



# Assessing vulnerability and impacts of climate change on selected coastal bird species of Bhavnagar coastal region

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## Abstract

*Climate change is a very big term which has been there since the earth was evolved. Climate change occurs naturally but has increased after the interference of anthropogenic activities. The impacts of climate change can be observed all over the world. The impacts are observed in agriculture, transport, forestry, coastal etc. Majorly the impacts of climate change are on the agricultural sector and on coastal sector. Coastal life is very important as one third population resides near the coast. Most of the people residing nearby the coast are directly or indirectly relying on coast for their livelihood which also has direct as well as indirect impacts on the marine life. Coastal area is one of the key systems for global sustainability. Coastal regions gained importance because of multiple uses, like high productivity of the ecosystem, highly concentrated population, industry friendly, waste disposal, tourism, transportation, strategic planning in military and many more. These coasts are always in a dynamic state trying to change, and nature always work for maintaining the equilibrium. Despite all that Indian coasts are under threat due to multiple stresses like global climate change and human intervention. These stresses are driving vulnerabilities like sea-level rise, coastal erosion, frequent extreme events, and saltwater encroachment. In this scenario, coastal management has become one of the very important issues in last two decades. Thus, coastal vulnerability assessment methods have been developed to identify and manage vulnerable areas over the coast. Proper planning and protection strategies for Indian coast must be taken swiftly by the coastal management and policy makers to safeguard coastal ecosystem and livelihoods. In recent years, there has been much focus on the coastal vulnerability assessments using various kinds of data.*

**Key Words:** *Vulnerability Assessment, Climate Change Vulnerability Index, Coastal Management Policy*

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## INTRODUCTION

Climate change is one of the all-encompassing global environmental changes likely to have deleterious effects on natural and human systems, economies and infrastructure, due to its effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones, causing multi-dimensional vulnerability. Business and industry have a vital responsibility in making global effort for climate protection successful. Current study shows that the overall cost of climate change amount to losing 5% or more of the world's GDP annually. If an extensive range of risk or influences are considered, the damage cost could be 20% of global GDP.

Rising atmospheric CO<sub>2</sub> is one of the most critical problems because its effects are globally pervasive and irreversible on ecological timescales. The primary direct consequences are increasing ocean temperatures and acidity. There have been few systematic reviews of the impacts of rising CO<sub>2</sub> and climate change on marine ecosystems. A political economy approach is argued for- using the 'entitlements approach' in the analyses of vulnerability. From a natural hazard perspective then, vulnerability may be defined as the characteristics of a person, or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard.

We can use the Index as part of a variety of analyses, including assessing the relative risk of species of any assessment of the vulnerability of species to climate change. The UNFCCC (United Nations Framework Convention on Climate Change) highlights two fundamental response strategies: mitigation and adaptation. While

mitigation seeks to limit climate change by reducing the emissions of GHG (greenhouse gases) and by enhancing 'sink' opportunities, adaptation aims to alleviate the adverse impacts through a wide-range of system-specific actions.

Developing countries are highly vulnerable and have less coping capacity. Based on the evaluation of vulnerability, India is one of the most vulnerable to projected climate change. The adaptation and mitigation agenda are needed and of much importance as the population of Indian cities is likely to grow by 500 million over the next 50 years. In India 12% of land is vulnerable to floods in coastal areas. Mean climate variability is projected along India's coast and this sea-level would eventually have tremendous socio-economic impact on local communities and their livelihood. Risk in the Indian cities is more of associated to intrinsic vulnerability rather than external exposure to hazards. Thus, it is very necessary to understand the parameters that cause vulnerability in coastal disasters.

India is one of the world's most vulnerable countries to climate change. About half of India's population is dependent upon agriculture or other climate sensitive sectors and about 76 percent of the population lives on less than \$2 a day.

Gujarat stands out, amongst all the Indian states, for its economic growth. With only five per cent of the country's population and six per cent of the country's geographical area, Gujarat contributes to about 16 per cent of industrial and 12 per cent of agricultural production in India, and is dominant in the manufacturing and infrastructure sectors.

## STUDY AREA

Sartanpar is a Village in Talaja Taluka in Bhavnagar District of Gujarat State, India. It is located 54 km towards South from District headquarters Bhavnagar 253 km from State capital Gandhinagar. Sartanpar is surrounded by Palitana Taluka towards west, Sihor Taluka towards North, Mahuva Taluka towards South, Ghogha Taluka towards North. Talaja, Palitana, Sihor, Mahuva are the nearby Cities to Sartanpar. It is near to Arabian Sea. There is a chance of humidity in the weather. Current Temperature is 26 °C, Humidity: 50% and Wind: From NW at 7 kph.

Gopnath Beach is a beach situated in the Talaja Taluka of Bhavnagar district of Gujarat state of India. It is located on the coast of the Gulf of Khambhat, at a distance of 75 km from the city of Bhavnagar and 22 km. away from Talaja. Gopnath is a pristine beach known for its natural beauty. There is nice fort of king of Gohilvad in Gopnath.



Map of study area (Source: Google earth)

## METHODOLOGY

The CCVI (Climate change Vulnerability Index) bases its determination of vulnerability to climate change on two main factors: exposure to future projected climate change and sensitivity to climate change.

Sensitivity to climate change is based on a variety of factors, including dispersal capability; past climate regime and reliance on specific thermal and hydrological conditions; dependence on disturbance; restriction to certain geological types; reliance on inter specific interactions (e.g., herbivory and predator/prey relationships); genetic



variation; and climate related changes in phenology. Each species is scored for each sensitivity factor from “decrease vulnerability” to “gently increase vulnerability” (or subset range of these categories). Descriptions of each factor and examples of how to score them are available in the spreadsheet to help assessors make choices with scoring. Some factors are optional, but certain numbers of factors in each group must be filled out or the Index score is “insufficient Evidence.”

The output is one of the five categories of vulnerability and one indicating lack of evidence. Definitions, and the abbreviations that are used throughout this document.

**Extremely Vulnerable (EV):** Abundance and/or range extent within geographical area assessed extremely likely to substantially decrease or disappear by 2050.

**Highly Vulnerable (HV):** Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050.

**Moderately Vulnerable (MV):** abundance and/or range extent within geographical area assessed likely to decrease by 2050.

**Not Vulnerable/Presumed stable (PS):** available evidence does not suggest that abundance and/or range extent within the geographical area assessed will change (increase/decrease) substantially by 2050. Actual range boundaries may change.

**Not Vulnerable/Increase likely (IL):** Available evidence suggests that abundance and/ or range extent within geographical area assessed is likely to increase by 2050.

**Insufficient Evidence (IE):** Available information about species vulnerability is inadequate to calculate and index score.

## RESULT AND DISCUSSION

The index aims to use component analyses to consistently arrive at a 3-level series of scores; i.e., High, Medium, and Low; where quantitative data are available, numerical scores should aim to be normalized to a 0.0 to 1.0 scale. Numerical results for component analyses are then averaged. However, where quantitative models are unavailable for a given analysis, expert categorization for each score is sufficient. The H/M/L result for resilience is the average of scores for indirect effects and for adaptive capacity. The H/M/L result for sensitivity is the average of scores for 10 direct effects. From this point, a simple logic model combines categorical results for resilience and sensitivity to arrive at an overall categorization of climate change vulnerability.

	Weather		LULUC				Disaster					
<b>Black headed Ibis</b>	Temperature	Precipitation	Man grove cover	Vegetation Cover	Vegetation Density	Vegetation Diversity	Cyclone	Drought	Flood	Heat wave	Urbanization/Commercial/Industrialization	Coastal tourism
Habitat	L	L	H	H	H	H	H	L	L	L	H	H
Breeding	L	M	L	L	L	L	H	L	L	M	L	H
Feeding	L	L	H	H	H	H	H	L	L	L	H	L

Table-1 H/M/L values of different parameters affecting different phases of Black headed Ibis.

	Weather		LULUC				Disaster					
<b>Indian Skimmer</b>	Temperature	Precipitation	Man grove cover	Vegetation Cover	Vegetation Density	Vegetation Diversity	Cyclone	Drought	Flood	Heat wave	Urbanization/Commercial/Industrialization	Coastal tourism
Habitat	L	L	H	H	H	H	H	M	L	L	H	H
Breeding	L	M	L	M	L	L	H	L	L	M	L	M



Feeding	M	L	H	H	H	H	H	L	M	L	H	L
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Table-2 H/M/L values for different parameters affecting different phases of Indian Skimmer.

	Weather		LULUC				Disaster					
<b>Lesser Flamingo</b>	Temperature	Precipitation	Man grove cover	Vegetation Cover	Vegetation Density	Vegetation Diversity	Cyclone	Drought	Flood	Heat wave	Urbanization/Commercial/Industrialization	Coastal tourism
Habitat	L	L	H	H	H	H	H	H	L	L	H	H
Breeding	L	M	L	H	L	H	H	H	L	M	H	H
Feeding	L	L	H	H	H	H	H	L	L	L	H	L

Table-3 H/M/L values for different parameters affecting different phases of lesser Flamingo.

	Weather		LULUC				Disaster					
<b>Painted Stork</b>	Temperature	Precipitation	Man grove cover	Vegetation Cover	Vegetation Density	Vegetation Diversity	Cyclone	Drought	Flood	Heat wave	Urbanization/Commercial/Industrialization	Coastal tourism
Habitat	L	L	H	H	H	L	H	L	L	L	H	H
Breeding	L	M	L	L	L	L	H	L	L	M	L	H
Feeding	L	L	H	L	H	H	H	L	L	L	H	L

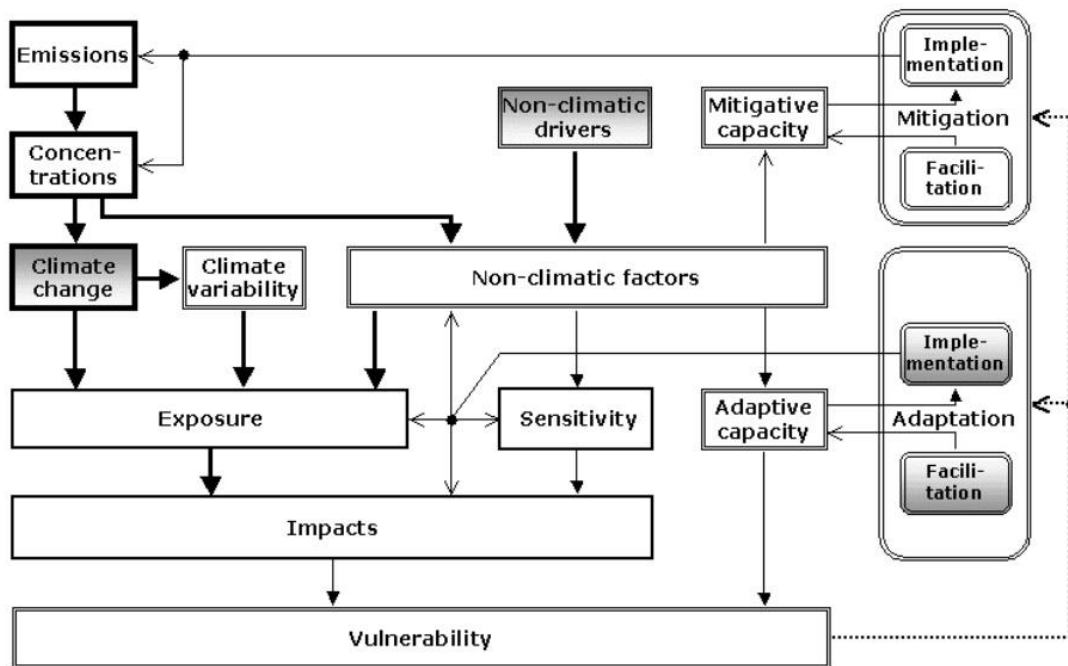
Table-4 H/M/L values for different parameters affecting different phases of Painted Stork.

**Very High climate change vulnerability** results from combining high sensitivity with low resilience. These are circumstances where climate change stress and its effects are expected to be most severe, and relative resilience is lowest. Ecosystem transformation is most likely to occur in upcoming decades.

**High climate change vulnerability** results from combining either high or moderate sensitivity with low or medium resilience. Under either combination, climate change stress would be anticipated to have considerable impact.

**Moderate climate change vulnerability** results from a variety of combinations for sensitivity and resilience; initially with circumstances where both are scored as moderate. However, this also results where resilience is scored high, if combined with either high or medium sensitivity. Where both resilience and sensitivity are low, some degree of climate change vulnerability remains.

**Low climate change vulnerability** results from combining low sensitivity with high resilience. These are circumstances where climate change stress and its effects are expected to be least severe or absent, and relative resilience is highest.



**Figure 1:** - Flow Chart for Habitat Climate Change Vulnerability Index (HCCVI)

## CONCLUSION

Study for species vulnerability index indicates that selected bird species like Black headed Ibis (*Threskiornis melanocephalus*), Indian Skimmer (*Rynchops albicollis*), Lesser Flamingo (*Phoeniconaias minor*) and Painted Stork (*Mycteria leucocephala*) for them more vulnerable factors are Coastal tourism, Land use land use changes (Urbanization, Commercialization and Industrialization), Disaster (Cyclone – but Bhavnagar is less prone to the cyclone as compared to other coast, but yes in future is there is a possibility of disaster then it makes more harm to the species) and depletion of mangrove cover. Direct effect from climate change like temperature rise is directly affecting reproduction of birds also seasonal shifting is responsible for degradation for the number of species. Changes in precipitation can affect coast plant growth, soil moisture, water storage, insect abundance and distribution so it is also affecting the food chain of bird species. Mangrove forest require stable sea level for long term survival. They are therefore extremely sensitive to current rising sea levels caused by global warming and climate change. Mangrove forest and estuaries are the breeding and nursery ground for a number of marine organisms including birds. Mangroves are also shield against cyclone, ecological disaster and as protector of shorelines. So basically, species are more vulnerable to changes in land use as compared to climate change. Although climate change is affecting land use pattern and the vegetation cover of mangrove. There are also possible impacts due to sea level rise, many studies prove that species are becoming vulnerable, threaten and extinct due to rise in sea level, but here in Bhavnagar there is no strong evidence of sea level rise. Therefore this study concludes that there is a possible effect on sea shore (coast) birds due to sea level changes.

Analysis done by meteorological data also proves that there is change (In term of increase and decrease as well) in temperature, Cold and precipitation. Due to climate change there will be long term effect but recently degradation in the number of species is more due to changes in land use pattern and coastal tourism. As we know that the tourism and especially coastal tourism is increasing day by day this study also conclude that species are more affected due to coastal tourism and habitat disturbance. One of the reasons is anthropogenic activity which disturb their habitat. Due to Industrialization/commercialization (Sea foods), urbanization the food chain and habitat are disturbed and will disturb more day by day. Vulnerability index indicates that out of 10 points the vulnerability due to coastal tourism, cyclone and mangrove cover change shows highly vulnerable rate. If it will continue for 25 years the species Painted Stork, Lesser Flamingo and Black-headed Ibis will become extinct.

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