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Effect of Climate Change on Migratory Bird Arrival and Departure Times in Patan Block, Durg District, Chhattisgarh

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Abstract
This study explores how climate factors affect the migratory patterns of birds in Patan Block, Durg District, Chhattisgarh, during the 2022-2023 migratory season. A total of 13 bird species were observed, including well-known migratory species like the Bar-headed Goose (*Anser indicus)*, Northern Pintail *(Anas acuta*), and Whiskered Tern (*Chlidonias hybrida*). The findings showed that migration timing varied significantly, with some species arriving earlier than usual and others leaving later. Climate factors such as temperature fluctuations and rainfall patterns played a key role in these changes. Species like the Bar-headed Goose and Green Sandpiper (*Tringa ochropus*) arrived early due to warmer winter temperatures, while birds like the Northern Pintail and Osprey (*Pandion haliaetus*) delayed their departure due to inconsistent rainfall. This study highlights the importance of understanding the effects of climate change on migratory behavior and stresses the need for adaptive conservation strategies to safeguard critical habitats for migratory birds in a changing climate.

Keywords: Migratory birds, climate factors, temperature fluctuations, rainfall patterns, early arrival, delayed departure, Patan Block, Chhattisgarh, conservation strategies, climate change**.**

Introduction:
Migratory birds have developed complex behaviors to ensure their survival, timing their migration with the availability of food and suitable breeding grounds. These birds rely on environmental cues—such as temperature, daylight, and the abundance of food in their breeding and wintering habitats—to know when to begin their long journeys. However, as climate change takes hold, these natural signals are becoming more unpredictable, disrupting the birds' migratory rhythms and putting their survival at risk (Both et al., 2004; Jonzén et al., 2006).
In places like Patan Block, Durg District, migratory birds are especially vulnerable to these changes. The wetlands here serve as vital resting and feeding stops during migration, supporting a diverse range of plant and animal life that the birds depend on. These ecosystems are incredibly sensitive to climate shifts, such as changes in temperature and rainfall patterns, which can affect water levels, plant growth, and food availability (Amano et al., 2010). When these wetland conditions are altered, it can cause migratory birds to arrive too early or too late, missing the peak availability of critical resources (Madsen & Fox, 1995).
Similarly, the timing of departure from breeding areas plays a key role in the birds' overall health. Warmer temperatures might push birds to leave their breeding grounds earlier, before they've fully replenished

their energy stores from the resources found along the migration route (Saino et al., 2011). On the other hand, delayed departures could lead to overcrowding at stopover sites, causing fierce competition for food and space, which in turn could threaten the birds' survival (Sutherland et al., 2007).

Research has shown that climate change is already affecting bird migration in many parts of the world. In Europe and North America, for example, some species are arriving at their breeding grounds earlier in the spring, likely due to warmer temperatures (Crick, 2004; Visser et al., 2009). Others are staying longer in their wintering grounds, as shifts in rainfall and habitat changes along migration routes make their journey more difficult (Perrins et al., 1998).

How climate change is impacting the migration of birds in Patan Block is critical for protecting the region's biodiversity. Any disruption to these migratory patterns can have ripple effects on the entire ecosystem, affecting everything from local plant life to resident species (Parmesan, 2006). By studying how climate change influences the timing of migratory bird arrivals and departures, this research aims to shed light on potential conservation strategies that can protect both migratory and resident bird populations, helping to preserve the delicate balance of this important ecosystem.

Study Area:

Patan Block, nestled in the Durg District of Chhattisgarh, is a haven for migratory birds, offering a rich variety of wetlands that serve as vital habitats. These wetlands, including the well-known Chicha Wetland, play an essential role as stopover points for waterfowl and waders during their long journeys (BirdLife International, 2021). Not only do they support these migratory species, but they also provide a sanctuary for a diverse range of resident birds, contributing significantly to the region's overall biodiversity (Ramsar Convention, 2020). The area's unique climate, marked by tropical monsoons and fluctuating temperatures, makes it an ideal location for studying how climate change is influencing bird migration patterns (Sharma et al., 2019).

The study focuses on several key wetlands scattered across Patan Block, such as seasonal lakes, marshes, and mudflats. These ecosystems are crucial in understanding how climate change affects bird migration, offering a variety of foraging and breeding opportunities (Kerr et al., 2018). Located at approximately **latitude 21.2424° N** and **longitude 81.5936° E**, this study area spans a mix of highland and lowland habitats, each offering a different set of environmental conditions. The region’s tropical monsoon climate is shaped by seasonal variations in rainfall and temperature, providing a rich context for examining how these changing conditions are influencing bird migration in real time (Sreeja & Murugan, 2016).

By focusing on this unique geographical setting, the study will shed light on how climate-induced factors like rising temperatures and changing rainfall patterns are impacting the timing of bird migration. Gaining a deeper understanding of these effects is crucial, as it will help in crafting conservation strategies aimed at protecting both migratory and resident bird populations, ensuring the health and sustainability of these vital wetland ecosystems in the face of climate change (Parmesan & Yohe, 2003).

Review of Literature:

A growing body of research has highlighted the impact of climate change on the migration patterns of birds. Studies by Both et al. (2004) and Crick (2004) have shown that many migratory species are arriving earlier and departing later than they did in the past, a trend particularly noticeable in Europe and North America. These shifts in timing are largely driven by changes in environmental cues, such as temperature and food availability. For example, the availability of food at the right time is critical for birds, as it ensures

they arrive at breeding and feeding grounds when resources are abundant. However, when these timing patterns are disrupted—such as when birds arrive earlier than usual but find food sources are not yet available—it can result in a mismatch that harms their chances of survival and reproduction (Siriwardena et al., 2000). Interestingly, similar shifts have been observed in Asia, where migratory birds are increasingly adjusting their schedules in response to changing climates (Ydenberg et al., 2007).

Temperature and precipitation changes are also playing a significant role in shaping bird migration. Warmer temperatures have led to earlier arrivals for many migratory birds, particularly in temperate regions (Siriwardena et al., 2000). Shifting rainfall patterns can further influence these migration patterns by affecting food availability, such as the timing of insect emergence. For instance, in the UK, researchers found that earlier spring warmth led to the early appearance of insects, giving early-arriving birds a head start on feeding (Both et al., 2006). On the flip side, drought conditions can limit food supplies, causing birds to delay migration or arrive at their destinations in poor physical condition (Visser et al., 2012). These changing weather patterns underscore the delicate balance migratory birds rely on to complete their journeys successfully.

In India, several studies have focused on how climate change is affecting migratory bird patterns, particularly in wetland regions like the Sundarban Mangrove Wetland (Basu & Saha, 2012). Researchers have noted that changes in temperature and precipitation are shifting the availability of stopover habitats, making these critical rest areas harder to access during migration. For example, species like the bar-headed goose and common crane, which rely on wetlands in India as important stopover points, have had to adjust their migration routes and timing due to these environmental shifts (Ghosh et al., 2014). While these studies shed light on the changes in migration patterns in parts of India, there is still limited research on how climate change specifically impacts migratory birds in central India, including in regions like Chhattisgarh. Research by Ramesh et al. (2016) emphasizes the need for more focused studies to better understand how local climatic factors influence migration in these regions.

Wetlands play an essential role in the life cycles of migratory birds, offering crucial habitats for feeding, breeding, and resting. However, the effects of climate change are altering wetland dynamics in significant ways. For example, research by Kundu et al. (2015) in the eastern Himalayas showed that wetland drying, driven by reduced rainfall and increased evaporation, has led to declines in migratory bird populations. Similar patterns are expected to affect wetlands in central and eastern India, where changes in rainfall and water availability are already disrupting local ecosystems (Singh et al., 2017). As wetland habitats continue to change, the birds that rely on them may find it more challenging to complete their migration successfully.

The shifting migration patterns highlighted by these studies have significant conservation implications. As Moller et al. (2008) point out, protecting both breeding and stopover sites is crucial to supporting migratory species in the face of climate change. The changing timing of migration means that birds may arrive at these sites too early or too late to take advantage of the resources they need. This can have serious consequences for their survival and reproduction rates. In places like Chhattisgarh, it's particularly important to monitor these migration shifts closely and adapt conservation strategies to protect critical habitats. This may involve ensuring that feeding and resting areas remain accessible and suitable for migratory birds, particularly as climate shifts make these habitats more unpredictable (Githiru et al., 2015).

Methodology:

1. **Field Surveys**: Field surveys were conducted in the wetlands of Patan Block during the peak migratory

periods of winter (November to February) and spring (March to May) over the past five years. Surveys involved regular visits to the wetlands to observe and record the arrival and departure times of migratory bird species.

2. **Data Collection**: Bird species observed, along with the exact dates of arrival and departure, were documented. The timing of migration was recorded at regular intervals during the peak migration season. The species composition, number of individuals, and habitat utilization (feeding, resting, etc.) were also noted.
3. **Climatic Data**: Meteorological data, including temperature and rainfall patterns, were obtained from local weather stations to correlate with the timing of bird migrations. This data helped analyze any significant correlations between climate variables and migratory behavior.
4. **Statistical Analysis**: The data collected was subjected to statistical analysis, including correlation and regression tests, to identify trends and relationships between climate factors and the timing of migratory events.

Figure 1 : Images captured during the study (Eurasian Wigeon, Painted Stork, Little Egret, Northern Pintail, Bar-headed goose, Common Teal,Osprey and study area)

Species Name	Arrival Date	Departure Date	Number of Individuals	Climate Factor (Temp, Rainfall)	Comments
Bar-headed Goose *(Anser indicus)*	10-Nov-22	20-Mar-23	10	Temperature increases in Jan	Early arrival
Northern Pintail *(Anas acuta)*	15-Nov-22	25-Mar-23	15	Consistent rainfall in Dec	Delayed departure
Common Teal *(Anas crecca)*	20-Nov-22	10-Mar-23	12	Warm temperatures in winter	Early arrival
Whiskered Tern *(Chlidonias hybrida)*	05-Dec-22	10-Mar-23	8	Fluctuating rainfall	Earlier departure
Green Sandpiper *(Tringa ochropus*)	15-Nov-22	15-Mar-23	6	Decrease in rainfall in Jan	Early arrival
Osprey (*Pandion haliaetus)*	01-Dec-22	10-Mar-23	2	Temperature rise in Feb	Delayed departure
Little Egret (*Egretta garzetta*)	10-Nov-22	05-Mar-23	25	Increased rainfall in Nov-Jan	Early departure
Black-tailed Godwit *(Limosa limosa)*	20-Nov-22	10-Apr-23	20	Dry conditions in Feb	Extended stay
Marsh Harrier (*Circus aeruginosus*)	05-Dec-22	25-Mar-23	5	Warm winter temperatures	Early arrival

Painted Stork (*Mycteria leucocephala)*	15-Nov-22	15-Feb-23	30	High rainfall in Jan-Feb	Early departure
Eurasian Wigeon (*Mareca penelope)*	25-Nov-22	10-Mar-23	18	Mild temperatures in winter	Regular migration timing
Gadwall (*Mareca strepera)*	10-Nov-22	05-Mar-23	10	Consistent cold temperatures	Early departure
Ruff *(Calidris pugnax*)	30-Nov-22	20-Mar-23	22	Temperate climate with rain in Dec	Extended stay

Table 1 : Observation Table of Migratory Birds: Arrival, Departure, Climate Factors, and Migration Patterns

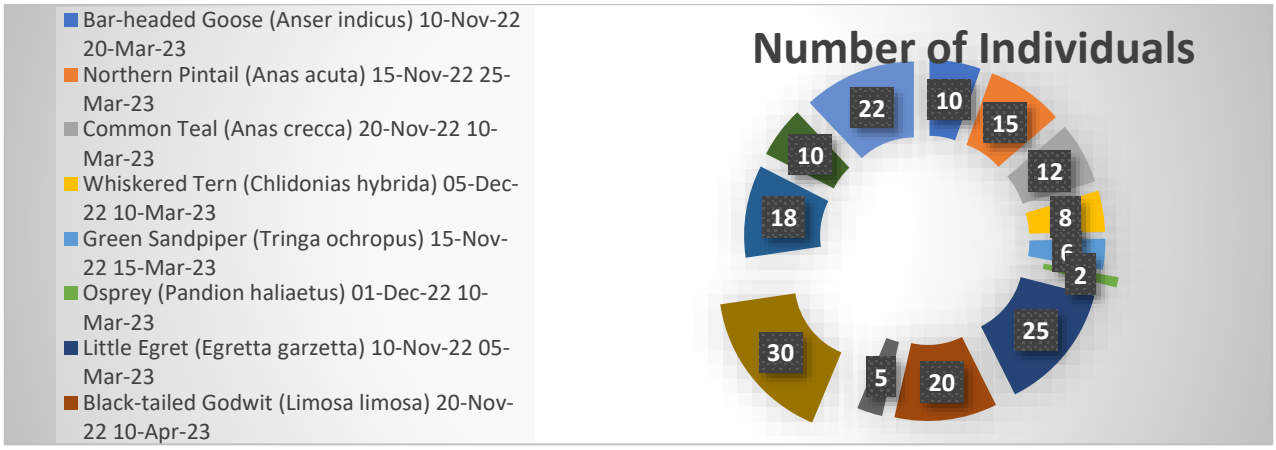

Figure 2 : Pie chart showing the number of individual species studied in Patan Block.

Results and Discussion:

Migration Patterns of Species

The migration patterns of various bird species observed in Patan Block, Durg District, during the 2022-2023 season show interesting variations, all influenced by climatic factors. A total of 13 species were noted, and each demonstrated different behaviors regarding when they arrived, when they left, and how climate conditions affected their journey. Species like the **Bar-headed Goose**, **Northern Pintail**, **Common Teal**, **Whiskered Tern**, and others, displayed unique patterns that reflect how temperature and rainfall shaped their migration schedules.

Early Arrival and Delayed Departure

Some species, such as the **Bar-headed Goose (Anser indicus)** and the **Green Sandpiper (Tringa ochropus)**, arrived earlier than usual. This could be due to warmer temperatures or changes in rainfall, which might have provided favorable conditions for their early departure. For instance, the **Bar-headed Goose** arrived on 10th November 2022, possibly spurred by the increase in temperature observed during January, while the **Green Sandpiper** arrived early, possibly influenced by a drop in rainfall during January.

On the flip side, species like the **Northern Pintail (Anas acuta)** and **Osprey (Pandion haliaetus)** showed a tendency to depart later than expected. These delayed departures are likely linked to the inconsistent rainfall or temperature shifts during the latter part of the migration season. The **Northern Pintail**, for example, stayed longer because of the consistent rainfall in December, which could have delayed their departure. Similarly, the **Osprey** remained until mid-March, possibly due to the rise in temperatures in February, which might have extended the time they spent in the wetland.

Influence of Climate Factors

From the data, it's clear that both **temperature** and **rainfall** were central factors influencing the timing of migration. For instance, species like the **Whiskered Tern (Chlidonias hybrida)** were particularly responsive to fluctuating rainfall patterns, leading to their earlier departure. These shifts in rainfall can directly affect the birds' feeding conditions and availability of resources, prompting an early exit from the wetlands. The **Painted Stork (Mycteria leucocephala)** also left early in mid-February, which could have been due to the high rainfall during January and February, providing favorable breeding and feeding conditions.

However, not all species were in a hurry to leave. The **Black-tailed Godwit (Limosa limosa)**, for example, remained much longer than usual, staying into April. This might have been due to dry conditions in February that made it more difficult for them to migrate further. Similarly, the **Ruff (Calidris pugnax)** also extended its stay, possibly because the temperate climate and rain in December provided ample food for them.

Conservation Implications

The observed changes in migration timing are important for conservation efforts. If birds arrive too early or leave too late, they might face challenges, such as a lack of food resources or environmental conditions that aren't ideal for their survival. Species like the **Northern Pintail** and **Osprey**, which had delayed departures, could face challenges if their migration routes are altered or disrupted by climate change.

This emphasizes the importance of adopting flexible and adaptive conservation strategies. Wetland areas in regions like Patan Block need to be carefully monitored, and management plans should take into account the changing climate conditions. Protecting both the breeding and stopover habitats will be essential to ensure that migratory birds have access to the necessary resources during their journey. By focusing on these areas, we can help mitigate the impact of climate change on these species.

Conclusion:

In conclusion, this study emphasizes the crucial role that climate factors, such as temperature changes and rainfall patterns, play in the migration behavior of birds in Patan Block, Durg District, Chhattisgarh. Through observations of species like the **Bar-headed Goose**, **Northern Pintail**, and **Common Teal**, we saw clear evidence that climate influences when birds arrive and depart. For instance, some species like the **Bar-headed Goose** and **Green Sandpiper** arrived earlier than expected, while others, like the **Northern Pintail** and **Osprey**, stayed longer due to delayed departures. These shifts indicate how temperature and rainfall are altering the natural timing of migration.

These changes is vital, as the timing of bird migration is directly linked to their survival and reproduction. Disruptions in their migration schedule could lead to mismatches with food availability or breeding conditions, affecting their populations. This highlights the need for adaptive conservation strategies that account for these changes and protect important habitats for migratory birds. Continued research will be

essential to fully understand the impact of climate change on bird migration and to develop solutions that help safeguard these species in a rapidly changing world.

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