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Economic impact of climate change on Mumbai, India

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Abstract

Climate change impacts will lead to economic losses for various sectors. In this paper the impacts of climate change on the financial capital of India, Mumbai, have been delineated. These include the impact of temperature rise on rains and floods, and their consequent effects on health. The other consequences such as rise in deaths from vector-borne diseases, dislocation due to floods and sea-level rise have been shown as projected economic losses for the years 2025 and 2050. The economic costs of sea-level rise in terms of loss of property along the coastline have also been projected for a 25- and 50-year timescale respectively. The costs arising due to increase in malaria, diarrhoea and leptospirosis outbreaks have been projected till 2050. The conservative estimate of total costs of all these impacts, including the impact of climate change on tourism, are found to be enormous.

Introduction

According to the National Climatic Data Center (NCDC),¹ the United States of America, the 13 warmest years of the last century occurred within the last 15 years, with the years 2001, 2002 and 2003 being the hottest years ever recorded.

Mega coastal cities like Mumbai could face profound consequences from climate changes. Mumbai has a high exposure level to such changes due to population density, and its major industrial and financial installations. Furthermore, the major proportion of its reclaimed land is in low-lying areas and the high population of its urban poor has limited coping capacity to face the consequences of climate change.

According to an earlier estimate of a study conducted 10 years ago, the economic damage to Mumbai, the country's financial capital, as a result of climate change could

amount to over Rs 2 lakh crore².# However, since then, urbanization and investments have only gone up in Mumbai.

According to the Intergovernmental Panel on Climate Change (IPCC), the sea level is expected to rise at the rate of 2.4 millimetres (mm) per year in India. By the middle of the century the rise will be 38 centimetres (cm). This would inundate low-lying areas, drown coastal marshes and wetlands, erode beaches, exacerbate flooding and increase the salinity of rivers, bays and groundwater.

Economic impact

Increase in temperature will lead to an increase in rainfall intensity and frequency. Extreme precipitation is likely to increase substantially over the western coast and west-central India. Overall, the summer monsoon rainfall will show a 20% increase over the

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#Rs 10 lakh = Rs 1 million
Rs 10 million = Rs 1 crore

present rate; the increase will be seen in all the states except Punjab, Rajasthan and Tamil Nadu. Simulations with climate models and observations indicate that rainfall extremes such as the Mumbai deluge of 2005 could become more frequent in India under the impact of climate change⁴. Both 2005 and 2006 had spells of excessive rainfall that normally would have occurred once in about 100 years. It has been observed that till 1989 the average rainfall of Mumbai was 2129 mm⁵. However, in 2005-2006 the average annual rainfall was found to be of 3214 mm, an increase of 50%. Besides the rainfall-related issue, energy consumption will also be a major issue.

Increase in rainfall and rise in the mean sea level (MSL), in addition to the poor

drainage of the city will increase the frequency of floods. Almost one fourth of Mumbai comprises low-lying areas (below or at MSL). Therefore low-income groups and poor residents living in vulnerable locations (accounting for nearly 50% of Mumbai's population) will be affected more.

A conservative estimate shows that about 40% population will be affected in the city of Mumbai as shown in Figure 1. Frequent floods and salt-water intrusion will affect the structural stability of high-rise buildings, which are mushrooming at an increasing rate. Floods, especially in the low-lying areas of the city, will result in dislocation of people and also deaths.

Figure 1: Low-lying areas in South Mumbai



Human health is another major area where the impact of climate change could be very severe. Such an impact would translate mainly into three major illnesses – diarrhoea, malaria and leptospirosis.

The tourism sector will also be hit by climate change. It is likely to suffer a loss of Rs 1 963 500 crores by the year 2050.

An economic analysis has been performed to understand these impacts with a view to plan out adaptability strategies for the city for the period up to 2050³. These cost considerations take into account the most conservative figures with regard to the period of impact, population affected, loss of earnings and material damage.

Table: Estimated economic losses due to the impact of climate change in Mumbai

Type of impact	Type of costs and period of impact	Cost in rupees (crores)
Dislocation due to extreme events of flooding of low-lying areas - every five years till 2050*	Cumulative costs over the period 2005–2050	407.6
Material damage to low-lying areas due to extreme events – every five years till 2050*	Cumulative costs over the period 2005–2050	6413
Mortality costs due to extreme events of flooding – every five years till 2050*	Cumulative costs over the period 2005–2050	3050
Disability-adjusted life years (DALYs) lost due to diseases like malaria, diarrhoea and leptospirosis**	Cumulative costs over the period 2005–2050	3153
Building-foundation damages for the period till 2050 due to sea-level rise***	Single-cost estimate for the year 2050	15 01 725
Tourism loss: less number of tourists visiting Mumbai****	Single-cost estimate for the year 2050, as compared with the base year 2005	19 63 500

*The costs of work disruption and material damage, as well as mortality costs (loss of earnings) have been computed on the basis of a conservative approach wherein it has been assumed that flooding would be limited to five days in an year and also that the frequency of such extreme occurrences shall be once every five years. The computation has been limited to the year 2050. It also conservatively assumes that the population in these areas will not change, though it would change depending upon the local government policy of development relevant to the timeframe up to 2050. Population figures have been taken from the census for locations shown in Figure 1 based on the area and density of population.

**Increase in the incidence of malaria, diarrhoea and leptospirosis would result in loss of income due to non-working days and deaths. Losses have been computed using Disability-adjusted life years (DALYs) for all the major illnesses likely to impact the population. Incidence of all these illnesses will increase steadily with increase in income loss; a sharp increase is likely from 2045 to 2055. By 2050 the cumulative income loss due to malaria, diarrhoea and leptospirosis, calculated on the basis of DALYs will be 155 597 and 2401 crores, respectively. The calculation of DALYs is based on the World Health Organization (WHO) guidelines^{8,9} and income levels prevalent for Mumbai.

***Due to sea-level rise there will be loss of coastal area and ingress of sea water. Assuming that sea water penetrates 200 m inland, calculations have been made showing the monetary loss due to buildings getting affected in the region near the shore. The current loss has been computed on the basis of the present value of buildings. This is based on the assumption that buildings along the coastline located within 200 m from the shore will get affected due to rise in the sea level and ingress of sea water.

****Calculations are based on Tourism Statistics of India¹⁰. Future costs have been calculated using the average gross domestic product (GDP) growth rate of India. It also takes the current rates of 6% and 13% increase respectively in domestic and foreign tourism per year into account.

Computations for economic losses due to climate change have been summarized in the table below. The first four types of costs indicated are for likely impacts of extreme events. The other two costs are for losses likely to be witnessed by the year 2050. The latter could turn out to be much higher if the frequency of occurrences of extreme events and their duration increase over the period considered in this analysis.

Besides the frequent disease outbreaks, heat stress caused by the rising mercury would also affect the workforce of the city. Episodes of heat cramps, heat exhaustion and heat stroke would affect the population, primarily the large poor section of the society. As the immune system weakens due to heat stress, susceptibility to diseases would further increase. The resulting increase in expenses on health care by individuals would escalate leading to greater stress. Hence, this vicious cycle would lead to depreciation of human resources. Besides human beings, heat stress would not even spare the cattle sheds. It has been found that cattle are more sensitive to heat stress; this could impact milk production from cattle sheds in Mumbai. The effect of raised body temperature is an adaptive depression of the metabolic rate associated with reduced appetite. Factors such as water deprivation, nutritional imbalance and nutritional deficiency may exacerbate the impact of heat stress.

Responses needed

Though there are indications of the impacts of climate change that could possibly be felt, their micro detailing has not been attempted as yet. Therefore, there is a need for such detailing for Mumbai to understand the

economic implications of these impacts and to deal with them effectively. The following could be some of the responses based on anticipated climate changes:

- Micro-level planning for developing an effective drainage system is needed.
- Building experts and other related experts will need to detail the steps to be taken for new building construction practices in order to reduce the salt content of building materials. For older buildings, an assessment and remedial plan will need to be prepared. Buildings very close to the sea shore also need to be examined from the point of view of stability of the land due to erosion (near Dadar and Juhu).
- Greater investment in health sector will be needed for treating people affected by climate change. More health care facilities and health infrastructure will be needed.
- Anti-erosion measures will need to be put in place at beaches and sea-fronts.
- The protection plan for mangroves and other wetland areas needs to be implemented.
- Energy conservation measures at all levels (appliances, building design, energy use pattern and alternative sources of energy, etc.) need to be instituted.
- An urban ecosystem enhancement (creation of more open spaces, greenery, parks and tree-lined roads, etc) needs to be undertaken.

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