

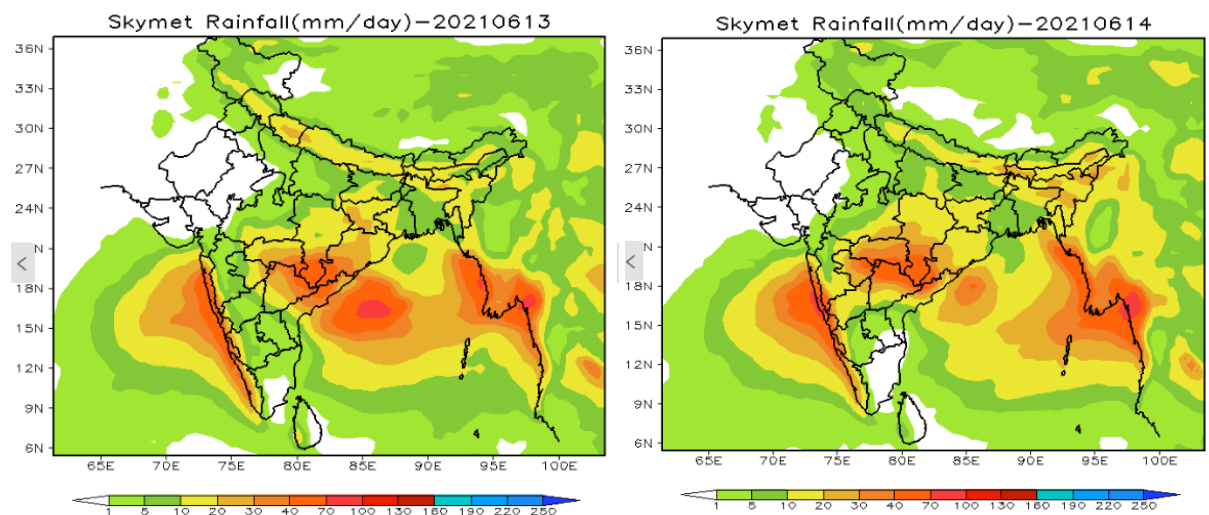
## Mumbai Monsoon: Global warming and rising threat of floods to the maximum city

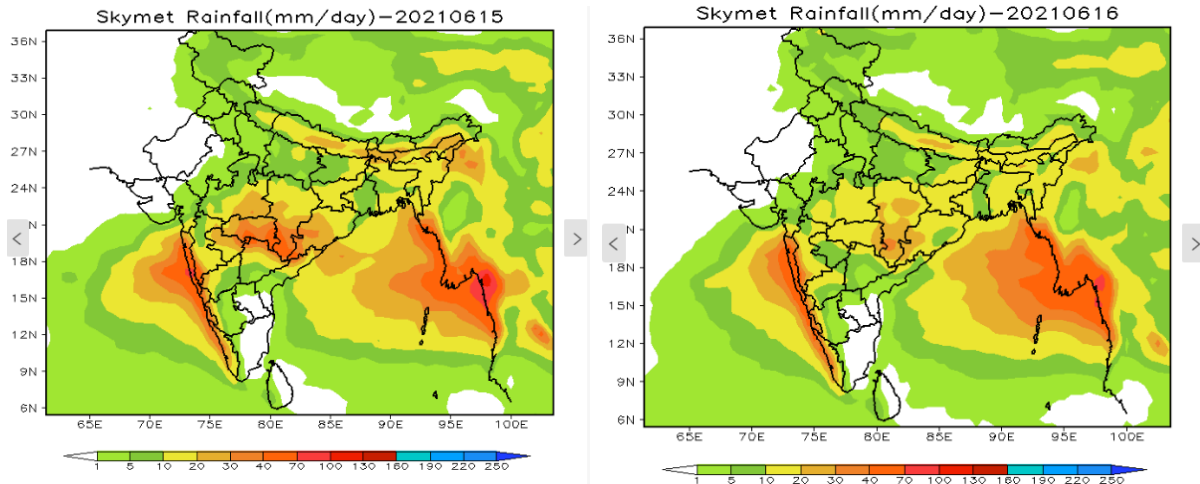
It is not very long when we saw extremely severe cyclone Tauktae wreaking havoc in Mumbai and claiming several lives. And now, it is the Mumbai Monsoon that has wrenched the maximum city on the very first day of its arrival.

Santa Cruz Observatory recorded a whopping 231 mm of rain in a span of 24 hours from 8:30 am on Wednesday. Although, it is not something unusual for Mumbai as the city has been witnessing several spells of 3-digit rainfall every year during the Monsoon season. According to weathermen, the ongoing weather is a very typical pattern of Mumbai Monsoon. However, it is now the coming days to watch out for as meteorologists warn of flood-like conditions in Mumbai.

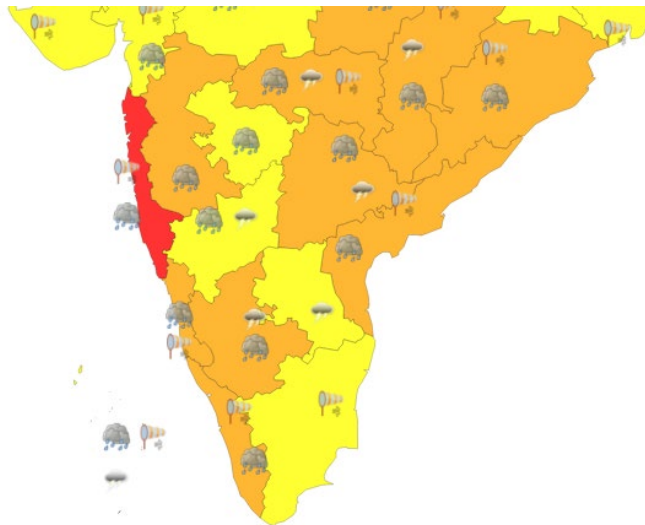
**GP Sharma, ex-AVM Meteorology, Indian Air Force and President-Meteorology and Climate Change at Skymet Weather** said, "A cyclonic circulation is marked over East-central and adjoining North Arabian Sea, along with an off-shore trough running off the West Coast. As a result, strong westerly winds were reaching Mumbai, resulting in extremely heavy showers."

Rains are likely to take a brief break on June 11. But with another weather system coming up in Bay of Bengal, heavy to very heavy rains will return June 12 onwards. "A cyclonic circulation is marked over east-central and adjoining Northeast Bay of Bengal. The weather system is expected to organize and deepen into a low-pressure area by tonight. In the subsequent 24 hours, it is likely to intensify further to a well-marked low or depression over the Head Bay of Bengal. Monsoon systems prevailing on either side of the coast tend to interact with each other, bringing widespread rainfall. This is known as 'dumble effect'. We can expect active to vigorous Monsoon conditions from June 11 to June 15. The western arm of the monsoon over the Arabian Sea will strengthen to lash the entire West Coast (Kerala, Karnataka, Goa, Konkan) with heavy to very heavy rains between 09th and 16th June. Mumbai will directly come in the firing range of Monsoon. The severe flooding situation is quite likely over and around Mumbai between June 13-15," **added Sharma.**





State-run India Meteorological Department (IMD) has also issued red alert for heavy rainfall for Mumbai on June 13-14. *Image Courtesy: [India Meteorological Department](#)*



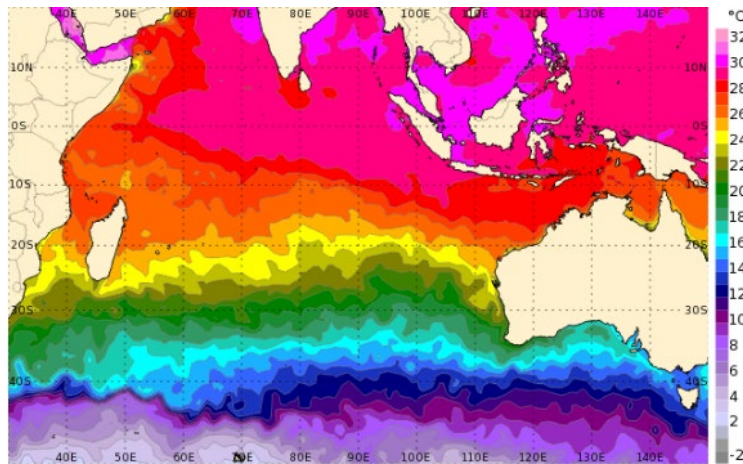
### How climate change is influencing the weather

We saw Cyclone Tauktae intensifying manifolds on account of above normal sea surface temperatures across Arabian Sea. In fact, by the time it was passing Mumbai, it had already intensified into an extremely severe cyclone, just one level down from being a super cyclone. Atmospheric conditions were so ripe that had there been more sea travel left ahead, it would have become a super cyclone too.

Although we do not see a similar situation right now, but global warming is surely playing a major part this time too. As per the weather experts, there is plenty of moisture available in the atmosphere with the onset of Monsoon. And, with sea surface temperatures still very warm, it will continue to fuel intensification system forming in Indian basins.

**Dr Roxy Mathew Koll, climate scientist at the Indian Institute of Tropical Meteorology, Pune** states, "Ocean and atmospheric conditions are still very much conducive for weather systems to intensify. Though there has been some sea surface cooling post the cyclones, the ocean continues to be warm with

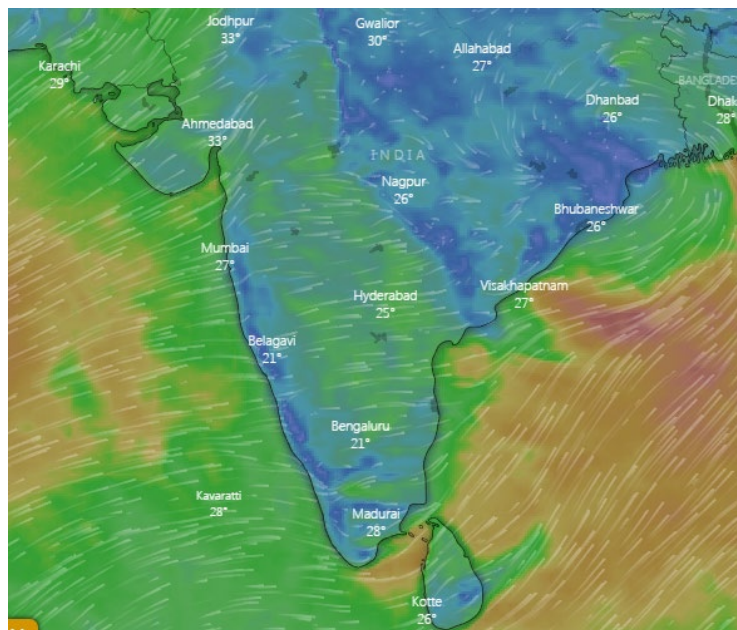
temperatures hovering around 30°C and over. These warm sea surface temperatures and low vertical wind shear are conducive for a low-pressure system to form and intensify over the north Bay of Bengal, but not a cyclonic storm. Arabian Sea is also warm and moist, so the monsoon winds may carry more moisture as it gets pulled inland and strengthens in response to the low-pressure system in the Bay. Our research shows that there is an increasing trend in these kinds of events resulting in heavy rains over the west coast and central India.” Image courtesy: [Bureau of Meteorology](#)



Sea surface temperature (deg C): Daily analysis for **Wed 9 Jun 2021**  
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**G P Sharma said,** “Mumbai rains have a peculiar feature wherein wind direction must be westerly for over the city. No matter how strong the system is but if winds are not westerly, rains would evade Mumbai. Now, the system in North Bay of Bengal, which is getting marked incessantly, would pull winds in westerly conditions. Stronger the system in head Bay of Bengal, better would be the flow of westerly winds over the Konkan region including Mumbai.”

Checkout the live [wind pattern](#) across the country:



## Threats to Coastal Cities

As climate change triggered tropical cyclones are on the rise in coastal India, the unplanned development adds to the vulnerability of these cities. For instance, flooding in India over the last decade caused \$3 billion of economic damage – about 10% of global economic losses from flooding. Cyclone Amphan in 2020 affected 13 million people and caused over \$13 billion in damage after it made landfall in West Bengal.

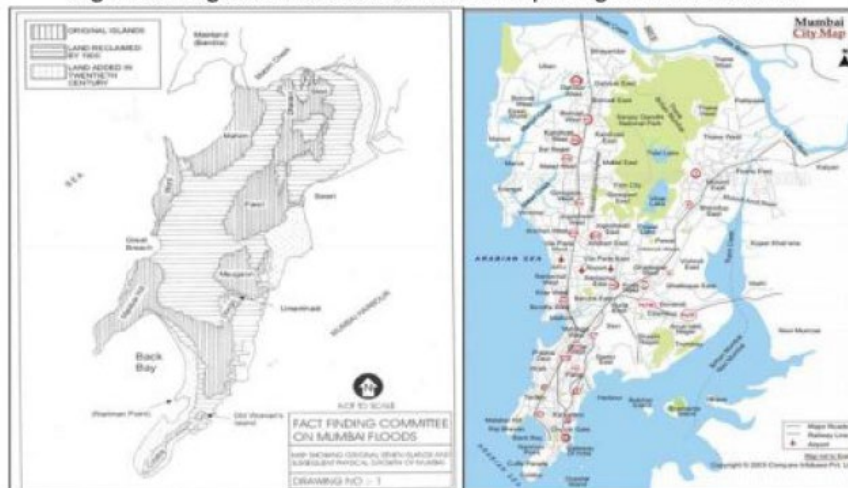
Multiple studies claim that India's largest coastal cities, like Mumbai and Kolkata, are facing the severest threats from climate-induced flooding. Floods in Mumbai and Kolkata are attributed to the impact of [climate shifts, urbanization, sea-level rise and other regional factors](#).

According to a report by the Ministry of Earth Sciences (MoES), Government of India, Assessment of Climate Change over the Indian region, Mumbai region is highly vulnerable to climate change due to sea-level rise, storm surge and extreme precipitation. During the last 20 years, Mumbai has already seen massive flood events in 2005, 2014, 2017.

Mumbai floods 2005 saw heavy downpour to the tune of 994 mm of rain in just 24 hours and 684 mm in only 12 hours. Rains triggered massive flooding of the Mithi river. The impact was further amplified by the high tide and inadequate drainage and sewage resulting in massive flooding.

Planned and unplanned development in most ecologically sensitive zones in these cities fail to address the risks of climate-change-related flooding owing to tendencies to sidestep questions of politics, power and the distributional conflicts that shape urban development. Mumbai has observed an unprecedented growth in the last few decades, methodically constructing on mangrove forests. Mangroves are swamp forests which provide many ecosystem services to coastal communities. The density of the trees, together with the variety of tree species, attenuate the inflow of water and create a sort of buffer zone against floods and storm surges.

Figure 1: Original seven islands and subsequent growth of Mumbai



Source: MCGM, 2006; MCGM, 2015

A recent [study](#) by Council for Energy Environment and Water (CEEW) states that more than 80 percent districts in Maharashtra are vulnerable to drought or drought-like situations. Districts like Aurangabad, Jalna, Latur, Osamabad, Pune, Nashik and Nanded are drought hotspots in the state. While on the other hand, it is quite evident that traditionally drought-prone districts have shown a shift towards extreme flood events and storm surges in the last decade. Additionally, there has been a six-fold increase in frequency of extreme flood events in Maharashtra in the last 50 years. These trends are a clear indicator of how climatic unpredictability is on the rise, making risk assessment a bigger challenge with increased compound disasters and threats.

### **Economic costs of climate change: Disastrous flooding in Mumbai**

Greater Mumbai is home to over 20 million people and is one of the most densely populated cities in the world. It is the financial capital of India with a large commercial and trading base. However, most of the coastal city lies less than 15 m above sea level and almost a quarter lies below or at mean sea level. It is therefore one of the most vulnerable port cities in the world, facing a wide range of climate-related risks including storm surge, flooding, coastal erosion and sea-level rise.

Climate change is certainly not the only driver of environmental risk in Mumbai. The city was originally built on a series of islands hugging the coast. However, its lakes, rivers, mudflats, wetlands, mangroves, woods and coastline have gradually been built over to serve a growing population and economy. The increase in hard surfaces and loss of tree cover has prevented rainfall from seeping into the groundwater. Instead, it runs rapidly over the asphalt and concrete, pooling in low-lying parts of the city instead of flowing into the sea. Poor sewage and drainage systems exacerbate the health risks of flooding, which include diseases such as malaria, diarrhoea and leptospirosis.

A [new review](#) by global think tank, ODI, explains that Mumbai has already been experiencing catastrophic floods and the city is ranked fifth in the world with annual losses of \$284 million. In July 2005, flooding killed 5,000 people and caused economic damage totalling \$690 million. Floods will only get worse when combined with the heavier rains, higher sea levels and more severe storms associated with climate change. In fact, experts have projected annual losses from flooding will reach \$6.1 billion per year in 2050. Most of these losses are uninsured and borne by individuals or small businesses.

Low-income rural communities who are dependent on coastal ecosystems for food and livelihoods would come in direct line of fire as the disappearance of coral reefs, degradation of mangroves and saline intrusion into the water table hampers the productivity of agricultural land and natural ecosystems.

***Amir Bazaz, Senior Lead-Practice at the Indian Institute for Human Settlements, said: "As we are seeing now with Cyclones Taukte and Yaas, low-income and other marginalised groups are most vulnerable to the impacts of climate change. They often live in dense settlements that lack basic services and infrastructure that could reduce risk. Many households also live on hazardous sites such as steep slopes and floodplains. It is therefore crucial to bring climate and development goals together."***

Cost of inaction or delays in mitigation and adaptation will only add to the cost incurred by climate change. This in turn acts as a dent on the plans for eradicating poverty and economic development.

**Rathin Roy, Managing Director (Research and Policy) at ODI**, said *“Pursuing a cleaner, more resource-efficient path to development could stimulate a faster, fairer economic recovery for India and help secure India’s prosperity and competitiveness in the long term. Lower-carbon options are more efficient and less polluting, producing immediate benefits such as cleaner air, greater energy security and rapid job creation.”*

A [survey](#) conducted to understand the perceptions and awareness of climate risks to large, medium and small businesses in the state of Maharashtra, found that Large Industries (78%) display relatively stronger acknowledgement of the issue versus MSMEs (68%) and over 50% believe that climate change impacts their sector, and 45% believe that it impacts their business as well. Overall, heavy rainfall, floods, cyclones, water shortage and rising temperature were seen as the main threats of climate change across industries and sectors. More than 400 businesses across sectors were surveyed and 37% of businesses each claimed that climate change is resulting in “capital destruction” and “destruction of flora and fauna which is leading to loss of business”.

### **Global warming impact on urban areas**

According to a report by global think tank, ODI, ‘The costs of climate change in India: a review of the climate-related risks facing India, and their economic and social costs’, although sea levels along the Indian coast would not rise as global sea levels are projected. However, slight increase will have a severe impact on infrastructure and property, particularly in low-lying and densely settled cities. This puts India’s three metropolitan cities of Mumbai, Chennai and Kolkata on high risk.

In general, urban areas are prone to river or flash flooding. The report “[Assessment of Climate Change over the Indian region](#)” stated that the major factors for urban floods include the effect of anthropogenic geographical alterations, inadequate drainage and storm water management system as well as high structural inhomogeneity due to intense land-use changes in proportion to increased urban population, and the increasing population.

Under global warming, the observed increasing trend in heavy rainfall events has resulted in more frequent and intense flash floods over urban areas. It is also reported that the regions which are not traditionally prone to floods experience severe inundation due to downpour and cloud burst during recent decades.