requirements for a wide variety of birds preferring different habitats like scrubland, grassland, open area, wooded area and wetland this was one of the areas rich in biodiversity and it was fed with a large fresh water tank that sustained a rich primary productivity in the area. Fore going results suggested sadahalli to be one of the biodiversity hot spot for native species of plants and animals. The area is also relatively free from human interference. Relatively sadahalli is away from the main road. Sadahalli was rich in birds. Some of the most abundant birds sighted in the area include Jungle myna, Rose ringed parakeet, Small bee-eater, Reed warbler and some of the least abundant species includes Grey francolin, Black kite, Spotted owlet, Indian tree pie and Rosy starling.

Table 1. Biodiversity indices for birds

	Doddasanne village	Bettakote lake	Bettakote state forest	Ramanahalli	Nallur tamarind groove	Sadahalli
Marglef's Species richness (R1)	19.54	19.518	18.129	17.831	18.495	18.494
Pielou's Evenness index (E1)	0.64	0.999	0.878	0.915	0.913	0.740
Shannon-weiner index (H')	1.61	1.615	1.543	0.512	1.637	1.323

Butterflies

The results pertaining to species richness and biodiversity parameters for butterfly community at different study location is presented in the table 2. The Shannon wiener index for butterflies is 1.30, species richness is 15.83 and the species evenness is 0.94. These values of the three indices reflect on the rich biodiversity of Doddasanne. As in this location agriculture still in practice and many flowering plants can be seen here. So, this supports the butterfly fauna in high numbers. Some of the most abundant species recorded were Common Indian crow, Common pierrot, Common sailer and Common mormoon. Some of the least abundant species were Southern birdwing, Lemon pancy, Paris peacock and striped tiger.

Totally 25 species of butterflies were recorded in Bettakote lake during the study period. The Shannon wiener index for butterflies is 1.31, species richness is 8.24 and the species evenness is 0.93. These values of the three indices reflect on the moderate biodiversity of Bettakote Lake. Some of the most abundant species recorded were common Indian crow, common mormoon, common sailer and common pierrot. Some of the least abundant species were crimson rose and striped tiger. Totally 23 species of butterflies were recorded in Bettakote state forest during the study period. As the area has been afforested with monoculture plantation of *Eucalyptus* and *Acacia*. The Shannon wiener index for butterflies is 1.26, species richness is 8.87 and the species evenness is 0.91. These values of the three indices reflect on the normal biodiversity of Bettakote state forest. Some of the most abundant species recorded were Common cerulean, Common pierrot and Plain tiger. Some of the least abundant species were Common bottle blue and Paris peacock.

Overall 21 species of butterflies were recorded in Ramanahalli during the study period. The list is a very low representation of butterfly's fauna. With respect to diversity parameters the bird species diversity following Shannon-wiener index (H') was 1.18 for the area. Species evenness indicated by Pielou's Evenness index (E_1) was 0.89 and the species richness indicated by Marglef's richness index was 7.42 (Table.2). These values of the three indices reflect on the very less biodiversity in Ramanahalli. Some of the most abundant species recorded were common cerulean, common Indian crow, and common pierrot. Some of the least abundant species were Jewel grass, Great orange tip and Blue mormoon.

Totally 26 species of butterflies were recorded in tamarind groove during the study period. The Shannon wiener index for butterflies is 1.38, species richness is 8.46 and the species evenness is 0.98. These values of the three indices reflect on the rich biodiversity of Nallur tamarind groove. Some of the most abundant and frequency species recorded were Great orange tip, Pansy yellow, Blue tiger and Pansy lemon. In case of Sadahalli twenty six species of butterflies were recorded in Sadahalli during the study period. The list is a fair representation of butterfly's fauna but it is not complete as more number of butterflies as expected in the area. The Shannon wiener index for butterflies is 1.39, species richness is 8.48 and the species evenness is 0.98. These values of the three indices reflect on the rich biodiversity of Sadahalli. Some of the most abundant species recorded were Common Grass Yellow, Yellow pansy and plain tiger.

Table 2. Biodiversity indices for Butterflies

	Doddasanne village	Bettakote lake	Bettakote state forest	Ramanahalli	Nallur tamarind groove	Sadahalli
Marglef's Species richness (R1)	15.839	8.24	8.873	7.423	8.467	8.487
Pielou's Evenness index (E1)	0.943	0.93	1.268	0.893	0.982	0.983
Shannon-wiener index (H')	1.309	1.31	1.264	1.185	1.389	1.392

There has been a drastic decline in the overall native biodiversity includes flora and fauna, in our study we considered birds and butterflies as flagship species and indicators of the biodiversity loss.

65 bird species were identified in the study area during 2009-2010 which includes some of the rare bird species were Grey Wagtail, Black Drongo, Sykes's Crested Lark, Rosy Starling, Blue Rock-Thrush, Small Green-Billed Malkoha, Indian Treepie, Bay-Backed Shrike, Grey-Headed Starling, Asian Paradise Flycatcher, Black Shouldered Kite, Spotted Owllet, Black Kite, Mottled Wood-Owl, Eurasian Golden Oriole and Barn Owl. Some of the bird species which could not tolerate built up area as a habitat must have moved to the surrounding hospitable areas. A comparative picture of bird community across six locations in BIA area has been presented.

In all 26 species of butterflies recorded in the study area some of the most abundant species of butterflies were common Indian crow, common pierrot, common sailer and common marmoon. Some of the rare species were paris peacock, southern bird wing and lemon pancy.

Our study concludes that, around the Bengaluru International airport area, Ramanahalli was severely impacted as it formed core area of BIA development. The butterflies and birds species showed a remarkable change comparing with the

other locations as in this location many developmental activities is taking place like conversion of agricultural lands into residential sites and other lands for commercial uses.

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