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# Climate change and its impacts on Indian birds: monsoon phenology and monitoring heronry birds

*A. J. Urfi*

*Field ornithology has provided important data about the impacts of climate change on biodiversity. Long-term nesting record-keeping traditions in Europe have played a crucial role in advances in our understanding of these phenomena. In the context of Asia, the seasonal monsoonal rains are the primary drivers of bird nesting and some studies have sought to establish a relationship between monsoon regimes and reproduction cycles of birds across India by elucidating the manner in which the rains trigger the food cycles of birds. An important group of birds which can further enhance our understanding of the underlying causal relationships between the monsoon and bird reproduction is heronry birds. These birds depend upon wetlands for food resources and long-term heronry monitoring programmes can be useful for conservation.*

Birds are excellent indicators of their environment[1] and their study can give information about the impacts of climate change on biodiversity[2]. Some decades ago, when climate change fears first surfaced, wader researchers had already embarked upon elaborate model-building exercises to predict impacts of habitat loss on coastal bird populations (e.g. see ref. 3). The reasoning was that as sea levels rise, coastal zones across many parts of the world will be submerged, resulting in reduced foraging area for migratory waders which use these habitats as staging or overwintering sites. But, besides modelling exercises, recent empirical studies utilizing large databases have provided evidence about phenological changes in nesting and migration dates of migratory birds due to climate change[4–6]. It is noteworthy that the long-term record-keeping traditions in many parts of the world have been crucial in our understanding of these phenomena[7].

In the context of Asia, the seasonal rains (monsoon), arising due to the differential heating of the oceans and the subcontinental land mass during the summer, have a major impact on biodiversity and economy. Moisture is a crucial resource for all life processes and the monsoon brings it, albeit only in certain months of the year, by way of precipitation. Arising from the Indian Ocean in May–June, moisture-laden winds move towards the subcontinental land mass. Known as the summer or 'southwest' monsoon, it brings rain across large parts of northern and NE India and also along the western coast, but after September these winds reverse their direction and flow outwards to the sea. Known as the winter or 'withdrawal' or 'northeast' monsoon, it then brings rain across several parts, though not uniformly, of South India. Though the broad impacts of monsoon on the reproductive cycles of Indian birds have long been known[8], recent studies seeking to establish a relationship between monsoon regimes and nesting cycles of passerines across India have elucidated the manner in which the rains trigger the food cycles of birds[9]. However, the influence of the monsoon can also be along non-trophic lines. For instance, nest placement in some passerines is strongly influenced by the monsoon winds[10].

Climate change will severely impact the Indian monsoon in terms of both creating more extremes and El Niño events and also impacting phenology[11,12]. Besides influencing biodiversity in general, this is bound to have an impact on birds, primarily by influencing their food cycles and indirectly their nesting times,

and so the question is how well prepared are we to understand these changes. Studying bird models can be convenient because it is possible to obtain data across large spatial and temporal scales, as in the case of the Asian Waterfowl Census (AWC), which seeks the involvement of hundreds of amateur ornithologists volunteering to gather data on bird populations across large geographical scales[1,13,14]. However, another good example of a volunteer-driven project to explore the impacts of climate change on birds across India is the internet-based programme known as 'MigrantWatch'[15]. Initiated by ornithologists to study the movements of migratory birds, in this programme one species of cuckoo, Pied Cuckoo (*Clamator jacobinus*), also known as the 'monsoon bird', has been tracked by dozens of volunteers across the country and its movements examined in relation to the progress of the monsoon[16].

## The case of heronry birds

Yet another system which merits attention in the present context is colonially nesting waterbirds, known as heronry birds (Figure 1) which includes species of darter, cormorant, heron, egret, ibis, spoonbill, pelican and stork belonging to families Anhingidae, Phalacrocoracidae, Ardeidae, Threskiornithidae, Pelecanidae and Ciconiidae. A major advantage with these birds is that since their nesting is concentrated in space and time, they are a good model for exploring relationships between fitness parameters and environmental factors. Significantly, and importantly, from the point of view of the present discussion is the fact that in most cases the food cycles of heronry birds are strongly driven by the monsoon, in the manner given below.

Rainfall → plankton cycles →

Fish spawning → bird reproduction.

Dispersal of food due to flooding and creation of islands, which effectively isolate nesting colonies from ground predators[17], are also believed to be important side effects (non-trophic) of the monsoon[18].

Several instances of close connection between the monsoon and heronry bird reproduction are on record. There are instances of birds skipping nesting altogether in drought years[19]. In the case of Painted Stork (*Mycteria leucocephala*), a fish-eating bird, which breeds across large parts of India and Sri Lanka and parts of SE Asia[20], a broad correlation between the monsoon pattern and nesting time is well documented[8]. One indication of this is the timing of nesting and its relation with monsoon arrival. For instance, in North India where the majority of the annual precipitation is on account of the northwest/summer monsoon, the nesting period of the Painted Stork commences in August–September, i.e. just a month or so after the outbreak of the monsoon. However, in South India, which is influenced by a different monsoon regime, the nesting time of Painted Stork is different.

**Figure 1.** Heronries, being a concentration of breeding effort in space and time, are a good model for understanding the relationships between fitness and environmental factors. The photograph shows a colony of wild Painted Stork at the Delhi Zoo. This colony has been in existence since 1960 (Photograph: A. J. Urfi).

### *Studies on Painted Stork*

For the past two decades we have been involved in a study of Painted Stork populations at different sites across North India. Our studies have covered various aspects of its ecology, including foraging[21], sexual size dimorphism[22], nesting[23,24], nest predation[17], etc. In our attempts to study the causal relationships between rainfall and nesting, we have been inclined towards examining correlative relationships between the two. As it is not possible for us to study these for extended periods and large datasets, stretching at least for a decade, we have looked at nesting records published by amateur ornithologists in bird journals and scientific reports. As shown in Figure 2, at many sites in North India a correlation between the amount of yearly rainfall and nesting of Painted Stork can be observed, although the data available from each site are for short periods and therefore inadequate.

The chief difficulty encountered is that nowhere do we find carefully maintained records with relevant parameters correctly recorded over sufficiently long periods of time. The commonest data, presence/absence type (checklists), are easily available and are often reliable, but when it comes to accurate records of abundance data (roost counts) or nesting parameters (clutch size, number of nests, etc.) or reproductive success from the same site over several years, we have been found wanting. In many reports there is ambiguity with respect to methodology (roost counts of heronry birds) leading to the type of problems well known in bird monitoring[1,14]. For heronry birds, during the course of a nesting season the population counts are highly variable[14] and most investigators have not been careful to define how the numbers recorded by them were attained.

## Conclusion and recommendations

Heronry birds are a good model for understanding the impacts of changing

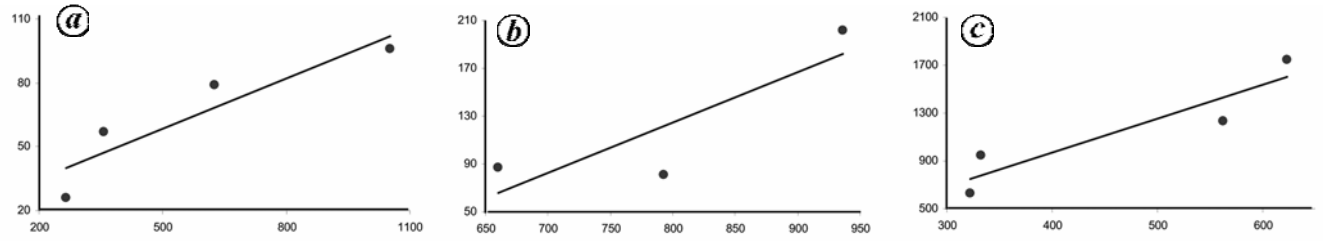


**Figure 2.** Relationship between yearly monsoon rain and Painted Stork nesting at three different sites in North India, along with correlation coefficient, year and source of data. ***a***, Sultanpur National Park ($r^2$ = 0.84, 2002–2005)[24], ***b***, Delhi Zoo ($r^2$ = 0.73, 1988, 1990, 1991)[27] and ***c***, Keoladeo Ghana National Park, Bharatpur ($r^2$ = 0.85, 1982–1985)[25]. In all graphs horizontal axis shows the amount of yearly rainfall (mm) and vertical axis shows the number of nests recorded. The rainfall data have been obtained from India Meterological Department.

monsoon phenology, influenced by climate change, on biodiversity. While there are several detailed studies on heronry birds from India, particularly on Painted Stork at the Delhi Zoo and heronries of the Keoladeo Ghana National Park at Bharatpur[25], there is an urgent need for initiating long-term heronry monitoring programmes for a better understanding of the causal links between monsoon rains and nesting efforts. While this will require not only a good understanding of the underlying biology and parameters involved[1,14], equally important is the need for initiating long-term monitoring programmes and instutionalizing them firmly in the administrative and educational set-up of parks and gardens, and zoos in the urban premises under whose jurisdiction heronries may lie. The Ministry of Environment and Forests, Government of India, might particularly wish to take note of this since it has been responsible for instituting census of wildlife, particularly big cats across India. Instituting monitoring programmes of heronry birds for the broad benefits of understanding the causal linkages between environmental change and biodiversity would be a relevant addition to its existing programmes[26].

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