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REVALUATION OF BIRDS OF UKKADAM LAKE, COIMBATORE WITH SPECIAL REFERENCE TO EFFECT OF SMART CITY DEVELOPMENT ON ITS COMMUNITY AND DIVERSITY

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Abstract: Wetland is considered as the most productive ecosystem. The total number of bird species decline once an area is urbanized. We studied bird community of Ukkadam lake, Coimbatore before smart city development and compared the result with same study area after the development of smart city. We followed transect method and total count method. Our study we could observe significant decline of bird population especially water bird. Nesting also severely affected due to cleaning of water plants. The development activity especially smart city leads to loss of biodiversity. Considering all these factors, management regions should ensure that adequate protection is given. We recommend some immediate actions to benefit the wetland are effectively and visibly demarcating the boundaries of nearby lakes, bunds should be made for the purpose should be designed in such a way they are green and stable. Bird attracting and native species of tree may be planted along the bunds or in the mounts in the lakes. Cleaning of the lakes should be undertaken in a scientific manner after understating the ecology and characteristics of the individual's lakes. Introduction of exotic floral and faunal species should be prohibited. Boating should be banned.

Key words: Coimbaotre, wetland, ukkadam lake, birds, smart city development.

1. Introduction

The wetlands could be considered as the world's most productive ecosystem. Wetlands are highly complex, land interactive, most productive and fertile ecosystem in the world, constitution a treasury of biodiversity (Wetzel 2001). Wetlands also supply habitat for birds and wildlife and create recreational opportunities. Ancient Tamil rulers have been known for their skills and technology in augmenting irrigation needs by constructing canals and waterways. The wetlands (locally called kulams) we now see in the Coimbatore city are the brainchild of the Tamil kings who developed it hundreds of years ago for irrigation, flood control and for recharging ground water. During the Kongu Chola's regime in 8th and 9th centuries there were 30 wetlands constructed on both sides of the River Noyyal for irrigation and floods mitigation. All these wetlands are interconnected to each other and with the River Noyyal (Coimbatore District Epigraphs Vol.1). Over the years these wetlands have played an important part in development of human history and environment in the region. Coimbatore developed in the watershed expanse of the Noyyal river basin and consists of a network of lakes and canals. In the past, there were numerous lakes in the surrounding areas but most got filled up. Currently, in the Noyyal river basin there are 24 lakes in Coimbatore. which includes our study area Ukkadam lake (Valankulam). Coimbatore district has been ranked lowest in terms of number of wetlands in Tamil Nadu (1.08%). The city has grown around wetlands. Although the wetland are constructed 1200 years ago, but over 800 years these wetland were served well to both mankind and environment for flood control and irrigational purpose, are now being treated as dump yards and wastelands for the city's sewage and garbage.

Ukkadam Lake is situated Coimbatore South. Geographically it is located at the latitude of 10° 57.51' N and Longitude: 76° 45.29' E. Water spread area is 187.059 Acres. Capacity of the lake is 24.42 M.cft. This lake gets water from Nelli Anicut Channel. Ukkadam lake conserves a very wide range of biodiversity and has a crucial importance from the point of native and immigrant bird species. The lake maintains an ecological balance of flora and fauna interrelationship. Though there are few studies on birds of this lake no proper checklist and study has been done and published so far. The study was carried out to assess the effect of smart city development on bird community structure.

Figure 1: UKKADAM LAKE – STATELITE VIEW

2. METHODS

We studied this in two years first study conducted July 2016 to March 2017 that is before smart city and second study conducted July 2021 to June 2022.

2.1 Bird Community Study

Determination of bird species and its population survey will be carried throughout the study period. The census using different sampling techniques as described by Bibby *et al*., (1992) and Sutherland (1996) depending on the species, areas, accessibility and habitat conditions were used to study the water bird species. Systematic censuses was carried out using block or transect count periodically throughout the year. The entire census was carried out from 0700 hrs to 1100 hrs with an interval of fortnight. The parameters like number of birds, species, behavior, habitat and other information was recorded during the survey. All breeding birds and their nesting trees and habitats was studied in the study area

3. RESULT

3.1 Overall abundance

The same kind of data were taken during 2016 July to March 2017. The result showed that nearly 17894 individuals of 66 species were recorded. Whereas after the development of smart city we recorded only 10688 individuals of 47 species. The difference between the number of individuals are 7206. Nearly 8% of the species and 30% of individuals we could not record after the development of smart city in that area (Table 1 &2, Figure 1). The month wise record also showed all the month the number of species are lesser after smart city (Figure 2)

Table 1: Number of species and individuals recorded before and after the smart city development

	Before smart city		After smart city	
Month	Species	Individuals	Species	Individuals
November	31	1954	35	897
December	33	2692	41	2056
January	31	2035	44	2049
February	36	3729	41	2126
March	38	3177	42	2008
April	33	2292	37	915
May	25	2015	31	637
		17894		10688

Table 2: Percentage of species and individuals recorded before and after the smart city development

	# of species	%	Individuals	%
Before smart city	66	62.61	17894	62.61
After smart city	47	37.39	10688	40
Total			28582	

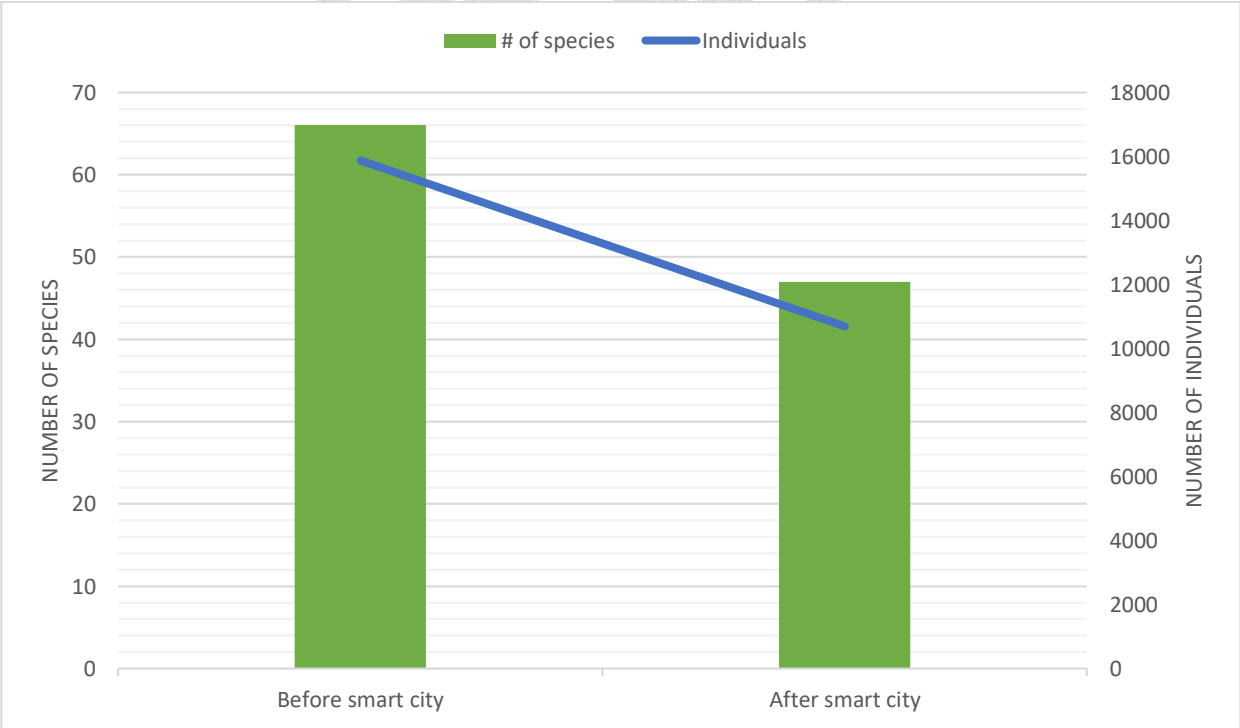

Figure 1: Percentage of species and individuals recorded before and after the smart city development

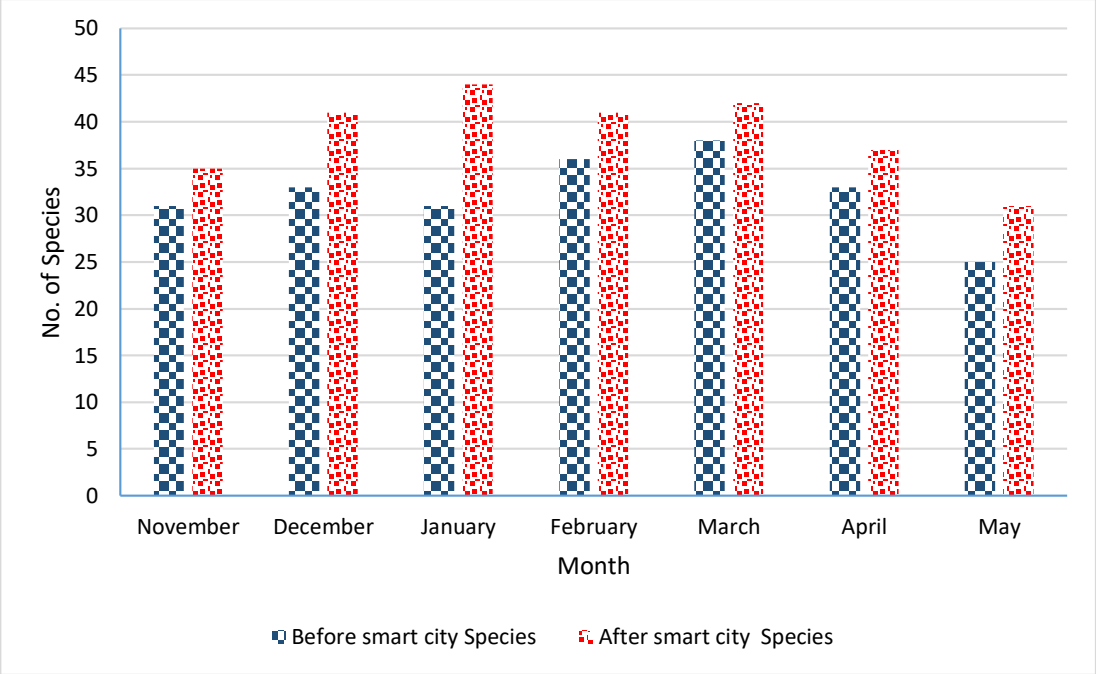

Figure 2: Number of species recorded before and after the smart city development

3.2 Feeding guilt

All the species recorded in the Ukkadam lake were classified according to feeding guilt. The result showed that Picivores are recoded more with 5149 individuals followed by omnivore with 2510 individuals minimum number of individuals recorded in nectivore with 41 individuals. Number of species recorded more in picivore (20) followed by insectivore (12), minimum of one species namely Rose-ringed parakeet recorded from frugivorous (Table 3, figure 3).

Table 3: Distribution of bird species with reference to feeding guild after establishment of Smart city in Ukkadam lake, Coimbatore.

FEEDING GUILT	# OF SPECIES	INDIVIDUALS
Carnivore	5	352
Picivore	20	5149
Frugivore	1	308
Insectivore	12	1058
Nectivore	2	41
Omnivore	3	2510
Seedivore	4	1270
Total	**47**	**10688**

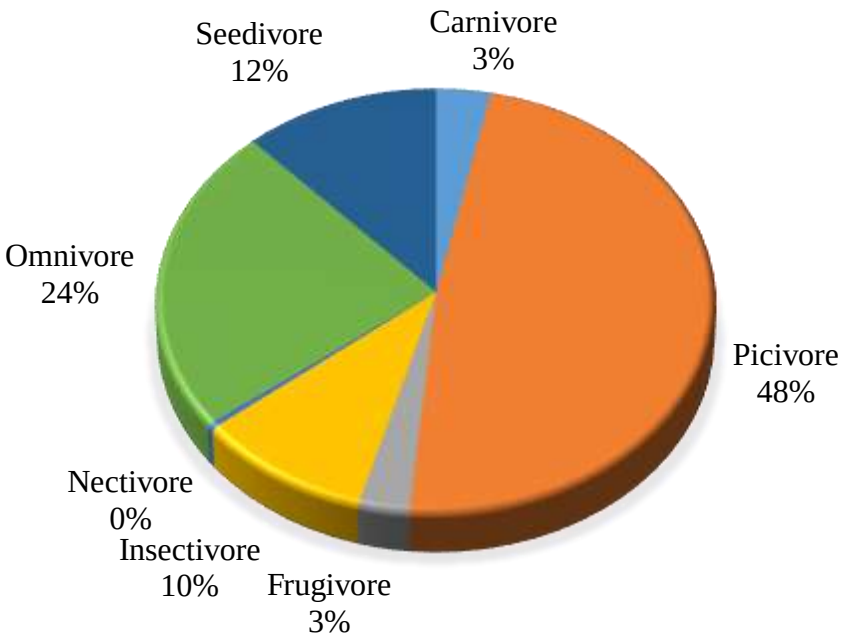

Figure 3: Distribution of bird species with reference to feeding guild after establishment of Smart city in Ukkadam lake, Coimbatore.

When we compare the feeding guilt of different birds before smart city we could record carnivorous birds belonging to seven families whereas after smart city development we could record only three families. In species result showed no difference in the case of number of individuals nearly 70% of the birds were not recorded after the development of smart city. In frugivorous before smart city 5 families two species and 578 birds were recorded. Whereas after the smart city development birds recorded from only one family one species and also 308 individuals there is almost 30% decline of frugivorous birds. In granivorous before smart city 1 family, 2 species and 300 birds were recorded. Whereas after the smart city development birds recorded from 3 families, 3 species and also 1094 individuals there is almost 57% increase of granivorous birds. In insectivorous before smart city 3 families, 25 species and 4001 birds were recorded. Whereas after the smart city development birds recorded from 12 families, 13 species and also 1234 individuals there is almost 53% decline of insectivorous birds. In nectarivorous before smart city 1 family, 2 species and 1010 birds were recorded. Whereas after the smart city development birds recorded from 2 family 2 species and 41 individuals there is almost 92% decline of nectarivorous birds. In omnivorous before smart city 5 families, 2 species and 903 birds were recorded. Whereas after the smart city development birds recorded from 2 families, 3 species and 2510 individuals there is almost 47% increase of omnivorous birds. In picivorous before smart city 3 families 28 species and 7100 birds were recorded. Whereas after the smart city development birds recorded from 9 families, 20 species and 5149 individuals there is almost 16 % decline of picivorous birds (Table 4, Figure 4).

Table 4: Comparison of bird species with reference to feeding guild before and after establishment of Smart city in Ukkadam lake, Coimbatore.

Feeding Guild	Families recorded before SC	Families recorded after SC	Difference	% of increase/decrease	Species recorded before SC	Species recorded after SC	Difference	% of increase/decrese	# of individuals recorded before SC	# of individuals recorded after SC	Difference	% of increase/decrease
Carnivores	7	3	-4	-40	5	5	-6	0	1987	352	-1635	-70
Frugivores	5	1	-4	-67	2	1	-1	-33	578	308	-270	-30
Granivores	1	3	2	50	2	3	1	20	300	1094	794	57
Insetivores	3	12	9	60	25	13	-12	-32	4001	1234	-2767	-53
Nectarivores	1	2	1	33	2	2	-3	0	1010	41	-969	-92
Omnivores	5	2	-3	-43	2	3	12	20	903	2510	1607	47
Picivores	3	9	6	50	28	20	-8	-17	7100	5149	-1951	-16
TOTAL	**25**	**32**	**-7**	**12**	**66**	**47**	**19**	**-17**	**15879**	**10688**	**5191**	**-20**

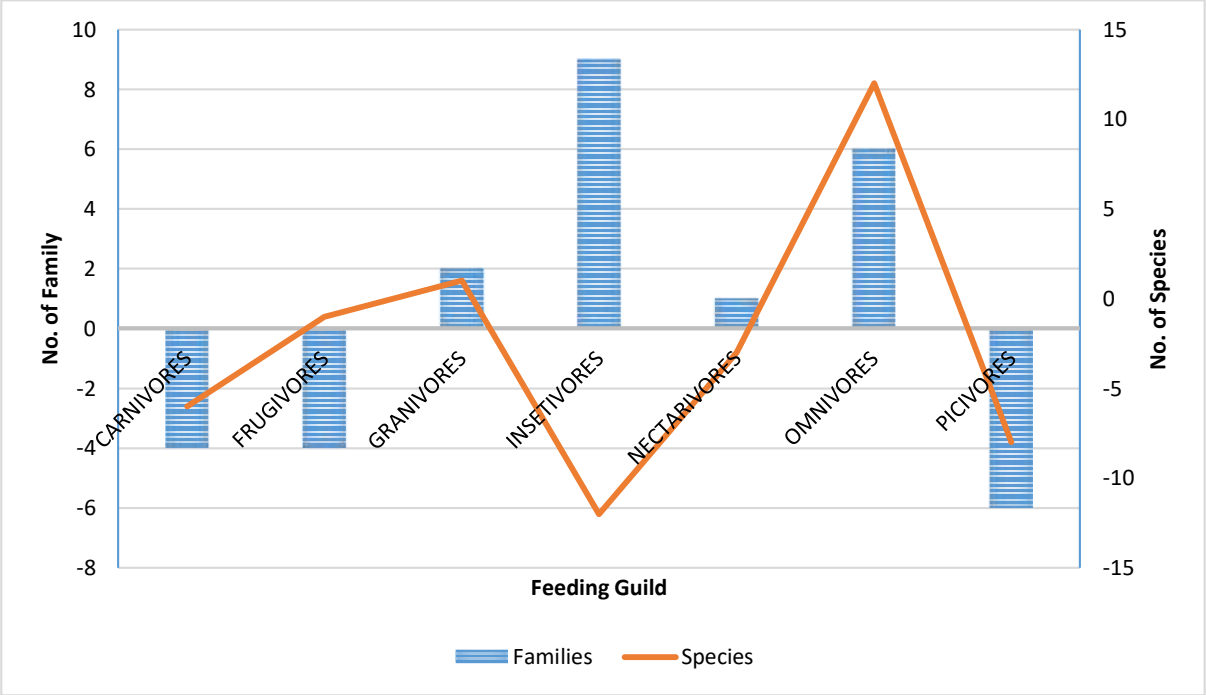

Figure 4: Number of bird families and species recorded in Ukkadam lake after the establishment of Smart city with reference to feeding guild

3.3 Family wise comparison

Comparison of number of species recorded in each family before and after the establishment of smart city in Ukkadam lake Coimbatore showed almost in all bird families showed declining trend (Table 5, Figure 5).

Table 5 : Number of species recorded in each families before and after the establishment of smart city

S. no	Family	Before Smart City	After Smart City
1	Accipitridea	7	3
2	Aedeidea	1	0
3	Alcedinidae	3	2
4	Anatidae	5	1
5	Anhingidea	1	0
6	Apodidae	0	1
7	Ardeidea	8	8
8	Caprimulagidea	1	0
9	Charadriidea	2	0
10	Charadriiformes	0	1
11	Ciconiidae	2	1
12	Cisticolidae	1	2
13	Columbidea	1	2
14	Corvidae	2	3
15	Cuculidea	1	1
16	Dicaeidea	0	1
17	Dicruidea	1	1
18	Hirundinidae	0	1
19	Leiothrichidae	2	1
20	Megalamidea	1	0
21	Meropidae	0	1
22	Motacillidae	0	1
23	Nectariniidae	0	1
24	Pandionidea	1	1
25	Passeridea	1	1
26	Pelecanidea	2	1
27	Phalacrocoraidea	3	3
28	Phasianidea	1	0
29	Porphyrio	1	0
30	Psittacidae	1	1
31	Pycnonotidea	1	0
32	Rallidea	5	3
33	Recurvirostridae	1	1
34	Scolopacidae	3	1
35	Strigidae	0	1
36	Sturnidae	3	1
37	Sylviinae	1	0
38	Threskionithidae	2	1
39	Turnicidea	1	0
	Total	**66**	**47**

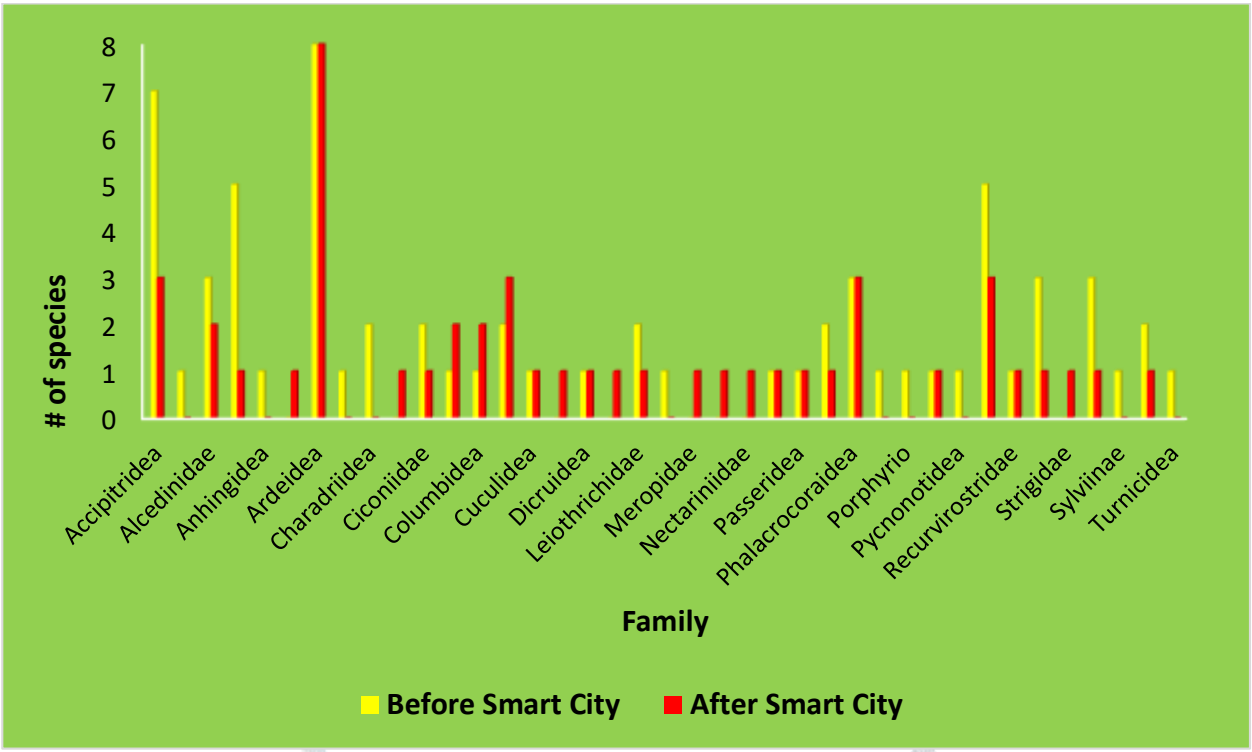

Figure 5: Comparison of number of species recorded in each family before and after the establishment of smart city in Ukkadam lake Coimbatore.

3.4 Accipitridea

Before smart city seven species were recorded from the family accipitridea whereas after the development of smart city we could record only three species. We could not record Tawny eagle, Creasted serpent eagle, Eurasian march harrier, palid harrier and pied harrier. this time we could record brahminy kite which was not recorded before the development of smart city (Figure 5). Aedeidea family we recorded only one species namely cinnamon bittern (*Ixobrychus cinnamomenus)* before smart city but after smart city we are unable to record even that one species after the development of smart city. In the case of Alcedinidae before smart city we recorded three species namely small king fisher, pied kingfisher and stork- billed kingfisher and after smart city two species namely small kingfisher and white throated kingfisher. In the case of anatidae before smart city five species were recorded whereas after smart city only one species recorded (Figure 6)

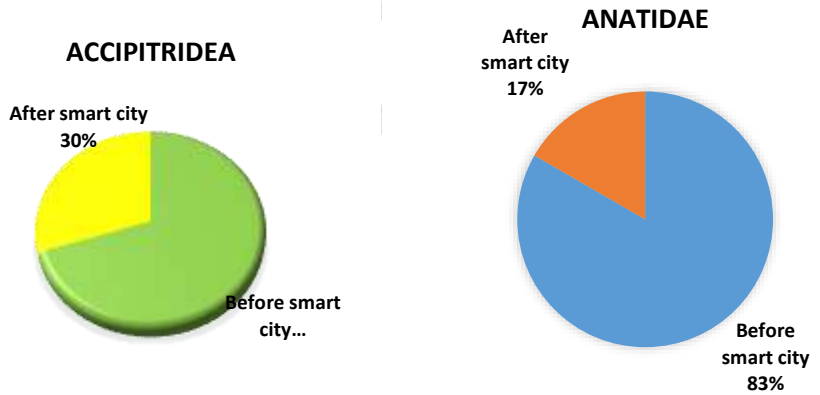

Figure 6: Percentage of bird speices recorded Before and after smart city development

Figure 9: Number of species recorded in Anatidae family before and after smart city development

In the family anhingidea, caprimulagidea, Megalamidea, Phasianidea, porphyrio, pycnonotidea sylviinae, turnicidea before smart city one species were recorded and after smart city we could not record even that. In Charadriidea two species before smart city.

3.5 Comparison of birds based on conservation status

Before smart city 2 Near threatened birds namely black headed ibis *Threskiornis melanocephalus* and great thick-nee *Esacus recurvirostris* were recorded. Whereas after the smart city only no near threatened species were recorded. Before smart city construction 68 least concern birds were recorded, after the smart city construction 47 least concern birds were recorded. Before smart city construction two vulnerable birds Ruddy-

breaseted crake *Zapornia fusca* and Changeable Hawk-eagle *Butorides striata* were recorded. After smart city we could not record vulnerable birds. Comparison of birds recorded before and after the smart city development based on conservation status is given in table 6.

Conservation status	Before Smart City	%	After Smart City	%
Near Threatened	2	3	0	0
Least Concern	62	94	47	100
Vulnerable	2	3	0	0
Total	66	100	47	100

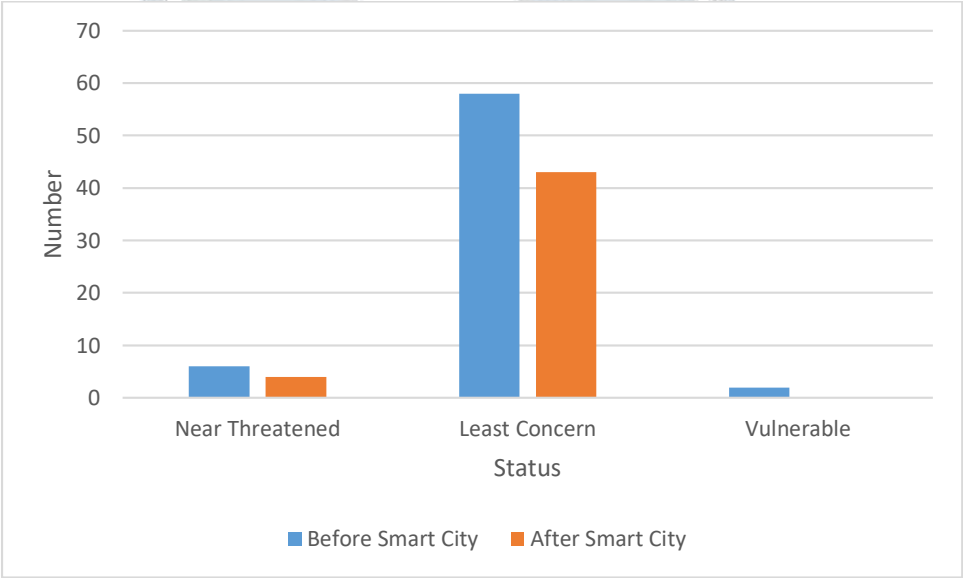

Figure 10: Comparison of birds recorded before and after the smart city development based on conservation status

3.7 Breeding biology

Total of 55 nests of eight species were recorded in the Ukkadam lake before smart city development. House crow occupied the maximum number of nest (26%), followed by Cinnamon bittern with 17% and other birds such as purple swampen, little Cormorant, moorhen, myna and pelicans occupaied remaining 37%. After smart city development we recorded 12 nest. Of eight nest belongs to crow and four Common Myna. But all these nest were recorded opposite side of lake and most of the myna nest were recorded the electrical post. It is important to note that no nest of water birds was recorded (Table 7).

Table 7: Number of nest recorded before and after smart city development

S.no	Name	Scientific name	Number of nest	
			Bsc	Asc
1	Purple Swamphen	*porphyrio porphyrio*	9	0
2	Little Cormorant	*phalacroax niger*	9	0
3	Cinnamon Bittern	*Ixobrychus cinnamomenus*	10	0
4	Common moorhen	*Gallinula chloropus*	3	0
5	House Crow	*Corvus spendences*	14	8
6	Spot-billed Pelican	*Pelecanus phillipensis*	4	0

7	Common Myna	*Acridotheres tristis*	5	4
8	White-breasted Kingfisher	Halcyon symyrnensis	1	0
			55	12

4. Discussion

Urbanization if the increase in the proportion of people living in towns and cities due to migration of people from rural area. The development in urban areas causes loss of wetland. The loss may go more than 60%. At the same time, it has severe impact on wetland ecosystem.

The major activities responsible for wetlands loss are urbanization, drainage and water system regulation. During the study it was observed that the urban lakes of Coimbatore have varying degrees of disturbance like infestation by aquatic weeds, release of untreated sewage and effluents, human settlements, encroachments. Despite all these problems it was observed that the lakes provide habitats to birds that are seldom seen in urban wetlands. The wetlands should be scientifically restored while the others sustainably managed; they could further add to the aesthetic value of the city while ecologically and economically benefiting mankind.

When we compare the birds of Ukkadam lake before and after smart city the result showed before smart city we recorded 17894 birds whereas after smart city 10688. There is a 20% decline in birds number. Though there is not much variation in numbers of individuals the number of species showed drastic variation nearly nine species we could not record after the development of smart city. The number of individuals doesn't showed much variation because of increased population of crow. Before smart city development the number of crows recorded was 213 whereas after the development of smart city its 1617. Before smart city only one species of crow was recorded whereas after smart city house crow and jungle crow both the species were recorded. The increase in crow population indicates the disturbance occurred in the region. The walk though area paves the way to the public movement. The wasted food materials attract crows.

Leo and Velayutham (2019) recorded the spot-billed pelican population is high in Ukkadam during July 2018 whereas no pelicans were recorded during our survey. In their study they said Pelicans were using bund. They also recorded the nesting of Spot-billed Pelicans. They also reported that anthropogenic activities also influenced the declining of the Spot-billed pelicans during the present study period. The pelicans, pelicanaries and their foraging grounds are under multitude of increasing pressures, which, if not addressed, could result in the decline or extinction of the species. They suggested that the future of nesting colonies of these birds located in protected areas appears to be safe when looked in isolation, but since breeding success is dependent on food supplies, their future will be assured only if their foraging grounds are in good health. The reduction in numbers has been attributed to the unscientific desilting, which has damaged native species and blocked the inflow and outflow of water. Rapid urbanization and overgrowth of invasive vegetation's like Water Hyacinth, Hydrilla, Prosopis juliflora and Parthenium are also seen as causes.

Ukkadam wetland is an ideal habitat for migratory and resident birds. This wetland is also support waders. Wetland shows the significance of the area as a wintering ground for migratory birds. Weather is the number one driving factor for migration Birds's sensitivity varies towards temperature and other environmental conditions. Migration can be acquired, abandoned or prolonged by a species, depending on conditions along their migratory routes (Das, 2008). During December several birds from the colder regions are spotted. While small birds like flycatchers arrive in early November, wagtails usually arrive in mid-October. Ducks turn up by end of October or early November in huge numbers.

Birds prefer habitat that provides them with plenty of foods. Praphadevi, *et al.*, (2011) at point Calimere documented water birds consuming a variety of food ranging from algae, plankton, worms, insects, mollscs and fish. This region is the biggest and premier roosting and nesting grounds for many wetlands wading birds. This ukkadam pond is also supporting more birds. Successful conservation of the species will depend on an improved understanding of its ecological requirements and moving patcterns of each species.

The reason for low diversity of birds might be that these pond situated in the hot of the city which support minimal birds in the non-native as observed in the case of many other endemics (Vijayan & GOkula 2006). One of the likely reasons perhaps may be the lack of their native insect fauna and thus having very little bird food resources (Cody 1985). In the pond and surrounding areas almost no ground vegetation layer was recorded; bare ground without much litter could food for this ground feeding bird. Low diversity of species during this survey shows that of the birds are strict habitat susceptible to habitat modification (Brooks *et al.*,1997; Castelletta *et al.*, (2000); Bird life International).

Ukkadam is a fast growing and busy city, however with large number of birds species occupying its wetlands, indicates the availability of resources and habitat, and non-availability of appropriate habitats elsewhere in the surroundings. But after the development of smart city there is a drastic decrease in the number of species and number of individuals. Due to the new path for walking around ukkadam lake and clearance of all the vegetation leads to the decrease of nesting, perching and roosting sites in the Ukkadam lake. Actually water bird population is reduced nearly 80%. The distribution of consumers is an indication of the distribution of resources in general.

Number of birds species recorded was more in the natural forest than man – made habitats. Besides the nest site, the avail pond habitats provided food source with cooler substrates and ambient temperature as well as high humidity; Similar kind result were reported by Das, (2008) in their study on bird community in Silent Valley Park. Mostly the natural forests are with water sources. Proximity of water streams provided suitable conditions for the high abundance of invertebrates (Cousin 2004). Variation in the structure and a biotic conditions of forest landscapes, for their part, set the limits of microclimatic variability which in turn affect the distribution of spices (Rykiel *et al*., 1988). Several works have suggested that higher birds abundance may be associated with greater arthropod abundance (Johnson & Sherry, 2001). Food availability is the driving force behind habitat selection in birds (Johnson &Sherry,2001). Hence, densities are higher in where food is abundant than where it is scarce (Newton 1998).

5. CONCLUSION

At present in India, only 50 percent of wetlands remain. They are disappearing at a rate of 2% to 3% every year. The loss of wetlands leads to environmental and ecological problems, which have a direct impact on the biodiversity. Serious consequences, including increased flooding, species decline, deformity, or extinction and decline in water quality could result.

Our previous study before the development of smart city showed that the encounter rates conformed that the diversity was more in the Ukkadam pond than man-made habitats as a reported in many community studies (Devy *et al., 1998; Yoganand & Davidar 2000; Davidar et al ., 2007). But* the study after the development of smart city showed drastic decline of the birds population due to clearance of vegetation. The walk thorugh area and jetty inside the lake created a human distrabance to the birds. And often removal of vegetation to maintain the cleaness of lake also one of the major reason for bird population decline. This time we could not record even a single nest of water birds. All the trees in and around the Ukkadam lake were decorated with light which disturbs bird roosting and nesting. Ukkadam lake in walk through area many shops were opened. And more place benches were laid to rest people which leads to pollution.

This Study has shown that the resident and near threatened birds has distinct microhabitat preferences within the pond which in turn lead to the patchy distribution of the species. Conserving several small pond patches would not be as efficient as conserving large protected area (MacArthur, 1961; Davidar *et al.*, 2007). Due to unplanned urban and agricultural development, industries, road construction, impoundment, resource extraction and dredge disposal, wetlands have been drained and transformed, causing substantial economic and ecological losses in the long term. The development activity especially smart city leads to loss of biodiversity. Considering all these factors, management regions should ensure that adequate protection is given.

6. Recommendations

Some of the immediate actions to benefit the wetland are

- Effectively and visibly demarcate the boundaries of nearby lakes
- The bunds should be made for the purpose should be designed in such a way they are green and stable.
- Bird attracting and native species of tree may be planted along the bunds or in the mounts in the lakes.
- Control encroachment activities the lakes, and move out and rehabilitate those who have lived in the encroachment for years.
- Appoint local watch and ward personal to report violations immediately to the authorities for immediate actions.
- Cleaning of the lakes should be undertaken in a scientific manner after understating the ecology and characteristics of the individual's lakes.
- Introduction of exotic floral and faunal species should be prohibited.
- Boating should be banned

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