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Effects of Climate Change on Slums with a
Special Focus on Mumbai, India

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Abstract

The contribution of the upper classes and lower classes to climate change are extremely contrasting. Those who lack the resources to contribute to climate change also lack the resources to fight it. Through the survey and consequent research conducted, this paper challenges what the general public assumes to be common knowledge in terms of slums being the root of all problems that an urban city like Mumbai faces. Highlighting the actual factors that cause climate change like improper waste management, lack of strong legislation in place for structural demolition and development, it also dives into what the consequences of them lead to climate injustice. The authors recommend several measures ranging from higher resident investment, youth awareness, to the proactive role that authorities should play with regards to identifying and serving the slum dwellers.

Keywords: *Climate change, slums, Mumbai, urban, development, waste management, contribution, climate injustice, awareness*

1.0 Introduction

"If not me, then who?

If not now, then when?

If not here, where?

Better start the change with you, right here, right now"

- *Hillel the Elder*¹

As the clock ticked down at the Metronome's 62-foot-wide 15-digit Climate Clock, it became inevitable that now is the time for a unified action against climate change. "The Earth has a deadline", the clock said on 19-Sept 2020 3:20 pm, warning the world with the numbers 7:103:15:40:07 (years, days, hours, minutes and seconds respectively) until that deadline. "The only constant in life is change," said Heraclitus². However, with the rapid rise in the mercury level, what is needed right now is the contrary of change in terms of climatic temperature. The purpose of this research is to paint a clearer picture of that which already exists. Climate change exists in the lives of each and every person on Earth. However, it is the lower strata of the society that is most rapidly getting affected by it. And it is their lives that this research intends to portray, with a focus on Urban Slums of Mumbai.

A sea of economically unstable people move into the slums of Mumbai, crammed into the tiny spaces, living a confined existence. Subjection to several side-effects of climate change leaves them with an insurmountable damage but life goes on. The lack of responsibility of authorities goes hand-in-hand with the ignorance of the slum dwellers, who have accepted these hardships as a part and parcel of life. Majority of their solid waste, instead of being ethically disposed, gets accumulated within the community itself or is informally disposed of. Ironically, Mumbai's informal recycling industry functions within these communities itself and has even been said to be more efficient than the ones in the United Kingdom, making the city more livable for everyone except for themselves.

¹ A Jewish religious leader

² An ancient Greek philosopher

A number of national as well as international bodies are working together to collectively battle climate change. In India, various legislations enacted for environmental protection have all contributed in their own ways to reverse the effects of Climate Change. Yet, all these measures aren't enough and the lack of awareness among people is making things worse. In this regard, the authors conducted a survey of 30 participants, intended to verify the secondary data that already existed. The same was aimed at residents of the Mumbai slums, especially, students who are relatively more literate and therefore, capable of answering the survey.

2.0 Causes of Climate Change

Human activities like burning fossil fuels, cutting down rainforests and farming livestock are constantly influencing the climate and the earth's temperature, adding enormous amounts of greenhouse gases to the atmosphere and leading to an increase in these greenhouse gases and thus leading to global warming. (European Commission, 2017) It has been named so due to the few naturally occurring gases in our atmosphere that acts like the 'glass' in a greenhouse. They trap the sun's heat, stopping it from leaking back into space. A few of these gases like carbon dioxide (CO₂), methane, nitrous oxide, and fluorinated gases are naturally occurring and have always existed in the atmosphere. However, over the years human activity has led to hazardous concentration of these gases in our atmosphere.

CO₂ is the greenhouse gas most commonly produced by human activities and it is responsible for 64% of man-made global warming. Its concentration in the atmosphere is currently 40% higher than it was when industrialization began. Other greenhouse gases are emitted in smaller quantities, but they trap heat far more effectively than CO₂, and in some cases are thousands of times stronger. Methane is responsible for 17% of man-made global warming, nitrous oxide for 6%. (European Commission, 2017) These emissions lead to Global Warming. Global warming occurs when carbon dioxide (CO₂) and other air pollutants and greenhouse gases collect in the atmosphere and absorb sunlight and solar radiation that have bounced off the earth's surface. Normally, this radiation would escape into space—but these pollutants, which can last for years to centuries in the atmosphere, trap the heat and cause the planet to get hotter. That's what's known as the greenhouse effect. (MacMillan, 2016)

The current global average temperature is 0.85°C higher than it was in the late 19th century. Each of the past three decades has been warmer than any preceding decade since records began in 1850. The world's leading climate scientists think human activities are almost certainly the main cause of the warming observed since the middle of the 20th century. (European Commission, 2017)

2.1 Improper disposal of waste

With the evolution of science and based on different needs of humans, the products and their materials we use also keep changing. Be it cloth, steel, plastic or something else, there are several different kinds of raw materials used to create them. Based on the multiple factors such as raw material used, usage, biodegradability, etc. waste is classified into three categories.

The three kinds of waste that exist are:

1. Biodegradable waste (wet waste) is made up of vegetable and fruit remainders, leaves, spoiled food, eggshells, cotton, etc.
2. Recyclable (dry waste) consists of newspapers, thermocol, plastic, battery cells, wires, iron sheets, glass, etc.
3. Debris includes construction waste, renovation waste, demolition waste, etc. Silt comprises earth and clay from drains and road corners.

It was estimated that by 2008 all of this waste would aggregate 9,000 tonnes per day due to the increase in the city's population. The Municipal Corporation of Greater Mumbai (MCGM) is formally responsible for the management of waste in the city. The prevailing approach has been one of collection and disposal, that is, garbage is collected from communities by the municipal authorities and disposed of at the three main dumping sites that are currently servicing the city. This largely manual operation involves 35,000 personnel employed by the MCGM and is collected by a fleet of 800 vehicles, including vehicles hired from private contractors. The amount of waste that is generated requires 2,000 trips every day to be collected and transported to the dumping grounds further contributing to pollution. (Davis, n.d.)

The dumping ground is where 95% of the waste generated in the city is disposed of. A dumping ground is, generally, a low-lying and marshy area, which is located on the outskirts of a city, where there is, usually, no human population. There are three dumping grounds which are

located in the northern part of Mumbai at Gorai (Borivali), Mulund and Deonar. (Davis, n.d.) Naturally, all the waste that can be sold is collected by the rag pickers from these dumping grounds and sold to informal dealers. However, all the organic and toxic waste that has no value is left at the dumping ground in large quantities to rot.

In Mumbai, every day 2,000 tonnes of debris is generated officially, of which some part goes to the dumping ground for spreading over the organic garbage, as the earth is expensive. The remaining debris is spread next to the roads, in the creeks, next to railway tracks and on open grounds. (Davis, n.d.) Renovation of old houses, buildings, structures generates the most debris. This debris is used to fill low-lying areas or for reclamation. Currently, no permission is required from the authorities except from the housing society for carrying out renovation. The only responsibility of the renovators is to clean up/dispose of the waste that is generated. There are truckers who earn a livelihood by collecting this debris and transporting it for disposal. However, disposing it off properly remains a concern, as there is very little space in Mumbai. It has to be carted over long distances which increase transportation costs so significantly as to make the entire “business” unprofitable. So it is dumped clandestinely in the creeks, thus, destroying our valuable mangroves. (Davis, n.d.)

As Mumbai has a coastal stretch of 603 sq. km, it has numerous creeks. These are channels of water which occupy marshy land during high tide. The salty water nurtures plants called mangroves. These plants have leaves which provide oxygen to the water for fishes to breed in the creeks. In many areas, like Versova, Gorai, Charkop and Mankhurd, the entire ecosystem of the creek has been destroyed as waste is dumped surreptitiously. (Davis, n.d.) Lately, rising land prices and construction activities are leading to demolition and new constructions. Both of these lead to more debris. Debris is heavy in nature and occupies more space, filling up the landfill faster than any other kind of waste. This in turn reduces the lifespan of the dumping ground. Therefore, municipalities, generally, refuse the entry of debris into dumping grounds other than what they need to cover the garbage. Finding few viable alternatives, people dump the debris by roadsides. Over time, people start dumping organic waste on top of debris not only compounding the waste disposal problem but also creating a health hazard. (Davis, n.d.)

2.1.1 Contribution of slums

In India, there has been a tremendous increase in urban population. The total urban population of the country had almost doubled by 1988. By 1991, it was 84.94 million and by March 2001, it had reached 285 million marks. The decadal growth rate of urban population has been 31.2%. By 2025, more than 50% of the population of India would be living in cities and in towns. This would obviously pose a challenge to the authorities of these mega million cities and towns in terms of planning, funds, and management.

In the 2011 Census three types of slum were recorded:

1. Notified slum (recognized and formally notified by the authorities, known as code1)
 2. Recognized slum (recognized but not formally notified by the authorities, known as code 2)
 3. Identified slums (should be identified and assigned, known as code3)
- (Government of India, 2019)

For example if the total Indian slum population is 100% then the notified slum occupy 34.3%, recognized slum 30.04% & identified slum 35.3%. (Swami, 2017, p. 11) As per provisional reports of Census of India 2011, the population of Mumbai city (excluding the metropolitan areas consisting of Ambernath, Badlapur, Greater Mumbai, Kalyan and Dombivali, Mira and Bhayander, Navi Mumbai, Thane, and Ulhasnagar) in 2011 was 12,442,373. Total number of slums in Mumbai city was 1,135,514 in which a population of 5,206,473 resided. (Mumbai (Greater Mumbai) City Population Census 2011-2020 | Maharashtra, n.d.) Since then, due to industrialization and consequent migration of rural population to the urban areas, lack of employment and livelihood opportunities in the rural areas, absence of adequate facilities in urban areas, low wages and ineffective land reforms have led to an increase in the populations of slum dwellers in Mumbai. Even though slum dwellers account for 41.84% of the total population of the Mumbai city, they occupy only 12% of its total geographic area. (FPJ Bureau, 2018)

Although, deeply studied, identified, and categorized, slums and slum dwellers struggle to be acknowledged and to receive basic facilities. The garbage collection activity itself has several differences amongst the localities; there are highly-serviced areas, medium-serviced areas and low-serviced areas. The low-serviced areas which are the slums are not seen as the rightful recipients of the formal systems of solid waste management (SWM). The local government extends its services only to regularized slums which are declared official or recognized under the census of slums (Notified and Recognized slums). This step-motherly treatment is, in effect, the city's own undoing, since slums form 12% of Mumbai city. Moreover, these artificial boundaries can hardly prevent the spread of dirt and disease. (Davis, n.d.)

Identified slums are deprived of even a basic structure or facility to dispose of their waste. This waste, however, has to go somewhere. This leads to informal disposing of waste. This waste isn't collected and disposed of in a specific spot. Instead, it's thrown away right after it has served its purpose; into the gutter, sewage, drains, behind houses, etc.

Where do you throw away your family's garbage? Aap apne ghar ka kachra kahan phekte hain?
30 responses

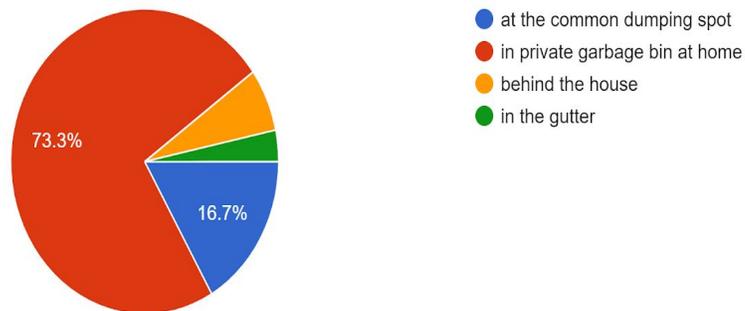


Figure 1: Survey participants' response to where they dispose of their family's waste.

2.1.2 Contribution of the 'Healthy, Wealthy and the Wise' (Middle and Upper class of the Society)

Mumbai generates waste to the tune of approximately 7,025 tonnes per day. The waste consists of:

- 5,025 tons of mixed waste (biodegradable and recyclable)
- 2,000 tons of debris and silt.

The generation of waste by an individual depends on the socio-economic conditions to which the person belongs to. A rich family will generate nearly 4 to 5kgs of mixed waste per day; a middle-class family will generate between 1 to 3kgs of mixed waste per day and a poor family, in slums, will generate close to 500grams per day. (Davis, n.d., pp. 1–7)

Evidently, the amount of waste that a rich family generates is approximately ten times the waste generated by a family living in the slums; however, the slum dwellers pay the price for it.

3.0 Effects of Climate Change

In 2016, the National Academies of Science, Engineering, and Medicine (USA) announced that it's now possible to confidently attribute certain weather events, like some heat waves, directly to climate change. (MacMillan, 2016) The observed frequency, intensity, and duration of some extreme weather events have been changing as the climate system has warmed. Scientists agree that the earth's rising temperatures are fueling longer and hotter heat waves, more frequent droughts, heavier rainfall, and more powerful hurricanes. The earth's ocean temperatures are getting warmer, too—which means that tropical storms can pick up more energy. So global warming could turn a category 3³ storm into a more dangerous category 4⁴ storm. The impacts of global warming are being felt across the globe. Extreme heatwaves have

³ 129mph, 96-112kt, 178-208km/h

Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.

⁴ 130-156mph, 113-136kt, 209-251km/h

Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

caused tens of thousands of deaths around the world in recent years. And in an alarming sign of events to come, Antarctica has been losing about 134 billion metric tons of ice per year since 2002. This rate could speed up if we keep burning fossil fuels at our current pace, some experts say, and causing sea levels to rise several meters over the next 50 to 150 years. (MacMillan, 2016)

3.1 Effects of Climate Change in Slums

No matter what the problem, the consequences of it are more evident for and intensely felt by the slum dwellers. Because of climate change, the rainfall density increases leading to more frequent floods. Poor people tend to be told what and what not to do to save the planet from any more harm even though they don't even have the resources to harm the planet in the first place.

Although, these issues affect all slum dwellers, the most affected are women and children. "While both women and men in poverty suffer from climate change, gender discrimination means women have fewer resources to cope. Women retain the full burden of household chores, spending hours every day using low-quality household solutions for lighting and cooking. The biggest health hazard is caused by kerosene used for lighting. Burning the fuel in poorly ventilated places contributes to indoor air pollution, the equivalent of smoking two packets of cigarettes per day. This causes premature death in women and young children" said Alexie Seller, CEO, Pollinate Group. (Dey, 2019) Additionally, burning firewood is a major contributor to ailments and the environment. It's not as if they wish to burn firewood but are forced to do so due to lack of basic resources.

3.1.1 Vulnerability of the slum dwellers

The increase in the population of the city has forced people to settle near the dumping grounds. This has led to the twin problems of people living in unhealthy conditions and protesting for the closure of the dumping grounds, as dumping causes health hazards for the people in the vicinity. The organic waste dumped in the dumping grounds undergoes natural decomposition and generates a fluid, which is known as a leachate, and is very harmful to the ecosystem, if not treated properly. The leachate penetrates the soil and, if not prevented, pollutes the groundwater. (Davis, n.d.) Furthermore, the census identified the number of semi-permanent

houses in Mumbai city to be 24,606 (3.86% of total houses) and temporary houses to be 5,059 (0.79% of total houses). (Directorate of Census Operations MAHARASHTRA, 2011) This means during the natural disasters or even during mild to extreme weather conditions, aggravated by climate change; the worst affected are these semi-permanent house residents, temporary house residents and the homeless. The effects of climate change lead to harsh living conditions in turn, leading to several other consequences ranging from life long ailments to loss of personal belongings.

3.1.2 Physical Ailments

Flies, mosquitoes and many other pests breed on the waste and unless properly maintained, dumps are a public health hazard. Naturally, the people living next to these dumping grounds are the most affected. Allergies, asthma, and infectious disease outbreaks have and will continue to become more common due to increased growth of pollen-producing ragweed, higher levels of air pollution, and the spread of conditions favourable to pathogens and mosquitoes. (MacMillan, 2016)

"The awareness level about climate change is less in women who live in slums. In Delhi slums, for example, many women are suffering from allergy problems, the reasons for which are generally waste accumulation in the surrounding areas, no proper sanitation system, and waterlogged drains which are mosquito breeding spots. But, they don't know that their health issues may be induced because of the environment. A problem that all slum dwellers face is asthma, because of the rising pollution levels in Delhi. They are not aware that these issues are happening because of climate change and what are the solutions and preventions," Kalyani Raj, Secretary-General, All India Women's Conference. (Dey, 2019) Even though Mumbai and Delhi are different cities located in different states, the same problems and their consequences exist across borders.

3.2 Factors

The world today is filled with several products that are not good for the environment. In a time when so many people are switching to more sustainable, biodegradable, zero-waste or eco-friendly options, the ones who are unable to make the switch are looked down upon. Moreover, their lifestyle is judged and their contribution to generating plastic waste scrutinized. A major factor that leads to accumulation of plastic in the slums is also their socio-economic background. This paper delves deeper by analyzing the factors that are at play here.

3.2.1 Economic Factors

How much income does your family generate in a month? Ek mahine mein aapke ghar wale kitna kamate hain?

30 responses

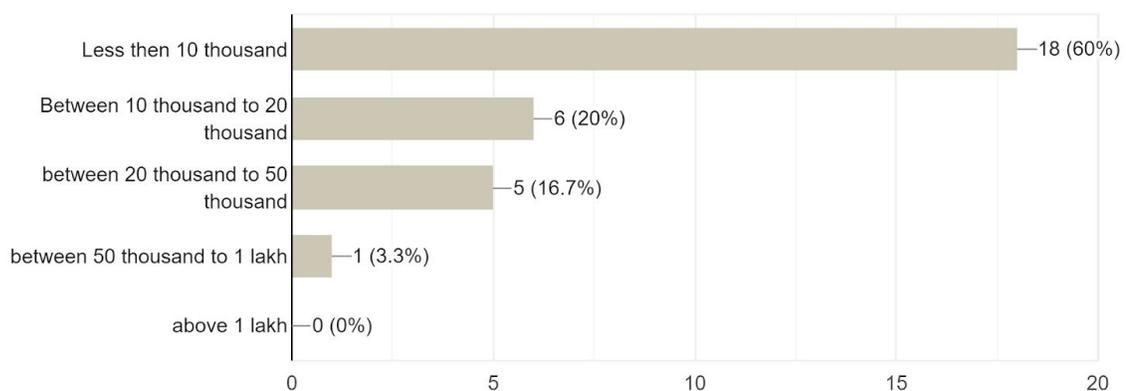


Figure 2: Survey participants' response specifying their family's monthly income

Slum conditions are defined by the United Nations as having inadequate access to durable housing, a sufficient living area, safe water, sanitation, basic services, and protection against forced eviction. These slums are often unhealthy environments for populations as a whole and particularly for vulnerable groups such as young children. (Huey, 2019) Based on the survey conducted, out of the twenty families who lived in slums, eighteen of them earned less than ten thousand rupees in a month and four of them earned between ten to twenty thousand. Earning as less as that, it is almost impossible to make ends meet in a city as expensive as

Mumbai. After paying the rent, electricity bills, fees, buying rations, and every other cost a life incurs, it becomes extremely difficult to get the recommended nutritional intake.

3.2.2 Inaccessibility to Nutritious Food

Deriving from the above observation, the lack of financial resources means that the individual's priority when buying food will be that it's cheap instead of nutritious. Cheap food tends to be packaged in plastic since plastic is cheap, it reduces the overall price of the product compared to being packaged in metal, glass or any other kind of packaging. Even though mid-day meals are served at public schools that exist in these areas, the provision and quality of those meals is questionable. Between 2015 to 2017, 467 students across Maharashtra suffered food poisoning after eating mid-day meals. (Pandit, 2017)

A recently published report on mid-day meals under the Centre's Midday meal (MDM) programme on its official website has revealed that Mumbai is one of the lowest-performing regions in the state of Maharashtra with over 32 per cent students in the region not having access to mid-day meals due to various reasons. As per the statistics stated in the report, 33 per cent of students studying under BMC schools and 51 per cent of students studying under other schools in the Mumbai region have no access to midday meals. It doesn't come as a surprise then that students feel the need to get their own food from home, a home which can't afford multiple nutritious meals to begin with.

How many plastic wrapped food products do you consume in a week? Aap plastic packets mein milne wali cheezein hafte mein kitni baar khaatein h... plastic bags, food delivered in plastic boxes, etc.
29 responses

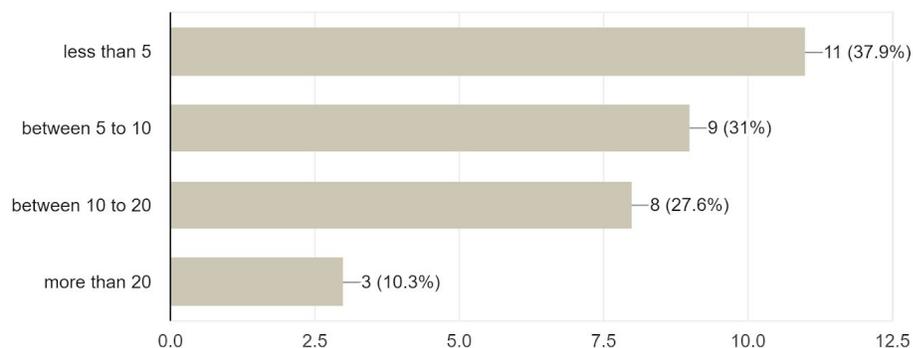


Figure 3: Survey participants' consumption of plastic-wrapped food products in a week

3.2.3 Malnutrition among Children and accumulation of plastic

According to a study conducted in the slums of Mumbai, just under half of children born in 48 Mumbai slums were likely to develop stunting, although their malnutrition may not have been obvious because they were generally not overtly thin for their stature. Socioeconomic status was a clear determinant, larger infants tended to ‘catch down’, and the pattern may have been set well before birth. About 21% of infants were born with low weight and the associations were unsurprising factors like poverty, less education, lower parity, etc. (Das, 2012) Based on an observation of a public school classroom located in the slums of Mumbai, students almost always brought multiple packets of chips and biscuits for lunch whenever they did. After multiple students were questioned about it, it was understood that the quantity of food in one packet wasn’t enough to satisfy their appetite and the food was cheap enough to be bought in multiples, therefore, the students did. This meant that the number of plastic-packaged food was increasing due to affordability leading to accumulation of plastic waste in slums.

On an average, how many plastic products do you throw away in a week? Aap ek hafte mein kitni plastic ki cheezein phektein hain? for eg. plastic bottles, plastic bags, plastic box, etc.
28 responses

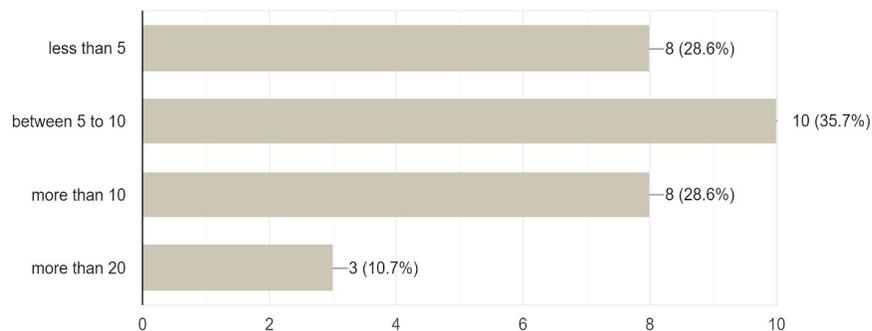


Figure 4: Survey participants’ response to the number of plastic products disposed in a week

Through the survey, a pattern was identified. 66.7% of the participants admitted to their family’s health ranging from falling sick sometimes to having a lifelong illness forming a strong correlation between the kind of residence of the participant, the lifestyle they have there, the

quality of food intake and physical ailments.

Generally, how would you describe the health of most people in your family?

30 responses



Figure 5: Survey participants' response to their family's health status in general

3.2.4 Rains

The present stormwater drainage system in Mumbai is over 70 years old capable of handling rain intensity of 25 mm per hour at low tide (Rana, 2013). Data analysis by Gupta K. (Gupta, 2007) that peak rainfall intensity for 15-minute duration exceeds 72 mm/h over 80% of the time is well over the current handling capacity of the drainage system. The situation is further exacerbated by urban encroachment such as slums, channel blockages and bad civic sense with debris and garbage ending up in drains. (Chandola, 2014) The Mithi river was originally created to take the flow load off the city, is now frequently dumped with debris and other solid and toxic liquid wastes. This leads to extreme pollution, damage, destruction to the lives of thousands of the residents living on the river banks and polluting the water at beaches accessed by lakhs of people on a daily basis. The flood that occurred in 2005 caused devastation in the central parts of Mumbai and it is estimated that the event will be repeated again in the next couple of decades.

Rana et al. did an analysis for the period 2010 to 2099 that showed significant intense strong rains coming in more frequently (Rana, Bosshard, 2013) in all future climate projections, amounts of precipitation increase ranging from 20% to 40% and occurrence of number of extreme rain events going up in the range of 0% to 40% even after considering factors that affect Mumbai's rains. (Chandola, 2014) During such events and even during comparatively milder

ones, the power circuits are affected and the electricity goes off. Several slums are built over land that wasn't useful to residential colonies i.e. on hills, therefore, during heavy rains; the slums on these hills are under the threat of landslides too. It isn't unsurprising that during such rains, slums which are usually located in low lying areas tend to get flooded. These slums that are semi-permanent or temporary in the first place also have unstable roofs, the rainwater flows into the houses through the roofs as well as any other ground openings, damaging most of the personal belongings of the residents. When it rains, the houses fill with water that drags black mould down the walls and seeps under the door, bringing with it the festering sludge of outside Mumbai. Lastly, out of all the houses, 13,041 (2.04%) of the houses in the slums receive tap water from untreated sources. (Directorate of Census Operations MAHARASHTRA, 2011) On top of that, during heavy rains, the water gets further contaminated and leads to water-borne diseases. Based on the survey conducted, more than 50% of the participants revealed that they didn't have or struggled to get access to clean water during rains.

Do you get clean drinking water during rains? Kya aapko baarish mein saaf paani milta hai?
29 responses

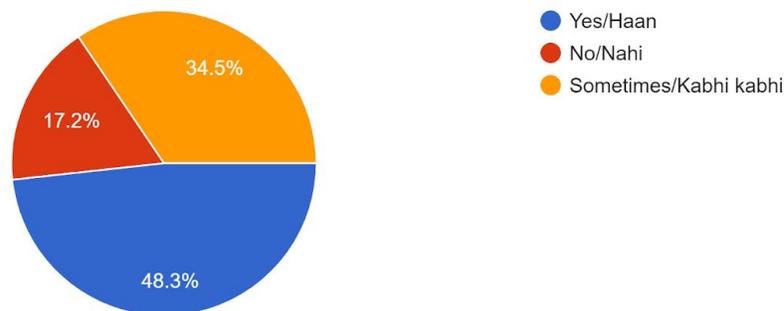


Figure 6: Survey participants' response to the availability of clean drinking water during the monsoon season.

3.3 Extremes of temperature

With the rising temperatures, Mumbai is experiencing a rise in many tropical diseases which only two decades back had declined or were non-existent. For example, the city of Mumbai has witnessed a marked increase in the instances of dengue and TB since 2008. (Chandola, 2014) During the summer season, the tiny rooms of the slums with tin sheds above

get extremely heated up making it almost unbearable to live inside. These houses become hot chambers making people suffer in their own sweat. In the dry season, the tin roof traps the heat inside the shacks, making it difficult to even breathe. In most houses, there is no ventilation and some of them don't even have a fan. On the other hand, some winter nights become too cold owing to the lack of strong structures that can keep the outside cold from permeating the thin tin sheets or walls. The year 2019 brought violent weather and environmental disasters across the world, and in India, at least 2,038 people died due to extreme weather events. According to the survey conducted by the authors, 70% of the participants admitted to being affected by extreme temperatures too.

Do the high or low temperatures affect the people in your community severely? Kya garmi ya thandi ke wajah se aapke area mein koi problems hoti hai?

30 responses

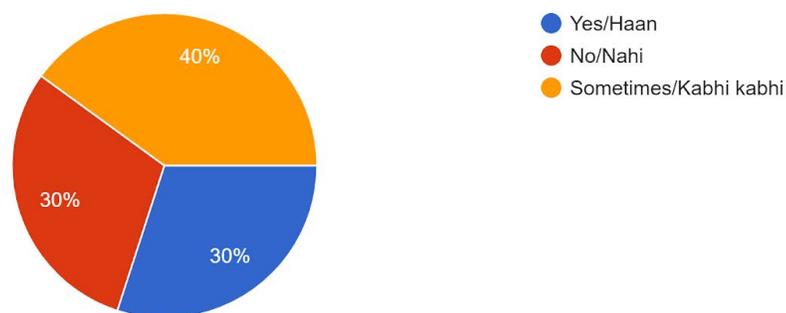


Figure 7: Survey participants' response to being affected by the fluctuating temperatures

While some slums consist of just a few houses, others are vast — Mumbai's famous Dharavi, for example, spans almost 2.2 square kilometres with a population of about a million. The living conditions in these communities are rough since most slums lack effective infrastructure and the houses are fragile, leaving people already highly exposed to the weather. Now that the climate is becoming ever more extreme, the adversity people face is escalating. Heatwaves in 2019 directly killed roughly 350 people in India. In Rajasthan, temperatures reached 50.3 degrees Celsius and for slum dwellers, retreating inside offered little reprieve.

About two-thirds of the country's reservoirs held below normal water levels in 2019, adding to the already steady depletion of groundwater, which supplies 40 per cent of India's water demands — but is predicted to run out in 21 cities this year due to overuse.

Slum-dwellers always live with limited water, but as shortages worsen, what little they have is likely to dramatically dwindle.

3.4 Rising sea levels

Rising sea levels is a long term result of climate change, as is mentioned in the Kyoto Protocol 1997, that might result in the inundation of low land areas whether inhabited or not. This Sea level rise is caused primarily by two factors related to global warming:

- The added water from melting ice sheets and glaciers and
- The expansion of seawater as it warms.

However, rising sea levels do not mean to scare the immediate inhabitants of coastal areas in Mumbai. Accordingly in the survey, when these people, mostly children, were asked about its immediate effects, most of them denied it as a concern. On being asked if the rising sea levels affected the participants of the survey, 30% of them owed certain problems in their life to the rising sea level if not at all times then some.

Do the rising sea levels have any immediate effects on your life? Kya samundar ka paani badhne ke kaaran aapke life mein koi problem ho rahi hai iss samay?

28 responses

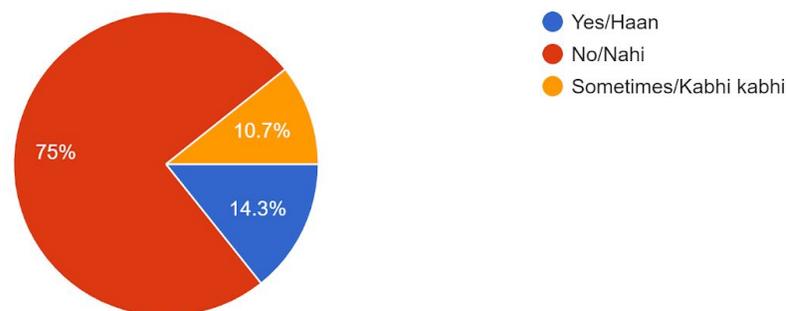


Figure 8: Survey participants' response to being affected by the rising sea water levels

4.0 Climate Injustice

The relationship between India's poor and India's rich runs parallel to that of India or any other Third world nation and the developed nations of the world. Between them, the wealth and the waste are distributed, but unequally. While a small and yet powerful fraction of people takes most of the former, the rest of the people on earth are forced to live in the latter. (2017) Similarly, in case of Climate change, there is an unfair distribution of the benefits and damages that it causes. Climate change impacts all people around the globe, but the effects of it is evidently felt by the social and economically weak. "Therefore the situation becomes such that the people who contribute least to climate change are the ones who get affected the most by it." (Dey, 2019) This phenomenon is, in fact, most evident in big cities, where slum dwellers often suffer heavily because of climate change, despite their minimal contribution in causing it. Kavya Michael, an Associate Fellow at The Energy and Resources Institute (TERI), likes to call this situation paradoxical which is in violation to climate justice. (Dey, 2019) "Slums or informal settlements contribute least to the emissions," Michael told a news agency News18.com. "In a way, waste picking done by slum dwellers is also an ecosystem service because they are cleaning up the city. But, the effects of climate change fall on slum dwellers heavily. This is a classic case of climate injustice," she added. (Dey, 2019)

Climate Justice is the process of viewing climate change through the lens of human rights, where all human beings are deemed equal rights and it intends to protect the rights of those who are most vulnerable to the climate crisis and its effects. Slums which are built on low-lying land are more vulnerable to flooding during extreme weather conditions, as was seen in Mumbai floods in 2005 and are also more vulnerable to extreme heat, due to urban heat pockets within cities and the negative impact of greenhouse gas emissions. (Dey, 2019)

"Everyone needs to have an equal right to amenities and services that a city provides. But, those who live in these informal settlements, which are deemed illegal by the government, are mostly migrants. Therefore, they do not necessarily have access to the public distribution system. This reduces the entire support system they have," Michael pointed out. (Dey, 2019)

5.0 Role of Authorities

It becomes difficult for an average adult who has never been to school, to figure out ways and measures that could benefit one's own community and the world at large. So, figuring out garbage disposal on one's own for these slum-dwellers is not an option. The authors believe it the responsibility of the government and the local authorities to make them aware of the consequences of their actions and support them with measures to ensure better solid waste management in the slums. Without any awareness of what proper disposal of waste looks like or what facilities are owed to them by the government, citizens cannot be expected to follow the said structures or access the much-needed facilities.

Has any government body/individual ever explained effective garbage disposal to you? Kya kabhi kisi government wale ne aapko samjhaya hai ki kaunsa kachra kaise aur kahan phekna chahiye?
29 responses

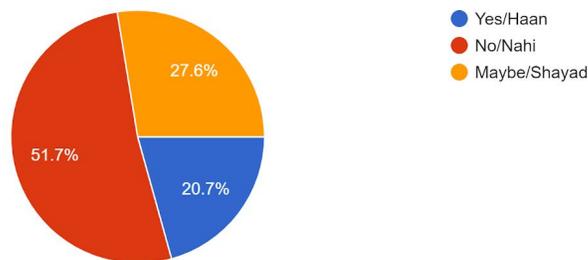


Figure 9: Survey participants' response on being asked if they were made aware of what effective garbage disposal is and how it can be implemented

Are you aware of and access most of the government services & facilities about waste management available for you? Kya aapko kachre ke...aapko jaankaari hai aur kya woh aapko milti hain?
30 responses

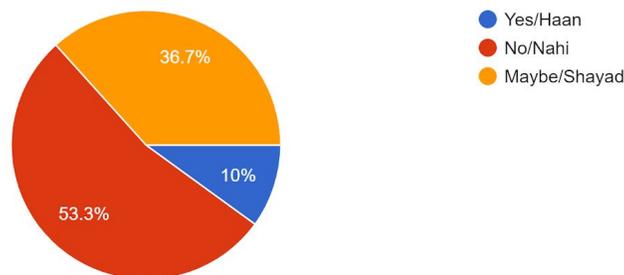


Figure 10: Survey participants' awareness and accessibility to waste management services provided by the government

There are other complications to address and the government plans of development, aimed at a transition from slums to apartments can be nothing less than challenging. Many slum dwellers feel that the state should be providing a solution to their poverty and lack of economic growth.

Currently, the only state initiative for the Mumbai's urban poor is a resettlement program under the Slum Rehabilitation Authority (SRA), a government entity that handles slum policy and redevelopment regulations in Mumbai. Since slums begin as squatter settlements, landowners hold a right to evict them. However, if they don't do so within a certain time period, the squatters gain partial rights to that land which in turn means that if they are evicted, they have to be rehoused. The SRA, and a few NGOs under it, are working to create financially viable situations for developers and slum dwellers alike. (Osborne, 2020)

6.0 Adaptation to Climate Change

Slums are usually treated as eyesores and looked at as eyesores though they're a solution to a problem that the best of city planners have been unable to address, housing. "Almost half of Mumbai's population lives in slums, and the area they occupy is roughly around twelve per cent, and still, we call them a problem?" said Yash Panday, founder of Footprints E.A.R.T.H, an Ahmedabad based architecture firm. "I am not romanticizing slums, but it is energy efficient. All they need is land and infrastructure, which of course the government can provide," he added. (Dey, 2019)

Dharavi is a fully functioning economy with 5000 businesses and 15,000 single-room factories. Therefore, these slums function as workspaces with residential facilities reducing the need for slum dwellers to travel or take public transport. India is known as the second most polluted country in the world. In Mumbai alone, 9,400 tonnes of waste is generated daily. With 15,000 factories dedicated to recycling and sorting Mumbai's waste, Dharavi employs 250,000 people just for this. 80% of Mumbai's solid waste is recycled and given new life within Dharavi (<https://greenisthenewblack.com/author/trisha/>, 2018)

7.0 Measures to control Climate change

Climate change is a global phenomenon and it becomes imperative for all nations to come together in addressing issues related to it. The effects of climate change is felt by all sections of people across nations, therefore the solutions need a global platform to work. Following are some of the key events that have shaped the way climate change is addressed in today's scenario on the global stage.

7.1 The Kyoto Protocol, 1997

Kyoto Protocol entered into force on 16 February 2005 becoming the first edition to the United Nations' Framework Convention on Climate Change (UNFCCC), an international treaty that committed its states in developing action plan programs, targeted at reducing the emission of greenhouse gases. an increase in the number of extreme climate-related events. Currently, there are 192 Parties to the Kyoto Protocol.

The targets for the first commitment period of the Kyoto Protocol cover emissions of the six main greenhouse gases, namely:

- Carbon dioxide (CO₂);
- Methane (CH₄);
- Nitrous oxide (N₂O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulphur hexafluoride (SF₆)

7.2 The Paris Conference (2015)

Officially known as the 21st Conference of the Parties (COP) to the UNFCCC, the aim of the conference has been to bring all nations under a common cause to undertake ambitious efforts to combat climate change, strengthening the global responses to its threats. Additionally, the agreements also target to strengthen the abilities of countries to deal with the impact of Climate change. On the 22nd of April, 2016 a whopping 174 countries signed the agreement in New York, aiming to, aiming to adopt it in their own legal systems.

7.3 Measures within the nation

As a developing nation, India has kept up with the other nations in the process to tackle the effects of global warming and has thereby come up with feasible solutions to control it. Some of the major changes brought about within the nation are listed below.

7.3.1 Major climate laws

As a large, emerging economy, India faces big challenges relating to energy and climate change. On one hand, the country has hundreds of millions of people without access to electricity and an economy demanding more energy to power growth. These pressures mean that energy use, and emissions, are likely to grow substantially over the next few decades. At the same time, India is vulnerable to the impacts of climate change, in particular, water stress, impacts on agriculture and susceptibility to weather-related disasters (Climate Home, 2013)

7.3.1.1 National Action Plan on Climate Change/2008

Despite having no obligation, as a developing country, to tackle emissions, India is coordinating comprehensive policies across the economy covering both mitigation of greenhouse gas emissions and adaptation. (Climate Home, 2013) India's approach has so far been one of policy rather than comprehensive climate change legislation. For example, the National Action Plan on Climate Change from 2008 outlines eight national 'missions' that run up to 2017. These missions include:

- The National Solar Mission (setting a goal of increasing production of photovoltaic electricity to 1,000MW per year and to deploy at least 1,000MW of solar thermal power generation with an overall aim of making solar energy competitive with fossil-based energy) (Climate Home, 2013)
- The National Mission for Enhanced Energy Efficiency, the National Mission for a Green India (focused on increasing forest cover)(Climate Home, 2013)
- The National Mission for Sustaining the Himalayan Ecosystem to help protect India's water supply. (Climate Home, 2013)

More recently, India approved its 12th Five Year Plan (2012-2017) which includes a target for growth of 8.2% over the period. The Plan makes clear that high growth requires growth in energy and that the government must take steps to reduce the energy intensity of production processes and to increase domestic energy sources. Again, it is important to note that, beyond the scope of the GLOBE study, many States in India are preparing (and some have already launched) state-level Action Plans on Climate Change. (Climate Home, 2013)

7.3.1.2 National Electricity Plan/2012

The Plan's 4th chapter deals with initiatives and measures for GHG mitigation, and aims to keep CO₂ intensity declining while massively expanding rural access and increasing power generation to meet the demands of a rapidly growing economy. (Climate Home, 2013)

7.3.1.3 Post-Copenhagen domestic actions/2010

On 10 May 2010, India released its Greenhouse Gas (GHG) Emissions Inventory for 2007, with the aim of enabling informed decision-making and to ensure transparency. India has become the first "non-Annex I" (i.e. developing) country to publish such updated numbers. (Climate Home, 2013)

7.3.1.4 Tariff Policy/2006

Under the Electricity Act 2003 and the National Tariff Policy 2006, the central and the state electricity regulatory commissions must purchase a certain percentage of grid-based power from renewable sources. (Climate Home, 2013)

7.3.1.5 Environmental Laws:

In India, a number of legislations have been adopted to preserve the environment which in turn serves as measures against climate change. The Indian judiciary has in fact managed to increase the ambit of Article 21 of the Indian Constitution through various judicial pronouncements in order to include the right to a healthy and clean environment as a fundamental human right under Right to Life. A judicial pronouncement by the Supreme Court of India in this regard has been:

Subhas Kumar versus State of Bihar - where the Court observed that the right to life guaranteed by Article 21 includes the right to pollution-free water and air and therefore the right to a wholesome environment to live in. Apart from this, various legislations enacted for environmental protection are:

- The Environment Protection Act(1986)- with the primary objective of protection and improvement of the environment
- Air Prevention and Control of Pollution Act (1981)- to prevent the release of particular matters like Lead, CO, SO₂, NO and other toxic substances beyond a certain prescribed level into the air.
- Water Prevention and Control of Pollution Act (1974) - The main objective is to provide for prevention control and abatement of water pollution and the maintenance or restoration of the pureness of water.
- National Forest Policy (1988) - All of these measures have all contributed in their own ways to reverse the effects of Climate change.

7.3.2 Schemes Run by Municipal Corporation of Greater Mumbai (MCGM)

7.3.2.1 Slum Adoption Scheme

Community-based organizations and public participation was leveraged for this scheme. When it was realized that the heterogeneous populations lacked incentive to be more hygienic and keep the slums clean. MCGM identified this problem and gave birth to the Slum Adoption Scheme.

7.3.3 Initiatives

7.3.3.1 Advanced Locality Management

Advanced Locality Management (ALM) is local management of solid waste by citizens who organize themselves to manage their waste. Organization of the community, training and initiation is done jointly by residents and MCGM, and is initially funded by residents and the Corporation. At later stages, the activities are completely funded by the residents. The residents are expected to segregate the waste at the household level and the composting is done at the local level. There are in all 643 ALMs along with 276 vermicomposting pits spread over six zones of

the MCGM's jurisdiction. This prevents approximately 20-25tonnes of garbage per day from reaching the dump yards. The MCGM has also established vermicomposting projects on its own, to demonstrate to the citizens the benefits of vermiculture technology.

7.3.3.2 Recycling Debris

Debris is recycled to make new construction-related products like bricks, interlocking pavers. City and Industrial Development Corporation (CIDCO) and YUVA, an NGO, have collaborated on this effort to convert the debris and reduce the load on dumping grounds. Presently, the plant in Navi Mumbai converts three tons of debris per day. Set up in 1999, this plant is one of its kind in the whole of India and has been successful in developing products conforming to Indian Standard Codes of practice of the Central Government. The plant has successfully completed recycling 1,000 tons of debris till date.

7.3.3.3 Upliftment of the ragpicker children and women

Parisar Vikas Scheme Stree Mukti Sanghatana, an NGO, has initiated a scheme which focuses on uplifting the most downtrodden section of the society - the ragpicker women and children. This scheme is an ideal solution, since rag pickers together with the ALM system manage the upkeep of their environment. The rag pickers play an important role in managing the solid waste; they retrieve all possible recyclable items from waste and, thus, put these materials back to proper reuse. (Davis, n.d.)

8.0 Recommendations

With the legislation and action plan programs being mentioned, a dearth of measures that might have immediate results on the planet and the people have been observed. "Where there is a will, there is a way" and that is the way it should be. With that being said, there could be simple measures that the people and the government officials could undertake hand in hand.

8.1 Residents' investment

The 3 “Rs” being taught to and followed by all residents is the first step to any difference.

- Reduce

As the budget of the Municipal Corporation indicates, as much as 28% is spent only on transportation of waste. There is an urgent need to reduce the waste by cutting down on transportation. The reduction of waste can happen only when as citizens of Mumbai, everyone reduces waste generation in the first place.

- Reuse

Simple habits like carrying a cloth bag while going shopping will be helpful to reduce the need for plastic bags. Not buying any products in a polythene bag could help the environment as a whole.

- Recycle

To recycle, one should segregate one's garbage at source. Wet garbage can be recycled by composting or vermicomposting in your backyard or in the vicinity. This would produce good manure that could be used for gardens and lawns. The dry garbage can be given to the rag pickers who sell it to re-users. (Davis, n.d.)

8.2 Preventing deforestation

To maintain and regulate climatic temperatures & reduce the risk of landslides, trees play a significant role. A number of activists like Sundarlal Bahuguna, Medha Patkar have started with Chipko Movement and Narmada Bachao Andolan that directly or indirectly prevents deforestation. It becomes even more important in a city like Mumbai since it is home to the Aarey forest that has been under constant threat since the urbanization of the city began. This threat has become even more immediate with the metro project underway. It won't only harm the environment if the metro project is given a green light but it will also uproot the lives of several tribal slum dwellers that have lived in the jungles of Aarey even before Mumbai as a city existed.

8.3 Proper waste disposal

Proper waste disposal from factories and other manufacturing industries prevent water pollution which in turn helps in regulating the climatic temperatures. In case of household wastes, disposing them properly helps in the regular flow of canals and prevents plastic clogging

in the drains and gutters. Maintaining these drainage systems prevents overflow during rains and safeguards the health of all citizens.

8.4 Setting up formal structures and resources for Solid Waste Management

It is imperative that the authorities recognize the informal recycling industry in Mumbai and facilitate its functioning. Not only that, authorities also need to accept their shortcomings in terms of Solid Waste collection from the slums and set up a more accessible and hygienic structure for these communities to be able to live in better conditions. A step as small as this could have a massive impact since it will reduce the slum dwellers' exposure to several physical ailments.

9.0 Conclusion

"We deserve a safe future. And we demand a safe future. Is that really too much to ask?" asks Greta Thunberg at the Global Climate Strike, New York, 20 September 2019 (Greta Thunberg Quotes: 10 Famous Lines from Teen Activist - CBBC Newsround, 2019). And it indeed becomes thought-provoking and calls for immediate action in unity, with the urge. And with the Black Summer across Australia, burning more than 18.626 million hectares (46.03 million acres) of land (as of reports till 14 January 2020) it is time for all to mourn. The planet is burning- suffering like never before. The people across countries are enraged. The time is now, for action. "No one is too small to make a difference".(Greta Thunberg Quotes: 10 Famous Lines from Teen Activist - CBBC Newsround, 2019) A study done by Youth for Unity and Voluntary Action (YUVA) in 1998, covering 100 communities in the slum pocket of Jogeshwari (East), found that while residents were aware of the problems related to inadequate practices of household disposal of waste and systems of collection and transportation of garbage in the community, there was very little community involvement in solving the problem. Therefore, the prime need of the hour is both awareness and action.

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